Providing Ground Solutions

Pegasus Life Limited

79 Fitzjohn's Avenue, Camden, London

Basement impact assessment – Revision 1

March, 2016

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1. INTRODUCTION

Pegasus Life Limited is proposing the redevelopment of 79 Fitzjohn's Avenue comprising the demolition of the existing buildings onsite and construction of a nine storey structure including two-level basement comprising a lower ground floor (lgf) and basement level. Card Geotechnics Limited (CGL) has been Gleeds Management Services Ltd (the Project Managers for the project) on behalf of Pegasus Life Limited to update the previous Basement Impact Assessment (BIA) for the proposed development to assess the potential impact on surrounding structures and hydrological and hydrogeological features. The structural engineer and basement designer for the project is MLM who has prepared the Basement Construction Plan (BCP). Camden Guidance CPG4[1] requires Basement Impact Assessments (BIA) to be undertaken for new basements in the borough and sets out a 5 stage approach:

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

This report is intended to address the screening, scoping and impact assessment processes set out in CPG4 and the Camden geological, hydrogeological, and hydrological study (CGHHS)[2]. It identifies key issues relating to land stability, hydrogeology and hydrology as part of the screening process. A site investigation has already been carried out for the site. As such, the scoping process will comprise a review of this existing site investigation data and other publically available ground investigation data in the immediate area, and its suitability for use in the BIA and the establishment of a conceptual site model. The report also provides an impact assessment of geotechnical impacts on adjacent structures and the surrounding area based on available site investigation data and structural details. This includes calculations to determine ground movements resulting from the basement excavation, including heave and lateral movements around the basement perimeter.

[1] Camden Planning Guidance, CPG4, Basements and Lightwells, July 2015.
[2] Ove Arup and Partners, Camden geological, hydrogeological, and hydrological study. Guidance for subterranean development, November 2010.

2. SITE CONTEXT

2.1 Site location

The site is located at 79 Fitzjohn's Avenue in the London Borough of Camden and is situated to the southwest of Hampstead Heath. The National Grid reference for the approximate centre of the site is 526446, 185514.

A site location plan is presented in Figure 1.

2.2 Site description

The site is currently undergoing demolition of the existing buildings on site comprising a hotel belonging to the Hyelm Group. The hotel included two five storey buildings, and was surrounded by planters and hard standing to the north-east and south-east. There was an area of soft landscaping to the west of the hotel.

There are four semi-detached houses with private gardens located approximately 5m to the north-west of the site along Fitzjohn's Avenue. These are numbered 81-87. Fitzjohn's Avenue runs along the north-eastern boundary of the site, and Prince Arthur Road bounds the site to the south-east. Two semi-detached houses are located approximately 25m north-west of the site fronting Ellerdale Road. The properties have private, south facing gardens that abut the site. A line of properties is situated approximately 30m south-east of the site, on the southern side of Prince Arthur Road. A tunnel and train line associated with the West Hampstead Thames Link is located approximately 300m south-east of the site.

The north-eastern and south-eastern site boundaries are occupied by hard standing and planters fronting the pavements of Prince Arthur Road and Fitzjohn's Avenue respectively. The north-western boundary of the site is bounded by a brick wall that separates the site from the properties fronting Fitzjohn's Avenue. The western corner of the site is bounded by fences and hedgerows.

A site layout plan is presented in Figure 2.

2.3 Proposed development

The proposed development comprises the demolition of the existing structure and construction of a nine storey complex of buildings including a lower ground floor and a basement level. The basement footprint does not extent below the entire footprint of the proposed buildings, and occupies a broadly rectangular section within the centre of site.

The basement will be formed at a level of approximately 94mOD and will be excavated beneath the lower ground floor level.

The super-structure of the proposed development will be supported on a new piled foundation which will comprise 450/600mm diameter reinforced concrete bearing piles as shown on the MLM Drawings attached in Appendix A.

The excavation of the basement level will be enabled through installation of a secant piled retaining wall from lgf and at its closest, the basement will be approximately 20m from the nearest foundations of the neighbouring properties fronting Fitzjohn's Avenue – 83A Fitzjohn's Avenue (Section A-A), adjacent to the north-western site boundary, and Prince Arthur Road property - 16A Prince Arthur Road (Section B-B), adjacent to the south-western site boundary.

The lower ground floor extends around the perimeter of the proposed building on site and will be formed at a level of approximately 100.3mOD and at its closest will be some 1.5m from the nearest property fronting Prince Arthur Road (Section B-B), and 3.0m from the nearest property on Fitzjohn's Avenue (Section A-A).

Proposed development plans and sections are presented in Appendix A.

2.4 Site history

Ordnance Survey maps dating back to 1870 have been reviewed to inform the BIA. The salient points are summarised below.

Mapping from the 1870's indicates that the area was used as agricultural and private land associated with *Mount Farm*. Some farm buildings were present approximately 50m to the north of the site, and there were trees approximately 100m to the south-west. The site was bounded to the east by *Church Place*, to the south by what appeared to be a garden, and to the west by a field. Several small paddocks were located approximately 100m south-west of the site and extended for approximately 200m in that direction. The map indicates two ponds approximately 300m south-west of the site.

The 1895 map indicates that the farm buildings were partially demolished and the farmland was redeveloped. A building occupied the northern end of the site, whilst the southern end was a private garden. Four semi-detached houses were built approximately 5m to the north of the site, and a further two were built approximately 30m to the west.

Prince Arthur Road was built around this time and bounded the site to the south-east. The road that bounded the north-east of the site was named *Fitzjohn's Avenue*.

There were no significant changes until 1935, when the map indicates a substantial development to the southern end of the site, with the presence of a large building orientated parallel to the existing Prince Arthur Road.

In 1955, the building towards the southern corner of the site was demolished; there was no further significant change noted until 1974, when a new building was built in its place.

Available aerial photographs show that by 1999, both buildings had undergone further development and extension to form one large building, which predominantly occupied the site. A further building had been built in the centre of the site, and hard standing formed a car park between the two buildings. Hard standing and planters were identified along the north-eastern, south-eastern, south-western site boundaries.

No further significant changes were noted between 1999 and present day.

2.5 Bomb damage

The London County Council Bomb Damage Maps 1939-1945 show that there was no recorded bomb damage to any of the buildings within the site area. A building labelled as *St John's House,* located approximately 260m east of the site, suffered 'total destruction', and four houses located approximately 170m south of the site on *Ellerdale Road* suffered 'damage beyond repair'.

However in accordance with the Detailed UXO threat and risk assessment undertaken by Alpha Associates Ltd. (2016)[3] for the site, although there is no record of any High Explosive (HE) bomb strikes within the site itself, the Air Raid Precaution (ARP) did note HE bomb strikes (during WWII) recorded specifically 5m northwest, 45m northwest, 125m northwest, 150m southwest, 155m south, 185m southeast and 185m west of site.

It is noted within the UXO assessment[3] that the site has been subjected to several stages of post-war development and demolition and most likely that any UXO's within the structural footprint of the post-war structures on site would have been discovered and removed.

[3] Alpha Associates Ltd, Fitzjohn's Avenue, Hampstead, London NW3 6PA, Report on Detailed Unexploded Ordanance (UXO) Threat & Risk Assessment, February 2016.

Nevertheless a risk level of low/medium was proposed mainly due to the potential for WWII German HE bombs and a residual risk due to projectiles used to defend against German bombing raids during WWII.

2.6 Topography

The site is located on the south-western side of *Parliament Hill*. The topography of the site slopes towards the west/south-west, decreasing in elevation from 106.39mOD in the eastern corner of the site, to 101.99mOD in the western corner of the site. To the north, the corner of the site is at 105.94mOD, and to the south it is at 102.71mOD. The topography of the site from east to west slopes at approximately 3.7° (1:16 gradient).

The topography is typified by a 'ridge' trending in a north-westerly to south-easterly direction. The area surrounding the site generally slopes up towards the north-east (before slope down on the opposite side of the 'ridge') at an angle of approximately 5° (1:11 gradient) and slopes down towards the south-west at an angle of approximately 3.5° (1:16 gradient).

2.7 Published geology

With reference to the British Geological Survey (BGS) sheet 256[4] for the local area, the site is shown to be underlain by the Bagshot Formation from the surface. No superficial deposits are noted to be in the area of the site. The Bagshot Formation is underlain by the Claygate Member, which is in turn underlain by the London Clay formation, Lambeth Group and the Thanet Sand Formation, with Chalk at depth.

The Bagshot Formation is a predominantly light yellow-brown grey laminated, fine to coarse grained sand. Thin lenses of white sand and 'pipe clay' occur sporadically, increasing in thickness towards the top of the unit. The formation has a basal bed of gravelly coarse grained sand.

The Claygate Member consists of dark grey clays, interbedded with laminated sands and bioturbated silts. Ferruginous concretions and septarian nodules are observed in places.

The London Clay is a very stiff, highly fissured and over consolidated grey blue clay. It typically has a high plasticity, and is finely laminated. It may contain silty or fine grained

[4] British Geological Survey. (1994). *North London*. England and Wales Sheet 256. Solid and Drift Geology. 1:50,000 Series.

sandy units, as well as claystone, calcareous and phosphatic nodules, as well as traces of gypsum and pyrite.

2.8 Unpublished geology

Historical BGS borehole records within 500m of the site have been reviewed to place the site within a wider geological context and are summarised in Table 1.

Table 1. Summary of BGS borehole records.

BH record	Approximate Distance (m)	[bearing]	Base of BH (mbgl)	Ground water level (mbgl)	Stratum (depth encountered in mbgl)				
					MG/TS	Possible Head Formation	Bagshot Formation	Claygate Member	London Clay
TQ28NE44 BH1	75	E	9.1	-	GL	-	0.91	5.18	-
TQ28NE44 BH2	75	E	9.1	-	GL	-	0.60	5.36	-
TQ28NE44 BH3	75	E	12.19	-	GL	-	0.79	10.05	-
TQ28NE44 BH4	75	E	6.09	-	GL	-	1.09	1.40	-
TQ28NE95	350	NW	12.67	9.75	GL	0.60	1.82	3.35	5.48
TQ28NE6	430	NE	182.88	-	GL	-	-	-	2.13

The BGS borehole records are in general agreement with the conditions anticipated based on the geological sheet. The Bagshot Formation and Claygate Formation were not recorded in TQ28NE6 and correspond directly to a sharp decline in topography, with the borehole record located on the opposite side of the 'ridge'. This does not correlate with the North Camden Geological Map which indicates that the Claygate Member should be present within the borehole.

Made Ground was recorded in the BGS borehole records, with the thickness varying from site to site, based on the individual site history. No superficial deposits were recorded in the BGS borehole records reviewed.

The top of the London Clay was encountered at approximately 85mOD during a CGL investigation undertaken some 125m to the south of the site.

2.9 Hydrogeology

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

The bedrock has been classified as a Secondary 'A' aquifer, and is classified as a Minor Aquifer High groundwater vulnerability zone. The site is not within a groundwater source protection zone.

2.10 Hydrology

The nearest recorded surface water feature is *Highgate Ponds* located approximately 900m northeast of the site. These are a string of six ponds that correspond with the interface of the Claygate Member and the underlying London Clay.

Existing and historical spring lines are present at the interface of the Claygate Member and the underlying London Clay. These springs have been the source of a number of London's 'lost' rivers, notably the *Fleet*, *Westbourne* and *Tyburn*, most of which are now diverted underground. Several river sources are located to the west and south of the site.

The closest tributary source was situated approximately 300m south of the site. It formerly flowed roughly from the north to south, parallel to the existing *Netherball Gardens*, located approximately 50m to the west of the site. The groundwater is likely to be sourced from spring's lines at the interface of the London Clay and Claygate Beds. Given the proximity of this former water course to the site, it is possible that some fluvial reworking of the shallow soils may be present between *Netherball Gardens* and the site.

The next closest tributary was located some 320m to the south-east of the site.

2.11 Flood risk

With reference to Environment Agency mapping, the site is not located within a Flood Risk Zone. Notwithstanding this, and with reference to Figure 15 (Flood Map) of the Arup report[2], Finchley Road and Frognal (located to the southwest of the site) were flooded in 2002, and *Arkwright Road* (located to the south of the site) was flooded in 1975.

3. SCREENING (STAGE 1)

3.1 Introduction

A screening process has been adopted in accordance with CPG4, based on the flowcharts presented in that document. Responses to the questions posed by the flowcharts are presented below, and where 'yes' or 'unknown' may be simply answered with no analysis required, these answers have been provided.

3.2 Subterranean (Groundwater) flow

This section answers questions posed by Figure 3 in CPG4:

Table 2. Responses to Figure 3, CPG4.

Question	Response	Action required
1a. Is the site located directly above an aquifer?	Yes The site is located over a secondary 'A' aquifer corresponding to the Bagshot Formation.	Confirm by investigation and assessment
1b. Will the proposed basement extend beneath the water table surface?	Unknown Unpublished geological records are unclear as to where the groundwater level is.	Confirm by investigation and assessment
2. Is the site within 100m of a watercourse, well or potential spring line?	No The nearest former tributary of the former *River Westbourne* was located approximately 300m to the south of the site.	None
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No The site is not within the catchment of the chain ponds on *Hampstead Heath* which are situated approximately 900m northeast of the site.	None
4. Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	No Although the proposed structure will extend further than the existing building, the area is already under hardstanding.	None
5. As part of site drainage, will more surface water than at present be discharged to ground (e.g. via soakaways and/or SUDS)?	No No significant change is being made to area of hard standing at the surface. Surface water will be discharged to the sewer network through connections.	None

Question	Response	Action required
6. Is the lowest point of the proposed excavation close to, or lower than, the mean water level in any local pond or spring lines?	No Although the spring lines and ponds of *Hampstead Heath* noted to the south and north-east are at a lower elevation than the site.	None

In summary, it is considered that the basement excavation will not affect or be effected by surface water features, specifically the pond chains on *Hampstead Heath*, or local former surface water features. The site is situated above an aquifer, and this should be taken into consideration in the design and construction of the basement.

3.3 Slope/land stability

This section answers questions posed by Figure 4 in CPG4.

Table 3. Responses to Figure 4, CPG4.

Question	Response	Action required
1. Does the site include slopes, natural or man-made, greater than approximately 1:8?	No The general gradient is approximately 1:16	None
2. Will the proposed re-profiling of the landscaping at site change slopes at the property boundary to greater than approximately 1:8?	No	None
3. Does the development neighbour land including railway cuttings and the like with a slope greater than approximately 1:8?	No	None
4. Is the site within a wider hillside setting in which the general slope is greater than approximately 1:8?	No With reference to Figure 16 within the Arup report[2], slope angles are less than 7°.. The topography of the surrounding area generally slopes up towards the north-east a gradient of 1:11 and slopes down towards the south-west at a gradient of 1:16 gradient.	None
5. Is the London Clay the shallowest stratum on site?	No	Confirm by investigation and assessment

Question	Response	Action required
6. Will any trees be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained?	Yes Excavations and retaining wall construction are to be undertaken within existing tree protection zones. Design to address issues by avoiding the application of loads and stresses on the roots and ensuring that the footprint of the excavation will not extend beyond the current limits. King pile walls have been proposed to minimise disturbance within the root protection zones.	None
7 Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such at the site?	Unknown The shallow soils, particularly the cohesive beds of the Clay Member are likely to be susceptible to volume change, however, no damage to buildings has been identified.	Impact assessment
8. Is the site within 100m of a watercourse or a potential spring line?	No The nearest former tributary was situated approximately 300m away.	None
9. Is the site within an area of previously worked ground?	No Site history is agricultural and residential.	None
10. Is the site within an aquifer and if so will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No See Table2, Question 1a.	Confirm by investigation and assessment
11. Is the site within 50m of the Hampstead Heath ponds?	No The *Hampstead Heath* ponds are located approximately 900m to the north-east of the site.	None
12. Is the site within 5m of a highway or pedestrian right of way?	Yes The site is bounded to the northeast by *Fitzjohn's Avenue*, and *Prince Arthur Road* to the southeast.	Impact assessment
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes The proposed basement will be deeper than the foundations of the neighbouring property 83A Fitzjohn's Avenue (approximately 102.3 mOD) and the neighbouring property at 16A Prince Arthur Road (approximately 100.5 mOD)	Impact assessment
14. Is the site over (or within the exclusion zone of) any tunnels?	No	None

In summary, there is Bagshot Formation, Claygate Member and London Clay located below the site, and it is anticipated that heave movements/long term settlement will occur during construction and over the long-term. Construction related settlement may also occur as the proposed basement walls are installed. The Bagshot Formation and granular beds of

the Claygate Member are susceptible to running sands conditions where groundwater or perched water is present. The London Clay is anticipated at approximately 85mOD.

A basement impact assessment will be undertaken to determine the likely magnitude of ground movements around the basement perimeter. This will include the effects of deflections of retaining walls and associated ground settlement. The results of the ground movement analysis will be used to assess potential damage categories developed in adjacent structures.

3.4 Surface flow and flooding

This section covers the main surface flow and flooding issues as set out in CPG4, however detailed design of the site drainage will be completed by other parties.

Table 4. Responses to Figure 5, CPG4.

Question	Response	Action required
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No	None
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off), be materially changed from the existing route?	No	None
3. Will the proposed development result in a change in the proportion of hard surfaced/paved external areas?	No	None
4. Will the proposed basement result in a change to the profile of the inflows of surface water being received by adjacent properties or downstream watercourses?	No It is understood that all surface water will be discharged to the sewer network through existing connections and the volumes of surface water run-off from the site are not anticipated in increase significantly.	None
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No The construction of the basement will remove existing Made Ground from this area of the site. As such there will be no degradation in water quality to adjacent properties or downstream water courses.	None

Question	Response	Action required
6. Is the site in an area known to be at risk from surface flooding, or is it at risk from flooding because the proposed basement is below the static water level of a nearby surface water feature?	No Arkwright Road and other local roads were flooded previously.	None

In summary, the proposed basement will not result in a change to the area of hard surfaces and therefore there should be no change in volume of surface run-off water, or a material reduction in attenuation characteristics. It is understood that all surface water is discharged to the sewer network through existing connections and the volumes of surface water run-off from the site are not anticipated to change.

With reference to Environment Agency mapping, the site is not located within a Flood Risk Zone. Notwithstanding this, and with reference to Figure 15 (Flood Map) of the Arup report, Finchley Road and Frognal (located to the southwest of the site) were flooded in 2002, and Arkwright Road (located to the south of the site) was flooded in 1975.

3.5 Summary

On the basis of this screening exercise, the basement impact assessment will address the following:

Table 5. Summary of Basement Impact Assessment requirements.

Item	Description
1.	*Subterranean (Groundwater flow)* Confirm the ground conditions and if groundwater is present within the Bagshot Formation/Claygate Beds and, therefore, whether groundwater will be a consideration for the basement design, and if the basement will effect groundwater flows in and around proposed structures within the Secondary A Aquifer.
2.	*Slope stability* Estimate movements associated with construction in Bagshot Formation/Claygate Beds and London Clay, including short and long term heave movements, settlement associated with retaining wall deflections, foundation settlement and ground movements around the basement perimeter.
3.	Impact assessment to determine effect of basement construction on adjacent residential properties and infrastructure.

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

4. SCOPING (STAGE 2)

4.1 Introduction

This section of the report covers the scoping process (Stage 2) of the assessment in accordance with CPG4, which is used to identify potential impacts of the proposed scheme and establish a conceptual site model. The scoping stage also informs the scope of the site investigation.

4.2 Existing Site Investigation

An intrusive investigation was undertaken in August 2014 by Ian Farmer Associates[5] (Ian Farmer) and factual details are presented in Appendix C. The investigation comprised the excavation of three window sampler boreholes (BH1, BH3 & BH4) and two cable percussions boreholes (BH2 and BH5) to depths of between 11mbgl and 20mbgl.

In-situ testing was undertaken and comprised Standard Penetration Tests (SPTs). Groundwater monitoring wells were installed within the boreholes BH2, BH4 and BH5 and the groundwater level was monitored on three occasions.

Three inspection pits were excavated on the north-western site boundary to expose and record the existing foundations. The foundations are likely to be consistent with those of the neighbouring properties and the details have been used with the land stability assessment.

The intrusive investigation is considered to be sufficient to generate the ground model for the development.

[5] Ian Farmer Associates, Fitzjohn's Avenue, Hampstead NW3 6PA, Report on Phase 2 Ground Investigation, November 2014..

5. GROUND AND GROUNDWATER CONDITIONS

5.1 Summary

With reference to the Ian Farmer intrusive investigation[5], the ground conditions beneath the site generally comprised a limited thickness of Made Ground over interbedded sands and clays, over clay. The summary of ground conditions presented in the Ian Farmer investigation has been reproduced in Table 6 below.

Table 6. Summary of Ian Farmer investigation findings

Stratum	**Depth encountered (mbgl) [mOD]***	**Thickness (m)**
Made Ground/possible Made Ground	0.0 [106.1 to 102.1]	0.25 to 1.8
Bagshot Formation	0.25 to 1.8 [102.95 to 100.4]	6.8 to 14.65
Claygate Member (London Clay Formation	8.5 to 14.9 [93.6 to 88.3]	>11.5 Proven to 20mbgl

*mOD levels indicative only.

Although the Ian Farmer report provides a summary of the ground conditions with strata names, the boreholes records do not. On this basis, the lithostratigraphy has been interpreted by CGL with reference to known regional geology and correlations with previous near-by borehole records. Plots of SPT 'N' versus level and cu versus level are presented in Figure 3 and Figure 4 respectively.

A generalised geological section is presented within the conceptual site model (Figure 5). It is noted that the shallow soils are highly variable, comprising interbedded sands and clays and there is no clear differentiation between the granular Bagshot Formation and interbedded Claygate Member. On this basis, the strata will be considered undifferentiated within the ground movement assessment.

Although not identified as such by Ian Farmer, soils with a description consistent with the London Clay Formation were encountered in borehole BH2 at approximately 86mOD and borehole BH5 at approximately 87.4mOD. The soils are described as stiff, fissured, dark grey, silty, sandy clay.

Groundwater was encountered within the granular soils of the Bagshot Sand/Claygate Member at levels between 94.3mOD and 95.7mOD during three monitoring visits in 2014. For design purposes, groundwater level has been taken at 96.0mOD.

5.2 Geotechnical Parameters

Geotechnical design parameters for the ground conditions encountered have been derived based on the soil descriptions and in-situ testing within the available borehole records.

The geotechnical design parameters utilised within the PDISP settlement/heave analysis and Wallap analysis are outlined in Table 7 below.

Table 7. Geotechnical design parameters adopted within BIA analysis

Stratum	**Design level (mOD)**	**Bulk Unit weight γ_b (kN/m³)**	**Undrained Cohesion c_u (kPa) [c']**	**Friction angle Φ' (°)**	**Young's modulus E_u (MPa) [E']**
Made Ground (Granular)	Varies	18	0[b]	30[b]	2.5[b] [1.9]
Bagshot Formation/Claygate Member (granular)	Varies	20	-	32[c]	[30]
Bagshot Formation/Claygate Member (cohesive)	Above 98mOD	18	55[a] [0]	25[b]	27.5[c] [20.6][d]
Bagshot Formation/Claygate Member (cohesive)	Below 98mOD	18	50+7.5z[f] [0]	32[b]	25+4.5z[c] [18+3.4z][d]
Possible London Clay Formation	85	19	147+7.5z[f] [5]	-	88+4.5z[c] [66+3.4z][d]

a. Based on empirical relationship of Cu = 4.5N(SPT) (Stroud,1989)
b. BS 8002:2015 Code of practice for Earth retaining structures, British Standards institution.
c. Burland, J., Standing, J. and Jardine, F. (2001). Building Response to Tunnelling, CIRIA.
d. Based on 500 Cu for Bagshot Formation/Claygate Beds and 600 Cu for London Clay - Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.
e. Based on 0.75Eu - Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.
f. z = depth below design level.

The geotechnical design parameters utilised within the WALLAP retaining wall analysis consider that the presence of sand beds within the Bagshot Formation/Claygate Member will facilitate the movement of water between the clays and sands and as such the soils are expected to behave in the drained condition. This is considered reasonable as the soils are highly variable in nature and are likely to have a reasonably high mass permeability.

The above values are considered to be moderately conservative and are unfactored (Serviceability Limit State) parameters.

5.3 Conceptual site model

A conceptual site model (CSM) has been developed based on the available data and in accordance with the recommendations of the Arup CGHHS report[2] and is presented diagrammatically in Figure 5.

5.3.1 Critical sections

Four critical sections for analysis have been identified for analysis, their locations are shown on Figure 2.

- Section A-A: from north-west to south-east through adjacent property on *Fitzjohn's Avenue – 83A Fitzjohn's Avenue* and north-western lower ground floor wall; and;
- Section B-B: from north-east to south-west through adjacent property on *Prince Arthur Road – 16A Prince Arthur Road* and south-western lower ground floor wall; and;
- Section C-C: from north-east to south-west through the roadway of *Fitzjohn's Avenue* and north-eastern lower ground floor wall.
- Section D-D: from north-west to south-east through adjacent property on *Ellerdale Road – 3A Ellerdale Road* and north-eastern lower ground floor wall.

Section A-A and Section B-B have been analysed to assess the potential for ground movements due to the construction of the basement to cause damage to the neighbouring properties 83A Fitzjohn's Avenue and 16A Prince Arthur Road respectively.

With reference to Figure 5, Sections C-C has been analysed to indicate the potential ground movements which may impact on Fitzjohn's Avenue and Section D-D has been analysed to indicate potential ground movements to the rear garden of the property 3A Ellerdale Road.

6. SUBTERRANEAN (GROUNDWATER) FLOW (STAGE 4)

6.1 Introduction

This section addresses outstanding issues raised by the screening process regarding groundwater flow (see Table 2).

Although the Bagshot Formation/Claygate Member is designated a Secondary 'A' Aquifer, groundwater has been recorded at a level below the proposed basement and, on this basis, the proposed basement is not considered impact upon the aquifer.

6.2 Impact on groundwater flow

Groundwater was encountered within the granular soils of the Bagshot Sand/Claygate Member at a level between 94.3mOD and 95.7mOD. It is anticipated that groundwater will be flowing towards the south within the Bagshot Formation/Claygate Member. This is considered to represent an unconfined perched aquifer above the Claygate Member.

Groundwater is likely to be approximately 1.3m above or at the proposed basement level (94.4mOD) therefore groundwater controls during construction of the basement section are required. The installation of secant piled retaining walls to enable the construction of the basement will provide adequate groundwater control and may provide a barrier to ground water flow between 94mOD to 89mOD (potential toe level of the secant piles).

However due to the relatively small size of the proposed basement section on site, it is anticipated that groundwater will be able to flow freely around the basement perimeter within the relatively permeable soils. On this basis, the proposed development is unlikely to have further cumulative impacts on groundwater flow.

6.3 Recommendations for groundwater control

Groundwater has been encountered within the granular Bagshot Formation/Claygate Member at a depth approximately 1.3m above or at the proposed basement.

The proposed construction of a secant piled retaining wall to enable the excavation of the basement will also control ground water from lower ground floor level (+100.3mOD) to below the basement formation level (+94mOD) allowing dry excavation condition during construction within the basement area. Should water bearing sand horizons/lenses be encountered at shallower depths than the proposed lower ground floor level (i.e. >100.3mOD) then some limited seepage into excavations may be encountered. It is

considered that this limited seepage will be low in volume and may be controlled through localised sump pumps, however such conditions are not anticipated based on the available information

7. LAND STABILITY (STAGE 4)

7.1 Introduction

This section provides calculations to assess ground movements that may result from the excavation of the lower ground floor level to typically 100.3mOD and the excavation of the basement level of typically 94mOD and how these may affect adjacent structures. It is understood that a secant piled wall will be used to retain the excavation of the basement level and a combination of king-post, and sheet piled retaining walls will enable the excavation of the lower ground floor level.

Ground movements are considered to derive from:

- Piled wall installation: Ground disturbance during retaining wall installations may cause ground settlement/ heave;
- Piled wall deflection: Deflection of the piled walls during excavation may cause settlement behind the wall, which could impact the neighbouring property and garden party walls;
- Heave movements: The London Clay is susceptible to short term heave and time dependant swelling on unloading, which will occur as a result of the demolition on site and basement excavation, generating upward ground movements; and
- Long term ground movement: The net loading on formation soils will generate ground movement, which could affect adjacent foundations. This takes into account existing stress conditions, additional loads from the new structure and total stress reduction from the excavated soil.

7.2 Ground movements due to piled wall installation

With reference to CIRIA C580[6], horizontal and vertical surface movements due to the installation of King-post piled walls through the use of pre-boring are assumed to follow that of contiguous piled construction which are generally reported not to exceed 0.04% and 0.05% of the wall depth respectively. The distance to negligible movements is anticipated to be no more than twice the wall depth.

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

An assessment of heave due to sheet pile installation has been undertaken in accordance with the approached presented by Finno *et. al*, (1998)[7] which considers the potential volume change (heave) of the ground due to the inclusion of the sheet piles. The reduction in heave behind the wall is based on a 45 degree spread.

The calculated vertical and horizontal ground movements due to retaining wall installations within each section are summarized in Table 9 below.

Table 8. Summary of Vertical and Horizontal Ground Movements due to Wall Installation

Section	Structure Type	Section Size	Max. Excavation Depth [m]	Total Wall Depth [m]	Max. Horizontal Displacement [mm]	Max. Vertical Displacement [mm]
					At Building Level*	At Building Level*
Section A-A	King Post Wall	600mm /2.5m crs	5.00	7.90	2.4	4.0 (Settlement)
Section B-B	Sheet Pile Wall	PU12	2.60	4.20	0.9	-3.5 (Heave)
Section C-C	Sheet Pile Wall	PU18^{-1}	6.00	8.80	3.1	-3.9 (Heave)
Section D-D	Sheet Pile Wall	PU12	2.80	6.5	2.6	-3.5 (Heave)
*Level of assumed foundations of the adjacent buildings as follows: -Section A-A: Adjacent Property 83A Fitzjohn's Avenue foundation level assumed at approx. 102mOD -Section B-B: Adjacent Property 16A Prince Arthur Road foundation level assumed at approx. 100mOD -Section C-C: Road level approximately 106mOD -Section D-D: Adjacent Property 3A Ellerdale Road rear garden level assumed at approx. 102mOD						

7.3 Ground movement arising from basement excavation

The calculated unloading due to excavation takes account of the slope from around 106mOD in the north-east to around 102mOD in the south-west of the site and assumes a formation level across the basement of 100.3mOD at the lower ground floor level and maximum excavation of 94mOD at basement level. On this basis, the soils at formation level will be subject to stress relief during excavation, as between 2m to 10m of overburden is removed to form the basement and lower ground floor levels including up to 0.8m of basement floor slab and heave precautions. This is likely to give rise to a degree of elastic heave over the short term and potential heave or settlement over the longer term

[7] Richard J. Finno, Steven M. Nerby, and Dimitrios K. Atmatzidis, "Ground response to sheet pile installation in clay" (June 1, 1988).International Conference on Case Histories in Geotechnical Engineering. Paper 34.

as pore pressures recover in the cohesive units of the Bagshot Formation/Claygate Member and the underlying London Clay.

Given the highly variable nature of the Bagshot Formation/Claygate Member, comprising interbedded sands and clays, the analysis has assumed cohesive soils at formation level and below, acting in the drained condition. This is considered to be a conservative, worst-case assessment of potential heave movements. The magnitude of such movements has been assessed using OASYS Limited *PDISP* (*Load (**P**) **DISP**lacement*) analysis software. *PDISP* assumes that the ground behaves as an elastic material under loading, with movements calculated based on the applied loads and the soil stiffness (E_u and E') for each stratum input.

The proposed basement development gives rise to a net unloading of the underlying strata both during construction and over the long term. The excavation the proposed basement will unload the soils at the lower ground floor formation level by between 50kPa to 90kPa, and at the basement formation level of approximately between 130kPa to 190kPa. These values assume a typical bulk unit weight of 19kN/m^3 for cohesive excavated soils. The combined effects of both the immediate undrained unloading and the long-term drained recovery of pore pressures have been analysed.

The loading information and drawings provided by the structural engineers indicate that the basement slab will be underlain by heave board to accommodate positive vertical displacements of the ground subsequent to unloading, and will be dowelled into piles forming the secant piled wall. Due to this, no additional net loads are modelled in the long term as structural loads are transmitted to the ground by the piles.

7.3.1 PDISP results

Total heave is predicted to be approximately 85mm, occurring beneath the central region of the proposed basement, reducing to around 10mm to 15mm around the basement perimeter and 10mm at the nearest foundation of the adjacent property on Prince Arthur Road.

There is potential for up to 5mm to 10mm of undrained heave within the London Clay around at the basement perimeter, reducing to around 5mm at the nearest foundation of the adjacent property on Prince Arthur Road.

A contour plot showing the short-term ground movements caused by the demolition of the existing buildings on site and the basement excavation within Figure 6 and the long-term

ground movement contour plot is presented in Figure 7. Full PDISP output can be provided upon request.

7.4 Ground movements due to retaining wall deflections

7.4.1 General

Ground movements due to retaining wall deflections have been calculated using GeoSolve WALLAP retaining wall analysis software. Four critical sections have been identified and analysed for Serviceability Limit State (SLS) in accordance with *BS 8002:1994 Code of practice for Earth retaining Structures*. Indicative construction details and methodology have been assumed based on the information supplied by the structural engineer.

7.4.2 WALLAP model assumptions

The WALLAP analysis includes the following assumptions:

1. King-posts such as those used in Section A-A to be installed in a 600mm diameter drilled holes spaced at 2.5m centres. King-post retaining wall to retain the soil below ground level during excavation of the lower ground floor level;

2. PU12 Section Sheet piles to be installed in Section B-B and Section D-D to retain the soil below ground level during excavation of the lower ground floor level;

3. PU18^{-1} Section Sheet piles to be installed in Section C-C to retain the soil below ground level during excavation of the lower ground floor level;

4. The following adjacent property foundations surcharge loads were assumed for:

    - Section A-A - A 150kPa surcharge was applied 0.5m behind the wall to a 1.0m wide strip to the north of the site to model the imposed load from 83A Fitzjohn's Avenue.

    - Section B-B - A 30kPa surcharge was applied 1.0m behind the wall to the west of the site to model the imposed load from 16A Prince Arthur Road.

5. For Section C-C a 10kPa surcharge was applied to the eastern site boundary to model Fitzjohn's Avenue and a 20kPa surcharge was applied adjacent to the retention wall as an allowance for facilities on site which may be present.

6. At Section D-–D a 5kPa surcharge was applied to model live loads (from pedestrian traffic) within site boundary and the rear garden of 3A Ellerdale road.

The piled retaining walls will be propped in the temporary condition to provide stability and limit deflections.

7.4.3 Retaining wall construction sequence

7.4.3.1 Section A-A

The proposed construction sequence for Section A-A (King-post retaining wall) is as follows:

- Form base of piling platform at +102.15mOD and install king post piles;
- Excavate to +102.5mOD and install struts at +103.0mOD; a berm will be required for the installation of the raking prop;
- Continue excavation to the required dig level (+99.6mOD) to enable construction of floor slab.

7.4.3.2 Section B-B

The proposed construction sequence for Section B-B (Sheet piled wall – PU12) is as follows:

- Install sheet pile;
- Remove existing structure;
- Form piling platform at +102.0mOD for the installation of foundation piles;
- Excavate to +101.2mOD and install raking prop at +101.7mOD;
- Excavate to +99.6mOD to enable construction of floor slab.

7.4.3.3 Section C-C

The proposed construction sequence for Section C-C (Sheet piled wall – $PU18^{-1}$) is as follows:

- Install sheet pile walls;
- Form piling platform at +103.0mOD and form a berm to the top of the excavation;
- Excavate to +102.5mOD and install props at +103.0mOD;

- Excavate to +100.2mOD to enable construction of floor slab.

7.4.3.4 Section D-D

The proposed construction sequence for Section D-D (Sheet piled wall – PU12) is as follows:

- Install sheet pile wall;
- Form piling platform at +102.0mOD for the installation of foundation piles;
- Excavate to +99.6mOD to enable construction of floor slab.

7.4.4 WALLAP results

The WALLAP results for piled wall deflections and corresponding horizontal and vertical ground movements arising from deflections of the retaining walls in each section are presented in Table 10 below. Full WALLAP output is available on request.

Table 9. Pile wall deflection and corresponding ground settlement.

Critical section Reference	Deflection at top of pile (mm)	Maximum wall deflection (mm)	Level of max. deflection (mOD)	Max. Horizontal Displacement [mm]	Max. Vertical Displacement [mm]
				At Building Level*	At Building Level*
Section A-A	7.0	7.0	101.1	6.0	3.0 (Settlement)
Section B-B	1.0	2.0	100.2	2.0	1.0 (Settlement)
Section C-C	13.0	13.0	106.2	11.0	5.5 (Settlement)
Section D-D	11.0	11.0	102.5	11.0	2.5 (Settlement)
*Level of assumed foundations of the adjacent buildings as follows: -Section A-A: Adjacent Property 83A Fitzjohn's Avenue foundation level assumed at approx. 102mOD -Section B-B: Adjacent Property 16A Prince Arthur Road foundation level assumed at approx. 100mOD -Section C-C: Road level approximately 106mOD -Section D-D: Adjacent Property 3A Ellerdale Road rear garden level assumed at approx. 102mOD					

Movements should be reviewed once the loading, construction sequence and methodology have been finalised.

7.5 Damage category assessment

The calculated ground movements have been used to assess potential 'damage categories' that may apply to neighbouring properties due to the proposed lower ground level and basement construction. The methodology proposed by Burland and Wroth[8] and later supplemented by the work of Boscardin and Cording[9] has been used, as described in *CIRIA Special Publication 200*[10] and *CIRIA C580*[11].

General damage categories are summarised in Table 11 below:

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

Category	Description
0 (Negligible)	Negligible – hairline cracks
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm)
2 (Slight)	Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm).
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks > 3mm).
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15mm to 25mm but also depends on number of cracks).
5 (Very Severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

For the critical sections the impact of short term heave, long term movements and pile wall deflection/installation have been combined to determine the deflection ratio and general combined vertical ground movements for the adjacent properties and structures which are presented graphically in Figure 8, Figure 10, Figure 12 and Figure 14.

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

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

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

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

Horizontal movements are calculated based on deflections behind the retaining walls determined during the WALLAP analysis. The combined lateral ground movements for each critical section is presented graphically in Figure 9, Figure 11, Figure 13, and Figure 15.

7.5.1 Damage Categories for Sections A-A and B-B

The calculated for Sections A-A (83A Fitzjohn's Avenue) with an assumed property width of 8m and Section B-B (16A Prince Arthur Road) which has an assumed width of 3m (single storey extension building adjacent to site are summarized in Table 12 below.

Table 11. Summary of ground movements and corresponding damage category.

Party Wall Reference	Horizontal movements at neighbouring foundation (mm)	Maximum deflection (mm)	Horizontal Strain Δ/L^b (%)	Deflection ratio δ_h/L^a (%)	Damage category
Section A-A 83A Fitzjohn's Avenue	4.0	3.0	0.0499	0.0375	1 – very slight
Section B-B: 16A Prince Arthur Road	1.0	1.0	0.0332	0.0333	1 – very slight

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

The predicted damage category imposed on the neighbouring properties due to the proposed lower ground level and basement development and assuming a good standard of workmanship will be marginally 'Category 1' corresponding to very slight damage for 83A Fitzjohn's Avenue and marginally 'Category 1' corresponding to very slight damage if for 16A Prince Arthur Road.

These damage categories are presented graphically in Building Interaction Chart in Figure 16.

7.5.2 Damage Categories for Sections C-C and D-D

Although no properties exist within Section C-C or Section D-D, the Fitzjohn's Avenue roadway (consisting of a single carriageway each direction) with an assumed with of 6m, and the rear garden of 3A Ellerdale Road property have been analysed to indicate the potential damage to these structures caused by the proposed works on site.

With reference to Figure 12 and Figure 13, up to 20mm of heave and 4mm of horizontal deflection is anticipated beneath the carriageway of Fitzjohn's Avenue and on this basis

the proposed construction works onsite is unlikely to cause significant damage to these structures.

With reference to Figure 14 and Figure 15 the rear garden of 3A Ellerdale Road has a maximum predicted vertical ground movement of 15mm (heave) and 3.7mm of horizontal deflection. It is therefore suggested that the proposed construction works on site is unlikely to cause significant damage the rear garden brick walls.

7.5.3 Sensitivity check on the damage category.

A supporting system has been designed to ensure the stability of the retaining walls and limit associated deflections within acceptable limits during Stage 2 Construction. The required props will be standard UC steel sections or proprietary props, installed as horizontal or raking props accordingly. The props will be pinned on steel wallings (UB standard sections) along the perimeter of the site and on reinforced concrete corbels along the perimeter of the basement capping beam.

A sensitivity check has been carried out in the worst case scenario for section A-A where cumulative deflections due to both the retaining wall and wallings have been considered in the building damage assessment. Under this assumption the maximum cumulative deflection achieved is approximately 11mm and will move the potential damage of the neighbouring property slightly closer to damage category 2 in the building assessment.

7.6 Monitoring strategy

The results of the ground movement analysis suggest that with good construction control, damage to adjacent structures generated by the assumed construction methods and sequence are likely to be (within Category 1) 'very slight'. To ensure movements do not fall outside of that predicted, it is recommended that a formal monitoring strategy is implemented on site to observe and control ground movements during construction.

A triggering level of 4mm Green, 6mm Amber and 8mm Red should be considered to contain the movement within a category 1 for the building damage assessment.

The monitoring system should operate broadly in accordance with the 'Observational Method' as defined in CIRIA Report 185[12]. Monitoring can be undertaken by using positional surveys compared to baseline values established before any excavation work is

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

undertaken onsite. Regular monitoring of these positions will determine if any horizontal translation, tilt or differential settlement of the neighbouring structure is occurring as the construction progresses. Monitoring data should be checked against predefined trigger limits and can also be further analysed to assess and manage the damage category of the adjacent buildings as construction progresses.

8. SURFACE FLOW AND FLOODING (STAGE 4)

It is noted in Section 3.4 of this report that the proposed basement will not significantly alter present surface water conditions as the majority of the site is currently occupied by buildings or hardstanding.

As already identified, the site lies outside any EA designated Flood Zone and the site is not located on a street that flooded in the 1975 and 2002 events.

Surface waters will join the existing drainage infrastructure (via basement pumping if a gravity fed solution is not feasible), with no significant changes in drainage outflows anticipated from the site.

As such the development will have a negligible impact on surface water flow and flooding. In addition, the basement is likely to provide enhanced attenuation given its requirement to be drained in accordance with building.

9. NON-TECHNICAL SUMMARY

9.1 General

The findings of this updated *Basement Impact Assessment* are informed by ground investigation data, information regarding construction methods provided by the client's team and assumed construction sequence and detail.

- From the available information, it is considered that the proposed basement construction will have a negligible effect on groundwater, surface water and flooding at this site.

- The construction of the basement will generate ground movements due to a variety of causes including; short-term and long-term ground movements and retaining wall installation and deflection during and after excavation

- Conservative calculations indicate that these will give rise to a damage category within 'Category 1' (very slight damage) for the adjacent properties 83A Fitzjohn's Avenue and 16A Prince Arthur Road assuming a good standard of workmanship.

- Ground movement calculations indicate that a maximum of 20mm heave is expected below the carriageway of Fitzjohn's Avenue and a maximum of 15mm heave is anticipated within the rear garden of the adjacent property 3A Ellerdale road, therefore it is proposed negligible impact will be imposed on the roadway and rear garden respectively due to the proposed construction works on site assuming a good standard of workmanship.

- Groundwater is anticipated to be approximately at basement formation level (94mOD) or 0.5m above basement formation level. Groundwater to be controlled by the construction of a secant piled retaining wall from lower ground floor level to below the basement level, therefore it is expected that no groundwater pumping will be required.

- It is recommended that an appropriate monitoring regime is adopted to manage risk and potential damage to the neighbouring structures during construction.

- The analyses reported are based on the information currently available and should be revised if changes are made to the proposed design, loading, construction method or sequence.

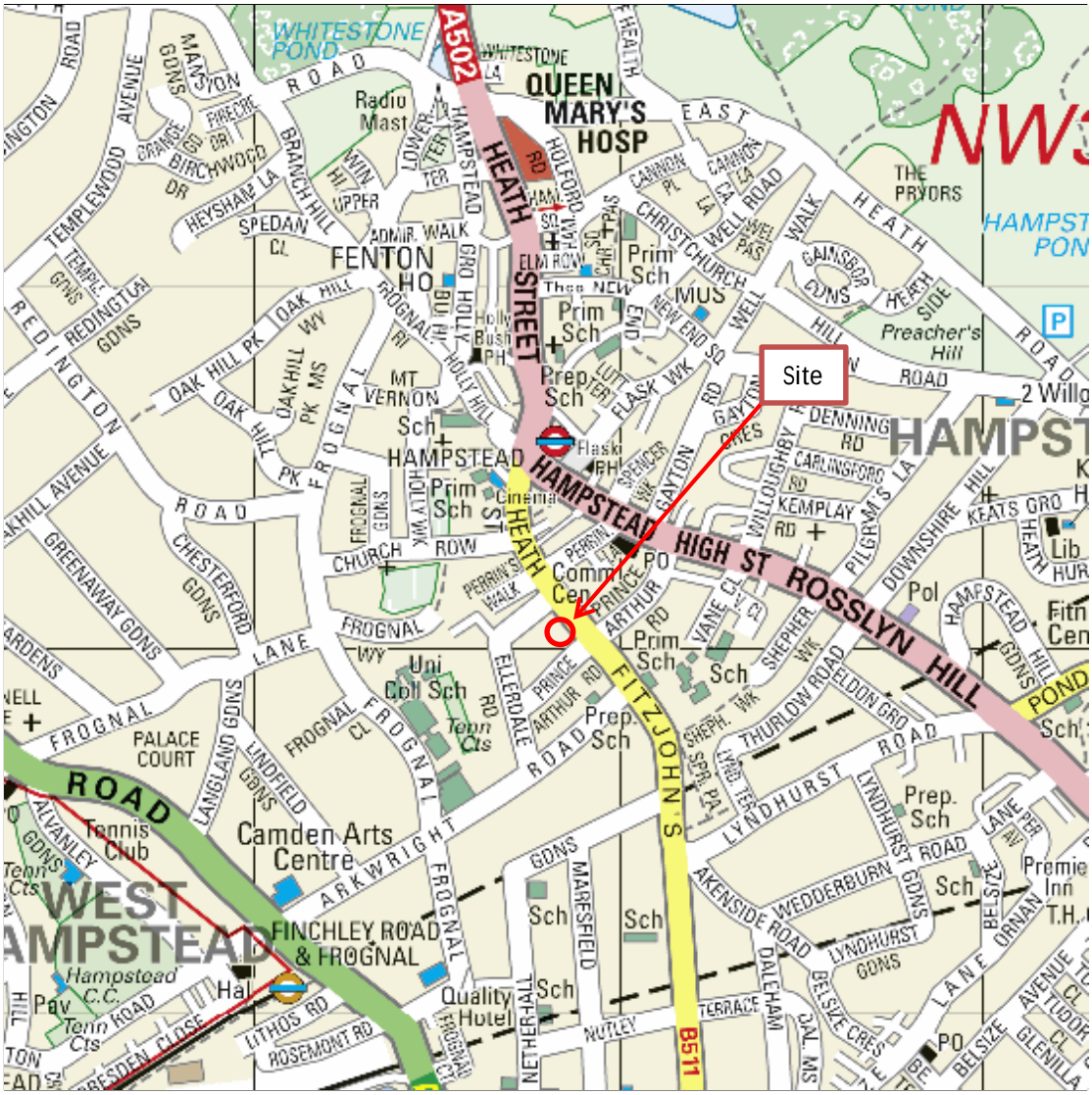
9.2 Cumulative impacts

It is considered that there are no significant cumulative impacts in respect of ground or slope stability due to the proposed development.

The shallow ground conditions beneath the site comprise Made Ground over interbedded sands and clays of the Bagshot Formation/Claygate Member. Groundwater has been encountered within the granular deposits, corresponding to a depth approximately at basement formation level. Additionally, the secant piled wall will allow groundwater to flow around and beneath basement. On this basis, groundwater is free to flow beneath the proposed and built basements, and it is therefore considered that the proposed development would not contribute further to any cumulative effects.

The proposed development will not materially alter the proportion of hardstanding across the site. It is understood that the existing surface water run-off is currently, and will be discharged to the sewer network through existing connections. On this basis, the development is not considered to contribute to any significant cumulative impact with regard to surface flow or flooding.

FIGURES



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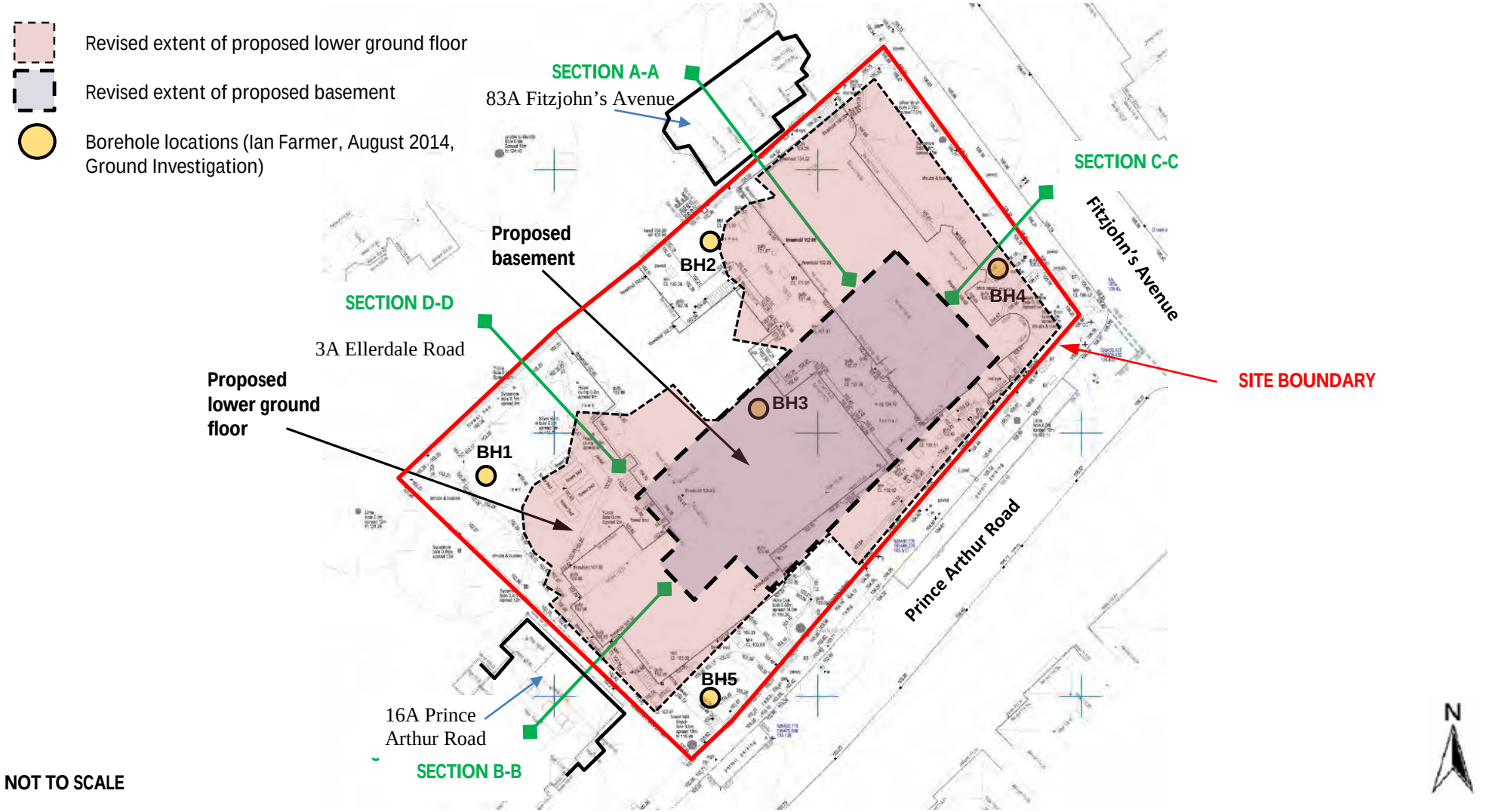
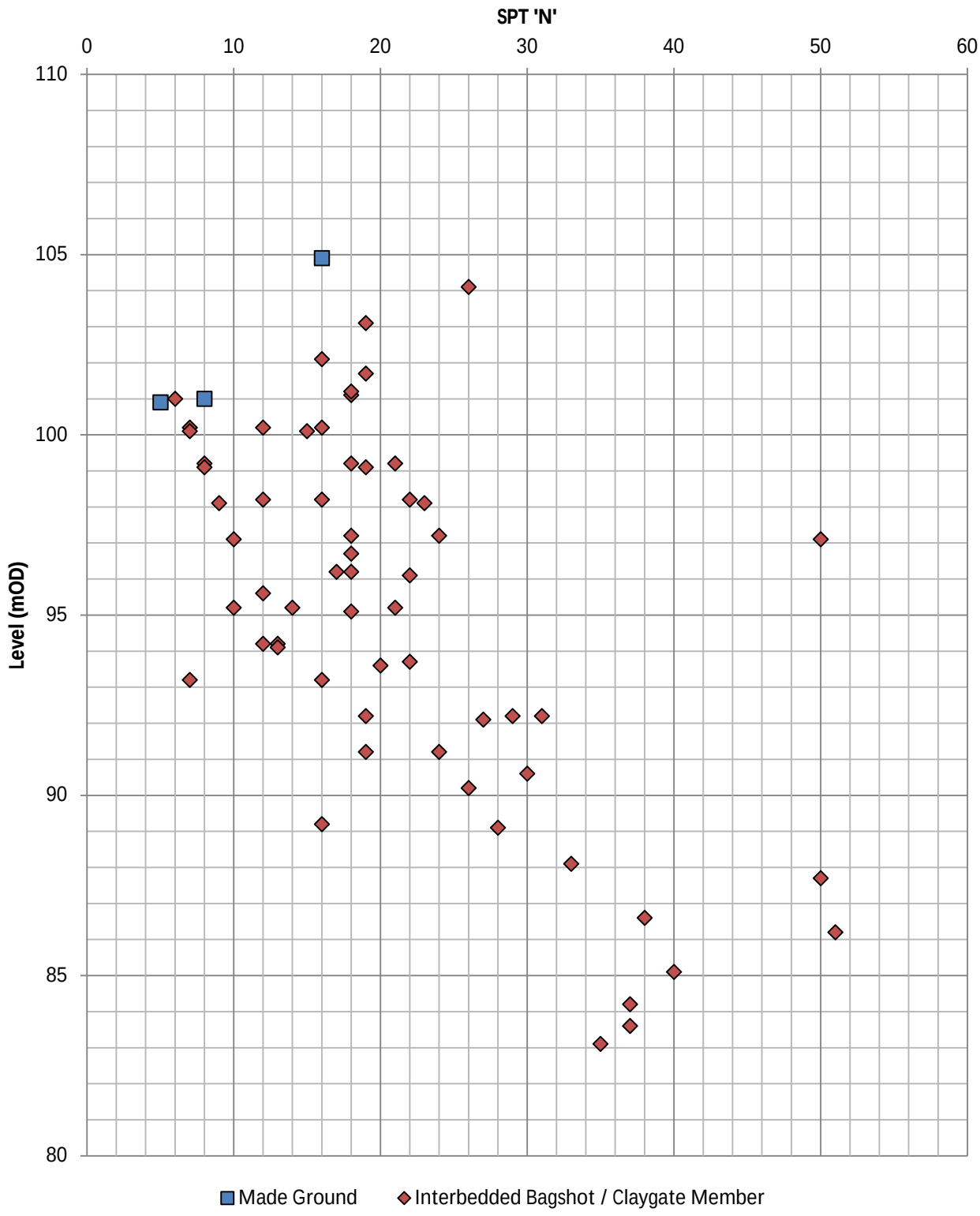
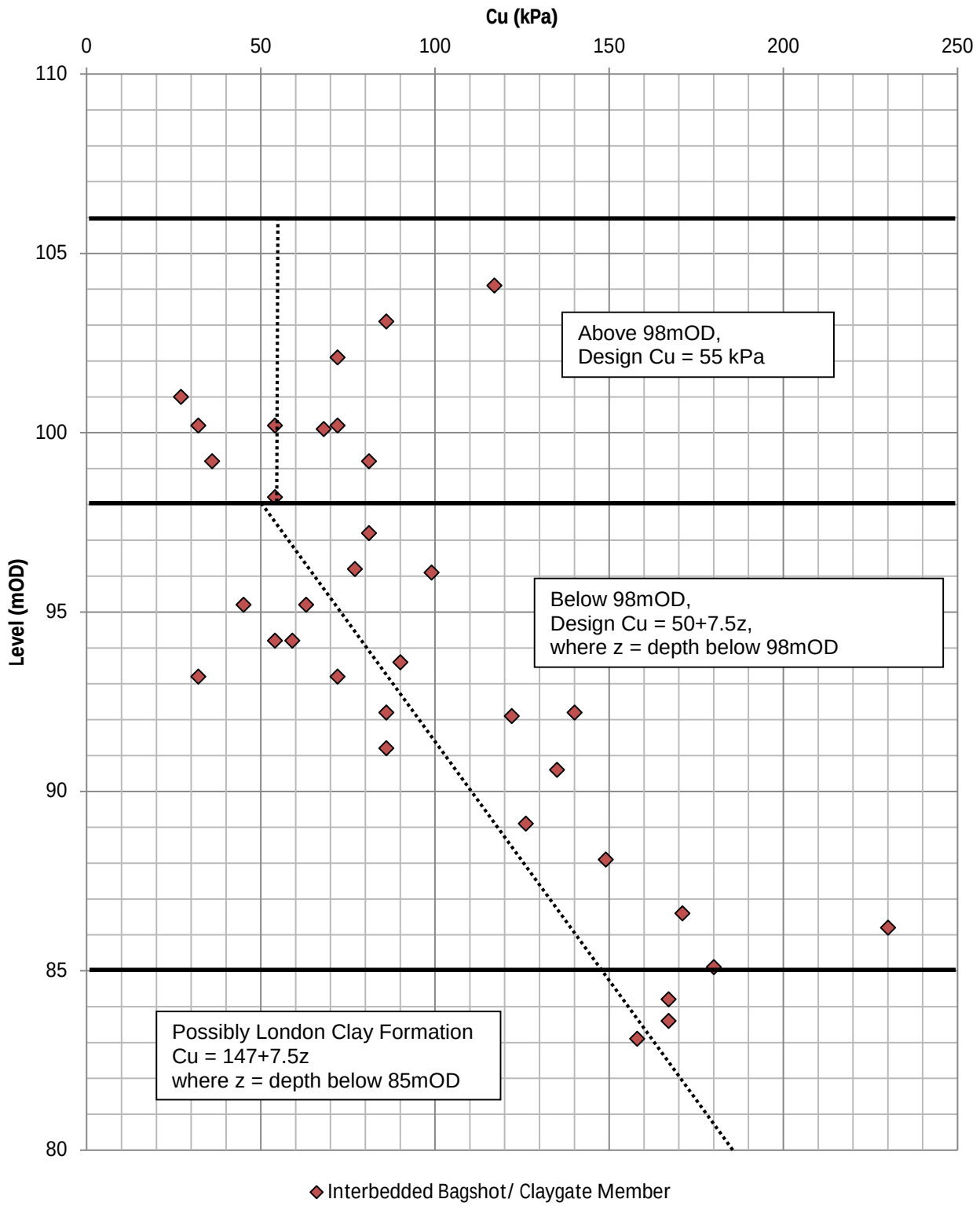
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Site location plan**	**Figure 1**



Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Site layout plan**	**Figure 2**



Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
CGL	Title **SPT 'N' versus level (mOD)**	**Figure 3**



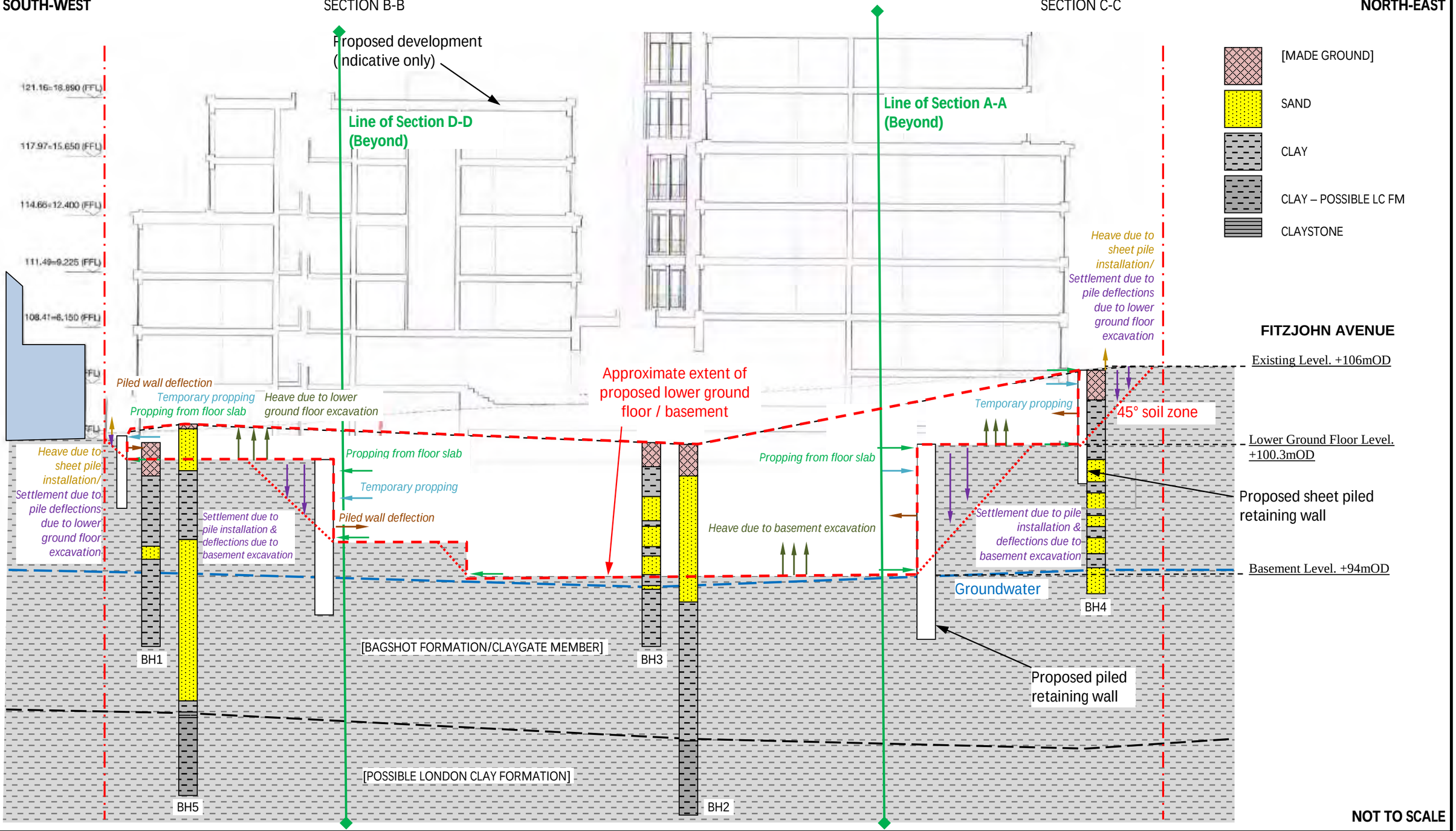
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
CGL	Title: **c_u versus level (mOD)**	**Figure 4**

SOUTH-WEST

SECTION B-B

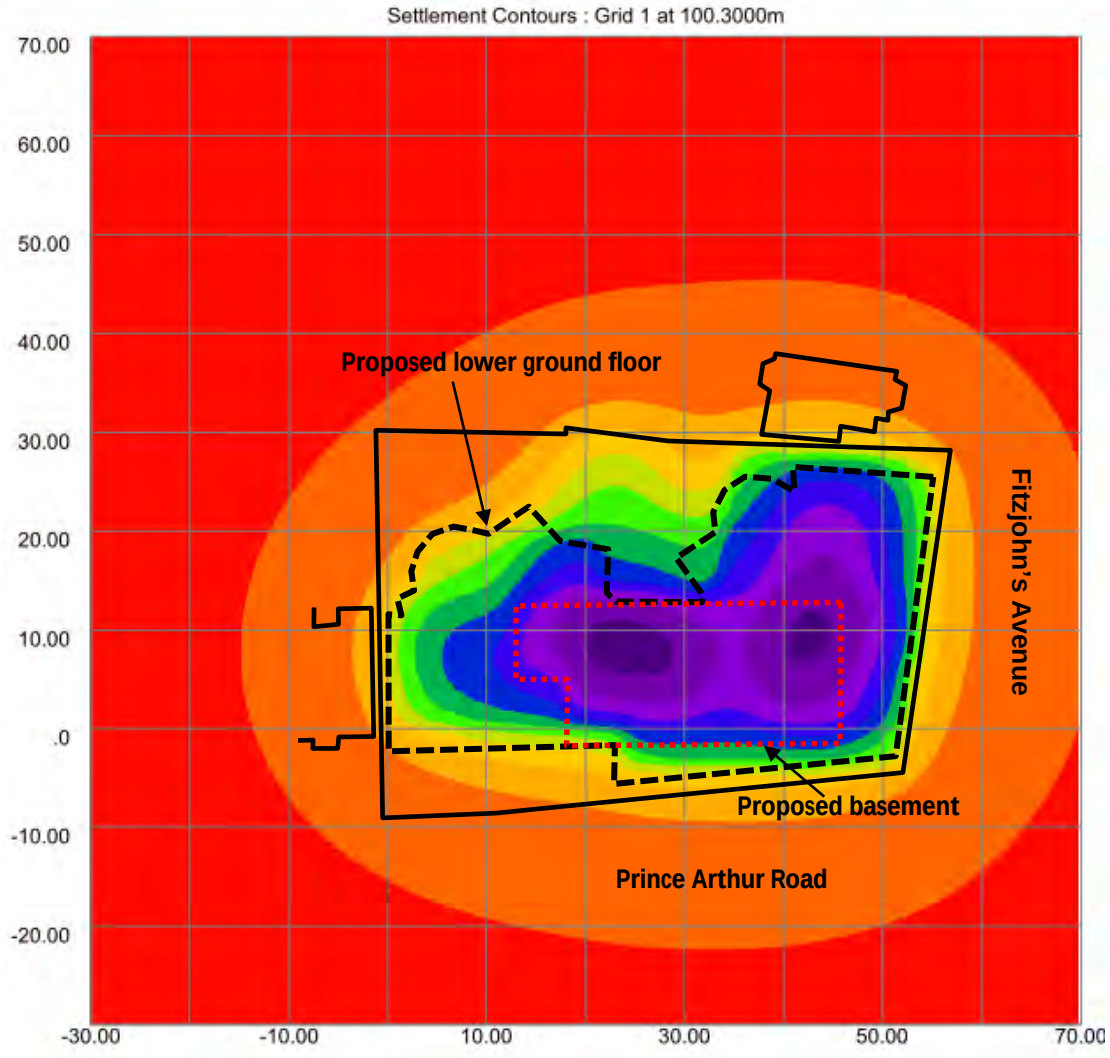
SECTION C-C

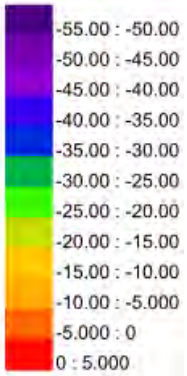
NORTH-EAST



NOT TO SCALE

Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Conceptual site model**	**Figure 5**





Ground movements in mm.

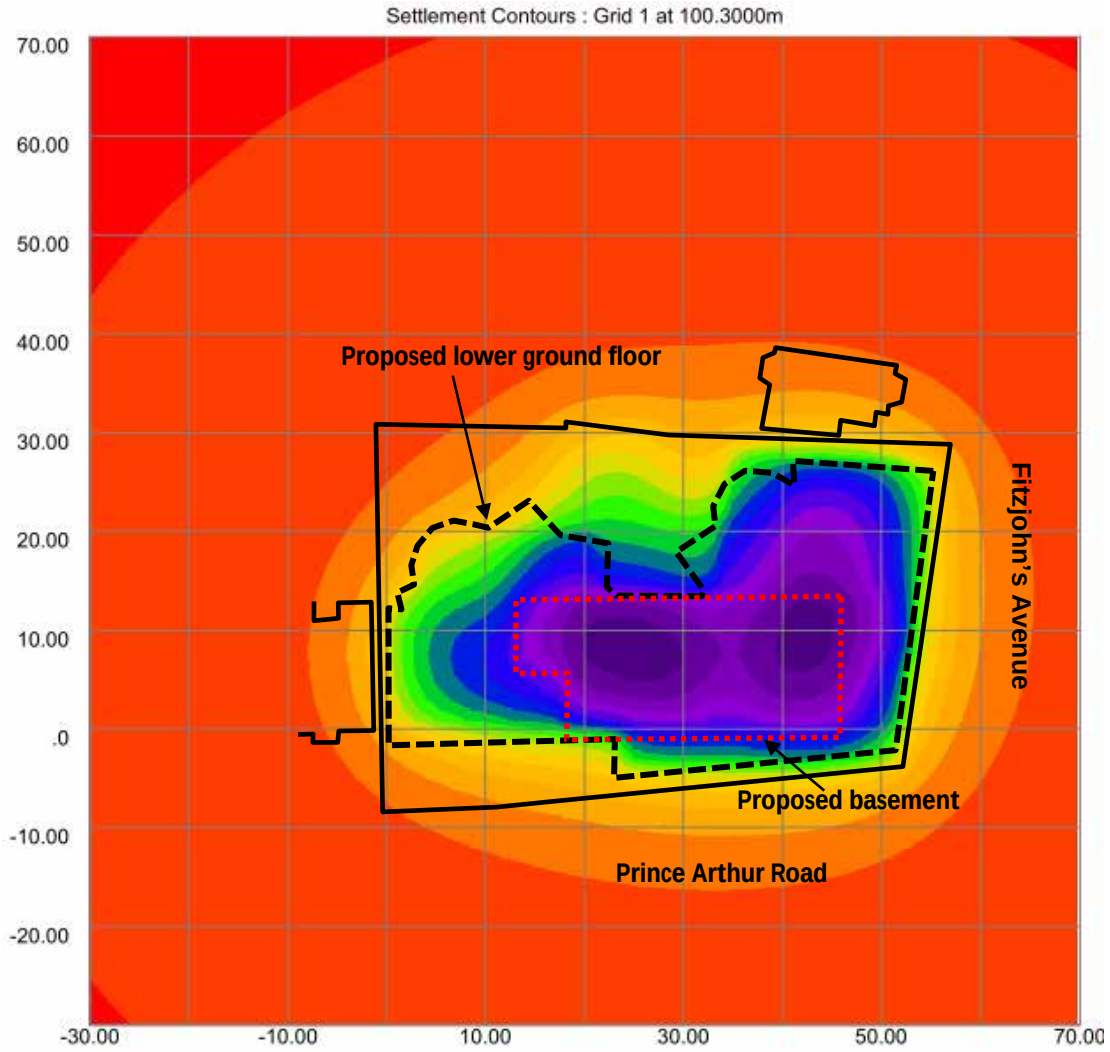
Positive values are settlement, negative values are heave.

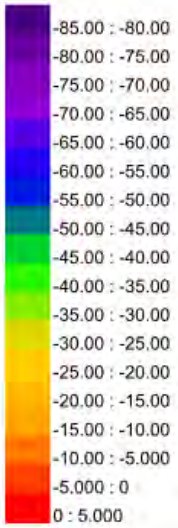
Note: the contours are based on an analysis grid at the base of the excavation and should be viewed as indicative for the general distribution of ground movements. Actual movements for the critical section are based on analysis grid lines (see Figures 8, 10, 12 and 14).

N

NOT TO SCALE

Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Short term ground movement contour plot**	**Figure 6**





Ground movements in mm.

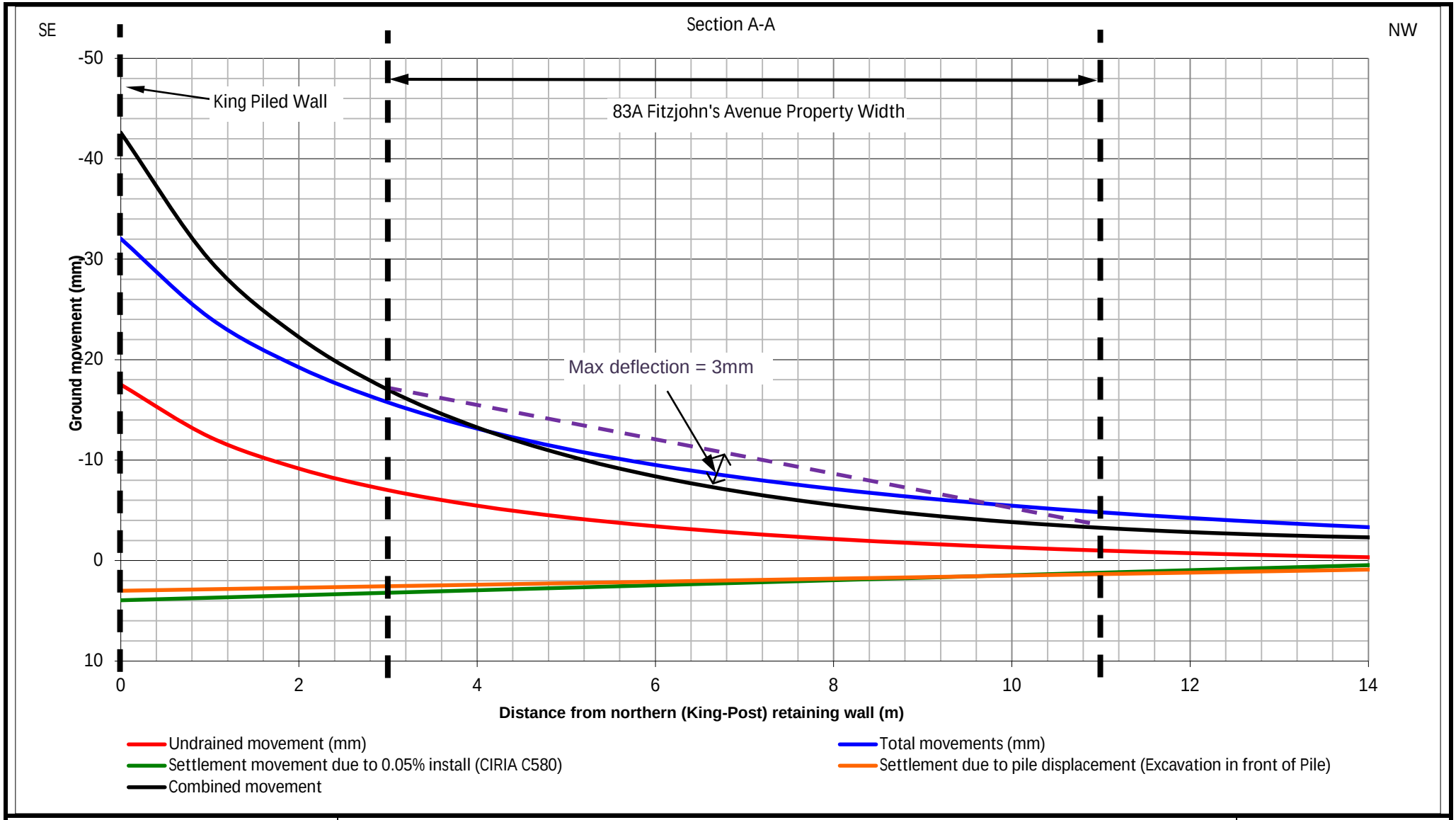
Positive values are settlement, negative values are heave.

Note: the contours are based on an analysis grid at the base of the excavation and should be viewed as indicative for the general distribution of ground movements. Actual movements for the critical section are based on analysis grid lines (see Figures 8, 10, 12 and 14).

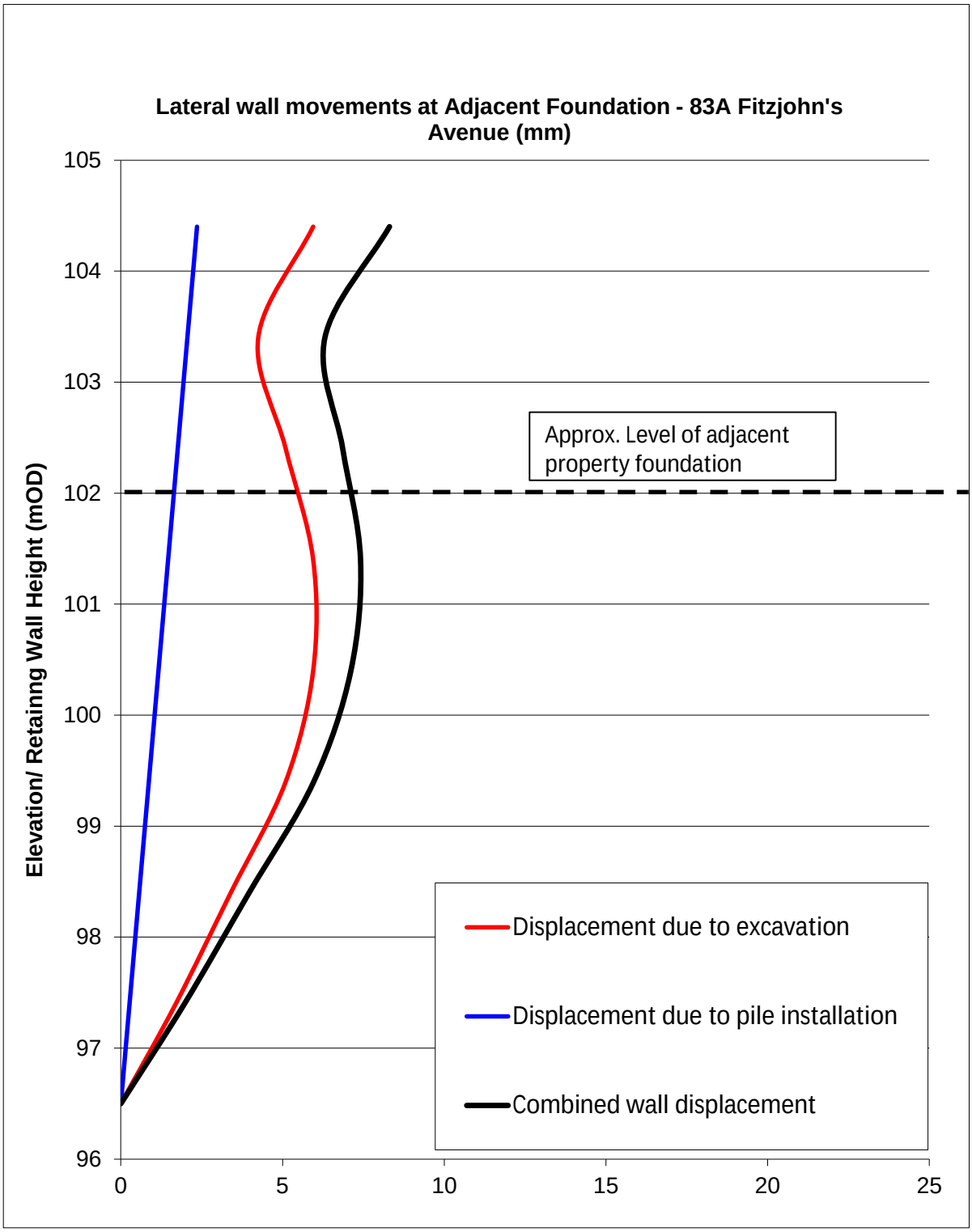
N

NOT TO SCALE

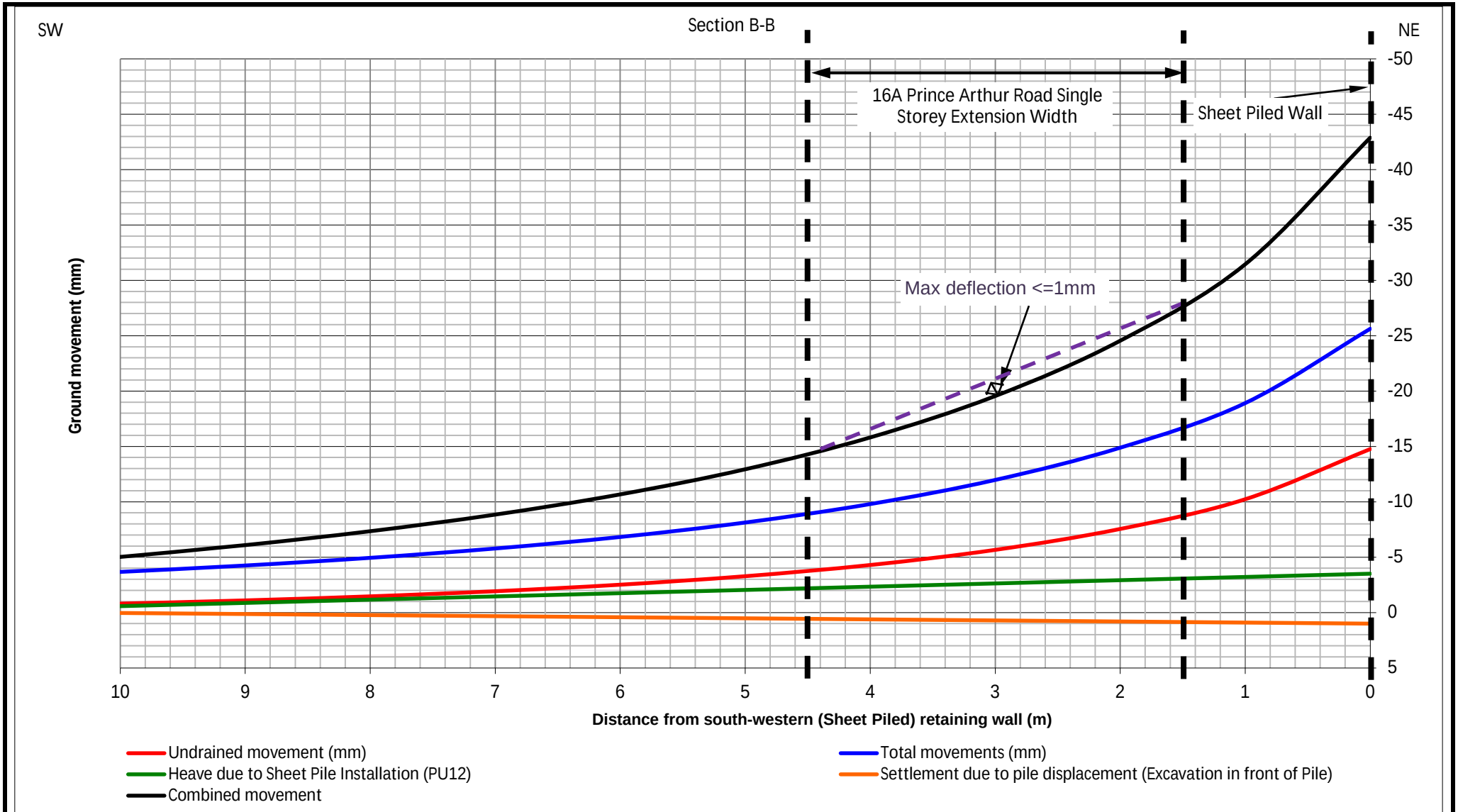
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
CGL	Title **Long term ground movement contour plot**	**Figure 7**



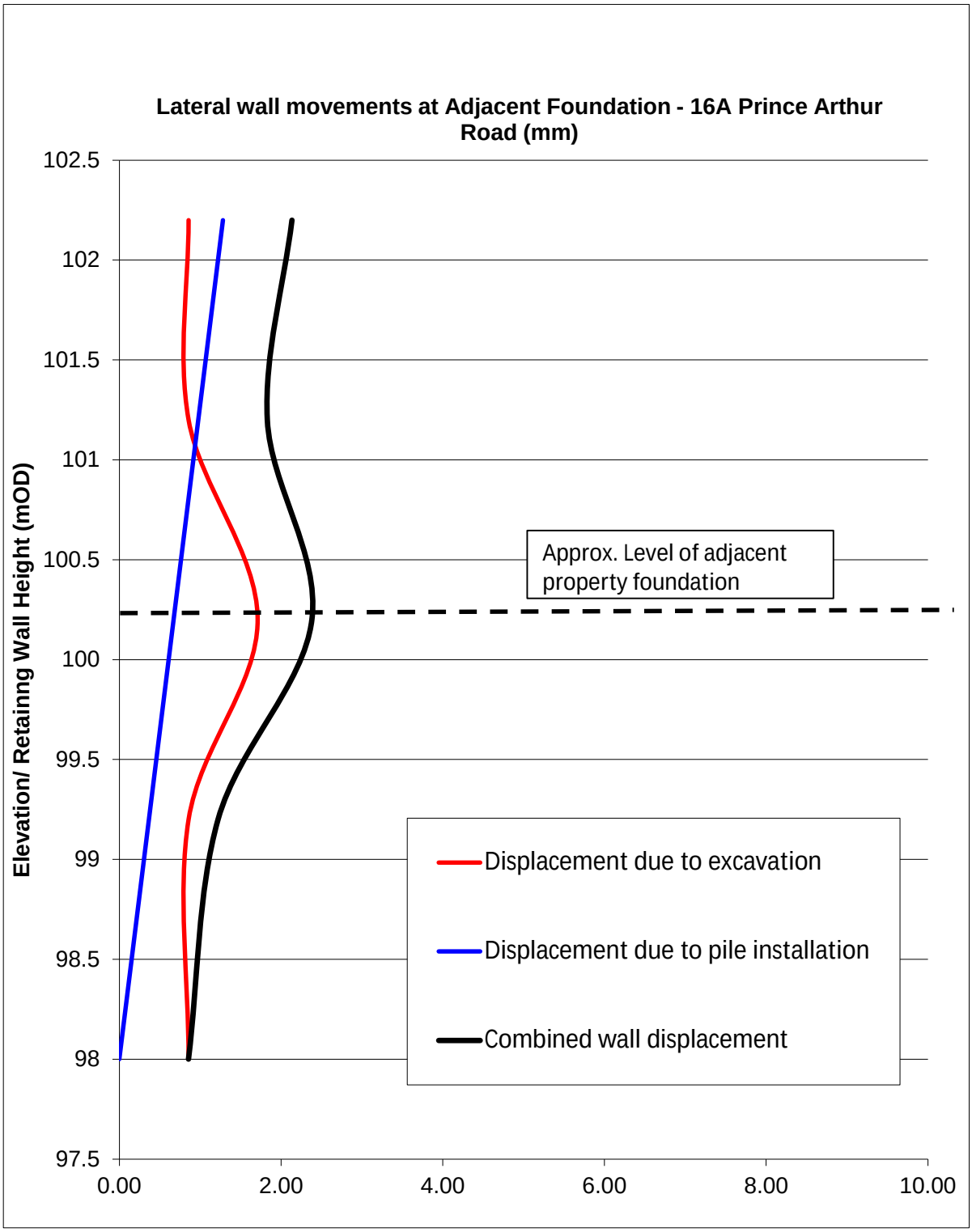
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohns Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Combined vertical ground movement: Section A-A**	**Figure 8**



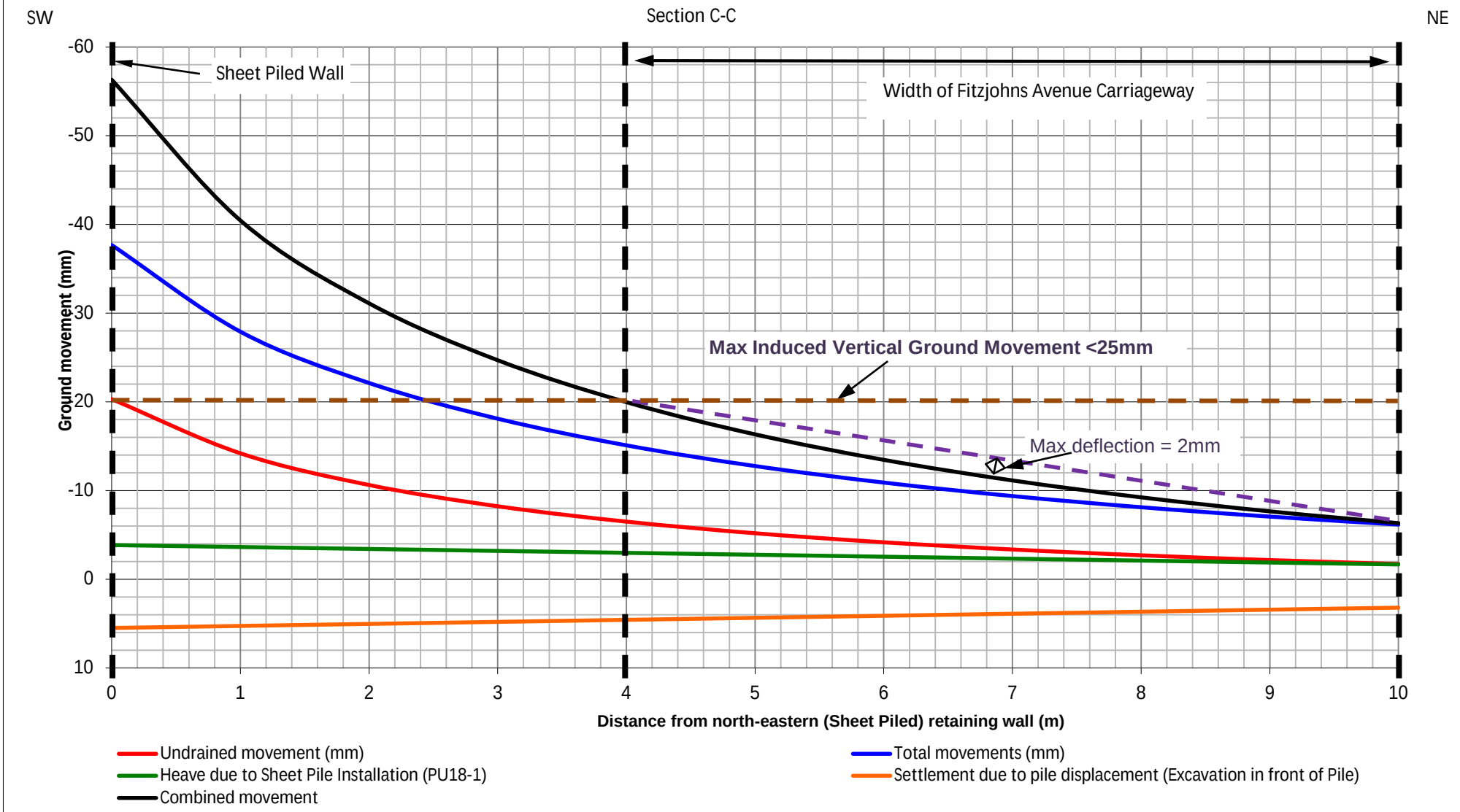
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
	Title	
	Combined lateral ground movements – Section A-A	**Figure 9**



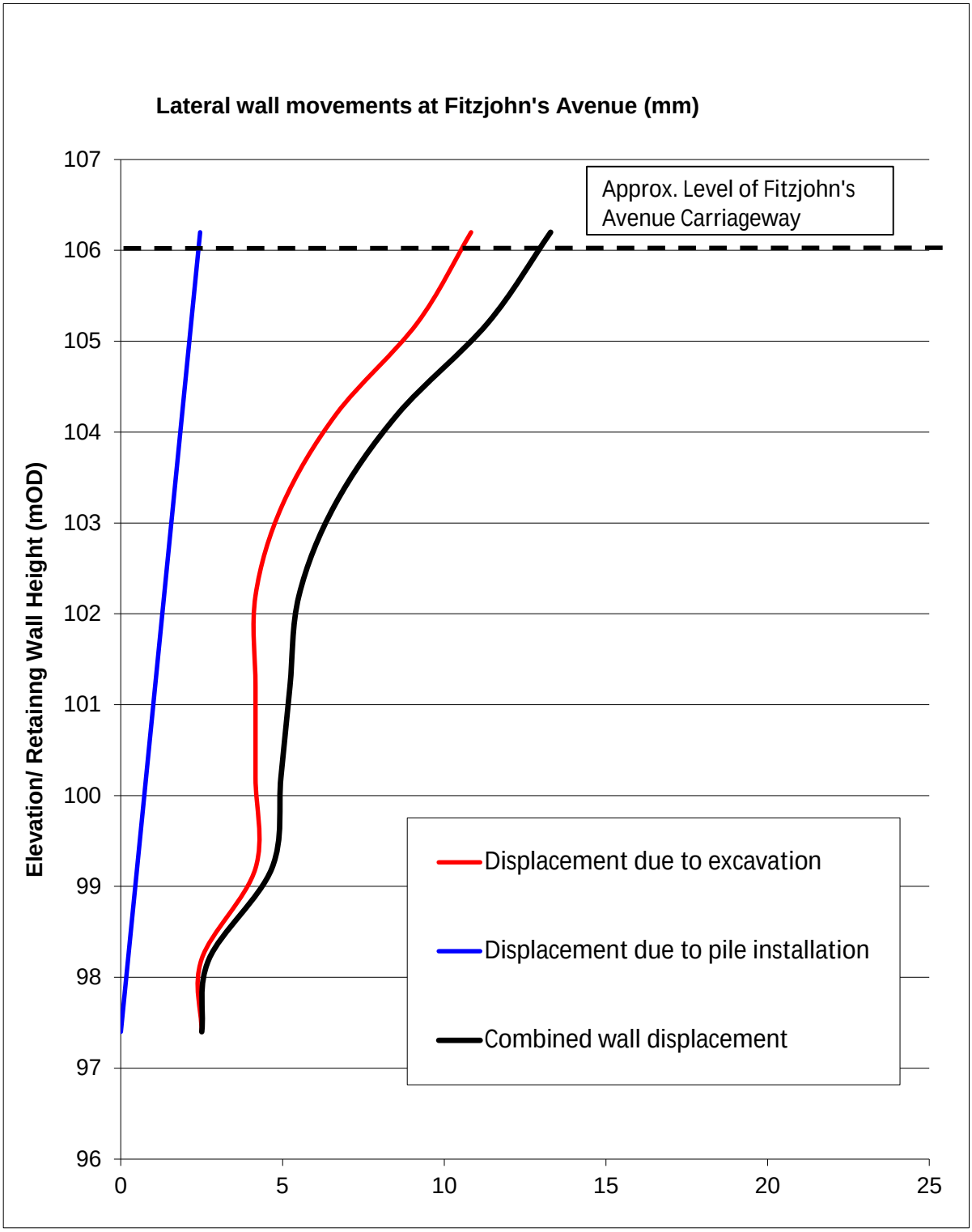
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohns Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Combined vertical ground movement: Section B-B**	**Figure 10**



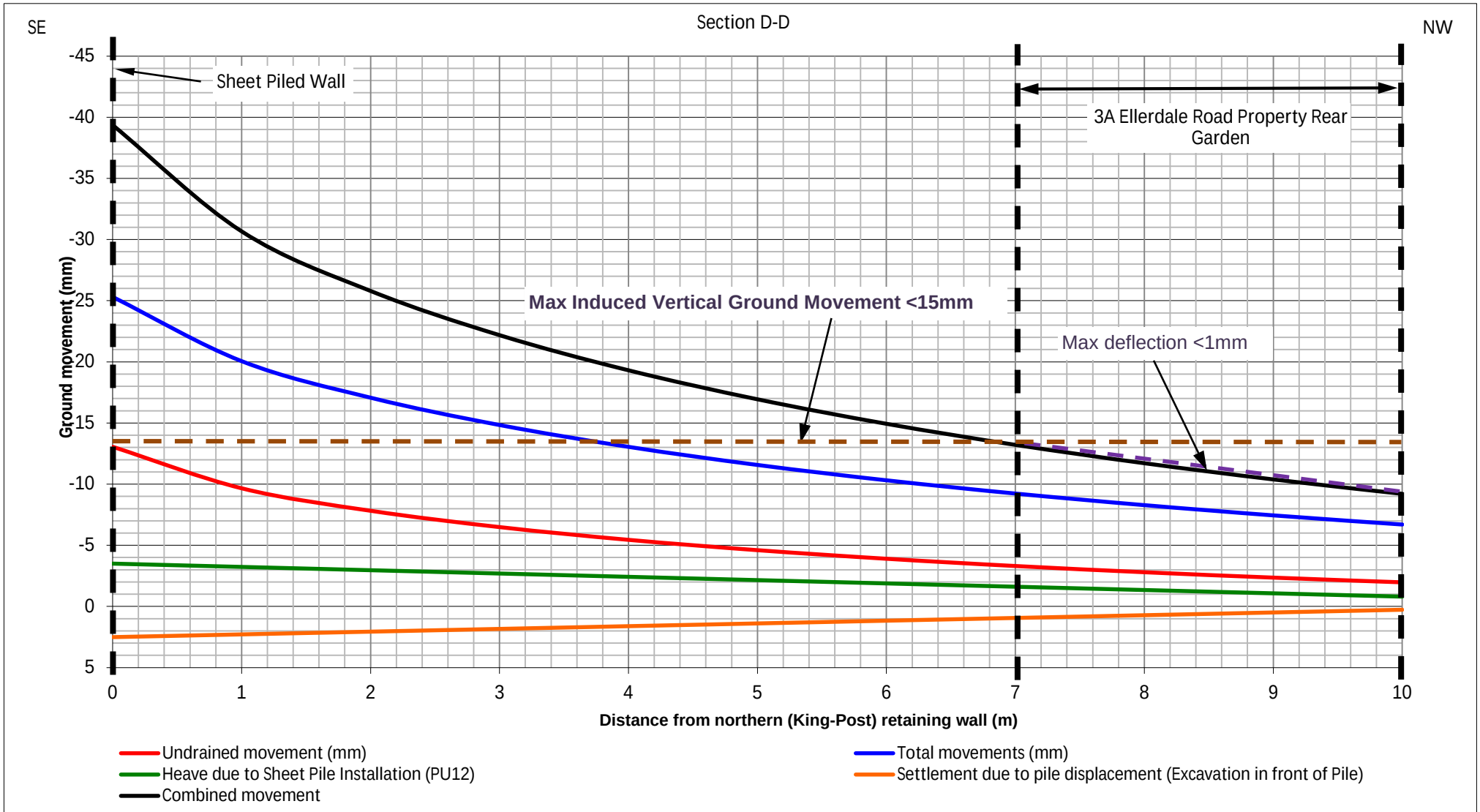
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
	Title	
	Combined lateral ground movements – Section B-B	**Figure 11**



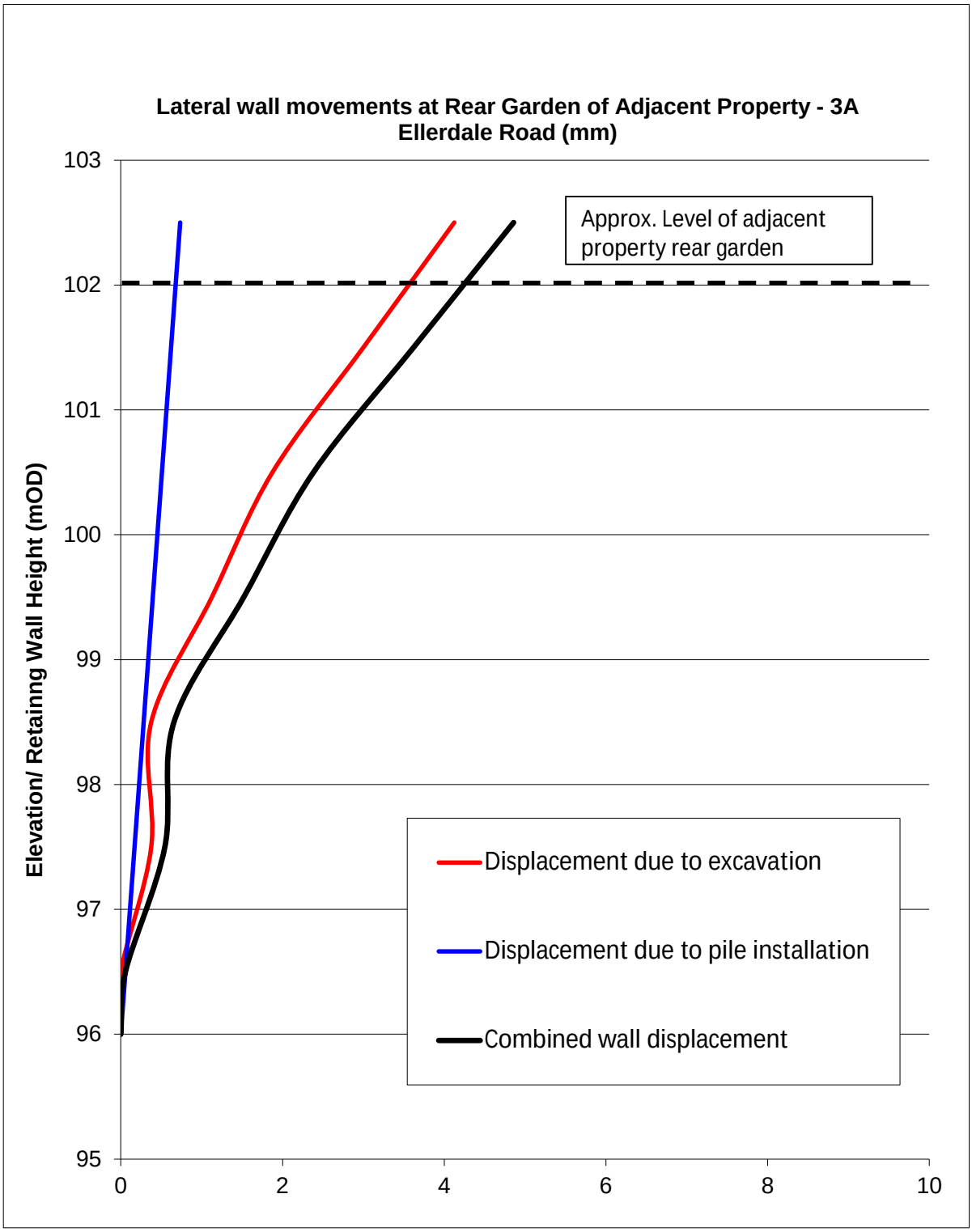
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohns Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Combined vertical ground movement: Section C-C**	**Figure 12**



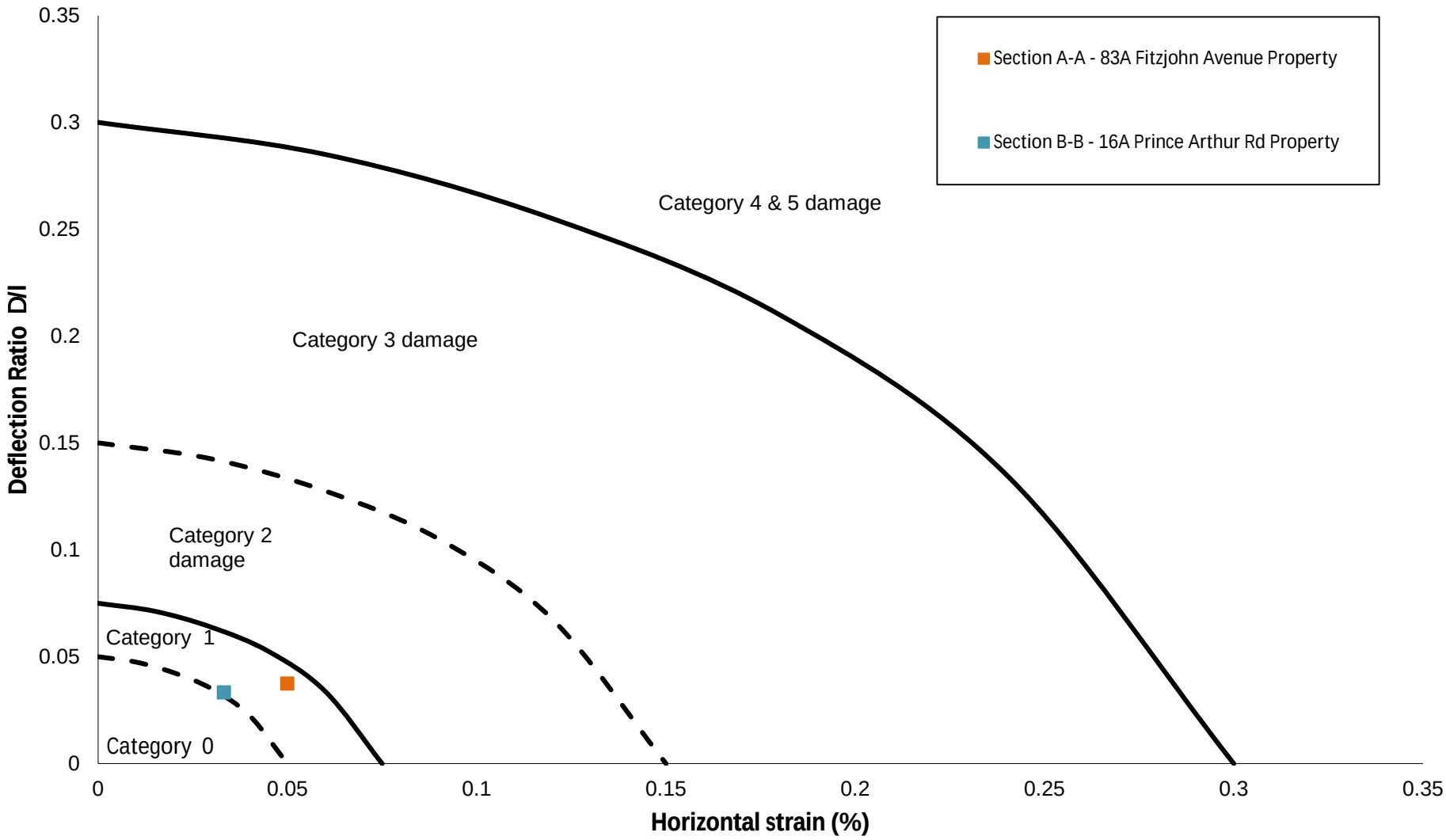
Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
	Title	
	Combined lateral ground movements – Section C-C	**Figure 13**



Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohns Avenue, Camden, London**	**CGL/09008**
CGL	Title: **Combined vertical ground movement: Section D-D**	**Figure 14**



Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CGL/09008**
	Title	
	Combined lateral ground movements – Section D-D	**Figure 15**



Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohns Avenue, Camden, London**	**CGL/09008**
CGL	Title **Building interaction chart – Section AA and Section BB**	**Figure 16**

APPENDIX A

Proposed development plans and sections

CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATION 2015

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REF:	MEMBER	STRUCTURAL MATERIAL
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B3	1000 x 600mm	CONCRETE C32/40
B4	1500 x 850mm	CONCRETE C32/40
B5	250 x 400mm	CONCRETE C32/40
B6	250 x 450mm	CONCRETE C32/40
B7	250 x 600mm	CONCRETE C32/40
B16	550 x 600mm	CONCRETE C32/40

STRUCTURAL CONCRETE COLUMN SCHEDULE

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C6	215 x 450mm
C10	215 x 600mm
C11	215 x 800mm
C20	300 x 360mm
C21	300 x 450mm
C22	215 x 750mm

STRUCTURAL CONCRETE WALL SCHEDULE

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W2	MLM_Wall_215mmConcrete	Shear
W3	MLM_Wall_200mmConcrete	Shear
W4	MLM_Wall_300mmConcrete	Shear
W5	MLM_Wall_250mmConcrete	Shear
W6	MLM_Wall_175mmConcrete	Shear
W7	MLM_Wall_350mmConcrete	Shear
W8	MLM_Wall_275mmConcrete	Shear

NOTES:

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4.3 CONCRETE TO GROUND FLOOR SLAB TO BE RC 32/40 IN ACCORDANCE WITH MLM SPECIFCATION E10.

4.4 CONCRETE TO INTERNAL BASEMENT COLUMNS /WALLS UP TO UNDERSIDE GROUND FLOOR LEVEL TO BE C40/50 IN ACCORDANCE WITH MLM SPECIFICATION E10

4.5 FOR FULL DETAILS OF SERVICE ENTRIES AND PUBLIC HEALTH PENETRATIONS REFER TO M&E DRAWINGS.

4.6 REFER TO LIFT MANUFACTURER'S DRAWINGS FOR DETAILS OF CAST IN FIXINGS.

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GROUND FLOOR SLAB GENERALLY:	120Kg/m³
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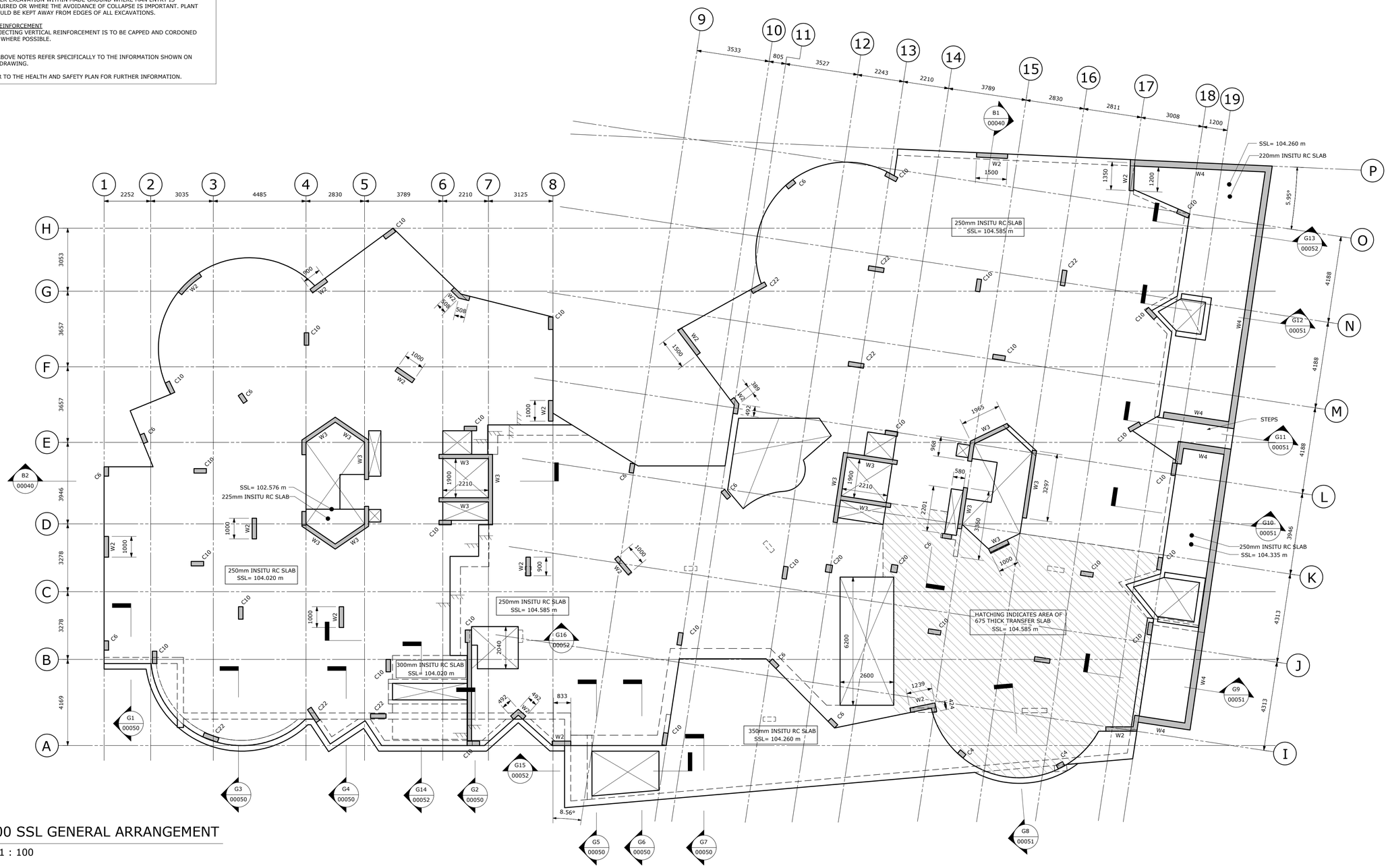

00 SSL GENERAL ARRANGEMENT

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Rev	Date	Description	Made	Checked
P3	11/03/2016	LEVELS CHANDED TO AOD. TRANSFER BEAMS OMITTED AND COLUMNS UNDER RE-POSITIONED. TRANSFER SLAB ADDED	KJW	GDW
P2	22/01/2016	SITE LAYOUT INDICATED	KJW	GDW
P1	19/01/2016	WORK IN PROGRESS	KJW	GDW

Drawing Status

STAGE E

MLM

Multidisciplinary Consulting

North Kiln, Felaw Maltings, 46 Felaw Street, Ipswich, Suffolk, IP2 8PN
Tel: 01473 231100
Website: www.mlm.uk.com

Client

PEGASUS LIFE

Project

79 FITZJOHNS AVENUE, HAMPSTEAD

Drawing Title

GROUND FLOOR GENERAL ARRANGEMENT

Drawn/Design	KJW/ ETN	Date	NOV 2015	Scales	As indicated @ A1
Checked	ETN	Approved	GDW	MLM Ref	581197

Drawing No. FZJ- MLM- XX- 00- DR- ST- 00200 Rev P3

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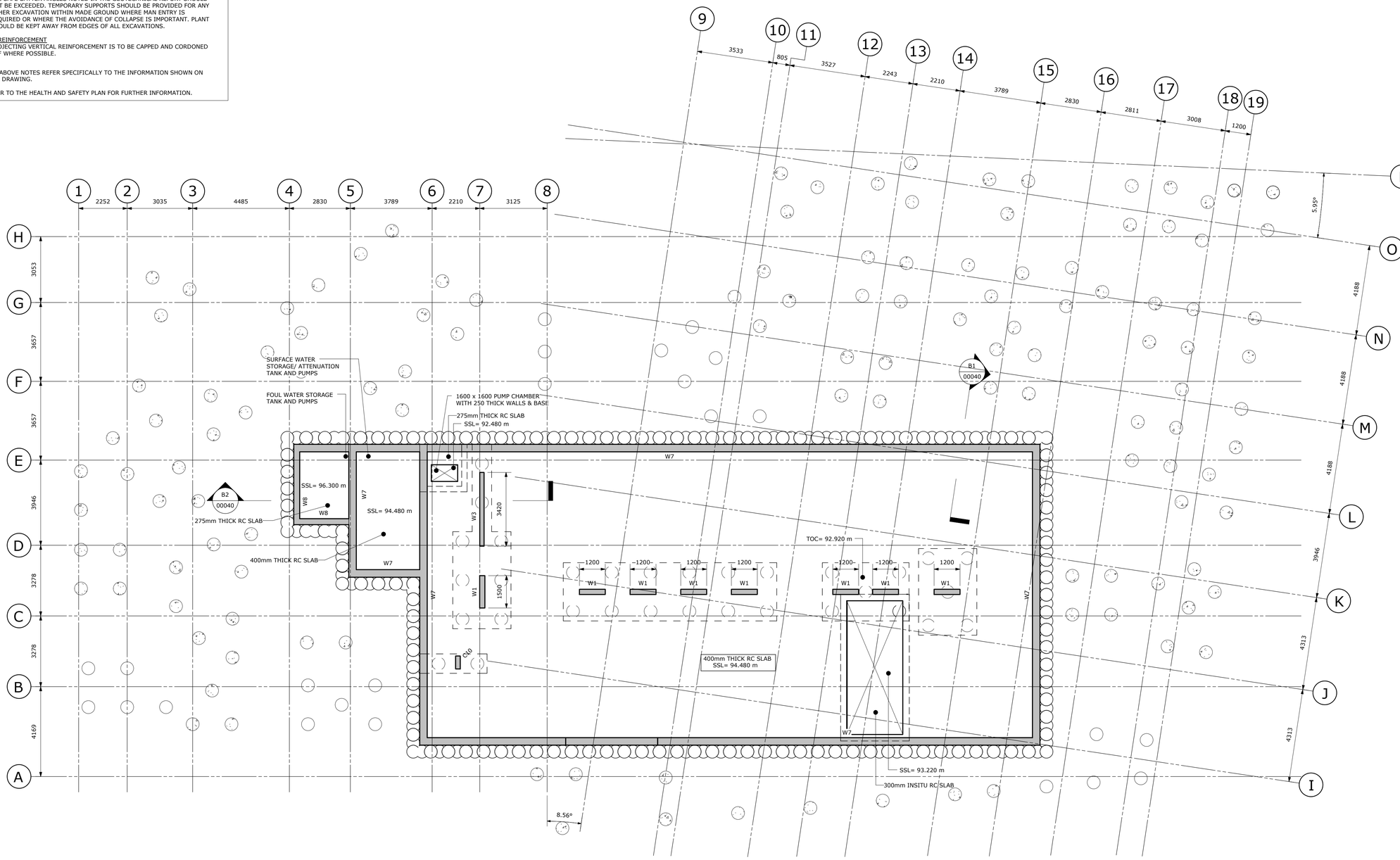

B1 SSL GENERAL ARRANGEMENT

1 : 100

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Drawing Status

STAGE E

MLM

Multidisciplinary Consulting

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Tel: 01473 231100
Website: www.mlm.uk.com

Client

PEGASUS LIFE

Project

79 FITZJOHNS AVENUE, HAMPSTEAD

Drawing Title

BASEMENT GENERAL ARANGEMENT

Drawn/Design	KJW/ ETN	Date	NOV 2015	Scales	As indicated @ A1
Checked	ETN	Approved	GDW	MLM Ref	581197

Drawing No. FZJ- MLM- XX- B1- DR- ST- 00020

Rev P3

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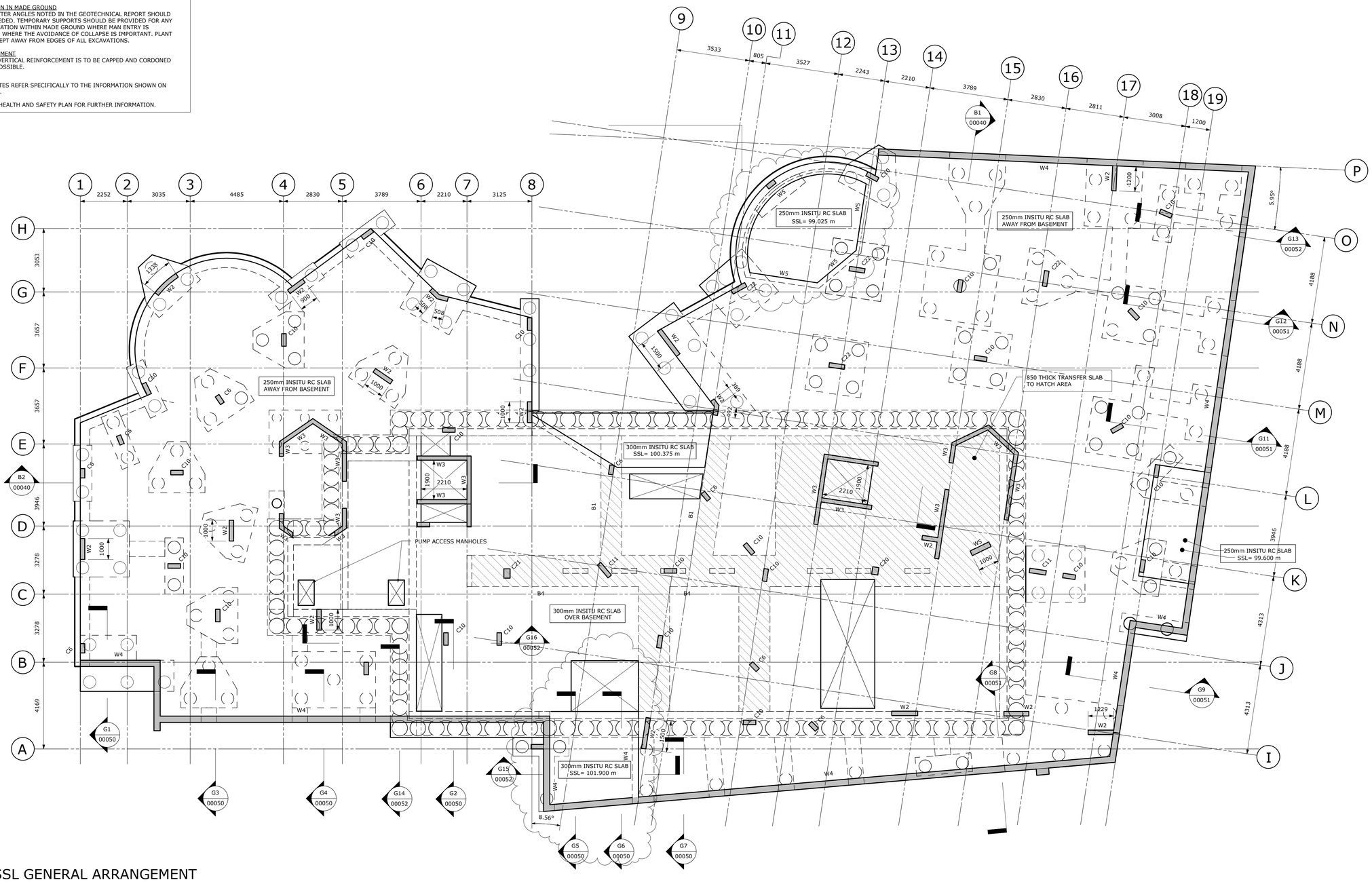

LG SSL GENERAL ARRANGEMENT

1 : 100

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4.4 CONCRETE TO INTERNAL BASEMENT COLUMNS /WALLS UP TO UNDERSIDE GROUND FLOOR LEVEL TO BE C40/50 IN ACCORDANCE WITH MLM SPECIFICATION E10

4.5 FOR FULL DETAILS OF SERVICE ENTRIES AND PUBLIC HEALTH PENETRATIONS REFER TO M&E DRAWINGS.

4.6 REFER TO LIFT MANUFACTURER'S DRAWINGS FOR DETAILS OF CAST IN FIXINGS.

4.7 ALLOWANCE IS TO BE MADE FOR SUPPLYING & FIXING THE FOLLOWING QUANTITIES OF REINFORCING STEEL:-

GROUND FLOOR SLAB GENERALLY:	120Kg/m³
LOWER GROUND FLOOR SLAB GENERALLY:	160Kg/m³
AREAS OF THICKENED TRANSFER SLABS OR BEAMS:	180Kg/m³
BASEMENT SLAB:	160Kg/m³
CAPPING BEAM:	200Kg/m³
RETAINING WALLS AND BASEMENT LINING WALLS:	160Kg/m³
INTERNAL WALLS:	110Kg/m³
COLUMNS:	200Kg/m³
PILE CAPS:	150Kg/m³

4.8 ALLOW FOR ADDITIONAL ANCON OR SIMILAR PROPRIETARY PUNCHING SHEAR RAILS WITHIN SLABS AT 60% OF COLUMN POSITIONS.

4.9 IN ADDITION TO THE SERVICE RISER HOLES ALREADY SHOWN ON THE DRAWING, ALLOW FOR FORMING 250x250mm SQUARE HOLES THROUGH THE SLAB AT A RATE OF 1 HOLE PER 10 SQUARE METRES OF SLAB.

4.10 ALL STAIRS ARE TO COMPRISE INSITU RC LANDINGS AND FLIGHTS.

4.11 MAKING GOOD OF SECANT WALL AND CAPPING BEAM PENETRATIONS ANNULUS BETWEEN SLEEVE AND SERVICE TO BE FILLED USING FOSROC CONBEXTRA HF OR EQUIVALENT NON-SHRINK GROUT. SELF ADHESIVE HYDROPHILIC STRIPS TO BE APPLIED TO SERVICE PIPE AND INSIDE OF SLEEVE. EXTERNAL FACE OF PENETRATION TO BE DRESSED USING 2 COATS OF FOSROC PROOFEX LM OR EQUIVALENT. REFER TO TYPICAL DETAILS ON DRAWING No. FZJ-MLM-XX-XX-DR-ST-XXXXX

Rev	Date	Description	Made	Checked
P4	18/03/2016	BASEMENT LAYOUT REVISED	KJW	GDW
P3	11/03/2016	LEVELS CHANGED TO AOD. CONTIGUIOUS PILES CHANGED TO SECANT. COLUMNS IN WELLNESS AREA REVISED. STORAGE TANKS UNDER INDICATED. BASEMENT SIZE UNDER REVISED. PILING REVISED. OTHER REVISIONS AS CLOUDED	KJW	GDW
P2	22/01/2016	SITE LAYOUT INDICATED	KJW	GDW
P1	19/01/2016	WORK IN PROGRESS	KJW	GDW

Drawing Status

STAGE E

MLM

Multidisciplinary Consulting

North Kiln, Felaw Maltings, 46 Felaw Street, Ipswich, Suffolk, IP2 8PN
Tel: 01473 231100
Website: www.mlm.uk.com

Client

PEGASUS LIFE

Project

79 FITZJOHNS AVENUE, HAMPSTEAD

Drawing Title

LOWER GROUND FLOOR GENERAL ARRANGEMENT

Drawn/Design	KJW/ ETN	Date	NOV 2015	Scales	As indicated @ A1
Checked	ETN	Approved	GDW	MLM Ref	581197

Drawing No. FZJ- MLM- XX- LG- DR- ST- 00030 Rev P4

NOTES:

1. GENERAL NOTES

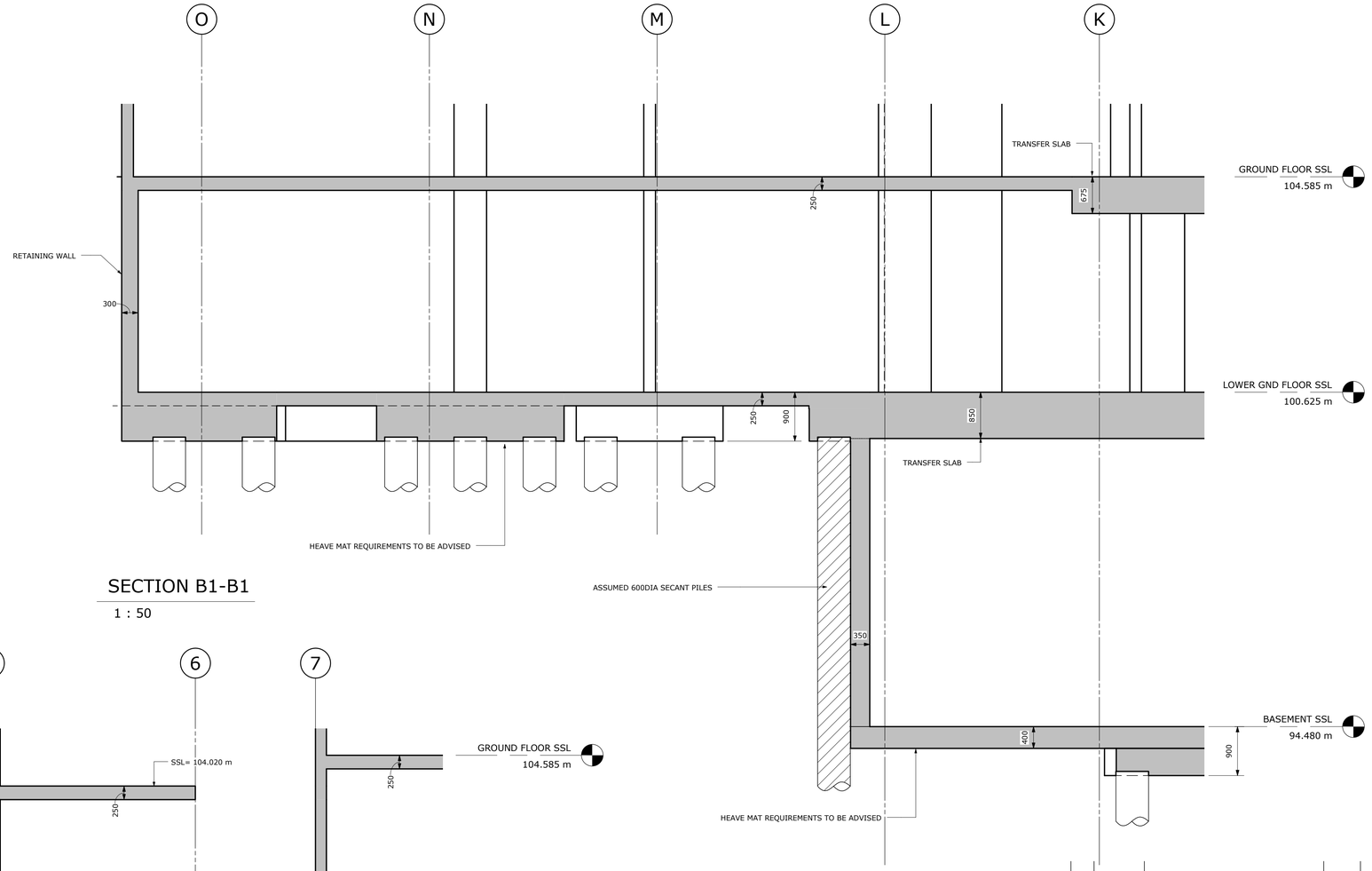
1.1 THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S, SERVICE ENGINEERS', SPECIALIST DRAWINGS AND THE SPECIFICATION. WHERE ANY DISCREPANICES OR CONFLICTS OCCUR, ADVICE SHOULD BE SOUGHT FROM THE CONTRACT ADMINISTRATOR (CA) BEFORE COMMENCING WORK.

1.2 REFER TO THE CDM DESIGNERS HAZARD INFORMATION BOX ON THIS DRAWING FOR PARTICULAR HEALTH AND SAFETY RISKS SPECIFIC TO THIS PROJECT.

1.3 ALL DIMENSIONS ARE IN mm, ALL LEVELS ARE IN m.

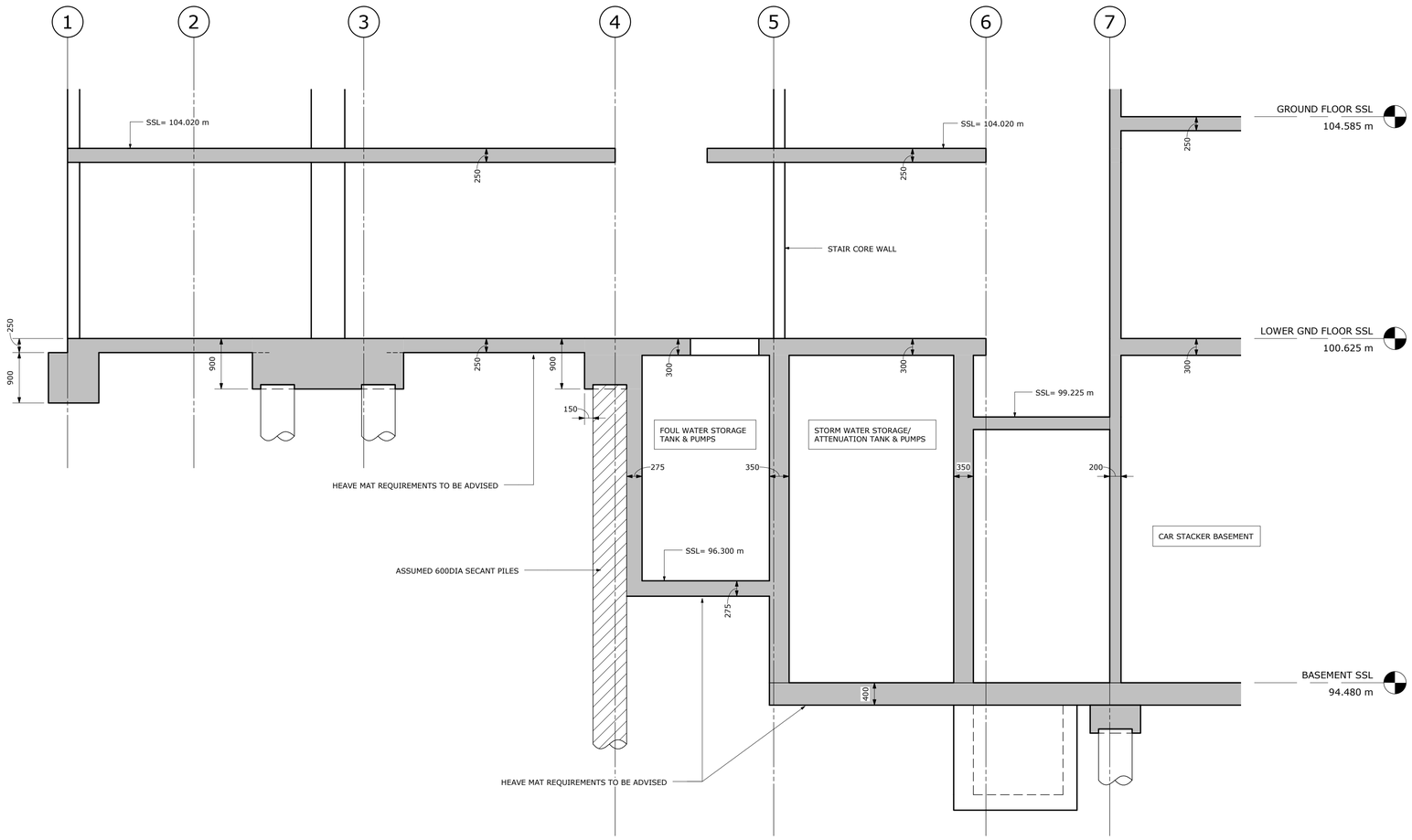
1.4 THIS DRAWING IS NOT TO BE SCALED FOR CONSTRUCTION PURPOSES. ONLY WRITTEN OR CALCULATED DIMENSIONS AND LEVELS ARE TO BE USED. REFER TO THE ARCHITECT'S DRAWINGS FOR GENERAL SETTING OUT INFORMATION UNLESS NOTED OTHERWISE.

1.5 FOR ALL OTHER NOTES REFER TO DRAWINGS 00020, 00030 & 00200



SECTION B1-B1

1 : 50



SECTION B2-B2

1 : 50

CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATION 2015

DESIGNERS HAZARD INFORMATION FOR CONSTRUCTION

1. IF YOU DO NOT FULLY UNDERSTAND THE RISKS INVOLVED DURING THE CONSTRUCTION OF THE ITEMS INDICATED ON THIS DRAWING ASK YOUR MANAGER, HEALTH & SAFETY ADVISOR OR A MEMBER OF THE DESIGN TEAM BEFORE PROCEEDING.

2. ASBESTOS
THE CONTRACTOR SHOULD ENSURE THAT A TYPE 3 ASBESTOS SURVEY IS UNDERTAKEN PRIOR TO ANY DEMOLITION. ANY ABESTOS IDENTIFIED SHOULD BE REMOVED IN A SFE MANER BY A SPECIALIST CONTRACTOR AND DISPOSED OF TO A SUITABLY LICENCED TIP.

3. BURIED SERVICES
THE CONTRACTOR SHOULD COLLATE ALL CURRENT SERVICES INFORMATION AND IS ADVISED TO UNDERTAKE HIS OWN ON-SITE SEARCHES/SURVEYS TO CHECK FOR ANY FURTHER SERVICES. ALL KNOWN SERVICES IDENTIFIED SHOULD BE RECORDED AND MARKED OUT ON SITE.

4. GROUND CONTAMINATION
HIGH STANDARDS OF PERSONAL HYGIENE ARE TO MAINTAINED AND ALL WORKERS SHOULD BE VIGILANT AND USE APPROPRIATE PPE. QUALIFIED ENVIRONMENTAL ENGINEERS ARE TO BE APPOINTED TO MONITOR AND TEST THE SOILS.

5. DRILLING RIG STABILITY
THE PILLING CONTRACTOR SHOULD CONSTRUCT A WORKING PLATFORM USING A SUFFICENT THICKNESS OF COMPACTED CRUSHED CONCRETE OR SIMILAR MATERIAL DESIGNED TO SAFELY ACCOMODATE THE LOADS GENERATED BY THE PROPOSED PLANT AND MACHINERY.

6. EXCAVATION IN MADE GROUND
THE SAFE BATTER ANGLES NOTED IN THE GEOTECHNICAL REPORT SHOULD NOT BE EXCEEDED. TEMPORARY SUPPORTS SHOULD BE PROVIDED FOR ANY OTHER EXCAVATION WITHIN MADE GROUND WHERE MAN ENTRY IS REQUIRED OR WHERE THE AVOIDANCE OF COLLAPSE IS IMPORTANT. PLANT SHOULD BE KEPT AWAY FROM EDGES OF ALL EXCAVATIONS.

7. REINFORCEMENT
PROJECTING VERTICAL REINFORCEMENT IS TO BE CAPPED AND CORDONED OFF WHERE POSSIBLE.

THE ABOVE NOTES REFER SPECIFICALLY TO THE INFORMATION SHOWN ON THIS DRAWING.

REFER TO THE HEALTH AND SAFETY PLAN FOR FURTHER INFORMATION.

Rev	Date	Description	Made	Checked
P1	11/03/2016	FIRST ISSUE	KJW	GDW

Drawing Status

STAGE E

MLM

Multidisciplinary Consulting

North Kiln, Felaw Maltings, 46 Felaw Street, Ipswich, Suffolk, IP2 8PN
Tel: 01473 231100
Website: www.mlm.uk.com

Client

PEGASUS LIFE

Project

79 FITZJOHNS AVENUE, HAMPSTEAD

Drawing Title

BASEMENT/ FOUNDATION SECTIONS

Drawn/Design	KJW/ GDW	Date	MARCH 2016	Scales	As indicated @ A1
Checked	GDW	Approved	GDW	MLM Ref	581197

Drawing No. FZJ- MLM- XX- SL- DR- ST- 00040 Rev P1

APPENDIX B

BGS borehole records

Reproduced from BGS Geology Viewer of Britain.

Client	Project	Job No
Pegasus Life Limited	**79 Fitzjohn's Avenue, Camden, London**	**CG/18008**
CGL	Title **BGS borehole record location plan**	**Appendix B**

GEOLOGICAL SURVEY OF GREAT BRITAIN

RECORD OF SHAFT OR BORE FOR MINERALS

(*For Survey use only*)

6-inch Map Registered No. TQ28NE/6

Name of Shaft or Bore given by Geological Survey:

Name and Number given by owner: Hampstead Brewery

For whom made

Town or Village Hampstead County

Exact site

Attach a tracing from a map, or a sketch-map, if possible.

Purpose for which made Water

Nat. Grid Reference 267685 79

1" N.S.Map No.	1" O.S.Map No.	Confidential or not
256		

Ground Level at shaft / bore relative to O.D. If not ground level give O.D. of beginning of shaft / bore

Made by Date of sinking 1878

Information from Date received

Examined by

SPECIMEN NUMBERS AND ADDITIONAL NOTES

(*For Survey use only*) Geological Classification	DESCRIPTION OF STRATA	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
	"London Memoir" Vol II. p. 107 (In Full)			600	

HAMPSTEAD. Brewery. 1878.

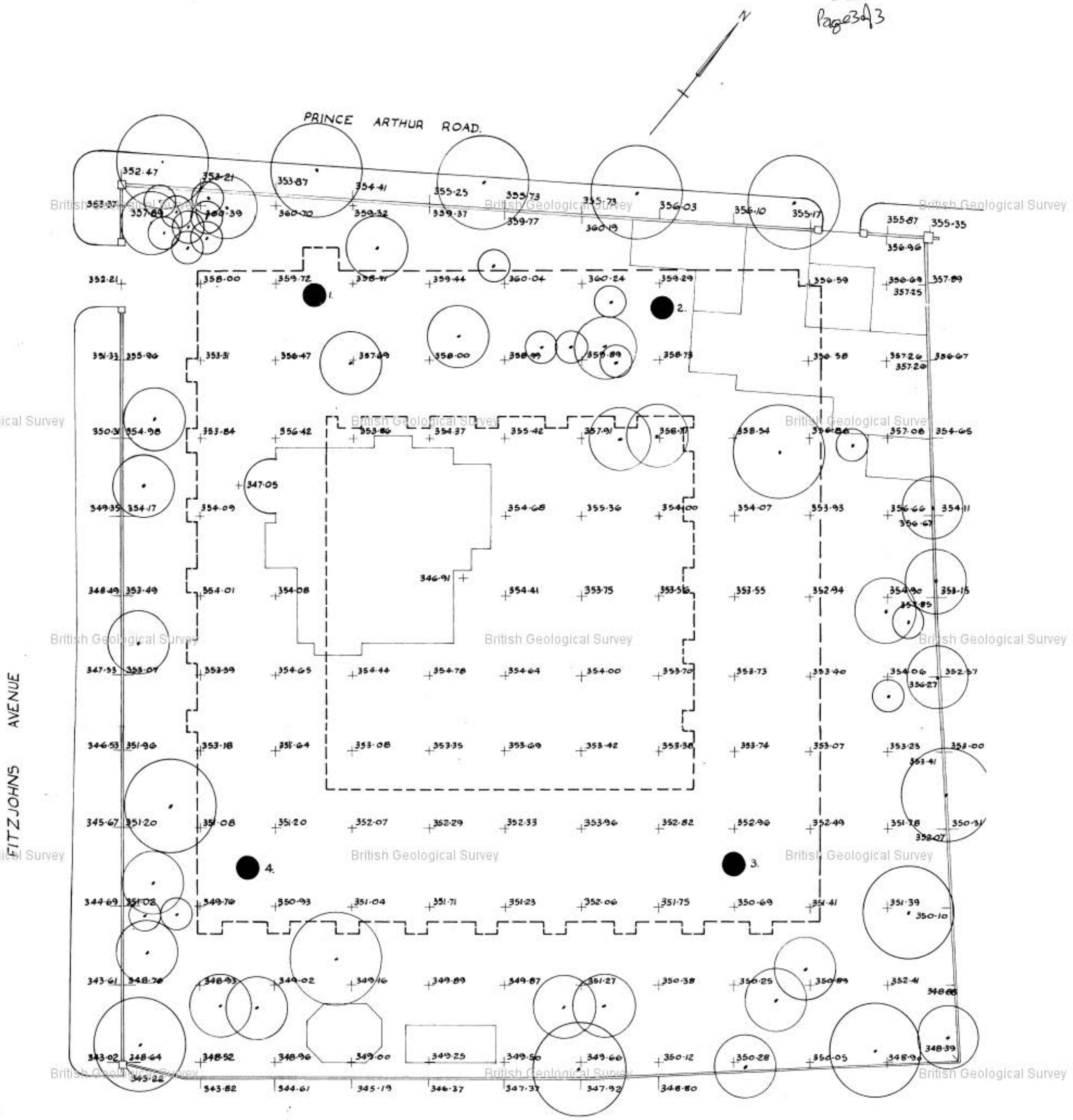
Communicated by MR. J. W. GROVER.
315 feet above Ordnance Datum.
Shaft 340 feet, the rest bored. Water rose to 325 feet from the surface.

		Thickness.	Depth.
[? Top soil, or made earth]		7 {6}	7
[London Clay, 353 feet.]	Brown clay	33	40
	Clay with shells	40	80
	[? Clay] shells at 90 feet; claystone and calcareous spar (nodules) at 145–147 feet; and also (with shells and iron-pyrites) at 196–206 feet; shells at 223 feet;	about 172	252
	[? Darker clay]	„ 25	277
	[? Clay: shells]	„ 33	310
	[? Rather darker clay]	30	340
	Sandy clay and shells	20	360
[Woolwich and Reading Beds, 53 feet.]	Clay	about 22	382
	Clay, reddish	„ 8	390
	[? Clay, mottled], nodules of iron-pyrites	10	400
	[? Clay, mottled]	about 7	407
	Clay and pebbles	„ 6 {5}	413
[Thanet Sand, 31 feet.]	Clay and sand	„ 18	431
	Grey sand	„ 11 {12}	442
	Flints	„ 2	444
Chalk		156 {155}	600

Perhaps the London Clay should be carried lower. In Spon's "Present Practice of Sinking and Boring Wells," Ed. 2, p. 233 (not seen until the above was in print) it is carried down to 408 feet, which seems too low, and the Thanet Sand is not recognized. There are also some differences of detail from the above. {The figures in these brackets are taken from this book.}

(5412) Wt.32837/PS.154 2m 10/64 G.W.B.Ltd. Gp.863

TQ 28 NE/44
2652.8550
256
Page 343



PLAN.

OUTLINES OF EXISTING BUILDINGS SHEWN THUS. ————————
OUTLINES OF PROPOSED NEW BUILDINGS SHEWN THUS. — — — —

TQ 28 NE/44
2652,8550
256
Page 1 of 3

BOROUGH OF HAMPSTEAD.

CHARLES E. JACOB
A.R.I.B.A.
CHARTERED ARCHITECT

HOUSING ARCHITECT

TELEPHONE: HAMPSTEAD 7171/EXT. 131

Re: [illegible]

YOUR REF. .....

MY REF. MW/PA. P/43

HOUSING ARCHITECT'S DEPARTMENT,
222, HAVERSTOCK HILL,
N.W.3.

11th December, 1963.

Ack by Mr. 12 Dec '63

The Director,
Geological Survey & Museum,
Exhibition Road,
South Kensington, S.W.7.

Dear Sir,

102, Fitzjohn's Avenue. N.W.3.

I refer to Circular No.18/62 from the Ministry of Housing and Local Government and enclose copies of the following documents, for your information, giving details of the trial boreholes that were sunk on this site during July 1963:-

1/1250 O.S.Sheet showing the location of the site
Drawing No.899/4 showing the position of the boreholes on the site.

The following deposits were encountered in the boreholes:-

No.1 Boring	Thickness	Depth below surface.
Topsoil	3'0"	3'0"
Brown fine sand with a little silt and small clay pockets	14'0"	17'0"
Stiff to very stiff laminated grey sandy clay and brown silty fine sand	13'0"	30'0"
Total from surface	30'0"	30'0"

No.2 Boring		
Made ground (sand, ashes, stones etc.)	2'0"	2'0"
Yellow/brown fine sand with a little silt and small clay pockets	15'6"	17'6"
Stiff laminated grey sandy clay and orange/brown silty fine sand	12'6"	30'0"
Total from surface	30'0"	30'0"

/contd:

TQ28NE/44
2652 8550
256.

The Director,
Geological Survey & Museum

Continuation Sheet No.1. Page 2 of 3

No.3 Boring +35.1 OD (+ 106.98 m)

		Thickness	Depth below surface.
	Topsoil	2'6"	2'6"
Bagshot Beds	Stiff laminated grey sandy clay and brown silty fine sand	11'6"	14'0"
	Yellow/brown silty fine sand, clayey at some levels	19'0"	33'0"
Claygate Beds	Coarsely laminated grey sandy clay and orange/brown silty sand	4'0"	37'0"
	Brown silty very fine sand with trace of clay	3'0"	40'0"
	Total from surface	40'0"	40'0"

No.4 Boring +35.0

Made ground (clayey sand, gravel, topsoil, etc.)	3'6"	3'6"
Sandy clay with stones	1'0"	4'6"
Firm to stiff laminated grey sandy clay and silty fine sand	15'6"	20'0"
Total from surface	20'0"	20'0"

Yours faithfully,

G.L. Jacob.

Housing Architect.

Encls:

TQ/28NE/95
2635.857 OF 8

RECORD OF BOREHOLE No: OF 8

HOLLY BUSH VALE,
:HAMPSTEAD HEATH

No. : 431

Boring : Shell + Auger

(started) : 20·5·69

Borehole Dia : 6"

Casing :

Ground Level : 356·863'

Sheet 1 of 2

Water Level	SAMPLES Depth	Type	No.	STRATA Legend	Depth	Thickness	DESCRIPTION OF STRATA
	2·6"	D	1		2:0	2:0	MADE GROUND (Brick Rubble)
	5·0"	U	2		4:0	2:0	Mottled grey, orange brown + light brown firm slightly sandy CLAY
	7·6"	D	3		6·0		Loose dry golden brown fine micaceous SAND
	10·0"	U	4		5:0		(very local soft grey clay pockets)
	12·6"	D	5		11·0	2:0	Light brown silty soft/ firm CLAY + fine orange brown sand.
	15·0"	U	6		13·0	3:0	Firm brown sandy CLAY
	17·6"	D	7		16·0	2:0	Grey silty firm CLAY + fine brown sand.
	20·0"	U	8		18·0		
	22·6"	D	9				Dark grey stiff silty micaceous CLAY, (locally greenish tinge)
	25·6"	U	10				
	27·6"	D	11		23·6		
	30·0	U	12				356 11 345
	32·6"	D	13				
	35·0	U	14				
	37·6"	D	15				
4:0	40:0"	U	16		40·0		

Water first met at 32:0"
Piezometer installed at 40·0"

Foundation Engineering Ltd.

TQ/28NE/95

2635 - 8978. OF.8

RECORD OF BOREHOLE No: OF3

HOLLY BUSH VALE,
: HAMPSTEAD HEATH

: No. : 431

: of Boring : Shell + Auger

Date (started) : 20.5.69

Borehole Dia : 6"

Casing :

Ground Level : 356.863

Sheet 2 of 2

Water Level	SAMPLES			STRATA			DESCRIPTION OF STRATA
	Depth	Type	No.	Legend	Depth	Thickness	
					41.6		as on sheet 1.
					Borehole Complete		

Foundation Engineering Ltd.

APPENDIX C

Ian Farmer Associates exploratory hole records

PEGASUS LIFE LIMITED

FITZJOHN'S AVENUE,
HAMPSTEAD, NW3 6PA

REPORT ON PHASE 2 GROUND INVESTIGATION

Contract: 52247A

Date: November 2014

Ian Farmer Associates (1998) Limited
Unit 1A, Lower Luton Road,
Harpenden, Herts AL5 5BZ
Tel: 01582 460018
Fax: 01582 469287

REPORT ON PHASE 2 GROUND INVESTIGATION

carried out at

FITZJOHN'S AVENUE,

HAMPSTEAD, NW3 6PA

Prepared for

PEGASUS LIFE LIMITED
105 – 107 Bath Road
Cheltenham
GL53 7PR

Contract No: 52247A

Date: November 2014

Ian Farmer Associates (1998) Limited
Unit 1A, Lower Luton Road,
Harpenden, Herts AL5 5BZ
Tel: 01582 460018
Fax: 01582 469287

Report Issue Log

Draft Issue	**Issued By** **DA**	**Checked By** **WGG**
Issue Method **E**	Date **16/9/2014**	Date **22/09/2014**

Final Issue	**Issued By** **DA**	**Checked By** **WGG**
Issue Method **D**	Date **22/9/2014**	Date **23/9/2014**

Revision	**Issued By** **WGG**	**Checked By** **DAA**
Issue Method **E**	Date **05/11/2014**	Date **07/11/2014**

Issue Method: E = Electronic
P = Paper
D = Disc

EXECUTIVE SUMMARY

On the instructions of Gleeds Management Services Limited, on behalf of Pegasus Life Limited, an investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

The site, where it is proposed to develop a five and seven storey structure with part lower ground level (basement), for residential purposes, is situated at the junction of Fitzjohn's Avenue and Prince Arthur Road, approximately 200m to the south of Hampstead Tube Station, and may be located by Grid Reference TQ 264 855.

Published geological and hydrogeological records indicate the site to be situated above a Secondary A aquifer relating to the granular Bagshot Formation with the Claygate Member outcropping directly to the southwest. No superficial deposits are anticipated though Made Ground formed during the development of the existing and previous structures is anticipated to a moderate depth.

Site works were undertaken between the 13 and 29 August 2014 and comprised five boreholes to depths of between 11m and 20m below ground level (bgl), with one further borehole location aborted due to the presence of services. Three hand-dug trial pits were also carried out to reveal the foundations to the adjacent boundary wall.

The exploratory locations encountered the anticipated geological sequence being solid deposits of the Bagshot Formation, generally comprising interbedded firm occasionally stiff to very stiff sandy occasionally slightly gravelly clay and medium dense, occasionally loose or dense, clayey occasionally slightly gravelly fine sand. The Bagshot Formation, where proven, extended to a depth of between 8.50m and 14.90m bgl and was underlain by the Claygate Member of the London Clay Formation to the full depth of the investigation. This generally comprised unweathered stiff fissured dark grey occasionally sandy silty clay with partings of sand and clusters and speckling of iron pyrite.

The natural strata were overlain by Made Ground or Possible Made Ground (borehole 2) which extended to a depth of between 0.25m and 1.80m bgl and was unproven in trial pit 1 at 0.70m bgl.

On the basis of these observations together with results of in-situ and laboratory tests consideration could be given to the adoption of shallow spread foundations to support the proposed structure. Such foundations, at the proposed elevations for the new structure of 103.29m, 100.84m and 98.7m AOD, assuming the Bagshot Formation at shallow depth to be essentially a clay soil, may be designed to an allowable bearing pressure of 80kPa, 110kPa and 125kPa respectively, which would provide an adequate factor of safety against shear failure. Settlements, assuming a 1m wide pad, are likely to be less than 20mm. However, it may be considered that for foundations over a certain size and depth it may be more economical to adopt piles.

For the purposes of this contamination risk assessment, the results of the soil analyses have been compared to the Assessment Criteria (AC) derived in-house using the CLEA Software Version 1.06, CLEA SGVs published in Environment Agency Science Reports SCR050021 and SC050021/SR3, where available, and Generic Assessment Criteria (GAC), determined by LQM and CIEH, in accordance with current legislation and guidance.

Elevated levels of lead, benzo(a)pyrene and TPH were encountered within the soils at two locations while leachate analysis indicated elevated levels of lead, copper and TPH when compared to the relevant assessment criteria.

Recommendations have been made which include removal of contaminated soil and placing clean materials in order to prevent any potential risk to human health while it is also recommended that groundwater sampling and testing be undertaken in order to assess the risk to controlled waters.

Elevated levels of carbon dioxide have been recorded during the monitoring phase. As the results are also variable, it is recommended that further monitoring is undertaken.

CONTENTS

APPENDIX 7 - GAS GENERATION

General Notes on Gas Generation vii/i-vii/x

1.0 INTRODUCTION

1.1 It is understood that it is proposed to develop the site for residential purposes, comprising a five and seven storey structure that is joined at ground level and lower ground level (basement), which will house forty-three apartments.

1.2 On the instructions of Gleeds Management Services Limited, on behalf of Pegasus Life Limited, an investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

1.3 This report should be read in conjunction with the Preliminary Investigation, which was reported under reference 52247 in August 2013.

1.4 It is recommended that a copy of this report be submitted to the relevant authorities to enable them to carry out their own site assessments and provide any comments.

1.5 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

1.6 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.7 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated at the junction of Fitzjohn's Avenue and Prince Arthur Road in Hampstead, North London and approximately 200m to the south of Hampstead Tube Station. The site can be located by Grid Reference TQ 264 855.

2.1.2 A site plan is included in Appendix 1, Figure A1.1.

2.2 Geological Setting

2.2.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No. 256, 'North London', solid and drift edition, 1:50000 scale, published 2006.

2.2.2 The geological map indicates the site is not underlain by superficial deposits.

2.2.3 The solid geology is represented by the Bagshot Formation consisting of pale yellow-brown to pale grey or white, locally orange or crimson, fine to coarse grained sand that is frequently micaceous and locally clayey, with sparse glauconite and sparse seams of gravel. The Bagshot Formation is, in turn, underlain by the Claygate Member of the London Clay Formation comprising clay, silt and fine grained sand.

3.0 SUMMARY DESK STUDY FINDINGS

3.1 A Preliminary Investigation in the form of a desk study and site reconnaissance was carried out in August 2014 in order to assess the potential hazards on and adjacent to the site and prepare a risk assessment for further consideration.

3.2 Potential hazards relating to the underlying geology which may impact on the proposed development included Made Ground formed during the development of the existing and previous structures, which may be present to a moderate depth and likely be compressible and of low strength, and potentially high concentration of sulphates and sulphides associated with the Claygate Member, which may result in concrete attack.

3.3 A walkover survey was carried out on the 7 August 2014, at which time the site was at two levels. To the northeast, the ground level was at the same level as the surrounding area at about 105.80m AOD. To the southwest, ground level had been reduced to approximately 102.00m AOD, which was between 1.00m and 2.00 below the original ground level, to produce a level platform. Two structures occupied the majority of the site and were connected at first floor level. The building to the northeast was brick clad and between five and six storeys high with the building to the southwest, again brick clad, between three and four storeys high. Both buildings were in use as a residential hostel operated by the Hyelm Group.

3.4 A review of available historical maps indicated the site to have been undeveloped until the 1860s/1870s when Mount Farm was first shown. The site was redeveloped in the 1890s as a single Victorian dwelling with a large garden and remained substantially unchanged until the early 1970s when a new structure was constructed in the garden area of the site. The Victorian house was replaced around the late 1990s/early 2000s.

3.5 The research identified Made Ground, formed during previous development of the site, as a potential source of contamination which may form part of a pollutant linkage and would require further investigation.

4.0 SITE WORK

4.1 The site work was carried out between 13 and 29 August 2014. The locations of exploratory holes were identified by the client.

4.2 Three boreholes, designated 2, 5 and 6, were sunk by light cable percussion method, three boreholes, designated 1, 3 and 4, were undertaken by window sampler technique and three trial pits, designated 1 to 3, were dug by hand at the positions shown on the site plan, Appendix 1, Figure A1.1. The depths of boreholes and trial pits, descriptions of strata encountered and comments on groundwater conditions are given in the borehole and trial pit records, Appendix 2, Figures A2.1 to A2.8.

4.3 Borehole 6 was attempted but, due to the presence of services and difficulties in excavating an inspection pit prior to boring, was abandoned.

4.4 Representative disturbed and undisturbed samples were taken at the depths shown on the borehole and trial pit records and despatched to the laboratory. Standard (split-barrel and cone) penetration tests, ref. 10.6, were carried out in the boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records.

4.5 Samples for environmental purposes were collected in amber glass jars and kept in a cool box.

4.6 Monitoring installations protected by a stopcock cover were installed in boreholes 4 and 5, as detailed in the borehole records and tabulated below.

Borehole No	Depth To Base (m)	Response Zone (m bgl)	Nominal Pipe Diameter (mm)	Gas Valve/Lockable Cover
BH4	12.00	1.00 to 12.00	50	Yes
BH5	20.00	1.00 to 20.00	50	Yes

4.7 The ground levels at the borehole and trial pit locations, reported on the records, were interpolated from spot levels on a survey drawing provided by the Client.

4.8 Gas monitoring visits were undertaken on the 13 and 21 October and 4 November 2014 and the results provided in Appendix 2, Figure A2.13.

5.0 LABORATORY TESTS

5.1 Geotechnical Testing

5.1.1 Geotechnical soil analysis was undertaken of samples obtained during the investigation as follows:

5.1.2 12 No. Water Content Tests

5.1.3 8 No. Plasticity Index Tests

5.1.4 11 No. Particle Size Distributions (by Wet Sieving)

5.1.5 6 No. pH Values

5.1.6 6 No. Sulphate Contents (Water Soluble)

5.1.7 7 No. Special Digest 1 Test Suites

5.1.8 The laboratory test reports are given in Appendix 3, Figures A3.1 and A3.2.

5.2 Chemical Testing

5.2.1 The suite of chemical analyses has been based upon the findings of the preliminary investigation, along with any on-site observations, to investigate the potential sources of contamination identified in the conceptual model. The chemical analyses were carried out on selected samples of the Made Ground. Leachate analysis was also conducted on selected samples of the Made Ground. The nature of the analyses is detailed below:

5.2.2 **Metals Suite** - arsenic, boron (water soluble), cadmium, chromium (hexavalent), chromium (total), copper, lead, mercury, nickel, selenium and zinc.

5.2.3 **Organic Suite -** petroleum hydrocarbons – TPH CWG speciated analysis, polycyclic aromatic hydrocarbons (PAH) – USEPA 16 suite and phenols, BTEX compounds and MTBE.

5.2.4 **Inorganics Suite** – cyanide (free) and sulphate (water soluble).

5.2.5 **Others** - pH, organic matter content and asbestos.

5.2.6 The results of these tests are shown in Appendix 4, Figure A4.1 and Figure A4.2.

6.0 GROUND CONDITIONS ENCOUNTERED

6.1 Sequence

6.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.

6.1.2 Interpolation of strata depths between locations should be undertaken with caution, particularly for depths of Made Ground where structures are still present at the time of the investigation.

6.1.3 The sequence and indicative thicknesses of strata are provided below:

Strata Encountered	Depth Encountered (m bgl)		Strata Thickness (m)
	From	To	
Made Ground/Possible Made Ground	0.00	0.25 to 1.80	0.25 to 1.80
Bagshot Formation	0.25 to 1.80	8.50 to 14.90	6.80 to 14.65
Claygate Member (London Clay Formation)	8.50 to 14.90	>20.00	>11.50

6.2 Made Ground/Possible Made Ground

6.2.1 This was encountered at each of the exploratory location and extended to a depth of between 0.25m below ground level (bgl) in borehole 5 and 1.80m bgl in borehole 1.

6.2.2 Boreholes 1 and 4, undertaken in areas of soft landscaping encountered a surface layer of topsoil 0.80m and 0.40m thick.

6.2.3 Whilst boreholes 2, 3 and 5, undertaken through existing hard standings, encountered a 0.10m thick layer of asphalt over reinforced concrete to 0.40m and 0.30m bgl in boreholes 2 and 3 respectively, and block paving over sandy granite sub-base to 0.15m bgl in borehole 5. Borehole 6 was terminated in an undermined thickness of concrete.

6.2.4 The natural strata directly underlay the hard standing in borehole 5, and possible Made Ground comprising soft sandy gravelly clay with sand pockets underlay the hard standing in borehole 2 to a depth of 1.70m bgl.

6.2.5 The Made Ground continued in boreholes 1, 3 and 4, below the hard standing or topsoil, generally as brown slightly gravelly to gravelly occasionally slightly clayey silty sand with varying proportions of clinker, glass, asphalt and brick fragments, and rootlets in boreholes 1 and 4, to a depth of 1.45m bgl in borehole 1 and to the full depth of the stratum in boreholes 3 and 4.

6.2.6 A further layer of Made Ground was encountered in borehole 1 between 1.45m ad 1.80m comprising firm brown silty sandy clay with rootlets and rare brick and clinker fragments.

6.2.7 Trial pits 2 and 3 encountered Made Ground to a depth of 0.60m bgl and unproven at 0.70m bgl in trial pit 1.

6.3 Bagshot Formation

6.3.1 This underlay the Made Ground/Possible Made Ground to a depth proven in boreholes 1, 2 and 5 of between 8.50m and 14.90m bgl generally increasing in depth broadly from the north to the south.

6.3.2 The stratum generally comprised interbedded firm to stiff occasionally stiff to very stiff orange brown silty sandy to very sandy occasionally slightly gravelly clay and medium dense slightly clayey to clayey silty occasionally slightly gravelly fine sand. Gravels were well rounded flint.

6.3.3 Boreholes 3 and 4, and trial pits 2 and 3 were terminated in this stratum and thus the full thickness was unproven.

6.4 Claygate Member

6.4.1 Deposits consistent with the Claygate Member of the London Clay Formation underlay the Bagshot Formation in the remaining locations to the full depth of the investigation at 20m bgl.

6.4.2 This stratum generally comprised unweathered stiff fissured dark grey occasionally sandy silty clay with partings of sand and clusters and speckling of iron pyrite.

6.4.3 A bed of claystone was noted between 15.50m and 15.80m bgl.

6.5 Groundwater

6.5.1 Several groundwater strikes were recorded throughout the soil profile.

6.5.2 These observations suggest groundwater, associated with the Bagshot Formation, is present at levels of between 93.2m and 95.5mAOD, and associated with the Claygate Member at levels of between 83.7m and 90.0m AOD rising in a twenty minute period to levels of between 87.1m and 90.8. The latter likely to be under sub-artesian pressure.

7.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

7.1 Structural Details

7.1.1 It is understood that the proposed development is to consist of a five and seven storey structure that is joined at ground level and lower ground level (basement), to form forty-three apartments.

7.1.2 Precise structural details were not available at the time of preparation of this report.

7.1.3 Details of the foundations to the adjacent boundary wall to the site are provided in the trial pit logs given in Appendix 2, Figures A2.6 to A2.8 and trial pit photographs Figures A2.9 to A2.11.

7.2 Assessment of Soil Condition

7.3 General

7.3.1 It was not possible to retrieve undisturbed samples from the strata encountered due to the frequency of groundwater strikes, the interbedded nature of the strata and the proportion of fine sand.

7.3.2 A plot of SPT 'N' value, as measured and uncorrected, with elevation is provided in Appendix 5, Figure A5.1.

7.4 Made Ground

7.4.1 Made Ground or possible Made Ground was encountered to a depth of between 0.25m and 1.80m bgl and was principally comprised of silty sand and occasionally sandy clay.

7.4.2 SPTs were undertaken which recorded 'N' values of between 5 and 16 suggesting the material to be generally loose to medium dense.

7.5 Bagshot Formation

7.5.1 These generally comprised interbedded sandy clay and clayey sand with perched groundwater and extended to depths where proven of between 8.50m and 14.90m bgl.

7.5.2 Laboratory testing for the clay beds recorded natural moisture contents of between 11% and 25%, with an average of 19% and plasticity indices of between 18% and 33%, with an average of 27%. The plastic index test results are presented on the plasticity classification chart, Appendix 3, Figure A3.3.

7.5.3 These results indicate the clay beds in the stratum are of low to intermediate plasticity and of low to medium volume change potential as defined by the National House Building Council, ref. 10.9 and other published data, refs 10.10 and 10.11.

7.5.4 Therefore based on the average plasticity index of 27% it is considered that for design purposes medium volume change potential should be adopted. Changes in moisture content could result in moderate changes in volume, seasonal changes being exacerbated by the presence of trees.

7.5.5 Particle size distributions undertaken on bulk samples from a range of depths indicated a gravel content of between 0% and 10%, with one value of 45% and an average of 7%, a sand content of between 29% and 83%, with an average of 58%, a silt content of between 8% and 44%, with an average of 20% and a clay content of between 4% and 27%, with an average of 15%. The sand was predominantly fine grained.

7.5.6 SPTs were undertaken and where full penetration was achieved, recorded 'N' values of between 7 and 29, with one value of 50 and an average of 17 suggesting the stratum is generally medium dense, occasionally loose towards the top of the stratum.

7.5.7 Using empirical correlations and assuming the stratum to be a clay soil an average 'N' value of 17 might suggest an m_v value of 0.13 m^2/MN for this stratum with a conservative value for the top of the stratum in the order of 0.32m^2/MN.

7.6 Suggested Soil Characteristic Values

7.6.1 Summary of the geotechnical parameters derived from the laboratory and in-situ testing:

	Minimum	Maximum	Characteristic
Moisture Content (%)	11	25	19
Plasticity Index (%)	18	33	27
SPT 'N' value	7	29 (50)	17
Derived Compressibility, m_v (m^2/MN)	0.08	0.32	0.13
Gravel Content (%)	0	10	7
Sand Content (%)	29	83	58
Silt Content (%)	8	44	20
Clay Content (%)	4	27	15

7.7 Claygate Member

7.7.1 This was proven to underlay the Bagshot Formation to the full depth of the investigation at 20m bgl and generally comprised unweathered stiff fissured dark grey occasionally sandy silty clay with partings of sand and clusters and speckling of iron pyrite, with possible sub-artesian groundwater.

7.7.2 Laboratory testing undertaken on one sample of the clay recorded a natural moisture content of 25% with a plasticity index of 37%. The plastic index test result is presented on the plasticity classification chart, Appendix 3, Figure A3.3.

7.7.3 This result indicates the stratum to be of high plasticity and of medium volume change potential as defined by the National House Building Council, ref. 10.9 and other published data, refs 10.10 and 10.11.

7.7.4 A participle size distribution indicated a gravel content of 0%, a sand content of 56%, a silt content of 28% and a clay content of 16%.

7.7.5 SPTs were undertaken and where full penetration was achieved, recorded 'N' values of between 20 and 41, with an average of 34 which when using empirical correlations suggests the stratum is generally stiff to very stiff and of high to very high strength.

7.8 Foundation Design

7.8.1 On the basis of observations made on site together with results of in-situ and laboratory tests consideration could be given to the adoption of shallow spread foundations to support the proposed structure.

7.8.2 Therefore, at the proposed formation elevations for the new structure of 103.29m, 100.84m and 98.7m AOD such foundations, assuming the Bagshot Formation at shallow depth is essentially a clay soil, may be designed to an allowable bearing pressure of 80kPa, 110kPa and 125kPa respectively, which would provide an adequate factor of safety against shear failure. Settlements, assuming a 1m wide pad, are likely to be less than 20mm, however, these should be checked when the final structural loading is known.

7.8.3 In addition conventional shallow spread footings should be taken through any Made Ground/Possible Made Ground and placed in the underlying natural strata, be at a minimum depth of 0.90m bgl and where within the zone of influence of recently removed, existing or proposed trees, foundations should be taken through the Made Ground and placed at depths recommended by the NHBC for soils of medium volume change potential. Compressible material should be placed on the inside faces of foundations as specified by the NHBC.

7.8.4 However, it may be considered that for foundations over a certain size and depth it may be more economical to adopt piles. Guidelines for the design of piles are given in Appendix 5, which may be used with the plot of 'N' value with depth included in Figure A5.1.

7.8.5 Within the zone of influence of trees the piles should be sleeved to depths equivalent to those specified by the NHBC for a foundation at the same location. Compressible material should be placed below and on the inside faces of pile caps and beams, as specified by the NHBC.

7.8.6 The carrying capacity of piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art techniques are often employed before they reach the public domain, perhaps several years down the line. Therefore, it is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

7.8.7 It should be noted that groundwater was present, which could affect the installation of the piles.

7.9 Retaining Wall Design

7.10 Estimation of ϕ' for Retaining Wall Design

7.10.1 New retaining walls for the proposed structure, which are understood to extend to a depth of some 7.7m bgl, are likely to be require to support predominantly the interbedded Bagshot Formation, which for the purpose of this report is considered to be a clay soil.

7.10.2 To determine the long term clay strength, effective stress analyses may be carried out, either fully drained or undrained with pore water pressure measurements. However, such tests must be carried out slowly to ensure equalisation of pore pressures and are therefore time consuming. It was not possible to retrieve suitable samples of the Bagshot Formation for such analysis due to the interbedded nature of the stratum and the high percentage of fine sand.

7.10.3 Therefore, based on the sample descriptions and laboratory classification tests together with readily available published literature, it is considered reasonable for design purposes that an assumed angle of internal friction, ϕ' for the Bagshot Formation of 24^{o} could be adopted.

7.10.4 If the undrained strength of stiff clay is to be relied upon during temporary works construction, then care is necessary to ensure that there are no sand or silt partings containing free water that would affect the undrained shear strength. Sand beds were encountered within the Bagshot Formation for the depth of the proposed basement and though perched water was not observed.

7.11 Ground/Basement Floor Slabs

7.11.1 On the basis of observations on site together with the results of laboratory tests, it is recommended that outside the zone of influence of trees, consideration is given to constructing the ground/basement floor slabs on formation prepared in the Bagshot Formation. Any soft or deleterious material should be removed and replaced with properly compacted granular fill.

7.11.2 Within the zone of influence of trees, the ground floor slabs should be suspended over a void, in accordance with NHBC guidelines.

7.12 Excavations

7.12.1 On the basis of observations on site together with the results of in-situ and laboratory tests, it is considered that excavations to less than 1.20m would not stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations, ref. 10.14.

7.12.2 Groundwater should not be expected in shallow excavations for foundations or services. However, it is possible that perched groundwater could be present in the Made Ground overlying the clay beds of the Bagshot Formation. It is considered that this could be dealt with by the use of a small pump.

7.12.3 Groundwater could be expected in excavations taken to depths in excess of 8m bgl.

7.13 Road and Hard Standing Design

7.13.1 The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, CBR, scale from which the subgrade surface modulus can be estimated. Experience has indicated that the measurement of the in-situ CBR value tends to give unreliable results because of the influence of the moisture content of the materials. In practice, the correlation given by the Highways Agency, ref. 10.15, is usually more appropriate than direct determination of the CBR.

7.13.2 The process of design given in the guidance notes requires an estimate of CBR and subgrade stiffness modulus to be made at the design stage and in-situ measurement prior to construction.

7.13.3 On the basis of laboratory classification tests it is recommended that for formation prepared in the Bagshot Formation, with a characteristic plastic index value of 27%, a subgrade CBR value of 4% be adopted for design purposes. The assessment assumes there to be a low water table, good construction conditions and a thin pavement construction. Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

7.13.4 For routine cases, all material within 450mm of the road surface should be non frost-susceptible, ref. 10.16.

7.14 Chemical Attack on Buried Concrete

7.14.1 The site has been classified in accordance with BRE Special Digest 1, ref. 10.17, as Made Ground, and as natural ground without the presence of pyrite being the Bagshot Formation and as natural ground that contains pyrite being the Claygate Member. Laboratory testing was undertaken accordingly. It is recommended that the guidelines given in BRE Special Digest 1, ref. 10.17, be adopted.

7.14.2 The results of chemical tests in the Made Ground indicate a sulphate concentration in the soil of between 24mg/l and 1300mg/l as a 2:1 water/soil extract, with pH values in the range of 7.2 to 11.1.

7.14.3 The results of chemical tests in the Bagshot Formation indicate a sulphate concentration in the soil of between 27mg/l and 63mg/l as a 2:1 water/soil extract, with pH values in the range of 6.1 to 8.5.

7.14.4 The results of chemical tests in the Claygate Member, indicate a sulphate concentration in the soil of between 180mg/l and 350mg/l as a 2:1 water/soil extract, a total sulphate concentration of between 0.11% and 0.12% and total sulphur of between 0.48% and 0.60%, with pH values in the range of 7.2 to 7.6.

7.14.5 It is recommended that for conventional shallow foundations the groundwater should be regarded as mobile.

7.14.6 Characteristic values for each strata have been derived from laboratory results for pH, 2:1 water/soil extract (WS), total (acid) soluble sulphate (AS), equivalent Total Potential Sulphate (TPS) and Oxidisable Sulphate (OS), and are presented in the table below, together with Design Sulphate Class and the ACEC Class: -

Stratum	pH	WS (mg/l)	AS (%)	TPS (%)	OS (%)	Groundwater Condition	DS	AC
Made Ground	7.2	1300	N/a	N/a	N/a	Mobile	2	2
Bagshot Formation	6.1	63	N/a	N/a	N/a	Mobile	1	1
Claygate Member (unweathered)	7.2	350	0.12	1.80	1.68	Static	1/4	1s/3s

7.14.7 Values for OS greater than 0.30% indicate that pyrite is present and may be oxidised to sulphate where the ground is disturbed.

7.14.8 On the basis of the laboratory test results it is considered that a Design Sulphate Class for concrete located in the non-pyritic soils may be taken as DS-1. The site conditions would suggest that an ACEC class for the site of AC-1 would be appropriate, however where concrete is to come into contact with the Made Ground consideration should be given to DS and ACEC 2.

7.14.9 Where concrete is to be exposed to disturbed ground in which pyrite is available to be oxidised to sulphate, in this instance the Claygate Member below a depth of about 8.5m bgl, consideration should be given to a Design Sulphate Class of DS-4 with an ACEC class of AC-3s. However, it is considered that oxidisation is unlikely to occur below this depth following the installation of piles. Therefore, it is recommended that should piles be adopted a Design Sulphate Class of DS-1 and ACEC class of AC-1, as indicated by the water soluble sulphate would be appropriate.

8.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

8.1 Contaminated Land

8.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref. 10.18, which was introduced by the Environment Act 1995, ref. 10.19, as;

8.1.2 'Land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.'

8.2 Risk Assessment

8.2.1 The definition of contaminated land is based on the principles of risk assessment. Risk is defined as a combination of:

- The probability, or frequency of exposure to a substance with the potential to cause harm, and:
- The seriousness of the consequence.

8.3 Pollutant Linkage

8.3.1 The basis of an environmental risk assessment involves identifying a 'source' of contamination, a 'pathway' along which the contamination may migrate and a 'receptor' at risk from the contamination.

8.3.2 Current legislation defines the various elements of the pollution linkage as:

- A contaminant is a substance, which is in or under the ground and which has the potential to cause harm or to cause pollution of controlled waters.
- A pathway is one or more routes through which a receptor is being exposed to, or affected by, a contaminant, or could be so affected.
- A receptor is either a living organism, an ecological system, a piece of land or property, or controlled water.

8.3.3 A pollutant linkage indicates that all three elements have been identified. The site can only be defined as 'Contaminated Land' if a pollutant linkage exists and the contamination meets the criteria in Section 8.1 above.

8.3.4 The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification
- Hazard Assessment
- Risk Assessment
- Risk Evaluation

8.3.5 The hazard identification and hazard assessment have been based upon the Preliminary Investigation and formed the conceptual site model, detailed in our report, reference 52247, dated August 2014.

8.3.6 The risk assessment and evaluation stages are presented in this phase 2 interpretive report, after an intrusive ground investigation has taken place.

8.4 Risk Assessment – Human Health

8.4.1 It is understood that it is proposed to develop the site for residential purposes, comprising a five and seven storey structure that is joined at ground level and lower ground level (basement), which will house forty-three apartments. The risk assessment has therefore been based on guidelines for a residential end use end use.

8.4.2 The results of the soil analyses have been compared to CLEA SGVs published in Environment Agency Science Reports SC050021/SR3, ref. 10.20, and SC050021, ref. 10.21, where available, and Generic Assessment Criteria (GAC), determined by LQM and CIEH, ref. 10.22, as well as Assessment Criteria (AC) derived in-house using the CLEA Software Version 1.06, ref. 10.23. The CLEA AC have been derived by Ian Farmer Associates in accordance with current legislation and guidance, as detailed in Appendix 6.

8.4.3 The guidance values used within this contamination assessment have been tabulated and are detailed within Appendix 6. The results have been tabulated, and compared against the relevant assessment criteria, and a summary table presented in Appendix 6, Figure A6.1

8.4.4 The results of chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref. 10.24. Where the concentrations determined on site are at or below the respective assessment criteria, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated.

8.4.5 Those contaminants with observed concentrations above the Guidance Level are detailed below:

Location	Depth (m)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
BH1	0.30	Lead	1500	450
		Benzo(a)pyrene	1.3	0.83
BH3	1.00	TPH Aromatic C_{16}-C_{21}	440	250
		TPH Aromatic C_{21}-C_{35}	2900	890

8.4.6 Where the concentration of any contaminant is above the Guidance Level, further statistical analysis of the results has been conducted in accordance with the CIEH and CL:AIRE guidance, the results of which are presented in the summary table and on 'output sheets' in Appendix 6, Figure A6.1.

8.4.7 Before determining which statistical test can be applied to the data set, it is first necessary to determine the normality of the data distribution by carrying out the Shapiro-Wilk normality test, ref. 10.25. Where the data distribution is shown to be normal, the Upper Confidence Limit (UCL) test can be applied to the results and where data deviates from normality, an alternative method is selected.

8.4.8 The Shapiro-Wilk normality test indicates that the data for the results is normally distributed.

8.4.9 The relevant methods were applied to the contaminants of concern, the results of which gives the estimated upper bound of the 95th UCL of the samples. This test indicates whether any high concentrations represent a significant possibility of harm to human health.

8.4.10 The calculations from the UCL tests are provided in Appendix 6, Figure A6.1, and the results are tabulated below:

Contaminant	Value of UCL (mg/kg)	Guidance Value (mg/kg)	Comments
Lead	521	450	Outlier test required
Benzo(a)pyrene	0.50	0.83	Risk within acceptable limits for proposed use
TPH Aromatic C_{16}-C_{21}	126	250	Risk within acceptable limits for proposed use
TPH Aromatic C_{21}-C_{35}	825	890	Risk within acceptable limits for proposed use

8.4.11 To assess the significance of the contaminant concentrations that exceed the Guidance Level, the outlier test has been undertaken. This test determines whether the highest recorded contaminant concentrations are from the same population or represent a 'hotspot'.

8.4.12 The calculation from the outlier test for lead is provided in Appendix 6, Figure A6.1. This indicates that the result for lead is not an outlier and therefore represents a background concentration within the strata sampled. However, if this result is removed, the 95th percentile result no longer continues to exceed the Guidance Value.

8.5 Risk Assessment - Controlled Waters

8.5.1 The site is located above a Secondary A aquifer and there are no surface watercourses within 1km of the site.

8.5.2 An initial assessment of the risk to controlled waters has been carried out on the basis of the results of leachate analysis undertaken on samples from the Made Ground. The leachate results have been screened against the Water Supply (Water Quality) Regulations 2000, ref. 10.29.

8.5.3 It should be noted that there is no TPH guideline parameter within the Water Supply Regulations 2000. As such, the guidance value of 10µg/l within the Water Supply Regulations 1989, ref. 10.30, has been adopted as a conservative approach.

8.5.4 The leachate analysis indicates exceedances for lead, copper and TPH when compared against the Water Supply Regulations. However, if the leachate analysis is compared to freshwater EQS, ref. 10.31, then only TPH exceeds the relevant guidance level.

8.5.5 It is recommended that the Environment Agency be consulted with regard to the significance of these results, particularly in light of the fact that there is no current guideline TPH parameter within the Water Supply Regulations 2000.

8.5.6 Given the ground conditions encountered at the site and the results of this contamination assessment, it is considered likely that further assessment of the risks to controlled waters will be required.

8.6 Gas Generation

8.6.1 Gas monitoring visits were undertaken during October and November, generally during periods of low or falling atmospheric pressure. The results of the gas monitoring are included within Appendix 2, Figure A2.13.

8.6.2 Methane concentrations of less than 0.1% by volume were recorded during the various monitoring phases together with carbon dioxide concentrations of between <0.1% and 10.3%. Variable oxygen concentrations were recorded ranging from near atmospheric to depleted (12.9%).

8.6.3 Flow rates were recorded over a three minute period during the various return monitoring visits. The maximum of the three minute average flows was recorded at less than 0.1l/hr (limit of detection).

8.6.4 In accordance with the methodology published in CIRIA Document C665, ref. 10.47, the maximum recorded values were taken to calculate a Gas Screening Value for the site. The GSV calculated for carbon dioxide is 0.01l/hr. The GSV calculated for methane is 0.0001l/hr. Although this value indicates the site to be Characteristic Situation 1 (Appendix 7, Table A7.2), the high levels of carbon dioxide recorded on each visit would indicate that Characteristic Situation 2 would be more applicable. For Situation A, being any development other than low rise residential with suspended floor slab and ventilated void, gas protective measures are given in Appendix 7, sections A7.7 and A7.10.

8.6.5 These comments are based on three sets of readings over a period of 4 weeks, which does not follow the recommended guidelines given in Appendix 7, Table A7.1. These values were elevated and varied over the period of monitoring and therefore, it is recommended that a continued programme of monitoring be carried out to comply more closely with these guidelines before final design is undertaken.

8.6.6 Radon - The BRE guidance on Radon producing areas within the UK, (BR211:2007), indicates that the site lies within an area where radon protective measures are not required.

8.6.7 It is recommended that the Local Authority/NHBC are consulted regarding these gas protection measures for their approval prior to commencing construction.

8.7 Protection Of Services

8.7.1 Due to the increasing number of developments being undertaken on potentially contaminated land, the Water Supply Industry has identified the need to protect newly laid water supply pipes. They are likely to impose constraints on the nature of water supply pipes that are to be laid in contaminated land. Current guidance on the selection of materials for water pipes is provided by the UK Water Industry Research Limited, ref. 10.32, though some water supply companies may continue to refer to the previous guidance provided by Water Regulations Advisory Scheme, ref. 10.33, and should be consulted for confirmation.

8.8 Risk Evaluation

8.8.1 The conceptual model formed within the Preliminary Investigation has been updated to reflect the findings of the contamination risk assessment and the revised conceptual model, detailing the relevant pollutant linkages, is tabulated below:

Source	Potential Pathways	Receptor Group
Made Ground (lead, PAH, TPH)	• Ingestion of contaminated soil by direct contact • Ingestion of contaminants through vegetables • Entry of contaminants by skin or eye contact with contaminated soils or dust • Inhalation of contaminated dust	Humans • Site occupants[1] • Site users[1] • Construction workers[2] • Maintenance workers[1] • Neighbouring site users[2]
Made Ground (copper, lead. TPH)	• Infiltration • Migration • Surface run-off	Water Environment • Groundwater
Made Ground (Ground gas)	• Inhalation or migration of toxic / explosives gases / vapours	Humans • Site occupants[1] • Site users[1] • Construction workers[2] • Maintenance workers[1]
[1] – Assumes no remediation is undertaken [2] – Pathway exists only during the construction period		

8.9 Summary of Risk Evaluation

8.9.1 The above assessment identifies that the 'source – pathway – receptor' linkage potentially occurs with lead impacting upon the identified receptors. Therefore, it would be necessary to manage the risk at this location by either eliminating one of the links or by minimising the potential effects.

8.9.2 The elevated level of lead was from BH1 at a depth of 0.30m. The borehole was sunk within the garden area in the northwest corner of the site.

8.10 Waste

8.10.1 An initial assessment of the likely waste classification for any material to be disposed of has been conducted on the basis of the chemical test results obtained as part of the contamination risk assessment.

8.10.2 This assessment has been conducted using the HazWasteOnline[tm] tool, ref. 10.34, the summary output sheet from which is included within Appendix 4, Figure A4.3, with a full copy of the output included on the accompanying CD.

8.10.3 This initial assessment indicates that the following sample could be classified as hazardous waste:

Location	Depth (m)	Classification Result	Contaminant	Hazardous Property
BH1	0.30	Hazardous	Lead	H7: Carcinogenic H14: Ecotoxic
			Cyanide	H12: Release of toxic gases

8.10.4 It should be noted that this sample also identified the presence of asbestos fibres (amosite) which is also likely to classify the material as hazardous waste.

8.10.5 Individual tips might require further analysis prior to the disposal of any material from the site. Any such requirements should be clarified with the tip prior to any further analysis being undertaken.

9.0 MANAGEMENT OF CONTAMINATION

9.1 Remediation and Verification

9.1.1 The risk management framework set out in the Model Procedures for the Management of Land Contamination, CLR 11, ref. 10.35, is applicable to the redevelopment of sites that may be affected by contamination.

9.1.2 The risk management process set out in the Model Procedures has three main components:

- Risk assessment
- Options appraisal
- Implementation

9.1.3 This initial risk assessment has identified the presence of elevated lead, benzo(a)pyrene and total petroleum hydrocarbons concentrations within the Made Ground in the garden area and central forecourt of the site, plus elevated levels of lead, copper and TPH within the leachate results. Relevant pollutant linkages have been identified, as demonstrated in the updated conceptual model.

9.1.4 The remediation strategy will need to review methods of reducing or controlling the identified unacceptable risks. This could be done by removing or treating the sources of contamination, removing or modifying the pathways or removing or modifying the behaviour of the receptors, to ensure there is no significant risk of significant harm to either human health or controlled waters from the identified contamination, in relation to the proposed end use.

9.1.5 An important part of the risk management process is identifying and informing all stakeholders with an interest in the outcome of the risk management project. To this end, if the regulators have not yet been contacted with regard to the redevelopment of this site, it is recommended that they be supplied with a copy of both the Preliminary Investigation report and this Phase 2 Ground Investigation report in order to enable liaison to be undertaken with them.

9.1.6 Following liaison with the relevant regulatory bodies, a remediation strategy could be formulated, which should incorporate an options appraisal and summarise in detail the chosen remedial approach, along with the verification proposals. The remediation strategy should then be approved by the relevant regulatory authorities prior to implementation.

9.1.7 Where remediation is required, a verification report will need to be formulated following implementation of the remediation strategy, which should provide a complete record of all remedial activities conducted on site and include all the data obtained to support the remedial objectives and demonstrate that the remediation has been effective. Any unexpected conditions encountered during the remedial works should also be detailed within the verification report.

9.1.8 The elevated TPH identified in BH3 is likely to be removed as part of the construction as a basement is to be constructed.

9.1.9 This would only leave the elevated benzo(a)pyrene and lead identified in BH1 which will be within a garden area and would require some form of remediation. In gardens, landscaped areas or areas likely to be used for the growing of vegetables/fruit for consumption, a capping layer of 'inert' material could be provided to break the pathway between the identified contamination and end users of the site. The required thickness of the capping layer could be determined using guidance provided by the BRE, ref. 10.36.

9.1.10 In order to minimise the impact on future maintenance workers, where services are to be placed at a depth that puts them at or below the level of the source of contamination, it would be prudent to line the trenches and surround the services with clean inert material.

9.1.11 With respect to groundwater, the removal of the source during basement construction would go some way to reducing the potential risk to groundwater. However, it would be prudent to undertake groundwater sampling on at least two occasions in order to ascertain the impact on the groundwater from the elevated contaminants in the soil.

9.1.12 Elevated levels of carbon dioxide have been recorded during the monitoring period. However, the results are variable and it is recommended that further monitoring is undertaken to confirm these results.

9.2 Management of Unidentified Sources of Contamination

9.2.1 There is the possibility that sources of contamination may be present on the site, which were not detected during the investigation. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly. A number of options are available for handling this material, which include:

- The removal from site and disposal to a suitably licensed tip of all material suspected of being contaminated. The material would need to be classified prior to disposal.

- Short-term storage of the suspected material while undertaking verification testing for potential contamination. The storage area should be a contained area to ensure that contamination does not migrate and affect other areas of the site. Depending upon the amounts of material under consideration, this could be either a skip or a lined area.

- Having a suitably experienced environmental engineer either on-call or with a watching brief for the visual and olfactory assessment of the material, and sampling for verification purposes.

9.3 Consultation

9.3.1 During the development of a site, consultation may be required for a number of reasons with a number of regulatory Authorities. The following provides an indication as to the most likely Authorities with which consultation may be required.

- **Local Authority.** There may be a planning condition regarding contamination and consultation will be required with a designated Contaminated Land Officer within the Environmental Health Department. The Local Authority is generally concerned with human health risks. Some Authorities now require 'Completion Certificates' to be signed off following remediation works.

- **Environment Agency.** Where a site is situated above an aquifer, within a groundwater protection zone or has been designated as a special site, the Environment Agency is likely to be involved to ensure that controlled waters are protected.

- **National House Building Council, NHBC.** Section 4.1 of the NHBC Standards requires land management to be addressed. For a new housing development to be approved by the NHBC, any remediation will require a validation report.

9.3.2 Based on the results of any consultation, there may be specific remediation requirements imposed by one or more of the Authorities.

9.4 Risk Management During Site Works

9.4.1 During ground works, some simple measures may have to be put in place to mitigate the risk of any known or previously unidentified contamination affecting the site workers and the environs. The majority of the proposed measures represent good practice for the construction industry and include:

- Informing the site workers of the contamination on site and the potential health effects from exposure.

- Where appropriate, the provision of suitable Personal Protective Equipment (PPE) for workers who may be potentially impacted by working in areas of the contamination.

- Ensuring good hygiene is enforced on site and washing facilities are maintained on the site. Workers are discouraged from smoking, eating or drinking without washing their hands first.

- Dust monitoring, and if necessary, suppression measures should be put into practice where contamination is becoming airborne.

9.4.2 Where contaminated materials are being removed from the site they should be disposed of at a suitably licensed landfill, with a 'duty of care' system in place and maintained throughout the disposal operations.

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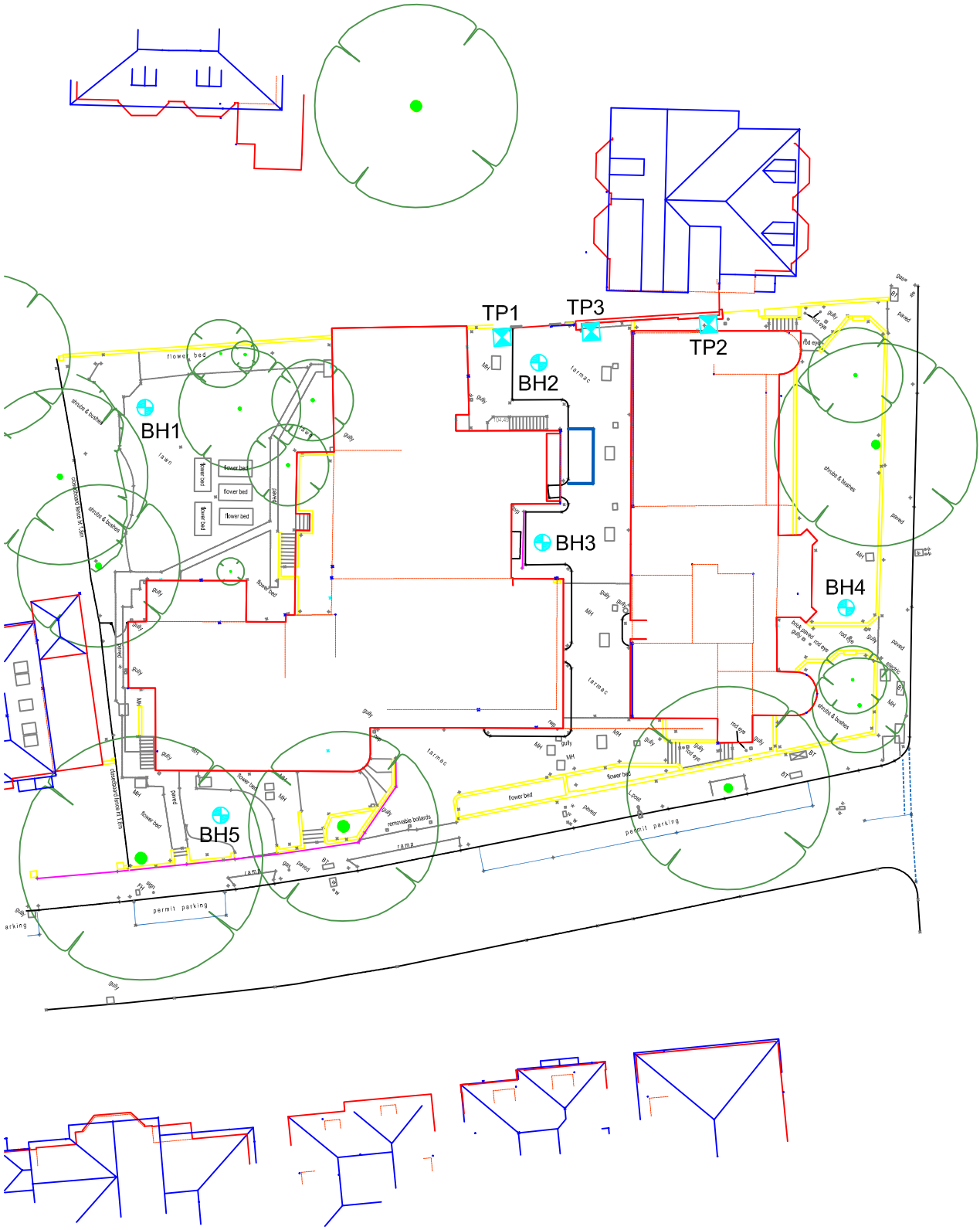
APPENDIX 1

DRAWINGS

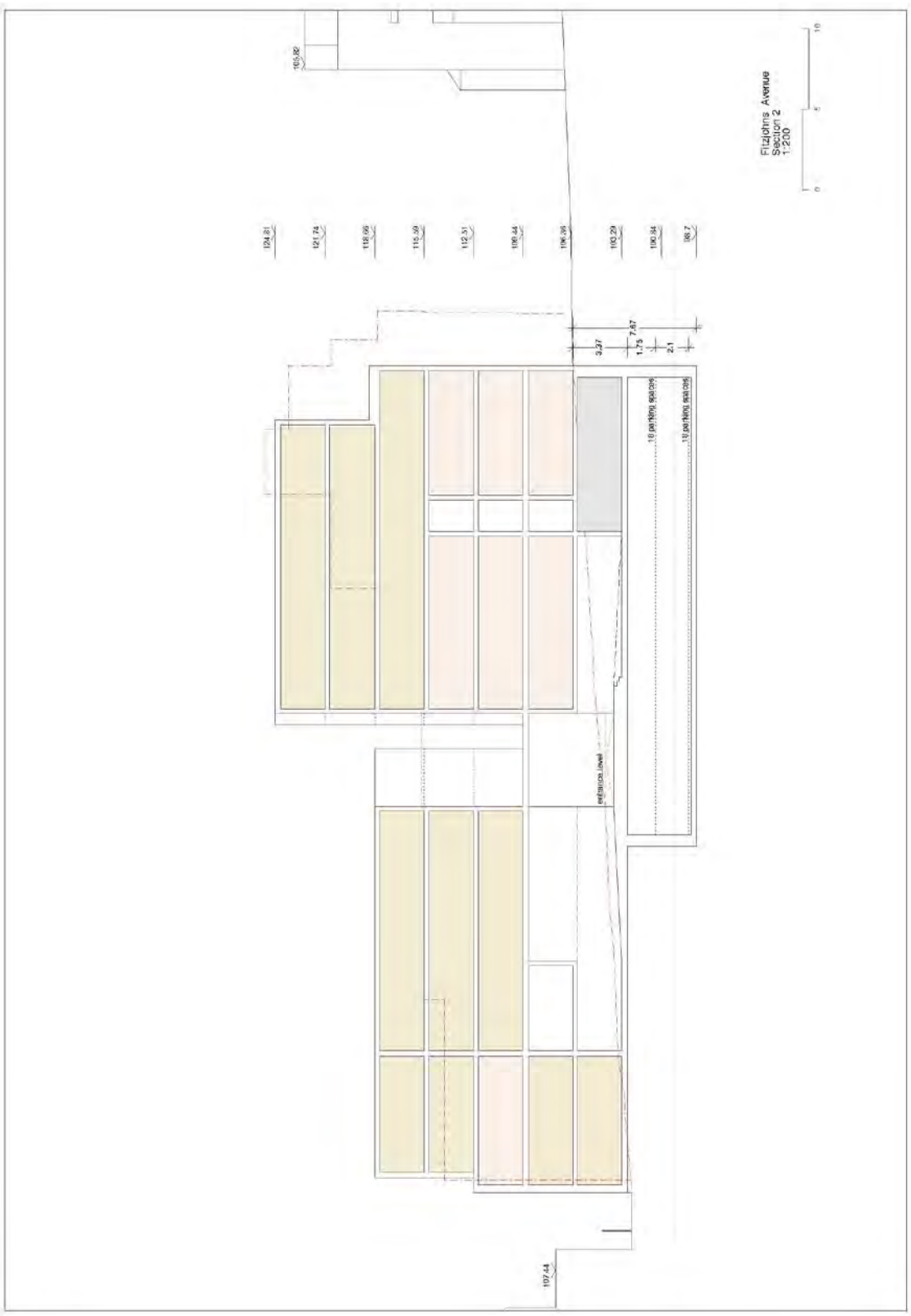


Scale :	N.T.S.
Drawn By :	P.L.E.
Job No:	52247
Fig:	A1.1

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

SITE PLAN

Arthur West House, Fitzjohn's Avenue, Hampstead NW3 6PA.



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PROPOSED BUILDING ELEVATIONS**	Job no. 52247A
	Fitzjohn's Avenue, Hampstead, NW3 6PA	Fig. A1.2

APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SITE WORK

A2.1.1 General

Site work is carried out in general accordance with the guidelines given in ISO 1997, 10.4 and BS 5930, ref. 10.3.

A2.1.2 Trial Pits

Shallow trial pits are generally dug by mechanical excavator, however, in difficult access locations or adjacent to structures, such pits may be hand dug. Pits are best used where the ground will stand unsupported and generally, the maximum depth of machine dug pits is 4m to 5m. Where personnel are required to enter pits, it is essential that side support is provided. Entry by personnel into unsupported pits deeper than 1.2m is not allowed for health and safety reasons.

Trial pits allow the in-situ condition of the ground to be examined both laterally and vertically and also allow discontinuities to be recorded. The field record should give the orientation of the pit with details of which face was logged, assessment of stability of sides of pit and groundwater as well as the strata encountered. Photographs of the pit should also be taken.

In-situ testing, such as hand penetrometer, hand vane, Macintosh probe, or similar, can be undertaken in the sides or base of pits while both disturbed and undisturbed samples recovered.

It is generally advisable to backfill the pits as soon as possible, open pits should not be left unattended.

A2.1.3 Light Cable Percussion Boring

For routine soil exploration to depths in excess of 3m, the light cable percussion rig is generally employed for boring through soils and weak rocks, refs 10.3, 10.4 and 10.5. It consists of a powered winch and tripod frame, with running wheels that are permanently attached so that the rig may be towed behind a suitable vehicle. The rig is towed into position and set up using its own winching system.

The locations of services are checked to make sure the borehole is not situated unacceptably near any services. Regardless of the proximity of services, a CAT scan is undertaken at the borehole location and a trial hole dug to 1.20m by hand.

Boreholes are advanced in soil by the percussive action of the cable tool. The force of the cylindrical tool as it is dropped a short distance cuts a plug of cohesive soil that is removed by the tool.

In non-cohesive soils, the borehole is advanced by a ‘shell’, otherwise known as a ‘bailer’ or ‘sand pump’, which incorporates a clack valve. Material is transferred into the shell and retained by the clack valve. The water level in a borehole is maintained above that in the surrounding granular soil to allow for temporary reductions in the head of water as the shell is withdrawn from the borehole. Water should flow from the borehole into the surrounding soil at all times to prevent ‘piping’ and loosening the soil at the base of the hole. The casing is always advanced with the borehole in granular soil so that material is drawn from the base rather than the borehole sides.

Obstructions to boring are overcome by fitting a serrated chiselling ring to the base of the percussion tool. For large obstructions, a heavy chisel with a hardened cutting edge may have to be used.

Disturbed samples are taken in polythene bags, jars or tubs that are sealed against air or water loss.

Undisturbed samples are generally taken in cohesive materials at changes in strata and at one metre intervals to 5 metres then at 1.5 metre intervals to the full depths of the borehole. The general purpose open-tube sampler is suitable for firm to stiff clays, but is often used to retrieve disturbed samples of weak rocks, soft or hard clay and also clayey sand or silts. This has been adopted for routine use, and usually consists of a 100mm internal diameter tube (U100), which is capable of taking soil samples up to 450mm in length. The undisturbed samples are sealed at each end using micro-crystalline wax to prevent drying.

Standard penetration tests are generally carried out in non-cohesive soils but also in stiff clays and soft rocks at frequencies similar to that of undisturbed sampling.

A2.1.4 Percussive Window Sampling Rig

The percussive sampler consists of a track mounted window sampler, ref. 10.38, with tube sizes varying in diameter from 98mm to 86mm. The sample tube is driven by a drop weight, which can also be used for dynamic probing and standard SPT tests. A cutting shoe is fitted to the bottom of each tube, whilst the sample is collected in a plastic sleeve.

The borehole is extended by using progressively smaller diameter tubes.

A2.2 IN-SITU TESTS

A2.2.1 Standard Penetration Test

The Standard Penetration Test is carried out in accordance with the proposals recommended by ISO 1997, ref. 10.4, BS 1377, Part 9, 1990 ref. 10.6 and ISO 22476 ref. 10.5.

The standard penetration test, **SPT**, covers the determination of the resistance of soils to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows to achieve the standard penetration of 300mm is reported as the 'N' value.

The test is generally carried out in fine soils, however, it may also be carried out in coarse granular soils, weak rocks and glacial tills using the same procedure as for the SPT but with a 50mm diameter, 60° apex solid cone replacing the split spoon sampler, **CPT.**

When attempting the standard penetration test in very dense material or weathered rocks it may be necessary to terminate the test before completion to prevent damage to the equipment. In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler. This may be achieved in the following manner:

- Where the seating drive has been completed, the test drive is terminated if 50 blows are reached before the full penetration of 300mm is achieved. The penetration for 50 blows is recorded and an approximate N value obtained by linear extrapolation of the number of blows for the partial test drive.

- If the seating drive of 150mm is not achieved within the first 25 blows, the penetration after 25 blows is recorded and the test drive then commenced.

- For tests in soft rocks, the test drive should be terminated after 100 blows where the penetration of 300mm has not been achieved.

The N-value obtained from the Standard Penetration Test may be used to assess the relative density of sands and gravels as follows:

Term	SPT N-Value : Blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

A2.3 SAMPLES

A2.3.1 General

Samples have been recovered and stored in accordance with the guidelines given in ISO 22475-1:2006, ref. 10.38 and BS 5930, ref. 10.3.

The undisturbed samples recovered from the percussive sampler were of varying diameters depending upon the depth taken and the ground conditions encountered.

In accordance with EN ISO 22475, ref. 10.38, and BS 5930, ref. 10.3, the thick walled U100 sample is considered as a Class B sampling technique and will only produce Class 3 to 5 quality samples in accordance with EN 1997-2:2007, ref. 10.4. A similar assumption can be made from samples tested from the percussive window sample probing.

Laboratory strength and consolidation testing can only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 10.4. This is due to possible disturbance during sampling, giving a weaker strength in testing.

Therefore values for c_u and mv derived for use in this report can only be used as guidance and not used to determine the shear strength properties of the clay and is not used to give a descriptive strength in the borehole records.

UT represents undisturbed 100mm diameter samples taken in thin walled sample tubes, the number of blows to obtain the sample also recorded.

U represents undisturbed 100mm diameter sample, the number of blows to obtain the sample also recorded.

U fail indicates undisturbed sample not recovered

J represents sample recovered in an amber jar, generally for environmental analysis

HV represents Hand Vane test with equivalent undrained shear strength in kPa.

PP represents Pocket Penetrometer test with equivalent undrained shear strength in kPa.

CBR represents California Bearing Ratio test

B represents large bulk disturbed samples

D represents small disturbed sample

W represents water sample

$\underline{\nabla}$ represents water strike

$\underline{\blacktriangledown}$ represents level to which water rose

A2.4 DESCRIPTION OF SOILS

A2.4.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref. 10.39, supplemented by section 6 of BS 5930, ref. 10.3 have been used in the soil descriptions contained within this report.

IAN FARMER ASSOCIATES

Site	Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive Window Sampler		102.20	Pegasus Life Ltd	52247a
	Location TQ263854	**Dates** 13/08/2014	**Engineer** Gleeds Management Services Ltd	**Sheet** 1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	E1				(0.80)	TOPSPOIL. Dark brown slightly gravelly sandy silt with occasional roots, rootlets, brick, concrete, clinker and glass fragments. Gravel is flint.		
				101.40	0.80			
0.90	E2				(0.65)	MADE GROUND. Brown slightly clayey, slightly gravelly silty fine to medium sand with occasional rootlets, organic remains, rare clinker and glass fragments. Becoming claying with depth. Gravel is flint.		
1.20-1.65 1.20	SPT(C) N=8 D3		1,1/2,2,2,2	100.75	1.45			
					(0.35)	MADE GROUND. Firm brown silty fine sandy clay with occasional organic remains, rootlets and rare traces of brick and clinker. Occasional fine to medium flint gravel.		
				100.40	1.80	1.60m to 2.00m; No recovery.		
2.00-2.45 2.00	SPT(C) N=7 D4		1,1/1,1,2,3			Firm brown mottled orange-brown slightly gravelly silty sandy CLAY. Sand is fine. Gravel is fine to coarse well-rounded flint.		
2.50	D5							
3.00-3.45 3.10	SPT(C) N=8 D6		1,1/1,2,2,3		(3.00)			
3.50	D7					3.40m to 4.40m; Soft to firm.		
4.00-4.45 4.00	SPT(C) N=16 D8		2,2/4,4,4,4					
4.50	D9							
				97.40	4.80			
4.90 5.00-5.45	D10 SPT(C) N=18		2,2/3,5,5,5			Firm orange-brown mottled light brown silty sandy CLAY interbedded with slightly clayey, and occasionally clayey, fine SAND.Rare well-rounded flint gravel		
5.30	D11					5.10m to 5.60m; Firm to stiff.		
5.80	D12					5.6m to 6.30m; Medium dense, slightly clayey fine SAND.		
6.00-6.45	SPT(C) N=17		4,5/5,5,4,3					
6.30	D13					Below 6.30m; Occasionally interlaminated orange-brown and brown with lenses of fine sand.		
6.80	D14							
7.00-7.45	SPT(C) N=10		2,2/2,2,3,3 Seepage(1) at 7.10m.					∇_1
7.50	D15				(5.50)			
8.00-8.45	SPT(C) N=13		2,3/4,3,3,3 Water strike(2) at 8.20m.					∇_2
8.50	D16					8.50m to 9.00m; Firm to stiff.		
9.00-9.45 9.10	SPT N=16 D17		2,3/3,4,4,5			9.00m to 10.00m; 10% recovery.		
10.00-10.45	SPT N=31		3,3/7,7,8,9					

Remarks
Slight seepage at 7.10m.
Groundwater struck at 8.20m.
Difficult drilling below 9.00m due to ingress of groundwater and sand.

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.1

IAN FARMER ASSOCIATES

Site	Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive Window Sampler		102.20	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ263854	13/08/2014	Gleeds Management Services Ltd	2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.00 10.10	D18 D19			91.90	10.30	... as previous 10.00m to 11.00m; 10% recovery.		
					(0.70)	Stiff dark grey silty CLAY with frequent specks and clusters of iron pyrite crystals.		
				91.20	11.00	Complete at 11.00m		

Remarks
Borehole terminated at 11.00m

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.1

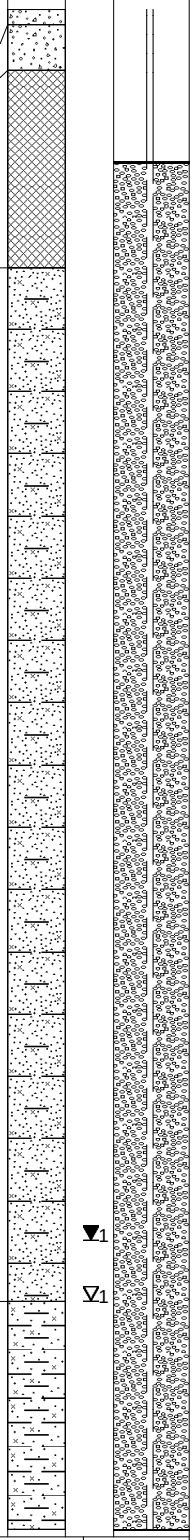
IAN FARMER ASSOCIATES

Site	Borehole Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	200mm cased to 12.00m 150mm cased to 18.00m	102.10	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 264 855	26/08/2014- 29/08/2014	Gleeds Management Services Ltd	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					102.00	0.10	ASPHALT
						(0.30)	
					101.70	0.40	Reinforced CONCRETE.
0.50	D1						Possible MADE GROUND. Soft brownish grey sandy gravelly clay with occasional pockets of orange-brown fine to medium sand. Gravel is fine to coarse subangular to rounded flint.
						(1.30)	
1.20-1.65	SPT(C) N=5	1.00	DRY	1,0/2,1,1,1			
1.50	B1						
1.70	D2				100.40	1.70	Loose becoming medium dense orange-brown slightly clayey silty fine SAND.
2.00-2.45	SPT N=7	2.00	DRY	1,1/1,2,2,2			
2.00	D3						
3.00-3.45	SPT N=8	3.00	DRY	2,1/2,2,2,2			
3.00	B2						
3.00	D4						
4.00-4.45	SPT N=9	4.00	DRY	2,2/2,3,2,2			
4.00	D5						
							4.00m to 6.00m; Occasional coarse gravel-sized lumps of bluish grey sandy clay.
5.00-5.45	SPT N=10	5.00	DRY	2,2/3,2,3,2		(6.80)	
5.00	B3						
5.00	D6						
6.00	D7						
6.50-6.95	SPT N=12	6.00	DRY	2,3/3,2,3,4			
6.50	D8						
7.00	B4						
7.50	D9						
8.00-8.45	SPT N=13	8.00	DRY	3,4/3,4,3,3			
8.00	D10						
8.50	D11			Water strike(1) at 8.50m, rose to 8.10m in 20 mins.	93.60	8.50	Stiff, fissured dark grey silty sandy CLAY with occasional specks of iron pyrite and partings of orange-brown silty sand.
8.50-8.95	SPT N=20	8.00	DRY	4,5/5,3,5,7			
9.00	B5						
9.00	D12						
10.00-10.45	SPT N=27	10.00	DRY	6,5/8,5,7,7			

Legend / Water / Instr



Remarks
Chiselling from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.2

IAN FARMER ASSOCIATES

Site	Borehole Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	200mm cased to 12.00m 150mm cased to 18.00m	102.10	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 264 855	26/08/2014- 29/08/2014	Gleeds Management Services Ltd	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00	D13						... as previous			
10.50	D14						10.00m to 12.50m; Firm to stiff with occasional bands of dark greenish grey and orange-brown.			
									▼2	
11.50-11.95 11.50	SPT N=30 D15	11.00	DRY	4,4/4,7,11,8						
				Water strike(2) at 12.10m, rose to 11.30m in 20 mins.					▽2	
12.50	D16						At 12.50m; Recovered as soft to firm with frequent pockets of orange-brown sandy clay.			
13.00-13.45 13.00 13.00	SPT N=28 B6 D17	13.00	12.00	5,4/6,6,7,9						
14.00-14.45 14.00	SPT N=33 D18	14.00	11.00	4,4/7,8,8,10		(11.50)	From 14.00m; Firm and grey with greenish and reddish brown banding, and partings of light grey fine sand and silt.			
15.00	D19									
15.50-15.95 15.50	SPT N=38 D20	15.00	12.00	6,6/8,9,11,10						
16.00	D21						From 16.00m; No banding.			
17.00-17.45 17.00	SPT N=40 D22	17.00	13.00	5,5/11,10,8,11						
18.00	D23									
18.50-18.95	SPT N=37	18.00	13.00	6,6/7,12,10,8						
19.00-19.45 19.00	SPT N=35 D24			8,7/8,9,10,8						
					82.10	20.00				

Remarks

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.2

IAN FARMER ASSOCIATES

Site	Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive Window Sampler		102.20	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ264855	14/08/2014	Gleeds Management Services Ltd	1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				102.10	0.10	ASPHALT		
					(0.20)			
				101.90	0.30	Reinfored CONCRETE.		
0.50	E1					MADE GROUND. Yellowish brown fine to coarse gravelly sand with frequent concrete and brick fragments/ cobbles, and occasional clinker, glass and asphalt fragments and flints.		
0.70	D1				(1.00)			
1.00	E2							
1.20-1.65	SPT(C) N=6		0,0/1,1,2,2	100.90	1.30	Firm brown mottled orange-brown silty sandy CLAY. Occasionally very sandy.		
1.40	D2							
1.90	D3							
2.00-2.45	SPT(C) N=12		2,2/3,3,3,3		(1.60)			
2.50	D4					From 2.65m; Firm to stiff.		
				99.30	2.90	Medium dense brown slightly clayey fine SAND.		
3.00-3.45	SPT(C) N=21		5,5/5,6,5,5					
3.00	D5				(1.30)			
3.70	D6							
4.00-4.45	SPT(C) N=22		1,2/4,6,6,6					
				98.00	4.20	Firm orange-brown mottled light brown silty sandy CLAY interbedded with clayey or slightly clayey fine SAND.Rare well-rounded flint gravel.		
4.30	D7					4.50m to 5.60m; Silty clayay fine SAND.		
5.00-5.45	SPT(C) N=24		4,5/6,6,6,6					
5.00	D8							
5.80	D9							
6.00-6.45	SPT(C) N=18		3,3/4,4,4,6			6.10m to 7.10m; Slightly clayey silty fine SAND.		
6.50	D10							
7.00-7.45	SPT(C) N=14		2,2/3,4,3,4					
7.20	D11							
					(6.80)			
			Water strike(1) at 7.70m.			7.70m to 7.90m; Slightly clayey fine SAND.		∇_1
8.00-8.45	SPT(C) N=12		2,2/3,2,3,4			8.00m to 9.00m; 75% recovery.		
8.20	D12							
8.80	D13							
9.00-9.45	SPT(C) N=7		2,2/1,2,2,2			9.00m to 10.00m; No Recovery.		
10.00-10.45	SPT(C) N=19		4,4/4,5,5,5					

Remarks
Slight seepage at 3.70m.
Groundwater struck at 7.70m.
Difficult drilling below 8.00m due to ingress of groundwater and sand.

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.3

IAN FARMER ASSOCIATES

Site	Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive Window Sampler		102.20	Pegasus Life Ltd	52247a
	Location TQ264855	**Dates** 14/08/2014	**Engineer** Gleeds Management Services Ltd	**Sheet** 2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						... as previous 10.00m to 11.00m; No Recovery.		
11.00-11.45	SPT(C) N=19		3,4/4,4,5,6	91.20	11.00	Complete at 11.45m		

Remarks
Borehole terminated at 11.00m.

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.3

IAN FARMER ASSOCIATES

Site	Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive Window Sampler		106.10	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ264855	15/08/2014	Gleeds Management Services Ltd	1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.40)	TOPSOIL. Dark brownslightly gravelly clayey silty fine to medium sand with occasional roots, rootlets, brick, concrete and clinker fragments.			
0.30	E1			105.70	0.40				
0.80	E2				(0.70)	MADE GROUND. Brown slightly gravelly silty fine sand with occasional rootlets, brick fragments and rare clinker fragments.			
				105.00	1.10				
1.20-1.65	SPT(C) N=16		1,3/4,4,4,4		(0.50)	MADE GROUND. Dense brown mottled orange-brown silty clayey fine sand with occasional brick and clinker fragments. Rare flint pebbles.			
1.20	D3			104.50	1.60				
1.80	D4					Stiff to very stiff, becoming firm with depth, brown mottled orang-brown silty sandy CLAY with frequent decomposing rootlets.			
2.00-2.45	SPT(C) N=26		6,6/5,6,7,8			From 2.00m; Orange-brown mottled grey. Occasionally very sandy with occasional decomposing rootlets.			
2.30	D5								
2.90	D6								
3.00-3.45	SPT(C) N=19		5,5/5,5,4,5		(3.20)				
3.30	D7								
3.80	D8					From 3.70m; Becoming firm with occasional bands of fine sand.			
4.00-4.45	SPT(C) N=16		3,4/3,4,4,5						
4.20	D9								
4.60	D10								
4.80	D11			101.30	4.80				
5.00-5.45	SPT(C) N=18		2,3/4,4,5,5			Medium dense brown slightly silty clayey fine SAND. 5.00m to 5.65m; Very clayey.			
5.20	D12				(1.20)				
5.70	D13								
6.00-6.45	SPT(C) N=15		2,3/3,2,5,5	100.10	6.00	Firm to stiff orange-brown mottled light brown silty sandy CLAY interbedded with slightly clayey, and occasionally clayey, fine SAND.Rare well-rounded flint gravel			
6.20	D14					6.60m to 7.45m; Brown slightly clayey fine SAND.			
6.70	D15								
7.00-7.45	SPT(C) N=19		3,5/6,5,4,4						
7.50	D16					7.45m to 7.80m; Firm very sandy CLAY.			
						7.80m to 8.40m; Brown fine SAND.			
8.00-8.45	SPT(C) N=23		5,6/6,6,5,6						
8.20	D17					8.40m to 9.00m; Firm very sandy CLAY.			
8.60	D18								
9.00-9.45	SPT(C) N=50		8,8/9,11,14,16		(6.00)	9.00m to 9.85m; Brown slightly clayey fine SAND.			
9.50	D19								
10.00-10.45	SPT(C) N=22		2,3/3,4,6,9			9.85m; to 10.60m; Firm orange-brown and			

Remarks
35mm slotted standipipe installed to 11.50m.
Groundwater struck at 10.60m.

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.4

IAN FARMER ASSOCIATES

Site	Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Percussive Window Sampler		106.10	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ264855	15/08/2014	Gleeds Management Services Ltd	2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00	D20					grey silty sandy CLAY. ... as previous			
10.50	D21		Water strike(1) at 10.60m.			10.60m to 12.00m; Orange-brown slightly clayey, becoming clayey, fine SAND.		∇_1	
10.70	D22								
11.00-11.45	SPT(C) N=18		4,4/4,4,4,4,6						
11.30	D23		Water strike(2) at 11.30m.					∇_2	
11.80	D24								
				94.10	12.00	Complete at 12.00m			

Remarks

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.4

IAN FARMER ASSOCIATES

Site	Borehole Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH5

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 20.00m	103.20	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 264 854	20/08/2014-21/08/2014	Gleeds Management Services Ltd	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					103.05	(0.15) 0.15	Block paving over sand sub base.
					102.95	0.25	MADE GROUND. Dark reddish brown silty sandy medium to coarse subangular granite gravel (Type 1 granular sub base).
0.50	D1					(0.55)	
0.50	E1				102.40	0.80	Brown slightly gravelly silty fine SAND with occasional roots and rootlets.
1.00	D2						Medium dense orange and greyish brown slightly clayey silty fine SAND.
1.00	E2						
1.50-1.95	SPT N=19	1.00	DRY	6/4,5,5,5		(1.70)	
1.50	D3						
2.00-2.45	SPT N=18	2.00	DRY	9/5,4,5,4			
2.00	D4						
					100.70	2.50	Firm orange and yellowish brown mottled grey very sandy silty CLAY with occasional bands and pockets of clayey to very clayer fine SAND.
2.90	D5						
3.00-3.45	SPT N=16	3.00	DRY	6/4,4,4,4			
3.00	D6						
3.50	D7						
4.00-4.45	SPT N=18	4.00	DRY	6/5,5,4,4			
4.00	D8					(3.70)	
4.50	D9						
5.00-5.45	SPT N=12	5.00	DRY	6/3,3,3,3			
5.00	D10						
6.00	D11						
					97.00	6.20	Medium dense brown clayey silty fine SAND.
6.50-6.95	SPT N=18	6.00	DRY	7/4,3,5,6			
6.50	D12						
8.00-8.45	SPT N=21	8.00	DRY	9/5,6,5,5			
8.00	D14						
9.00	D15						
				Moderate(1) at 9.30m, rose to 9.10m in 20 mins.			
9.50-9.95	SPT N=22	9.00	DRY	11/5,6,6,5			

Water: ▼1 ▽1

Remarks
Chiselling from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.5

IAN FARMER ASSOCIATES

Site	Borehole Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	BH5

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 20.00m	103.20	Pegasus Life Ltd	52247a
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 264 854	20/08/2014-21/08/2014	Gleeds Management Services Ltd	2/2

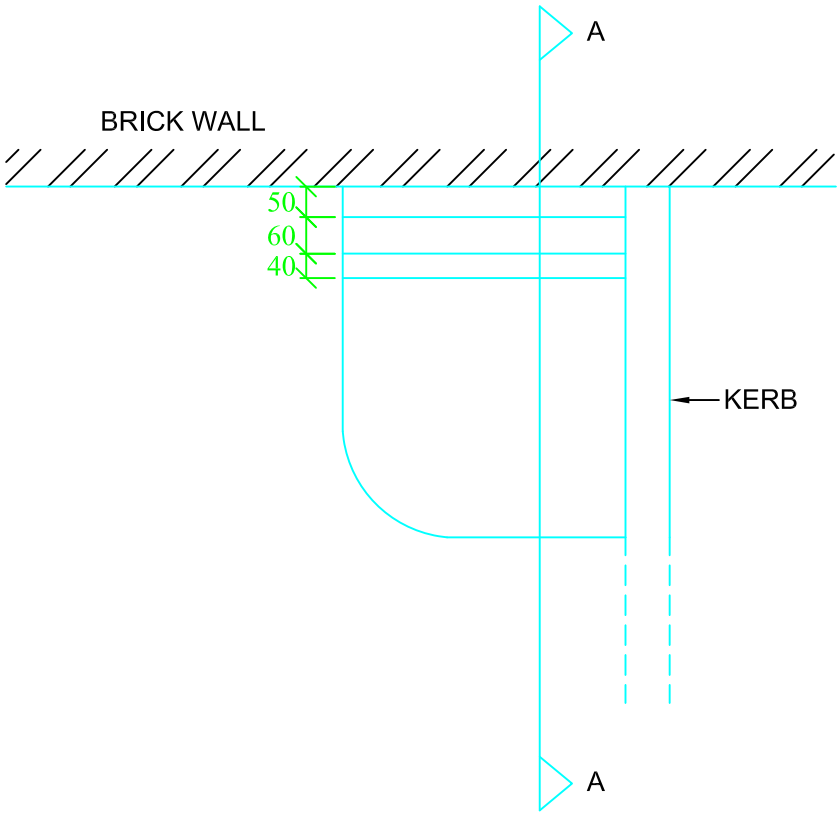
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00	D16						... as previous At 10.00m; Very wet.		▼2	
						(8.70)				
11.00	D17			Moderate(2) at 11.00m, rose to 10.00m in 20 mins.					▽2	
11.00-11.45	SPT N=29	11.00	10.00	10/7,8,6,8						
12.00-12.45 12.00	SPT N=24 D18	12.00	DRY	13/5,7,5,7			From 12.00m; Wet and very clayey with occasional pockets of grey clay.			
13.00-13.45 13.00 13.00	SPT N=26 D19 D20	13.00	DRY	12/7,7,8,4						
14.00-14.45	SPT N=16	14.00	DRY	8/3,5,5,3						
					88.30	14.90	Stiff dark grey silty sandy CLAY.			
15.00	D21					(0.60)				
15.50-15.95	SPT N=50	15.00	DRY	20/25,25	87.70	15.50	CLAYSTONE			
						(0.30)				
					87.40	15.80	Stiff, becoming firm and occasionally fissured, dark grey silty sandy CLAY with occasional specks of iron pyrite.		▼4 ▼3	
16.00	D22									
17.00 17.00	D23 D24			Moderate(3) at 17.00m, rose to 16.10m in 20 mins.			At 17.00m; Soft to Firm, and dark bluish grey.		▽3	
17.00-17.45	SPT N=41	17.00	16.00	15/10,8,11,12						
						(4.20)				
18.00	D25						At 18.00m; Firm, brownish grey and slightly sandy.			
19.00-19.45 19.00	SPT N=37 D26	19.00	16.00	15/9,9,11,8			At 19.00m; Firm bluish grey with brown mottling and sandy.			
				Moderate(4) at 19.50m, rose to 16.00m in 20 mins.					▽4	
					83.20	20.00				

Remarks
Chiselling from 15.50m to 15.80m for 1 hour.

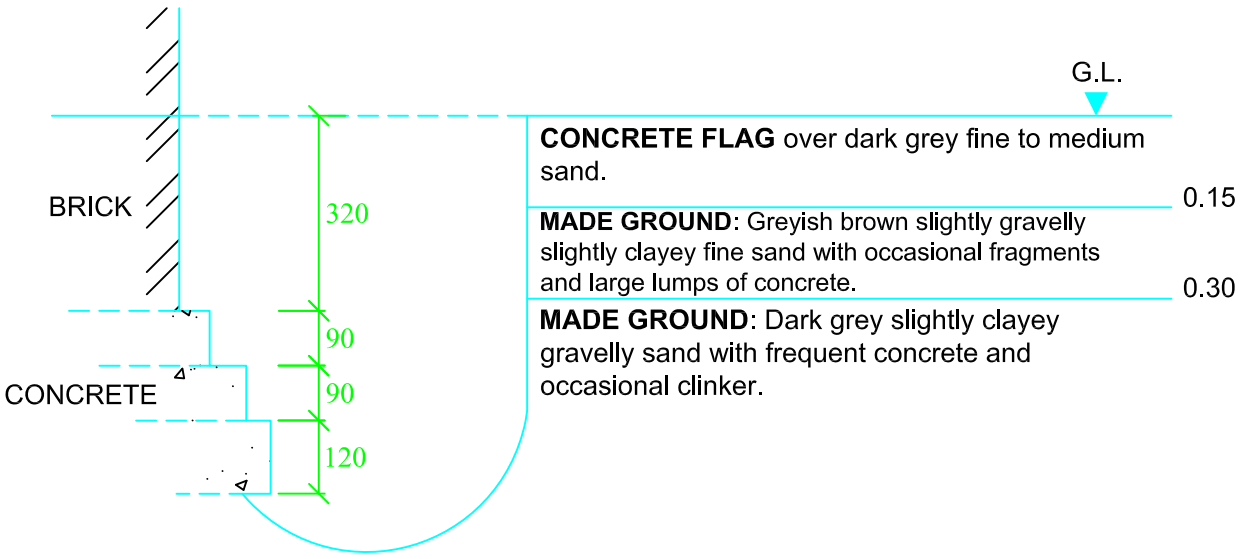
Scale (approx)	Logged By
1:50	BP/DAA

Figure No. A2.5

PLAN



SECTION A-A



END OF TRIAL PIT 0.70m

All dimensions in millimetres.
Depths of strata changes in metres.
Groundwater not encountered during excavation.
Date of Sitework 22/08/14.

Scale :	N.T.S.
Drawn By :	P.L.E.

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

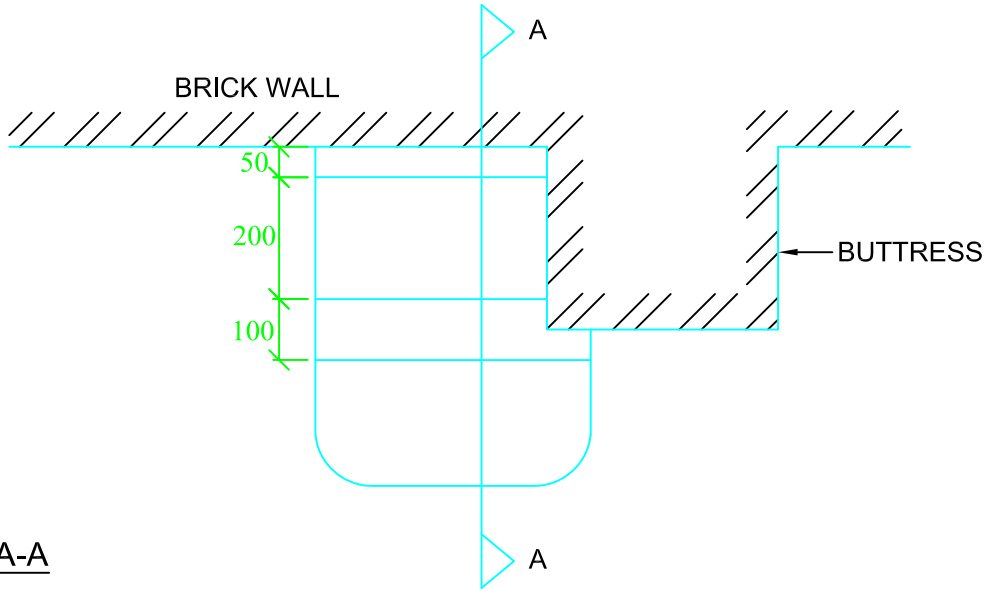
TRIAL PIT RECORD No 1

Arthur West House, Fitzjohn's Avenue, Hampstead NW3 6PA.

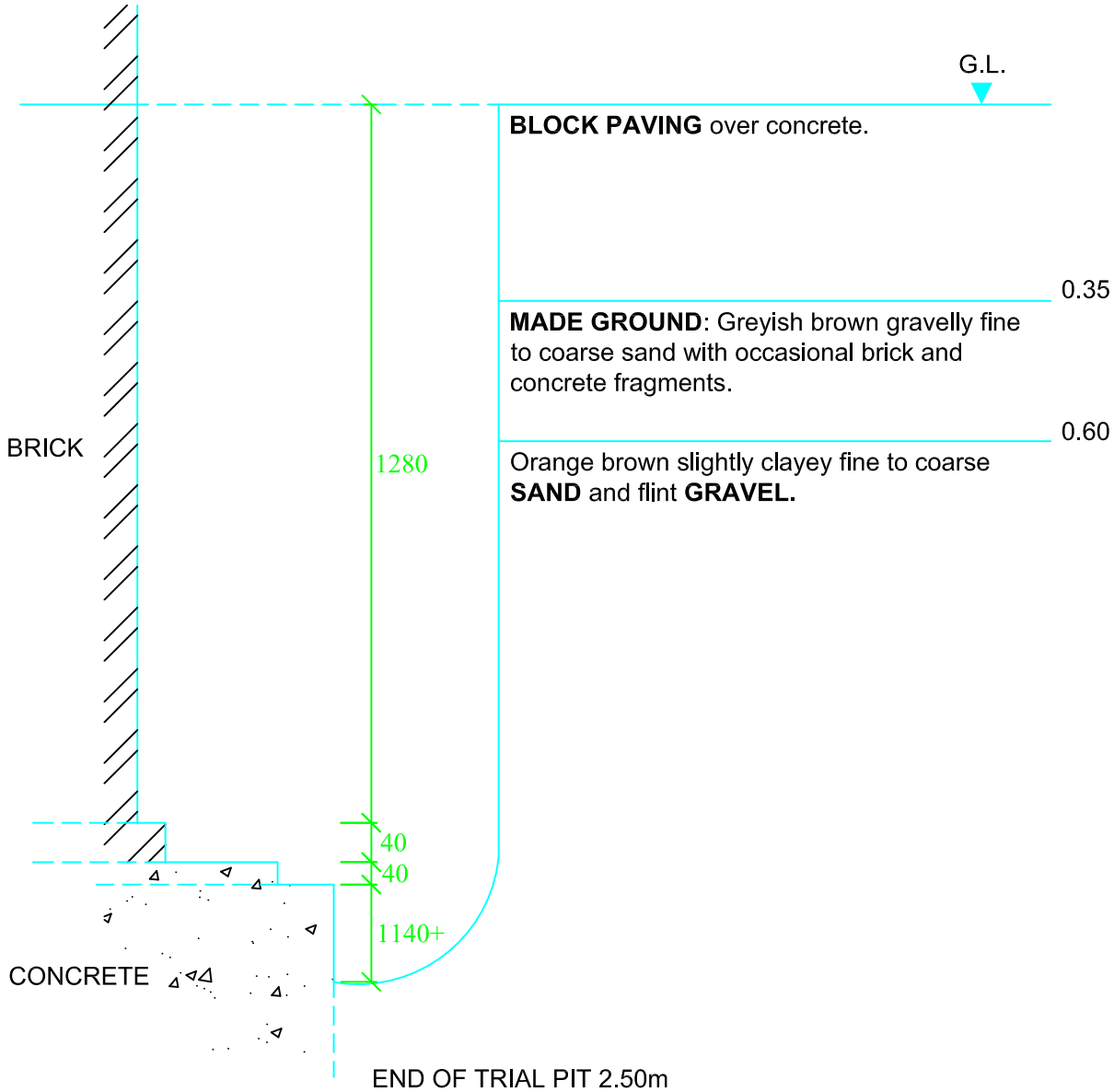
Job No: 52247

Fig: A2.6

PLAN



SECTION A-A



All dimensions in millimetres.
Depths of strata changes in metres.
Groundwater not encountered during excavation.
Date of Sitework 22/08/14.

Scale :	N.T.S.
Drawn By :	P.L.E.

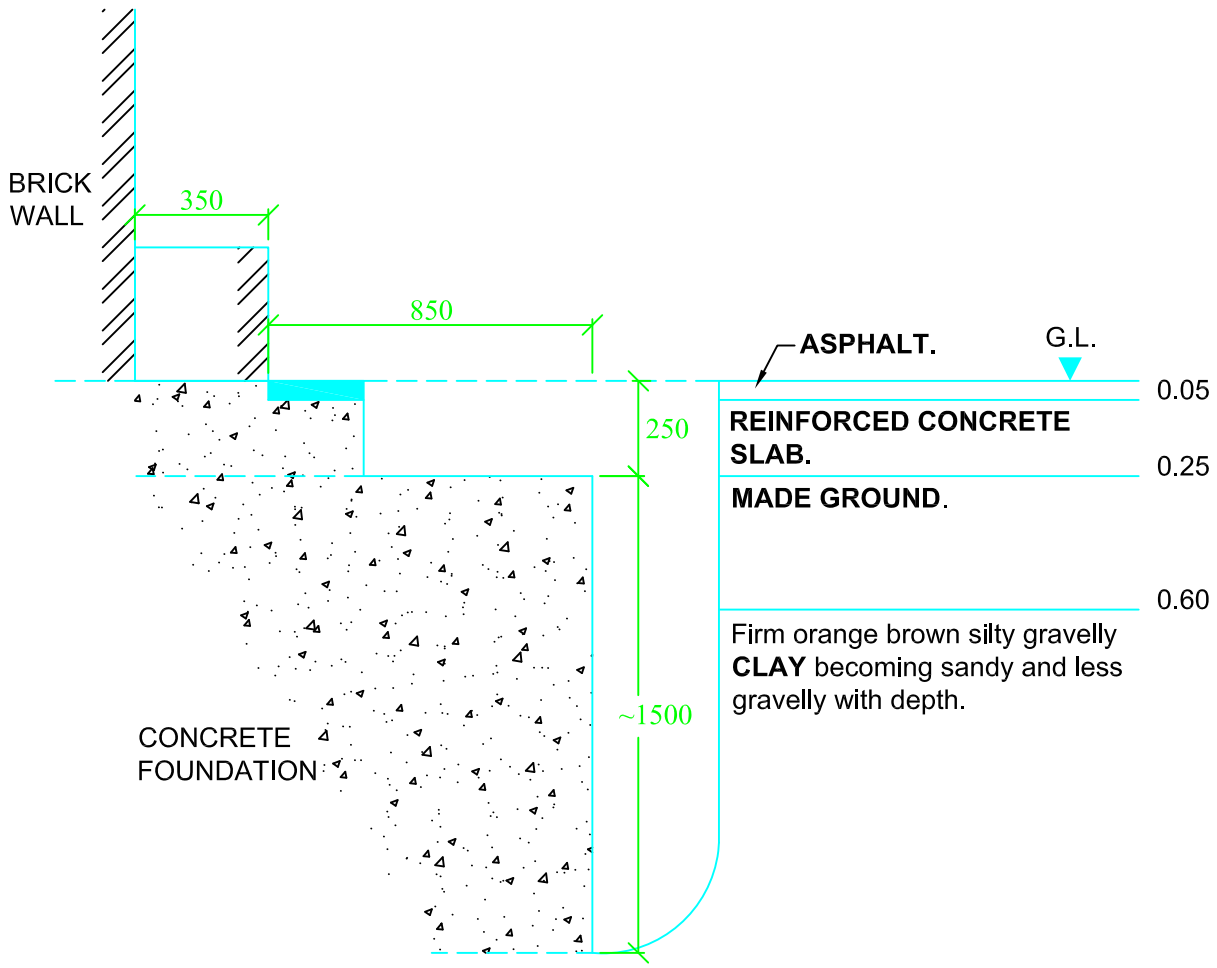
IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

TRIAL PIT RECORD No 2

Arthur West House, Fitzjohn's Avenue, Hampstead NW3 6PA.

Job No: 52247

Fig: A2.7



END OF TRIAL PIT 1.50m

All dimensions in millimetres.
Depths of strata changes in metres.
Groundwater not encountered during excavation.
Date of Sitework 22/08/14.

Scale :	N.T.S.
Drawn By :	P.L.E.
Job No:	52247
Fig:	A2.8

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

TRIAL PIT RECORD No 3

Arthur West House, Fitzjohn's Avenue, Hampstead NW3 6PA.

Trial pit 1

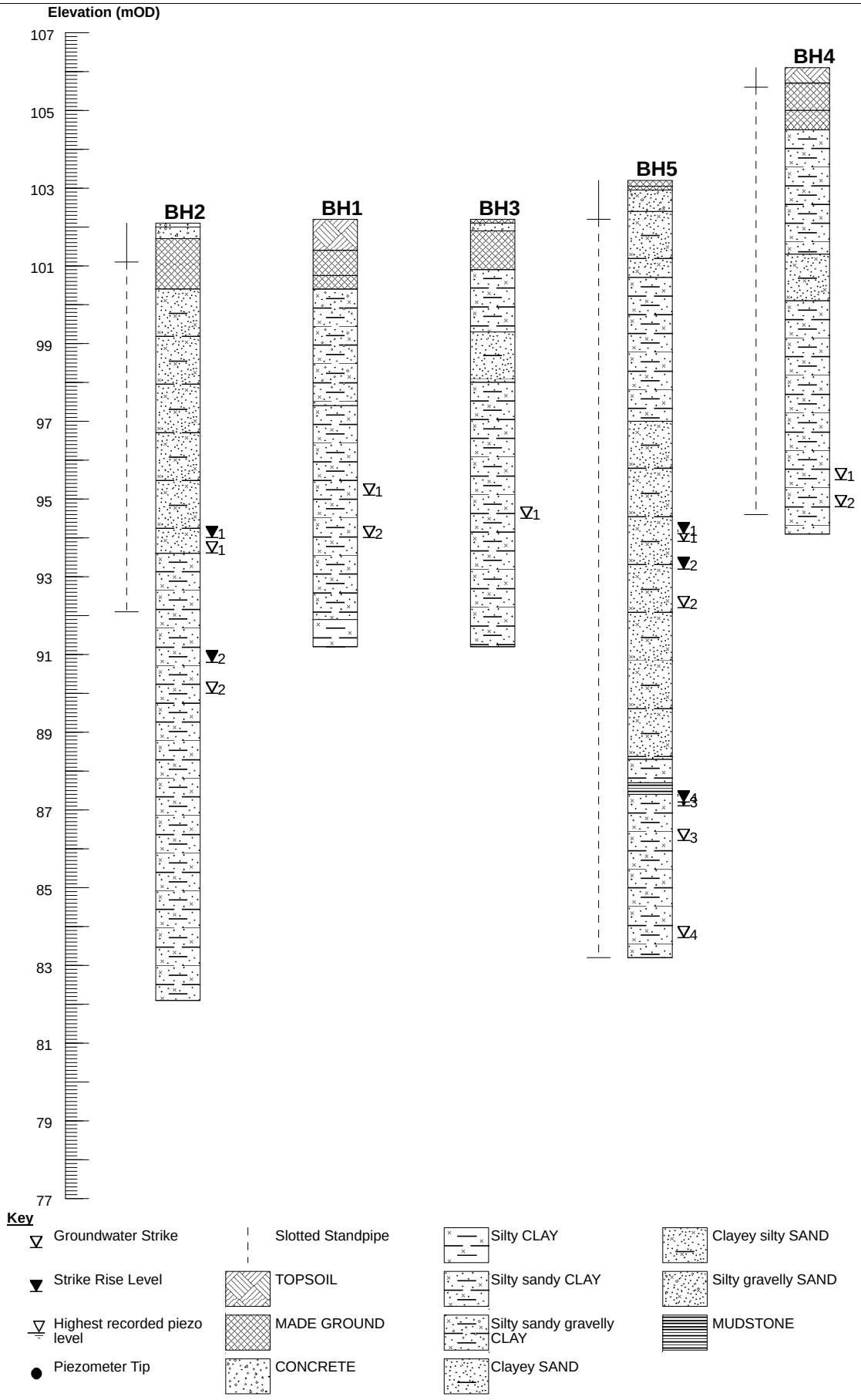
IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**TRIAL PIT PHOTOGRAPHS**	Job no. 52247A
	Fitzjohn's Avenue, Hampstead, NW3 6PA	Fig. A2.9

Trial pit 2

IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**TRIAL PIT PHOTOGRAPHS**	Job no. 52247A
	Fitzjohn's Avenue, Hampstead, NW3 6PA	Fig. A2.10

Trial pit 3

IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**TRIAL PIT PHOTOGRAPHS**	Job no. 52247A
	Fitzjohn's Avenue, Hampstead, NW3 6PA	Fig. A2.11



IAN FARMER ASSOCIATES

Nominal Section

Site	Date Drawn	Date Checked	Sheet	Job Number
Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	19/09/2014		1/1	52247a
Client	**Drawn By**	**Checked By**	**Scale**	**Figure No.**
Pegasus Life Ltd			1:150[V]	A2.12

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

RESULTS OF GAS AND GROUNDWATER MONITORING

Arthur West House, Fiztjohn's Avenue, Hampstead

Job No: 52247A

Figure No: A2.13

Background Readings:	Date of Visit	13/10/2014				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	0.0	0.0	21.0	0	0	NR
	Weather Conditions		Wet			
	Ground Conditions (dry/wet etc.)		Wet			
	Atmospheric Pressure (mb)		989			

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH2	11:45	989	0.0	0.0	0.0	8.0	8.0	13.4	13.4	0	0	0	0	NR	NR	6.86	10.16	N
BH4	11:50	989	0.0	0.0	0.0	0.0	0.0	20.7	20.7	0	0	0	0	NR	NR	10.38	11.30	N
BH5	11:35	989	0.0	0.0	0.0	10.3	10.3	12.9	12.9	0	0	0	0	NR	NR	8.84	15.08	N

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **BP** Checked By: **WGG**

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Background Readings:	Date of Visit	21/10/2014				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	0.0	0.0	20.9	0	0	NR
	Weather Conditions		Sunny			
	Ground Conditions (dry/wet etc.)		Wet			
	Atmospheric Pressure (mb)		1000			

Arthur West House, Fiztjohn's Avenue, Hampstead

RESULTS OF GAS AND GROUNDWATER MONITORING

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH2	15:15	1000	0.0	0.0	0.0	8.6	8.6	13.4	13.4	0	0	0	0	NR	NR	6.80	10.13	N
BH4	15:20	1000	0.0	0.0	0.0	2.4	2.4	19.4	19.4	0	0	0	0	NR	NR	10.40	11.26	N
BH5	15:30	1000	0.0	0.0	0.0	0.0	0.0	20.8	20.8	0	0	0	0	NR	NR	8.82	14.99	N

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **LH** Checked By: **WGG**

Job No: 52247A

Figure No: A2.13 cont'd

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

RESULTS OF GAS AND GROUNDWATER MONITORING

Arthur West House, Fiztjohn's Avenue, Hampstead

Job No: 52247A

Figure No: A2.13 cont'd

Background Readings:	Date of Visit	04/11/2014				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	0.0	0.0	20.8	0	0	NR
	Weather Conditions		Sunny			
	Ground Conditions (dry/wet etc.)		Dry			
	Atmospheric Pressure (mb)		986			

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH2	8:31	986	0.0	0.0	0.0	6.4	6.4	15.2	15.2	0	0	0	0	NR	NR	6.80	10.13	N
BH4	8:50	986	0.0	0.0	0.0	4.0	4.0	17.8	17.8	0	0	0	0	NR	NR	10.39	11.26	N
BH5	8:15	986	0.0	0.0	0.0	0.3	0.3	20.6	20.6	0	0	0	0	NR	NR	8.83	15.00	N

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **AH** Checked By: **WGG**

APPENDIX 3

LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are given in the laboratory test reports.

A3.1.2 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

A3.2 SOIL CLASSIFICATION

A3.2.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

A3.2.2 This line is defined from experimental evidence and does not represent a well-defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

A3.2.3 Clays and silts are divided into five zones of plasticity:

Low Plasticity (L)	LL less than 35
Intermediate Plasticity (I)	LL between 35 and 50
High Plasticity (H)	LL between 50 and 70
Very High Plasticity (V)	LL between 70 and 90
Extremely High Plasticity (E)	LL greater than 90

A3.2.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

Project Name:	Fitzjohn's Avenue, Hampstead NW3 6PA	**Samples Received:**	26/08/2014
		Project Started:	27/08/2014
Client:	Ian Farmer Associates	**Testing Started:**	10/09/2014
Project No:	522474A **Our job/report no:** 17352	**Date Reported:**	15/09/2014

K4 SOILS

Borehole No:	Sample No:	Depth (m)	Description	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425 mm (%)	Remarks
BH1	D6	3.10	Light brown and orange brown slightly gravelly slightly fine sandy silty CLAY (gravel is fmc and sub-rounded)	18	33	15	18	79	
BH3	D2	1.40	Light brown fine sandy silty CLAY	25	47	16	31	100	
BH3	D4	2.50	Light brown fine sandy silty CLAY	21	43	19	24	100	
BH4	D4	1.80	Orange brown and greenish grey mottled slightly gravelly fine sandy silty CLAY with occasional roots and rotlets (gravel is fine)	16	48	15	33	98	
BH4	D6	2.90	Light brown fine sandy silty CLAY	11	47	16	31	100	
BH5	D5	2.90	Orange brown and light brown fine sandy silty CLAY with pockets of light green grey fine sand	20	43	15	28	100	
BH5	D7	3.50	Orange brown, light brown and blue grey mottled fine sandy silty CLAY	22	41	17	24	100	

UKAS TESTING 2519

Summary of Test Results

BS 1377 : Part 2 : Clause 4.3 : 1990 Determination of the liquid limit by the cone penetrometer method.
BS 1377 : Part 2 : Clause 5 : 1990 Determination of the plastic limit and plasticity index.
BS 1377 : Part 2 : Clause 3.2 : 1990 Determination of the moisture content by the oven-drying method.

Checked and Approved
Initials: K.P
Date: 17/09/2014

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

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

All samples connected with this report ,incl any on 'hold' will be stored and disposed off according to Company policy.Acopy of this policy is available on request. MSF-11/R2

Figure A3.1

Project Name:	Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	**Samples Received:**	29/08/2014
		Project Started:	01/09/2014
Client:	Ian Farmer Associates	**Testing Started:**	15/09/2014
Project No:	52247a **Our job/report no:** 17375	**Date Reported:**	17/09/2014

K4 SOILS

Borehole No:	Sample No:	Depth (m)	Description	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425 mm (%)	Remarks
BH2	B5	9.00	Dark grey slightly gravelly silty CLAY with occasional pockets of reddish brown fine sand	25	60	23	37	100	
BH3	D3	1.90	Brown clayey silty SAND	24					
BH4	D5	2.30	Orange brown silty sandy CLAY	14					
BH4	D7	3.30	Orange brown silty sandy CLAY	15					
BH4	D8	3.80	Orange brown and slightly grey clayey silty SAND	21					

UKAS TESTING 2519

Summary of Test Results

BS 1377 : Part 2 : Clause 4.3 : 1990 Determination of the liquid limit by the cone penetrometer method.
BS 1377 : Part 2 : Clause 5 : 1990 Determination of the plastic limit and plasticity index.
BS 1377 : Part 2 : Clause 3.2 : 1990 Determination of the moisture content by the oven-drying method.

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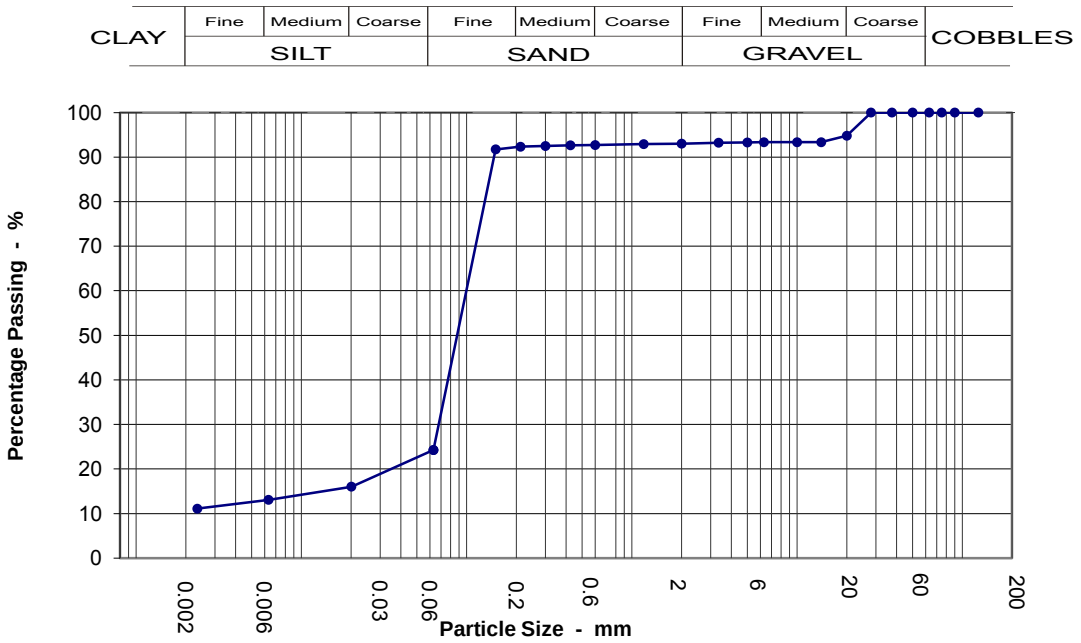
Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH1
		Depth	2.50 m
Visual Soil Description	Brown gravelly clayey silty fine SAND (gravel is fmc and sub-rounded to rounded)	Sample Type/No	D - 5



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	16
90	100	0.006	13
75	100	0.002	11
63	100		
50	100		
37.5	100		
28	100		
20	95		
14	93		
10	93		
6.3	93		
5	93		
3.35	93		
2	93		
1.18	93		
0.6	93		
0.425	93		
0.3	92		
0.212	92		
0.15	92		
0.063	24		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	7.0
Sand	69.3
Silt & Clay	23.7

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

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Date: 15/09/2014

UKAS TESTING

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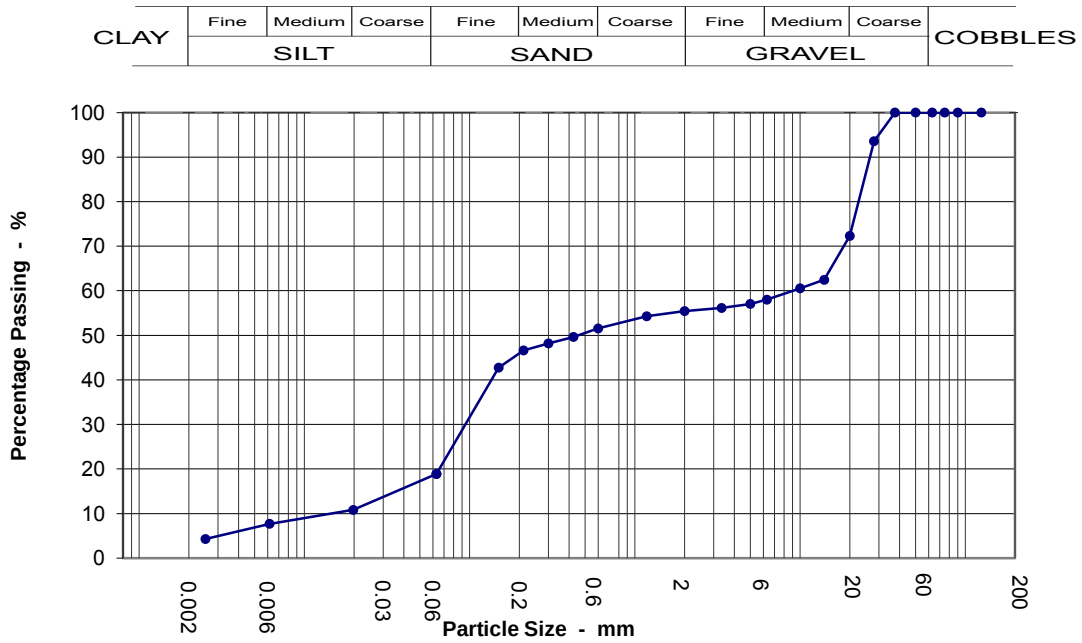
Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH1
		Depth	4.90 m
Visual Soil Description	Dark greyish brown silty clayey very sandy GRAVEL (gravel is fmc and sub-rounded to rounded)	Sample Type/No	D - 10



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	11
90	100	0.006	8
75	100	0.003	4
63	100		
50	100		
37.5	100		
28	94		
20	72		
14	62		
10	61		
6.3	58		
5	57		
3.35	56		
2	55		
1.18	54		
0.6	52		
0.425	50		
0.3	48		
0.212	47		
0.15	43		
0.063	19		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	44.6
Sand	37.1
Silt & Clay	18.3

Grading Analysis	
D100	125.0
D60	9.2
D10	
Uniformity Coefficient	N/A

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Date: 15/09/2014

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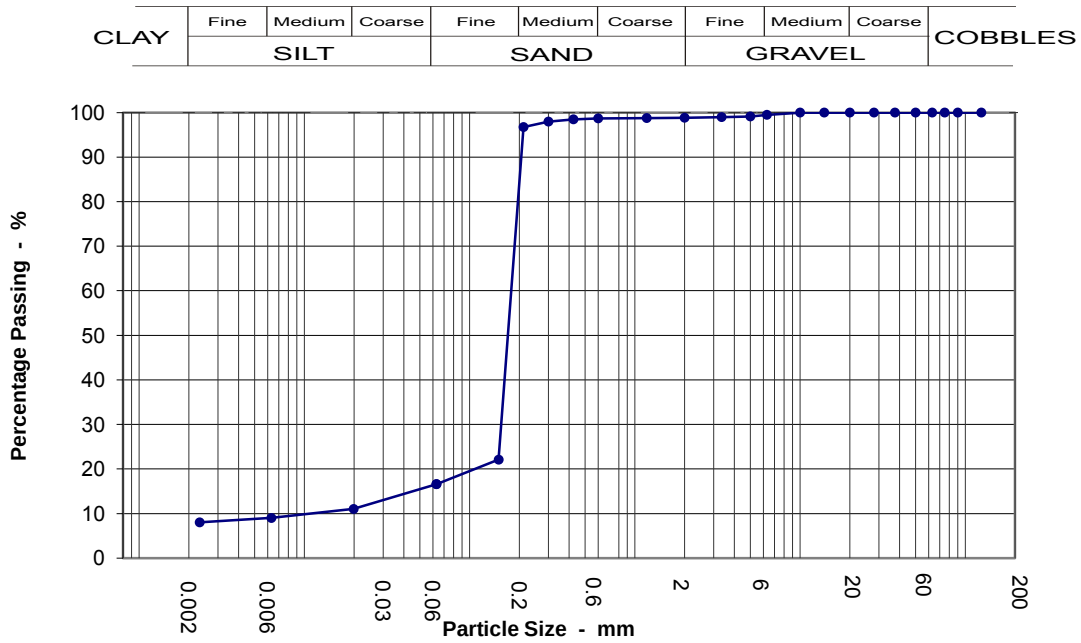
2519

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17375
		Project No:	52247a
Location	Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH2
		Depth	2.00 m
Visual Soil Description	Brown clayey silty SAND with rare fine gravel	Sample Type/No	D - 3



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	11
90	100	0.006	9
75	100	0.002	8
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	99		
5	99		
3.35	99		
2	99		
1.18	99		
0.6	99		
0.425	98		
0.3	98		
0.212	97		
0.15	22		
0.063	17		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	1.2
Sand	82.6
Silt & Clay	16.2

Grading Analysis	
D100	125.0
D60	0.2
D10	
Uniformity Coefficient	N/A

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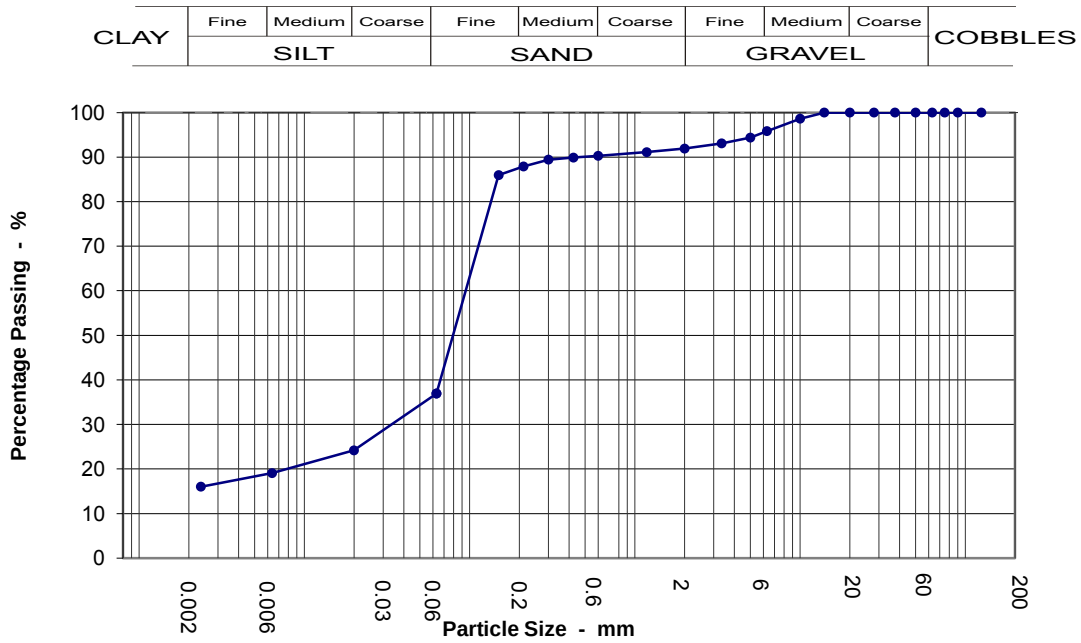
Date: 17/09/2014

UKAS TESTING

2519

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17375
		Project No:	52247a
Location	Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH2
		Depth	5.00 m
Visual Soil Description	Brown and occasional grey and reddish brown sandy silty CLAY with occasional fm mudstone fragments	Sample Type/No	D - 6



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	24
90	100	0.006	19
75	100	0.002	16
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	96		
5	94		
3.35	93		
2	92		
1.18	91		
0.6	90		
0.425	90		
0.3	89		
0.212	88		
0.15	86		
0.063	37		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	8.1
Sand	55.9
Silt & Clay	36.1

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

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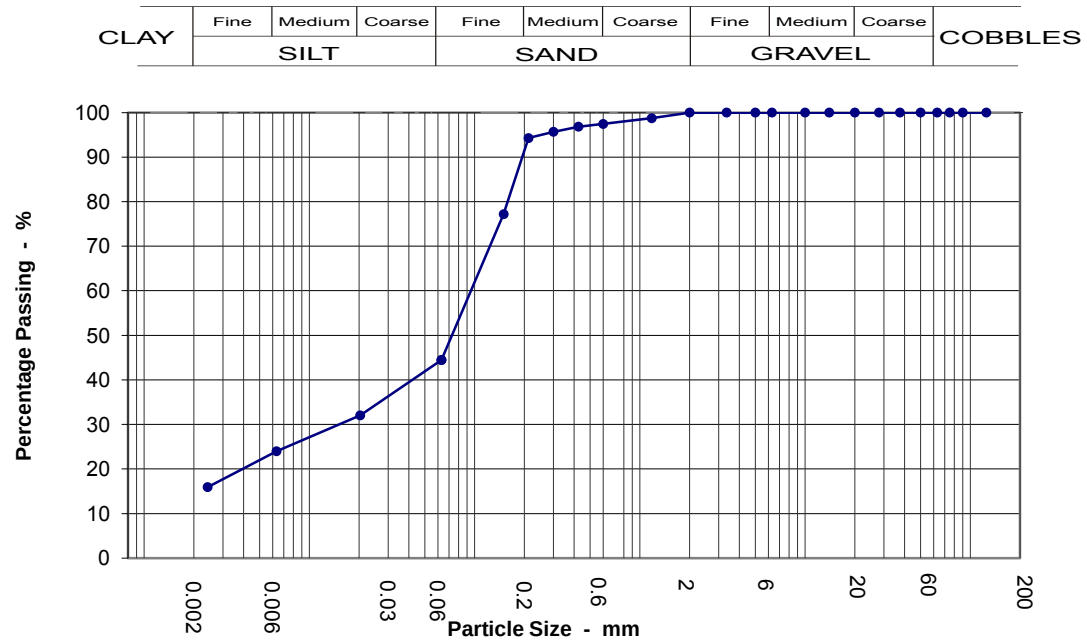
Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17375
		Project No:	52247a
Location	Arthur West House, 79 Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH2
		Depth	15.50 m
Visual Soil Description	Grey sandy silty CLAY	Sample Type/No	D - 20



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	32
90	100	0.006	24
75	100	0.002	16
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	99		
0.6	97		
0.425	97		
0.3	96		
0.212	94		
0.15	77		
0.063	44		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	56.4
Silt & Clay	43.6

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

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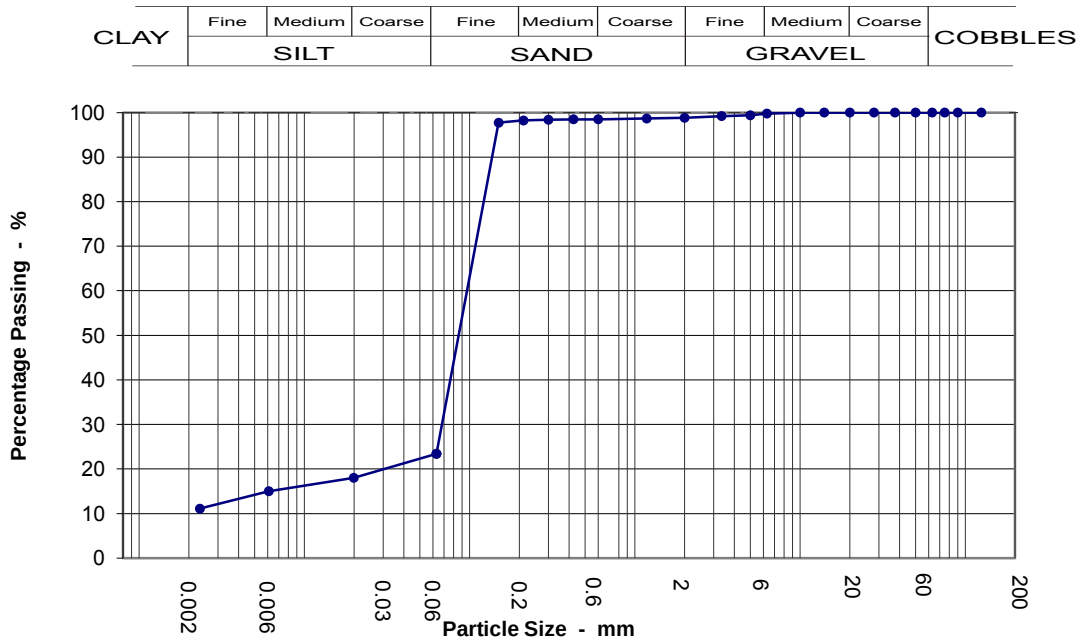
Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH3
		Depth	6.50 m
Visual Soil Description	Orange brown and occasional grey slightly gravelly silty clayey SAND (gravel is fine and angular)	Sample Type/No	D - 10



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	18
90	100	0.006	15
75	100	0.002	11
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	99		
2	99		
1.18	99		
0.6	98		
0.425	98		
0.3	98		
0.212	98		
0.15	98		
0.063	23		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	1.2
Sand	75.8
Silt & Clay	23.0

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

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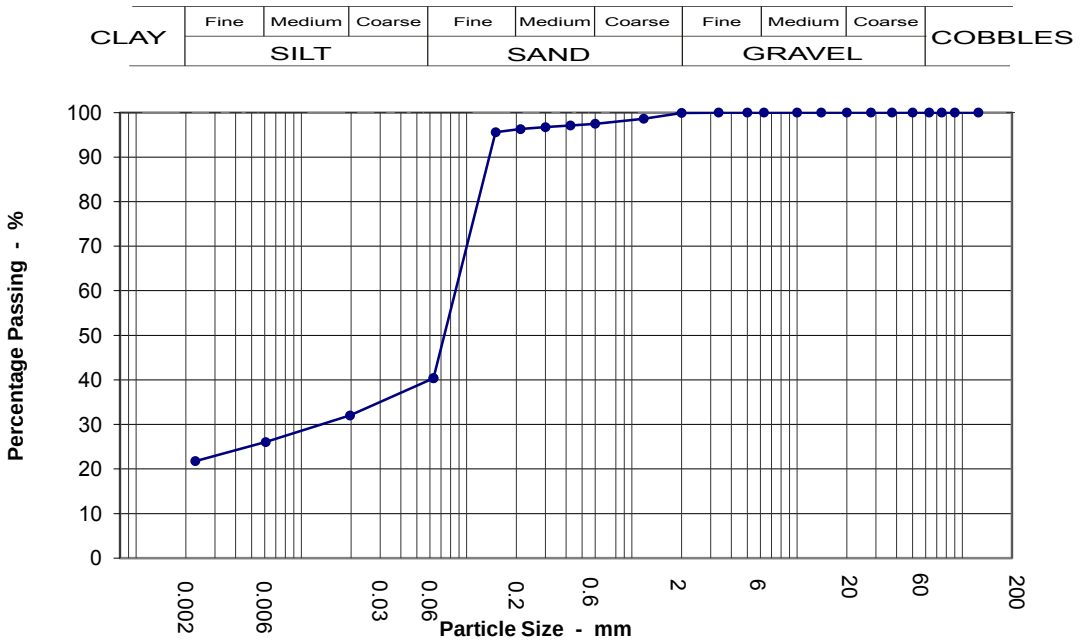
Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH4
		Depth	6.20 m
Visual Soil Description	Greyish brown and occasional orange brown sandy silty CLAY	Sample Type/No	D - 14



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	32
90	100	0.006	26
75	100	0.002	22
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	99		
0.6	97		
0.425	97		
0.3	97		
0.212	96		
0.15	96		
0.063	40		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	0.1
Sand	60.1
Silt & Clay	39.8

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

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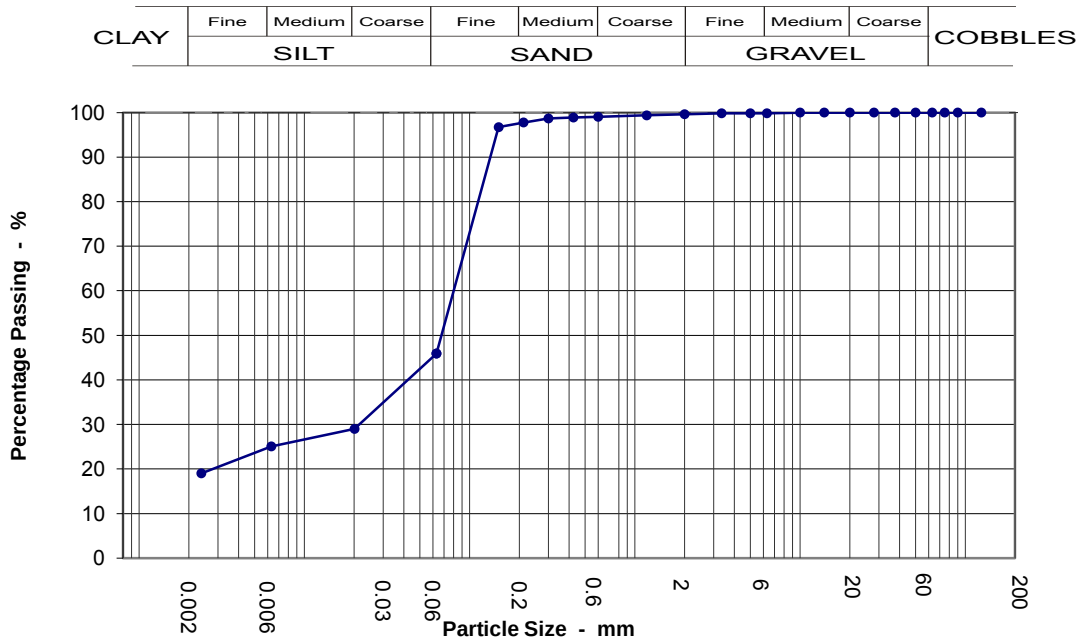
Date: 15/09/2014

UKAS TESTING

2519

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH4
		Depth	7.50 m
Visual Soil Description	Pale grey, pale brown and occasional orange brown fine sandy silty CLAY	Sample Type/No	D - 16



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	29
90	100	0.006	25
75	100	0.002	19
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	99		
0.6	99		
0.425	99		
0.3	99		
0.212	98		
0.15	97		
0.063	46		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	0.4
Sand	54.9
Silt & Clay	44.7

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

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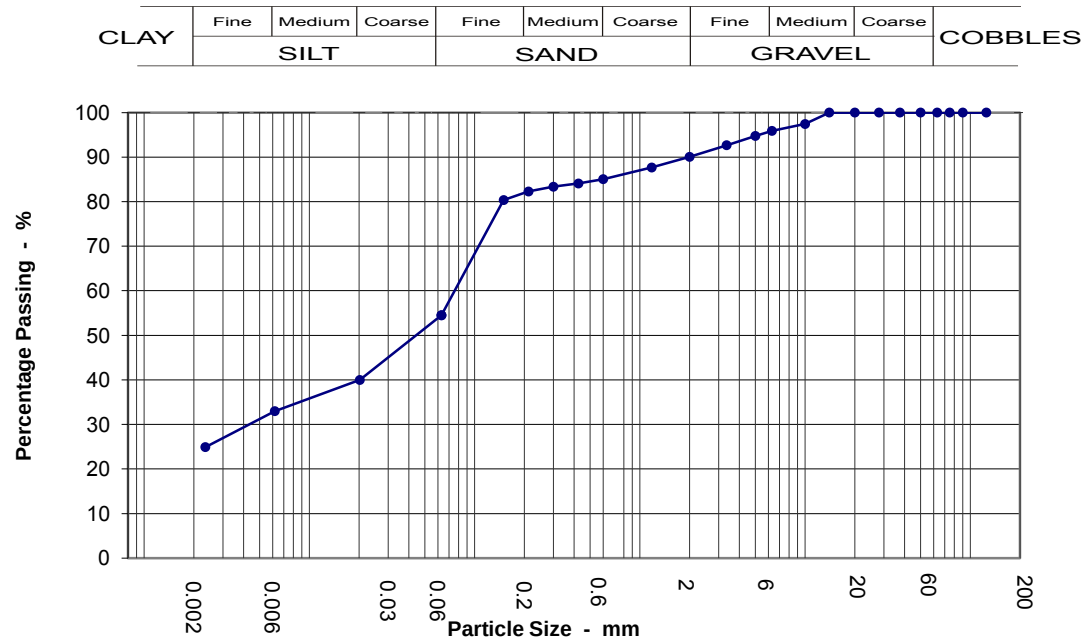
UKAS TESTING

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH4
		Depth	10.00 m
Visual Soil Description	Orange brown and grey sandy silty CLAY with occasional fm mudstone fragments	Sample Type/No	D - 20



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	40
90	100	0.006	33
75	100	0.002	25
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	97		
6.3	96		
5	95		
3.35	93		
2	90		
1.18	88		
0.6	85		
0.425	84		
0.3	83		
0.212	82		
0.15	80		
0.063	55		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	9.9
Sand	36.6
Silt & Clay	53.5

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU.
E-mail: k4soils@aol.com

Approved Signatories:
K.Phaure(Tech.Mgr) J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

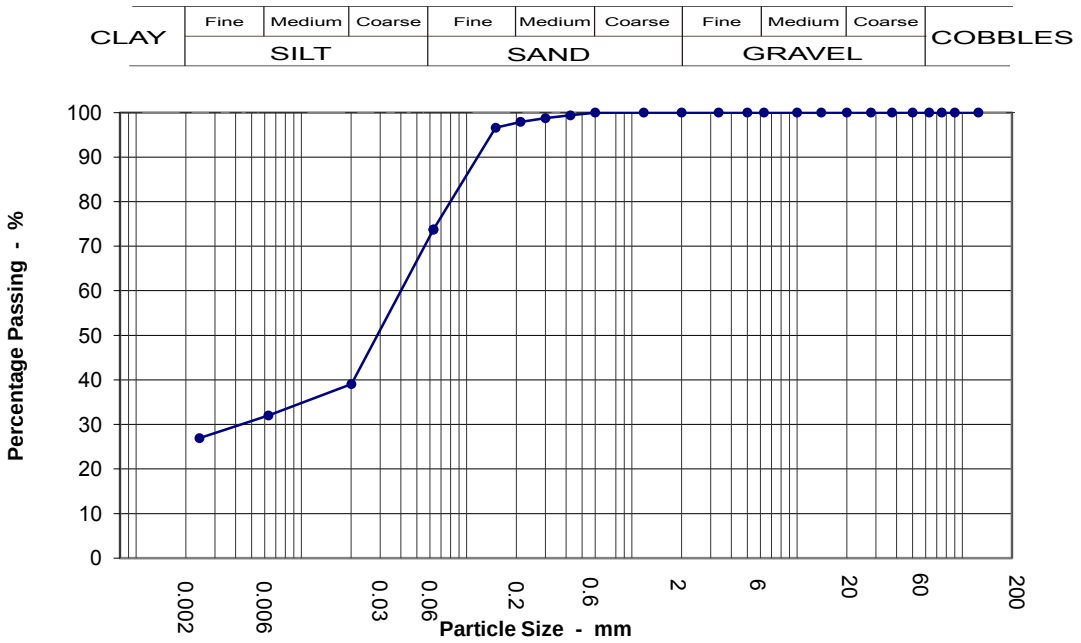
Checked and Approved
Initials: kp
Date: 15/09/2014

UKAS TESTING

2519

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH5
		Depth	3.00 m
Visual Soil Description	Pale brown and pale grey slightly sandy silty CLAY	Sample Type/No	D - 6



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	39
90	100	0.006	32
75	100	0.002	27
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	99		
0.3	99		
0.212	98		
0.15	97		
0.063	74		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	28.7
Silt & Clay	71.3

Grading Analysis	
D100	125.0
D60	
D10	
Uniformity Coefficient	N/A

K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU.
E-mail: k4soils@aol.com

Approved Signatories:
K.Phaure(Tech.Mgr) J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

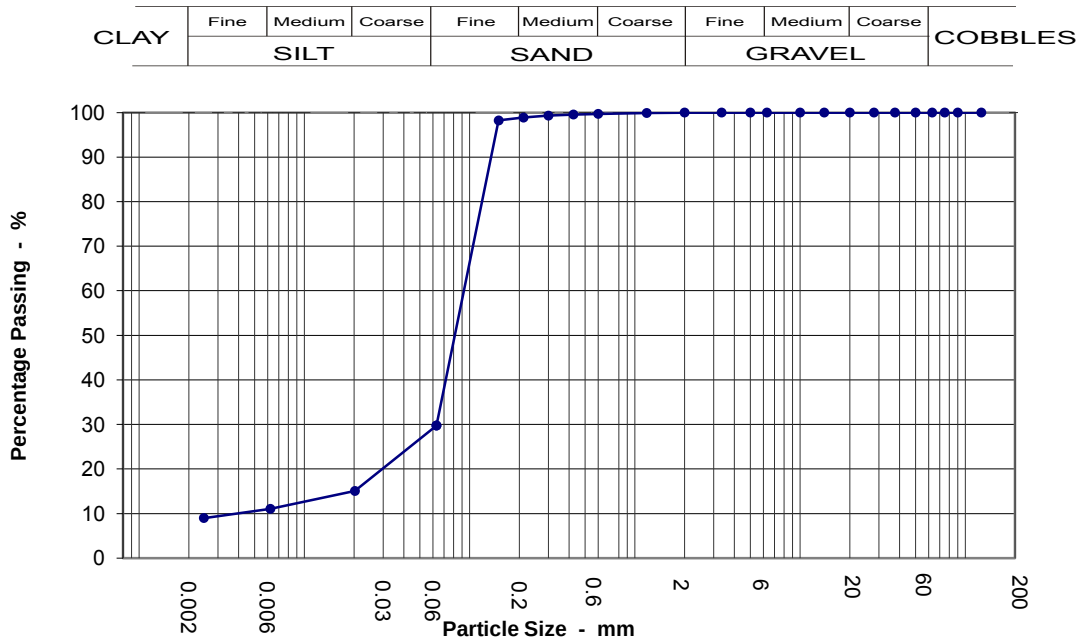
Checked and Approved
Initials: kp
Date: 15/09/2014

UKAS TESTING

2519

Figure A3.1

K4 SOILS	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	17352
		Project No:	522474A
Location	Fitzjohn's Avenue, Hampstead NW3 6PA	Borehole / Trial Pit No:	BH5
		Depth	8.00 m
Visual Soil Description	Greyish brown clayey silty SAND	Sample Type/No	D - 14



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.020	15
90	100	0.006	11
75	100	0.002	9
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	99		
0.212	99		
0.15	98		
0.063	30		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	Clause 9.4
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	0.0
Sand	71.3
Silt & Clay	28.7

Grading Analysis	
D100	125.0
D60	0.1
D10	
Uniformity Coefficient	N/A

K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU.
E-mail: k4soils@aol.com

Approved Signatories:
K.Phaure(Tech.Mgr) J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 15/09/2014

UKAS TESTING

2519

Figure A3.1

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 14-14078

03-Sep-14

Client Ian Farmer Associates
1A Batford Mill
Lower Luton Road
Harpenden
Herts
AL5 5BZ

Our Reference 14-14078

Client Reference 52247

Contract Title Fitzjohn's Avenue, Hampstead

Description 9 Soil samples.

Date Received 28-Aug-14

Date Started 28-Aug-14

Date Completed 03-Sep-14

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

UKAS TESTING
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Figure A3.2

Summary of Chemical Analysis
Soil Samples

Our Ref 14-14078
Client Ref 52247
Contract Title Fitzjohn's Avenue, Hampstead

			Lab No	691461	691462	691463	691464	691465	691466	691467	691468	691469
			Sample ID	BH1	BH1	BH3	BH4	BH5	BH3	BH5	BH5	BH5
			Depth	1.20	2.00	0.70	1.20	0.50	1.90	4.00	13.00	16.00
			Other ID									
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	13/08/14	13/08/14	14/08/14	15/08/14	21/08/14	14/08/14	21/08/14	21/08/14	21/08/14
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**									
Inorganics												
pH	DETSC 2008#			7.5	7.5	11.1	7.2	8.5	7.3	6.6	7.7	7.6
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	24	62	1300	59	27	36	48	61	280
Total Sulphur as S	DETSC 2320	0.01	%						0.05	< 0.01	0.03	0.60
Total Sulphate as SO4	DETSC 2321#	0.01	%						0.14	0.02	0.07	0.12

Figure A3.2

Key: # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 14-14078
Client Ref 52247
Contract Fitzjohn's Avenue, Hampstead

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
691461	BH1 1.20 SOIL	13/08/14	PG	pH (7 days)	
691462	BH1 2.00 SOIL	13/08/14	PG	pH (7 days)	
691463	BH3 0.70 SOIL	14/08/14	PG	pH (7 days)	
691464	BH4 1.20 SOIL	15/08/14	PG	pH (7 days)	
691465	BH5 0.50 SOIL	21/08/14	PT 1L		
691466	BH3 1.90 SOIL	14/08/14	PG	pH (7 days)	
691467	BH5 4.00 SOIL	21/08/14	PT 1L		
691468	BH5 13.00 SOIL	21/08/14	PT 1L		
691469	BH5 16.00 SOIL	21/08/14	PT 1L		

Key: P-Plastic G-Bag T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Figure A3.2

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 14-14566

10-Sep-14

Client Ian Farmer Associates
1A Batford Mill
Lower Luton Road
Harpenden
Herts
AL5 5BZ

Our Reference 14-14566

Client Reference 52247

Contract Title Fitzjohn's Avenue, Hampstead

Description 4 Soil samples.

Date Received 03-Sep-14

Date Started 03-Sep-14

Date Completed 10-Sep-14

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

UKAS TESTING
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Figure A3.2

Summary of Chemical Analysis
Soil Samples

Our Ref 14-14566
Client Ref 52247
Contract Title Fitzjohn's Avenue, Hampstead

			Lab No	694365	694366	694367	694368
			Sample ID	BH2	BH2	BH2	BH2
			Depth	0.50	3.00	8.50	10.50
			Other ID				
			Sample Type	D	D	D	D
			Sampling Date	27/08/14	27/08/14	27/08/14	27/08/14
			Sampling Time	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Inorganics							
pH	DETSC 2008#			8.5	6.1	7.2	7.4
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	31	63	350	180
Total Sulphur as S	DETSC 2320	0.01	%		0.02	0.48	0.51
Total Sulphate as SO4	DETSC 2321#	0.01	%		0.04	0.12	0.11

Key: # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Figure A3.2

Information in Support of the Analytical Results

Our Ref 14-14566
Client Ref 52247
Contract Fitzjohn's Avenue, Hampstead

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
694365	BH2 0.50 SOIL	27/08/14	PT 1L		
694366	BH2 3.00 SOIL	27/08/14	PT 1L		
694367	BH2 8.50 SOIL	27/08/14	PT 1L		
694368	BH2 10.50 SOIL	27/08/14	PT 1L		

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

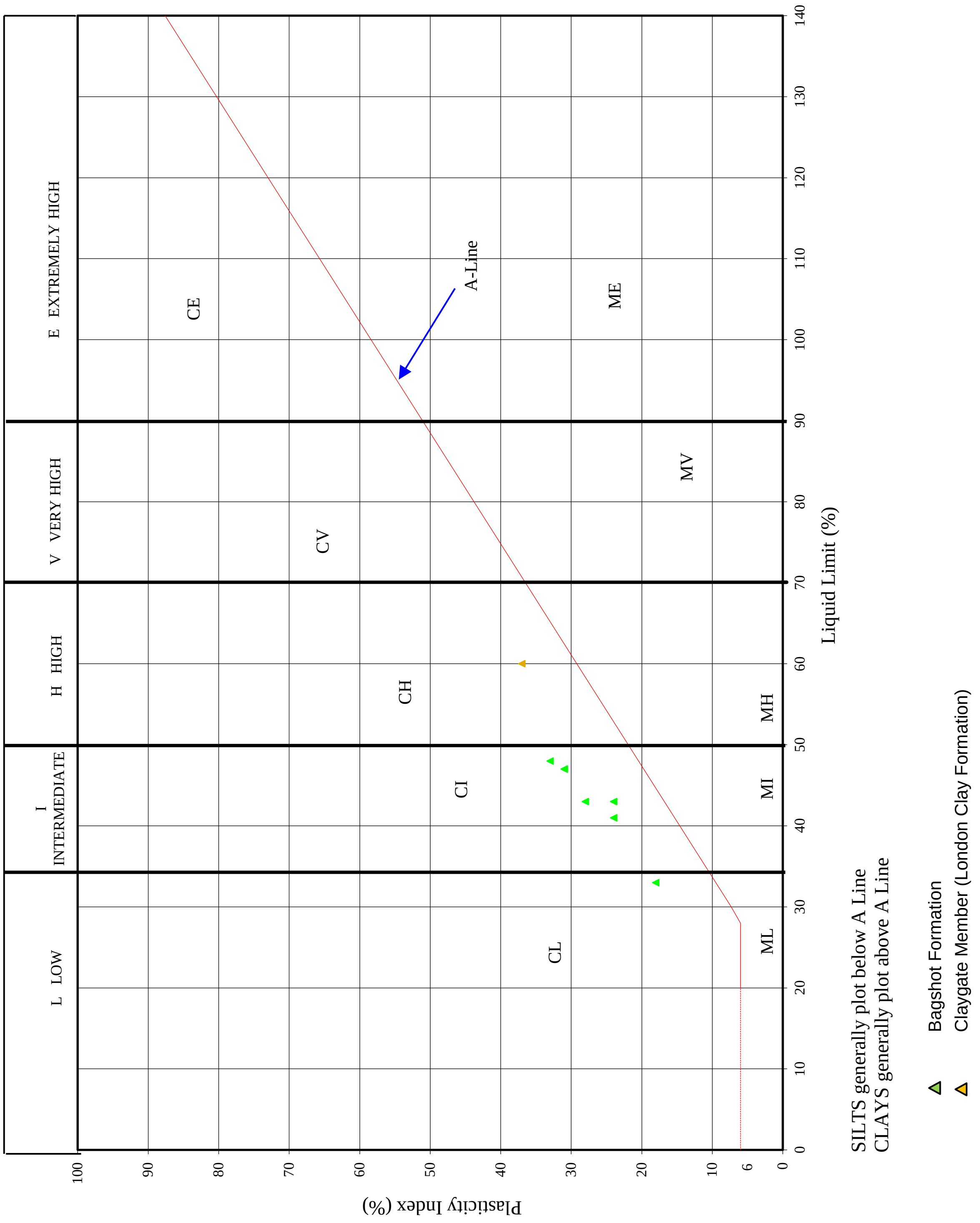
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Figure A3.2



PLASTICITY CLASSIFICATION CHART

Fitzjohn's Avenue, Hampstead, NW3 6PA

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Job no.	52247A
Fig no.	A3.3

APPENDIX 4

CHEMICAL TESTS

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 14-13464-2

22-Sep-14

Client Ian Farmer Associates
1A Batford Mill
Lower Luton Road
Harpenden
Herts
AL5 5BZ

Our Reference 14-13464-2

Client Reference 52247

Contract Title Fitzjohn's Avenue

Description 4 Soil samples, 2 Leachate samples.

Date Received 19-Aug-14

Date Started 19-Aug-14

Date Completed 22-Sep-14

Test Procedures Identified by prefix DETSn (details on request), Asbestos Analysis DETSC 1101.

Notes **This report supersedes 14-13464-1. Leachates added**

Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
2139

Figure A4.1

Summary of Chemical Analysis
Matrix Descriptions

Our Ref 14-13464-2
Client Ref 52247
Contract Title Fitzjohn's Avenue

Sample ID	Depth	Lab No	Completed	Matrix Description
BH1	0.3	687704	22/09/2014	brown gravelly sandy CLAY
BH1	0.9	687705	22/09/2014	brown gravelly sandy CLAY
BH3	0.5	687706	22/09/2014	brown gravelly sandy CLAY
BH3	1	687707	22/09/2014	brown gravelly sandy CLAY

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-13464-2
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	687704	687705	687706	687707
			Sample ID	BH1	BH1	BH3	BH3
			Depth	0.30	0.90	0.50	1.00
			Other ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sampling Date	13/08/14	13/08/14	14/08/14	14/08/14
			Sampling Time	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Metals							
Arsenic	DETSC 2301#	0.2	mg/kg	22	15	8.0	12
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	2.4	2.2	1.5	2.0
Cadmium	DETSC 2301#	0.1	mg/kg	1.5	0.7	0.2	0.4
Chromium	DETSC 2301#	0.15	mg/kg	78	93	81	91
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	83	41	8.2	15
Lead	DETSC 2301#	0.3	mg/kg	1500	330	54	180
Mercury	DETSC 2325#	0.05	mg/kg	0.43	0.52	< 0.05	0.17
Nickel	DETSC 2301#	1	mg/kg	28	20	14	18
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	0.6	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	450	120	44	83
Inorganics							
pH	DETSC 2008#			7.5	7.5	11.2	10.5
Cyanide free	DETSC 2130#	0.1	mg/kg	0.2	< 0.1	< 0.1	< 0.1
Organic matter	DETSC 2002#	0.1	%	4.7			0.6
Petroleum Hydrocarbons							
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	< 1.2	< 1.2	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	11
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	< 3.4	< 3.4	28
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	39
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9	< 0.9	7.8
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	19
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	0.6	< 0.6	< 0.6	440
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4	< 1.4	< 1.4	2900
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	3300
TPH Ali/Aro	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	3400
Benzene	DETSC 3321#	0.01	mg/kg			< 0.01	
Ethylbenzene	DETSC 3321#	0.01	mg/kg			< 0.01	
Toluene	DETSC 3321#	0.01	mg/kg			< 0.01	
Xylene	DETSC 3321#	0.01	mg/kg			< 0.01	
MTBE	DETSC 3321	0.01	mg/kg			< 0.01	
PAHs							
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	0.1	< 0.1	< 0.1	< 0.1

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-13464-2
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	687704	687705	687706	687707
			Sample ID	BH1	BH1	BH3	BH3
			Depth	0.30	0.90	0.50	1.00
			Other ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sampling Date	13/08/14	13/08/14	14/08/14	14/08/14
			Sampling Time	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Anthracene	DETSC 3301	0.1	mg/kg	0.2	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	1.3	< 0.1	< 0.1	< 0.1
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	1.3	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	1.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	0.5	< 0.1	< 0.1	< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	1.2	< 0.1	< 0.1	< 0.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	2.3	0.6	0.3	0.4
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	0.9	< 0.1	< 0.1	< 0.1
Pyrene	DETSC 3301	0.1	mg/kg	2.1	0.7	0.3	0.4
PAH	DETSC 3301	1.6	mg/kg	11	< 1.6	< 1.6	< 1.6

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Figure A4.1

Summary of Chemical Analysis
Leachate Samples

Our Ref 14-13464-2
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	701272	701273
			Sample ID	BH1	BH3
			Depth	0.90	1.00
			Other ID		
			Sample Type	LEACHATE	LEACHATE
			Sampling Date	13/08/14	14/08/14
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Preparation					
NRA Leachate Preparation	DETS 036*			Y	Y
Metals					
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	2.6	1.3
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	< 0.03	< 0.03
Chromium, Dissolved	DETSC 2306	0.25	ug/l	1.0	1.5
Copper, Dissolved	DETSC 2306	0.4	ug/l	4.4	1.1
Lead, Dissolved	DETSC 2306	0.09	ug/l	6.2	0.86
Mercury, Dissolved	DETSC 2306	0.01	ug/l	0.02	< 0.01
Nickel, Dissolved	DETSC 2306	0.5	ug/l	0.8	0.8
Selenium, Dissolved	DETSC 2306	0.25	ug/l	1.8	1.3
Zinc, Dissolved	DETSC 2306	1.25	ug/l	3.23	< 1.25
Inorganics					
pH	DETSC 2008			5.8	7.0
Cyanide free	DETSC 2130	20	ug/l	< 20	< 20
Petroleum Hydrocarbons					
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aliphatic C5-C35	DETSC 3072*	10	ug/l	60	60
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 15.0	< 15.0
Aromatic C5-C35	DETSC 3072*	10	ug/l	60	60
TPH Ali/Aro	DETSC 3072*	10	ug/l	120	120

Key: * -not accredited. n/s -not supplied.

Figure A4.1

Summary of Asbestos Analysis
Soil Samples

Our Ref 14-13464-2
Client Ref 52247
Contract Title Fitzjohn's Avenue

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
687704	BH1 0.30	SOIL	Amosite	Amosite present as fibre bundles	Jeff Cruddas
687706	BH3 0.50	SOIL	NAD	none	Jeff Cruddas

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * -not included in laboratory scope of accreditation.

Figure A4.1

Information in Support of the Analytical Results

Our Ref 14-13464-2
Client Ref 52247
Contract Fitzjohn's Avenue

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
687704	BH1 0.30 SOIL	13/08/14	GJ 250ml (250ml), GV (40ml), PT 1L (1kg)		
687705	BH1 0.90 SOIL	13/08/14	GJ 250ml (250ml), GV (40ml), PT 1L (1kg)		
687706	BH3 0.50 SOIL	14/08/14	GJ 250ml (250ml), GV (40ml), PT 1L (1kg)		
687707	BH3 1.00 SOIL	14/08/14	GJ 250ml (250ml), GV (40ml), PT 1L (1kg)		
701272	BH1 0.90 LEACHATE	13/08/14	GJ 1L (1L)		
701273	BH3 1.00 LEACHATE	14/08/14	GJ 1L (1L)		

Key: G-Glass P-Plastic J-Jar V-Vial T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETSC 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETSC 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETSC 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETSC 2076	Sulphate Aqueous Extract as SO4	mg/l	10	Air Dried	No	Yes	Yes
DETSC 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETSC 2321	Total Sulphate as SO4	%	0.01	Air Dried	No	Yes	Yes
DETSC 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETSC 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETSC2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETSC2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETSC2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETSC2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETSC2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETSC2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETSC2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETSC 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

Figure A4.1

Certificate of Analysis

Certificate Number 14-13783

29-Aug-14

Client	Ian Farmer Associates 1A Batford Mill Lower Luton Road Harpenden Herts AL5 5BZ
Our Reference	14-13783
Client Reference	52247
Contract Title	Fitzjohn's Avenue
Description	2 Soil samples.
Date Received	22-Aug-14
Date Started	22-Aug-14
Date Completed	29-Aug-14
Test Procedures	Identified by prefix DETSn (details on request), Asbestos Analysis DETSC 1101.
Notes	Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

2139

Figure A4.1

Summary of Chemical Analysis
Matrix Descriptions

Our Ref 14-13783
Client Ref 52247
Contract Title Fitzjohn's Avenue

Sample ID	Depth	Lab No	Completed	Matrix Description
BH5	0.5	689432	29/08/2014	Brown gravelly sandy CLAY
BH5	1	689433	29/08/2014	Brown gravelly sandy CLAY with odd rootlets

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-13783
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	689432	689433
			Sample ID	BH5	BH5
			Depth	0.50	1.00
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	18/08/14	18/08/14
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Metals					
Arsenic	DETSC 2301#	0.2	mg/kg	7.1	10
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	0.8	1.1
Cadmium	DETSC 2301#	0.1	mg/kg	0.1	0.2
Chromium	DETSC 2301#	0.15	mg/kg	97	82
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	8.4	7.0
Lead	DETSC 2301#	0.3	mg/kg	14	11
Mercury	DETSC 2325#	0.05	mg/kg	0.05	0.06
Nickel	DETSC 2301#	1	mg/kg	5.8	8.7
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	25	29
Inorganics					
Cyanide free	DETSC 2130#	0.1	mg/kg	< 0.1	< 0.1
Organic matter	DETSC 2002#	0.1	%		0.4
Petroleum Hydrocarbons					
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	< 3.4
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	< 0.6	< 0.6
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4	< 1.4
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10
TPH Ali/Aro	DETSC 3072*	10	mg/kg	< 10	< 10

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-13783
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	689432	689433
			Sample ID	BH5	BH5
			Depth	0.50	1.00
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	18/08/14	18/08/14
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
PAHs					
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
PAH	DETSC 3301	1.6	mg/kg	< 1.6	< 1.6

Figure A4.1

Summary of Asbestos Analysis
Soil Samples

Our Ref 14-13783
Client Ref 52247
Contract Title Fitzjohn's Avenue

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
689432	BH5 0.50	SOIL	NAD	none	Keith Wilson

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Figure A4.1

Information in Support of the Analytical Results

Our Ref 14-13783
Client Ref 52247
Contract Fitzjohn's Avenue

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
689432	BH5 0.50 SOIL	18/08/14	GJ 250ml (250ml), GV (40ml), PT 1L (1kg)		
689433	BH5 1.00 SOIL	18/08/14	GJ 250ml (250ml), GV (40ml), PT 1L (1kg)		

Key: G-Glass P-Plastic J-Jar V-Vial T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETSC 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETSC 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETSC 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETSC 2076	Sulphate Aqueous Extract as SO4	mg/l	10	Air Dried	No	Yes	Yes
DETSC 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETSC 2321	Total Sulphate as SO4	%	0.01	Air Dried	No	Yes	Yes
DETSC 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETSC 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETSC2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETSC2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETSC2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETSC2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETSC2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETSC2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETSC2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETSC 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

Figure A4.1

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 14-13784-1

22-Sep-14

Client Ian Farmer Associates
1A Batford Mill
Lower Luton Road
Harpenden
Herts
AL5 5BZ

Our Reference 14-13784-1

Client Reference 52247

Contract Title Fitzjohn's Avenue

Description 2 Soil samples, 1 Leachate sample.

Date Received 22-Aug-14

Date Started 22-Aug-14

Date Completed 22-Sep-14

Test Procedures Identified by prefix DETSn (details on request), Asbestos Analysis DETSC 1101.

Notes **This report supersedes 14-13784. Leachates added**

Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
2139

Figure A4.1

Summary of Chemical Analysis
Matrix Descriptions

Our Ref 14-13784-1
Client Ref 52247
Contract Title Fitzjohn's Avenue

Sample ID	Depth	Lab No	Completed	Matrix Description
BH4	0.4	689434	22/09/2014	Dark grey gravelly sandy CLAY with odd rootlets
BH4	0.8	689435	22/09/2014	Brown gravelly sandy CLAY (made ground includes brick)

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-13784-1
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	689434	689435
			Sample ID	BH4	BH4
			Depth	0.40	0.80
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	15/08/14	15/08/14
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Metals					
Arsenic	DETSC 2301#	0.2	mg/kg	13	11
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	1.3	1.1
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.2
Chromium	DETSC 2301#	0.15	mg/kg	100	120
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	28	19
Lead	DETSC 2301#	0.3	mg/kg	84	97
Mercury	DETSC 2325#	0.05	mg/kg	0.19	0.43
Nickel	DETSC 2301#	1	mg/kg	17	10
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	73	45
Inorganics					
pH	DETSC 2008#			7.9	7.7
Cyanide free	DETSC 2130#	0.1	mg/kg	< 0.1	< 0.1
Organic matter	DETSC 2002#	0.1	%		1.6
Petroleum Hydrocarbons					
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	< 3.4
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	< 0.6	< 0.6
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4	< 1.4
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10
TPH Ali/Aro	DETSC 3072*	10	mg/kg	< 10	< 10
Benzene	DETSC 3321#	0.01	mg/kg	< 0.01	
Ethylbenzene	DETSC 3321#	0.01	mg/kg	< 0.01	
Toluene	DETSC 3321#	0.01	mg/kg	< 0.01	
Xylene	DETSC 3321#	0.01	mg/kg	< 0.01	
MTBE	DETSC 3321	0.01	mg/kg	< 0.01	
PAHs					
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-13784-1
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	689434	689435
			Sample ID	BH4	BH4
			Depth	0.40	0.80
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	15/08/14	15/08/14
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	0.3	< 0.1
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Pyrene	DETSC 3301	0.1	mg/kg	0.3	< 0.1
PAH	DETSC 3301	1.6	mg/kg	< 1.6	< 1.6

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Figure A4.1

Summary of Chemical Analysis
Leachate Samples

Our Ref 14-13784-1
Client Ref 52247
Contract Title Fitzjohn's Avenue

Lab No	701271
Sample ID	BH4
Depth	0.80
Other ID	
Sample Type	LEACHATE
Sampling Date	15/08/14
Sampling Time	n/s

Test	Method	LOD	Units	
Preparation				
NRA Leachate Preparation	DETS 036*			Y
Metals				
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	2.7
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	< 0.03
Chromium, Dissolved	DETSC 2306	0.25	ug/l	2.6
Copper, Dissolved	DETSC 2306	0.4	ug/l	2.6
Lead, Dissolved	DETSC 2306	0.09	ug/l	3.9
Mercury, Dissolved	DETSC 2306	0.01	ug/l	0.02
Nickel, Dissolved	DETSC 2306	0.5	ug/l	0.5
Selenium, Dissolved	DETSC 2306	0.25	ug/l	2.3
Zinc, Dissolved	DETSC 2306	1.25	ug/l	1.60
Inorganics				
pH	DETSC 2008			5.5
Cyanide free	DETSC 2130	20	ug/l	< 20
Petroleum Hydrocarbons				
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C16-C21	DETSC 3072*	1	ug/l	6.1
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C5-C35	DETSC 3072*	10	ug/l	< 10
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	7.5
Aromatic C12-C16	DETSC 3072*	1	ug/l	8.4
Aromatic C16-C21	DETSC 3072*	1	ug/l	13
Aromatic C21-C35	DETSC 3072*	1	ug/l	11
Aromatic C5-C35	DETSC 3072*	10	ug/l	40
TPH Ali/Aro	DETSC 3072*	10	ug/l	47

Key: * -not accredited. n/s -not supplied.

Figure A4.1

Summary of Asbestos Analysis
Soil Samples

Our Ref 14-13784-1
Client Ref 52247
Contract Title Fitzjohn's Avenue

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
689434	BH4 0.40	SOIL	NAD	none	Keith Wilson

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Figure A4.1

Information in Support of the Analytical Results

Our Ref 14-13784-1
Client Ref 52247
Contract Fitzjohn's Avenue

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
689434	BH4 0.40 SOIL	15/08/14	GJ 250ml (250ml), GJ 60ml (60ml), PT 1L (1kg)		
689435	BH4 0.80 SOIL	15/08/14	GJ 250ml (250ml), PT 1L (1kg)		
701271	BH4 0.80 LEACHATE	15/08/14	GJ 1L (1L)		

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETSC 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETSC 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETSC 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETSC 2076	Sulphate Aqueous Extract as SO4	mg/l	10	Air Dried	No	Yes	Yes
DETSC 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETSC 2321	Total Sulphate as SO4	%	0.01	Air Dried	No	Yes	Yes
DETSC 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETSC 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETSC2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETSC2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETSC2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETSC2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETSC2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETSC2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETSC2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETSC 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

Figure A4.1

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 14-14255

04-Sep-14

Client Ian Farmer Associates
1A Batford Mill
Lower Luton Road
Harpenden
Herts
AL5 5BZ

Our Reference 14-14255

Client Reference 52247

Contract Title Fitzjohn's Avenue

Description 2 Soil samples.

Date Received 29-Aug-14

Date Started 29-Aug-14

Date Completed 04-Sep-14

Test Procedures Identified by prefix DETSn (details on request), Asbestos Analysis DETSC 1101.

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

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THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

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Figure A4.1

Summary of Chemical Analysis
Matrix Descriptions

Our Ref 14-14255
Client Ref 52247
Contract Title Fitzjohn's Avenue

Sample ID	Depth	Lab No	Completed	Matrix Description
TP1	0.2	692710	04/09/2014	Brown clayey sandy GRAVEL (sample matrix outside MCERTS scope of accreditation)
TP2	0.5	692711	04/09/2014	Dark brown grey gravelly silty sandy CLAY (made ground includes brick)

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-14255
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	692710	692711
			Sample ID	TP1	TP2
			Depth	0.20	0.50
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	27/08/14	27/08/14
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Metals					
Arsenic	DETSC 2301#	0.2	mg/kg	10	7.7
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	1.4	1.4
Cadmium	DETSC 2301#	0.1	mg/kg	0.5	0.9
Chromium	DETSC 2301#	0.15	mg/kg	96	98
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	10	20
Lead	DETSC 2301#	0.3	mg/kg	16	310
Mercury	DETSC 2325#	0.05	mg/kg	< 0.05	0.19
Nickel	DETSC 2301#	1	mg/kg	29	9.1
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	62	55
Inorganics					
pH	DETSC 2008#			8.6	8.3
Cyanide free	DETSC 2130#	0.1	mg/kg	< 0.1	< 0.1
Petroleum Hydrocarbons					
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	1.9
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	25
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	270
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	300
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	< 0.6	7.8
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4	32
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10	40
TPH Ali/Aro	DETSC 3072*	10	mg/kg	< 10	340
Benzene	DETSC 3321#	0.01	mg/kg	< 0.01	
Ethylbenzene	DETSC 3321#	0.01	mg/kg	< 0.01	
Toluene	DETSC 3321#	0.01	mg/kg	< 0.01	
Xylene	DETSC 3321#	0.01	mg/kg	< 0.01	
MTBE	DETSC 3321	0.01	mg/kg	< 0.01	
PAHs					
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Anthracene	DETSC 3301	0.1	mg/kg	< 0.1	0.4

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Figure A4.1

Summary of Chemical Analysis
Soil Samples

Our Ref 14-14255
Client Ref 52247
Contract Title Fitzjohn's Avenue

			Lab No	692710	692711
			Sample ID	TP1	TP2
			Depth	0.20	0.50
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	27/08/14	27/08/14
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	0.6
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	0.3
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	0.4
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	0.7
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	< 0.1	0.2
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	0.3	0.5
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	0.4	0.2
Pyrene	DETSC 3301	0.1	mg/kg	0.2	0.4
PAH	DETSC 3301	1.6	mg/kg	< 1.6	3.5

Summary of Asbestos Analysis
Soil Samples

Our Ref 14-14255
Client Ref 52247
Contract Title Fitzjohn's Avenue

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
692710	TP1 0.20	SOIL	NAD	none	Colin Patrick

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Figure A4.1

Information in Support of the Analytical Results

Our Ref 14-14255
Client Ref 52247
Contract Fitzjohn's Avenue

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
692710	TP1 0.20 SOIL	27/08/14	GJ 250ml (250ml), GJ 60ml (60ml), PT 1L (1kg)		
692711	TP2 0.50 SOIL	27/08/14	GJ 250ml (250ml), GJ 60ml (60ml), PT 1L (1kg)		

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETSC 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETSC 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETSC 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETSC 2076	Sulphate Aqueous Extract as SO4	mg/l	10	Air Dried	No	Yes	Yes
DETSC 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETSC 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETSC 2321	Total Sulphate as SO4	%	0.01	Air Dried	No	Yes	Yes
DETSC 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETSC 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETSC2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETSC2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETSC2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETSC2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETSC2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETSC2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETSC2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETSC2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETSC2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETSC2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETSC2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETSC 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETSC 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETSC 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETSC 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETSC 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Figure A4.1

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETSC 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETSC 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETSC 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

Figure A4.1

Waste Classification Report

VJQ5F-AQF86-N4WF6

Job name

52247A Fitzjohn's Avenue

Waste stream

Default Contaminated Land

Comments

Apartment block for over 55s

Project

52247A

Site

Fitzjohn's Avenue

Classified by

Name:
Greenwood, Gavin
Date:
17/09/2014 15:02
Telephone:
01582 460018

Company:
Ian Farmer Associates
Unit 1A, Batford Mill
Lower Luton Road
Harpenden
AL5 5BZ

Report

Created by: Greenwood, Gavin
Created date: 17/09/2014 15:02

Job summary

Figure A4.2

APPENDIX 5

DESIGN CONSIDERATIONS

APPENDIX 5

GUIDELINES FOR THE DESIGN OF PILES

FIRST APPROXIMATION OF WORKING LOAD

A5.1 GENERAL

The ultimate carrying capacity, Qu, of a particular pile is taken as the sum of the ultimate shaft friction resistance, Qs, and the ultimate end bearing resistance, Qb. This may be expressed as follows:-

$$Qu = Qs + Qb$$

$$= f.As + q.Ab$$

where f = unit shaft resistance

As = embedded surface area of pile

q = unit end bearing resistance

Ab = effective cross-sectional area of pile base

A5.2 COHESIVE SOILS

A5.2.1 Shaft Resistance

The ultimate shaft resistance, f, for piles in both compression or tension in cohesive soils is determined by applying a factor to the undrained shear strength, Cs, which exists in the soils along the embedded length of the pile, and is given by:-

$$f = \alpha.Cs$$

Where α is an adhesion factor, which for straight-shafted bored piles may be taken as 0.45 to 0.60.

Ultimate unit shaft friction should not exceed 100kPa.

A5.2.2 End Bearing

For piles terminating in cohesive soils, the ultimate unit end bearing resistance q, is given by:-

$$q = Nc.Cb$$

where Cb is the undrained shear strength at the base of the pile

and Nc is a bearing capacity factor

The value of Nc for a cohesive material is variable, depending on the depth of the penetration of the pile into the bearing stratum. Generally, Nc could be taken to have a value of 9, except in the case of large diameter short piles where a lesser value should be used.

A5.3 COHESIONLESS SOILS

A5.3.1 Shaft Resistance

For piles driven in cohesionless soils the ultimate unit shaft resistance, f, may be calculated using the following method, which gives:-

$$f = 0.5\gamma' (D+d) Ks \tan \delta$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to the pile toe or to the base of the granular stratum whichever is the lesser

d = depth to the top of the granular stratum

δ = angle of friction between pile and soil (see below)

Ks = a coefficient (see below)

VALUES OF Ks AND δ

Pile Type	**δ**	**Ks**		
		Relative Density		**Tension Piles**
		Low	**High**	
Steel	20°	0.5	1.5	0.5
Concrete	0.75ϕ	1.0	2.0	0.5

For bored and cast-in-place piles, δ = 22° and Ks = 1 should be used to allow for loosening of the soil during boring.

It has been found that the ultimate unit shaft resistance does not exceed 100kPa and therefore this value should not be exceeded in design.

A5.3.2 End Bearing

The unit ultimate end bearing resistance (q) of piles in cohesionless soils may be calculated as follows:-

$$q = \gamma'.D.Nq$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to pile toe

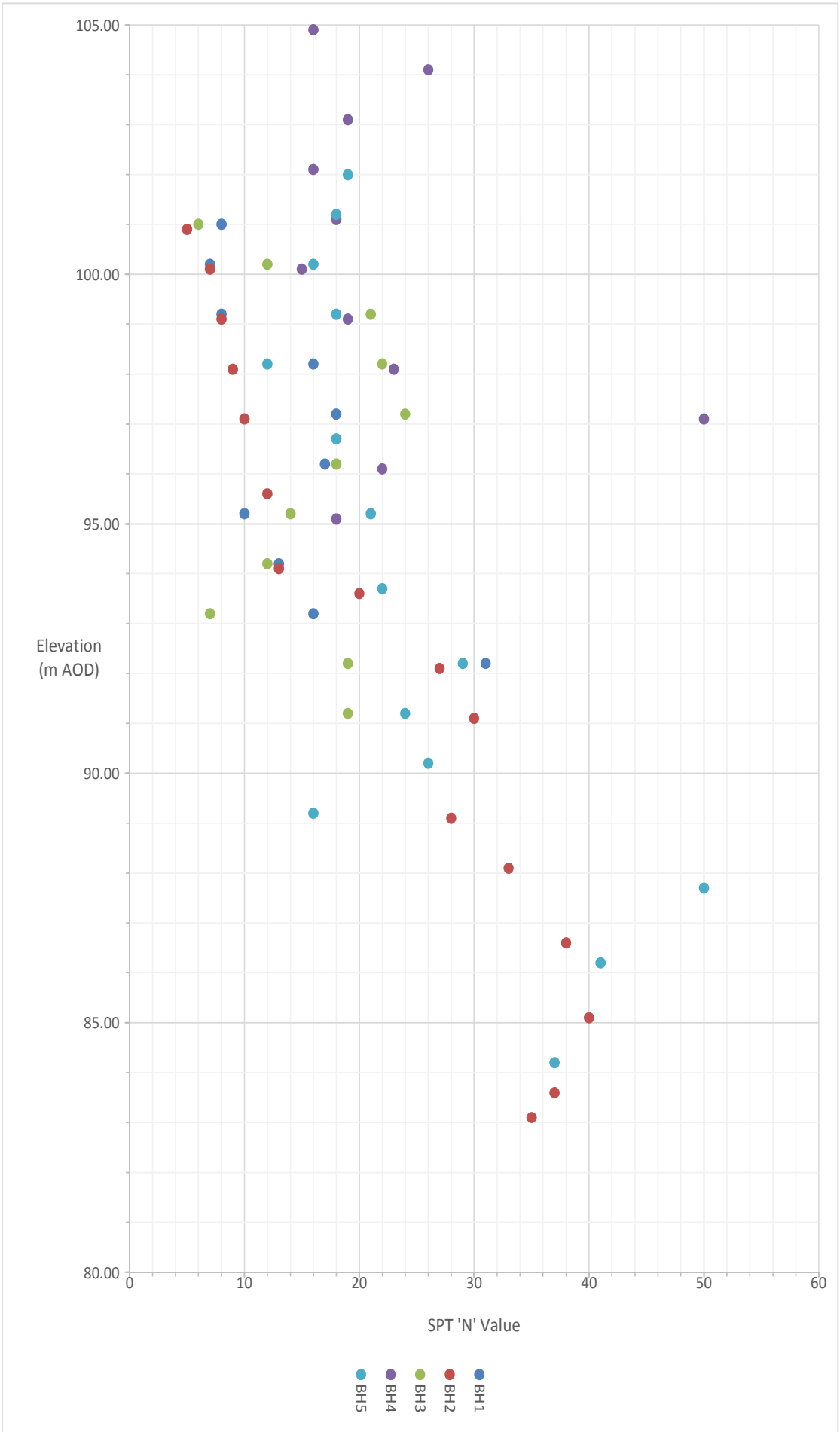
Nq = bearing capacity factor

In addition, the ultimate unit base resistance should not exceed a value of 11,000kPa. For bored and cast-in-place piles the value of Nq used should correspond to loose soil conditions.

A5.4 FACTORS OF SAFETY

A5.4.1 Cohesive and Non-cohesive Soils

For cohesive and non-cohesive soils a factor of safety of 3 may be used to obtain the allowable or safe carrying capacity of piles from the ultimate carrying capacity.



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PLOT OF SPT 'N' VALUE WITH ELEVATION**	Job no. 52247A
	Fitzjohn's Avenue, Hampstead, NW3 6PA	Fig No A5.1

APPENDIX 6

CONTAMINATION ASSESSMENT

APPENDIX 6

GENERAL NOTES ON CONTAMINATION ASSESSMENT

A6.1 STATUTORY FRAMEWORK AND DEFINITIONS

A6.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref. 10.18, which was introduced by the Environment Act 1995, ref. 10.19;

'Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused.'

A6.1.2 The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the new legislation has been summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the last remaining guidance document, CLR 11, ref. 10.35 was published in 2004. In 2008 CLR reports 7 to 10 were withdrawn by DEFRA and the Environment Agency and updated version of CLR 9 and 10 were produced in the form of Science Reports SR2, ref. 10.26 and SR3, ref. 10.20.

A6.1.3 In establishing whether a site fulfils the statutory definition of 'contaminated land' it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- is resulting in significant harm being caused to the receptor in the pollutant linkage,
- presents a significant possibility of significant harm being caused to that receptor,
- is resulting in the pollution of the controlled waters which constitute the receptor, or
- is likely to result in such pollution.

A6.1.4 A *'pollutant linkage'* may be defined as the link between a contaminant *'source'* and a *'receptor'* by means of a *'pathway'*.

A6.2 ASSESSMENT METHODOLOGY

A6.2.1 The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

A6.2.2 Stages 1 and 2 develop a *'conceptual model'* based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref. 10.41. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

A6.2.3 The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref. 10.42. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. CLR 8, ref. 10.43, together with specific DoE 'Industry Profiles' provides guidance on the nature of contaminants relating to specific industrial processes. Although CLR 8 has been withdrawn, no replacement guidance has been published that lists the contaminants likely to be present on contaminated sites and as such the guidance relating to this issue of CLR 8 is considered to still be relevant.

A6.2.4 If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref. 10.1. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a contamination risk assessment to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A6.2.5 A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

A6.2.6 All site works should be in general accordance with the British Standards, BS 5930:1999, ref. 10.3, ISO 1997, ref. 10.4 and BS 10175:2001, ref. 10.2.

A6.2.7 The generic contamination risk assessment screens the results of the chemical analysis against generic guidance values. Soils will be compared to Assessment Criteria (AC) generated using the Contaminated Land Exposure Assessment (CLEA) Software Version 1.06, ref. 10.22. Toxicological and physico-chemical/fate and transport data used to generate the AC has been derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs

   (DEFRA) documents;

2. Other documents produced by UK Government or state organisations;

3. European institution documents;

4. International organisation documents;

5. Foreign government institutions.

A6.2.8 In the case of the majority of contaminants considered, the toxicological data has been drawn from the relevant CLR 9 TOX report, or updated toxicological data published by the Environment Agency (2009), ref. 10.21, where available. Where no TOX report is available reference has been made to the health criteria values, derived for use in Land Quality Press (2006), ref. 10.27, as this is considered to represent a peer reviewed data source. Similarly, fate and transport data has been derived in the first instance from Environment Agency (2003), ref. 10.44 and for contaminants not considered in this document the fate and transport data used in previous versions of the CLEA model has been used.

A6.2.9 Recommendations for tolerable intakes of lead are based on evaluation of the relationship between exposure and blood lead levels. Consequently the Tox report for lead considers a health criteria value based on an uptake dose, whereas the CLEA model estimates exposure in terms of an intake dose, therefore, the CLEA model is not considered appropriate for determining an assessment criteria for lead. In the absence of a current published assessment criterion, the SGVs for lead reported in R&D Publication CLR 10 ref. 10.45 have been used in this assessment.

A6.2.10 Chemical laboratory test results are processed as follows. A statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref. 10.22. Individual concentrations are compared to the selected guideline values to identify concentrations of contaminants that are above the selected screening criteria.

A6.2.11 Initially the distribution of the data set is tested using the Shapiro-Wilk normality test, ref. 10.25 to determine if the data set is, or is not, normally distributed. Where the distribution of the data is shown to be normal, the mean value test is applied to determine whether the mean characteristics of the selected soil unit present a significant possibility of significant harm to human health. Where the data is not normally distributed a method based on the Chebychev Theorem can be applied to test the same hypothesis. The significance of the data is further tested using the maximum value test. This determines whether the highest recorded contaminant concentrations are from the same statistical distribution or whether they may represent a 'hot spot'.

A6.2.12 Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

A6.2.13 The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.

A6.2.14 The potential receptors include:

1) Humans – current site occupants, construction workers, future site users and neighbouring site users.

2) Controlled Waters – surface water and groundwater resources

3) Plants – current and future site vegetation

4) Building materials

A6.2.15 The potential hazards to be considered in relation to contamination are:

a) Ingestion and inhalation.

b) Uptake of contaminants via cultivated vegetables.

c) Dermal contact

d) Phytotoxicity (the prevention or inhibition of plant growth)

e) Contamination of water resources

f) Chemical attack on building materials and services

g) Fire and explosion

A6.2.16 Dependent on the outcome of the initial, generic contamination risk assessment, further detailed assessment of the identified risks may be required.

A6.3 Generic Guidance Values Used Within Contamination Risk Assessment

Residential End Use

	Determinant	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
		1% SOM	2.5% SOM	6% SOM	
PAH	Acenaphthene	210	450	1000	LQM CIEH GAC
	Acenaphthylene	170	400	850	LQM CIEH GAC
	Anthracene	2300	4900	9200	LQM CIEH GAC
	Benzo(a)anthracene	3.1	4.7	5.9	LQM CIEH GAC
	Benzo(a)pyrene	0.83	0.94	1	LQM CIEH GAC
	Benzo(b)fluoranthene	5.6	6.5	7	LQM CIEH GAC
	Benzo(ghi)perylene	44	46	47	LQM CIEH GAC
	Benzo(k)fluoranthene	8.5	9.6	10	LQM CIEH GAC
	Chrysene	6	8	9.3	LQM CIEH GAC
	Dibenzo(ah)anthracene	0.76	0.86	0.90	LQM CIEH GAC
	Fluoranthene	260	460	670	LQM CIEH GAC
	Fluorene	160	380	780	LQM CIEH GAC
	Indeno(123-cd)pyrene	3.2	3.9	4.2	LQM CIEH GAC
	Naphthalene	1.5	3.7	8.7	LQM CIEH GAC
	Phenanthrene	92	200	380	LQM CIEH GAC
	Pyrene	560	1000	1600	LQM CIEH GAC
Other Organics	Phenol	210	390	780	LQM CIEH GAC
Metals	Arsenic	32	32	32	EA 2009
	Beryllium	51	51	51	LQM CIEH GAC
	Boron	291	291	291	LQM CIEH GAC
	Cadmium	10	10	10	EA 2009
	Chromium (III)	3000	3000	3000	LQM CIEH GAC
	Chromium (VI)	4.3	4.3	4.3	LQM CIEH GAC
	Copper	2330	2330	2330	LQM CIEH GAC
	Lead	450	450	450	CLEA SGV 10
	Inorganic Mercury	169	169	169	EA 2009
	Nickel	130	130	130	EA 2009
	Selenium	350	350	350	EA 2009
	Vanadium	75	75	75	LQM CIEH GAC
	Zinc	3750	3750	3750	LQM CIEH GAC

SOM = Soil Organic Matter

Commercial End Use

	Determinant	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
		1% SOM	2.5% SOM	6% SOM	
PAH	Acenaphthene	85000 (57)	98000 (141)	100000	LQM CIEH GAC
	Acenaphthylene	84000 (86)	97000 (212)	100000	LQM CIEH GAC
	Anthracene	530000	540000	540000	LQM CIEH GAC
	Benzo(a)anthracene	90	95	97	LQM CIEH GAC
	Benzo(a)pyrene	14	14	14	LQM CIEH GAC
	Benzo(b)fluoranthene	100	100	100	LQM CIEH GAC
	Benzo(ghi)perylene	650	660	660	LQM CIEH GAC
	Benzo(k)fluoranthene	140	140	140	LQM CIEH GAC
	Chrysene	140	140	140	LQM CIEH GAC
	Dibenzo(ah)anthracene	13	13	13	LQM CIEH GAC
	Fluoranthene	23000	23000	23000	LQM CIEH GAC
	Fluorene	64000 (31)	69000	71000	LQM CIEH GAC
	Indeno(123-cd)pyrene	60	61	62	LQM CIEH GAC
	Naphthalene	200 (76)	480 (183)	1100 (432)	LQM CIEH GAC
	Phenanthrene	22000	22000	23000	LQM CIEH GAC
	Pyrene	54000	54000	54000	LQM CIEH GAC
Other Organics	Phenol	1100000 (24200)	1100000 (38100)	1200000	LQM CIEH GAC
Metals	Arsenic	640	640	640	EA 2009
	Beryllium	420	420	420	LQM CIEH GAC
	Boron	192000	192000	192000	LQM CIEH GAC
	Cadmium	230	230	230	EA 2009
	Chromium (III)	30400	30400	30400	LQM CIEH GAC
	Chromium (VI)	35	35	35	LQM CIEH GAC
	Copper	71700	71700	71700	LQM CIEH GAC
	Lead	750	750	750	CLEA SGV 10
	Inorganic Mercury	3640	3640	3640	EA 2009
	Nickel	1800	1800	1800	EA 2009
	Selenium	13000	13000	13000	EA 2009
	Vanadium	3160	3160	3160	LQM CIEH GAC
	Zinc	665000	665000	665000	LQM CIEH GAC

SOM = Soil Organic Matter
Values in brackets indicate the solubility or vapour saturation limit where this is exceeded by the GAC

A6.3.1 Generic Assessment Criteria for Petroleum Hydrocarbons

Residential	Guidance Value (mg/kg) 1% SOM	Guidance Value (mg/kg) 2.5% SOM	Guidance Value (mg/kg) 6% SOM	Primary Data Source
Aliphatic				
EC 5-6	30	55	110	LQM CIEH GAC
EC >6-8	73	160	370	LQM CIEH GAC
EC >8-10	19	46	110	LQM CIEH GAC
EC >10-12	93 (48)	230 (118)	540 (283)	LQM CIEH GAC
EC >12-16	740 (24)	1700 (59)	3000 (142)	LQM CIEH GAC
EC >16-35	45000 (8.48)	64000 (21)	76000	LQM CIEH GAC
EC >35-44	45000 (8.48)	64000 (21)	76000	LQM CIEH GAC
Aromatic				
EC 5-7 (benzene)	65	130	280	LQM CIEH GAC
EC >7-8 (toluene)	120	270	611	LQM CIEH GAC
EC >8-10	27	65	151	LQM CIEH GAC
EC >10-12	69	160	346	LQM CIEH GAC
EC >12-16	140	310	593	LQM CIEH GAC
EC >16-21	250	480	770	LQM CIEH GAC
EC >21-35	890	1100	1230	LQM CIEH GAC
EC >35-44	890	1100	1230	LQM CIEH GAC
Aliphatic and Aromatic				
EC >44-70	1200	1300	1300	LQM CIEH GAC
BTEX				
Benzene	0.08	0.18	0.33	EA 2009
Toluene	119	319	611	EA 2009
Ethylbenzene	65.2	183	354	EA 2009
Xylenes	45.2	126	246	EA 2009

SOM = Soil Organic Matter
Values in brackets indicate the solubility or vapour saturation limit where this is exceeded by the GAC

Commercial	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
	1% SOM	2.5% SOM	6% SOM	
Aliphatic				
EC 5-6	3400 (304)	6200 (558)	13000 (1150)	LQM CIEH GAC
EC >6-8	8300 (144)	18000 (322)	42000 (736)	LQM CIEH GAC
EC >8-10	2100 (78)	5100 (190)	12000 (451)	LQM CIEH GAC
EC >10-12	10000 (48)	24000 (118)	49000 (283)	LQM CIEH GAC
EC >12-16	61000 (24)	83000 (59)	91000 (142)	LQM CIEH GAC
EC >16-35	1600000	1800000	1800000	LQM CIEH GAC
EC >35-44	1600000	1800000	1800000	LQM CIEH GAC
Aromatic				
EC 5-7 (benzene)	28000 (1220)	49000 (2260)	90000 (4710)	LQM CIEH GAC
EC >7-8 (toluene)	59000 (869)	110000 (1920)	190000 (4360)	LQM CIEH GAC
EC >8-10	3700 (613)	8600 (1500)	18000 (3580)	LQM CIEH GAC
EC >10-12	17000 (364)	29000 (899)	34500 (2150)	LQM CIEH GAC
EC >12-16	36000 (169)	37000	37800	LQM CIEH GAC
EC >16-21	28000	28000	28000	LQM CIEH GAC
EC >21-35	28000	28000	28000	LQM CIEH GAC
EC >35-44	28000	28000	28000	LQM CIEH GAC
Aliphatic and Aromatic				
EC >44-70	28000	28000	28000	LQM CIEH GAC
BTEX				
Benzene	28.1	57	94.7	EA 2009
Toluene	59000 (869)	125000 (2260)	189000 (4360)	EA 2009
Ethylbenzene	16800 (518)	40400 (1450)	65700 (2840)	EA 2009
Xylenes	6940 (478)	18600 (1330)	34600 (2620)	EA 2009

SOM = Soil Organic Matter
Values in brackets indicate the vapour saturation limit where this is exceeded by the GAC or SGV

END USE: Residential with plant uptake		Risk Assessment Value	Sample Id				BH1	BH1	BH3	BH3	BH4	BH4	BH5	BH5	TP1	TP2
			Depth - m				0.30	0.90	0.50	1.00	0.40	0.80	0.50	1.00	0.20	0.70
			US_{95}	T	Outlier	Average										
Metals																
Arsenic	mg/kg	32	14	-	-	12	22	15	8.0	12	13	11	7.1	10	10	7.7
Boron (water soluble)	mg/kg	290	1.8	-	-	1.5	2.4	2.2	1.5	2.0	1.3	1.1	0.80	1.1	1.4	1.4
Cadmium	mg/kg	10	0.83	-	-	0.53	1.8	0.70	0.20	0.40	0.30	0.20	0.10	0.20	0.50	0.90
Chromium	mg/kg	3000	101	-	-	94	78	93	81	91	100	120	97	82	96	98
Hexavalent Chromium	mg/kg	4.3	1.00	-	-	1.00	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0
Copper	mg/kg	2330	37	-	-	24	83	41	8.2	15	28	19	8.4	7.0	10	20
Lead	mg/kg	450	521	1.8	No	260	1500	330	54	180	84	97	14	11	16	310
Mercury	mg/kg	1	0.32	-	-	0.21	0.43	0.52	<0.05	0.17	0.19	0.43	0.05	0.06	<0.05	0.19
Nickel	mg/kg	130	21	-	-	16	28	20	14	18	17	10	5.8	8.7	29	9.1
Selenium	mg/kg	350	0.53	-	-	0.51	<0.5	0.60	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	mg/kg	3750	172	-	-	99	450	120	44	83	73	45	25	29	62	55
Inorganics																
pH		5-9	-	-	-	8.7	7.5	7.5	11.2	10.5	7.90	7.70			8.6	8.3
Free Cyanide	mg/kg	34	0.13	-	-	0.11	0.20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Organic matter	%		-	-	-	1.8	4.7			0.60		1.6		0.40		
Petroleum Hydrocarbons																
Aliphatic C5-C6	mg/kg	30	0.01	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aliphatic C6-C8	mg/kg	73	0.01	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aliphatic C8-C10	mg/kg	19	0.01	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aliphatic C10-C12	mg/kg	93	1.5	-	-	1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Aliphatic C12-C16	mg/kg	740	1.4	-	-	1.3	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	1.9
Aliphatic C16-C21	mg/kg	45000	9.3	-	-	4.8	<1.5	<1.5	<1.5	11	<1.5	<1.5	<1.5	<1.5	<1.5	25
Aliphatic C21-C35	mg/kg	45000	81	-	-	33	<3.4	<3.4	<3.4	28	<3.4	<3.4	<3.4	<3.4	<3.4	270
Aromatic C5-C7	mg/kg	65	0.01	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aromatic C7-C8	mg/kg	120	0.01	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aromatic C8-C10	mg/kg	27	0.01	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aromatic C10-C12	mg/kg	69	2.7	-	-	1.5	<0.9	<0.9	<0.9	7.8	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Aromatic C12-C16	mg/kg	140	5.7	-	-	2.4	<0.5	<0.5	<0.5	19	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aromatic C16-C21	mg/kg	250	126	-	-	45	0.60	<0.6	<0.6	440	<0.6	<0.6	<0.6	<0.6	<0.6	7.8
Aromatic C21-C35	mg/kg	890	825	-	-	294	<1.4	<1.4	<1.4	2900	<1.4	<1.4	<1.4	<1.4	<1.4	32
TPH Ali/Aro	mg/kg		-	-	-	-	<10	<10	<10	3400	<10	<10	<10	<10	<10	340
PAHs																
Acenaphthene	mg/kg	210	0.10	-	-	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	170	0.10	-	-	0.10	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	2300	0.20	-	-	0.14	0.20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.40
Benzo(a)pyrene	mg/kg	0.83	0.50	-	-	0.27	1.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.60
Benzo(a)anthracene	mg/kg	3.1	0.46	-	-	0.24	1.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.30
Benzo(b)fluoranthene	mg/kg	5.6	0.42	-	-	0.23	1.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.40
Benzo(k)fluoranthene	mg/kg	8.5	0.33	-	-	0.20	0.50	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.70
Benzo(g,h,i)perylene	mg/kg	44	0.10	-	-	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	6	0.42	-	-	0.22	1.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.20
Dibenzo(a,h)anthracene	mg/kg	0.76	0.10	-	-	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	260	0.85	-	-	0.47	2.3	0.30	0.30	0.40	0.30	<0.1	<0.1	<0.1	0.30	0.50
Fluorene	mg/kg	160	0.10	-	-	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	mg/kg	3.2	0.10	-	-	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	mg/kg	1.5	0.10	-	-	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	92	0.37	-	-	0.22	0.90	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.40	0.20
Pyrene	mg/kg	560	0.78	-	-	0.43	2.1	0.30	0.30	0.40	0.30	<0.1	<0.1	<0.1	0.20	0.40
Total PAH	mg/kg						11	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	3.5
BTEX Compounds																
Benzene	mg/kg	0.08	0.01	-	-	0.01			<0.01		<0.01				<0.01	
Toluene	mg/kg	119	0.01	-	-	0.01			<0.01		<0.01				<0.01	
EthylBenzene	mg/kg	65.2	0.01	-	-	0.01			<0.01		<0.01				<0.01	
o-Xylene	mg/kg	250	0.01	-	-	0.01			<0.01		<0.01				<0.01	
m-Xylene	mg/kg	240	0.01	-	-	0.01			<0.01		<0.01				<0.01	
p-Xylene	mg/kg	230	0.01	-	-	0.01			<0.01		<0.01				<0.01	
MTBE	mg/kg	23	0.01	-	-	0.01			<0.01		<0.01				<0.01	
Miscellaneous																
Asbestos	-		-	-	-	-	Amosite		NAD		NAD		NAD		NAD	

IAN FARMER ASSOCIATES

RESULTS OF CONTAMINATION TESTS (SOIL)

Job No: 52247

Fitzjohn's Avenue, Hampsetad, NW3 6PA

Fig. No: A6.1

STATISTICAL ANALYSIS OF LEAD DATA

Data

Exploratory Hole Number	Depth m	Value mg/kg	Log_{10} Value
BH1	0.3	1500	3.176
BH1	0.9	330	2.519
BH3	0.5	54	1.732
BH3	1	180	2.255
BH4	0.4	84	1.924
BH4	0.8	97	1.987
BH5	0.5	14	1.146
BH5	1	11	1.041
TP1	0.2	16	1.204
TP2	0.7	310	2.491
	MEAN	259.6	1.948

The sample mean value (x) based on only a few samples may be a poor estimate of the true (population) mean. Therefore, any decision made on the basis of x < RAV may not be adequately health protective when x is computed from a small number of samples. It is desirable to state with a given level of confidence (95th percentile) that the population mean is less than the relevant RAV.

Mean Value Test

This provides the upper 95th percentile of the sample population and is calculated from;

$$US_{95} = x + (t.s/(n)^{0.5})$$

In this case, the values used are as follows;

x (arithmentic mean) = 259.6
s (unbiased standard deviation) = 451.35
t (t value from published values) = 1.833
n (sample population) = 10

US_{95} = 521.22

Is the 95th percentile less than the RAV for lead?

No. Further sampling may be necessary.

Maximum Value Test

The Maximum Value Test calculates a value of T. If this T is smaller than some critical value, then the maximum value may be accepted as a member of the underlying population. If T is greater than the critical value, then the maximum value is treated as an outlier i.e.; a hot-spot which may be indicative of a localised area of contamination.

The Maximum Value Test is calculated by;

$$T = (y_{max} - y)/Sy$$

In this case, the values used are as follows;

y (log transformed arithmetic mean) =	1.948
Sy (unbiased standard deviation of y values) =	0.69
y_{max} =	3.176
T =	1.78

Is T smaller than the critical value for the given population (*n*);

n (sample population) =	10
5% Critical Value =	2.18
10% Critical Value =	2.04

Does this represent an outlier: No

Figure A6.1

STATISTICAL ANALYSIS OF BENZO(A)PYRENE DATA

Data

Exploratory Hole Number	Depth m	Value mg/kg	Log_{10} Value
BH1	0.3	1.3	0.114
BH1	0.9	0.1	-1.000
BH3	0.5	0.1	-1.000
BH3	1	0.1	-1.000
BH4	0.4	0.1	-1.000
BH4	0.8	0.1	-1.000
BH5	0.5	0.1	-1.000
BH5	1	0.1	-1.000
TP1	0.2	0.1	-1.000
TP2	0.7	0.6	-0.222
	MEAN	0.27	-0.81

The sample mean value (x) based on only a few samples may be a poor estimate of the true (population) mean. Therefore, any decision made on the basis of x < RAV may not be adequately health protective when x is computed from a small number of samples. It is desirable to state with a given level of confidence (95th percentile) that the population mean is less than the relevant RAV.

Mean Value Test

This provides the upper 95th percentile of the sample population and is calculated from;

$$US_{95} = x + (t.s/(n)^{0.5})$$

In this case, the values used are as follows;

x (arithmentic mean) = 0.27
s (unbiased standard deviation) = 0.39
t (t value from published values) = 1.833
n (sample population) = 10

US_{95} = 0.50

Is the 95th percentile less than the RAV for benzo(a)pyrene?

Yes. Therefore, no action is required in the averaging area based on the mean value test.

STATISTICAL ANALYSIS OF TPH AROMATIC C12-C16 DATA

Data

Exploratory Hole Number	Depth m	Value mg/kg	Log_{10} Value
BH1	0.3	0.5	-0.301
BH1	0.9	0.5	-0.301
BH3	0.5	0.5	-0.301
BH3	1	19	1.279
BH4	0.4	0.5	-0.301
BH4	0.8	0.5	-0.301
BH5	0.5	0.5	-0.301
BH5	1	0.5	-0.301
TP1	0.2	0.5	-0.301
TP2	0.7	0.5	-0.301
	MEAN	2.35	-0.14

The sample mean value (x) based on only a few samples may be a poor estimate of the true (population) mean. Therefore, any decision made on the basis of x < RAV may not be adequately health protective when x is computed from a small number of samples. It is desirable to state with a given level of confidence (95th percentile) that the population mean is less than the relevant RAV.

Mean Value Test

This provides the upper 95th percentile of the sample population and is calculated from;

$$US_{95} = x + (t.s/(n)^{0.5})$$

In this case, the values used are as follows;

x (arithmentic mean) = 2.35
s (unbiased standard deviation) = 5.85
t (t value from published values) = 1.833
n (sample population) = 10

US_{95} = 5.74

Is the 95th percentile less than the RAV for TPH Aromatic C12-C16?

Yes. Therefore, no action is required in the averaging area based on the mean value test.

STATISTICAL ANALYSIS OF TPH AROMATIC C21-C35 DATA

Data

Exploratory Hole Number	Depth m	Value mg/kg	Log_{10} Value
BH1	0.3	1.4	0.146
BH1	0.9	1.4	0.146
BH3	0.5	1.4	0.146
BH3	1	2900	3.462
BH4	0.4	1.4	0.146
BH4	0.8	1.4	0.146
BH5	0.5	1.4	0.146
BH5	1	1.4	0.146
TP1	0.2	1.4	0.146
TP2	0.7	32	1.505
	MEAN	294.32	0.61

The sample mean value (x) based on only a few samples may be a poor estimate of the true (population) mean. Therefore, any decision made on the basis of x < RAV may not be adequately health protective when x is computed from a small number of samples. It is desirable to state with a given level of confidence (95th percentile) that the population mean is less than the relevant RAV.

Mean Value Test

This provides the upper 95th percentile of the sample population and is calculated from;

$$US_{95} = x + (t.s/(n)^{0.5})$$

In this case, the values used are as follows;

x (arithmentic mean) = 294.32
s (unbiased standard deviation) = 915.59
t (t value from published values) = 1.833
n (sample population) = 10

US_{95} = 825.04

Is the 95th percentile less than the RAV for TPH Aromatic C21-C35?

Yes. Therefore, no action is required in the averaging area based on the mean value test.

		Sample Id	BH1	BH3	BH4							
END USE:		Depth - m	0.90	1.00	0.80							
Freshwater - DWS		Date	-	-	-							
Metals		Risk Assessment Value										
Arsenic	ug/l	50	2.6	1.3	2.7							
Boron	ug/l	2000										
Cadmium	ug/l	5	<0.03	<0.03	<0.03							
Chromium	ug/l	5	1.00	1.5	2.6							
Copper	ug/l	1	4.4	1.1	2.6							
Lead	ug/l	4	6.2	0.86	3.9							
Mercury	ug/l	1	0.02	<0.01	0.02							
Nickel	ug/l	50	0.80	0.80	0.50							
Selenium	ug/l	10	1.8	1.3	2.3							
Zinc	ug/l	8	3.2	<1.25	1.6							
Inorganics												
pH		5-9	5.8	7.0	5.5							
Organics												
TPH	ug/l	10	<10	<10	47							

IAN FARMER ASSOCIATES

RESULTS OF CNTAMINATION TESTS (LEACHATE) — **Job No: 52247A**

Fitzjohn's Avenue, Hampstead, NW3 6PA — **Fig. No: A6.2**

APPENDIX 7

GAS GENERATION

APPENDIX 7

GENERAL NOTES ON GAS GENERATION

A7.1 GENERAL

A7.1.1 In the past, a series of guidance documents were published by CIRIA, ref. 10.45, providing advice on hazards associated with methane. This earlier guidance was consolidated in CIRIA Document C659 to provide a risk based approach to gas contaminated land. This was subsequently re-issued as CIRIA Document C665, ref. 10.47. In 2007, British Standard, BS8485, ref. 10.48, dealing with ground gas was published. It is recommended that guidance in C665 and BS8485 is adopted to provide a consistent approach in dealing with ground gas contamination, the principal details being as follows.

A7.1.2 This guidance is based on a similar approach to that for dealing with contaminated soil. The presence of hazardous gases could be deemed to be the 'source' in a 'pollutant linkage' that could lead to the conclusion that significant harm is or could be caused to people, buildings or the environment. In such circumstances the land could be deemed 'contaminated', ref. 10.18.

A7.1.3 Should a potential source of gas be identified in the conceptual model, a gas risk assessment should be carried out, sufficient to demonstrate to the local authority that the proposals mitigate any hazards associated with ground gas. The authority enforces compliance with Approved Document Part C of the Building Regulations, ref. 10.49.

A7.2 APPROACH

A7.2.1 A flow chart detailing the approach to assessing a site is given in CIRIA document C665, Figure 1.1. This may be summarised as follows.

- Carry out Phase 1 desk study, including initial conceptual model
- Assess site, potential presence of gas / potential unacceptable risk / identify further action, if necessary
- Monitor gas concentrations
- Assessment of Risk
- Recommendations / remediation
- Validation

A7.3 POLLUTANT LINKAGE ASSESSMENT

A7.3.1 A pollutant linkage assessment is presented in Appendix 3 of the Phase 1 Desk Study Report.

A7.3.2 Using the risk model in the desk study, the pollutant linkage can be identified and a preliminary estimate of risk undertaken. If there is no relevant pollutant linkage identified there is no risk. If there is a very low risk, it is likely that no further assessment is required. If further assessment is necessary, then gas monitoring is required.

A7.4 SITE MONITORING

A7.4.1 For sites with low generation potential, giving consistently low concentrations of soil gas under the worst-case conditions, a limited programme of monitoring would be appropriate. Where high or variable concentrations are anticipated or recorded, an extended programme of monitoring would be appropriate. The following guideline has been proposed, ref. 10.51.

Table A7.1

		Generation potential of source				
Sensitivity of development		**Very low**	**Low**	**Moderate**	**High**	**Very high**
	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with gardens)	6/3*	9/6	12/6	24/12	24/24

Notes

1. First number is minimum number of readings and second number is minimum period in months, for example 4/1 – Four sets of readings over 1 month.

2. At least two sets of readings must be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions (see Boyle and Witherington, 2006).

3. The frequency and period stated are considered to represent typical minimum requirements. Depending on specific circumstances fewer or additional readings may be required (e.g. any such variation subject to site specific justification). * The NHBC guidance is also recommending these periods/frequency of monitoring (Boyle and Witherington, 2006)

4. Historical data can be used as part of the data set.

5. Not all sites will require gas monitoring however, this would need to be confirmed with demonstrable evidence.

6. Placing high sensitivity end use on a high hazard site is not normally acceptable unless the source is removed or treated to reduce its gassing potential. Under such circumstances long-term monitoring may not be appropriate or required.

A7.4.2 Before taking any readings, zero the instrument, record atmospheric pressure and temperature.

A7.4.3 Gas flow should be recorded, giving the range of pressures, ensuring positive or negative flow is recorded.

A7.4.4 Record gas levels, recording peak and steady. Where steady state not obtained within 3 minutes, record change in concentration, where concentrations are decreasing, always record peak value. For very high concentrations, record for longer period of up to 10 minutes.

A7.5 ASSESSMENT OF RISK AND RECOMMENDATIONS

A7.5.1 The main method of characterising a site is the method described by Wilson and Card, ref. 10.52 and is termed Situation A. This can be used for all types of development except conventional low-rise housing with suspended ground floor and ventilated underfloor void.

A7.5.2 Low rise housing, Situation B, was developed by Boyle and Witherington, ref. 10.53 and was developed for the NHBC for classifying gassing sites for houses with suspended ground floor slab with ventilated void.

A7.5.3 Although the Code of Practice, ref. 10.48, assesses the characteristic gas situation as CIRIA recommend for Situation A, see Table A7.2 below, their solution for gas protection systems is different, see section A7.10.

A7.6 SITUATION A - ASSESSMENT

A7.6.1 This system proposed by Wilson and Card, ref. 10.52 was originally developed in CIRIA Report 149, ref. 10.45.

A7.6.2 The method uses both gas concentrations and borehole flow rate for methane and carbon dioxide to define a Characteristic Situation for a site.

A7.6.3 Gas Screening Value (litre/hr) = borehole flow rate (litre/hr) x (gas concentration (%))/100. The GSV is determined for methane and carbon dioxide and the worst case adopted. The Characteristic Situation can then be determined from the table below. The GSV can be exceeded if the conceptual model indicates it is safe to do so, and other factors may lead to a change in the Characteristic Situation.

Table A7.2

Characteristic Situation	Risk Classification	Gas screening value (CH_4 or CO_2(1/hr)[1]	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1% and/or carbon dioxide ≤5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" Made Ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to Characteristic Situation 3	Natural soil, high peat/organic content. "Typical" Made Ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures	Mineworking – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very high risk	>70		Recent landfill site

1. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Table A7.1
2. Source of gas and generation potential/performance must be identified.
3. If there is no detectable flow use the limit of detection of the instrument.

A7.7 SITUATION A – SOLUTION

A7.7.1 The Characteristic Situation can be used to define the scope of gas protective measures required.

A7.7.2 The CIRIA approach uses the characteristic situation to define the level of gas protection as follows:

Table A7.3

Characteristic situation	**Residential building (Not low-rise traditional housing)**		**Office/commercial/industrial development**	
	Number of levels of protection	**Typical scope of protective measures**	**Number of levels of protection**	**Typical scope of protective measures**
1	None	No special precautions	None	No special precautions
2	2	a) Reinforced concrete cast in situ floor slab (suspended non-suspended or raft) with at least 1200g DPM and underfloor venting b) Beam and block or pre-cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting All joints and penetrations sealed	1 to 2	a) Reinforced concrete cast in-situ floor slab (suspended non-suspended or raft) with at least 1200g DPM b) Beam and block or pre cast concrete slab and minimum 2000g DPM/reinforced gas membrane c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use All joints and penetrations sealed
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g/reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space
4	3	All types of floor slab as above.	2 to 3	All types of floor slab as above.

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
		All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in ground venting layer		All joints and penetration sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility
5	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting wells or barriers	3 to 4	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility. In ground venting wells or barriers
6	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design	4 to 5	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

1. Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments.

2. Note the type of protection is given for illustration purposes only. Information on the detailing and construction of passive protection measures is given in BR414, ref. 10.50.

3. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.

4. Foundation design must minimise differential settlement particularly between structural elements and ground-bearing slabs.

5. Commercial buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas protection for characteristic situations 3 and 4.

6. Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block and beam floor is used it should be well detailed so it has no voids in it that membranes have to span, and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m^3 and the top surface should have a 4:1 sand cement grout brushed into all joints before placing any membrane (this is also good practice to stabilise the floor and should be carried out regardless of the need for gas membrane).

7. The gas-resistant membrane can also act as the damp-proof membrane.

A7.8 SITUATION B -ASSESSMENT

A7.8.1 The NHBC has developed a characterisation system that is similar to Situation A but is specific to low-rise housing development with a clear ventilated underfloor void. The gas emission rates are compared to generic 'Traffic Lights'.

A7.8.2 The Traffic Lights include a Typical Maximum Concentration that is used for initial screening purposes. Where the Typical Maximum Concentration is exceeded the risk-based Gas Screening Value, GSV, should be adopted. The GSVs are determined for the 'model' low rise development and where they differ from this model, the GSV should be reassessed, ref. 10.47.

A7.8.3 The calculations should be made for both methane and carbon dioxide, and the worst case adopted. The GSV is only a guideline.

Table A7.4

Traffic light	Methane		Carbon dioxide	
	Typical maximum concentration[2] (% v/v)	**Gas screening value (GSV)[3] (litres per hour)**	**Typical maximum concentration[2] (% v/v)**	**Gas screening value (GSV)[1,2] (litres per hour)**
Green				
	1	**0.16**	5	**0.78**
Amber 1				
	5	**0.63**	10	**1.56**
Amber 2				
	20	**1.56**	30	**3.13**
Red				

1. Generic GSVs are based on guidance contained within latest revision of Department of the Environment and the Welsh Office (2004 edition) "The Building Regulations: Approved Document C" and used a sub-floor void of 150mm thickness.

2. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgement will be required, based on a thorough understanding of the gas-regime identified at the site where monitoring in the worst temporal conditions has occurred.

3. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

A7.9 SITUATION B – SOLUTION

A7.9.1 On the basis of this Traffic Light classification the following protection should be applied to low-rise housing.

Table A7.5

Traffic Light Classification	Protection measures required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. A specialist contractor should always fit membranes. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

A7.10 CODE OF PRACTICE – SOLUTIONS

A7.10.1 The Characteristic Gas Situation is determine in a similar manner to that recommended by CIRIA, see Table A7.2 above.

A7.10.2 Having selected the Characteristic Gas Situation, the appropriate gas protection could be selected for the building. The tables below give a guide as to the relative performance of the various designs and systems.

A7.10.3 A guidance value for the required gas protection, in the range 0 to 7 should be obtained from Table A7.6 below. Then, a combination of ventilation and/or barrier system should be chosen from Table A7.7 to meet that requirement.

Table A7.6

Characteristic gas situation, CS	NHBC *traffic light*	Required gas protection			
		Non-managed property, e.g. private housing	**Public building [A)]**	**Commercial buildings**	**Industrial buildings [B)]**
1	*Green*	0	0	0	0
2	*Amber 1*	3	3	2	1[C)]
3	*Amber 2*	4	3	2	2
4	*Red*	6[D)]	5[D)] 6[E)]	4 5 7	3 4 6

NOTE: Traffic light indications are taken from NHBC Report no.: 10627-R01 (04) [3] and are mainly applicable to low-rise residential housing. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.

A) Public buildings include, for example, managed apartments, schools and hospitals.
B) Industrial buildings are generally open and well ventilated. However, areas such as office pods might require a separate assessment and may be classified as commercial buildings and require a different scope of gas protection to the main building.
C) Maximum methane concentration 20% otherwise consider an increase to CS3.
D) Residential building on higher traffic light/CS sites is not recommended unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.
E) Consideration of issues such as ease of evacuation and how false alarms will be handled are needed when completing the design specification of any protection scheme.

A7.10.4 Having determined the appropriate guidance value from Table A7.6, an element or combination of elements from a), b), c) or d) in Table A7.7, should be chosen to achieve the required level of protection.

Table A7.7

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A)]	Very good performance	2.5	*Ventilation performance in accordance with Annex A, ref. 10.48*
	Good performance	1	*If passive ventilation is poor this is generally unacceptable and some form of active system will be required*

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A)]		2.5	*There have to be robust management systems in place to ensure the continued maintenance of any ventilation system.* *Active ventilation can always be designed to meet good performance.* *Mechanically assisted systems come in two main forms: extraction and positive pressurization.*
Ventilated car park (basement or undercroft)		4	*Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F and IstructE guidance*
b) Barriers			
Floor slabs			
Block and beam floor slab		0	*It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum.* *Breached in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances*
Reinforced concrete ground bearing floor slab		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab		1.5	
Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints		1.5	
Fully tanked basement		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with validation[B), C)]		0.5	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints*
Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current good practice under independent inspection (CQA)[B), C)]		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent validation		2	
d) Monitoring and detection (not applicable to non-managed property, or in isolation)			
Intermittent monitoring using hand held equipment		0.5	
Permanent monitoring and alarm system[A)]	Installed in the underfloor venting/ dilution system	2	*Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.*
	Installed in the building	1	

PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
e) Pathway intervention		
Pathway intervention	-	*This can consist of site protection measures for off-site or on-site sources (see Annex A, ref. 10.48)*

NOTE: In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection

A) It is possible to test ventilation systems by installing monitoring probes for post installation validation.

B) If a 1200 g DPM material is to function as a gas barrier it should be installed according to BRE 414, ref. 10.50 being taped and sealed to all penetrations.

C) Polymeric Materials >1200g can be used to improve confidence in the barrier. Remember that their gas resistance is little more than the standard 1200g (proportional to thickness) but their physical properties mean that they are more robust and resistant to site damage.