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Basement Impact Assessment Report
Stages 3 & 4 (Site Investigation/Impact Assessment)

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

Site: 36 Redington Road, London NW3

Client: Mill Hill Properties Ltd

Report Date: May 2015

Project Reference: J11894Rev01

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SUMMARY

The site comprises a two-storey semi detached property with front and rear gardens. It is proposed to redevelop the site with a new three-storey residential property including a single level basement. The footprint of the new building will be slightly bigger than the existing above ground, but extends out below the existing front and rear garden areas.

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

A single phase of intrusive investigation was carried out.

The soils encountered comprised superficial made ground over sandy clays presumed to be Claygate Member over London Clay at around 5m depth.

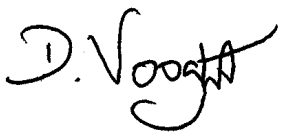
Groundwater levels appear to be shallow, and influenced by the higher permeability of the overlying Claygate Member soils.

The sulphate content of the fill and natural soil was found to fall within Class DS-3. The ACEC classification for the site is AC-3.

The development includes a basement which is anticipated to be constructed using bored pile walls. Parameters for retaining wall design are given.

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

Assessments of the impact of the proposed basement in relation to groundwater and ground movements have been undertaken and these indicate very small changes are likely to occur which should have little effect on neighbouring properties.



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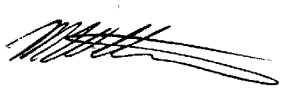

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For and on behalf of Southern Testing Laboratories Limited

STL: J11894
27 May 2015

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A STAGE 3 SITE INVESTIGATION

1 Authority

Our authority for carrying out this work is contained in an STL Order from Mr M Parvardin of Archetype Associates Ltd. Completed on behalf of Abbey Property, dated 26th June 2014.

2 Location

The site is located in a residential road about 0.6 km to the northwest of Hampstead Underground Station. The approximate National Grid Reference of the site is TQ 257 859.

3 Proposed Construction

It is proposed to redevelop the site with a new three-storey residential property including a single level basement. The footprint of the new building will be slightly bigger than the existing above ground, but extends out below the existing front and rear garden areas.

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

4 Object

The object of the investigation was to assess foundation bearing conditions and other soil parameters relevant to the proposed development. An initial Basement Impact Assessment (Stages 1&2 Screening/Scoping) exercise was undertaken and this report addresses some of the relevant issues that came out of that work.

5 Scope

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

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

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

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

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

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

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

B DESK STUDY & WALKOVER SURVEY

6 Desk Study

A desk study has been carried out. Reference has been made to the following information sources.

- Geological Maps
- Online Historical Ordnance Survey Maps
- Environment Agency website
- Camden Borough Council website
- Bomb Maps
- BRE Radon Atlas[4]

The environmental databases search report compiled for this desk study contains site-specific environmental data drawn from data sets that comprise publicly available information together with data from third parties, some of which is under review. Accordingly, Southern Testing Laboratories Limited does not warrant its accuracy, reliability or completeness.

6.1 Geology

The British Geological Survey Map No 256 indicates that the site geology consists of Claygate Member overlying London Clay. The overlying Bagshot Formation outcrops approximately 200m to the northeast.

Bagshot Formation

This formation consists of fine white, buff and crimson sands with occasional seams of pipe clay, silt, and local beds of flint gravel.

The Beds are usually 30-45m in thickness and often have a band of flint pebbles at the base. There is a basal layer of mottled loams and clay, with subordinate amounts of reddish sand that resembles the Reading Beds. The clays are succeeded by more sandy, locally pebbly, yellow or gold coloured strata. These beds produce a marked feature above the loam, and sometimes have been taken as the junction with the underlying London Clay.

Claygate Member

The Claygate Member of the London Clay formation comprises sandy transition beds, about 15 m thick, at the top of the London Clay and consists of alternations of sand and clay. Sand predominates above, and clay below. They were commonly worked for brick making.

[4] BR 211 (2007) 'Radon: guidance on protective measures for new buildings'

London Clay

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

6.2 Hydrology and Hydrogeology

Data from the Environment Agency and other information relating to controlled waters is summarised below.

Data		Remarks	Possible Hazard to/from Site Y/N
Aquifer Designation	Superficial Deposits	No superficial Deposits present.	N
	Bedrock	Secondary A aquifer, relating to the Bagshot Formation and Claygate Member. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers	Y
Groundwater Vulnerability		Minor Aquifer High.	Y
Abstractions		The site on the EA website on 8th August 2014 does not show any abstractions within the area.	N
Source Protection Zones		The site on the EA website on 8th August 2014 is not shown within an area mapped as overlying a SPZ.	N
Surface Water Features		The nearest feature is a pond on Hampstead heath some 550m to the northeast.	N
Marine/Fluvial Flood Risk		The site on the EA website on 8th August 2014 is not shown within an area mapped as being at risk.	N
Surface Water Flood Risk		The site on the EA website on 8th August 2014 is shown within an area mapped as being at low to high risk.	Y
Reservoir Flood Risk		The site on the EA website on 8th August 2014 is not shown within an area mapped as being at risk.	N

The greatest risk from any onsite contamination is to the underlying minor aquifer. Additionally the site would appear to be at potential risk from surface flooding (also highlighted in BIA Stage 1 screening/exercise); this could be evaluated by a site-specific surface water flood risk assessment.

6.3 Historical Map Search

A viewing of publicly available (online) historical Ordnance Survey maps indicates that the site was undeveloped until around 1900 when it became part of the garden for a large house in Templewood Avenue. The site appears to have remained garden until sometime after 1954 when a pair of semi-detached houses were constructed, the south-eastern of which comprises this site.

6.4 Other Sources

Camden Borough Council's planning website indicates that the planning application for the subject property as part of semi-detached houses was passed in 1955. Since that time the property has had permission for two single-storey extensions to be added.

With reference to The London County Council 'Bomb Damage Maps 1939-1945', this site was not subject to damage during WWII.

6.5 Radon Risk

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

7 Walkover Survey

A walkover survey was carried out on 9th July 2014.

7.1 General Description

The site is a rough rectangular shape with a width of around 10 to 15m and some 40m in depth from the frontage. The existing two-storey semi detached house has a single-storey extension and garage to the side, taking up the entire width of the plot. The rear garden area is set to lawn with a couple of fruit(?) trees, the front garden area is again lawn with a concrete driveway and path. There is an established hedge at the front and forming the boundaries to the rear garden. There are a number of mature trees along the eastern boundary.

Immediately to the west the other half of the semi-detached house has been redeveloped with a three-storey building with basements both to the front and rear of the building. In the immediate area around this site the buildings are almost entirely detached residential properties of varying sizes.

In terms of topography, the site is relatively level, with a slight slope to the east. In the immediate area, looking along the roads, the area slopes down slightly to the junction with Heath Rise just to the east, which is located in the base of a shallow valley features itself sloping from north to south.

C SITE INVESTIGATION

11 Method

The strategy adopted for the intrusive investigation comprised the following:

- 2 No 20m deep boreholes were drilled using a light percussion, 150mm diameter, breakdown shell and auger boring rig.

- 2 shallow hand excavated trial trenches were dug to examine the presence of tree roots as per specification from the project arboriculturalist.

Exploratory hole locations are shown in Figure 1 in Appendix A. Subsequently variable head permeability tests were undertaken within the shallow Claygate Member deposits.

12 Weather Conditions

The fieldwork was carried out between 15th July and 23rd July 2014, at which time the weather was generally dry and sunny.

13 Soils as Found

The soils encountered are described in detail in the attached exploratory hole logs (Appendix A), but in general comprised a thin covering of made ground over sandy clays (assumed to represent the Claygate Member) over London Clay. A summary is given below.

Depth	Thickness	Soil Type	Description
GL to 0.7m	0.7m	Made Ground	Dark brown to brown silty sandy CLAY with occasional to frequent brick, ash and concrete fragments.
0.7 to 5.1/5.2m	4.5/4.6m	Claygate Member	Variable firm pale brown to brown and bluish grey silty sometimes slightly sandy CLAY. Some more gravelly or clayey fine SANDS are also present.
5.1/5.2 to 20m+	Thickness unproven	London Clay	Firm to stiff /high strength dark brown to grey silty CLAY.

13.1 Visual and Olfactory Evidence of Contamination

No obvious evidence of possible contamination was recorded during the fieldwork other than the presence of superficial made ground; which can contain elevated levels of some contaminants.

14 Groundwater Strikes

Water was struck in the exploratory holes as follows:

BH	Water Strikes
BH1	Groundwater strike at 2.7m depth.
BH2	No groundwater strikes were made.

The shallow trenches were dry.

D FIELD TESTING AND SAMPLING

The following in-situ test and sampling methods were employed. Descriptions are given in Appendix B together with the test results.

- Disturbed samples;
- Open Drive U100 samples;
- Standard Penetration Tests;
- Hand Penetrometer tests.

E GEOTECHNICAL LABORATORY TESTS

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

- Moisture content & Atterberg Limit determinations;
- Soluble sulphate & pH value determinations;
- Undrained Triaxial tests.

F CONCEPTUAL GROUND MODEL

A conceptual site model has been derived for this site, which is illustrated in Figure 4 included in Appendix A. The neighbouring properties are shown, namely the adjacent No. 38 Redington Road; which will share a party wall and No. 7 Redington Gardens to the east. The foundations for No. 7 Redington Gardens are approximately 5m from the nearest part of the proposed basement. The highway boundary with Redington Road is within 1m or so with the proposed basement wall.

Analysis of ground movements in relation to the neighbouring properties is included within section H.

G DISCUSSION OF GEOTECHNICAL TEST RESULTS AND RECOMMENDATIONS

15 Soil Classification and Properties

Soil Type	Depth	Compressibility	VCP	Permeability	Frost Susceptible	CBR	Remarks
Made Ground	GL to 0.7m	Potentially high	N/A	Variable	Potentially	Poor	Not suitable for foundations
Claygate Member	0.7 to 5.1/5.25m	Low to moderate	Medium	Low generally, but better in the upper more sandy layers	Potentially	Poor	Seepages in the shallow more sandy layers probable.
London Clay	5.1/5.2m +	Low to moderate	High	Low generally	No	Poor	Seepages on fissures possible

16 Swelling and Shrinkage

The results of the Atterberg Limit determinations for the soils on this site indicate that NHBC High Volume Change Condition precautions should be adopted. Any foundations for the proposals are generally to a depth beyond where shrinkage and swelling effects will be noted. However given the very close presence to the proposed structure to existing mature trees, especially along the eastern boundary, the Engineer should check their influence using guidance within NHBC Chapter 4.2 and make sure that the design caters for the potential effects of lateral pressure/heave from the trees in the future.

17 Groundwater Levels

Groundwater levels vary considerably from season to season and year to year, often rising close to the ground surface in wet or winter weather, and falling in periods of drought. Long-term monitoring from boreholes or standpipes is required to assess the ground water regime and this has not been possible during the course of this site investigation.

While siteworks were in progress, a groundwater entry in the more permeable shallow materials was noted, with no significant entries being recorded in the lower London Clay.

The groundwater monitoring visits to date have measured standing water levels within BH1 at between 1.04 -1.11m BGL and 0.97 - 8.82m BGL in BH2. These observations probably reflect the perched groundwater levels within the shallow Claygate Member deposits.

Measurements of standing water levels for the boreholes indicate that there is a hydraulic gradient from the rear garden to the front, although the exact direction of fall is not able to be determined with just two data points. The relatively long and narrow nature of the site along with the existing structures makes locating a third groundwater monitoring point difficult to achieve good information especially within the more sandy materials. Our measured permeability results along with estimations made for particle size distribution curves, indicate permeabilities with the range of $1x10^{-5}$-$1x10^{-7}$ for the most permeable sandy materials.

On the basis of the measurements to date, groundwater ingress should be anticipated from the upper sandy layers within the Claygate Member. The use of secant piled walls will mean that this should not be a significant issue during construction, however if contiguous piled walls are employed, then some form of dewatering will need to be allowed for, to control water inflows and prevent potential loss of material from between the piles. In the short-term very local lowering of the watertable within the Claygate Member may occur where pumping methods are employed.

For the longer term condition, where secant piled walls are not used, seepage entries from fissure flow within the clays and from within the sandy clays should be allowed for in the design of the basement area e.g. provision of drainage cavity/tanking, and also for hydrostatic uplift of the floor slab. Equilibrium standing water levels should be anticipated at around 1m BGL.

Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10^{-9} m/s and 1x 10^{-14} m/s, with an even lower vertical permeability. The Claygate Member will have slightly higher permeability values, but, the overall groundwater flow rate is anticipated to be very low.

Any groundwater flows that take place will likely follow the local topography which in this instance is very gently to the south and southwest, in line with the measured observations within the groundwater wells. Given the slight topography and hence negligible hydraulic gradient, and the generally very low permeability nature of the underlying clays, there is a very low risk of the proposed basement walls causing a "damming effect" or mounding of water on the upstream faces. It is also noted that on the upstream side of this proposal is a recently constructed two-level basement.

Effects of the construction of the basement on groundwater are further explored within the Stage 4 Impact Assessment section of this report.

18 Sulphates and Acidity

The recorded pH values within the natural soils are in the range 6.3 to 8.0, being generally mildly alkaline in reaction. The made ground samples indicated similar mildly alkaline results.

The Design Sulphate Class is DS-3. Groundwater should be assumed to be mobile due to the recorded shallow seepage into BH1. The ACEC site classification is AC-3.

19 Bearing Capacity & Foundations

Given the proposals include for the construction of a single-level basement as part of the new dwelling and the fact that the proposed footprint will be close to the front and eastern boundary and abutting the recently constructed basement to the west, it is assumed that a contiguous or secant piled wall construction would be used. The design of the structure is likely to allow for long-term propping of the walls by the floorslabs. It would also be anticipated that the main loadings of the building will be supported on nominated piles along the walls and piles within the main footprint. It is understood that the adjacent building at 38 Redington Road was designed with contiguous piled walls.

At the anticipated formation level of around 3.5m BGL, the base of the excavation and basement floors will be formed within the firm more clayey part of the Claygate Member. For any foundations proposed at this depth a net allowable bearing pressure of 80 kPa would be available. Excavation of the basement will result in soil unloading and associated unload displacements within the clay soils, both immediate and long-term in nature. Heave precautions will be required in the design of the basement slab. Ground movements are further explored within the Stage 4 Impact Assessment section.

19.1 Piling

If secant or contiguous bored piles are to be installed as part of the basement construction, as with any piling scheme, discussions should be held with selected piling contractors to discuss the technical and financial merits of their various systems and overall resources, with respect to equipment available for the soils described and anticipated, to achieve the depths and diameters considered with an adequate safety margin.

From the viewpoint of pile type, and given the close proximity of adjacent structures, a bored pile solution is considered to be a more appropriate pile type. In terms of bored piles and, noting the presence of potentially unstable soils (sandy clays), and the potential presence of perched groundwater, a continuous flight auger grout injected pile (CFA) would be best suited to the ground conditions encountered. Careful monitoring during construction of these pile types is, however, required. The site history is unknown however it should be noted that subsurface obstructions could be encountered in the form of old foundations, drain runs etc. accordingly allowances for their removal/breaking out should be made when carrying out piling works and excavations.

Within the Claygate Member/London Clay the design of piles is typically based on a cohesive model using a plot of undrained cohesion versus depth derived from both SPT results and triaxial tests. The equivalence factor for SPT to undrained cohesion was chosen as $f_1 = 4.5$. The plot of results from the boreholes is appended as figure P1 on which a suggested design line is indicated. Capacities could be calculated using the following crude soil model:

0- 1m depth: made ground (no contribution to the pile capacity)

1 – 5.2m depth: Claygate Member with cohesion profile as shown in figure P1.

5.2 - 20m depth: London Clay with cohesion profile as shown in figure P1.

Given that a basement level of around 3.5m bgl is proposed, skin friction over this depth should be ignored.

If second bored pile walls are considered, this will provide an effective solution against the risk of soil loss into any excavation, especially within the upper more sandy materials. This will be most important along the southwestern wall, very close to the highway boundary and along the southeastern wall adjacent to the existing trees and 7 Redington Gardens.

In the case of a contiguous bored pile wall solution, this will likely comprise a series of bored piles with a typical gap of approximately 100-150mm between each pile. There is a risk of erosion/migration of very sandy materials from between the gaps in the piles (particularly with the shallow perched groundwater) and therefore some form of dewatering measures along with the use of mesh/sprayed concrete to ensure that no soil erosion/movement takes place from between the pile gaps could be considered. In addition to cater for the permeation of groundwater

through the piled wall and sprayed concrete, a drainage cavity or some other form of waterproofing measures will need to be considered as part of the basement construction.

20 Heave

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

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

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

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

Undrained Poisson Ratio (ν_u) =0.5

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

Drained Poisson Ratio (ν_d) =0.2

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

Calculations for the magnitude of any movements have been undertaken and are contained within the Stage 4 Impact Assessment.

21 Basement Construction

The following soil parameters are suggested for design of retaining walls:

Soil Type	Bulk density γ_b (kN/m^3)	Undrained Shear Strength (Temporary Condition)	Long Term Drained Condition	
			c' (kN/m^2)	φ^o
Made Ground	19	N/A	0	27
Claygate Member	20	See Figure P1	0	27
London Clay	20	See Figure P1	0	25

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

22 Excavations and Trenching

Statutory lateral earth support will be required in all excavations where men must work. Instability of the sides of any open excavations carried out must be expected. Accordingly, measures should be taken at all times to ensure that excavations are adequately supported. If secant piled walls are not used then groundwater seepages into excavations from the upper sandy materials should be anticipated unless dewatering methods are used, until suitable waterproofing measures have been employed.

Given the presence of the existing adjacent foundations, close attention in design of temporary and permanent propping is required at all times to prevent settlement or excessive lateral yielding of the excavation/foundations.

23 Discussion on Waste Disposal

Two samples of shallow made ground and one of the underlying natural soils were sent for chemical testing and a sample of the made ground and one from the natural soils have been subject to Waste Acceptance Criteria testing.

The test results, included within Appendix D, indicate that the made ground and underlying soils are likely to be classified as inert or non-hazardous waste. However, final waste classification is determined by the receiving landfill, so we would suggest that all the results be forwarded to the landfill for their assessment.

H STAGE 4 IMPACT ASSESSMENT

24 Impact of the Proposed Basement in terms of Ground Movement

24.1 Assumptions and model used for the analysis of ground movements

Allowing for thickness of the slab, etc, the formation level of the proposed basement will be about 3.5m below existing site levels. It is proposed to construct the basement by installing contiguous or secant bored piles. The length of the piles is to be determined by the piling contractor, but given a retained height of approximately 3.5m, a length of 11m has been assumed for the purpose of this analysis (as outlined within the structural engineer's 'Method Statement for Subterranean Development'). It is also assumed that, given the adjacent property No. 38 Redington Road was formed using piled foundations with bored pile retaining walls, the construction methodology e.g. propping at high level will take account the type of foundation to this property and the effects of the proposed works will be negligible.

The effect of demolition of the building and excavation of the soil to form the basement will cause a reduction in stress at the new formation level, due to the weight of the soil removed. This unloading of the ground is normally modelled as producing a short-term (undrained) response followed by a longer term (drained) response. The predicted ground response was modelled using the OASYS program PDISP. This program assumes a linear elastic behaviour of the soil and a flexible structure. In reality, the finite stiffness of the structure(s) will tend to redistribute or smooth out the movements, when compared to those predicted by PDISP. The settlement calculations therefore represent free field movements unaffected by the stiffness of the structure(s) and are likely to be conservative (i.e. the distortions of the structure would be less than those obtained from the predicted movements).

For PDISP modelling purposes London Clay was assumed to extend from ground surface to depth. The rigid base for the analysis was taken as 40m BGL. The soil parameters used are presented in section 20 of this report. Site ground level was taken as an arbitrary value of 100m OD, the rigid base for the analysis was taken as 60m OD.

24.2 Movements from demolition & excavation

The current structure has been estimated to apply a loading of approximately 25kPa over its footprint. Demolition and excavation of 3.5m of soil to form the basement will therefore produce an unload at the new formation level of about 90kPa.

A short-term (undrained) analysis was undertaken to determine the heave movements likely to arise as a result of the demolition and excavation. This indicated a maximum undrained heave of about 15mm occurring within the central area of the basement (see Figure U1 included in Appendix F). For the purpose of illustrating the likely heave displacements occurring beneath the neighbouring property, No. 7 Redington Gardens, a displacement line was extended from the nearest corner of the basement excavation towards No. 7 Redington Gardens (Figure LU1). The neighbouring property is located approximately 5m from the corner of the excavation and an undrained heave movement of 1mm is indicated at the nearest corner of No. & Redington Gardens reducing to zero at the furthest side.

The movements of the ground following construction were also analysed for the long-term (drained) case. The analysis was again undertaken for the combination of the unloading due to demolition and excavation of the basement. The PDISP assessment indicates a maximum long-term drained heave of about 23mm occurring within the central area of the basement area (Figure V1). Referring to displacement line plot (Figure LV1) a heave movement of 2.25mm is indicated at the nearest corner of No. 7 Redington Gardens reducing to zero on the furthest side of the property.

It should be noted that the above values of heave given take no account of the effect of the proposed piled retaining wall to restrain vertical movements of the soil. It should also be noted that in practice, the heave movements that develop from unloading the soil do not occur in isolation from other ground movements associated with basement construction and excavation (as discussed below).

24.3 Movements due to pile installation and basement excavation

In addition to the changes in vertical stress caused by demolition of the property and the excavation of the soil to form the basement, the installation of a piled wall, and then the removal of soil from in front of the new walls will also generate both horizontal and vertical movement in the ground. Assessment of the ground movements resulting from the pile installation and the excavation to form the basement has been undertaken with reference to CIRIA guide C580 "Embedded retaining walls – guidance for economic design". This provides guidance on the horizontal and vertical movements of the soil adjacent to an embedded retaining wall as a result of pile installation and of excavation in front of the wall based on numerous case histories, for the case of a high stiffness (propped) retaining wall and a low stiffness (cantilevered) retaining wall. It is assumed that in this instance a high stiffness support system will be applied to support the piled wall.

Estimates of movements due to pile installation and basement excavation using CIRIA guide C580, are based on empirical data. Since such data is likely collected during and soon after construction, it is assumed to include any short term heave element. However, long-term ground movements from changes in vertical stress would likely not have occurred when the measurements of ground movement were made.

24.3.1 Movements due to Pile Installation

Ground movement guidance in C580 is divided into movements resulting from pile installation and from the mass excavation in front of the wall. However, the empirically derived relationship for ground movements resulting from pile installation given in the CIRIA guide is now considered to be overly conservative, since more recent projects have demonstrated that significantly smaller movements can be achieved with good quality workmanship, with negligible horizontal movements caused by pile installation, and vertical movements limited to 0.025% of pile length, and extending no more than 1.5 times the pile length from the pile wall. The length of the proposed contiguous piles has yet to be determined, but a pile length of 11m and has been assumed as the basis to calculate ground movements.

Referring to the displacement line plot (Figure CL1), the effect of the pile installation of a 10 m long piled wall on No. 7 Redington Gardens would be expected to generate 2.5mm of vertical movement (settlement) at the pile wall, with vertical movements reducing linearly with distance from the wall, becoming negligible at a distance of about 15m from the face of the wall. Taking the corner of No. 7 Redington Gardens to be 5 metres from the nearest corner of the basement, a settlement of approximately 1.9mm is predicted at the nearest corner of that property reducing to 0.3mm on the furthest side of the property.

24.3.2 Movements due to Excavation in Front of the Piled Wall

The methodology within C580 indicates that the excavation to create the basement will, for a high stiffness (propped) wall, produce horizontal movements of 0.15% of the excavation depth at the wall, with movements extending to four times the depth of the excavation, while peak vertical movements will be about 0.1% of the excavation depth, with such movements becoming zero at 3.5 times the depth of the excavation. Horizontal movements will decrease in a generally linear fashion with distance from the wall, whereas vertical movements peak at about half the excavation depth from the wall, with movements at the wall being about 0.05% of the excavation depth.

Assuming stiffened corners to the bored pile wall/excavation and referring to the displacement line plot (Figure EL1), the resultant horizontal movement of No. 7 Redington Gardens in towards the corner of the excavation are likely to be about 2.1mm reducing to zero on the furthest side. The predicted vertical settlement of No. 7 Redington Gardens is 1.25mm reducing to zero on the furthest side of the property.

The movements derived from the CIRIA guidance are based on the empirical data within C580. As such, it is assumed that they include any short term element of ground movement due to vertical stress change. However, it is unlikely that the C580 data includes the long-term movements resulting from vertical stress changes. Total ground movements resulting from the proposed development are therefore taken as the sum of the predicted ground movements using C580, plus the difference in estimated PDISP movements between short and long-term conditions.

24.4 Summary of Ground Movements

In summary the cumulative short term effects of the pile installation and bulk excavation indicate that the No. 7 Redington Gardens will experience about 3.15mm of settlement and 2.1mm of horizontal movement on the nearest corner of the property with zero horizontal movements and 0.3mm vertical movement on the furthest side of the property.

As noted previously, it is unlikely that the C580 data includes the long-term movements resulting from vertical stress changes. Therefore total vertical ground movements resulting from the proposed development are taken as the sum of the predicted ground movements using C580, plus the difference in movement between short and long-term, as predicted from the PDISP analysis.

For the long-term drained condition, predicted movements of No. 7 Redington Gardens will be 1.9mm of settlement and 2.1mm horizontal movement on the nearest corner of the property with zero horizontal movements and 0.3mm settlement on the furthest side of the property.

On the basis of the above, the horizontal strain across No. 7 Redington Gardens is estimated to be around 0.021% with deflection ratios of between 0.03% (short term) and 0.017% (long term).

The combination of horizontal and vertical strains for the short-term and long-term conditions therefore suggests a damage category 0 (negligible) as classified within C580 for No. 7 Redington Gardens. The above assumes good quality working practice during pile construction is employed and that appropriate propping of the excavation is maintained at all times.

A formal monitoring system should be employed during construction in order to observe and monitor ground movements, especially in critical areas such as boundaries with neighbouring properties. Monitoring data should be checked against predefined trigger limits to give early indications if any deviating ground movements are occurring.

25 Impact of the Proposed Basement on Groundwater

25.1 Existing Groundwater conditions and assumptions made for the analysis

As noted previously in section 17 the site covers only a small area and is strongly linear. Coupled with the physical constraints of the on-site features, it was not possible to install a third monitoring point such that meaningful triangulation of groundwater head could be achieved.

However, from the general hydrogeological setting of the site, it would be reasonable to assume flow in a southerly direction, obliquely across the site. Such a southerly flow places the proposed development entirely within the 'shadow' of the existing basement beneath No. 38 Redington Road. Under these conditions, the construction of the proposed basement at No. 36 will have no effect on the existing groundwater flow.

Nonetheless, it is conceivable that there may be a more south-westerly component to the groundwater flow, more parallel with the historical course of the Westbourne River that is mapped as following the alignment of Redington Gardens in this locale. If this were the case, and flow were along the length of the site rather than obliquely across it, this would also represent a worst case in terms of potential impact on the movement of groundwater due to the construction of the proposed basement. Accordingly, it was considered useful to assess the potential impact under such circumstances.

For the purposes of the assessment, the following conditions have been assumed:

- Groundwater flow from NE to SW, along the length of the site, normal to the alignment of the rear elevation of the proposed building.
- Groundwater flow is within the relatively more permeable Claygate Beds only.
- The base of the permeable zone is at 3m below ground level.
- The site surface and the base of the aquifer are effectively horizontal within the area of interest.
- The aquifer is homogeneous and isotropic.
- No. 7 Redington Gardens does not have a basement.
- Both the existing basement at No.38 Redington Road and the proposed basement fully penetrate the aquifer.

25.2 Groundwater Model Used

A groundwater model was developed in the Visual Modflow environment. The model comprises a single layer, reflecting the simple stratigraphy of the site. The model was established as a square area, 100m to a side, with an initial grid spacing of 5m, with grid refinement around the existing and proposed structure footprints to give enhanced resolution in the area of greatest interest, see Figure G1 (see Appendix G).

The model was run to a 'steady state' condition to reproduce the measured groundwater levels on site (Figure G2). As can been seen, within this existing condition the groundwater beneath the site shows the influence of the adjacent basement at No. 38 Redington Road.

The model was then run again with the inclusion of the proposed basement as a no-flow zone (Figure G3). The change in groundwater level was visualized as a 'drawdown' from the initial steady state condition. Accordingly, rises in level are denoted as negative, and vice versa. The model was run with two different hydraulic conductivity values, 1E-5m/s and 1E-7m/s, to confirm any groundwater changes over the range of identified permeability values within the more sandy elements of the Claygate Member.

25.3 Results and Conclusions from the Groundwater Analysis

The modelled changes in groundwater level resulting from the construction of the proposed basement are shown as contours in plan, in Figure G4 for 1E-5m/s and in Figure G5 for1E-7m/s. The modelling indicates that a rise in groundwater level of around 2 to 3cm should be anticipated in the vicinity of the 'upstream' face of the basement, with a corresponding fall in level at the 'downstream' face. The change in level declines rapidly with distance from the face of the basement walls, with a rise in level of less than 2cm indicated beneath the nearest part of the neighbouring property to the southeast (No. 7 Redington Gardens). Similar changes in level are indicated against the up and downstream faces of the existing basement beneath No. 38 Redington Road.

In conclusion, the magnitudes of changes to the groundwater level in response to the construction of the proposed basement are negligible. To put this into context such changes would be significantly less than the anticipated annual variation in groundwater levels due to normal hydrogeological affects.

APPENDIX A

Site Plan, Exploratory Hole Logs & Figures

Key to Exploratory Hole Logs

General

All soil and rock descriptions in general accordance with BS5930:1999+A2:2010
Geology Code only entered where positive identification of the sampled strata has been made

Sampling

ES	Environmental Sample (taken in appropriate sampling container)
D	Disturbed Sample
B	Bulk Sample
LB	Large Bulk for Earthworks testing
C	Core Sample
U	Undisturbed Sample (number of blows indicated in results column)
SPTLS	SPT Liner Sampler
P	Piston Sample
W	Water Sample

Insitu Tests

SPT	Standard Penetration Test in accordance with BS EN22476-3:2005
SPT (C)	Cone Penetration Test in accordance with BS EN22476-3:2005
PT	Penetration Test - STL documented equivalent SPT N Value
PPT	Perth Penetration Test - STL in house documented method (N Value)
UCS (⊥)	Unconfined Compressive Strength measure by hand penetrometer (kN/m^2)
IVN	Hand Vane (kPa)
PID	Photo Ionisation Detector Results (ppm)
MEXE	Mexecone CBR Result

Drilling Records (In accordance with BS 5930:1999+A2:2010)

Depth to standing water level	▼
Depth to water strike	▽
TCR	Total Core Recovery (%)
SCR	Solid Core Recovery (%)
RQD	Rock Quality Index (%)
FI	Fracture Index

Backfill Symbols

Arisings
Concrete
Blacktop
Bentonite Seal
Gravel Filter
Sand Filter

Pipe Symbols

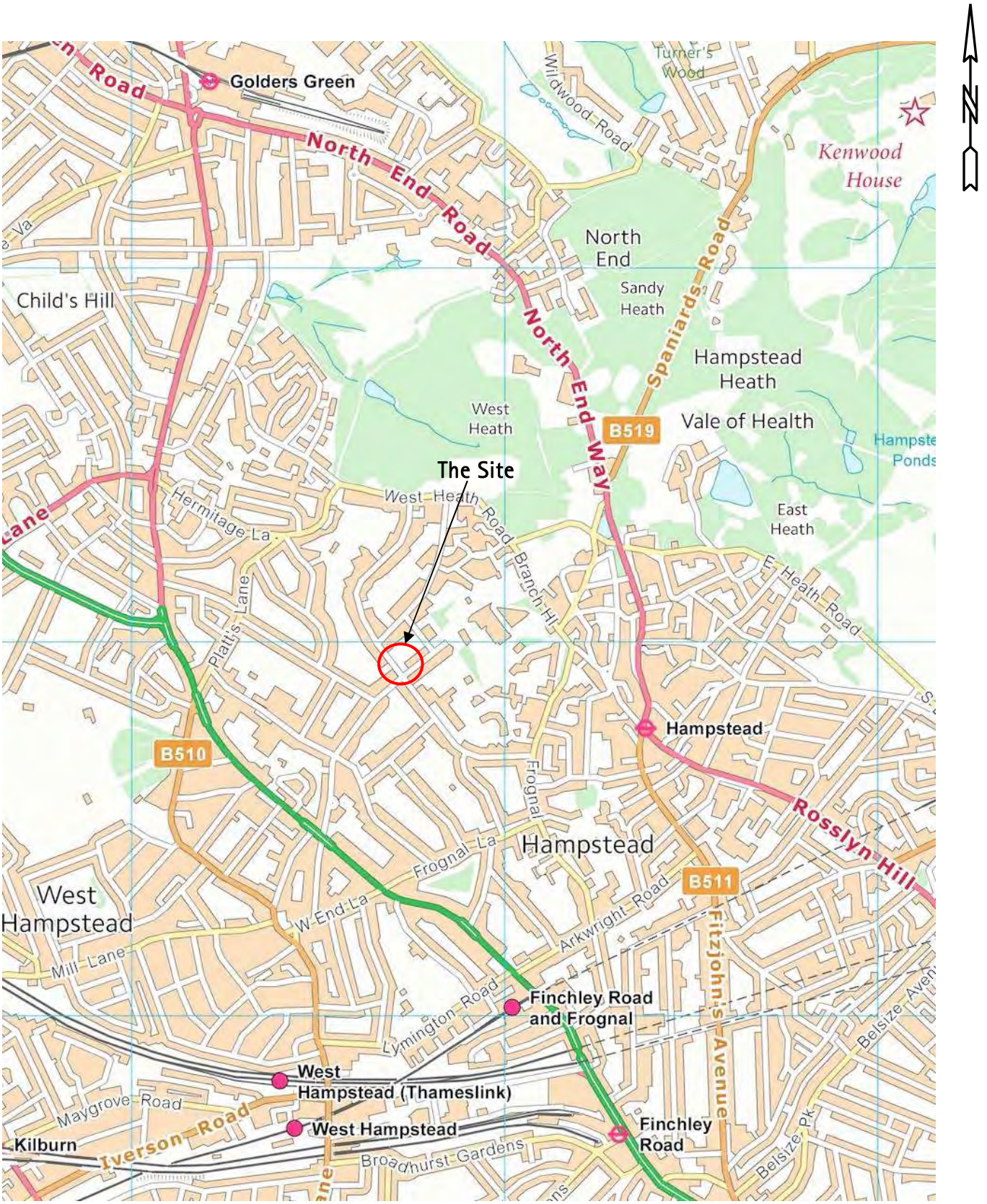
Plain Pipe
Slotted Pipe
Filter Tip

Principal Soil Types

Topsoil
Made Ground
Clay
Silt
Sand
Gravel
Peat

Principal Rock Types

Mudstone/Claystone
Siltstone
Sandstone
Limestone
Chalk

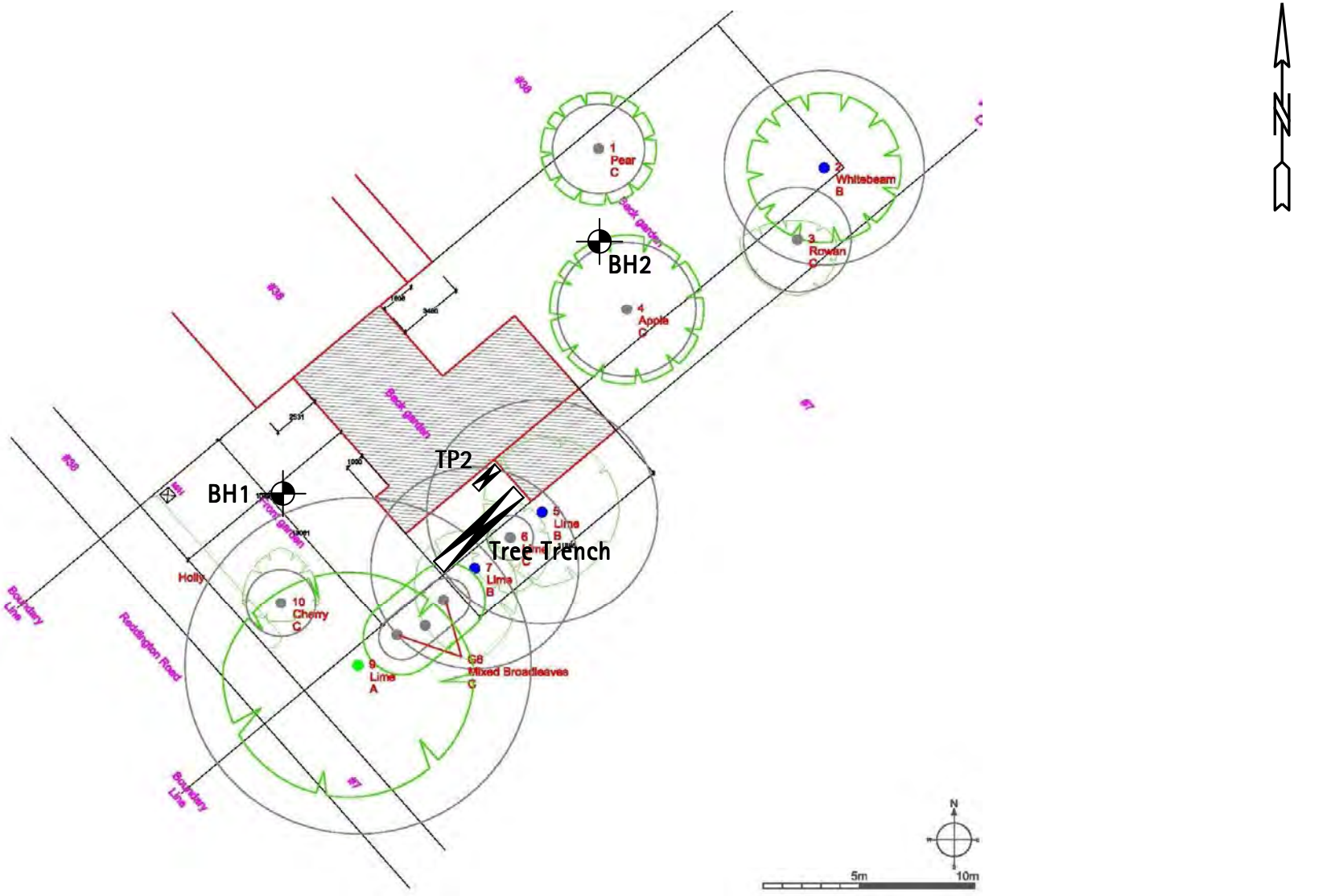


Site: 36 Redington Road, London NW3	STL: J11894	Fig No: 1c
Date: 15 May 2015	Site Location Plan	

Southern Testing

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

ST Consult



NB: Positions of Boreholes and/or Trial Pits are only indicative unless dimensioned

Site: 36 Redington Road, London NW3	STL: J11894	Fig No: 1
Date: 13 August 2014	Fieldwork Location Plan	

Southern Testing

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

ST Consult

Southern Testing | ST Consult

Tel: 01342 333100

Project No.	Hole Type	Borehole No
J11894	Cable	**BH1** Sheet 1 of 1

Project Name: 36 Redington Road (London NW3)

Dates: 15/07/2014-18/07/2014

Location: London NW3

NGR: -

Client: Archetype Associates Ltd

Level: -

Logged By: SM

Well	Water Strikes	Samples & In Situ Testing			Level (m AOD)	Thickness	Legend	Depth (m)	Stratum Description
		Depth (m)	Type	Results					
		0.20	ES			0.70			MADE GROUND brown, silty, sandy, CLAY, with occasional fragments of brick, ash, flint gravel and rootlets.
		0.50	D					0.70	
		1.00		UCS = 110		0.60			Firm, medium strength, yellow brown to pale orange brown, silty, sandy, CLAY.
		1.00	D					1.30	
		1.50	U						Dark greenish grey, slightly clayey, sandy SILT.
		2.00	D			1.60			
	▽	2.10	ES						
		3.00	SPT	N=15				2.90	Firm, medium to high strength, pale brown, slightly sandy, silty, CLAY.
		3.00		UCS = 80					
		3.00	D						
		3.00	SPTLS						
		4.00		UCS = 110		2.20			
		4.00	D						
		4.50		UCS = 250					
		4.50	D						
		4.50	U					5.10	
		5.00		UCS = 240					Firm to stiff, medium to high strength, laminated, dark grey, slightly silty, CLAY.
		5.00	D						
		6.00	SPT	N=15					
		6.00		UCS = 160					
		6.00	D						
		6.00	ES						
		6.00	SPTLS						
		7.00		UCS = 260					
		7.00	D						
		7.50		UCS = 300					
		7.50	D						
		7.50	U						
		8.00		UCS = 150					
		8.00	D						
		9.00	SPT	N=16					
		9.00		UCS = 230					
		9.00	D						
		9.00	SPTLS						
		10.00		UCS = 340					
		10.00	D						
		10.50		UCS = 290					
		10.50	D						
		10.50	U						
		11.00		UCS = 200					
		11.00	D						
		12.00	SPT	N=22		14.90			
		12.00		UCS = 350					
		12.00	D						
		12.00	SPTLS						
		13.00		UCS = 490					
		13.00	D						
		13.50		UCS = 470					
		13.50	D						
		13.50	U						
		14.00		UCS = 460					
		14.00	D						
		15.00	SPT	N=23					
		15.00		UCS = 450					
		15.00	D						
		15.00	SPTLS						
		16.00		UCS = 350					
		16.00	D						
		16.50		UCS = 430					
		16.50	D						
		16.50	U						
		17.00		UCS = 510					
		17.00	D						
		18.00	SPT	N=26					
		18.00		UCS = 410					
		18.00	D						
		18.00	SPTLS						
		19.50		UCS = 510					
		19.50	D						
		19.50	U					20.00	End of Borehole at 20.00 m

	Type	Results

Borehole Details

Casing Depth m bgl	Hole Depth m bgl	Casing Diameter mm
	0.00	

Water Strikes

Date	Water (m)	Casing (m)	Time (mins)	Rose to (m)	Sealed (m)
16/07/2014	2.70	-	-	-	5.00

General Remarks:

Southern Testing | ST Consult

Tel: 01342 333100

Project No.	Hole Type	Borehole No
J11894	Cable	**BH2** Sheet 1 of 1

Project Name: 36 Redington Road (London NW3)

Dates: 21/07/2014-23/07/2014

Location: London NW3

NGR: -

Client: Archetype Associates Ltd

Level: -

Logged By: SM

Well	Water Strikes	Samples & In Situ Testing			Level (m AOD)	Thickness	Legend	Depth (m)	Stratum Description
		Depth (m)	Type	Results					
		0.25	ES			0.70			MADE GROUND composed of dark grey brown, slightly sandy, silty CLAY, with frequent flint gravel, rootlets and occasional fragments of brick and concrete.
		0.50	ES					0.70	
		1.00		UCS = 10					Soft, very low strength, orange brown mottled grey brown, sandy, silty CLAY, with frequent fine to medium, sub-angular to sub-rounded, flint gravel.
		1.00	D						2.00m - 3.00m: Firm and medium strength.
		1.50	SPT	N=6					
		1.50	SPTLS			2.30			
		2.00		UCS = 90					
		2.00	D						
		3.00		UCS = 160				3.00	Firm, medium to high strength, laminated, orange brown mottled blue grey, slightly silty, CLAY.
		3.00	D						
		4.00		UCS = 110		2.20			
		4.00	D						
		4.00	U						
		4.50	SPT	N=15					
		4.50		UCS = 280				5.20	
		4.50	D						Firm to stiff, high strength, laminated, dark brown to grey, CLAY.
		4.50	SPTLS						
		5.00		UCS = 100					
		5.00	D						
		6.00		UCS = 250					
		6.00	D						
		7.00		UCS = 270					
		7.00	D						
		7.00	U						
		7.50	SPT	N=14					
		7.50	SPTLS						
		8.00		UCS = 250					
		8.00	D						
		9.00		UCS = 280					
		9.00	D						
		9.00	U						
		9.50		UCS = 260					
		9.50	D						
		10.00		UCS = 270					
		10.00	D						
		10.50	SPT	N=19					
		10.50	SPTLS						
		11.00		UCS = 280					
		11.00	D						
		12.00		UCS = 400					
		12.00	D						
		12.00	U			14.80			
		12.50		UCS = 380					
		12.50	D						
		13.00		UCS = 330					
		13.00	D						
		13.50	SPT	N=20					
		13.50	SPTLS						
		14.00		UCS = 300					
		14.00	D						
		15.00		UCS = 320					
		15.00	D						
		15.00	U						15.50m - 20.00m: Occasional silty patches.
		15.50		UCS = 200					
		15.50	D						
		16.00		UCS = 270					
		16.00	D						
		16.50	SPT	N=23					
		16.50	SPTLS						
		18.00		UCS = 410					
		18.00	D						
		18.00	U						
		18.50		UCS = 550					
		18.50	D						
		19.00		UCS = 300					
		19.00	D						
		19.50	SPT	N=24					
		19.50	SPTLS					20.00	End of Borehole at 20.00 m
			Type	Results					

Borehole Details

Casing Depth m bgl	Hole Depth m bgl	Casing Diameter mm
	0.00	

Water Strikes

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

General Remarks:

Southern Testing | ST Consult

Tel: 01342 333100

Project No.	Machine Type	Trialpit No
J11894	**Hand Dug**	**TREE TRENCH** Sheet 1 of 1

Project Name: 36 Redington Road (London NW3)

NGR: -

Level: -

Date: 15/07/2014

Location: London NW3

Dimensions: 5.00m

Depth 1.00m

0.60m

Client: Archetype Associates Ltd

Logged By SM

Samples & In Situ Testing			Level (m AOD)	Thickness	Legend	Depth (m)	Stratum Description
Depth (m)	Type	Results					
				0.10		0.10	CONCRETE
				0.20		0.30	MADE GROUND composed of yellow grey, slightly silty, fine to medium SAND, with frequent fragments of brick, concrete, roots and rootlets.
0.50	ES			0.70		1.00	MADE GROUND composed of dark brown, silty, sandy, CLAY, with occasional medium to coarse, sub-angular to sub-rounded, flint gravel and fragments of brick and ash.
							Trial Pit Complete at 1.00 m

Remarks: Root inspection trench

Pit Stability: Stable

Groundwater: Dry

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

Southern Testing | ST Consult

Tel: 01342 333100

Project No.	Machine Type	Trialpit No
J11894	**Hand Dug**	**TP2** Sheet 1 of 1

Project Name: 36 Redington Road (London NW3)

NGR: -

Level: -

Date: 16/07/2014

Location: London NW3

Dimensions: 1.00m

Depth 0.40m

0.50m

Client: Archetype Associates Ltd

Logged By SM

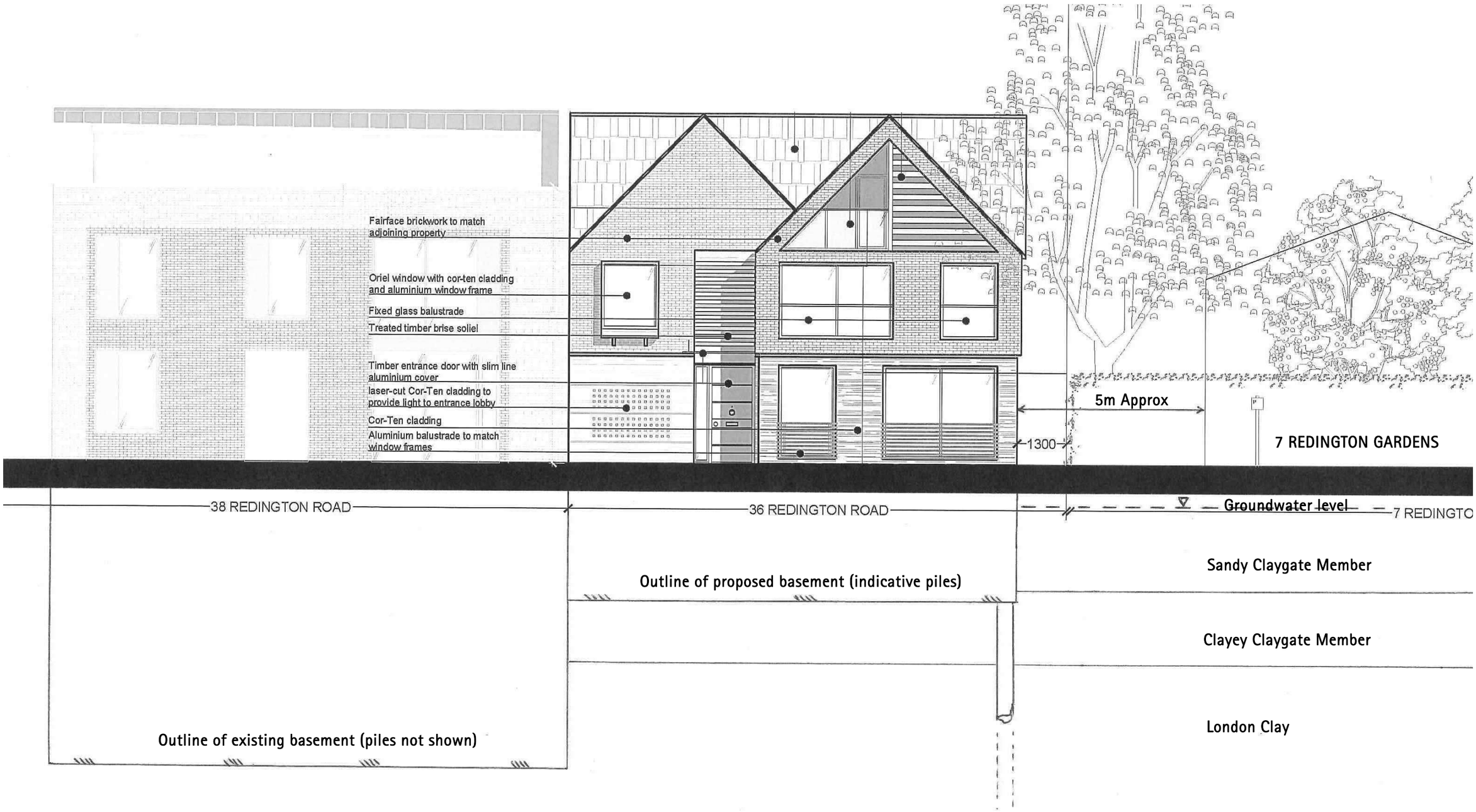
Samples & In Situ Testing			Level (m AOD)	Thickness	Legend	Depth (m)	Stratum Description
Depth (m)	Type	Results					
				0.10		0.10	CONCRETE
				0.30		0.40	MADE GROUND composed of yellow grey, silty, fine to medium SAND, with frequent fragments of brick, ceramic, concrete, roots and rootlets.
							Trial Pit Complete at 0.40 m

Remarks: Root inspection trench. Concrete obstruction at 0.4m

Pit Stability: Stable

Groundwater: Dry

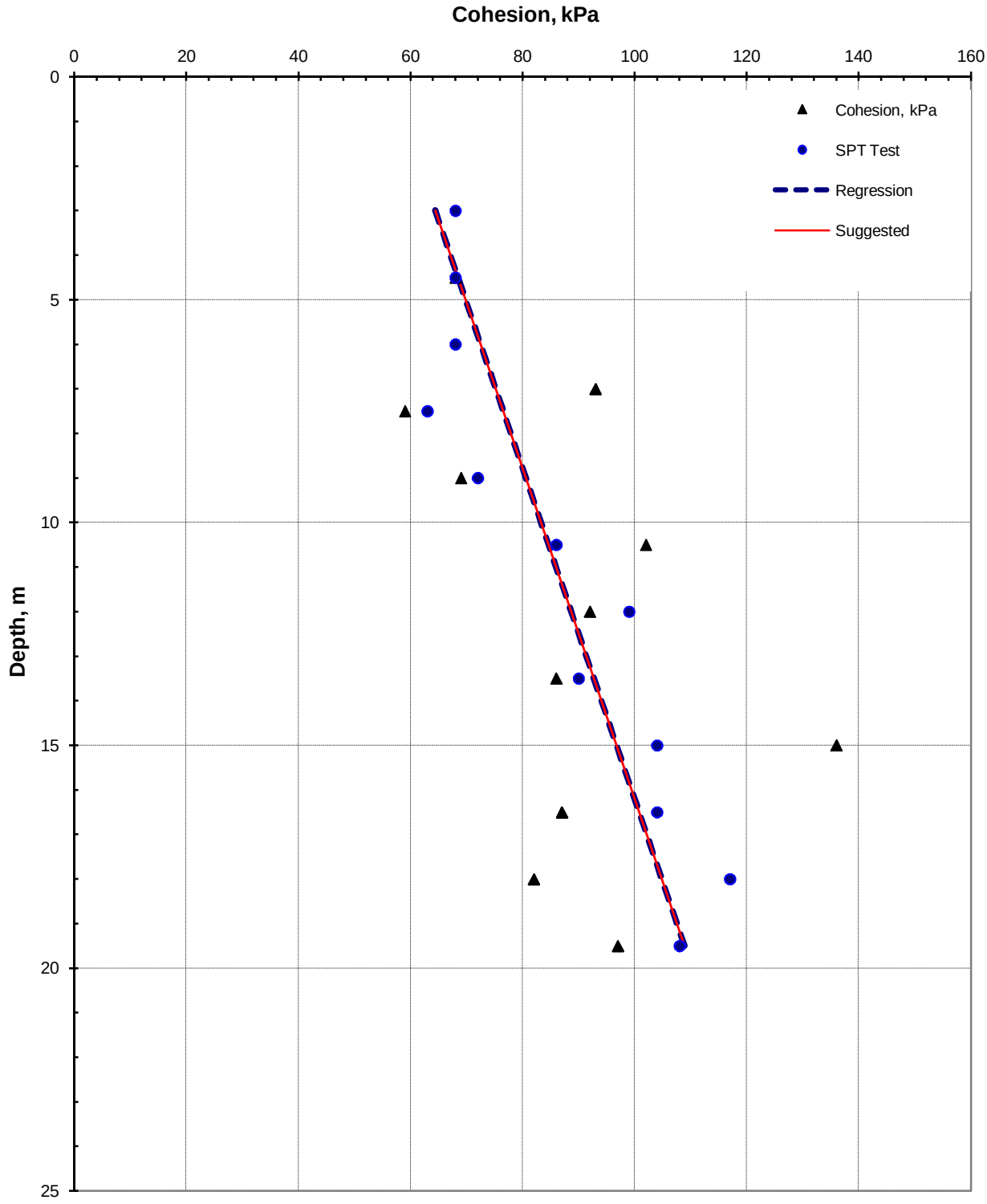
PPT = Perth Penetration Test 'N' Value , UCS = Unconfined Compressive Strength (kN/m2) by Hand Penetrometer, HV= Hand Vane Result (kPa)



Site: 36 Redington Road, London NW3	STL: J11894	Fig No: 4
Date: 26 May 2015	Conceptual Ground Model	

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

Plot of Cohesion vs Depth



Linear Regression of the Test Results: *Slope =* 2.7 *kPa/m,* *Zero intercept =* 56.3 *kPa*

Suggested Design Line: *Slope =* 2.7 *kPa/m,* *Zero intercept =* 56.3 *kPa*

Client: Mr Zolf	**Site:** 36 Redington Road, London NW3	
Job No: J11894	**Date:** 13/08/2014	**Figure No: P1**

APPENDIX B

Field Sampling and in-situ Test Methods & Results

Field Sampling and in-situ Test Methods

Disturbed Samples

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

Open Drive U100 Samples

U100 samples were taken in the clay soils at appropriate intervals. These samples are taken in a 100 mm diameter, 450 mm long, thin-walled steel tube, and are sealed with paraffin wax and tightly fitting end caps for transporting to the laboratory.

Standard Penetration Test

The Standard Penetration (SPT) Test is specified in BS EN ISO 22476-3 : 2005. In this test, a 51mm diameter open-ended tube is driven into the ground by a 63.5 kg hammer falling freely through 760 mm. The tube is seated by driving to a penetration of 150mm, or by 25 standard blows, whichever occurs first. It is then driven for a maximum of a further 300mm and the number of blows is termed the penetration resistance (N). If 300mm penetration cannot be achieved in 50 blows (100 blows in soft rock), the test drive is terminated.

When testing in gravels, a conical end piece is attached to the tube. The test is then called an SPT(C).

This test provides an indirect method of assessing the properties of cohesionless soils, and the following table (after Terzaghi and Peck) gives the approximate condition:-

Number Blows (N)	Density
0 - 4	Very Loose
4 – 10	Loose
10 – 30	Medium Dense
30 – 50	Dense
Over 50	Very Dense

Clay

An approximate value for the shear strength of clay may be obtained using Stroud (1974), which paper indicates that the cohesive strength is a function of plasticity and SPT 'N' value. The relation is:

C_u = f_i x N kPa

C_u = undrained shear strength

f_i = factor related to plasticity index and ranging from 4 to more than 6

The SPT test is not generally accepted as giving a reliable indication of the strength of cohesive soils but it does give a guide; often the following table:-

Number Blows (N)	Soil Strength
Less than 2	Very Soft (Very Low Strength)
2 – 5	Soft (Low Strength)
5 – 10	Firm (Medium Strength)
10 – 15	Stiff (High Strength)
15 – 30	Very Stiff (Very High Strength)

Hand Penetrometer Test

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

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

Results for Borehole Permeability Test -- Variable Head

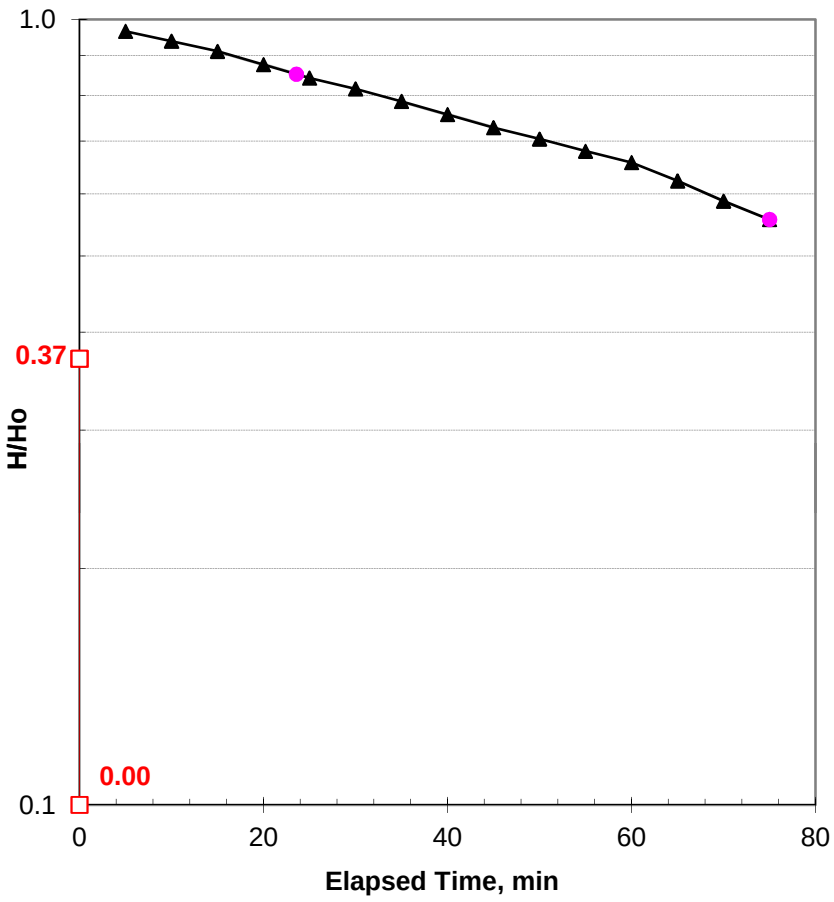
in accordance with BS 5930:1999, Section 25.4

Test Hole No : BH2

Test No : 1

Test Type : Rising head test

Plot to Determine Basic Time Factor (T)



Elapsed Time, min	Water Level, mbgl	H/Ho
5.000	2.900	0.967
10.000	2.817	0.939
15.000	2.734	0.911
20.000	2.630	0.877
25.000	2.528	0.843
30.000	2.449	0.816
35.000	2.361	0.787
40.000	2.272	0.757
45.000	2.186	0.729
50.000	2.114	0.705
55.000	2.040	0.680
60.000	1.973	0.658
65.000	1.870	0.623
70.000	1.762	0.587
75.000	1.670	0.557

Depth to Borehole Base, mbgl : 3.000
Depth to Casing End, mbgl : 1.000
Borehole Diameter Below Casing, m :
Internal Casing Diameter, m :
Depth to Intial Groundwater, mbgl :
Piezometer Installation : Without piezometer
Standpipe/Piezo Diameter, m : N/A
Cell Diameter, m : N/A
Depth to Top of Cell, m : N/A
Depth to Bottom of Cell, m : N/A
Intake Condition : d) Well point or hole extended in uniform soil

Length (L), m : 2.000
Effective Diameter (D), m : 0.080
Intake Factor (F) : 3.212
Depth of Water Level at Start, mbgl : 0.970
Head at Start of Test (Ho), m : 3.000
Basic Time Factor (T), min : N/A
Permeability by Time Lag Analysis, m/sec : N/A
Permeability by General Approach, m/sec : 2.2E-07

Remarks : Test in upper most permeable soils

Client:	Mill Hill Properties Ltd	**Job No:**	J11894	**Test Date:**	01/Apr/2015	
Site:	36 Redington Road, London NW3	**Tested By:**	JNR/HC	**Engineer:**	JNR	**Fig. P2**

APPENDIX C

Geotechnical Laboratory Test References & Results

Southern Testing | ST Consult

Atterberg and Moisture Content Summary

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

AGS

Project Name	36 Redington Road (London NW3)			Project Number	J11894
Client	Archetype Associates Ltd	PE	JNR	Date Issued	12-Aug-14

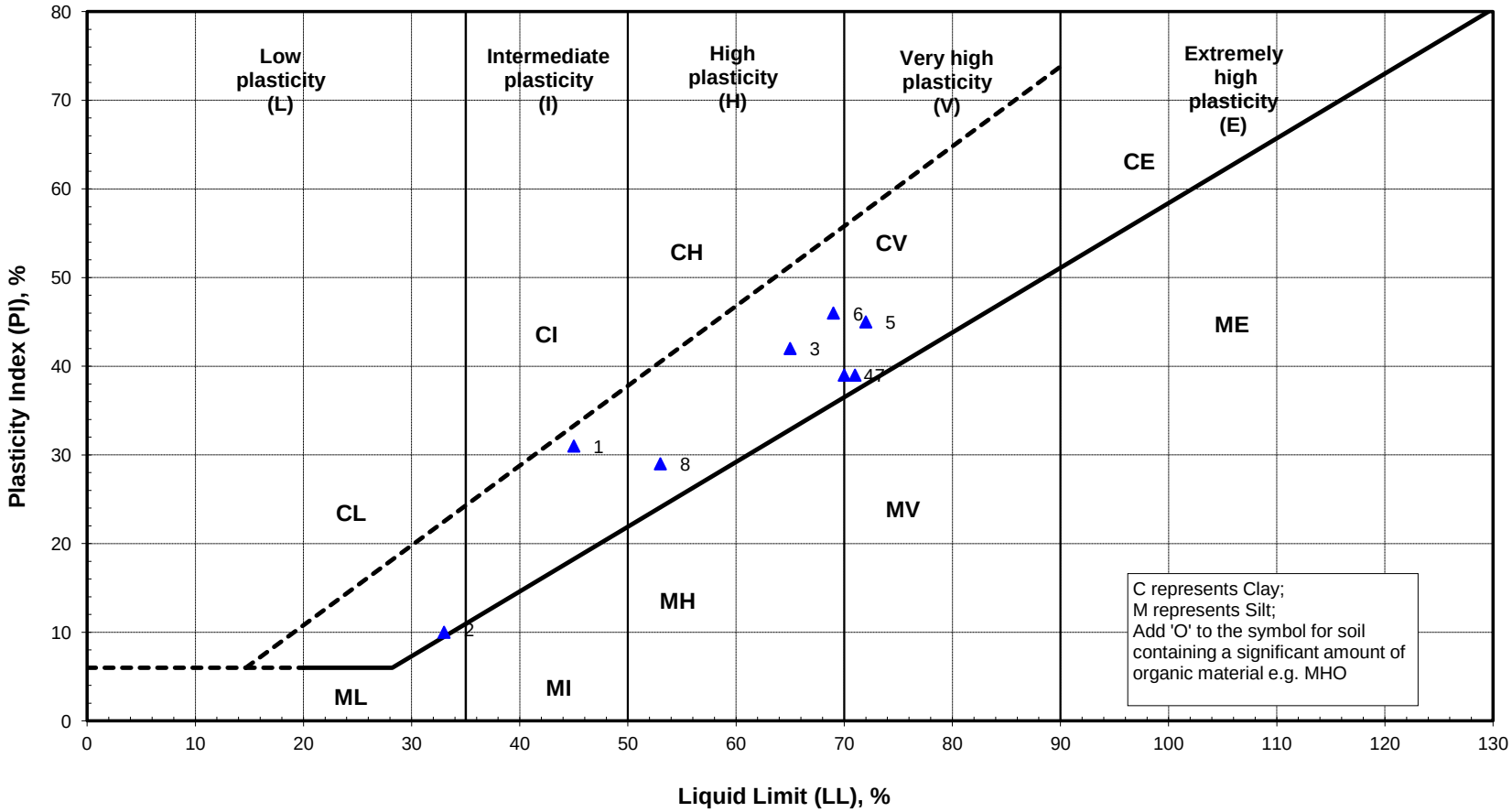
Location	Depth m	Sample Type	Visual Description	Comments	Natural MC %	Liquid Limit %	Plastic Limit %	Plasticity Index	Classi-fication	Passing 425 micron %
BH1	1.00	D	*Firm medium strength light brown patched yellow brown sandy CLAY with occasional flint and brick gravel.*		*23*	*45*	*14*	*31*	*CI*	*95*
BH1	2.00	D	*Very soft very low strength dark grey organic very sandy CLAY with occasional flint gravel.*		*27*	*33*	*23*	*10*	*CLO*	*95*
BH1	3.00	D	*Firm low strength light brown CLAY with occasional gravel.*		*34*	*65*	*23*	*42*	*CH*	*95*
BH1	7.50	U	*Very stiff fissured very high strength dark grey CLAY.*		*31*	*70*	*31*	*39*	*CH/CV*	*100*
BH1	16.50	U	*Very stiff very high strength dark brown CLAY.*		*27*	*72*	*27*	*45*	*CV*	*100*
BH2	2.00	D	*Firm medium strength light brown CLAY with occasional gravel.*		*34*	*69*	*23*	*46*	*CH*	*90*
BH2	9.00	U	*Very stiff fissured very high strength dark grey CLAY.*		*29*	*71*	*32*	*39*	*CV*	*100*
BH2	15.00	U	*Very stiff very high strength dark grey slightly sandy CLAY.*		*26*	*53*	*24*	*29*	*CH*	*100*

Plasticity Chart for Atterberg Limit Tests

Project Name	*36 Redington Road (London NW3)*			**Project Number**	*J11894*
Client Name	*Archetype Associates Ltd*	**PE**	*JNR*	**Date Issued**	*13-Aug-14*

Key

No.	TH No.	Depth
1	BH1	1.00
2	BH1	2.00
3	BH1	3.00
4	BH1	7.50
5	BH1	16.50
6	BH2	2.00
7	BH2	9.00
8	BH2	15.00



Liquid Limit		**Plastic Limit**		**Plasticity Index**	
Maximum Value	72	Maximum Value	32	Maximum Value	46
Minimum Value	33	Minimum Value	14	Minimum Value	10
Average Value	60	Average Value	25	Average Value	35

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PARTICLE SIZE DISTRIBUTION REPORT

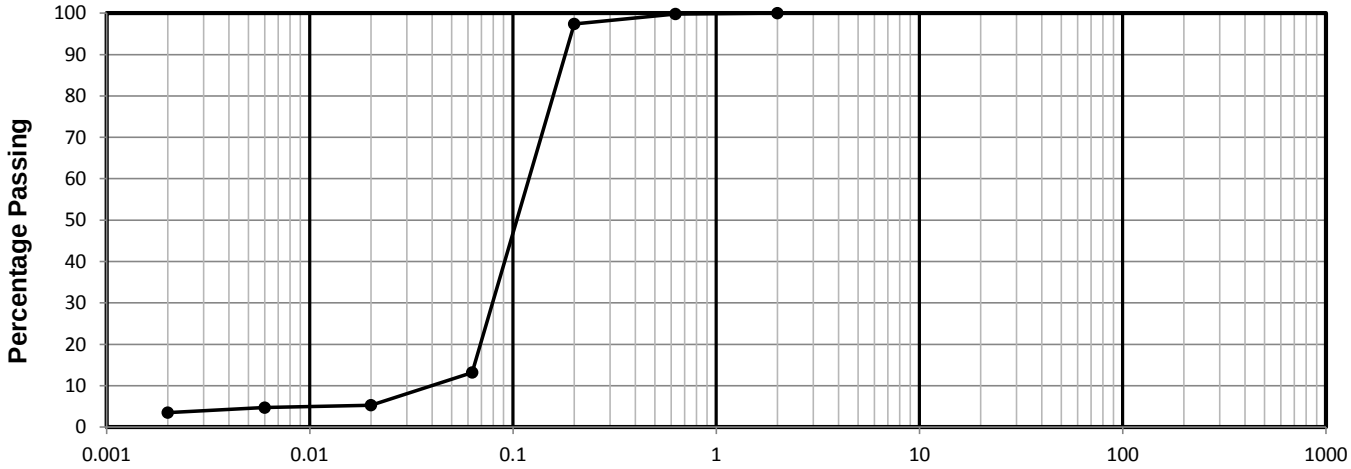
To BS1377-2:1990(2003) cl. 9.2-9.5

AGS

Project Name	*36 Redington Road (London NW3)*			**Project Number**	*J11894*
Client Name	*Archetype Associates Ltd*	**PE**	*JNR*	**Date Issued**	*13-Apr-15*

Particle Size	% Passing
2mm	100
630µm	100
200µm	97
63µm	13
20µm	5
6µm	5
2µm	3

Particle Size Distribution Chart



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			
4	10			87			0			

Sedimentation pre-treatment: None

Visual Description of Sample:
Grey SAND.

Particle Density (Assumed) Mg/m³	**2.65**
Coefficient of Uniformity	

Location	BH1
Depth (m)	1.50
Sample Type	D

Comments:

Test Methods:
Sedimentation by Pipette BS1377-2: 1990(2003) cl. 9.4

Tested By	STL Lab
Checked By	

Southern Testing | ST Consult

CHEMICAL & ELECTROCHEMICAL TESTING SUMMARY

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

AGS

Project Name	36 Redington Road (London NW3)					Project Number	J11894
Client	Archetype Associates Ltd			PE	*JNR*	Date Issued	*12-Aug-14*

TH No.	Depth m	Sample Type	Visual Description	Comments	Passing 2mm %	pH Value	Soil Sulphate 2:1 Water Extract		Groundwater Sulphate	
							g/l SO_3	BRE mg/l SO_4	g/l SO_3	BRE mg/l SO_4
BH1	2.00	D	Very soft very low strength dark grey organic very sandy CLAY with occasional flint gravel.		68.6	6.3	0.22	269		
BH1	4.50	U	Stiff very high strength light brown patched light blue grey CLAY.		100.0	7.8	2.15	2582		
BH1	10.50	U	Very stiff fissured very high strength dark grey CLAY.		100.0	7.9	0.47	566		
BH1	19.50	U	Very stiff very high strength dark grey sandy CLAY.		100.0	8.0	0.38	451		
BH2	1.00	D	Soft low strength grey brown sandy CLAY with occasional gravel.		53.6	7.5	0.86	1037		
BH2	3.00	D	Very stiff very high strength light brown CLAY.		100.0	7.7	0.17	202		
BH2	12.00	U	Very stiff fissured very high strength dark grey CLAY.		100.0	7.8	0.38	451		

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IMMEDIATE UNDRAINED TRIAXIAL SUMMARY

To BS1377-7:1990(1994)

AGS

Project Name	36 Redington Road (London NW3)			Project Number	J11894
Client	Archetype Associates Ltd	PE	JNR	Date Issued	12-Aug-14

Location	Depth (m)	Sample Type	Visual Description	Comments	Test Type	UCS by Hand Pen. (KPa)	NMC (%)	Cell Press. (KPa)	Deviator Stress (KPa)	Apparent Cohesion C_u (KPa)	Bulk Density (Mg/m^3)
BH1	4.50	U	*Stiff very high strength light brown patched light blue grey CLAY.*		*Single Stage*	*220*	*34.3*	*90*	*136*	*68*	*1.91*
BH1	7.50	U	*Very stiff fissured very high strength dark grey CLAY.*		*Single Stage*	*430*	*31.2*	*150*	*118*	*59*	*1.90*
BH1	10.50	U	*Very stiff fissured very high strength dark grey CLAY.*		*Single Stage*	*350*	*29.5*	*210*	*203*	*102*	*1.94*
BH1	13.50	U	*Very stiff fissured very high strength dark grey CLAY.*		*Single Stage*	*380*	*31.5*	*270*	*172*	*86*	*1.95*
BH1	16.50	U	*Very stiff very high strength dark brown CLAY.*		*Single Stage*	*370*	*30.7*	*330*	*173*	*87*	*1.99*
BH1	19.50	U	*Very stiff very high strength dark grey sandy CLAY.*		*Single Stage*	*310*	*28.3*	*390*	*193*	*97*	*1.97*
BH2	4.00	U	*Stiff fissured very high strength light brown CLAY.*	*Unsuitable sample for test.*	*Single Stage*	*310*	*31.4*				
BH2	7.00	U	*Very stiff fissured very high strength dark grey CLAY.*		*Single Stage*	*440*	*27.5*	*140*	*185*	*93*	*1.96*
BH2	9.00	U	*Very stiff fissured very high strength dark grey CLAY.*		*Single Stage*	*400*	*29.2*	*180*	*138*	*69*	*1.90*
BH2	12.00	U	*Very stiff fissured very high strength dark grey CLAY.*		*Single Stage*	*390*	*30.9*	*240*	*183*	*92*	*1.96*

Southern Testing | ST Consult

IMMEDIATE UNDRAINED TRIAXIAL SUMMARY

To BS1377-7:1990(1994)

AGS

Project Name	*36 Redington Road (London NW3)*			Project Number	J11894
Client	*Archetype Associates Ltd*	PE	JNR	Date Issued	12-Aug-14

Location	Depth (m)	Sample Type	Visual Description	Comments	Test Type	UCS by Hand Pen. (KPa)	NMC (%)	Cell Press. (KPa)	Deviator Stress (KPa)	Apparent Cohesion C_u (KPa)	Bulk Density (Mg/m^3)
BH2	15.00	U	*Very stiff very high strength dark grey slightly sandy CLAY.*		*Single Stage*	*340*	*25.9*	*300*	*276*	*138*	*2.06*
BH2	18.00	U	*Very stiff fissured very high strength dark grey CLAY.*		*Single Stage*	*510*	*27.5*	*360*	*164*	*82*	*1.91*

APPENDIX D

Contamination Laboratory Test Results

Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

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

Report Number: 411332-1

Date of Report: 05-Aug-2014

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

Customer Contact: Mr Jon Race

Customer Job Reference: J11894
Customer Purchase Order: J11894_1
Customer Site Reference: 36 Redington Road (London NW3)
Date Job Received at SAL: 25-Jul-2014
Date Analysis Started: 30-Jul-2014
Date Analysis Completed: 05-Aug-2014

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

UKAS TESTING
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mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

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

Issued by :
Miss Claire Brown
Customer Service Manager

SAL Reference: 411332
Project Site: 36 Redington Road (London NW3)
Customer Reference: J11894

Soil Analysed as Soil
STL Key Contamintion Suite

				SAL Reference	**411332 001**	**411332 002**	**411332 004**
				Customer Sample Reference	**BH1 @ 0.20m**	**BH1 @ 2.10m**	**BH2 @ 0.50m**
				Date Sampled	**15-JUL-2014**	**16-JUL-2014**	**18-JUL-2014**
				Type	**Fill**	**Clay**	**Fill**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Arsenic	T257	A40	2.0	mg/kg	**14**	**8**	**16**
Cadmium	T257	A40	0.1	mg/kg	**0.2**	<0.1	**0.3**
Chromium	T257	A40	0.5	mg/kg	**26**	**36**	**22**
Copper	T257	A40	2	mg/kg	**31**	**12**	**52**
Lead	T257	A40	2	mg/kg	**160**	**32**	**950**
Mercury	T245	A40	1.0	mg/kg	<1.0	<1.0	<1.0
Nickel	T257	A40	0.5	mg/kg	**16**	**6.8**	**16**
Selenium	T257	A40	3	mg/kg	<3	<3	<3
Zinc	T257	A40	2	mg/kg	**93**	**32**	**170**
Asbestos ID	T27	A40			Asbestos not detected	-	Asbestos not detected
Chromium VI	T6	A40	1	mg/kg	<1	<1	<1
Fraction Organic Carbon - F(oc)	T21	A40	1	%	<1	<1	<1
pH	T7	A40			**7.0**	**7.2**	**7.6**
Soil Organic Matter	T287	A40	0.1	%	**2.6**	**0.9**	**2.6**
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l	**0.01**	**0.08**	**0.07**
Sulphide	T4	AR	10	mg/kg	(64) <10	(64) <10	(64) <10
Cyanide(Total)	T4	AR	1	mg/kg	(64) <1	(64) <1	(64) <1
Phenols(Mono)	T221	AR	0.5	mg/kg	(64) <0.5	(64) <0.5	(64) <0.5
Moisture @ 105 C	T162	AR	0.1	%	**12**	**21**	**12**
Retained on 2mm	T2	A40	0.1	%	**3.6**	**0.4**	**3.3**

SAL Reference: 411332
Project Site: 36 Redington Road (London NW3)
Customer Reference: J11894

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

				SAL Reference	**411332 001**	**411332 002**	**411332 004**
				Customer Sample Reference	**BH1 @ 0.20m**	**BH1 @ 2.10m**	**BH2 @ 0.50m**
				Date Sampled	**15-JUL-2014**	**16-JUL-2014**	**18-JUL-2014**
				Type	**Fill**	**Clay**	**Fill**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Naphthalene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Acenaphthylene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Acenaphthene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Fluorene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1
Phenanthrene	T16	AR	0.1	mg/kg	**0.4**	<0.1	**0.8**
Anthracene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.2**
Fluoranthene	T16	AR	0.1	mg/kg	**1.3**	<0.1	**1.9**
Pyrene	T16	AR	0.1	mg/kg	**1.1**	<0.1	**1.7**
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	**0.5**	<0.1	**1.0**
Chrysene	T16	AR	0.1	mg/kg	**0.6**	<0.1	**1.0**
Benzo(b/k)Fluoranthene	T16	AR	0.1	mg/kg	**0.9**	<0.1	**1.6**
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	**0.4**	<0.1	**0.9**
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	**0.3**	<0.1	**0.4**
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	**0.1**	<0.1	**0.2**
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	**0.3**	<0.1	**0.4**
PAH(total)	T16	AR	0.1	mg/kg	**5.8**	<0.1	**10**

Index to symbols used in 411332-1

Value	Description
A40	Assisted dried < 40C

AR	As Received
64	Analysis was performed by an alternative technique
W	Analysis was performed at another SAL laboratory
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Reported results on as received samples are corrected to a 105 degree centigrade dry weight basis except phenol, cyanide and sulphide
Where an asbestos result of none detected is reported, this is obtained from analysis of a representative sub sample.
No loose asbestos fibres or asbestos containing materials were found
Sub contracted analysis performed by SAL Scotland & REC Asbestos South East Limited
Retained on 2mm is removed before analysis

Method Index

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

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Arsenic	T257	A40	2.0	mg/kg	U	001,004
Arsenic	T257	A40	2	mg/kg	M	002
Cadmium	T257	A40	0.1	mg/kg	U	001,004
Cadmium	T257	A40	0.1	mg/kg	M	002
Chromium	T257	A40	0.5	mg/kg	U	001,004
Chromium	T257	A40	0.5	mg/kg	M	002
Copper	T257	A40	2	mg/kg	U	001,004
Copper	T257	A40	2	mg/kg	M	002
Lead	T257	A40	2	mg/kg	U	001,004
Lead	T257	A40	2	mg/kg	M	002
Mercury	T245	A40	1.0	mg/kg	U	001-002,004
Nickel	T257	A40	0.5	mg/kg	U	001,004
Nickel	T257	A40	0.5	mg/kg	M	002
Selenium	T257	A40	3	mg/kg	U	001-002,004
Zinc	T257	A40	2	mg/kg	U	001,004
Zinc	T257	A40	2	mg/kg	M	002
Asbestos ID	T27	A40			SU	001,004
Chromium VI	T6	A40	1	mg/kg	N	001-002,004
Fraction Organic Carbon - F(oc)	T21	A40	1	%	WN	001-002,004
pH	T7	A40			U	001,004
pH	T7	A40			M	002
Soil Organic Matter	T287	A40	0.1	%	WN	001-002,004
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l	U	001,004
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l	M	002
Sulphide	T4	AR	10	mg/kg	WN	001-002,004
Cyanide(Total)	T4	AR	1	mg/kg	WU	001,004
Cyanide(Total)	T4	AR	1	mg/kg	WM	002
Phenols(Mono)	T221	AR	0.5	mg/kg	WU	001,004
Phenols(Mono)	T221	AR	0.5	mg/kg	WM	002
Moisture @ 105 C	T162	AR	0.1	%	N	001-002,004
Retained on 2mm	T2	A40	0.1	%	N	001-002,004
Naphthalene	T16	AR	0.1	mg/kg	U	001-002,004

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Acenaphthylene	T16	AR	0.1	mg/kg	U	001-002,004
Acenaphthene	T16	AR	0.1	mg/kg	U	001,004
Acenaphthene	T16	AR	0.1	mg/kg	M	002
Fluorene	T16	AR	0.1	mg/kg	U	001,004
Fluorene	T16	AR	0.1	mg/kg	M	002
Phenanthrene	T16	AR	0.1	mg/kg	U	001-002,004
Anthracene	T16	AR	0.1	mg/kg	U	001,004
Anthracene	T16	AR	0.1	mg/kg	M	002
Fluoranthene	T16	AR	0.1	mg/kg	N	001-002,004
Pyrene	T16	AR	0.1	mg/kg	N	001-002,004
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	U	001,004
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	M	002
Chrysene	T16	AR	0.1	mg/kg	U	001,004
Chrysene	T16	AR	0.1	mg/kg	M	002
Benzo(b/k)Fluoranthene	T16	AR	0.1	mg/kg	U	001,004
Benzo(b/k)Fluoranthene	T16	AR	0.1	mg/kg	M	002
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	U	001,004
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	M	002
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	U	001,004
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	M	002
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	U	001,004
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	M	002
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	U	001,004
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	M	002
PAH(total)	T16	AR	0.1	mg/kg	U	001-002,004

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limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

3 Crittall Drive
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Braintree
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CM7 2RT
Tel : 01376 560120
Fax : 01376 552923

Report Number: 411332-1 A

Date of Report: 05-Aug-2014

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

Customer Contact: Mr Jon Race

Customer Job Reference: J11894
Customer Purchase Order: J11894_1
Customer Site Reference: 36 Redington Road (London NW3)
Date Job Received at SAL: 25-Jul-2014
Date Analysis Started: 30-Jul-2014
Date Analysis Completed: 05-Aug-2014

The results reported relate to samples received in the laboratory
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING
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mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

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

Issued by :
Miss Claire Brown
Customer Service Manager

Waste Acceptance Criteria

Customer Sample Reference : BH1 @ 6.00m
SAL Sample Reference : 411332 003
Project Site : 36 Redington Road (London NW3)
Customer Reference : J11894
Test Portion Mass (g) : 175
Date Sampled : 16-JUL-2014
Type : Clay

Soil Summary					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
pH	Probe			M	7.5		>6.0	
Loss on Ignition @450C	Ign 450C/Grav	0.1	%	M	7.6			10.0
Total Organic Carbon	OX/IR	0.1	%	WN	0.3	3.0	5.0	6.0
Acid Neutralising Capacity (pH 7)	Titration	2.0	Mol/kg	N	<2.0			
BTEX (Sum)	Calc	0.040	mg/kg	U	<0.040	6.0		
Coronene	GC/MS (MCERTS)	0.1	mg/kg	N	<0.1			
PAH (Sum)	Calc	1.6	mg/kg	N	<1.6	100.0		
PCB EC7 (Sum)	Calc	0.00035	mg/kg	U	<0.35	1.0		
TPH (C10-C40)	GC/FID (SE)	10	mg/kg	M	<10	500.0		
Moisture @ 105 C	Grav (1 Dec) (105 C)	0.1	%	N	24			
Retained on 2mm	Grav	0.1	%	N	1.9			

10:1 Leachate					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
Antimony (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.06	0.7	5.0
Arsenic (Dissolved)	Calc / ICP/MS (Filtered)	0.0020	mg/kg	N	0.0032	0.5	2.0	25.0
Barium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.14	20.0	100.0	300.0
Cadmium (Dissolved)	Calc / ICP/MS (Filtered)	0.00020	mg/kg	N	<0.00020	0.04	1.0	5.0
Chloride	Calc / Discrete Analyser	10	mg/kg	N	65	800.0	15000.0	25000.0
Chromium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.5	10.0	70.0
Copper (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.016	2.0	50.0	100.0
Dissolved Organic Carbon	Calc / OX/IR	10	mg/kg	N	20	500.0	800.0	1000.0
Fluoride	Calc / Discrete Analyser	0.50	mg/kg	N	1.5	10.0	150.0	500.0
Lead (Dissolved)	Calc / ICP/MS (Filtered)	0.0030	mg/kg	N	<0.0030	0.5	10.0	50.0
Mercury (Dissolved)	Calc / ICP/MS (Filtered)	0.00050	mg/kg	N	<0.00050	0.01	0.2	2.0
Molybdenum (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.5	10.0	30.0
Nickel (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.043	0.4	10.0	40.0
Phenols(Mono)	Calc / Colorimetry (CE)	0.050	mg/kg	N	<0.050	1.0		
Selenium (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.0054	0.1	0.5	7.0
SO4--	Calc / Discrete Analyser	5.0	mg/kg	N	4700	**1000.0**	20000.0	50000.0
Total Dissolved Solids	Calc	100	mg/kg	N	5600	**4000.0**	60000.0	100000.0
Zinc (Dissolved)	Calc / ICP/MS (Filtered)	0.020	mg/kg	N	0.063	4.0	50.0	200.0

From: EC Directive 99/31/EC and Landfill Regulations 2002 (as ammended)

Note:- Sample failed to produce sufficient eluate within the specified time after vacuum filtration for 1 hour and centrifugation for 30 minutes. Therefore, the exact application of the two-step leaching test is precluded on technical grounds. (ref: Section 5.2.4 BS EN 12457-3:2002) Results are derived from a single step leaching at L/S 10/1 as prescribed by the EA guidance. (Ref Section C4.1.1 Guidance on Sampling and Testing of Wastes to meet Landfill Waste Acceptance Procedures Version 1 April 2005, Environment Agency)

Notes:- Cumulative release at L/S=10 (mg/kg of dry matter) in accordance with BS EN 12457. Soil leaching procedure is not covered by our UKAS accreditation

Waste Acceptance Criteria

Customer Sample Reference : Tree trench @ 0.50m
SAL Sample Reference : 411332 005
Project Site : 36 Redington Road (London NW3)
Customer Reference : J11894
Date Sampled : 15-JUL-2014
Test Portion Mass (g) : 175
Type : Fill

Soil Summary					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
pH	Probe			U	8.1		>6.0	
Loss on Ignition @450C	Ign 450C/Grav	0.1	%	U	4.6			10.0
Total Organic Carbon	OX/IR	0.1	%	WN	1.9	3.0	5.0	6.0
Acid Neutralising Capacity (pH 7)	Titration	2.0	Mol/kg	N	<2.0			
BTEX (Sum)	Calc	0.040	mg/kg	U	<0.040	6.0		
Coronene	GC/MS (MCERTS)	0.1	mg/kg	N	<0.1			
PAH (Sum)	Calc	1.6	mg/kg	N	10	100.0		
PCB EC7 (Sum)	Calc	0.00035	mg/kg	U	<0.35	1.0		
TPH (C10-C40)	GC/FID (SE)	10	mg/kg	U	44	500.0		
Moisture @ 105 C	Grav (1 Dec) (105 C)	0.1	%	N	5.2			
Retained on 2mm	Grav	0.1	%	N	13.6			

10:1 Leachate					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
Antimony (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.036	0.06	0.7	5.0
Arsenic (Dissolved)	Calc / ICP/MS (Filtered)	0.0020	mg/kg	N	0.036	0.5	2.0	25.0
Barium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.13	20.0	100.0	300.0
Cadmium (Dissolved)	Calc / ICP/MS (Filtered)	0.00020	mg/kg	N	0.00023	0.04	1.0	5.0
Chloride	Calc / Discrete Analyser	10	mg/kg	N	21	800.0	15000.0	25000.0
Chromium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.5	10.0	70.0
Copper (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.063	2.0	50.0	100.0
Dissolved Organic Carbon	Calc / OX/IR	10	mg/kg	N	29	500.0	800.0	1000.0
Fluoride	Calc / Discrete Analyser	0.50	mg/kg	N	8.5	10.0	150.0	500.0
Lead (Dissolved)	Calc / ICP/MS (Filtered)	0.0030	mg/kg	N	0.077	0.5	10.0	50.0
Mercury (Dissolved)	Calc / ICP/MS (Filtered)	0.00050	mg/kg	N	<0.00050	0.01	0.2	2.0
Molybdenum (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.031	0.5	10.0	30.0
Nickel (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.019	0.4	10.0	40.0
Phenols(Mono)	Calc / Colorimetry (CE)	0.050	mg/kg	N	<0.050	1.0		
Selenium (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.0066	0.1	0.5	7.0
SO4--	Calc / Discrete Analyser	5.0	mg/kg	N	28	1000.0	20000.0	50000.0
Total Dissolved Solids	Calc	100	mg/kg	N	570	4000.0	60000.0	100000.0
Zinc (Dissolved)	Calc / ICP/MS (Filtered)	0.020	mg/kg	N	0.033	4.0	50.0	200.0

From: EC Directive 99/31/EC and Landfill Regulations 2002 (as ammended)

Notes:- Cumulative release at L/S=10 (mg/kg of dry matter) in accordance with BS EN 12457. Soil leaching procedure is not covered by our UKAS accreditation

SAL Reference: 411332
Project Site: 36 Redington Road (London NW3)
Customer Reference: J11894

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

				SAL Reference	**411332 003**	**411332 005**
				Customer Sample Reference	**BH1 @ 6.00m**	**Tree trench @ 0.50m**
				Test Sample	**AR**	**AR**
				Date Sampled	**16-JUL-2014**	**15-JUL-2014**
				Type	**Clay**	**Fill**
Determinand	**Method**	**LOD**	**Units**	**Symbol**		
Naphthalene	GC/MS	0.1	mg/kg	U	<0.1	<0.1
Acenaphthylene	GC/MS	0.1	mg/kg	U	<0.1	<0.1
Acenaphthene	GC/MS	0.1	mg/kg	M	<0.1	-
Acenaphthene	GC/MS	0.1	mg/kg	U	-	<0.1
Fluorene	GC/MS	0.1	mg/kg	M	<0.1	-
Fluorene	GC/MS	0.1	mg/kg	U	-	<0.1
Phenanthrene	GC/MS	0.1	mg/kg	U	<0.1	**0.9**
Anthracene	GC/MS	0.1	mg/kg	M	<0.1	-
Anthracene	GC/MS	0.1	mg/kg	U	-	**0.2**
Fluoranthene	GC/MS	0.1	mg/kg	N	<0.1	**2.2**
Pyrene	GC/MS	0.1	mg/kg	N	<0.1	**1.8**
Benzo(a)Anthracene	GC/MS	0.1	mg/kg	M	<0.1	-
Benzo(a)Anthracene	GC/MS	0.1	mg/kg	U	-	**0.8**
Chrysene	GC/MS	0.1	mg/kg	M	<0.1	-
Chrysene	GC/MS	0.1	mg/kg	U	-	**0.9**
Benzo(b/k)Fluoranthene	GC/MS	0.1	mg/kg	M	<0.1	-
Benzo(b/k)Fluoranthene	GC/MS	0.1	mg/kg	U	-	**1.6**
Benzo(a)Pyrene	GC/MS	0.1	mg/kg	M	<0.1	-
Benzo(a)Pyrene	GC/MS	0.1	mg/kg	U	-	**0.9**
Indeno(123-cd)Pyrene	GC/MS	0.1	mg/kg	M	<0.1	-
Indeno(123-cd)Pyrene	GC/MS	0.1	mg/kg	U	-	**0.4**
Dibenzo(ah)Anthracene	GC/MS	0.1	mg/kg	M	<0.1	-
Dibenzo(ah)Anthracene	GC/MS	0.1	mg/kg	U	-	**0.2**
Benzo(ghi)Perylene	GC/MS	0.1	mg/kg	M	<0.1	-
Benzo(ghi)Perylene	GC/MS	0.1	mg/kg	U	-	**0.5**
Polyaromatic Hydrocarbons (Total)	GC/MS	0.1	mg/kg	U	<0.1	**10**

SAL Reference: 411332
Project Site: 36 Redington Road (London NW3)
Customer Reference: J11894

Soil Analysed as Soil
BTEX

				SAL Reference	**411332 003**	**411332 005**
				Customer Sample Reference	**BH1 @ 6.00m**	**Tree trench @ 0.50m**
				Test Sample	**AR**	**AR**
				Date Sampled	**16-JUL-2014**	**15-JUL-2014**
				Type	**Clay**	**Fill**
Determinand	**Method**	**LOD**	**Units**	**Symbol**		
Benzene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	-
Benzene	GC/MS(Head Space)(MCERTS)	10	µg/kg	U	-	<10
EthylBenzene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	-
EthylBenzene	GC/MS(Head Space)(MCERTS)	10	µg/kg	U	-	<10
Meta/Para-Xylene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	-
Meta/Para-Xylene	GC/MS(Head Space)(MCERTS)	10	µg/kg	U	-	<10
Ortho-Xylene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	-
Ortho-Xylene	GC/MS(Head Space)(MCERTS)	10	µg/kg	U	-	<10
Toluene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	-
Toluene	GC/MS(Head Space)(MCERTS)	10	µg/kg	U	-	<10

SAL Reference: 411332
Project Site: 36 Redington Road (London NW3)
Customer Reference: J11894

Soil Analysed as Soil
PCBs EC7 (SE)

	SAL Reference	411332 003	411332 005
	Customer Sample Reference	BH1 @ 6.00m	Tree trench @ 0.50m
	Test Sample	AR	AR
	Date Sampled	16-JUL-2014	15-JUL-2014
	Type	Clay	Fill

Determinand	Method	LOD	Units	Symbol		
Polychlorinated biphenyl BZ#101	GC/MS	20	µg/kg	M	(62) <50	-
Polychlorinated biphenyl BZ#101	GC/MS	20	µg/kg	U	-	(62) <50
Polychlorinated biphenyl BZ#118	GC/MS	20	µg/kg	M	(62) <50	-
Polychlorinated biphenyl BZ#118	GC/MS	20	µg/kg	U	-	(62) <50
Polychlorinated biphenyl BZ#138	GC/MS	20	µg/kg	M	(62) <50	-
Polychlorinated biphenyl BZ#138	GC/MS	20	µg/kg	U	-	(62) <50
Polychlorinated biphenyl BZ#153	GC/MS	20	µg/kg	M	(62) <50	-
Polychlorinated biphenyl BZ#153	GC/MS	20	µg/kg	U	-	(62) <50
Polychlorinated biphenyl BZ#180	GC/MS	20	µg/kg	M	(62) <50	-
Polychlorinated biphenyl BZ#180	GC/MS	20	µg/kg	U	-	(62) <50
Polychlorinated biphenyl BZ#28	GC/MS	20	µg/kg	M	(62) <50	-
Polychlorinated biphenyl BZ#28	GC/MS	20	µg/kg	U	-	(62) <50
Polychlorinated biphenyl BZ#52	GC/MS	20	µg/kg	M	(62) <50	-
Polychlorinated biphenyl BZ#52	GC/MS	20	µg/kg	U	-	(62) <50

Index to symbols used in 411332-1 A

Value	Description
AR	As Received
A40	Assisted dried < 40C
8:1	Leachate to BS EN 12457-3 (8:1)
2:1	Leachate to BS EN 12457-3 (2:1)
62	LOD was raised due to the method performance of the analytical procedure used
W	Analysis was performed at another SAL laboratory
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Sub contracted analysis performed by SAL Scotland
pH, LOI & TOC were performed on assisted dried samples (<40 degree centigrade). All other results relate to samples as received.
Reported results on as received samples are corrected to a 105 degree centigrade dry weight basis except ANC
Retained on 2mm is removed before analysis

APPENDIX E

Monitoring Data

Southern Testing Environmental & Geotechnical | ST Consult Environmental & Geotechnical

SOIL GAS AND GROUND WATER DAILY RECORD SHEET

Project Name:	36 Redington Road, London NW3	Project Engineer:	JNR	Date:	18-Aug-14	Project No:
Client:	Mr Zolf	Operative:	AW	Day of the week:	Monday	J11894

Well / TH No.	Atmospheric Pressure (mb) and Ambient Temperature		PID	BH pressure	Flow Rate		CH_4	CO_2	O_2	CO	H_2S	Depth to base of well	Water level	Height of Cover	Details of water samples (colour, clarity, odour etc)	Ground Conditions (soft, wet/dry, frozen etc) & Weather Conditions	General Remarks
			ppm	pa	l/hr		%	%	%	ppm	ppm	m below top of cover	m below top of cover	m above GL			
BH1		P				P						10.00	1.04	0.00			
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
BH2		P				P						10.00	8.82	0.00			
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					

Land Gas Data: PID to H_2S columns; Groundwater Data: Depth to base of well, Water level, Height of Cover; Remarks: final three columns.

P = Peak Reading, S = Steady reading | Equipment Used: Interface Meter, MiniRAE 2000, GFM435 Gas Analyser | Checked By | JNR

Southern Testing Environmental & Geotechnical | ST Consult Environmental & Geotechnical

SOIL GAS AND GROUND WATER DAILY RECORD SHEET

Project Name:	36 Redington Road, London NW3	Project Engineer:	JNR	Date:	01-Apr-15	Project No:	
Client:	Mill Hill Properties	Operative:	JNR	Day of the week:	Wednesday	J11894	

Well / TH No.	Atmospheric Pressure (mb) and Ambient Temperature		Land Gas Data: PID (ppm)	BH pressure (pa)	Flow Rate (l/hr)		CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)	Groundwater Data: Depth to base of well (m below top of cover)	Water level (m below top of cover)	Height of Cover (m above GL)	Remarks: Details of water samples (colour, clarity, odour etc)	Ground Conditions (soft, wet/dry, frozen etc) & Weather Conditions	General Remarks
BH1		P				P						10.00	1.11	0.00			
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
BH2		P				P						10.00	0.97	0.00			
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					
		P				P											
		S				S											
		Time Of Readings:				Time Of Readings:						Time Of Readings:					

P = Peak Reading, S = Steady reading — Equipment Used: Interface Meter, MiniRAE 2000, GFM435 Gas Analyser — Checked By: JNR

APPENDIX F

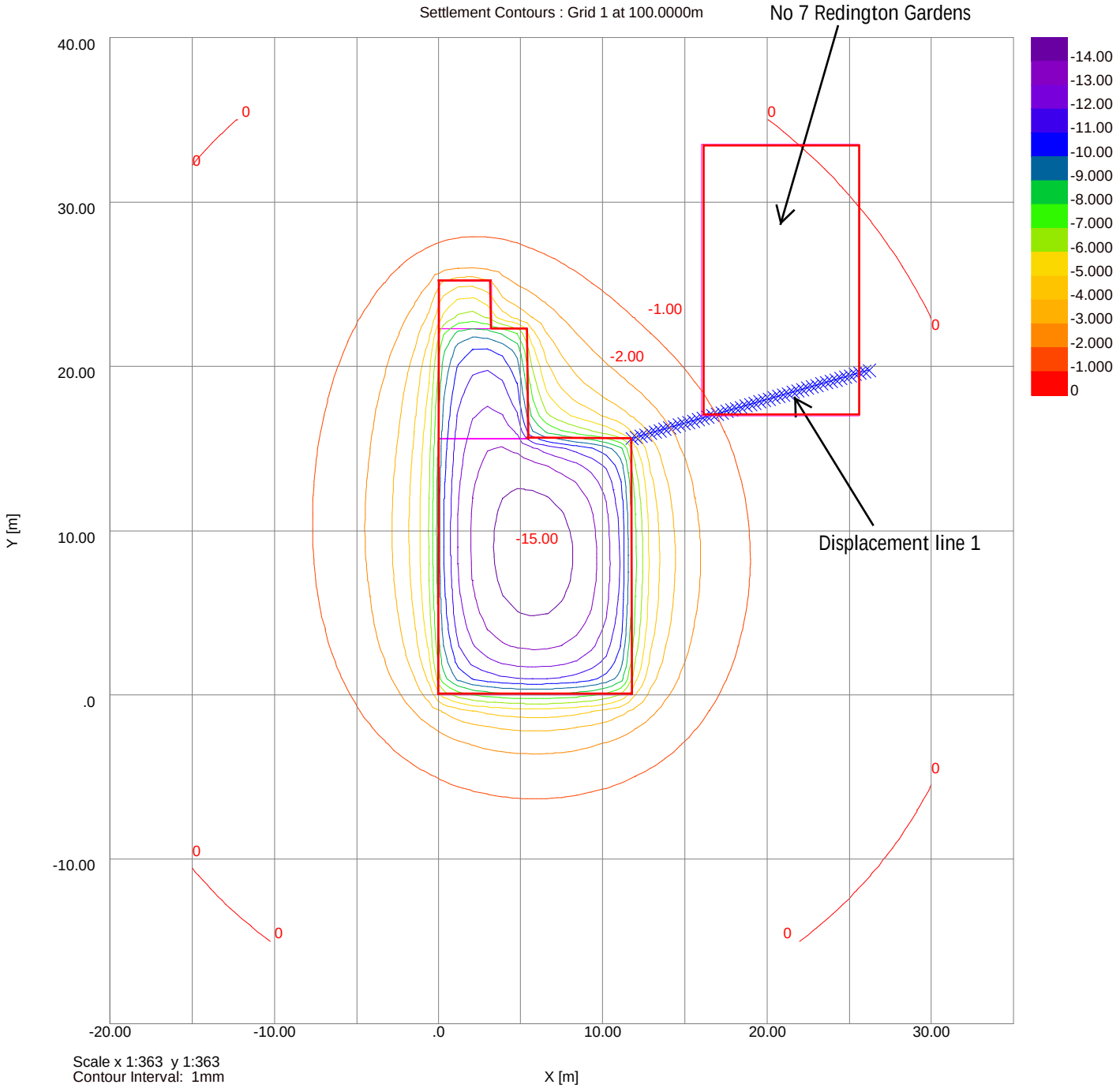
Ground Movement Analysis Results

Oasys

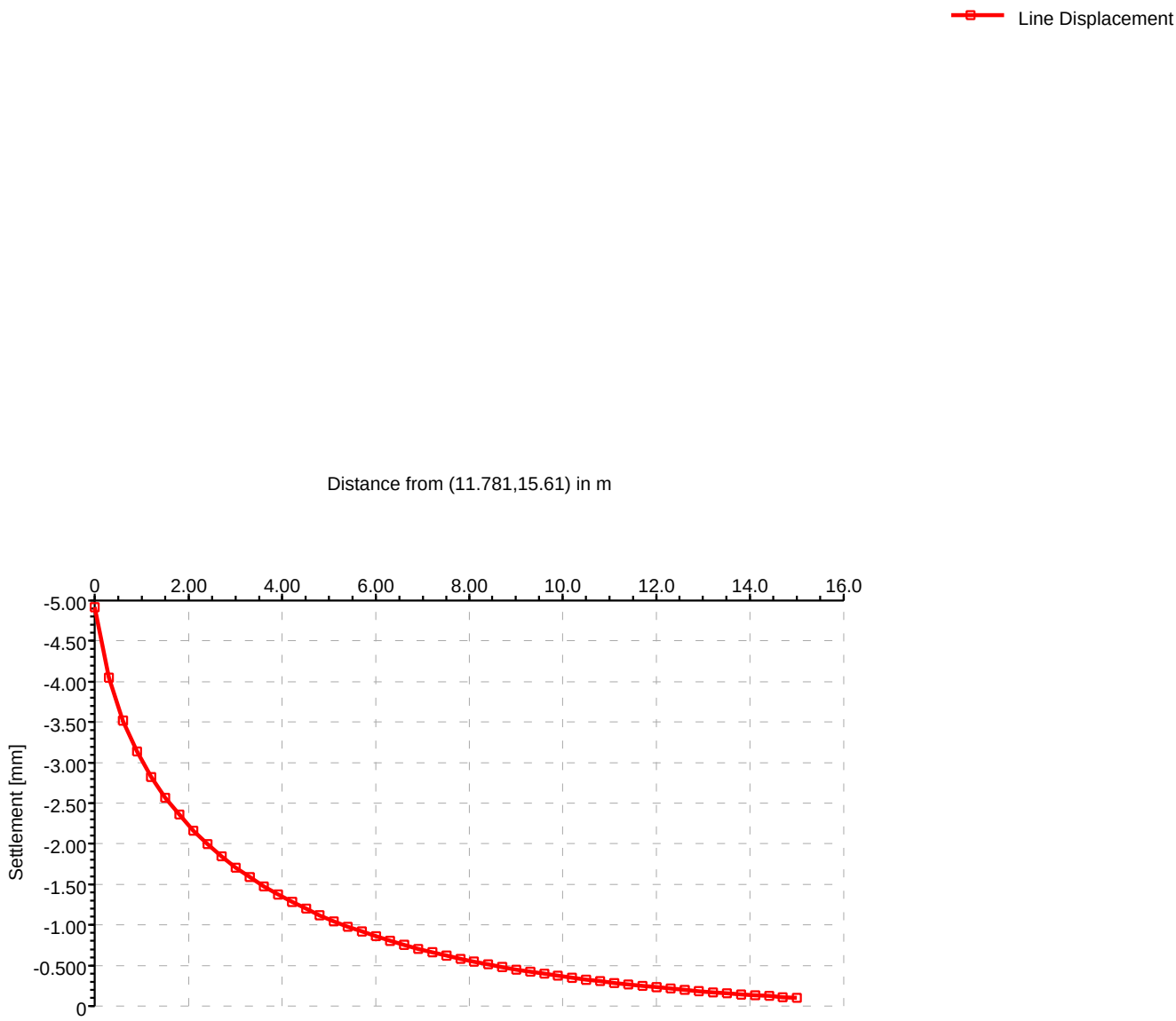
SOUTHERN TESTING LABORATORIES

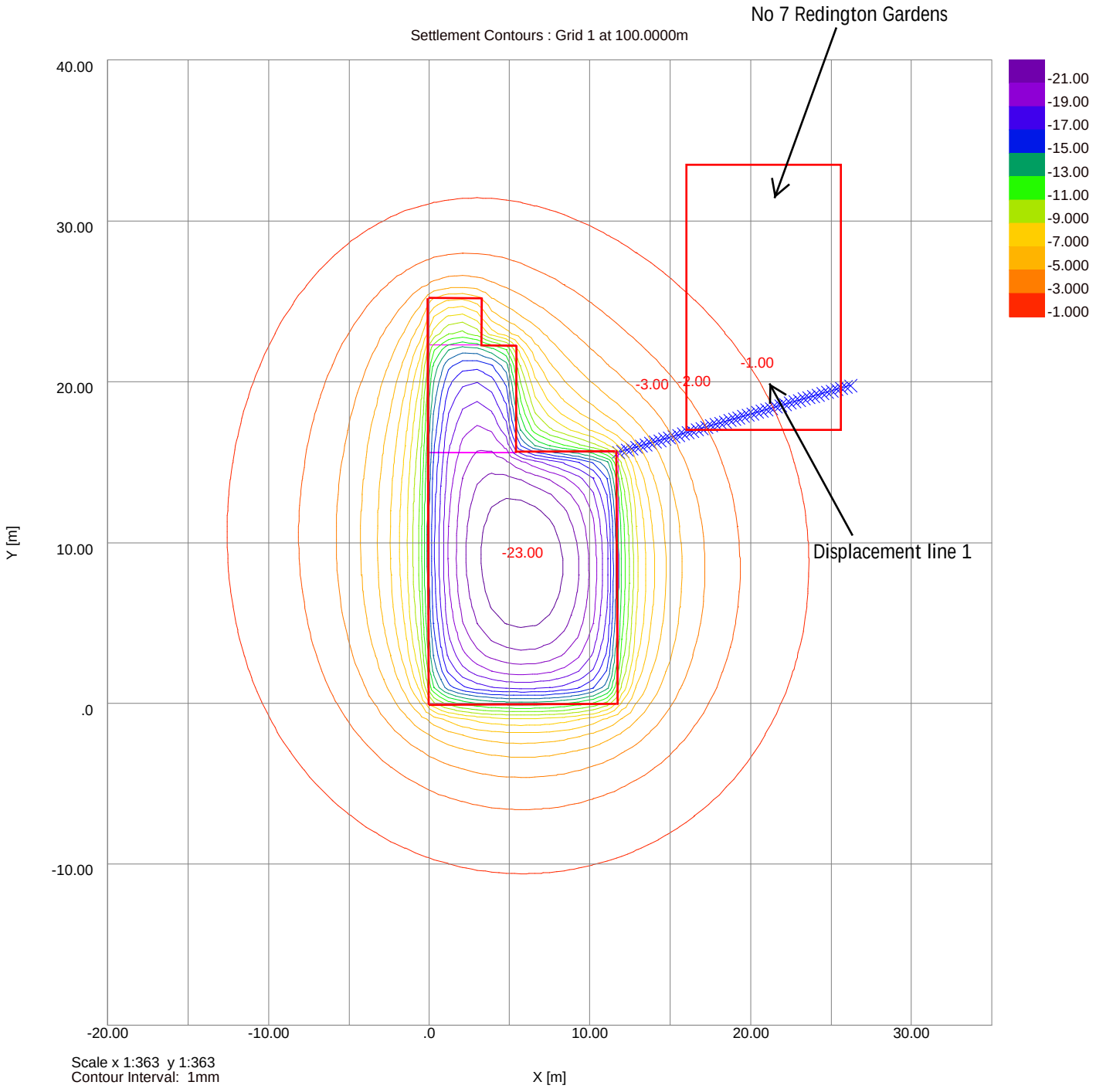
Job No.	Sheet No.	Rev.
J11894		
Drg. Ref.		
Made by	Date	Checked

36 Redington Road
Undrained Analysis
Figure U1

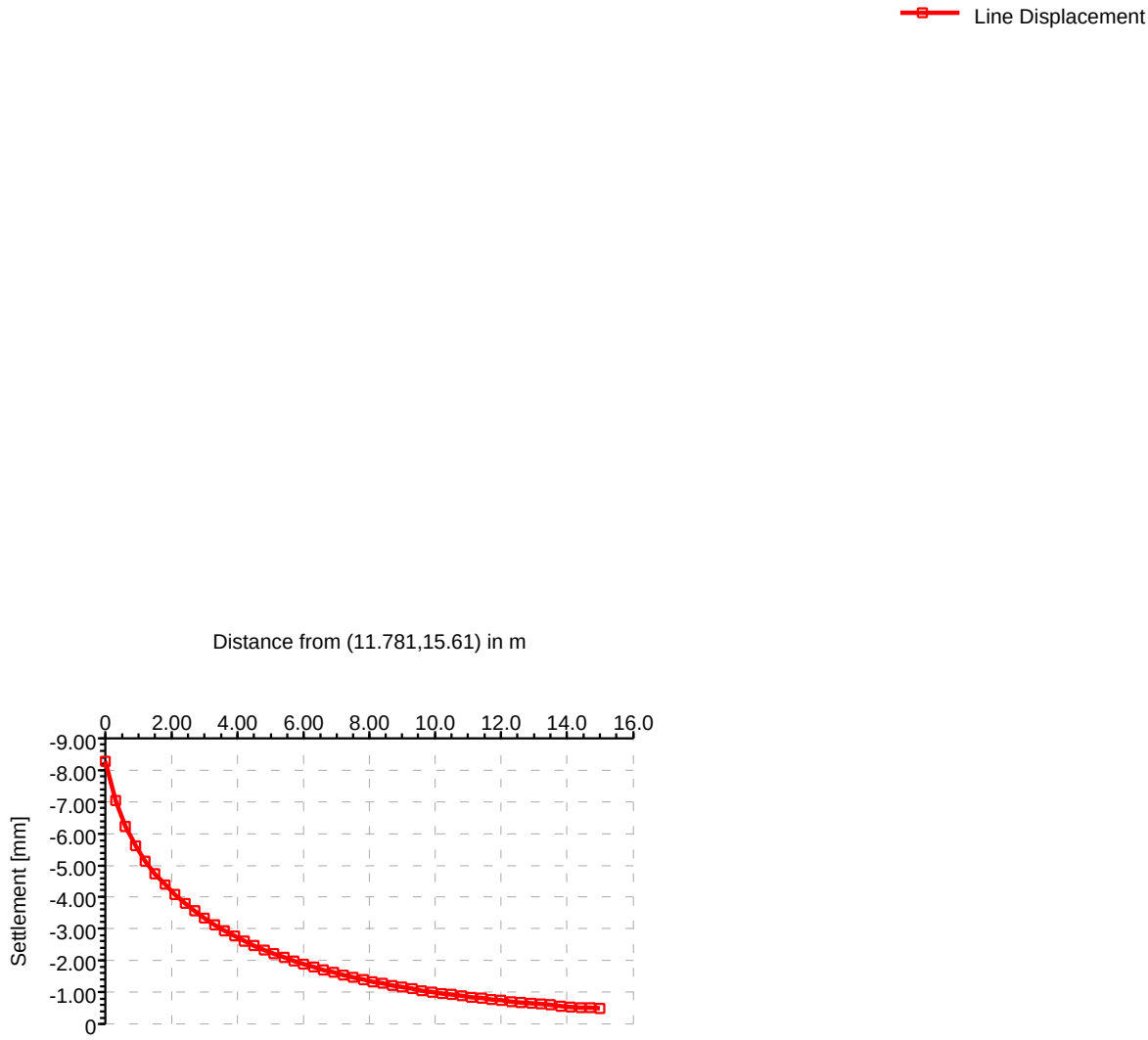


Displacement for Line 1



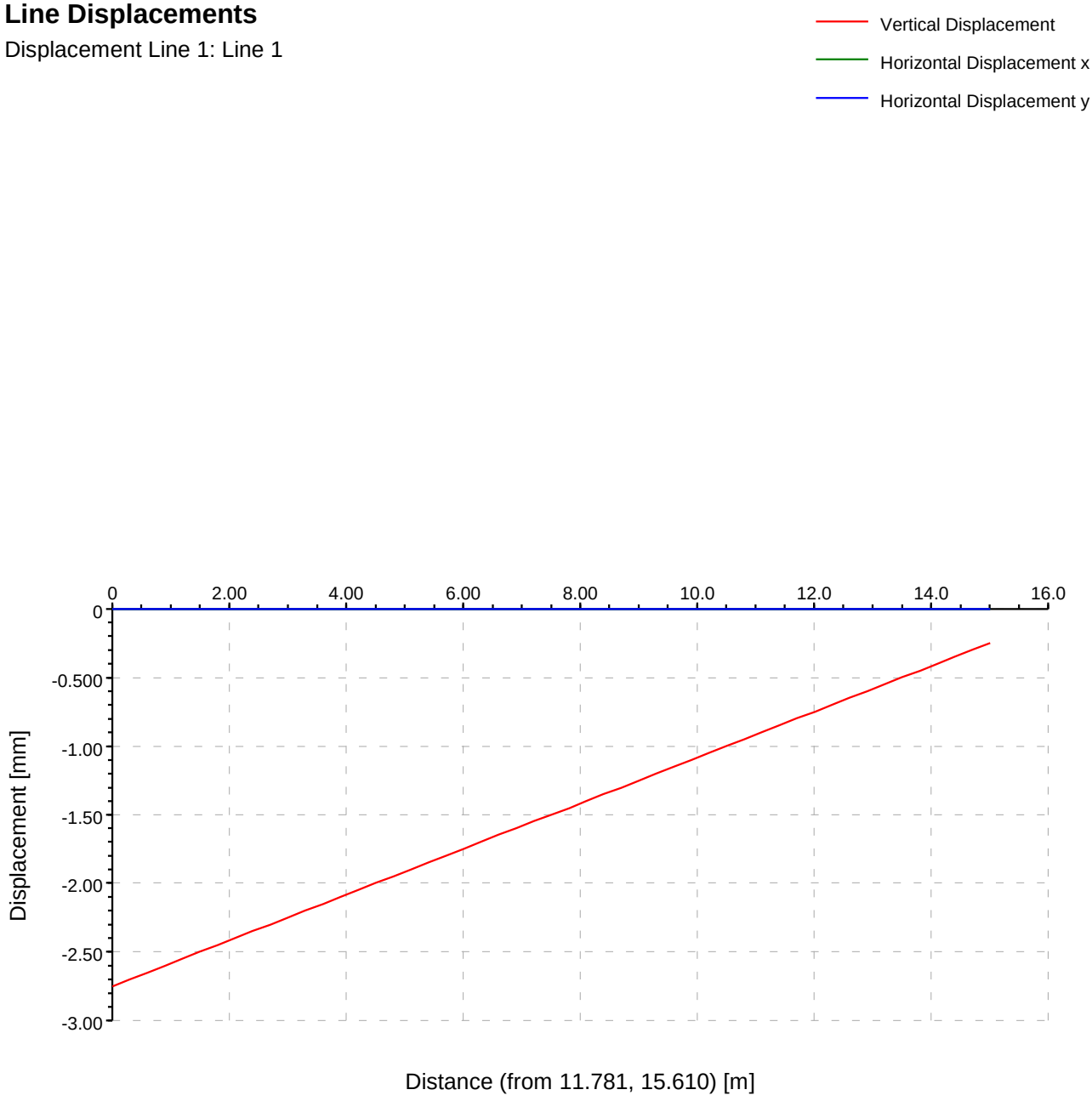

No 7 Redington Gardens
Settlement Contours : Grid 1 at 100.0000m
-21.00
-19.00
-17.00
-15.00
-13.00
-11.00
-9.000
-7.000
-5.000
-3.000
-1.000
-1.00
-3.00
-2.00
-23.00
Displacement line 1
40.00
30.00
20.00
10.00
.0
-10.00
-20.00
-10.00
.0
10.00
20.00
30.00
Y [m]
X [m]
Scale x 1:363 y 1:363
Contour Interval: 1mm

Displacement for Line 1



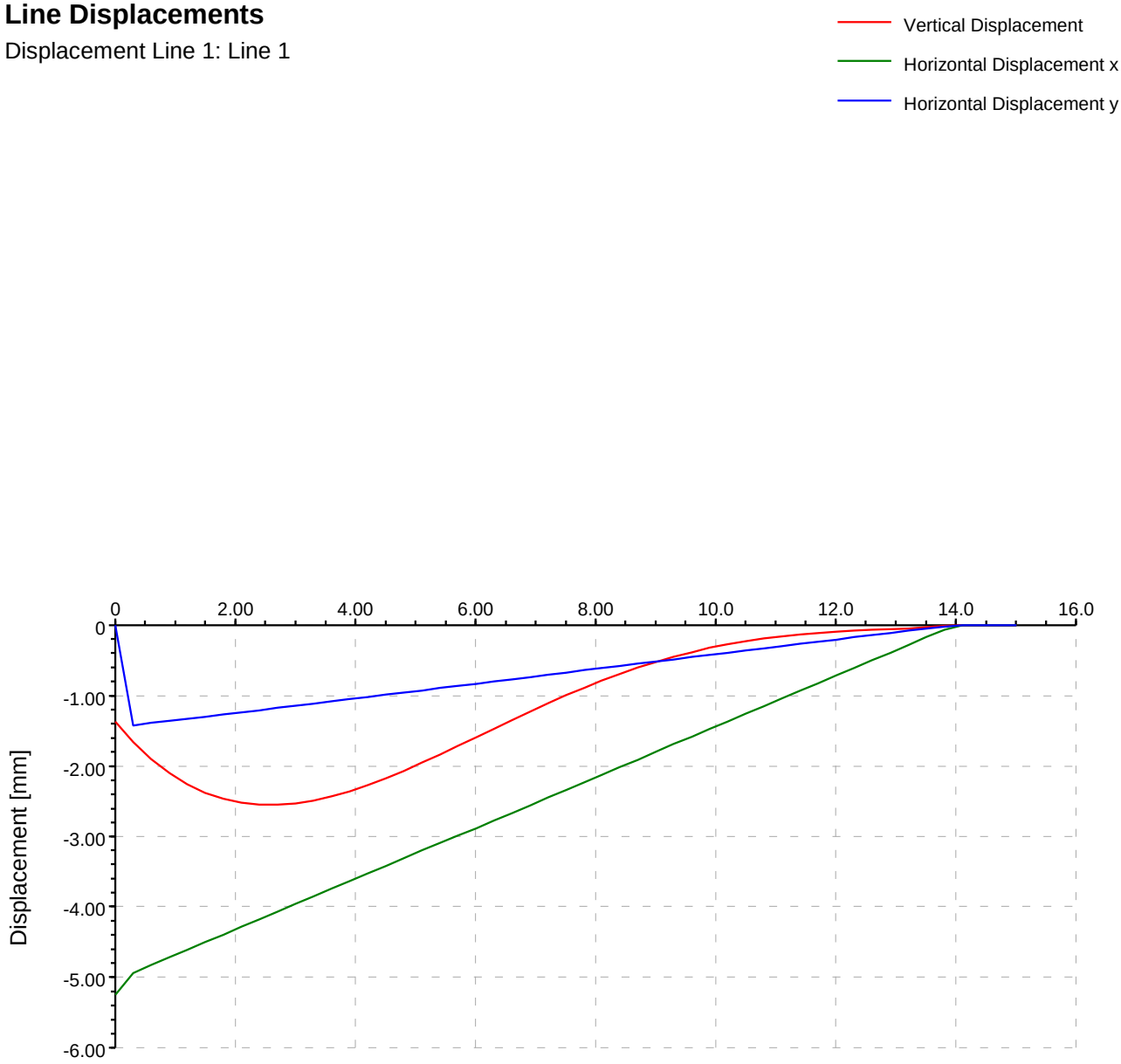
Line Displacements

Displacement Line 1: Line 1



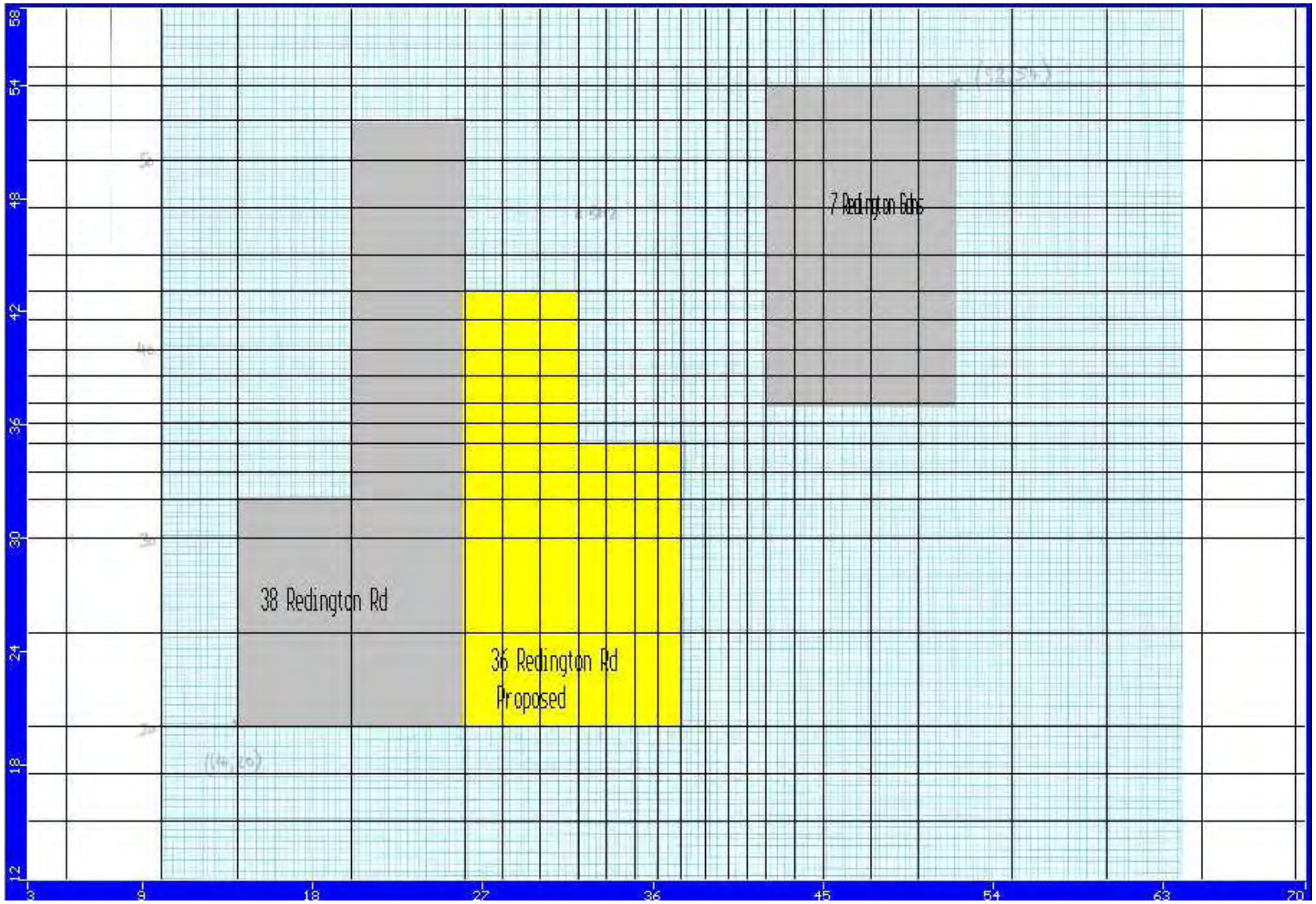
Line Displacements

Displacement Line 1: Line 1



APPENDIX G

Groundwater Analysis Results

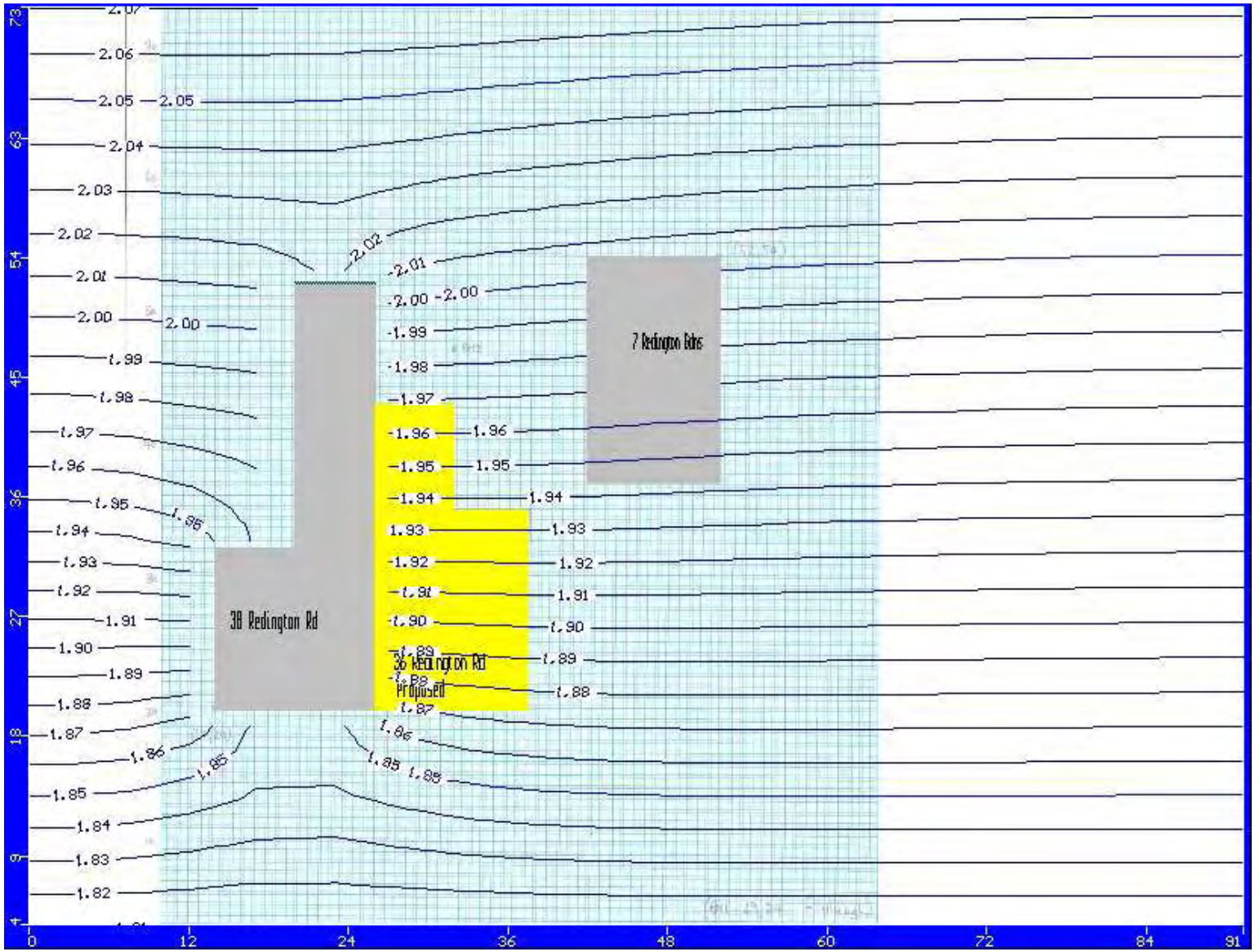


Site: 36 Redington Road, London NW3	STL: J11894	Fig No: G1
Date: 15 May 2015	Modflow output of part of model showing grid refinement and relevant structures	

Southern Testing

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

ST Consult

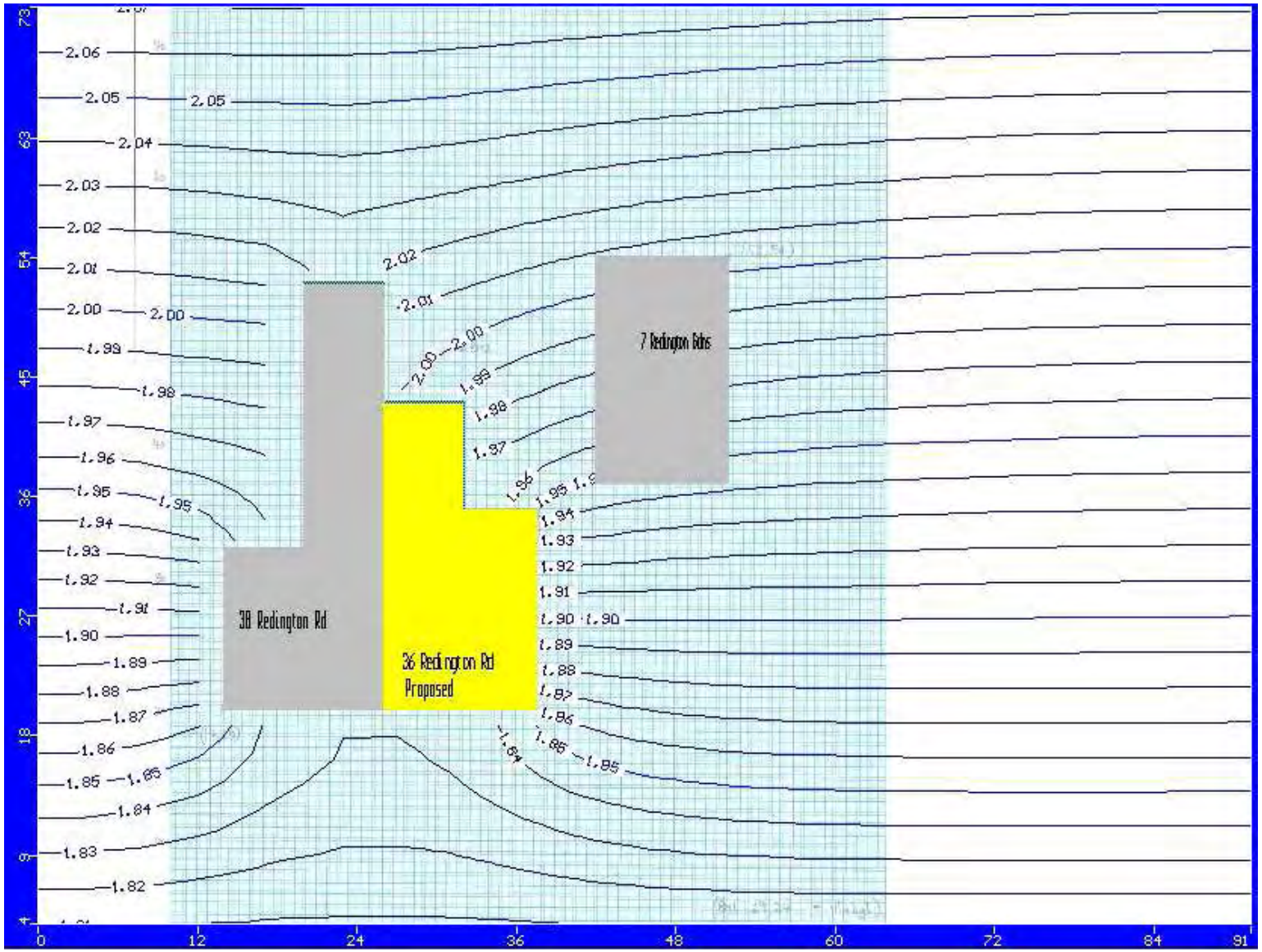


Site: 36 Redington Road, London NW3	STL: J11894	Fig No: G2
Date: 15 May 2015	Modflow output showing existing groundwater conditions (distribution of head)	

Southern Testing

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

ST Consult

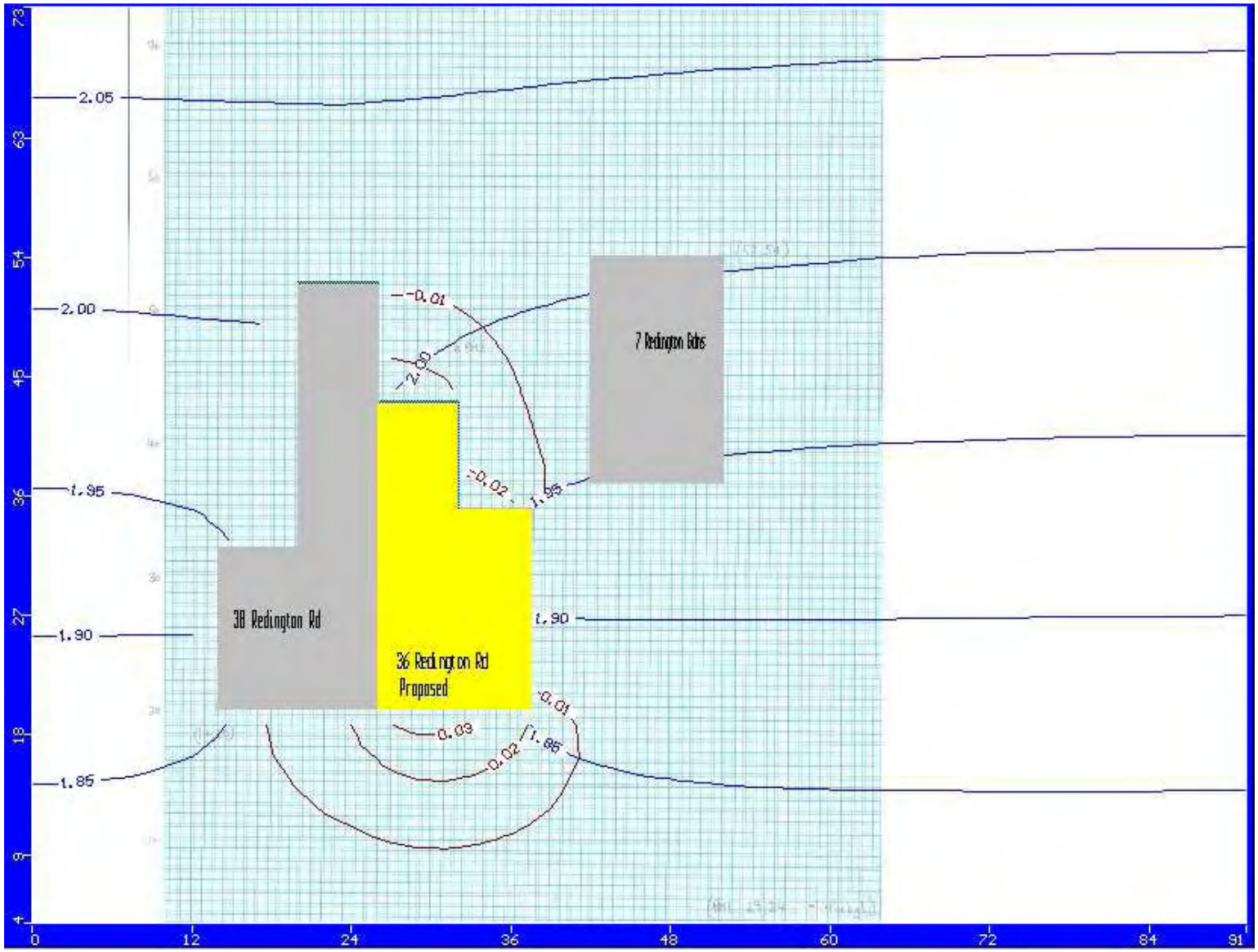


Site: 36 Redington Road, London NW3	STL: J11894	Fig No: G3
Date: 15 May 2015	Modflow output showing modified groundwater conditions (distribution of head) following basement construction at 36 Redington Road	

Southern Testing

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

ST Consult

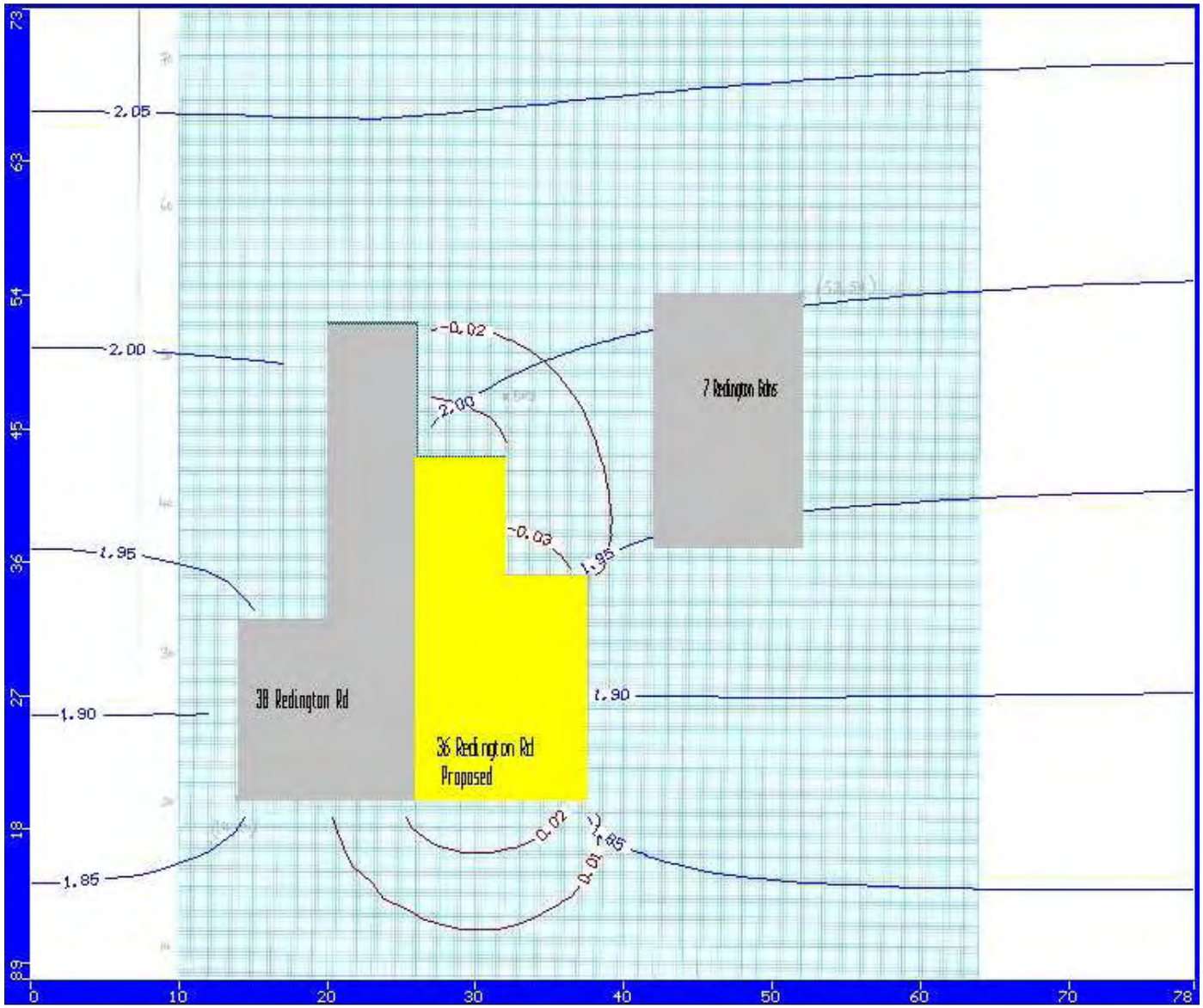


Site: 36 Redington Road, London NW3	STL: J11894	Fig No: G4
Date: 15 May 2015	Modflow output showing contours of change in groundwater levels using permeability of 1E-5m/s (contour scale in cm)	

Southern Testing

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

ST Consult



Site: 36 Redington Road, London NW3	STL: J11894	Fig No: G5
Date: 15 May 2015	Modflow output showing contours of change in groundwater levels using permeability of 1E-7m/s (contour scale in cm)	

Southern Testing

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

ST Consult