Basement Impact Assessment

in connection with proposed redevelopment at

Nos. 1-3 and Nos. 4-8
Ferdinand Place
Camden
London
NW1 8EE

for

Leverton & Sons Ltd

LBH4351bia Ver 3.0

August 2017

LBH WEMBLEY
ENGINEERING

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Foreword-Guidance Notes

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VALIDITY

Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances shall be at the client's sole and own risk. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should therefore not be relied upon in the future and any such reliance on the report in the future shall again be at the client's own and sole risk. LBH Wembley Engineering should in all such altered circumstances be commissioned to review and update this report accordingly.

THIRD PARTY INFORMATION

The report may present an opinion on the disposition, configuration and composition of soils, strata and any contamination within or near the site based upon information received from third parties. However, no liability can be accepted for any inaccuracies or omissions in that information.

DRAWINGS

Any plans or drawings provided in this report are not meant to be an accurate base plan, but are used to present the general relative locations of features on, and surrounding, the site.

1. Introduction

1.1 Background

Planning application (2016/2457/P) has been submitted to the London Borough of Camden (LBC) in June 2016 for the following development:

"Demolition of existing buildings and erection of two new four storey plus basement buildings to provide replacement funeral directory facility at ground and basement levels of 4-8 Ferdinand Place and provision of 19x residential units (6 x 1-bed, 8 x 2-bed and 5 x 3-bed units), split across both sites."

A Basement Impact Assessment (BIA) was prepared in October 2015, which predicted that the basement scheme has a risk of damage to the neighbouring properties no higher than Burland Scale 2 'slight'.

However, since then, the recent Camden Local Plan (June 2017) has stated that the BIAs should now demonstrate that the basement scheme has a risk of damage to the neighbouring properties no higher than Burland Scale 1 'very slight'.

1.2 Brief

LBH WEMBLEY have been appointed to complete a new BIA for submission to LBC, which seeks to limit damage to the neighbouring properties to Burland Scale 1 'very slight'.

1.3 Planning Policy

The CPG4 Planning Guidance on Basements and Lightwells refers primarily to Planning Policy DP27 on Basements and Lightwells.

The DP27 Policy reads as follows:

In determining proposals for basement and other underground development, the Council will require an assessment of the scheme's impact on drainage, flooding, groundwater conditions and structural stability, where appropriate. The Council will only permit basement and other underground development that does not cause harm to the built and natural environment and local amenity and does not result in flooding or ground instability. We will require developers to demonstrate by methodologies appropriate to the site that schemes:

- *a) maintain the structural stability of the building and neighbouring properties;*
- *b) avoid adversely affecting drainage and run-off or causing other damage to the water environment;*
- *c) avoid cumulative impacts upon structural stability or the water environment in the local area;*

and we will consider whether schemes:

- *d) harm the amenity of neighbours;*
- *e) lead to the loss of open space or trees of townscape or amenity value;*
- *f) provide satisfactory landscaping, including adequate soil depth;*
- *g) harm the appearance or setting of the property or the established character of the surrounding area; and*
- *h) protect important archaeological remains.*

The Council will not permit basement schemes which include habitable rooms and other sensitive uses in areas prone to flooding. In determining applications for lightwells, the Council will consider whether:

i) the architectural character of the building is protected;
j) the character and appearance of the surrounding area is harmed; and
k) the development results in the loss of more than 50% of the front garden or amenity area.

In addition to DP27, the CPG4 Guidance on Basements and Lightwells also supports the following Local Development Framework policies:

Core Strategies:

- CS5 Managing the impact of growth and development
- CS14 Promoting high quality places and conserving our heritage
- CS15 Protecting and improving our parks and open spaces & encouraging biodiversity
- CS17 Making Camden a safer place
- CS18 Dealing with our waste and encouraging recycling

Development Policies:

- DP23 Water
- DP24 Securing high quality design
- DP25 Conserving Camden's heritage
- DP26 Managing the impact of development on occupiers and neighbours

1.4 Report Structure

The report commences with a comprehensive desk study and characterisation of the site, before progressing to BIA screening and scoping assessments, whereby consideration is given to identifying the potential hydrogeological, hydrological and stability impacts to be associated with the proposed development. The findings of an intrusive ground investigation are then reported and a ground model is developed, followed by a discussion of the geotechnical issues.

Finally, an Impact Assessment is presented, including an assessment of the ground movements associated with the proposed works, along with consideration of the potential damage to the host building and neighbouring structures.

1.5 Documents Consulted

The following documents have been consulted during the preparation of this document:

1. Construction Method Statement, by Glass Light and Special Structures Ltd, Project No. CMS 304/A, dated August 2015.
2. Camden Planning Guidance 4, Basements and Lightwells, 2015.
3. Camden Development Policies DP27 – Basements and Lightwells, 2010.
4. London Borough of Camden Geological, Hydrogeological and Hydrological Study (CHGGS), by Ove Arup & Partners Limited, dated 18th November 2010, Issue 01.

2. The Site

2.1 Site Location

The site is situated on the gentle lower southeastern slopes of Hampstead Hill approximately 50m west of Chalk Farm Road and approximately 200m east of the Camden Roundhouse theatre. The site may also be located approximately by postcode NW1 8EE or by National Grid Reference 528518,184330.

2.2 Site Description

The site is split into two sections (Site A and Site B), divided by Ferdinand Place.

Site A comprises Nos 4-8 Ferdinand Place and is irregularly shaped and sits to the east of the sharp corner in Ferdinand Place. It is currently occupied by a single-storey shed used as a storage and maintenance garage for the funeral directors' vehicles.

The south of the building is used for the storage of coffins. To the north and east respectively, Site A is bordered by the rear gardens of houses on Collard Place and Harmood Street. To the south, and around the southeastern corner, Site A is bordered by the rear walls of extensions to the original houses on Harmood Street and Chalk Farm Road. In the southwest corner the site is bordered by the rear of a No.2 Ferdinand Place with the rest of the boundary formed by an access road which connects to a small forecourt area between Ferdinand Place and the existing building. There is a former oil storage tank beneath this courtyard, although it is currently unused.

Site B, comprising Nos. 1-3 Ferdinand Place, is roughly rectangular and contains a two-storey brick building with a single-storey brick rear extension, and is currently used as office space for the funeral directors.

To the east and south the site is bordered by Ferdinand Place and to the north it is bounded by an area of soft landscaping within the car park associated with the large block of flats to the immediate northwest of Site B. To the west the site boundary is formed by the eastern wall of No. 10 Ferdinand Street, the rear wall of a block of garages and a shed within the block of flats' car park.

Two semi-mature trees are present within the soft-landscaped area immediately north of Site B and three semi-mature to mature trees are present within the gardens immediately east of Site A.

2.3 Proposed Development

The building at **Site A** will be demolished and replaced by a four storey building, with car parking at ground floor level and residential above. A single storey basement (approx. 4m depth) is proposed beneath the entire building footprint and will contain a mortuary, coffin store, chemical store, cold store and bins.

The building at **Site B** will also be demolished and replaced by a five storey building. A single storey basement is similarly proposed for Site B (approx. 4m depth), but will only occupy part of the site and will include a lift pit. No soft landscaping is proposed at either Site A or Site B.

Given the ground conditions encountered and the scale of the development, sheet piling is to form the basement perimeter walls at both Site A and Site B. The basements are to be cast on compressible board supported by perimeter strip foundations and pad foundations beneath internal column positions.

Due to the neighbouring buildings near the proposed basement at Site A, a ground floor will be cast at a high level following the installation of the sheet piles, in order to allow a top-down form of construction.

The proposed construction methodology is contained within the appended Construction Method Statement.

3. Desk Study

3.1 Site History

In the 19th century, the northern end of Site A was occupied by houses and their associated gardens while the southern end was occupied by an engineering company contained in a ‘C’ shaped building with a central courtyard. The southernmost end of the site at that time appears to have been composed of the rearmost parts of gardens of houses fronting onto Chalk Farm Road.

Site B was occupied at this time by a house with some yard space and associated smaller buildings apparently used as stables/garages and kennels.

In the early 1920s Chalk Farm Bus Garage was constructed immediately north of Site A, following the demolition of houses on the east side of Ferdinand Place.

In the 1930s the motor engineers’ building in the south was replaced in part by a building along the southern boundary (built upon the previous gardens). The northern wing of the ‘C’ remained and the section running along the eastern boundary of the site was demolished. A further building was constructed in the northwestern corner of Site B.

At about the time of the Second World War the engineering business was replaced by an expansion of White Bros. & Jacobs, who occupied the adjacent site to the west and were aluminium sheet metal workers and stampers supplying “Stella” aluminium ware and also served the aviation industry.

The site does not appear to have been affected by bombing during the Second World War. During the blitz it appears that four bombs fell some distance to the west of the site, close to Belmont Street. The London County Council Bomb Damage Maps do not record any damage to the buildings at the site, but do suggest that there was bomb damage to the south and east of the site, with the terraces of houses to fronting Chalk Farm Road experiencing blast damage.

During the 1950s a further building (metals store) was added to the eastern boundary of Site A and the house and buildings on the eastern boundary of Site B were extended.

In the mid-1960s Site B was in use as a furrier business. In February 1966 permission was granted for alterations of site 4, 6, and 8 Ferdinand Place for garaging and storage. In 1979 permission was granted for the use of the houses on Site B as offices by Leverton & Sons Limited followed in 1981 for use for storage and embalming on part of the ground floor.

In 1995 planning permission was granted for the redevelopment of the bus garage immediately north of Site A into the houses and flats observed on Collard Road today.

3.2 Geological Information

The British Geological Survey (BGS) records indicate that the site is directly underlain by the London Clay.

3.3 Hydrogeological / Hydrological Information

The nearest surface water feature is a now culverted tributary of the River Fleet, that is believed to flow some 115m to the northeast of the site, at its nearest point being located beneath Chalcott School on Harmood Street.

The London Clay Formation is classified as Unproductive Strata.

3.4 Other Environmental Information

Searches have not indicated recorded or historic landfills within 500m of the site.

Information provided by the BGS and National Geographic Information Service (NGIS), indicates that the property is located in a lower probability radon area with less than 1% of homes expected to be above the action level. It is further reported that no radon protective measures are necessary in the construction of new dwellings or extensions in this area.

4. Stages 1 & 2 - Screening & Scoping Assessments

The Screening & Scoping Assessments have been undertaken with reference to Appendices E and F of the CGHSS, which is a process for determining whether or not a BIA is usually required.

4.1 Screening Assessment

The Screening Assessment consists of a series of checklists that identifies any matters of concern relating to the following:

- Subterranean (groundwater) flow
- Surface flow and flooding
- Slope stability

4.1.1 Screening Checklist for Subterranean (Groundwater) Flow

Question	Response	Justification
Is the site is located directly above an aquifer?	**No**	The London Clay is classed as Unproductive Strata. No groundwater is expected within the London Clay.
Will the proposed basement extend beneath the water table surface?	**No**	
Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	**No**	The nearest surface water feature is the River Fleet, now culverted, that is believed to flow some 115m to the northeast of the site.
Is the site within the catchment of the pond chains on Hampstead Heath?	**No**	The London Clay is classed as Unproductive Strata.
Will the proposed development result in a change in the area of hard-surfaced/paved areas?	**No**	The proposals will not result is any significant change to the surfacing.
Will more surface water (e.g. rainfall and run-off) than at present will be discharged to the ground (e.g. via soakaways and/or SUDS)?	**No**	There is no drainage to the ground.
Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than the mean water level in any local pond?	**No**	There are no nearby surface water features.

4.1.2 Screening Checklist for Surface Flow and Flooding

Question	Response	Justification
Is the site within the catchment area of the pond chains on Hampstead Heath?	**No**	The site is outside of the catchment areas of the Hampstead Heath ponds as shown in Figure 14 of the CGHHS
As part of the site drainage, will surface water flows (e.g. rainfall and run-off) be materially changed from the existing route?	**No**	Surface water flows will be disposed of by the existing means.
Will the proposed basement development result in a change in the proportion of hard-surfaced/paved areas?	**No**	The site is presently 100% covered by buildings and the proposed development also involves 100% coverage.
Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface-water being received by adjacent properties or downstream watercourses?	**No**	All drainage is to the sewer as per existing.
Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	**No**	All drainage is to the sewer as per existing.
Is the site in an area known to be at risk from surface water flooding, or is it at risk from flooding for example because the proposed basement is below the static water level of a nearby surface water feature?	**Yes**	Ferdinand Place is located within an area of high surface water flooding with reference to the Environment Agency Surface Flooding Maps.

4.1.3 Screening Checklist for Stability

Question	Response	Justification
Does the existing site include slopes, natural or manmade, greater than 7 degrees?	**No**	The site is level.
Does the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees?	**No**	No re-profiling of the site is planned.
Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees?	**No**	The neighbouring roads, schools and gardens are approximately flat-lying.
Is the site within a wider hillside setting in which the general slope is greater than 7 degrees?	**No**	No. Figure 16 of the CGHHS shows the site to be in an area of zero to seven degrees slope.

Is London Clay the shallowest strata at the site?	**Yes**	
Will trees be felled as part of the proposed development and/or are works proposed within tree protection zones where trees are to be retained?	**Yes**	No trees are present on site. However trees are present adjacent to the Site A basement.
Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	**No**	No evidence of cracks or building movements was evident upon visiting the site and no effects were noted in any of the adjacent and surrounding buildings.
Is the site within 100m of a watercourse of a potential spring line?	**No**	The nearest surface water feature is the River Fleet, now culverted, that is believed to flow some 115m to the northeast of the site.
Is the site within an area of previously worked ground?	**No**	No. Figure 2 of the CGHHS shows the site not to be in an area of worked ground.
Is the site within an aquifer?	**No**	The London Clay is classified as Unproductive Strata and no shallow water table is expected to be present.
Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	**No**	
Is the site within 50m of the Hampstead Heath ponds?	**No**	The Hampstead Heath ponds are approximately 2.2km to the north of the site.
Is the site within 5m of a highway or pedestrian right of way?	**Yes**	
Will the proposed basement significantly increase the differential depth of foundations relative to the neighbouring properties?	**Yes**	
Is the site over (or within the exclusion zone of) tunnels, e.g. railway lines?	**No**	No tunnels have been identified beneath, or significantly near the site.

4.2 Scoping Assessment

Where the checklist is answered with a “yes” or “unknown” to any of the questions posed in the flowcharts, these matters are carried forward to the scoping stage of the BIA process.

The scoping produces a statement which defines further the matters of concern identified in the screening stage. This defining should be in terms of ground processes, in order that a site specific BIA can be designed and executed (Section 6.3 of the CGHHS).

4.2.1 Scoping for Surface Flow and Flooding

- **Is the site in an area known to be at risk from surface water flooding, or is it at risk from flooding for example because the proposed basement is below the static water level of a nearby surface water feature?**

  The guidance advises that the developer should undertake a Flood Risk Assessment (FRA).

4.2.2 Scoping for Stability

- **Is London Clay the shallowest strata at the site?**

  The guidance advises that of the at-surface soil strata present in LB Camden, the London Clay is the most prone to seasonal shrink-swell (subsidence and heave).

- **Will trees be felled as part of the proposed development and/or are works proposed within tree protection zones where trees are to be retained?**

  The guidance advises that the soil moisture deficit associated with felled tree will gradually recover. In high plasticity clay soils (such as London Clay) this will lead to gradual swelling of the ground until it reaches a new value. This may reduce the soil strength which could affect the slope stability. Additionally the binding effect of tree roots can have a beneficial effect on stability and the loss of a tree may cause loss of stability.

- **Is the site within 5m of a highway or pedestrian right of way?**

  The guidance advises that excavation for a basement may result in damage to the road, pathway or any underground services buried in trenches beneath the road or pathway.

- **Will the proposed basement significantly increase the differential depth of foundations relative to the neighbouring properties?**

  The guidance advises that excavation for a basement may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations.

5. Stage 3 – Site Investigation

5.1 Exploratory Work

An investigation comprising window sampler boreholes and dynamic probing was carried out in July 2015, in order to assess the ground conditions and recover samples for geotechnical laboratory testing.

The site plan below indicates the approximate positions of the exploratory boreholes.

5.2 Ground Conditions

The intrusive investigation has confirmed that, beneath a limited thickness of made ground, the London Clay Formation is present.

5.3 Made Ground

Beneath the existing concrete flooring, made ground is present to a depth of around 0.5m and consists of dirty brown clayey sandy soil with stones, brick and concrete fragments.

5.4 London Clay Formation

Directly beneath the made ground, the London Clay Formation is present and comprises firm to stiff, becoming stiff, orange-brown and mottled grey silty clay. The London Clay has been shown to extend to some 60m depth in the area.

No claystones were encountered in the investigation, but can be expected to be present within the strata.

The results of plasticity index testing have confirmed the stratum to be of high shrinkability.

5.5 Groundwater

No groundwater was encountered during the investigation and a shallow groundwater is not present beneath the site.

6. Stage 4 - Impact Assessment

The screening and scoping stages have identified potential effects of the development on those attributes or features of the geological, hydrogeological and hydrological environment. This stage is concerned with evaluating the direct and indirect implications of each of these potential impacts.

6.1 Pedestrian Right of Way

Given the construction of a high stiffness basement retaining wall, as detailed in the section below, it is concluded that there will be no significant risk to the integrity of the adjacent highways or to the services that have been identified as lying beneath these and the pavements.

6.2 Neighbouring Buildings

The key factor to consider when undertaking a ground movement assessment for the development is that the design of the new basement construction will need to preserve the stability of the adjacent buildings, both during excavation and construction and in the permanent situation.

A ground movement assessment has been undertaken to assess the potential damage that will be caused to neighbouring structures.

6.2.1 Assessed Neighbouring Structures

6.2.1.1 No. 1A Harmood Street (Site A)

Just to the southeast of Site A is No. 1A Harmood Street. This is a pre-War 2-3 storey brick building, and is not envisaged to have an existing basement. The building is currently used as an office / warehouse. The foundation depth is assumed to be at a depth of 1m below current ground level.

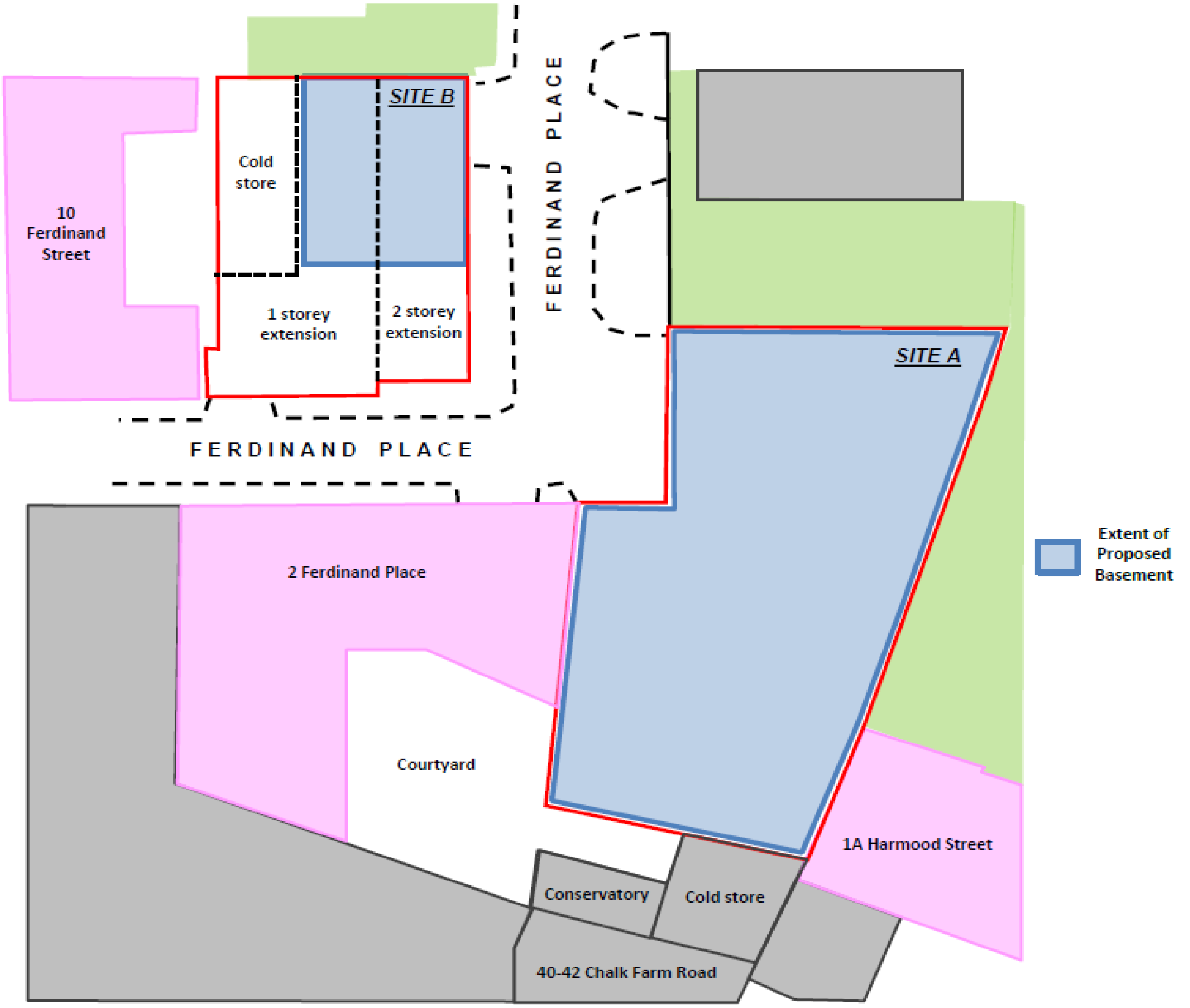
6.2.1.2 No. 2 Ferdinand Place (Site A)

Just to the southwest of Site A is No. 2 Ferdinand Place. This is a pre-War 3-4 storey brick residential building, with no envisaged basement. Similar to the building on the opposite side of the site, the envisaged foundation depth is no greater than 1m below current ground floor level.

6.2.1.3 No. 10 Ferdinand Pace (Site B)

No. 10 Ferdinand Street is just to the west of Site B. This is a 1960s 3 storey brick building that was extended and converted from a public house to residential accommodation in 2006. The section of this building closest to Site B does not contain a basement.

Given the 5m distance beween the proposed basement and this property, no undue effects resuting from the basement construction are envisaged.



Site plan showing neighbouring structures (pink) assessed for the purpose of ground movement

6.2.2 Modelled Ground Conditions

Excavation of the basement will result in unloading of the clay leading to theoretical heave movement of the underlying soil in both the short and long term, depending upon any reapplication of loading.

An analysis of the movements has been carried for a modelled situation, based on a soil model devised from both published information on the London Clay and the results of the ground investigation. The soil layers of this model are detailed in the table below.

Analysis Layer:	Upper Boundary (+m OD)	Thickness (m)	Average C_u (kN/m^2)	Soil Stiffness (kN/m^2)	
				E_u	E'
London Clay	24.50	2	80	36000	20000
London Clay	22.50	2	96	43200	24000
London Clay	20.50	2	112	50400	28000
London Clay	18.50	2	128	57600	32000
London Clay	16.50	3	144	64800	36000
London Clay	13.50	3	168	75600	42000
London Clay	10.50	3	192	86400	48000
London Clay	7.50	3	216	97200	54000
Assumed Rigid	4.50				

The Undrained Modulus of Elasticity (Eu) has been based upon an empirical relationship of Eu = 450 x Cu, and the Drained Modulus of Elasticity (E') has been based upon an empirical relationship of 250 x Cu.

Poisson's Ratios of 0.5 and 0.1 have been used for short term (undrained) and long term (drained) conditions respectively.

Based on the above parameters and loading/unloading and ignoring any benefit gained from the loading of previous buildings on site, the potential displacements and the post construction movements have been analysed.

The analysis uses classic modified Boussinesq elastic theory, assuming a fully flexible foundation applying a uniform loading/unloading to a semi-infinite elastic half-space, using the above parameters for stratified homogeneity and with the introduction of an assumed rigid boundary at 20m depth (+4.50m OD).

The programme calculates the theoretical Boussinesq elastic stress increase/decrease due to the applied net loadings/unloadings (over the given loaded/unloaded areas) at the mid-level of each stratum.

Short-term and long-term displacements are then calculated at each calculation point for each stratum, using the given values of Stiffness Moduli and Poisson's Ratio of the whole area of the site on a 1m calculation grid.

6.2.3 Short Term Movements to Neighbouring Structures

There are three components of short term movements that will interact to affect the neighbouring structures. These are settlements and horizontal movements associated with the pile installation, settlements and horizontal movements behind the wall due to yielding of the completed wall as excavation in front of the wall proceeds and lastly vertical heave movements due to demolition and soil unloading as the excavation proceeds.

However, the heave movements due to demolition and soil unloading will have no impact on the neighbouring structures as the vertical heave movements will occur within the bored piled wall retaining area. Similarly, long term movements due to soil loading from the construction of the new building will also have no impact on the neighbouring structures.

6.2.3.1 Ground Movements due to Installation of Piles

The ground surface movements arising from the installation of the sheet pile retaining wall may be estimated using default values in CIRIA report C760.

It should be noted that the amount of predicted movement is related to the wall depth, and for the purposes of this assessment, the predictions are made on the basis of a pile depth of 7m.

The analysis suggests that as a result of pile installation, No. 1A Harmood Street and No. 2 Ferdinand Place may experience up to 4mm of settlement, in conjunction with up to 6mm of horizontal movement.

However, in practice, a silent pile system is proposed to install the sheet piles, which is understood to cause minimal vibration to the neighbouring buildings. Refer to the Construction Method Statement for more details.

6.2.3.2 Ground Surface Movements due to Demolition and Excavation

The potential effect of the planned basement excavations has been considered by apply a net unloading of -25kN/m^2 due to removal of the existing buildings and -80kN/m^2 due to removal of soil within the basement areas (on the basis of a maximum excavation depth of 4m).

The analysis suggests that, by the time basement excavation is complete, up to 20mm of heave is likely to have taken place within the basement at Site A, whilst up to 15mm of heave is likely to have taken place within the basement at Site B.

6.2.3.3 Ground Movements due to Pile Wall Yielding

The ground surface movements arising from excavation in front of the pile retaining wall and consequent yielding of the piled wall have been estimated using default values contained with CIRIA report C760.

The amount of predicted movement is related to the excavation depth and the predictions are made on the basis of an excavation depth of 4m.

The analysis suggests that on the basis of a high stiffness wall (due to top-down construction), No. 1A Harmood Street and No. 2 Ferdinand Place could experience up to 2mm settlement, in conjunction with up to 6mm horizontal movement.

6.2.4 Damage Assessment

In view of the settlements and horizontal movements described above, an assessment of the potential damage to the neighbouring structures has been made. This has been achieved using the methodology proposed by Burland as described in CIRIA C760 for ground movements associated with a piled retaining wall.

The deflection ratio (Δ / L) has been calculated from the predicted net movements at either end of the section under assessment.

No. 1A Harmood Street

The length (L) of No. 1A Harmood Street is assumed to be 22m with an approximate wall height (H) of 7m. The strain has been assessed over the full length of the building.

No. 2 Ferdinand Place

The length (L) of No. 2 Ferdinand Place is assumed to be 24m with an approximate wall height (H) of 9m. The strain has been assessed over the full length of the building.

Site plan showing line of sections used for damage category assessment

6.2.4.1 No. 2 Ferdinand Place (Section A – A')

The maximum horizontal strain, Ɛh (δh / L) = 0.04%, and the maximum deflection ratio ∆ / L = -0.002 have been calculated over the full length of the building.

Based upon Figure 6.25b for L / H = 2.67, the limiting strain to this structure is assessed as 0.050%, less than the upper bound of 'negligible (Burland Category 0).

6.2.4.2 No. 1A Harmood Street (Section B – B')

The maximum horizontal strain, Ɛh (δh / L) = 0.051%, and the maximum deflection ratio ∆ / L = -0.046 have been calculated over the full length of the building.

Based upon Figure 6.25b for L / H = 3.14, the limiting strain to this structure is assessed as 0.055%, less than the upper bound of 'very slight' (Burland Category 1).

6.2.5 Mitigation of Ground Movements

In line with DP27, Camden will ensure that harm is not caused to neighbouring properties by basement development. Camden Local Plan (June 2017) states that the BIA must demonstrate that the basement scheme has a risk of damage to the neighbouring properties no higher than Burland Scale 1 'very slight'.

Given the construction of a high stiffness basement retaining wall via the use of a top-down form of construction, the above analysis suggests that the worst potential for damage to the neighbouring structures is expected to be Burland Scale 1 'very slight'.

This method of construction presents the best assurance of stiffness through providing permanent bracing prior to the commencement of excavation, with the intention of allowing negligible deflection and yielding at any level of the pile wall.

6.2.6 Long Term Movements

Following excavation of the basements, loading will be reapplied to the soil as a result of the weight of the new structure. This will be transferred to the London Clay Formation by means of the sheet piles and shallow foundations.

It is evident that there is a mismatch between the weight of soil that is to be removed during the basement excavation and the weight of the new structure that is to replace this. In this situation there will inevitably be a component of long term heave that could proceed for several decades.

It should be noted that although there is scope for this movement to be manifested inside the basement excavation, it is not envisaged that there will be discernible on-going heave outside the new basement retaining walls.

For the purpose of this assessment, the structural loading has not been modelled, in order to represent a worst-case scenario. The analysis suggests that owing to the net unloading in the permanent situation following construction, an additional 30mm of heave could occur beneath the basements. However, in practice this figure will be significantly reduced by the effected of the loading from the proposed foundations.

Suspended basement flooring is recommended with the inclusion of a layer of sub-slab compressible material beneath the flooring between the foundation bases in order to accommodate the envisaged basement heave movements.

6.3 Trees

An arboricultural assessment may be required to assess the potential impact of the proposed development upon the neighbouring trees. Given the depth of the proposed basement, no impact upon the proposed development is envisaged.

6.4 Risk of Surface Water Flooding

A Flood Risk Assessment may be required to assess the potential impact to the development.

6.5 Monitoring and Contingency Plan

Any monitoring plan will need to be sufficiently robust to enable mitigation to be effectively implemented in the event of agreed trigger values for vertical and horizontal movement being exceeded at agreed monitoring positions. During the actual basement excavation stage both start of shift and end of shift measurements will be necessary in order for movements to be checked and, in the event of any adverse movement, for a contingency plan to be effected sufficiently quickly to prevent excessive movement to the neighbouring properties.

The plan will need to make it clear what emergency measures or mitigation may be required to be implemented in the event of an exceedance and will demonstrate the availability of the required resources. The plan will also need to identify exactly who will have the responsibility for implementing the plan.

It is anticipated that the demolition and piling will in practice be separated by a number of weeks from the subsequent excavation. This period will provide an opportunity for the ground movements due to piling to be assessed and for the ground movement analysis to be reviewed prior to the main excavation taking place so that propping proposals can be adjusted if required

6.6 Residual Impacts

Given the mitigation measures afforded by the construction methodology that has been described, it is concluded that the proposed basement development will have no residual unacceptable impacts upon the surrounding structures, infrastructure and environment. Given the essentially impermeable nature of the soils that the new basements will be replacing, no cumulative impacts are envisaged.

7. Conclusion

This BIA has demonstrated that each of the potential impact and issues can be satisfactorily addressed through the use of appropriate engineering design and construction measures, and that the proposed construction can be successfully completed without detriment to the environment, flooding or ground instability.

Having reviewed the adequate design and construction methodology, it is envisaged that the basement construction will have no significant detrimental impact on the stability of the neighbouring structures and can be achieved without any cumulative impact.

Appendix

Exploratory & Testing Records

Burland Damage Category Assessment Diagrams

Construction Method Statement

PROJECT: Ferdinand Place

CLIENT: Leverton & Sons Limited

LBH4351

BOREHOLE WS1

BORING METHOD: Dynamic Window Sampler

Date: 01/07/2015 - 02/07/2015

GROUND WATER: No Groundwater Observed

REMARKS:

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (concrete)
1	D	0.30	c		0.50	MADE GROUND (dirty brown clayey sand with brick and concrete fragments)
2	D	0.70				Firm orange-brown mottled grey silty CLAY
3	D	1.50			1.50	
4	D	2.40				Stiff becoming very stiff dark grey silty CLAY
5	D	3.50				
6	D	4.30				
7	D	5.00			5.00	

Sheet No:

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY Geotechnical & Environmental

PROJECT: Ferdinand Place

CLIENT: Leverton & Sons Limited

LBH4351

BOREHOLE WS2

BORING METHOD: Dynamic Window Sampler

Date: 01/07/2015 - 02/07/2015

GROUND WATER: No Groundwater Observed

REMARKS:

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (concrete)
1	D	0.30	c		0.50	MADE GROUND (dirty brown clayey sand with brick and concrete fragments)
2	D	1.00	c		2.00	Firm orange-brown mottled grey silty CLAY - Hydrocarbon staining throughout
					3.20	Stiff becoming very stiff dark grey silty CLAY
						Borehole End

Sheet No:

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY Geotechnical & Environmental

PROJECT: Ferdinand Place LBH4351

CLIENT: Leverton & Sons Limited

BOREHOLE WS3

BORING METHOD: Dynamic Window Sampler

Date: 01/07/2015 - 02/07/2015

GROUND WATER: No Groundwater Observed

REMARKS:

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (concrete)
					0.50	MADE GROUND (dirty brown clayey sand with brick and concrete fragments)
					1.50	Firm orange-brown mottled grey silty CLAY
					4.00	Stiff becoming very stiff dark grey silty CLAY
						Borehole End

Sheet No:

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY Geotechnical & Environmental

PROJECT: Ferdinand Place

CLIENT: Leverton & Sons Limited

LBH4351

BOREHOLE WS4

BORING METHOD: Dynamic Window Sampler

Date: 01/07/2015 - 02/07/2015

GROUND WATER: No Groundwater Observed

REMARKS:

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (concrete)
					0.60	MADE GROUND (dirty brown clayey sand with brick and concrete fragments)
1	D	1.60			1.70	Firm orange-brown mottled grey silty CLAY
2	D	2.50				Stiff becoming very stiff dark grey silty CLAY
3	D	3.40				
4	D	4.60				

Sheet No:

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY Geotechnical & Environmental

PROJECT: Ferdinand Place | LBH4351

CLIENT: Leverton & Sons Limited

BOREHOLE WS4

BORING METHOD: Dynamic Window Sampler

Date: 01/07/2015 - 02/07/2015

GROUND WATER: No Groundwater Observed

REMARKS:

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
						Very stiff dark grey silty CLAY
5	D	5.50				
					6.00	
						Borehole End

Sheet No:

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

PROJECT: Ferdinand Place	LBH4351	**BOREHOLE WS5**
CLIENT: Leverton & Sons Limited		

BORING METHOD:	Dynamic Window Sampler	Date: 01/07/2015 - 02/07/2015
GROUND WATER:	No Groundwater Observed	
REMARKS:		

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
					0.25	MADE GROUND (concrete)
					0.40	MADE GROUND (dirty brown clayey sand with brick and concrete fragments)
					1.40	Firm orange-brown mottled grey silty CLAY
					2.00	Stiff becoming very stiff dark grey silty CLAY
						Borehole End

Sheet No:

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY **Geotechnical & Environmental**

PROJECT: Ferdinand Place | LBH4351 | **BOREHOLE WS5**

CLIENT: Leverton & Sons Limited

BORING METHOD: Dynamic Window Sampler

Date: 01/07/2015 - 02/07/2015

GROUND WATER: No Groundwater Observed

REMARKS:

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
					0.25	MADE GROUND (concrete)
1	D	0.30	c		0.50	MADE GROUND (dirty brown clayey sand with brick and concrete fragments)
2	D	1.00			1.60	Firm orange-brown mottled grey silty CLAY
3	D	2.00				Stiff becoming very stiff dark grey silty CLAY
4	D	3.00				
5	D	4.00				
6	D	5.00			5.00	

Sheet No:

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY **Geotechnical & Environmental**

PROJECT: Ferdinand Place	LBH4351	BOREHOLE WS7
CLIENT: Leverton & Sons Limited		

BORING METHOD:	Dynamic Window Sampler	Date: 01/07/2015 - 02/07/2015
GROUND WATER:	No Groundwater Observed	
REMARKS:		

G.L

Samples No	Samples Type	Depth m	Tests	Legend	Depth m	Description
					0.25	MADE GROUND (concrete)
					0.40	MADE GROUND (dirty brown clayey sand with brick and concrete fragments)
					1.40	Firm orange-brown mottled grey silty CLAY
					2.00	Stiff becoming very stiff dark grey silty CLAY
						Borehole End

Sheet No:

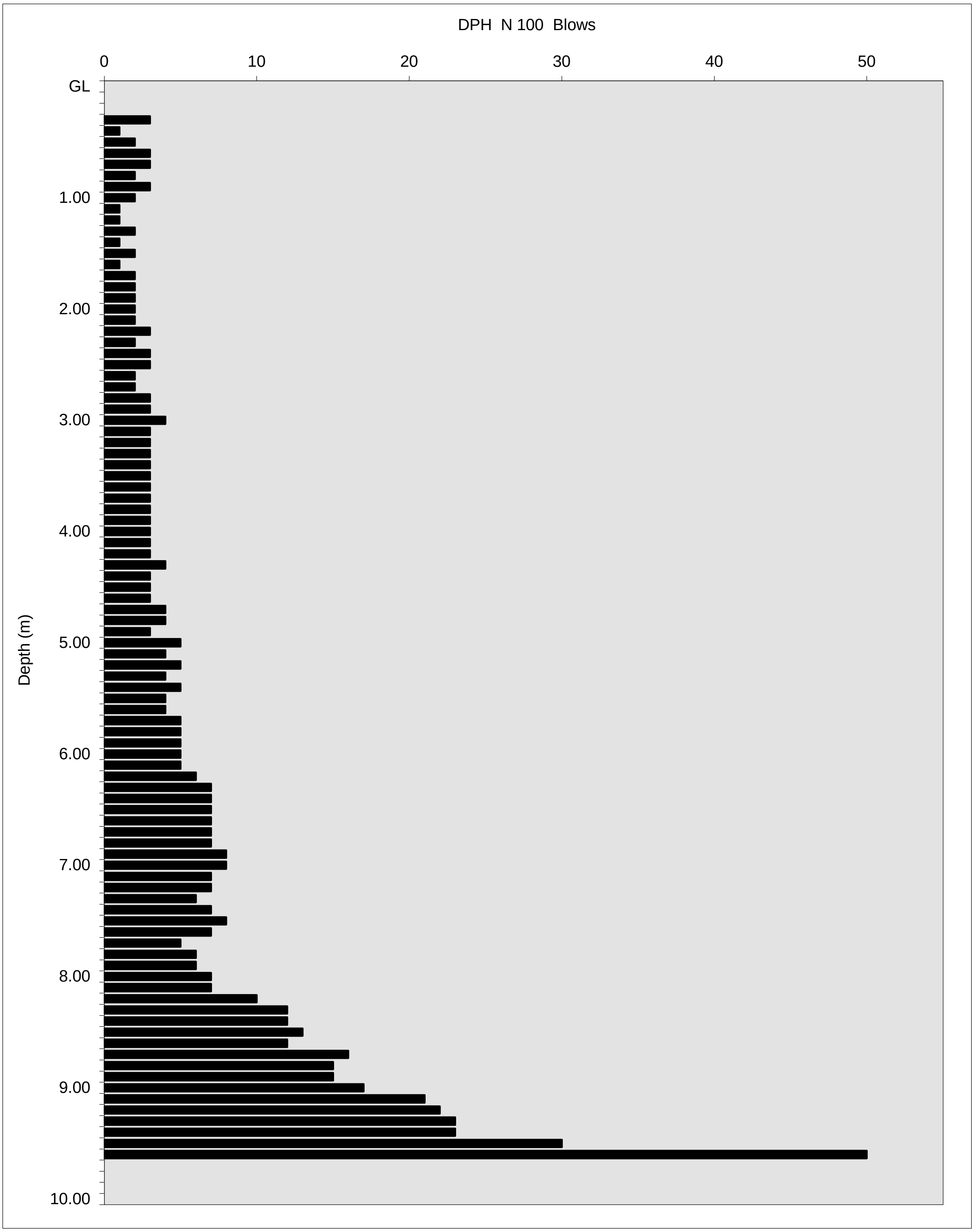
U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY **Geotechnical & Environmental**

PROJECT:	Ferdinand Place	**DYNAMIC PROBE RESULTS**
CLIENT:	Leverton & Sons Limited	

Probe No: 1

Date: 01/07/2015



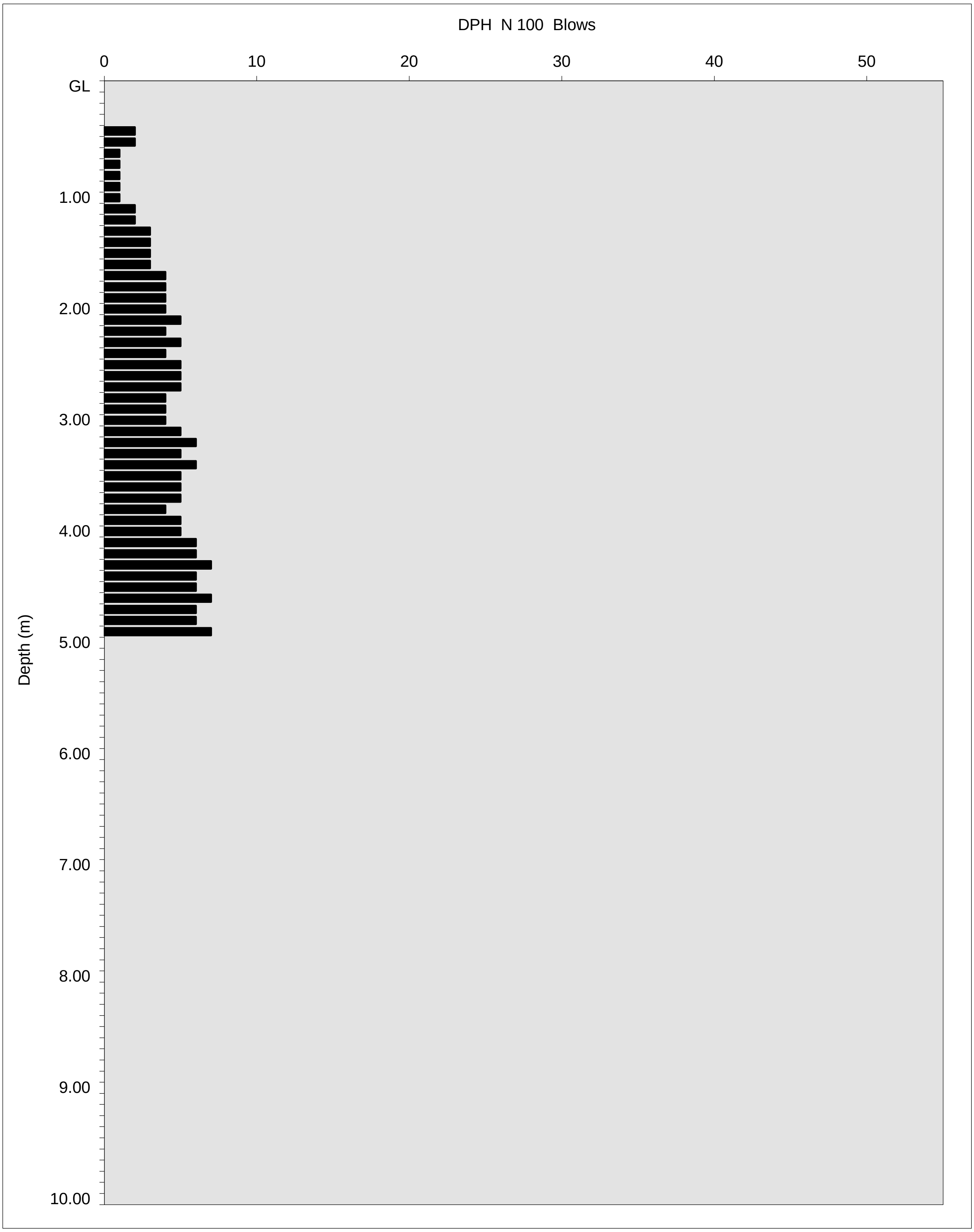
Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	
LBH4351	**LBH WEMBLEY Geotechnical & Environmental**

PROJECT:	Ferdinand Place	DYNAMIC PROBE RESULTS
CLIENT:	Leverton & Sons Limited	

Probe No: 2

Date: 01/07/2015



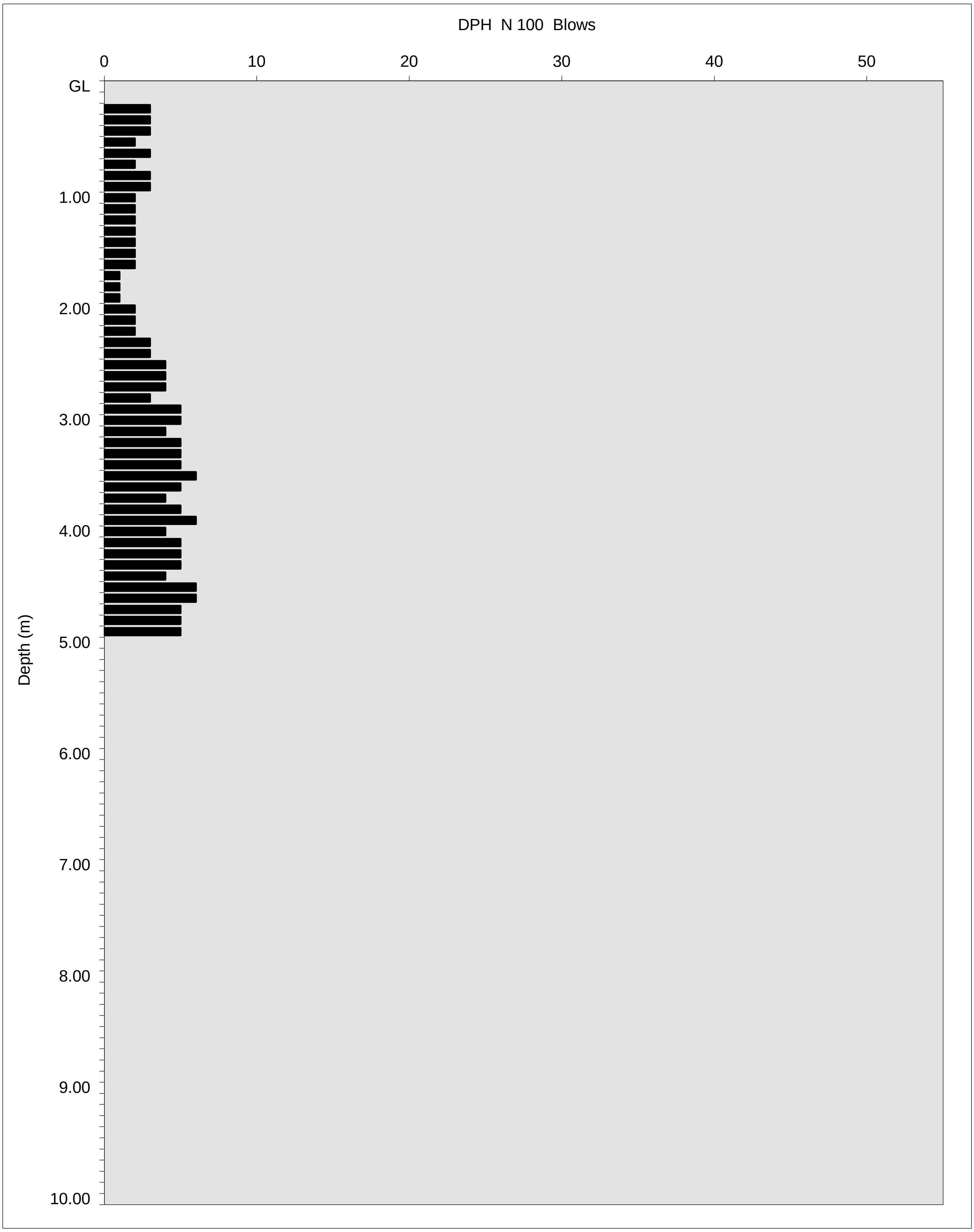
Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	LBH WEMBLEY **Geotechnical & Environmental**
LBH4351	

PROJECT:	Ferdinand Place	**DYNAMIC PROBE RESULTS**
CLIENT:	Leverton & Sons Limited	

Probe No: 3

Date: 01/07/2015



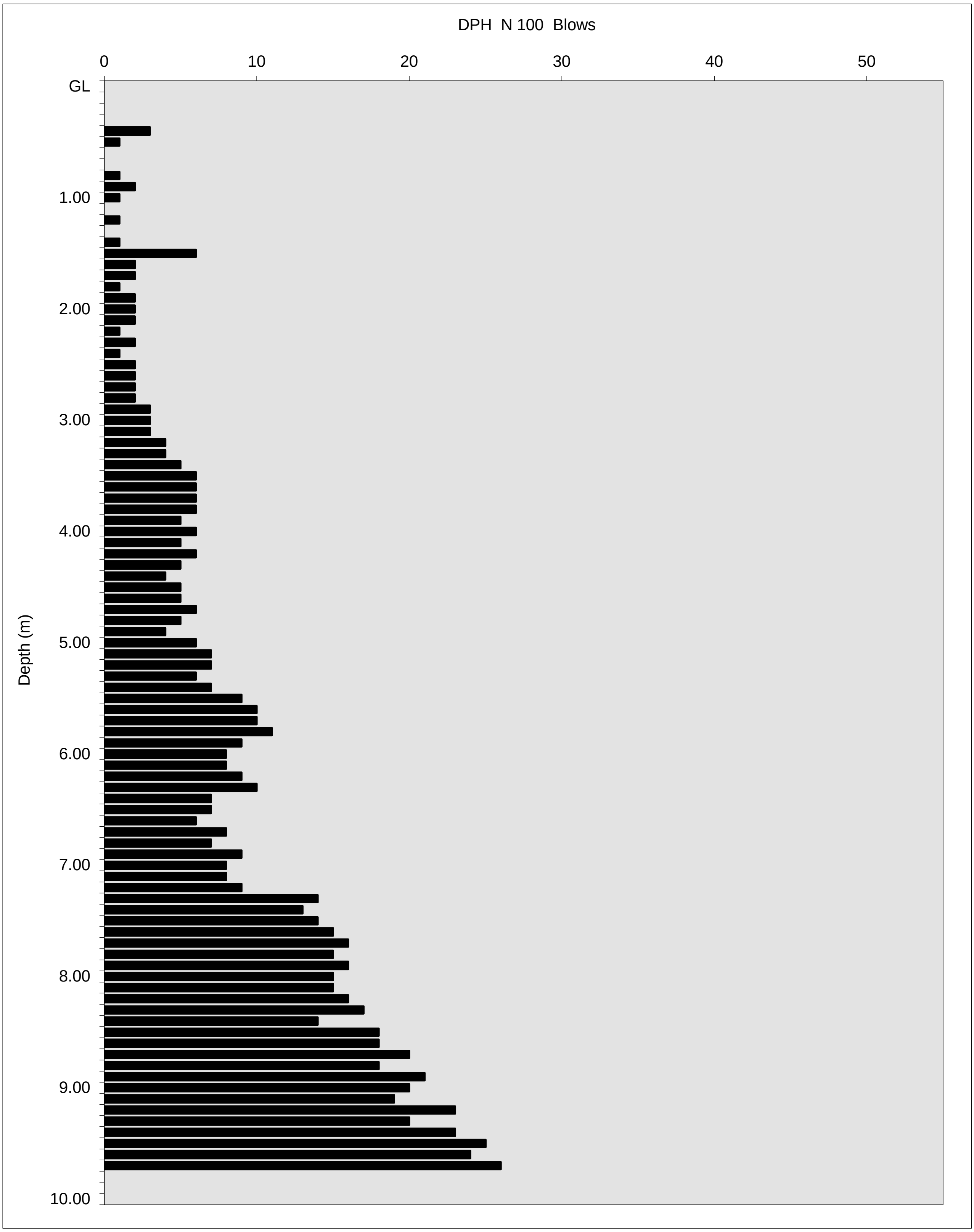
Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	**LBH WEMBLEY Geotechnical & Environmental**
LBH4351	

PROJECT:	Ferdinand Place	**DYNAMIC PROBE RESULTS**
CLIENT:	Leverton & Sons Limited	

Probe No: 4

Date: 02/07/2015



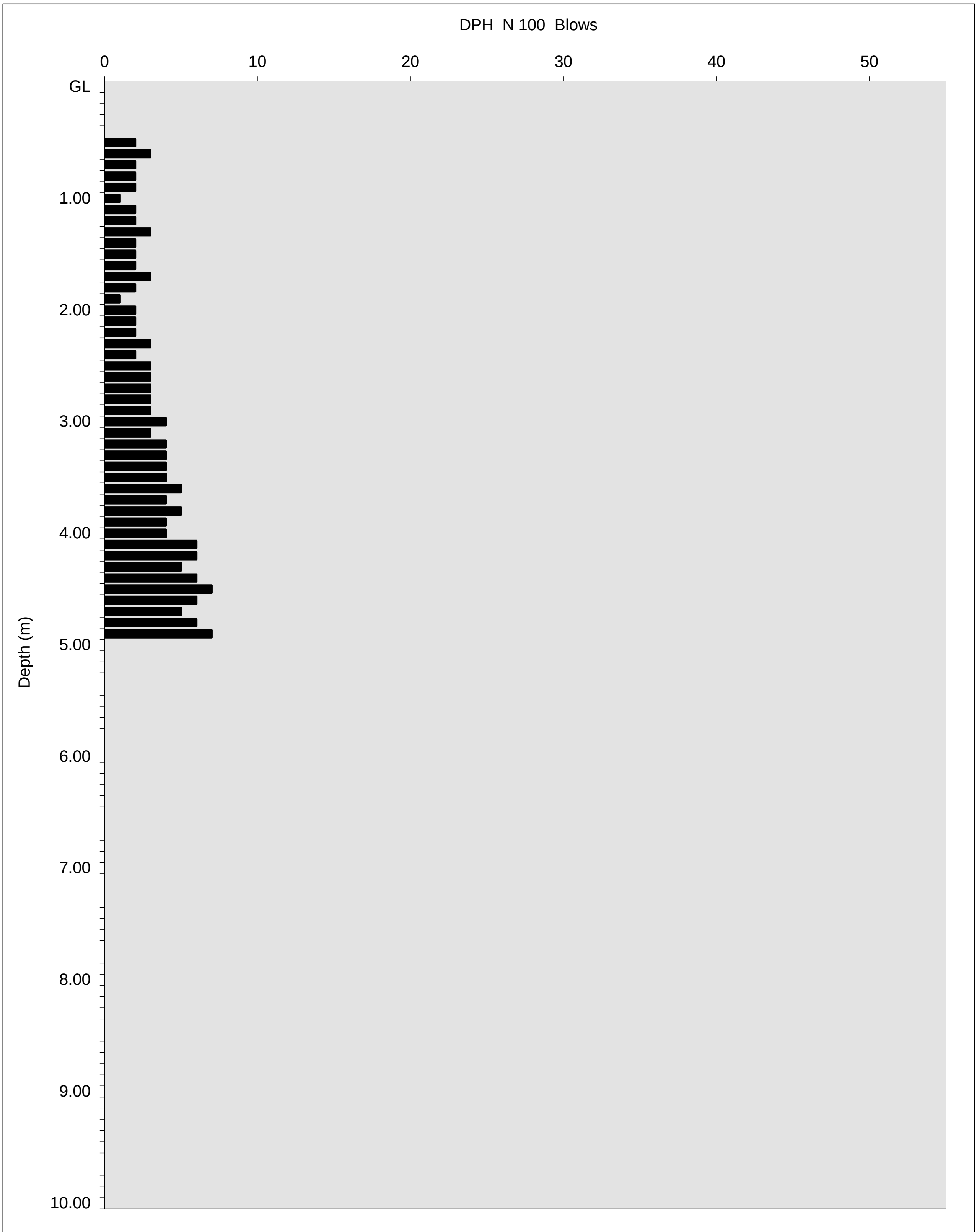
Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	**LBH WEMBLEY Geotechnical & Environmental**
LBH4351	

PROJECT:	Ferdinand Place	DYNAMIC PROBE RESULTS
CLIENT:	Leverton & Sons Limited	

Probe No: 5

Date: 02/07/2015

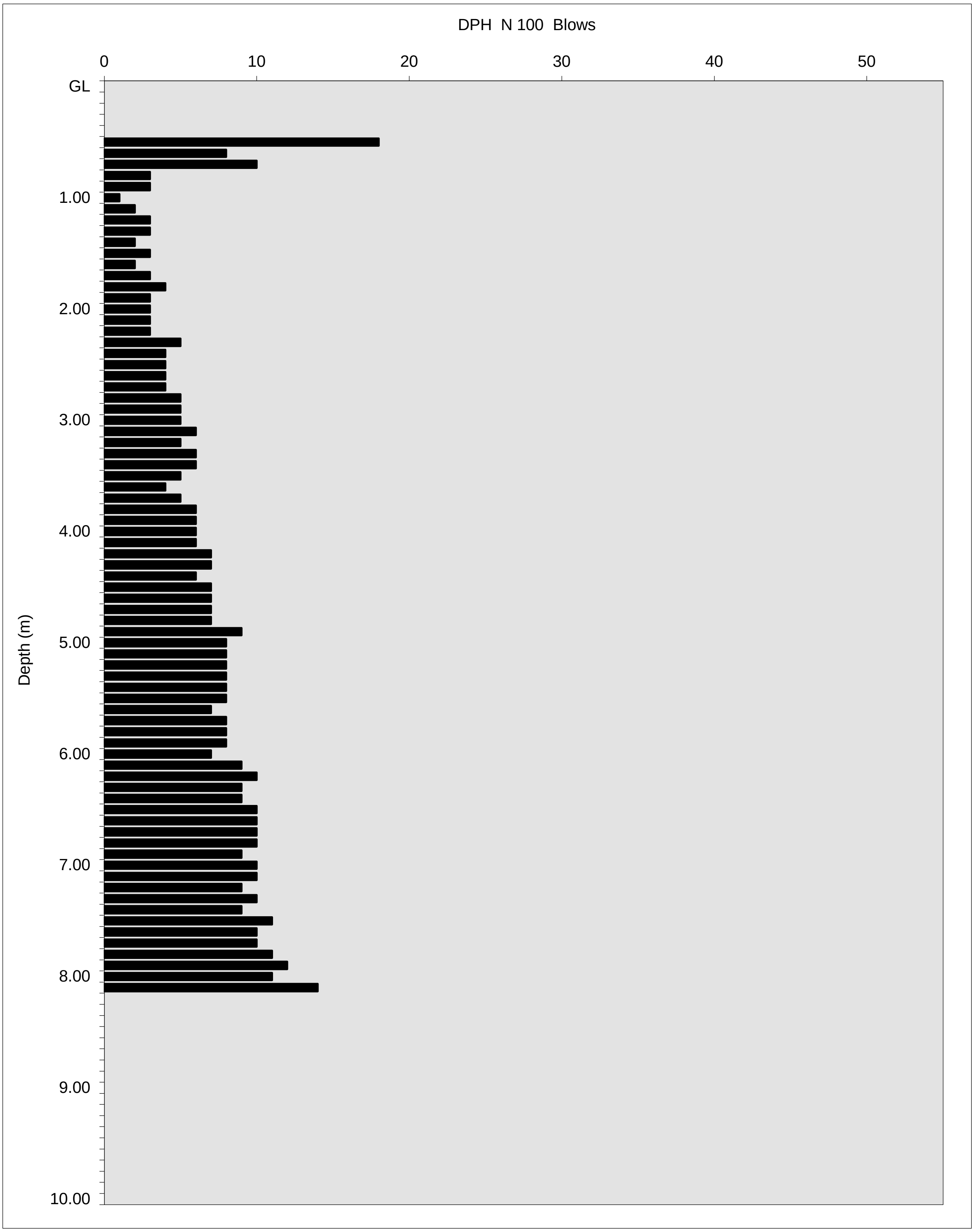


Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	
LBH4351	**LBH WEMBLEY Geotechnical & Environmental**

PROJECT:	Ferdinand Place	**DYNAMIC PROBE RESULTS**
CLIENT:	Leverton & Sons Limited	

Probe No: 6 Date: 02/07/2015



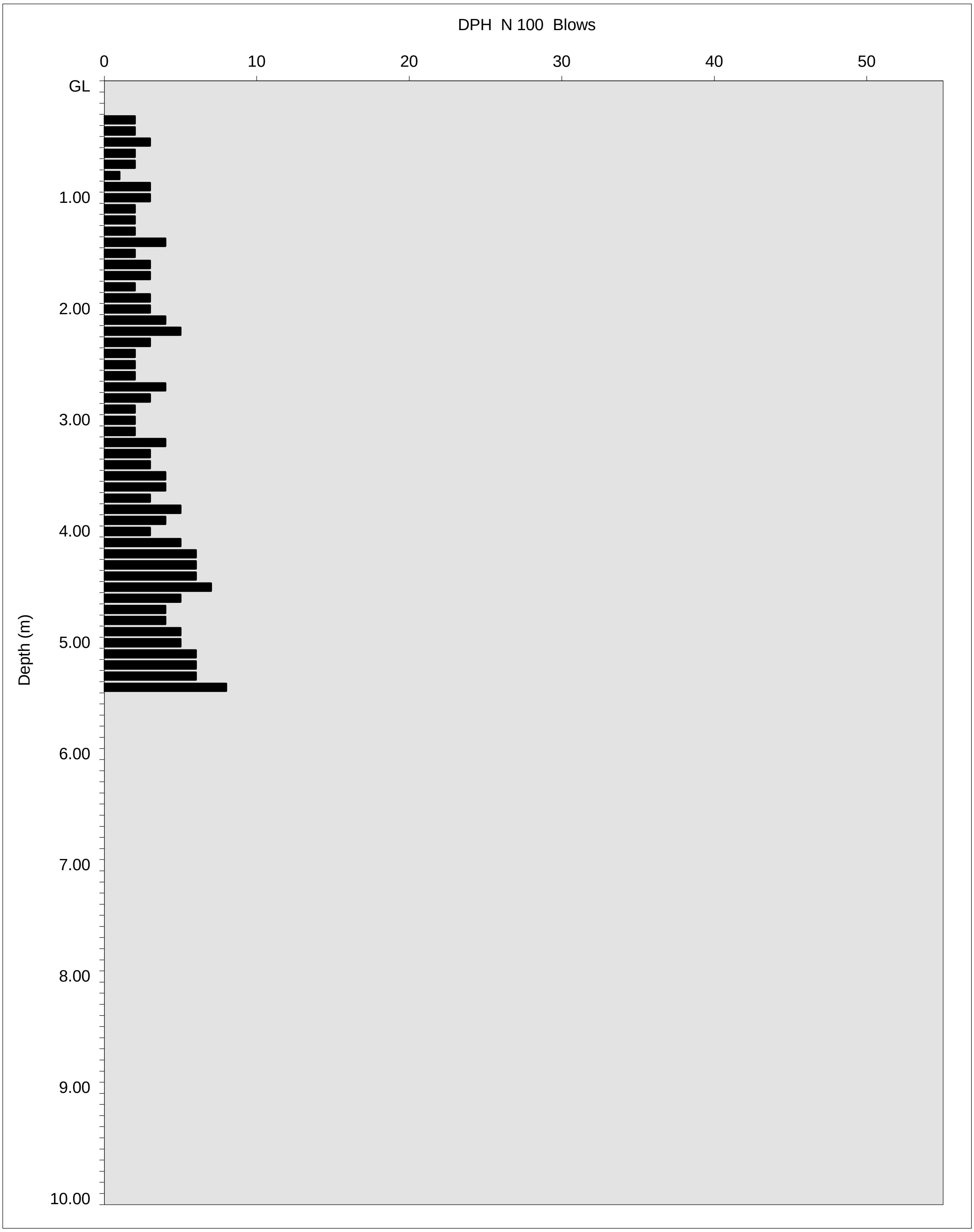
Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	
LBH4351	**LBH WEMBLEY Geotechnical & Environmental**

PROJECT:	Ferdinand Place	**DYNAMIC PROBE RESULTS**
CLIENT:	Leverton & Sons Limited	

Probe No: 7

Date: 02/07/2015



Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	
LBH4351	**LBH WEMBLEY Geotechnical & Environmental**

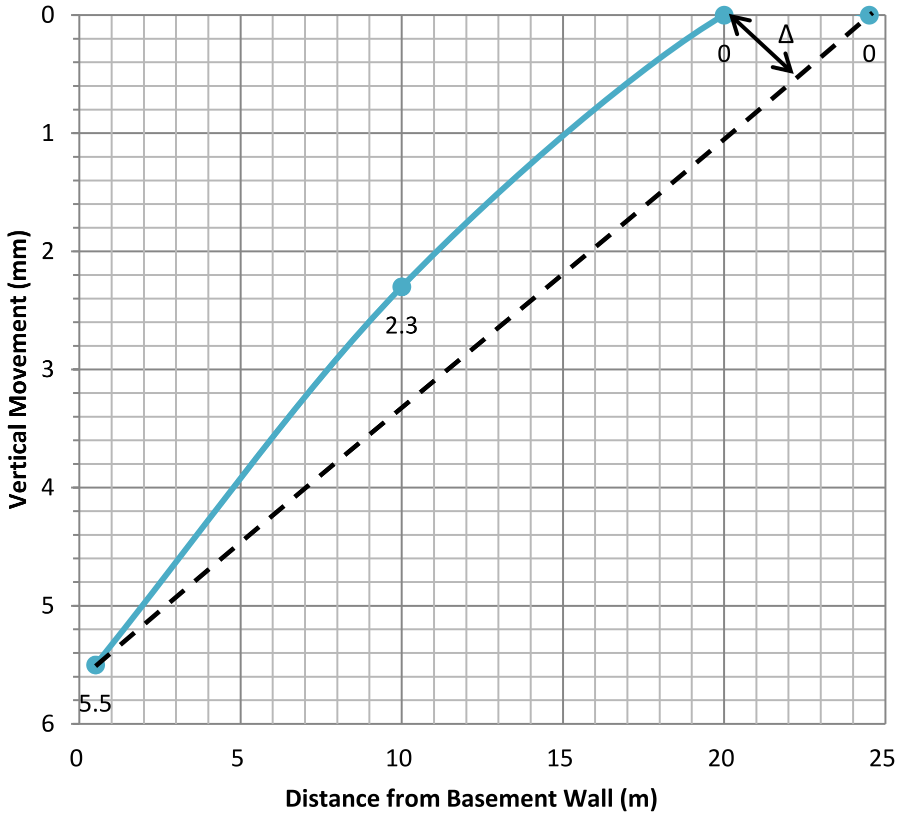
Reference: **LBH4351**
Site: **Nos. 1-3 and Nos. 4-8 Ferdinand Place**
Section: **No. 2 Ferdinand Place**
Date of analysis: **23/08/2017**
Project Engineer: **RL**

The damage category can be assessed from the calculated horizontal strain and deflection ratio of a "beam" under hogging or sagging.

Length of wall	**L =**	**24**	**m**
Height of wall	**H =**	**9**	**m**
Horiz. deflection	**Δ_{horiz} =**	**11.1**	**mm**
Vert. deflection	**Δ =**	**0.6**	**mm**

x	y	Distance from wall	Vert. mov'nt	Horiz. mov'nt
m	m	m	mm	mm
31.5	24.5	0.5	5.5	11.3
22	24.5	10	2.3	2.6
12	24.5	20	0	0.1
7.5	24.5	24.5	0	0.2

Vertical movement along Section A-A'

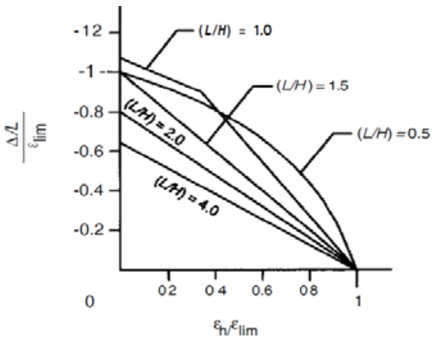


Reference: **LBH4351** Section: **No. 2 Ferdinand Place**

L/H = 2.6667

Horiz. Strain εh = 0.04625 % εlim = 0.050 %

Deflection ratio Δ/L = -0.0025



DAMAGE LEVEL --> 0.050 — **CATEGORY 0 NEGLIGIBLE**

0.075 — **CATEGORY 1 VERY SLIGHT**

0.150 — **CATEGORY 2 SLIGHT**

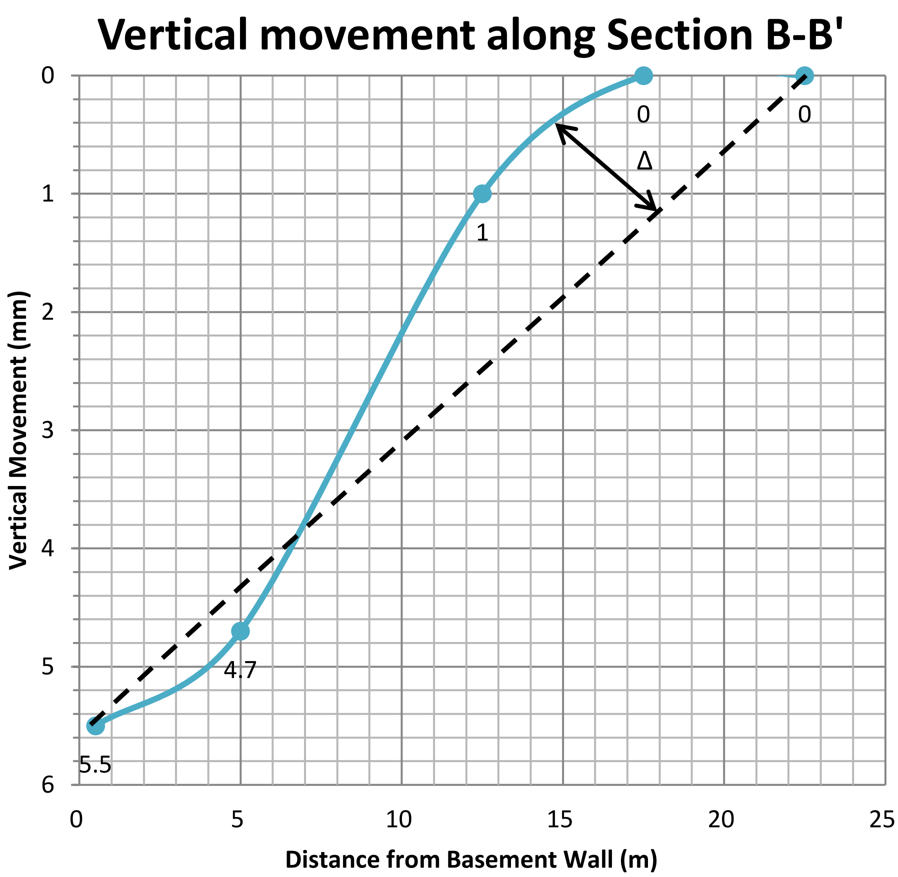
CATEGORY 3 MODERATE

Reference: **LBH4351**
Site: **Nos. 1-3 and Nos. 4-8 Ferdinand Place**
Section: **No. 1A Harmood Street**
Date of analysis: **23/08/2017**
Project Engineer: **RL**

The damage category can be assessed from the calculated horizontal strain and deflection ratio of a "beam" under hogging or sagging.

Length of wall	**L =**	**22**	**m**
Height of wall	**H =**	**7**	**m**
Horiz. deflection	**Δ_{horiz} =**	**11.2**	**mm**
Vert. deflection	**Δ =**	**1**	**mm**

x	y	Distance from wall	Vert. mov'nt	Horiz. mov'nt
m	m	m	mm	mm
48	8	0.5	5.5	11.3
53.6	7	5	4.7	6.5
58	7	12.5	1	1.3
50	7	17.5	0	0.1
70	6	22.5	0	0.1

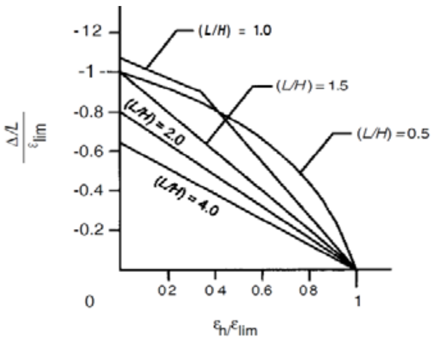


Reference: **LBH4351** Section: **No. 1A Harmood Street**

L/H = 3.1429

Horiz. Strain εh = 0.050909 % εlim = 0.055 %

Deflection ratio Δ/L = -0.004545



CATEGORY 0
NEGLIGIBLE

0.050

DAMAGE LEVEL -->

CATEGORY 1
VERY SLIGHT

0.075

CATEGORY 2
SLIGHT

0.150

CATEGORY 3
MODERATE