CampbellReith
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48 Shoot-up Hill
London NW2 3QB

Basement Impact Assessment Audit

For

London Borough of Camden

Project Number: 12336-53
Revision: F1

July 2016

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Document History and Status

Revision	Date	Purpose/Status	File Ref	Author	Check	Review
D1	May 2016	Comment	VPjw12336-53-190516-48 Shoot-up Hill-D1.doc	VP	EMB	EMB
F1	July 2016	For planning	VPjw12336-53-080716-48 Shoot-up Hill-F1.doc	VP	EMB	EMB

Document Details

Last saved	08/07/2016 12:57
Path	VPjw12336-53-080716-48 Shoot-up Hill-F1.doc
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Project Number	12336-53
Project Name	48 Shoot-up Hill, London NW2 3QB
Planning Reference	2016/1089/P

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Contents

Appendix

1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by London Borough of Camden, (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for 48 Shoot-up Hill (planning reference 2016/1089/P). The basement is considered to fall within Category B as defined by the Terms of Reference.

1.2. The Audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground, and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures.

1.3. CampbellReith was able to access LBC's Planning Portal and gain access to the latest revision of submitted documentation and reviewed it against an agreed audit check list.

1.4. The BIA has been carried out by Lyons O'Neill using individuals who possess suitable qualifications.

1.5. The BIA has confirmed that the proposed basement will be founded within Made Ground and its foundations will need to be deepened to encounter the London Clay below.

1.6. The proposed construction methodology and structural solution, which includes underpinning of the existing party and internal load-bearing walls, and concrete walls in combination with a contiguous piled wall elsewhere, is suitable for this scheme.

1.7. A comprehensive Structural Strategy Report (SSR) has not been included in the BIA. However, the sketches and explanatory text included in the BIA are sufficient and an SSR is not required for audit purposes. Design calculations had not been initially presented in the BIA. Calculations, showing preliminary designs of basement slab and retaining wall, were later received and reviewed by CampbellReith.

1.8. It is possible that ground water will be encountered during basement foundation excavation. The dewatering measures recommended in the BIA should be considered.

1.9. A revised Ground Movement Assessment was undertaken and submitted, in addition to the original preliminary GMA, and the damage categories established. Mitigating measures to limit the potential damage to neighbouring buildings to Burland Category 1 have been proposed.

1.10. Proposals for a movement monitoring strategy, during and post basement construction, have been included in the BIA and these should be implemented.

1.11. It is accepted that the surrounding slopes to the development site are stable.

1.12. It is accepted that the development will not impact on the wider hydrogeology of the area and is not in an area subject to flooding. However, anti-flood measures associated with sewer flooding, should be described.

1.13. Queries and requests for further information raised by the initial audit are discussed in Section 5 and summarised in Appendix 2. It is accepted that the revised BIA and supporting documents adequately identify the impact of the basement proposals and describe suitable mitigation.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 20 April 2016 to carry out a Category B Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for no. 48 Shoot-up Hill, Camden Reference 2016/1089/P.

2.2. The Audit was carried out in accordance with the Terms of Reference set by LBC. It reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development.

2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within

- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.
- Camden Planning Guidance (CPG) 4: Basements and Lightwells.
- Camden Development Policy (DP) 27: Basements and Lightwells.
- Camden Development Policy (DP) 23: Water.

2.4. The BIA should demonstrate 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; and,

c) avoid cumulative impacts upon structural stability or the water environment in the local area

and evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.

2.5. LBC's Audit Instruction described the planning proposal as *"excavation of basement with front and rear lightwells; alteration of the residential mix to comprise 4x1-bed and 3x2-bed units and associated works"* and confirmed that the basement proposals do not involve a listed building nor does the property neighbour any listed buildings.

2.6. CampbellReith accessed LBC's Planning Portal on 27 April 2016 and gained access to the following relevant documents for audit purposes:

- Basement Impact Assessment Report (BIA)

- Planning Application Drawings consisting of
  - Location Plan
  - Existing Plans and Elevations
  - Proposed Plans and Elevations
- Design & Access Statement

2.7. Additional information including a revised GMA, Arboricultural Method Statement and calculations showing preliminary designs of structural elements, was received on 8 June 2016.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	BIA Page 4.
Is data required by Cl.233 of the GSD presented?	Yes	
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	BIA and drawings.
Are suitable plan/maps included?	No	BIA Appendices Surface and Groundwater flood risk maps have not been presented.
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	Applicable to the maps presented only.
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	BIA Paragraphs 3.3, 4.2.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	No flood risk maps presented. Updated Flood Maps for Surface Water Flooding (CAMDEN SFRA 2014) have not been presented.
Is a conceptual model presented?	Yes	BIA Section 5.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Paragraph 3.3.

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Paragraph 3.2.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Paragraph 3.4.
Is factual ground investigation data provided?	Yes	BIA Sections 5 and 6.
Is monitoring data presented?	Yes	BIA Paragraph 6.1.
Is the ground investigation informed by a desk study?	Yes	BIA Section 5.
Has a site walkover been undertaken?	Yes	
Is the presence/absence of adjacent or nearby basements confirmed?	No	It is to be confirmed whether or not 46 Shoot-up Hill has a basement.
Is a geotechnical interpretation presented?	Yes	BIA Appendix G.
Does the geotechnical interpretation include information on retaining wall design?	No	However, calculations, presenting preliminary wall designs, have been submitted and accepted.
Are reports on other investigations required by screening and scoping presented?	No	
Are the baseline conditions described, based on the GSD?	Yes	BIA Section 3.
Do the base line conditions consider adjacent or nearby basements?	No	
Is an Impact Assessment provided?	Yes	BIA Section 4.
Are estimates of ground movement and structural impact presented?	Yes	A preliminary calculation based on assumed movement had been

Item	Yes/No/NA	Comment
		initially prepared (BIA Appendix F). A revised GMA was later submitted presenting the structural movements and likely damage.
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	Yes	
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	Yes	
Has the need for monitoring during construction been considered?	Yes	BIA Section 8.
Have the residual (after mitigation) impacts been clearly identified?	Yes	
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	A revised GMA and preliminary calculations have been submitted.
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	BIA Sections 3 & 4.
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	BIA Sections 3 & 4.
Does report state that damage to surrounding buildings will be no worse than Burland Category 2?	Yes	The scheme has been revised to restrict the anticipated damage to Fordwych Court to Burland Category 1. Negligible damage, corresponding to Category 0, is expected in the case of 46 Shoot-up Hill according to the GMA.
Are non-technical summaries provided?	No	

4.0 DISCUSSION

4.1. The Basement Impact Assessment (BIA) has been carried out by Lyons O'Neill and the individuals concerned in its production have suitable qualifications.

4.2. Neither a Structural Strategy Report (SSR) nor structural design calculations had been initially included in the BIA. Annotated sketches and explanatory text, outlining the construction methodology, had been presented in BIA Appendix C and it is accepted that no SSR is required for audit purposes. Calculations showing preliminary designs of basement slab and retaining wall were subsequently presented on CampbellReith's request. It is worth noting that the BIA indicates that the Contractor is "to submit an overall Method Statement" prior to commencement of site works together with "detailed drawings and calculations" which would include a ground movement assessment due to excavation, underpinning and piling.

4.3. The Design and Access Statement identified that the property "is not listed and is not located within a Conservation Area". This has also been confirmed by LBC in the BIA Audit Instruction.

4.4. The proposed basement consists of a single storey construction formed by "enlarging the existing basement to provide two additional units" according to the Design and Access Statement. The construction of the basement is proposed to comprise underpinning, using traditional "hit and miss" methodology, of the party wall and internal load-bearing walls. Concrete liner walls in combination with a contiguous piled wall are proposed elsewhere. The construction techniques are well established and suitable for the scheme.

4.5. The BIA has identified that the new basement will be founded at approximately 3.2 m bgl in London Clay which underlies Made Ground. The depth of the Made Ground varies from 0.1m to 2.7m according to the soil investigation based on 1 no. borehole, 2 no. window samples and 5 no. hand-dug trial pits.

4.6. The BIA presents groundwater monitoring data which indicates the presence of a "shallow water table" potentially due to perched water or surface infiltration sources. The report acknowledges that allowance should be made for dewatering during the construction of the basement and proposes that "intermittent pumping" from collector sumps is considered. In addition, the BIA proposes that the basement design incorporates waterproofing measures in the permanent condition.

4.7. The BIA has determined that the clay soils encountered at the site are of high volume change potential. The same report goes to conclude that no specific precautions should be considered due to the distance between the existing trees and basement foundations. An Arboricultural Method Statement (AMS), which identified the type, number and root protection areas of trees, was later submitted for review. The AMS confirmed that no trees were expected to be removed and it is accepted that these will not have an impact on the existing and new foundations.

4.8. The BIA has given consideration to the potential heave uplift that may occur upon basement excavation. Heave protective measures, in the form of compressible material placed beneath the ground bearing slab, are recommended in the BIA. Additional calculations, showing the proposed type and thickness of heave protection material, were subsequently provided by Lyon O'Neill.

4.9. Brief calculations of the potential movement of the neighbouring property, that may occur during the excavation of the basement, had been initially included in the BIA. These had been prepared based on assumed vertical and horizontal deflections. The BIA had stated that "revised values for deflections may be used during the detailed design stage". A revised Ground Movement Assessment (GMA), which reviewed the category and extent of potential damage to neighbouring properties, was later submitted for review. The GMA concluded that negligible damage to 46 Shoot-up Hill, corresponding to Burland Category 1, would be anticipated during the construction of the proposed basement. However, calculations indicate that the anticipated damage to Fordwych Court would fall within Burland Category 2. Mitigating measures, in the form of high level permanent wall propping, have been proposed by the Engineer and these should be adopted. It is accepted that these measures will reduce the anticipated damage to Fordwych Court walls from Burland Category 2 to Burland Category 1.

4.10. It is to be confirmed whether or not the neighbouring building has an existing basement. It is likely that there is a basement, of size similar to the existing at 48 Shoot-up Hill, at no. 46 Shoot-up Hill according to the BIA. No neighbouring basements have been considered when preparing the GMA.

4.11. The BIA proposes that a movement monitoring strategy is adopted during both excavation and construction works. An outline of the strategy and mitigating measures, which are suitable for this scheme, are detailed in the BIA.

4.12. The BIA states that contaminated soil was encountered during the site investigation. It also recommends that "allowance should be made for experienced verification of the excavation/remedial works by a geo-environmental engineer". The report also advises that soil remediation may be required as well as the provision of a hydrocarbon resistance vapour membrane within the floor slab construction.

4.13. Despite the site not being located within risk areas of surface or ground water flooding, anti-flood measures, in the form of non-return valves fitted to the basement drainage scheme, may be required to protect the basement from flooding due to local sewers operating under surcharge.

4.14. It can be concluded that the site is not located within flood risk areas based on the maps found in Camden SFRA 2014, although the BIA has not shown any maps of surface water or ground water flood risk areas. The BIA states that the scheme will not have an adverse impact on the overall site hydrogeology due to the "local falls in the local topography, low to negligible hydraulic gradient and the very low/impermeable nature of the underlying clay materials".

4.15. It is accepted that there are no slope stability concerns regarding the proposed development

5.0 CONCLUSIONS

5.1. The BIA has been carried out by Lyons O'Neill using individuals who possess suitable qualifications. Queries and requests for further information are discussed in Section 5 and summarised in Appendix 2.

5.2. A comprehensive SSR has not been included in the BIA, although an outline of the construction sequence has been presented in the form of annotated sketches and brief explanatory text. Calculations, presenting preliminary slab and retaining wall designs, were later submitted for review.

5.3. The BIA has confirmed that the property is not listed nor it is located within a Conservation Area.

5.4. The BIA has confirmed that the proposed basement will be founded within Made Ground and its foundations will be deepened to encounter the London Clay below.

5.5. It is possible that ground water may be encountered during basement foundation excavation and the BIA makes proposals for dewatering measures. The potential loss of fine soil particles will need to be taken into account should dewatering be employed.

5.6. The BIA concludes that no special precautions are required for foundation design although the London Clay found at the site is classed as high volume change Potential. An Arboricultural Method Statement was prepared and reviewed. It is accepted that the existing trees will have no impact on both new and existing foundations.

5.7. The proposed structural solutions and methodology for the construction of the basement are suitable for this scheme.

5.8. It is recommended that the party wall foundations are exposed prior to commencement of any basement construction works.

5.9. The revised GMA submitted by Lyons O'Neill has shown that the anticipated damage to 46 Shoot-up Hill would be negligible. The report has also shown that the anticipated damage to Fordwych Court would fall within Burland Category 2. However, this would be mitigated by providing permanent propping to the piled wall. The Engineer is to ensure that the proposed propping is designed so that the potential damage to Fordwych Court walls is limited to Burland Category 1.

5.10. Proposals for a movement monitoring strategy, during and post basement construction, have been included in the BIA and these should be implemented.

5.11. Anti-flood measures incorporated into the basement drainage scheme to prevent potential flooding due to local sewers operating under surcharge should be described.

5.12. It is accepted that the surrounding slopes to the development site are stable.

5.13. It is accepted that the development will not impact on the wider hydrogeology of the area and is not in an area subject to flooding.

5.14. Queries and requests for further information are discussed in Section 5 and summarised in Appendix 2.

Appendix 1: Residents' Consultation Comments

None

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Stability	Justification of GMA to be submitted for review	Closed - Revised GMA submitted and accepted.	1.07.2016
2	Stability	Design calculations to show adequacy of proposed structural solutions (concrete walls, ground bearing slab, capping beam etc.) to be prepared and submitted for review.	Closed - Preliminary designs of basement slab and retaining walls presented and accepted. The calculations included information on heave protective measures which are suitable for the scheme.	1.07.2016
3	Stability	Arboricultural report to be finalised and submitted for review	Closed - Arboricultural Method Statement submitted and reviewed.	16.06.2016

Appendix 3: Supplementary Supporting Documents

Information received from Simon Barker (Lyons O'Neill) on 1 July 2016

48 Shoot-Up Hill
GMA

Job Number:	15094
Revision:	P2
	June 2016

1. Introduction

Following and audit by Campbell Reith, Lyons O'Neill were instructed to complete a preliminary ground movement analysis on the proposed basement development at 48 Shoot-Up Hill.

This document is supplementary to the already submitted BIA report by Lyons O'Neill.

2. Assessments

Two assessment of the predicted ground movements have been undertaken based on CIRIA's document C580. Graphs and tables from C580 are used to approximate lateral and vertical movements soil during installation of retaining walls and excavation in front of retaining walls. Heave movements are also considered and are based on Pdisp calculations by Southern Testing.

The assessments are as follows:

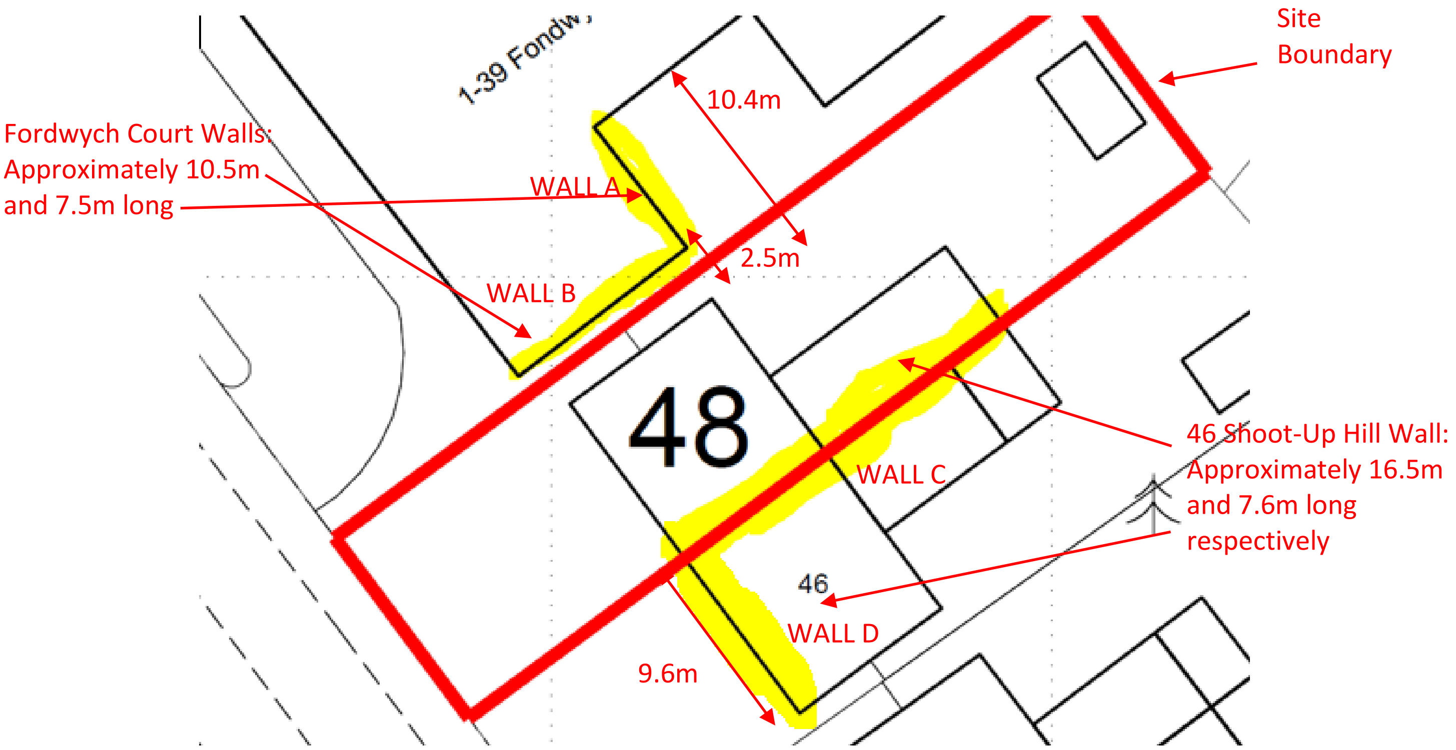
- Fordwych Court Wall

  There are two different wall types along this boundary. A contiguous piled wall acting as a cantilever and an RC underpin which will act as a propped cantilever. The piled wall is considered worst case and will be checked.

- 46 Shoot-Up Hill Wall

  The main wall type along this line is a RC underpin which will act as a propped cantilever.

NOTE: All walls will be designed to be performance specified to be within Damage Category 2.



3. Fordwych Court Wall

Two walls (A and B) of this structure are considered and are referenced in Section 2. Differential deflections across the perpendicular walls to the basement are determined and checked for their corresponding damage category.

3.1. Movement due to Installation

Table 2.2 *Ground surface movements due to bored pile and diaphragm wall installation in stiff clay*

Wall type	Horizontal movements		Vertical movements	
	Surface movement at wall (per cent of wall depth)	**Distance behind wall to negligible movement** (multiple of wall depth)	**Surface movement at wall** (per cent of wall depth)	**Distance behind wall to negligible movement** (multiple of wall depth)
Bored piles				
Contiguous	0.04	1.5	0.04	2
Secant	0.08	1.5	0.05	2
Diaphragm walls				
Planar	0.05	1.5	0.05	1.5
Counterfort	0.1	1.5	0.05	1.5

It is widely accepted that C580 report by CIRIA is overly conservative and with well-constructed piled walls no horizontal movement will be recorded and vertical movement will be limited to 0.02% of the wall depth. See 'Prediction of party wall movements using CIRIA report C580' by Richard Ball and Nick Langdon. This was also stated to us by Southern Testing, the geotechnical engineers who undertook the site investigation.

- Wall A

  Nearest distance from retaining structure (contiguous piles) = 2.5m
  Furthest distance from retaining structure (contiguous piles) = 10.5m
  Assumed Pile Depth = 10m

  Vertical Deflection Due to Installation at nearest end = 0mm (assume no deflection at this distance)
  Vertical Deflection Due to Installation at furthest end = 0mm (assume no deflection at this distance)

- Wall B

  Nearest distance from retaining structure (contiguous piles) = 2.5m
  Assumed Pile Depth = 10m

  Vertical Deflection Due to Installation = 0mm (assume no deflection at this distance)

3.2. Movement due to excavation

The graphs on the following page are from CIRIA C580 Figure 2.11 and allow conservative approximation of soil movement based on proximity of the wall in question and depth of excavation.

- Wall A

  Nearest distance from retaining structure (contiguous piles) = 2.5m
  Maximum Excavation Depth = 3.2m
  Distance from wall / Maximum excavation depth = 0.78

  Horizontal Movement = 0.32% / 100 * 3200 = 10.24mm
  Vertical Movement = 0.22% / 100 * 3200mm = 7.04mm

  Furthest distance from retaining structure (contiguous piles) = 10.5m
  Maximum Excavation Depth = 3.2m
  Distance from wall / Maximum excavation depth = 3.28

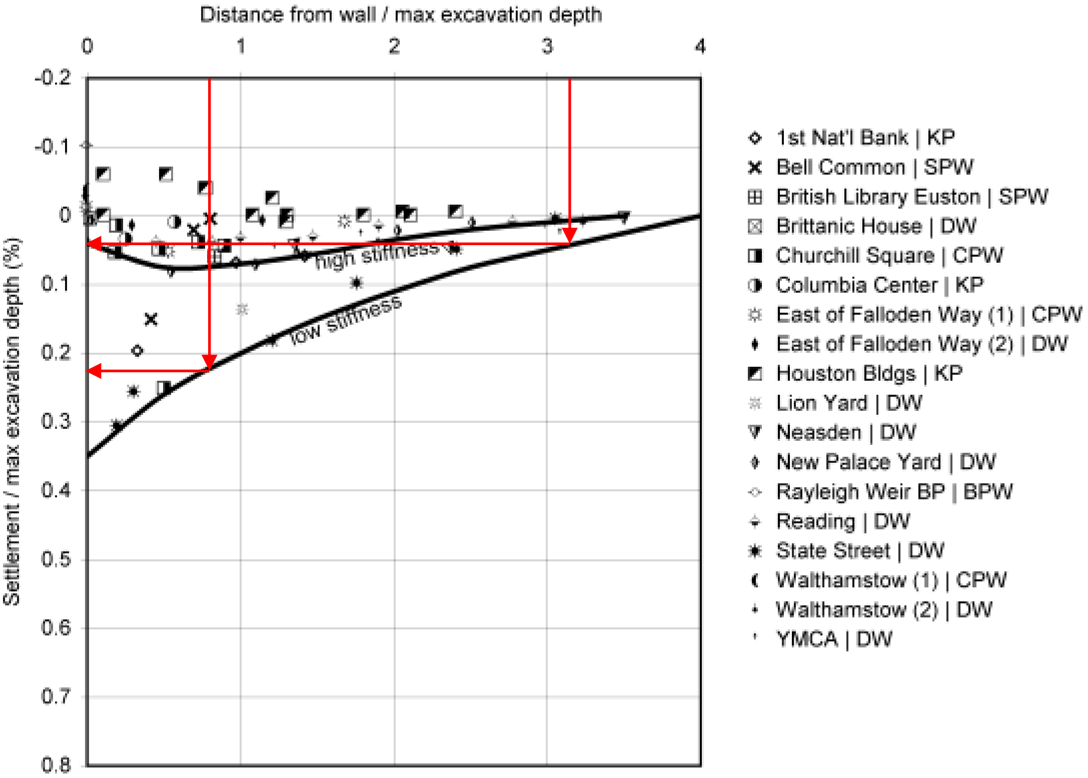
  Horizontal Movement = 0.05% / 100 * 3200 = 1.6mm
  Vertical Movement = 0.1% / 100 * 3200mm = 3.2mm

- Wall B

  Nearest distance from retaining structure (contiguous piles) = 2.5m
  Maximum Excavation Depth = 3.2m
  Distance from wall / Maximum excavation depth = 0.78

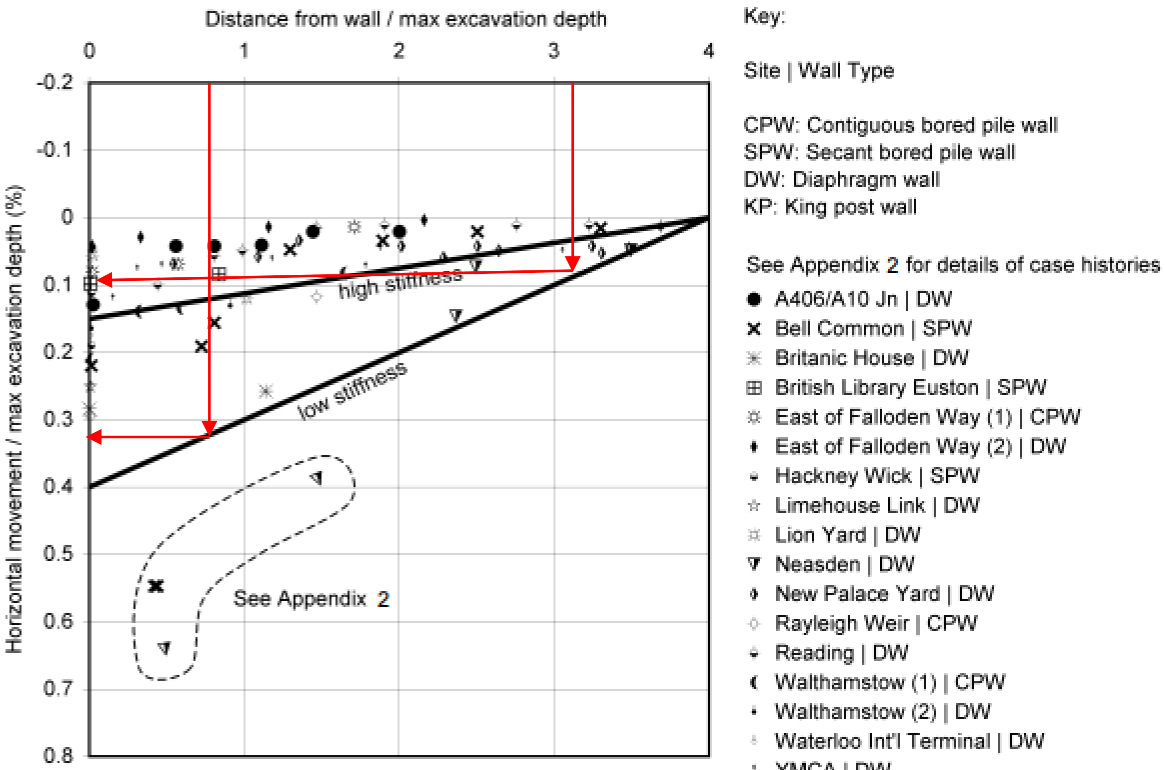
  Horizontal Movement = 0.32% / 100 * 3200 = 10.24mm
  Vertical Movement = 0.22% / 100 * 3200mm = 7.04mm

Lyons O'Neill Structural Engineers 5 Maidstone Mews, 72-76 Borough High Street, London, SE1 1GN	Project: 48 Shoot-Up Hill				Job No: 15094	
	Section: GMA				Sheet No: 4	
	By: SB	Date: 01/07/16	Chk'd by: IJ	Date: 01/07/16	App'd by:	Date:



(b) Vertical movements

Figure 2.11 *Ground surface movements due to excavation in front of wall in stiff clay*



(a) Horizontal movements

3.3. Movement due to Heave

Heave displacements have been calculated by Soiltechnics using Pdisp analysis. The results are shown on the following pages. Advice given by Soiltechnics was to consider the difference between long term and short term heave displacements and subtract this from the vertical movement when considering soil settlement.

For Fordwych Court there will be approximately 3mm of additional movement from long term heave at Wall A's nearest end and along Wall B. No heave is expected at the end of Wall A.

3.4. Total Differential Movement Along the Wall

- Wall A

  Total Vertical at Nearest End = 7.04mm + 0mm – 3.00mm = 4.04mm
  Total Horizontal at Nearest End = 10.24mm

  Total Vertical at Furthest End = 3.2mm + 0mm – 0mm = 3.2mm
  Total Horizontal at Furthest End = 1.6mm

  Total Differential Vertical Movement Along Wall = 0.84mm
  Total Differential Horizontal Movement Along Wall = 8.64mm

- Wall B

  It is assumed that Wall B will move as one and there will be no differential movement along the wall.

  A damage category will not be provided for this wall.

Oasys

Shoot-Up Hill

U1

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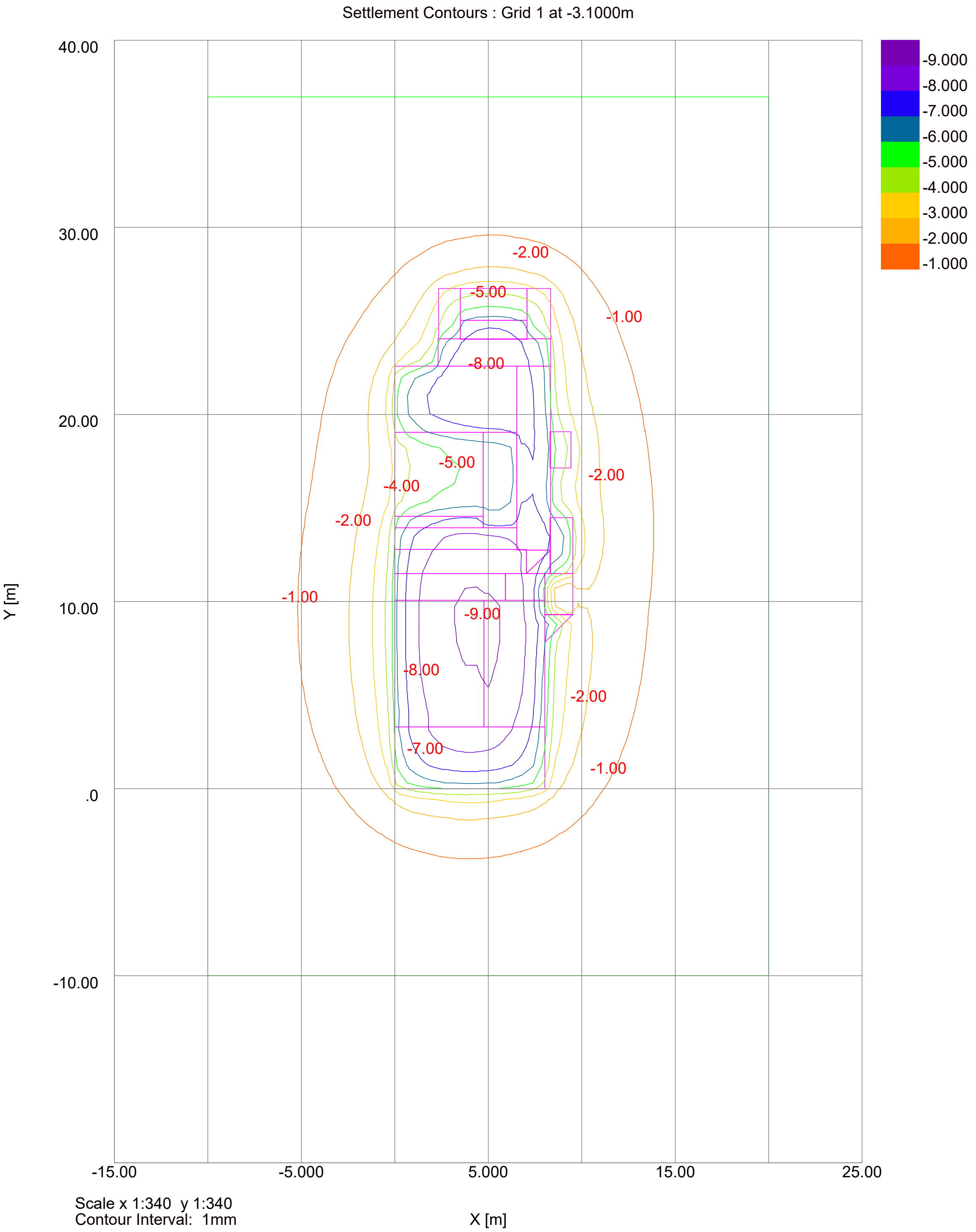

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Contour Interval: 1mm

Oasys

Shoot-Up Hill

D1

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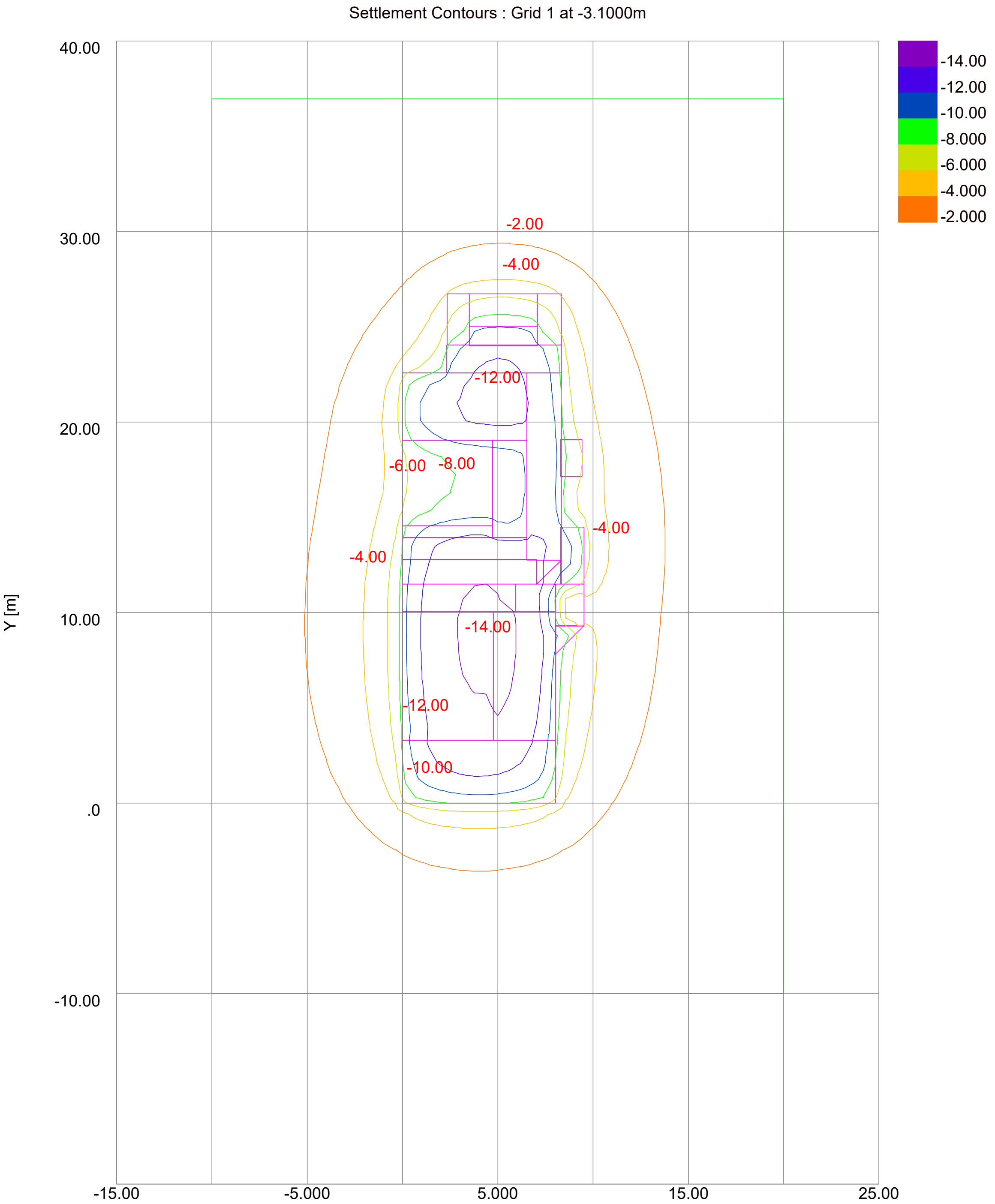

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3.5. Calculation of Damage Category

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Job	15094 - 47 Shoot-Up Hill - Fordwych Court Wall A	Date	Feb '16	Page	
Title	Monitoring and Damage Categories	By	SB	Chkd	

Title to Identify Wall

Longitudinal Length, L_1 = 7.5 m → L/H = 0.5
Transverse Length, L_2 = 7.5 m
Height, H = 15.0 m

Damage Category 0 ε_{lim} = 0.050 %

$\varepsilon_h/\varepsilon_{lim}$	ε_h (%)	δ_h (mm)	$(\Delta/L)/\varepsilon_{lim}$	Δ/L	Δ (mm)
0	0	0	1	5.0E-04	3.8
0.2	0.01	1	0.91	4.6E-04	3.4
0.4	0.02	2	0.8	4.0E-04	3.0
0.6	0.03	2	0.64	3.2E-04	2.4
0.8	0.04	3	0.42	2.1E-04	1.6
1	0.05	4	0	0.0E+00	0.0

Damage Category 1 ε_{lim} = 0.075 %

$\varepsilon_h/\varepsilon_{lim}$	ε_h (%)	δ_h (mm)	$(\Delta/L)/\varepsilon_{lim}$	Δ/L	Δ (mm)
0	0	0	1	7.5E-04	5.6
0.2	0.015	1	0.91	6.8E-04	5.1
0.4	0.03	2	0.8	6.0E-04	4.5
0.6	0.045	3	0.64	4.8E-04	3.6
0.8	0.06	5	0.42	3.2E-04	2.4
1	0.075	6	0	0.0E+00	0.0

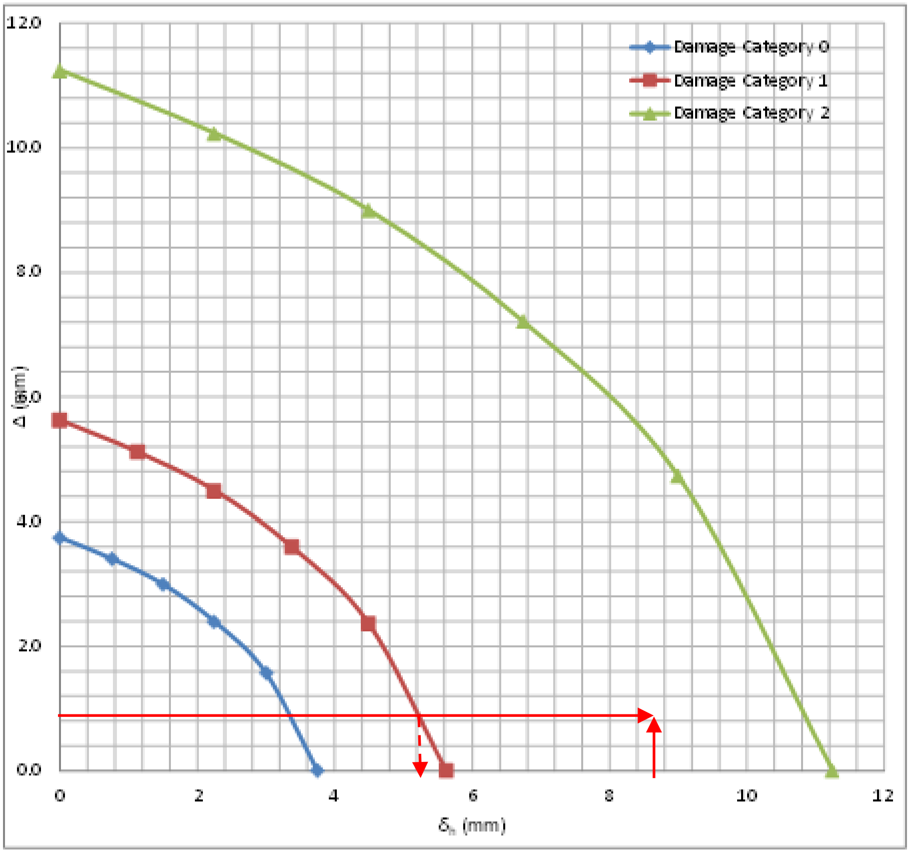
Damage Category 2 ε_{lim} = 0.150 %

$\varepsilon_h/\varepsilon_{lim}$	ε_h (%)	δ_h (mm)	$(\Delta/L)/\varepsilon_{lim}$	Δ/L	Δ (mm)
0	0	0	1	1.5E-03	11.3
0.2	0.03	2	0.91	1.4E-03	10.2
0.4	0.06	5	0.8	1.2E-03	9.0
0.6	0.09	7	0.64	9.6E-04	7.2
0.8	0.12	9	0.42	6.3E-04	4.7
1	0.15	11	0	0.0E+00	0.0

Lyons O'Neill Structural Engineers

Job	15094 - 47 Shoot-Up Hill - Fordwych Court Wall A	Date	Feb '16	Page
Title	Monitoring and Damage Categories	By	SB	Chkd

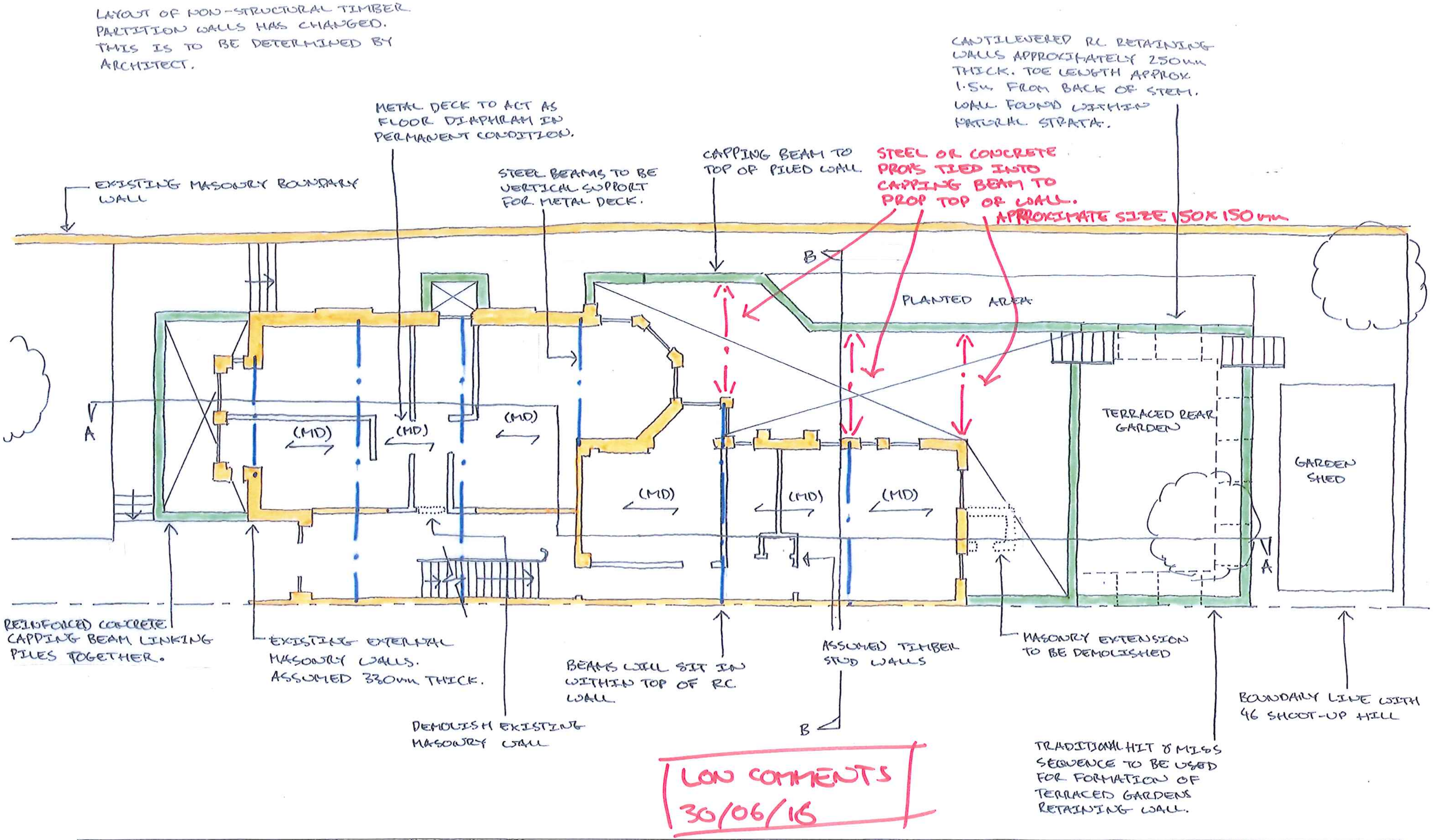
Plot Showing Upper Bound Limit of Acceptable Movement



Predicted Horizontal Movement from Calculations = 8.64mm
Predicted Vertical Movement from Calculations = 0.84mm

This will be within Damage Category 2. Camden council guidelines state all deflections should be limited to be within Damage Category 1.

By intermittently propping the capping beam connecting the piles at approximately 3m centres we will reduce the horizontal deflections and be within Damage Category 1. An approximate arrangement of propping is shown on the following page.



NOTES: KEY EXISTING MASONRY WALL RC PILECAP/RETAINING WALL STEEL BEAMS	INFORMATION PROPOSED GROUND FLOOR STATUS	REV COMMENTS DATE CHK	Lyons O'Neill 45 Great Guildford Street London SE1 0ES +44 (20) 7223 7222 info@lyonsoneill.co.uk lyonsoneill.co.uk	PROJECT: 48 SHOOT-UP HILL SUBJECT: PROPOSED GF PLAN	SCALE @ A3: 1:50 · BY: SB · DATE: FEB16 · CHECKED: IS	DRAWING No: SK007 · REV

4. 46 Shoot-Up Hill Wall

Ground movements for underpinning are not well documented, however, when construction is undertaken in a well-controlled manner these are typically small.

To provide some basis of estimating likely movements the underpinned section of the basement has been treated as piles. This is the recommendation of Southern Testing the geotechnical engineers for the job. CIRIA guide C580 provides guidance on the horizontal and vertical movement of the soil.

RC retaining walls will be modelled as propped cantilevers and will therefore have high support stiffness's.

Table 2.4 *Ground surface movements due to excavation in front of bored pile, diaphragm wall and sheet pile walls wholly embedded in stiff clays*

Movement type	High support stiffness (high propped wall, top-down construction)		Low support stiffness (cantilever or low-stiffness temporary props or temporary props installed at low level)	
	Surface movement at wall (per cent of max excavation depth)	**Distance behind wall to negligible movement** (multiple of max excavation depth)	**Surface movement at wall** (per cent of max excavation depth)	**Distance behind wall to negligible movement** (multiple of max excavation depth)
Horizontal	0.15	4	0.4	4
Vertical	0.1	3.5	0.35	4

Two walls (C and D) of this structure are considered and are referenced in Section 2. Differential deflections across the perpendicular walls to the basement are determined and checked for their corresponding damage category.

- Wall C

  It is assumed that Wall C will move as one and there will be no differential movement along the wall.
  A damage category will not be provided for this wall.

- Wall D

  Maximum excavation depth = 3.2m
  Horizontal Movement at Nearest End = 0.15%/100*3200 = 4.8mm
  Vertical Movement at Nearest End = 0.1%/100*3200 = 3.2mm
  Movement at the Furthest End from the wall will be negligible according the table above.
  Differential Movement in the wall Horizontally = 4.8mm
  Differential Movement in the wall Vertically = 3.2mm

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Job	15094 - 48 Shoot-Up Hill - 46 Shoot-Up Hill Wall	Date	Feb '16	Page	
Title	Monitoring and Damage Categories	By	SB	Chkd	

Title to Identify Wall

Longitudinal Length, L_1 = 9.6 m → L/H = 0.96
Transverse Length, L_2 = 9.6 m
Height, H = 10.0 m

Damage Category 0 ε_{lim} = 0.050 %

$\varepsilon_h/\varepsilon_{lim}$	ε_h (%)	δ_h (mm)	$(\Delta/L)/\varepsilon_{lim}$	Δ/L	Δ (mm)
0	0	0	1.18	5.9E-04	5.7
0.2	0.01	1	0.96	4.8E-04	4.6
0.4	0.02	2	0.8	4.0E-04	3.8
0.6	0.03	3	0.55	2.8E-04	2.6
0.8	0.04	4	0.26	1.3E-04	1.2
1	0.05	5	0	0.0E+00	0.0

Damage Category 1 ε_{lim} = 0.075 %

$\varepsilon_h/\varepsilon_{lim}$	ε_h (%)	δ_h (mm)	$(\Delta/L)/\varepsilon_{lim}$	Δ/L	Δ (mm)
0	0	0	1.18	8.9E-04	8.5
0.2	0.015	1	0.96	7.2E-04	6.9
0.4	0.03	3	0.8	6.0E-04	5.8
0.6	0.045	4	0.55	4.1E-04	4.0
0.8	0.06	6	0.26	2.0E-04	1.9
1	0.075	7	0	0.0E+00	0.0

Damage Category 2 ε_{lim} = 0.150 %

$\varepsilon_h/\varepsilon_{lim}$	ε_h (%)	δ_h (mm)	$(\Delta/L)/\varepsilon_{lim}$	Δ/L	Δ (mm)
0	0	0	1.18	1.8E-03	17.0
0.2	0.03	3	0.96	1.4E-03	13.8
0.4	0.06	6	0.8	1.2E-03	11.5
0.6	0.09	9	0.55	8.3E-04	7.9
0.8	0.12	12	0.26	3.9E-04	3.7
1	0.15	14	0	0.0E+00	0.0

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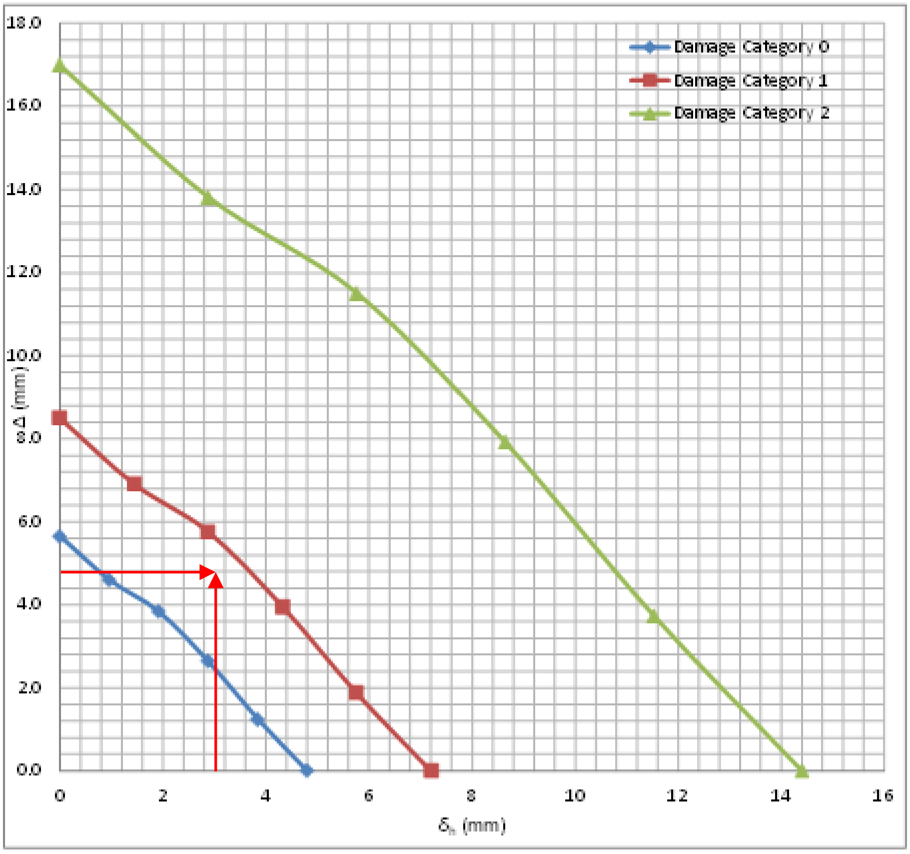
Job	15094 - 48 Shoot-Up Hill - 46 Shoot-Up Hill Wall	Date	Feb '16	Page
Title	Monitoring and Damage Categories	By	SB	Chkd

Plot Showing Upper Bound Limit of Acceptable Movement



Predicted Horizontal Movement from Calculations = 4.8mm
Predicted Vertical Movement from Calculations = 3.2mm

Deflections are within Damage Category 1.

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15094 - 48 Shoot-Up Hill

Preliminary Structural Calculations

Issue Date: June 2016

Lyons | O'Neill
Structural Engineers

Job 15094 - 48 SHOOT-UP HILL | Date 07/06/16 | Page 1
Title PRELIMINARY CALCULATIONS | By SB | Chkd

AS REQUESTED BY CAMPBELL REITH, LYONS O'NEILL HAVE COMPLETED PRELIMINARY CALCULATIONS ON SOME STRUCTURAL ITEMS.

CAMPBELL REITH HAVE REQUESTED THE FOLLOWING.

- HEAVE PROTECTION THICKNESS.
- PRELIMINARY CALCULATIONS ON RETAINING WALL.
- PRELIMINARY CALCULATIONS ON SUSPENDED SLAB.

• HEAVE PROTECTION.

- SI REPORT SHOWS HIGH PLASTICITY WITH RESPECTS TO NHBC GUIDELINES
- SLAB DEPTH EXPECTED TO BE ≈ 250mm

Table One

Results of Soil Analysis	NHBC Category	Predicted Ground Movement or BRE/ NHBC requirement	Depth of Cellcore HX required to achieve 'Equivalent Void'	
Plasticity Index	Shrinkage Category	Void Dimensions (mm)	HX S (mm)	HX B (mm)
10 - 20	Low	50	90	85
20 - 40	Medium	100	160	155
40 - 60*	High	150	225	220

* When the analysis exceeds 60 or a deeper void is required, please consult our Technical Services team.

Secondly, the grade of the product is determined by the depth of the concrete to be cast on the Cellcore, as detailed in table two below:

Table Two

Grade*	Safe Load (kN/m²)	Fail Load (kN/m²)	Maximum Concrete Depth** (mm)
7/10	7	10	220
9/13	9	13	300
13/18	13	18	460
18/24	18	24	660
24/32	24	32	900

* For easy identification the panel labels are coloured as shown.

** Based on the Eurocode and a live load allowance of 1.5kN/m2.

∴ 9/13 CELLCORE HX S OR EQUIVALENT CAN BE USED.

- SUSPENDED BASEMENT SLAB

  - SIMPLY SUPPORTED BETWEEN FOUNDATIONS

  - DOWNWARD LOADING.

    FINISHES 0.4 kPa
    SELFWEIGHT 0.25m x 24kN/m³ = 4.8 kPa

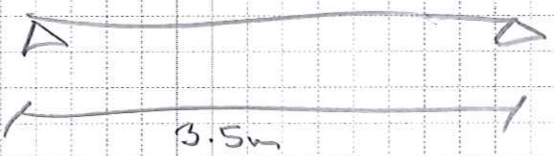
    TOTAL DEAD 5.2 kPa

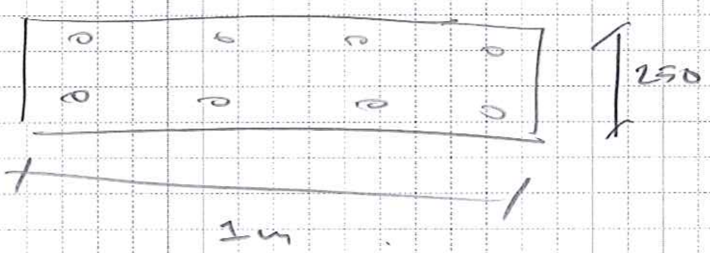
    TOTAL LIVE 1.5 kPa

  - UPWARD LOADING

    HEAVE (SLS) 9 kPa

SEE FOLLOWING CALCULATIONS





$W_{DOWN} = (5.2kPa \times 1.35 + 1.5 \times 1.5) \times 1m$
$= 9.27 kN/m$

$W_{UP} = (9kPa \times 1.5 - 4.8kPa \times 0.9) \times 1m$
$= 9.18 kN/m$

$W_{DESIGN} = 9.5 kN/m$

$M^* = 9.5 \times 3.5^2 / 8 = 14.55 kNm$

Section design to Eurocode 2 (DD ENV 1992-1-1 : 1992)

SOLID SLABS

INPUT Location 1st Floor, Span H-J

M	kNm/m	15	fck	N/mm²	30	γc = 1.50
δ		1.00	fyk	N/mm²	460	γs = 1.15
span	mm	3500	gk	kN/m²	5.20	
h	mm	250	qk	kN/m²	1.50	
Bar Ø	mm	10				
cover	mm	50	to this steel			

Section location SIMPLY SUPPORTE

OUTPUT 1st Floor, Span H-J

d = 250 - 50 - 10/2 = 195.0 mm

Equn A9 x = [195 - (195² - 1600/0.68 x 15 x 1.5/30)½]/0.8 = 5.7 mm

Equn A8 (x/d) limit = 0.448 x/d actual = 0.029 < 0.448 ok

4.2.1.3.3(12) z = 195 - 0.4 x 5.7 = 192.7 mm

As = 15E6/460/192.7 x 1.15 = 195 < As min = 293 mm²/m

5.4.2.1.1 As min = 1.5 x 195 = 293 mm²/m

4.4.2.2 As crack = 400 x 0.8 x 3 x 250/2 / 460 = 261 mm²/m

As def = 90 mm²/m

Provide T10 @ 250 = 314 mm²/m

Table 1 NAD $\psi 2$ = 0.2 (Dwelling)

4.4.3.2(4) fs = 460 x 5.50/9.27 x 195/314/1.15 = 147.0 N/mm²

Modification factor = 250/147.0 = 1.7007

Table 7 NAD Permissible L/d = 1.7007 x 33.714 = 57.337

Actual L/d = 3500/195 = 17.949 ok

250mm SLAB WITH A393 MESH
OKAY FOR BENDING.

- RC RETAINING WALLS

TYPICAL SPAN/DEPTH RATIO FOR CANTILEVERED RETAINING WALL IS: $H/_{10-24}$

ASSUME 250mm RC WALL.

WALL HEIGHT < 3200mm

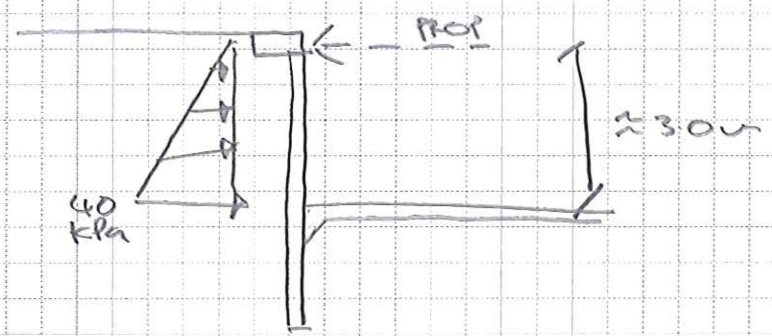
$\frac{3200}{10} = 320\text{mm}$

$\frac{3200}{24} = 133\text{mm}$

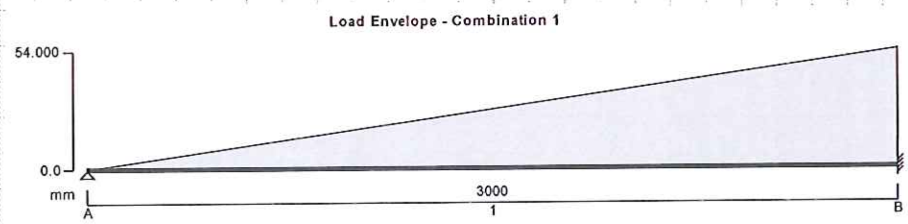
} 250mm WITHIN THIS RANGE ∴ OKAY AS PRELIM ASSUMPTION.

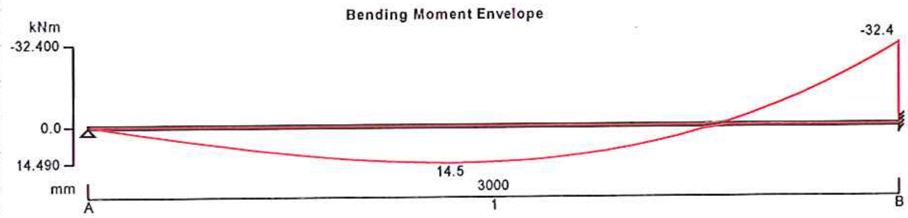
• CAPPING BEAM PRELIMINARY CALCULATIONS.

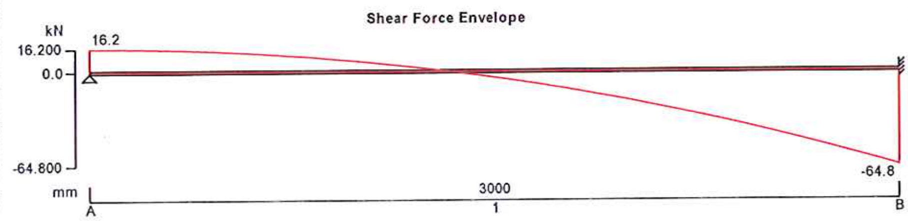
⇒ FIND LOAD PER M ONTO CAPPING BEAM.



ACTIVE PRESSURE CALCS ON FOLLOWING PAGE







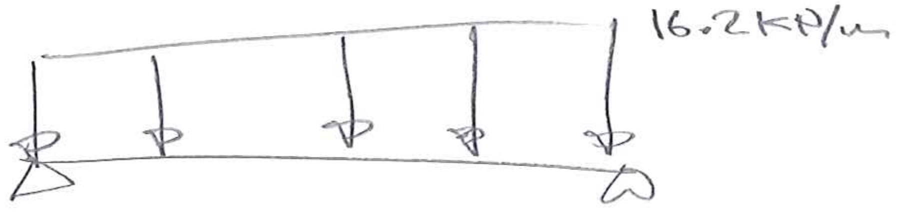
Lyons | O'Neill Structural Engineers	Project:		Job:	
45 Great Guildford Street	48 - Shoot-Up Hill		15094	
London	Section:		Sheet No:	
SE1 0ES	Capping Beam Design		15094	
	By:	Date:	Chk'd by:	Date:
	SB	Jul-16		

Calculation for Active Pressures - Combination 1

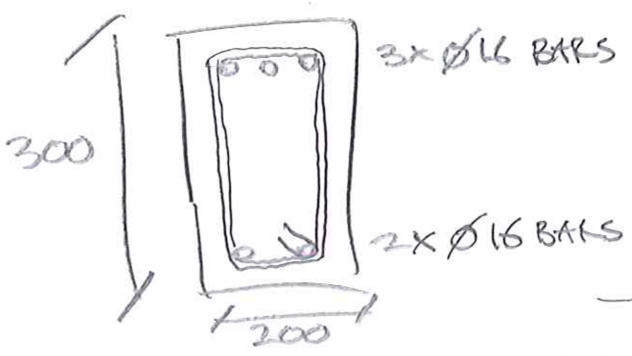
1.2 Water + 1.5 Surcharge + 1.35 Active Pressure

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Soil Layer	Depth below surface, z (m)	Density, γe (kg/m3)	∫ γ Z (kN/m2)	Head of water, z – zw ≥ 0 (m)	Pore water pressure, u (kN/m2)	Minimum surcharge' q(kN/m2)	Effective vertical stress ,σ' v, (kN/m2) (4) + (7) – (6)	ϕ'd (degrees)	Kh = Kad	Active horizontal pressure σ'ah, (kN/m2) (8) × (10) + (6)	Surcharge, qk(kN/m2) (7) × (10)	Water, qkw(kN/m2) (= 6)	Active Pressure, gk(kN/m2) (11) – (12) – (13)	Factored total (kN/m2)
Clay	0	1900	0	0	0	0	0	20	0.49	0	0	0	0	**0**
	3	1900	57	0	0	0	57	20	0.49	27.93	0	0	27.93	**37.7**

⇒ DESIGN OF CAPPING BEAM



SEE TEDDS CALCS ON FOLLOWING PAGES. USE:

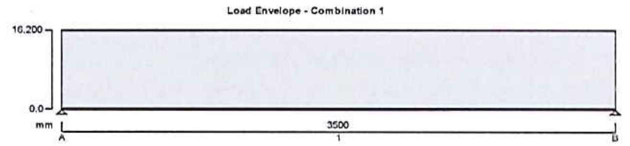


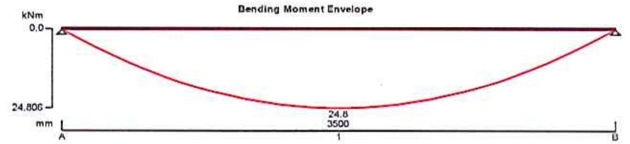
ACHIEVEABLE WITHIN CURRENT SCHEME.

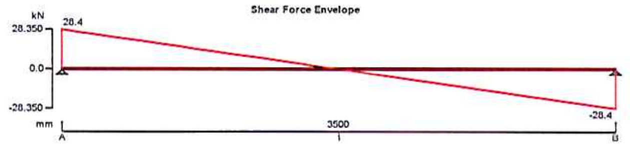
RC BEAM ANALYSIS & DESIGN (EN1992-1)

In accordance with UK national annex

TEDDS calculation version 2.1.15







Support conditions

Support A	Vertically restrained	
	Rotationally free	
Support B	Vertically restrained	
	Rotationally free	

Applied loading

Permanent full UDL 16.2 kN/m

Load combinations

Load combination 1	Support A	Permanent × 1.00
		Variable × 1.00
	Span 1	Permanent × 1.00
		Variable × 1.00
	Support B	Permanent × 1.00
		Variable × 1.00

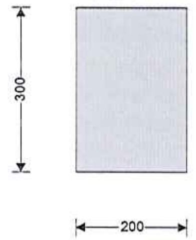
Analysis results

Maximum moment support A	M_{A_max} = **0** kNm	M_{A_red} = **0** kNm
Maximum moment span 1 at 1750 mm	M_{s1_max} = **25** kNm	M_{s1_red} = **25** kNm

Maximum moment support B	M_{B_max} = **0** kNm	M_{B_red} = **0** kNm
Maximum shear support A	V_{A_max} = **28** kN	V_{A_red} = **28** kN
Maximum shear support A span 1 at 234 mm	$V_{A\_s1\_max}$ = **24** kN	$V_{A\_s1\_red}$ = **24** kN
Maximum shear support B	V_{B_max} = **-28** kN	V_{B_red} = **-28** kN
Maximum shear support B span 1 at 3266 mm	$V_{B\_s1\_max}$ = **-24** kN	$V_{B\_s1\_red}$ = **-24** kN
Maximum reaction at support A	R_A = **28** kN	
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **28** kN	
Maximum reaction at support B	R_B = **28** kN	
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **28** kN	

Rectangular section details

Section width	b = **200** mm
Section depth	h = **300** mm



Concrete details (Table 3.1 - Strength and deformation characteristics for concrete)

Concrete strength class	**C28/35**
Characteristic compressive cylinder strength	f_{ck} = **28** N/mm^2
Characteristic compressive cube strength	$f_{ck,cube}$ = **35** N/mm^2
Mean value of compressive cylinder strength	$f_{cm} = f_{ck} + 8$ N/mm^2 = **36** N/mm^2
Mean value of axial tensile strength	$f_{ctm} = 0.3$ N/mm^2 $\times (f_{ck}/ 1$ N/mm$^2)^{2/3}$ = **2.8** N/mm^2
Secant modulus of elasticity of concrete	$E_{cm} = 22$ kN/mm^2 $\times [f_{cm}/10$ N/mm$^2]^{0.3}$ = **32308** N/mm^2
Partial factor for concrete (Table 2.1N)	γ_C = **1.50**
Compressive strength coefficient (cl.3.1.6(1))	α_{cc} = **0.85**
Design compressive concrete strength (exp.3.15)	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C$ = **15.9** N/mm^2
Maximum aggregate size	h_{agg} = **20** mm

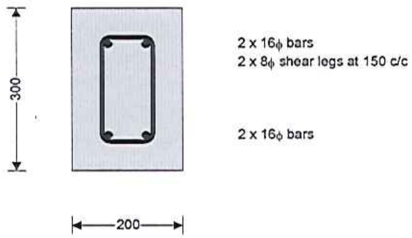
Reinforcement details

Characteristic yield strength of reinforcement	f_{yk} = **500** N/mm^2
Partial factor for reinforcing steel (Table 2.1N)	γ_S = **1.15**
Design yield strength of reinforcement	$f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm^2

Nominal cover to reinforcement

Nominal cover to top reinforcement	c_{nom_t} = **50** mm
Nominal cover to bottom reinforcement	c_{nom_b} = **50** mm
Nominal cover to side reinforcement	c_{nom_s} = **50** mm

Support A



Rectangular section in flexure (Section 6.1)

Minimum moment factor (cl.9.2.1.2(1)) — β_1 = **0.25**

Design bending moment — M = max(abs(M_{A_red}), β_1 × abs(M_{s1_red})) = **6** kNm

Depth to tension reinforcement — d = h - c_{nom_t} - ϕ_v - ϕ_{top} / 2 = **234** mm

Percentage redistribution — m_{rA} = **0** %

Redistribution ratio — δ = min(1 - m_{rA}, 1) = **1.000**

K = M / (b × d^2 × f_{ck}) = **0.020**

K' = 0.598 × δ - 0.181 × δ^2 - 0.21 = **0.207**

K' > K - No compression reinforcement is required

Lever arm — z = min((d / 2) × [1 + (1 - 3.53 × K)$^{0.5}$], 0.95 × d) = **222** mm

Depth of neutral axis — x = 2.5 × (d - z) = **29** mm

Area of tension reinforcement required — $A_{s,req}$ = M / (f_{yd} × z) = **64** mm²

Tension reinforcement provided — 2 × 16ϕ bars

Area of tension reinforcement provided — $A_{s,prov}$ = **402** mm²

Minimum area of reinforcement (exp.9.1N) — $A_{s,min}$ = max(0.26 × f_{ctm} / f_{yk}, 0.0013) × b × d = **67** mm²

Maximum area of reinforcement (cl.9.2.1.1(3)) — $A_{s,max}$ = 0.04 × b × h = **2400** mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Minimum bottom reinforcement at supports

Minimum reinforcement factor (cl.9.2.1.4(1)) — β_2 = **0.25**

Area of reinforcement to adjacent span — $A_{s,span}$ = **402** mm²

Minimum bottom reinforcement to support — $A_{s2,min}$ = β_2 × $A_{s,span}$ = **101** mm²

Bottom reinforcement provided — 2 × 16ϕ bars

Area of bottom reinforcement provided — $A_{s2,prov}$ = **402** mm²

PASS - Area of reinforcement provided is greater than minimum area of reinforcement required

Rectangular section in shear (Section 6.2)

Design shear force at support A — $V_{Ed,max}$ = abs(max(V_{A_max}, V_{A_red})) = **28** kN

Angle of comp. shear strut for maximum shear — θ_{max} = 45 deg

Maximum design shear force (exp.6.9) — $V_{Rd,max}$ = b × z × v_1 × f_{cd} / (cot(θ_{max}) + tan(θ_{max})) = **188** kN

PASS - Design shear force at support is less than maximum design shear force

Design shear force span 1 at 234 mm — V_{Ed} = max($V_{A\_s1\_max}$, $V_{A\_s1\_red}$) = **24** kN

Design shear stress — v_{Ed} = V_{Ed} / (b × z) = **0.547** N/mm²

Strength reduction factor (cl.6.2.3(3)) — v_1 = 0.6 × [1 - f_{ck} / 250 N/mm²] = **0.533**

Compression chord coefficient (cl.6.2.3(3)) — α_{cw} = **1.00**

Angle of concrete compression strut (cl.6.2.3)

θ = min(max(0.5 × Asin[min(2 × v_{Ed} / (α_{cw} × f_{cd} × v_1),1)], 21.8 deg), 45deg) = **21.8** deg

Area of shear reinforcement required (exp.6.13) — $A_{sv,req}$ = v_{Ed} × b / (f_{yd} × cot(θ)) = **101** mm²/m

Shear reinforcement provided — 2 × 8ϕ legs at 150 c/c

Area of shear reinforcement provided — $A_{sv,prov}$ = **670** mm²/m

Minimum area of shear reinforcement (exp.9.5N) — $A_{sv,min}$ = 0.08 N/mm² × b × (f_{ck} / 1 N/mm²)$^{0.5}$ / f_{yk} = **169** mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (exp.9.6N) — $s_{vl,max}$ = 0.75 × d = **175** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Crack control (Section 7.3)

Maximum crack width — w_k = **0.3** mm

Design value modulus of elasticity reinf (3.2.7(4)) — E_s = **200000** N/mm²

Mean value of concrete tensile strength — $f_{ct,eff}$ = f_{ctm} = **2.8** N/mm²

Stress distribution coefficient — k_c = **0.4**

Non-uniform self-equilibrating stress coefficient — k = min(max(1 + (300 mm - min(h, b)) × 0.35 / 500 mm, 0.65), 1) = **1.00**

Actual tension bar spacing — s_{bar} = (b - 2 × (c_{nom_s} + ϕ_v) - ϕ_{top}) / (N_{top} - 1) = **68** mm

Maximum stress permitted (Table 7.3N) — σ_s = **346** N/mm²

Concrete to steel modulus of elast. ratio — α_{cr} = E_s / E_{cm} = **6.19**

Distance of the Elastic NA from bottom of beam — y = (b × h² / 2 + $A_{s,prov}$ × (α_{cr} - 1) × (h - d)) / (b × h + $A_{s,prov}$ × (α_{cr} - 1)) = **147** mm

Area of concrete in the tensile zone — A_{ct} = b × y = **29435** mm²

Minimum area of reinforcement required (exp.7.1) — $A_{sc,min}$ = k_c × k × $f_{ct,eff}$ × A_{ct} / σ_s = **94** mm²

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent value of variable action — ψ_2 = **0.30**

Quasi-permanent limit state moment — M_{QP} = abs(M_{A_c21}) + ψ_2 × abs(M_{A_c22}) = **0** kNm

Permanent load ratio — R_{PL} = M_{QP} / M = **0.00**

Service stress in reinforcement — σ_{sr} = f_{yd} × $A_{s,req}$ / $A_{s,prov}$ × R_{PL} = **0** N/mm²

Maximum bar spacing (Tables 7.3N) — $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing

Minimum bottom bar spacing — $s_{bot,min}$ = (b - 2 × c_{nom_s} - 2 × ϕ_v - ϕ_{bot}) / (N_{bot} - 1) = **68** mm

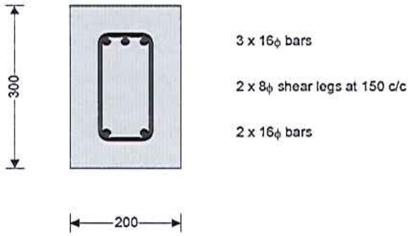
Minimum allowable bottom bar spacing — $s_{bar\_bot,min}$ = max(ϕ_{bot}, h_{agg} + 5 mm, 20 mm) + ϕ_{bot} = **41** mm

Minimum top bar spacing — $s_{top,min}$ = (b - 2 × c_{nom_s} - 2 × ϕ_v - ϕ_{top}) / (N_{top} - 1) = **68** mm

Minimum allowable top bar spacing — $s_{bar\_top,min}$ = max(ϕ_{top}, h_{agg} + 5 mm, 20 mm) + ϕ_{top} = **41** mm

PASS - Actual bar spacing exceeds minimum allowable

Mid span 1



Rectangular section in flexure (Section 6.1) - Positive midspan moment

Design bending moment — $M = abs(M_{s1\_red}) = \mathbf{25}$ **kNm**

Depth to tension reinforcement — $d = h - c_{nom\_b} - \phi_v - \phi_{bot} / 2 = \mathbf{234}$ **mm**

Percentage redistribution — $m_{rs1} = M_{s1\_red} / M_{s1\_max} - 1 = \mathbf{0}$ **%**

Redistribution ratio — $\delta = min(1 - m_{rs1}, 1) = \mathbf{1.000}$

$K = M / (b \times d^2 \times f_{ck}) = \mathbf{0.081}$

$K' = 0.598 \times \delta - 0.181 \times \delta^2 - 0.21 = \mathbf{0.207}$

K' > K - No compression reinforcement is required

Lever arm — $z = min((d / 2) \times [1 + (1 - 3.53 \times K)^{0.5}], 0.95 \times d) = \mathbf{216}$ **mm**

Depth of neutral axis — $x = 2.5 \times (d - z) = \mathbf{45}$ **mm**

Area of tension reinforcement required — $A_{s,req} = M / (f_{yd} \times z) = \mathbf{264}$ $\mathbf{mm^2}$

Tension reinforcement provided — 2 × 16ϕ bars

Area of tension reinforcement provided — $A_{s,prov} = \mathbf{402}$ $\mathbf{mm^2}$

Minimum area of reinforcement (exp.9.1N) — $A_{s,min} = max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times b \times d = \mathbf{67}$ $\mathbf{mm^2}$

Maximum area of reinforcement (cl.9.2.1.1(3)) — $A_{s,max} = 0.04 \times b \times h = \mathbf{2400}$ $\mathbf{mm^2}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear (Section 6.2)

Shear reinforcement provided — 2 × 8ϕ legs at 150 c/c

Area of shear reinforcement provided — $A_{sv,prov} = \mathbf{670}$ $\mathbf{mm^2/m}$

Minimum area of shear reinforcement (exp.9.5N) — $A_{sv,min} = 0.08\ N/mm^2 \times b \times (f_{ck} / 1\ N/mm^2)^{0.5} / f_{yk} = \mathbf{169}$ $\mathbf{mm^2/m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (exp.9.6N) — $s_{vl,max} = 0.75 \times d = \mathbf{175}$ **mm**

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design shear resistance (assuming cot(θ) is 2.5) — $V_{prov} = 2.5 \times A_{sv,prov} \times z \times f_{yd} = \mathbf{157.3}$ **kN**

Shear links provided valid between 0 mm and 3500 mm with tension reinforcement of 402 mm²

Crack control (Section 7.3)

Maximum crack width — $w_k = \mathbf{0.3}$ **mm**

Design value modulus of elasticity reinf (3.2.7(4)) — $E_s = \mathbf{200000}$ $\mathbf{N/mm^2}$

Mean value of concrete tensile strength — $f_{ct,eff} = f_{ctm} = \mathbf{2.8}$ $\mathbf{N/mm^2}$

Stress distribution coefficient — $k_c = \mathbf{0.4}$

Non-uniform self-equilibrating stress coefficient — $k = min(max(1 + (300\ mm - min(h, b)) \times 0.35 / 500\ mm, 0.65), 1) = \mathbf{1.00}$

Actual tension bar spacing — $s_{bar} = (b - 2 \times (c_{nom\_s} + \phi_v) - \phi_{bot}) / (N_{bot} - 1) = \mathbf{68}$ **mm**

Maximum stress permitted (Table 7.3N) — $\sigma_s = \mathbf{346}$ $\mathbf{N/mm^2}$

Concrete to steel modulus of elast. ratio — $\alpha_{cr} = E_s / E_{cm} = \mathbf{6.19}$

Distance of the Elastic NA from bottom of beam — $y = (b \times h^2 / 2 + A_{s,prov} \times (\alpha_{cr} - 1) \times (h - d)) / (b \times h + A_{s,prov} \times (\alpha_{cr} - 1)) = \mathbf{147}$ **mm**

Area of concrete in the tensile zone — $A_{ct} = b \times y = \mathbf{29435}$ $\mathbf{mm^2}$

Minimum area of reinforcement required (exp.7.1) — $A_{sc,min} = k_c \times k \times f_{ct,eff} \times A_{ct} / \sigma_s = \mathbf{94}$ $\mathbf{mm^2}$

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent value of variable action — $\psi_2 = \mathbf{0.30}$

Quasi-permanent limit state moment — $M_{QP} = abs(M_{s1\_c21}) + \psi_2 \times abs(M_{s1\_c22}) = \mathbf{25}$ **kNm**

Permanent load ratio — $R_{PL} = M_{QP} / M = \mathbf{1.00}$

Service stress in reinforcement — $\sigma_{sr} = f_{yd} \times A_{s,req} / A_{s,prov} \times R_{PL} = \mathbf{286}$ $\mathbf{N/mm^2}$

Maximum bar spacing (Tables 7.3N) — $s_{bar,max} = \mathbf{100}$ **mm**

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing

Minimum bottom bar spacing — $s_{bot,min} = (b - 2 \times c_{nom\_s} - 2 \times \phi_v - \phi_{bot}) / (N_{bot} - 1) = 68$ mm

Minimum allowable bottom bar spacing — $s_{bar\_bot,min} = max(\phi_{bot}, h_{agg} + 5\ mm, 20\ mm) + \phi_{bot} = 41$ mm

Minimum top bar spacing — $s_{top,min} = (b - 2 \times c_{nom\_s} - 2 \times \phi_v - \phi_{top}) / (N_{top} - 1) = 34$ mm

Minimum allowable top bar spacing — $s_{bar\_top,min} = max(\phi_{top}, h_{agg} + 5\ mm, 20\ mm) + \phi_{top} = 41$ mm

FAIL - Minimum allowable bar spacing exceeds top bar spacing

Deflection control (Section 7.4)

Reference reinforcement ratio — $\rho_{m0} = (f_{ck} / 1\ N/mm^2)^{0.5} / 1000 = \mathbf{0.005}$

Required tension reinforcement ratio — $\rho_m = A_{s,req} / (b \times d) = \mathbf{0.006}$

Required compression reinforcement ratio — $\rho'_m = A_{s2,req} / (b \times d) = \mathbf{0.000}$

Structural system factor (Table 7.4N) — $K_b = \mathbf{1.0}$

Basic allowable span to depth ratio (7.16b) — $span\_to\_depth_{basic} = K_b \times [11 + 1.5 \times (f_{ck} / 1\ N/mm^2)^{0.5} \times \rho_{m0} / (\rho_m - \rho'_m) + (f_{ck} / 1\ N/mm^2)^{0.5} \times (\rho'_m / \rho_{m0})^{0.5} / 12] = \mathbf{18.438}$

Reinforcement factor (exp.7.17) — $K_s = min(A_{s,prov} / A_{s,req} \times 500\ N/mm^2 / f_{yk}, 1.5) = \mathbf{1.500}$

Flange width factor — $F1 = \mathbf{1.000}$

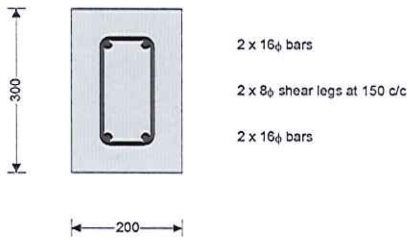
Long span supporting brittle partition factor — $F2 = \mathbf{1.000}$

Allowable span to depth ratio — $span\_to\_depth_{allow} = min(span\_to\_depth_{basic} \times K_s \times F1 \times F2, 40 \times K_b) = \mathbf{27.657}$

Actual span to depth ratio — $span\_to\_depth_{actual} = L_{s1} / d = \mathbf{14.957}$

PASS - Actual span to depth ratio is within the allowable limit

Support B



Lyons O'Neill Structural Engineers	Project				Job no.	
	15094 - 48 Shoot-Up Hill				15094	
Lyons O'Neill 5 Maidstone Mews 72 -76 Borough High Street London SE1 1GN	Calcs for: Capping Beam - Prelim Design				Start page no./Revision: 7	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	S	01/07/2016				

Rectangular section in flexure (Section 6.1)

Minimum moment factor (cl.9.2.1.2(1)) $\beta_1 = \mathbf{0.25}$

Design bending moment $M = \max(\text{abs}(M_{B\_red}), \beta_1 \times \text{abs}(M_{s1\_red})) = \mathbf{6\ kNm}$

Depth to tension reinforcement $d = h - c_{nom\_t} - \phi_v - \phi_{top} / 2 = \mathbf{234}$ mm

Percentage redistribution $m_{rB} = \mathbf{0}$ %

Redistribution ratio $\delta = \min(1 - m_{rB}, 1) = \mathbf{1.000}$

$K = M / (b \times d^2 \times f_{ck}) = \mathbf{0.020}$

$K' = 0.598 \times \delta - 0.181 \times \delta^2 - 0.21 = \mathbf{0.207}$

K' > K - No compression reinforcement is required

Lever arm $z = \min((d / 2) \times [1 + (1 - 3.53 \times K)^{0.5}], 0.95 \times d) = \mathbf{222}$ mm

Depth of neutral axis $x = 2.5 \times (d - z) = \mathbf{29}$ mm

Area of tension reinforcement required $A_{s,req} = M / (f_{yd} \times z) = \mathbf{64}$ mm²

Tension reinforcement provided $2 \times 16\phi$ bars

Area of tension reinforcement provided $A_{s,prov} = \mathbf{402}$ mm²

Minimum area of reinforcement (exp.9.1N) $A_{s,min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times b \times d = \mathbf{67}$ mm²

Maximum area of reinforcement (cl.9.2.1.1(3)) $A_{s,max} = 0.04 \times b \times h = \mathbf{2400}$ mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Minimum bottom reinforcement at supports

Minimum reinforcement factor (cl.9.2.1.4(1)) $\beta_2 = \mathbf{0.25}$

Area of reinforcement to adjacent span $A_{s,span} = \mathbf{402}$ mm²

Minimum bottom reinforcement to support $A_{s2,min} = \beta_2 \times A_{s,span} = \mathbf{101}$ mm²

Bottom reinforcement provided $2 \times 16\phi$ bars

Area of bottom reinforcement provided $A_{s2,prov} = \mathbf{402}$ mm²

PASS - Area of reinforcement provided is greater than minimum area of reinforcement required

Rectangular section in shear (Section 6.2)

Design shear force at support B $V_{Ed,max} = \text{abs}(\max(V_{B\_max}, V_{B\_red})) = \mathbf{28}$ kN

Angle of comp. shear strut for maximum shear $\theta_{max} = 45$ deg

Maximum design shear force (exp.6.9) $V_{Rd,max} = b \times z \times v_1 \times f_{cd} / (\cot(\theta_{max}) + \tan(\theta_{max})) = \mathbf{188}$ kN

PASS - Design shear force at support is less than maximum design shear force

Design shear force span 1 at 3266 mm $V_{Ed} = \text{abs}(\min(V_{B\_s1\_max}, V_{B\_s1\_red})) = \mathbf{24}$ kN

Design shear stress $v_{Ed} = V_{Ed} / (b \times z) = \mathbf{0.547}$ N/mm²

Strength reduction factor (cl.6.2.3(3)) $v_1 = 0.6 \times [1 - f_{ck} / 250\ N/mm^2] = \mathbf{0.533}$

Compression chord coefficient (cl.6.2.3(3)) $\alpha_{cw} = \mathbf{1.00}$

Angle of concrete compression strut (cl.6.2.3)

$\theta = \min(\max(0.5 \times \text{Asin}[\min(2 \times v_{Ed} / (\alpha_{cw} \times f_{cd} \times v_1),1)], 21.8\ deg), 45 deg) = \mathbf{21.8}$ deg

Area of shear reinforcement required (exp.6.13) $A_{sv,req} = v_{Ed} \times b / (f_{yd} \times \cot(\theta)) = \mathbf{101}$ mm²/m

Shear reinforcement provided $2 \times 8\phi$ legs at 150 c/c

Area of shear reinforcement provided $A_{sv,prov} = \mathbf{670}$ mm²/m

Minimum area of shear reinforcement (exp.9.5N) $A_{sv,min} = 0.08\ N/mm^2 \times b \times (f_{ck} / 1\ N/mm^2)^{0.5} / f_{yk} = \mathbf{169}$ mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (exp.9.6N) $s_{vl,max} = 0.75 \times d = \mathbf{175}$ mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Crack control (Section 7.3)

Maximum crack width $w_k = \mathbf{0.3}$ mm

Design value modulus of elasticity reinf (3.2.7(4)) $E_s = \mathbf{200000}$ N/mm²

Lyons O'Neill Structural Engineers	Project				Job no.	
	15094 - 48 Shoot-Up Hill				15094	
Lyons O'Neill 5 Maidstone Mews 72 -76 Borough High Street London SE1 1GN	Calcs for: Capping Beam - Prelim Design				Start page no./Revision: 8	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	S	01/07/2016				

Mean value of concrete tensile strength $f_{ct,eff} = f_{ctm} = \mathbf{2.8}$ N/mm²

Stress distribution coefficient $k_c = \mathbf{0.4}$

Non-uniform self-equilibrating stress coefficient $k = \min(\max(1 + (300\ mm - \min(h, b)) \times 0.35 / 500\ mm, 0.65), 1) = \mathbf{1.00}$

Actual tension bar spacing $s_{bar} = (b - 2 \times (c_{nom\_s} + \phi_v) - \phi_{top}) / (N_{top} - 1) = 68$ mm

Maximum stress permitted (Table 7.3N) $\sigma_s = \mathbf{346}$ N/mm²

Concrete to steel modulus of elast. ratio $\alpha_{cr} = E_s / E_{cm} = \mathbf{6.19}$

Distance of the Elastic NA from bottom of beam $y = (b \times h^2 / 2 + A_{s,prov} \times (\alpha_{cr} - 1) \times (h - d)) / (b \times h + A_{s,prov} \times (\alpha_{cr} - 1)) = \mathbf{147}$ mm

Area of concrete in the tensile zone $A_{ct} = b \times y = \mathbf{29435}$ mm²

Minimum area of reinforcement required (exp.7.1) $A_{sc,min} = k_c \times k \times f_{ct,eff} \times A_{ct} / \sigma_s = \mathbf{94}$ mm²

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent value of variable action $\psi_2 = \mathbf{0.30}$

Quasi-permanent limit state moment $M_{QP} = \text{abs}(M_{B\_c21}) + \psi_2 \times \text{abs}(M_{B\_c22}) = 0$ kNm

Permanent load ratio $R_{PL} = M_{QP} / M = \mathbf{0.00}$

Service stress in reinforcement $\sigma_{sr} = f_{yd} \times A_{s,req} / A_{s,prov} \times R_{PL} = 0$ N/mm²

Maximum bar spacing (Tables 7.3N) $s_{bar,max} = \mathbf{300}$ mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing

Minimum bottom bar spacing $s_{bot,min} = (b - 2 \times c_{nom\_s} - 2 \times \phi_v - \phi_{bot}) / (N_{bot} - 1) = 68$ mm

Minimum allowable bottom bar spacing $s_{bar\_bot,min} = \max(\phi_{bot}, h_{agg} + 5\ mm, 20\ mm) + \phi_{bot} = 41$ mm

Minimum top bar spacing $s_{top,min} = (b - 2 \times c_{nom\_s} - 2 \times \phi_v - \phi_{top}) / (N_{top} - 1) = 68$ mm

Minimum allowable top bar spacing $s_{bar\_top,min} = \max(\phi_{top}, h_{agg} + 5\ mm, 20\ mm) + \phi_{top} = 41$ mm

PASS - Actual bar spacing exceeds minimum allowable

Arboricultural method statement

Trees

at and adjacent to

48 Shoot Up Hill
London
NW2 3QB

for

Mr J Moore

Skerratt
R Skerratt BSc(For) M. Arbor. A.
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job no.: 467

document rev. no.:

date: 31.05.16

1. Scope and status

1.1 Scope

1.1.1 This method statement sets out measures for the protection of 6 trees or groups of trees standing within and adjacent to the property boundary of 48 Shoot Up Hill, London NW2 3QB, in relation to proposed residential development works.

1.1.2 The locations of the trees are shown on the **Tree protection plan** in **Appendix a.**

1.1.3 The development works to which this method statement refers include:

- Extension of an existing basement to provide additional habitable space
- Refurbishment of the existing dwelling
- Associated external works including resurfacing of existing hard standings, the creation of new pedestrian access and soft landscape works.

1.1.4 The measures contained in this method statement are based on the advice and guidance set out in *BS5837:2012 Trees in relation to design, demolition and construction – Recommendations.*

1.2 Status

1.2.1 This method statement forms a part of the building contract and its requirements are an integral part of the contract specification and schedule of works.

1.2.2 A copy of the method statement must be available for inspection on site at all times.

1.2.3 All persons working on site should be aware of the importance of avoiding damage to trees and should observe the necessary precautions. A guidance leaflet is included in this method statement in **Appendix c**.

2. Preparatory works prior to construction

2.1 Tree works

2.1 Tree works

2.1.1 Preparatory tree works to retained trees are listed in the **Tree works schedule** in **Appendix b** and should be carried out prior to the start of the main contract

2.1.2 All works will be carried out in accordance with *BS3998:2010 Recommendations for Tree Work.*

2.1.3 Unless otherwise specified, all arisings are to be taken off-site to an approved tip.

2.2 Protective measures: tree protection fencing

2.2.1 The extent and location of tree protection fencing is shown on the **Tree protection plan** in **Appendix a**. Fencing must be erected before any site works take place. It is particularly important that no demolition, soil stripping, breaking out of existing hard surfaces, re-grading or other excavation takes place before protective fencing has been erected.

2.2.2 Tree protection fencing will comply with the advice and guidance contained in *BS5837:2012 – Trees in relation to design, demolition and construction – Recommendations.*

2.2.3 In this case, fencing will be 2000mm high welded steel mesh panels (eg Heras round or square top panels or equivalent), mounted on compatible concrete or rubber feet, linked with 2 anti-tamper couplings and strutted at the ends. Struts will be attached at their lower ends to base plates secured with ground pins or to surface mounted concrete or rubber feet that are compatible with the strut size. A detail of full specification *BS5837:2012* fencing is included in **Appendix c.**

2.2.4 Areas separated from the construction site by tree protection fencing are **Construction Exclusion Zones (CEZ).**

2.2.5 **CEZs** are total exclusion areas. All of the following will be excluded:

- Animals
- Pedestrians
- Vehicles and construction equipment
- Materials and equipment storage
- Contamination from materials used outside the **CEZ** – (for example spillage of diesel or other toxic liquids)
- Surface water runoff from outside the **CEZ**

2.2.6 Clearly legible, weatherproof signs will be fixed to the perimeter fencing of the **CEZ** clearly setting out the access restrictions set out above. An example is included at the end of this statement in **Appendix c.**

3. Works during development

3.1 Storage, handling and use of materials

3.1.1 Phytotoxic materials (diesel or cement for example) must be stored in a bunded container and handled (poured or mixed for example) outside the **Root Protection Areas (RPAs)** of the trees shown on the **Tree protection plan** in **Appendix a.**

3.2 Safe positioning of heavy lifting and handling equipment

3.2.1 Lifting and handling equipment (eg cranes and excavators) must be located in such a way that, when in use, no part extends into the **CEZ.** When lifting and handling equipment is working beneath the crown spread of any retained tree, a banksman will be employed to guide operations and minimise the risk of damage to the tree's branch system.

3.3 No fires on site

3.3.1 No fires will be lit anywhere on site.

3.4 Special Construction Areas

3.4.1 Within the area marked **Special Construction Area** on the **Tree protection plan** in **Appendix a,** preparatory excavation for new hard surfaces must not extend below the depth of existing hard surfacing and its associated sub-base.

3.5 Removal of protective fencing

3.5.1 Protective fencing may be dismantled only when construction works are completed and all construction equipment has been removed from site.

4.Summary of methods

4.1 Conflicts and remedial actions

4.1.1 The main potential sources of damage to trees are listed in **Table 1** below together with the remedial measures that should be adopted to minimise or avoid damage.

Source of damage	Remedial actions	See	Trees at risk
Damage to tree stems and foliage	Erect protective fencing; plan construction activities to avoid damage to overhead branches:	Sections: 2.2, 3.2, 3.3 **Tree protection plan**	001-005
Damage by surface compaction from site traffic/storage of materials	Not applicable		
Damage from spillage of toxic materials	Phytotoxic materials to be stored in a bunded compound/ container outside RPAs	Section: 3.1	All
Damage to tree roots	Observe working constraints in **Special Construction Areas**	Section: 3.4 **Tree protection plan**	006

Table 1: Summary of Potential Damage Sources and Remedial Measures

Appendix a

Tree protection plan

KEY

EXISTING TREE

001

Trees are coloured on plan to correspond to the Retention Categories specified in: *BS5837:20 12 Trees in relation to design, demolition and construction - Recommendations* as follows:

Category A - GREEN
Category B - BLUE
Category C - GREY
Category U - RED

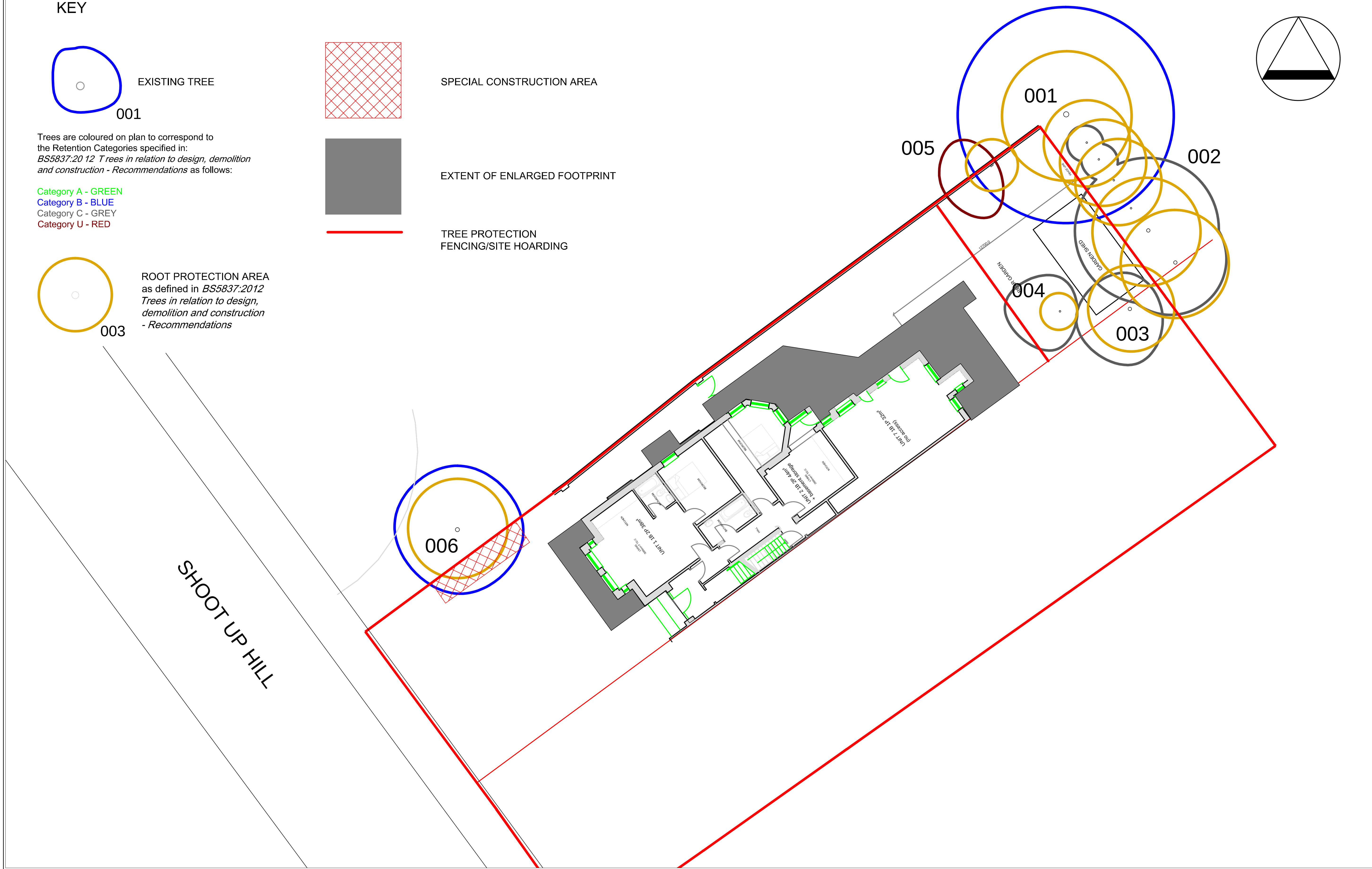
ROOT PROTECTION AREA as defined in *BS5837:2012 Trees in relation to design, demolition and construction - Recommendations*

003

SPECIAL CONSTRUCTION AREA

EXTENT OF ENLARGED FOOTPRINT

TREE PROTECTION FENCING/SITE HOARDING



Client: LONDON BOROUGH OF RICHMOND-UPON-THAMES	Drawing Title: TREE SURVEY PLAN DRAFT	
Job Title: ORLEANS SCHOOL HARTFORD ROAD TWICKENHAM	Date: 09.12.10 Drawing Number: 149.01.00	Scale: 1:500 (A3) Drawn by: RS

Skerratt
arboricultural advice
158 MALDEN ROAD, LONDON NW5 4BT
01274 566539

Appendix b

Pre-contract tree works schedule

Explanatory notes

For general information on any entry in the detailed survey text, refer to the notes below which are organised on a column by column basis.

Tree number
All trees have been numbered in the survey text to correspond to the location numbers shown on the accompanying Tree Survey Plan. No trees have been marked on site.

Species
Common English names have been used wherever possible and Latin names are listed (in brackets in *italics*) in all cases.

Dimensions

Height - are recorded in m.

Stem diameter – recorded in mm at breast height (1.5m) wherever possible. Where measurement at 1.5m is not possible, one of the alternative methods set out in *Annex C of BS5837:2012* has been used.
If the diameter has been measured at a different height, this has been recorded, e.g. 60 @ 1m = 60mm diameter at 1m height. Other abbreviations used:

av - average	est/e - estimated	
ms - multi-stemmed	max – maximum	gl - ground level

Crown spread - radial crown spreads in metres have been recorded at four points on the circumference of the crown (north, east, south and west). The accompanying Tree survey plan shows approximate crown shapes based on these measurements

Crown height - the height of the first major branch and the height of the lowest point of the crown are recorded in metres eg 3/3

Explanatory notes

Age

Y	Young	SM	Semi-mature
EM	Early mature	M	Mature
OM	Over-mature		

Where the precise age of a tree is known, it has been recorded in brackets adjacent to the general classification i.e. M(7).

Condition

Physiological condition
Gives a measure of biological vigour and of the presence or absence of disease, insect attack or other debilitating factors.

G Good
F Fair
P Poor

Structural condition
Gives a measure of each tree's physical form and mechanical stability.

G Good
F Fair
P Poor

Comments
See also **discussion** and **conclusions** in the accompanying report.

Explanatory notes

Recommendations
Preliminary management recommendations under existing conditions

Life expectancy
An approximate estimate for each tree's anticipated future safe life in the following ranges:

<10 years
10-20 years
20-40 years
40+ years

Retention category
This grading is based on the recommendations set out in BS 5837:2012 *Trees in relation todesign, demolition and construction - Recommendations.* The categories are summarised in the standard as follows:

A Trees of high quality with an estimated remaining safe life of at least 40 years
B Trees of moderate quality with an estimated remaining safe life of at least 20 years
C Trees of low quality with an estimated remaining safe life of at least 10 years, or young trees with a stem diameter below 150mm
U Trees in such a condition that they cannot realistically be retained as living trees in the context of the current land use for longer than 10 years

In addition the British Standard requires one or more subcategories to be applied to the main Retention Category. In summary these are as follows:

1 Mainly arboricultural qulaities (that is individual aesthetic characteristics)
2. Mainly landscape qualities
3. Mainly cultural values, including conservation

Tree works schedule

Skerratt

Tree No.	Species	Height (m)	Diam (mm)	Crown Spread (m)				Crown Height (m)	Age	Physiological Condition	Structural Condition	Comments	Recommendations	Life Expectancy	Retention Category	Retention Sub-category
				N	E	S	W									
001	Sycamore (*Acer pseudoplatanus*)	14	300 est	6	6	6	6	3/5	SM	G	G	Single upright stem: well proportioned rather open spreading crown: main branch fork at 3m: stands off-site in an adjacent garden	No immediate action required	40+	B	1/2
002	Leyland Cypress (*X Cupressocyparis leylandii*)	12 max	100-250 est	1	3e	3	4	1/1	SM	G	G	A line of approximately 5 stems (a grown-out hedge): the 2 stems at the east end of the line are much larger than the rest (approximately 250mm compared with <100mm): a useful low level screen standing off-site: crown dimesnions are for the group as a whole	No immediate action required	20-40	C	2
003	Sycamore (*Acer pseudoplatanus*)	12	200 est	2	2	3	3	2/2	SM	F	F	Single slightly leaning stem: main branch fork at about 2m: rather loose one sided crown: of natural seedling origin:stands off-site	No immediate action required	20-40	C	2
004	Turkey Oak (*Quercus cerris*)	6	85	2	1	2	3	1/0	Y	G	G	Single leaning stem with a rather one sided crown (to W): first lateral at less than 1m height: planted in a small brick planting enclosure	Lift crown to 3m above surrounding ground level	40+	C	1
005	Ash (*Fraxinus excelsior*)	12	85/ 85	2	0	2.5	3	2/2	SM	G	F	2 stemmed: rather high narrow but well balanced crown: grows at the base of the boundary wall where root action is	Remove within 5 years (future management problem)	<10	U	1/2
006	Italian Alder *(Alnus incana)*	12	230	3.5	3.5	3.5	3.5	2/2	SM	G	G	Single upright stem with slight sweep (localised curvature) at base: well proportioned crown: stands off site	No immediate action required	20-40	B	1

Client: Mr J Moore
Date: 31.05.16
Project: Tree survey schedule
Location: 48 Shoot Up Hill, London NW2 3QB
Job No.: 467

Specification

General

All works must be carried out in accordance with the provisions of *BS3889:2010 Tree works*

1. Felling

1.1 Where necessary to avoid damage to neighbouring trees and vegetation, trees for removal will be dismantled in sections and lowered under controlled conditions

1.2 No retained tree will be used as an anchorage point for any tree removal operation

2. Stump grinding

2.1 Stump grinding will be to a sufficient depth to extend through the base of the central part of the stump

2.2 Chippings from stump grinding will be treated as arisings and removed from site to an approved disposal location

3. Pruning: General

Active Target pruning

3.1 Pruning cuts will be made close to the point of origin of the branch or branchlet to be removed (to avoid stubs which can inhibit wound occlusion)

3.2 Where there is a visible branch bark ridge and branch collar, pruning cuts will be made between the outer edge of the branch bark ridge and the outer edge of the branch collar

3.3 Where no branch collar is visible, cuts should be made from the outer edge of the branch ridge at right angles to the grain of the branch to be removed

Size and location of pruning cuts

3.4 The size and number of all pruning cuts will be kept to a minimum consistent with the specified management objective

3.5 Preference will be given to the removal of a larger number of seconday branches rather than the removal of larger primary branches (to minimise pruning wound diameter) to achieve the specified management objective

3.6 Pruning cuts will not execeed 30% of the diameter of the parent branch or stem

4. Remove dead wood (safety)

4.1 Remove dead secondary branches and branchlets of 25mm diameter or greater at their point of origin following the principles of Active Target pruning

5. Crown lift (to a specified height)

5.1 Achieve the clearance specified between ground level and the lowest point of overhanging crown

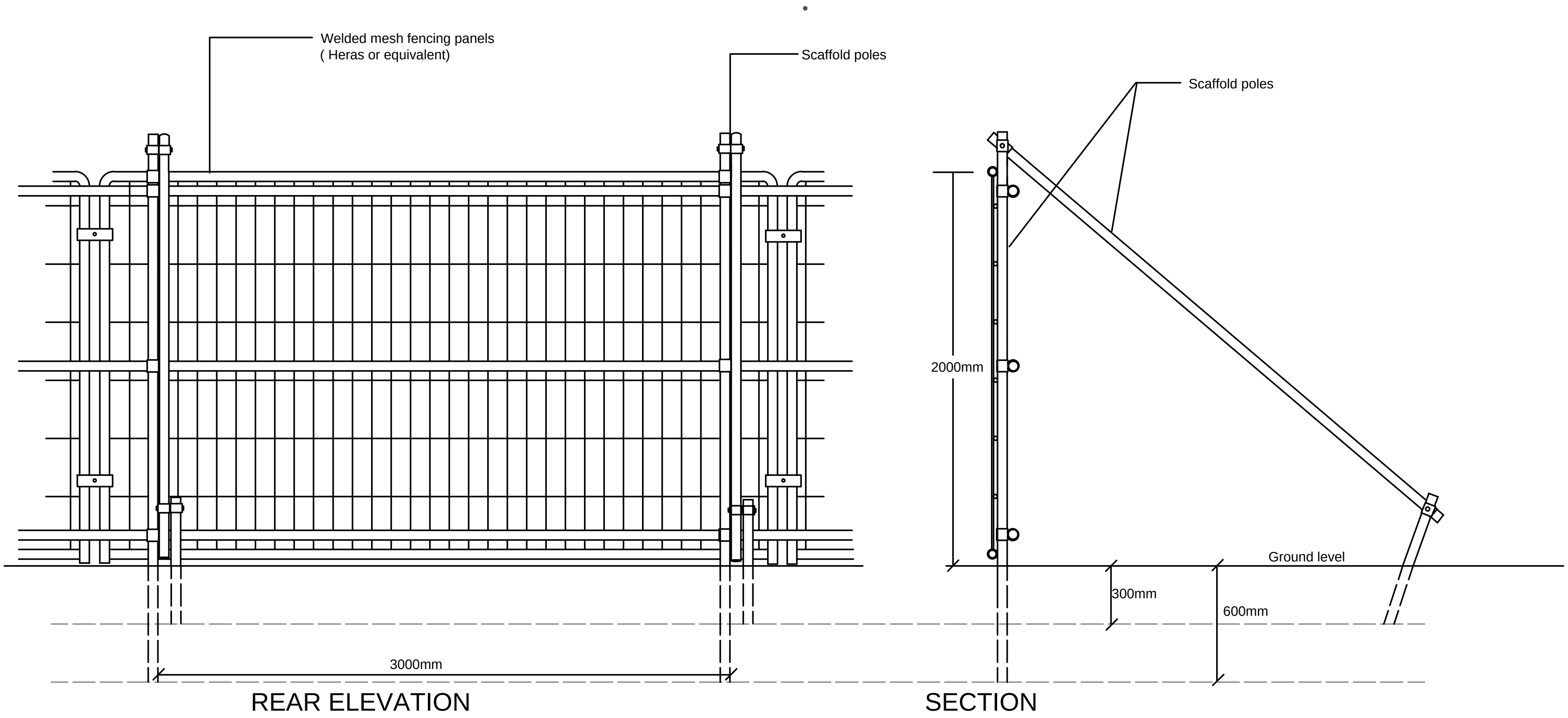
5.2 Achieve the specified increase in headroom by removing secondary branches with the smallest possible diameter in accordance with the principles of Active Target pruning

5.3 Where necessary to avoid pruning wounds in excess of 30% of the diameter of the parent branch or stem, shorten rather than remove the limb to be pruned back to a healthy lateral with the largest possible diameter in relation to its parent branch. .

5.4 Shortening cuts will be made distal to the union with the lateral branch using Active Target pruning principles

Appendix c

BS protective fencing detail
Tree protection notice
Tree protection notes



Excerpts from *BS5837:2012 Trees in relation to design, demolition and construction - Recommendations*

(*For barriers*) the default specification should consist of a vertical and horizontal scaffold framework comprising a vertical and horizontal framework, well braced to resist impacts, with vertical tubes spaced at a maximum interval of 3m and driven securely into the ground.
Onto this framework, welded mesh panels should be securely fixed. using wire or scaffold clamps.
Care should be exercised when locating the vertical poles to avoid underground services and, in the case of bracing poles, also to avoid contact with o structural roots

NOTE: The above is preferred because it is readily available, resistant to impact, can be re-used and enables inspection of the protected area

BS5837:2012 Protective Fencing Detail

Scale: 1:20 [A4]

Skerratt
arboricultural advice
158 MALDEN ROAD
LONDON NW5 4BT
07768 398776

TREE PROTECTION ZONE

KEEP OUT

NO DIGGING OR TRENCHING
NO STORAGE OF PLANT AND MATERIALS
NO VEHICULAR ACCESS
NO FIRES TO BE LIT
NO CHEMICALS TO BE STORED OR HANDLED IN THE VICINTY OF THIS ZONE
AVOID PHYSICAL DAMAGE TO TREES

REPORT DAMAGE TO TREES OR FENCING IMMEDIATELY

48 SHOOT UP HILL
LONDON
NW2 3QB

CARING FOR TREES

TREE PROTECTION NOTES

Trees are thin skinned and easily damaged

Their roots spread widely and run close to the ground surface.

All of the following can cause serious damage:

- Heavy traffic over and the storage of heavy materials above tree roots
- Direct damage to stems and branches from badly handled construction equipment,
- Root damage caused by unnecessary excavation
- Leakage of toxic liquids and powders above roots and close to tree stems.

Please keep the trees on site safe by following these simple rules carefully and in full.

There is a protective fence round each retained tree. These fenced-off areas are CONSTRUCTION EXCLUSION ZONES (CEZ). Don’t enter any CEZ unless authorised to do so

In Construction Exclusion Zones

- Don’t store any materials
- Don’t use heavy machinery
- Don’t handle toxic materials
- Stick to the planned work programme. Don’t undertake unscheduled variations
- Don’t light fires
- Report any damage to protective fencing to the Site Manager

Work Planning

Plan your work so that construction machinery does not come into contact with and cause damage to branches and stems of retained trees.

Appoint someone to supervise movement of machinery and equipment close to CEZs

Tell the Site Manager if tree pruning is needed to get machinery in, out or around the site. Don’t do it yourself

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