CampbellReith
consulting engineers

317 Finchley Road
London NW3 6EP

Basement Impact Assessment Audit

For

London Borough of Camden

Project Number: 12336-73
Rev: F1

October 2016

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Author	A J Marlow, BSc CEng MIStructE FConsE/ F Drammeh MEng (Hons)
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Project Number	12336-73
Project Name	317 Finchley Road, London NW3 6EP
Planning Reference	2016/2910/P

Contents

Appendices

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 317 Finchley Road (planning reference 2016/2910/P). The basement is considered to fall within Category C 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 review it against an agreed audit check list.

1.4. The BIA has been prepared and reviewed by personnel who have suitable qualifications.

1.5. Following demolition of the existing building, the proposal is to deepen and extend the existing basement to the rear from 2.85 to 7.50m below Finchley Road. The site is bounded by Finchley & Frognal Overground Station, Finchley Road, and the residential buildings adjacent to Billy Fury Way.

1.6. Ground investigations have identified that the site has varying depths of Made Ground overlying the London Clay to depth. Perched water was encountered within the Made Ground which will be removed during excavation.

1.7. It is proposed to install a secant bored pile retaining wall with the softer female piles terminated at just below basement level. An indicative temporary works propping solution has been provided as requested, however, final design details should reconsider potential prop deflections.

1.8. The proposals recognise that uplift forces due to heave and groundwater flotation effects will occur and proposes suitable mitigation measures.

1.9. Increases in areas of hard landscaping and roofs have been mitigated by the introduction of an attenuation storage tank and roof terrace container gardens to increase the rainfall interception storage capability.

1.10. The Drainage Strategy Report proposes an acceptable solution to restrict the surface water discharge from site to 5l/s which is a betterment of 50% from the existing situation.

1.11. Thames Water consultee comments requesting a condition be imposed upon the application, if successful, have been investigated with the BIA author who has confirmed his belief that

Thames Water have not taken account of a Drainage Strategy Report contained in the BIA. An updated response from Thames Water has been requested via the applicant, but has not been received for review. It is assumed the Planning Condition should be invoked unless otherwise advised by Thames Water.

1.12. It is accepted that the surrounding slopes to the development are stable, that no known ponds, wells or aquifers are in close proximity and that the site is outside the Hampstead pond chain catchment area. The site is identified as being in Flood Zone 1 and it is accepted to be at low risk from surface water flooding.

1.13. A ground movement assessment was undertaken using Oasys Frew for the movements due to excavation and the CIRIA C580 curves for the movements due to pile installation. A number of queries were raised on the initial GMA and these together with the responses from Webb Yates are discussed in Section 4.

1.14. The revised GMA predicts Category 1 (Very Slight) and Category 2 (Slight) damage to the neighbouring properties, which in accordance with CPG4 requires mitigation measures. Webb Yates have indicated mitigation measures had already been implemented into the analysis undertaken to date and that further measures are not considered feasible.

1.15. It is acknowledged that the assessment has demonstrated ground stability can be maintained and building damage controlled although the analysis is required to be refined and, where necessary, revised once the final construction sequence and methodology are agreed. The GMA and building damage assessments should be reviewed as part of the Party Wall award.

1.16. Whilst acceptable damage to the Network assets are part of a separate approvals process, it is recommended the revised ground movements are submitted to Network Rail.

1.17. Movement monitoring is proposed, however, no details are given. It is understood a monitoring scheme is being agreed with Network Rail. Details of the monitoring and trigger values for the neighbouring residential properties are subject to agreement at the Party Wall award stage.

1.18. It is accepted that the BIA and supplementary documents adequately identify the potential impacts of the proposed basement and subject to agreement of the Party Wall award, describe suitable mitigation.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) to carry out a Category C Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 317 Finchley Road (Camden Planning Reference 2016/2910/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 the *"Erection of a part 7 part 10 storey (above basement and low ground floor levels) building comprising 22 flats (Class C3) (4 x1 bed, 17 x 2 bed, 1 x 3 bed) and a flexible commercial unit (Use Classes A1/A2/A3) to the ground and lower ground floors, associated public realm improvements including a new footpath to the north of the site, landscaping and associated works, following demolition of existing public house, retail unit and associated structures."*

2.6. The Audit instruction confirmed that the basement proposals did not involve a listed building, nor did the site neighbour any listed buildings.

2.7. CampbellReith accessed LBC's Planning Portal on 6 July 2016 and gained access to the following relevant documents for audit purposes:

- Basement Impact Assessment Report (BIA) dated May 2016 by Webb Yates
- Construction Management Plan (CMP) dated May 2016 by Walter Lilly
- Amin Taha Architects Drawings:

  Drawing no. 240-101B - Existing Ground Flood Plan

  Drawing no. 240-400G – Proposed Basement Plan

  Drawing no. 240-401G – Proposed Lower Ground Floor Plan

  Drawing no. 240-402G – Proposed Ground Floor Plan

  Drawing no. 240-500G – Proposed Section A

  Drawing no. 240-501G – Proposed Section B

2.8. Subsequent to the issue of the initial audit report, CampbellReith was provided with the following document by email on 04 August 2016 in response to the queries raised:

- Basement Impact Assessment – Supplementary Information 04 August 2016 by Webb Yates.

2.9. Further queries were raised on the ground movement assessment and the letter response to these queries was sent via email from Webb Yates on 5 October 2016. This letter together with the supplementary information provided in August is included in Appendix 3.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	BIA Section 3 and Audit paragraph 4.1.
Is data required by Cl.233 of the GSD presented?	Yes	Within the BIA.
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 Section 5.
Are suitable plan/maps included?	Yes	BIA Appendices.
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	BIA Appendix B2.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	BIA Appendix B1.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	BIA Section B3.
Is a conceptual model presented?	Yes	BIA Section 9.1.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Section 7.2.

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Section 7.1.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Section 7.3.
Is factual ground investigation data provided?	Yes	BIA Appendix E.
Is monitoring data presented?	Yes	Standpipes monitored once, see BIA Section 8.1.
Is the ground investigation informed by a desk study?	Yes	
Has a site walkover been undertaken?	Yes	
Is the presence/absence of adjacent or nearby basements confirmed?	Yes	BIA Section 9.2.4.
Is a geotechnical interpretation presented?	Yes	BIA Section 9.
Does the geotechnical interpretation include information on retaining wall design?	Yes	Given on BIA Section 9.2.2 but incomplete, however, parameters provided in Frew analysis input.
Are reports on other investigations required by screening and scoping presented?	Yes	Network Rail, LOROL & LBC Highways Approval in-principle meetings held.
Are baseline conditions described, based on the GSD?	Yes	
Do the base line conditions consider adjacent or nearby basements?	Yes	
Is an Impact Assessment provided?	Yes	BIA Sections 9.
Are estimates of ground movement and structural impact presented?	Yes	BIA Section 9.

Item	Yes/No/NA	Comment
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 9.2.2.
Have the residual (after mitigation) impacts been clearly identified?	Yes	BIA Section 9.2.3 & 9.4.
Has the scheme demonstrated that the structural stability of the building and neighbouring properties maintained?	Yes	Although GMA to is be updated once construction sequence finalised and agreed as part of Party Wall award (see Audit paragraph 4.21).
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	BIA Section 9.3.
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	As above.
Does report state that damage to surrounding buildings will be no worse than Burland Category 2?	Yes	Category 1 (Very Slight) and Category 2 (Slight) predicted (see revised calculations in Appendix 3).
Are non-technical summaries provided?	Yes	BIA Section 2.

4.0 DISCUSSION

4.1. The BIA has been carried out by an established firm of consultants and the individuals involved possess suitable qualifications.

4.2. It is proposed to demolish the existing building and retain part of the existing basement, which is approximately 2.85 metres below Finchley Road. The replacement building will consist of seven to ten storeys above ground and the basement will be deepened to approximately 7.50 metres below Finchley Road and extended to the rear of the site to obtain an additional lower ground storey opening out into the existing garden.

4.3. The development site is bounded by Finchley Road on its eastern front elevation, Billy Fury Way, a pedestrian access way, to the south and Finchley & Frognal Overground station, and associated rail tracks, to the north. Residential buildings occupy the sites adjacent to Billy Fury Way.

4.4. Two ground investigations have been undertaken which, together, comprise seven no. boreholes and four no. trial pits. These identified varying depths of Made Ground of up to 4.70m below ground underlain by London Clay to the base of the 30m deep borehole. Groundwater was monitored and seepages were noted to occur within the Made Ground. It is accepted that the variation in recorded groundwater levels is indicative of discrete and isolated pockets of perched water which will be controlled by pumping as basement excavation proceeds. The investigation has determined that the existing building is founded in the London Clay and that the existing basement retaining walls are of masonry construction with stepped brick foundations.

4.5. The BIA includes a construction sequence which assumes demolition of the existing building to ground level; installation of temporary propping followed by demolition of existing ground and basement slabs; installation of secant piled retaining wall with the softer, female piles stopping at just below the new basement level and the hard, male piles continuing to depth to support vertical and horizontal loads. The temporary works propping system will be developed by the Contractor but assuming it is sufficiently stiff to meet the requirements of the ground movement analysis, it is accepted that the proposed piling solution will minimise ground movements, and hence potential damage to neighbouring structures, whilst allowing any groundwater flow to remain unimpeded. It was requested that an indicative temporary works propping solution be provided following the initial audit.

4.6. The additional information provided includes an indicative temporary works scheme which appears acceptable with regard to its general arrangement of propping members. A supporting calculation which is also provided produces deflections in the props which appear significant,

however, and these should be reassessed when final construction design details are submitted for the relevant approvals processes.

4.7. The BIA recognises that the basement slab should be designed to resist flotation and void formers are proposed to be included below the 1000mm thick basement slab to resist uplift forces due to heave and groundwater.

4.8. The BIA includes a Drainage Strategy Report (DSR) which identifies an increase in impermeable areas due to hard landscaping and roof proposals. Mitigation proposals include the installation of a geocelluar storage tank and a pump chamber together with roof terrace container gardens to increase the rainfall interception storage capability. The surface water and foul water drainage systems will remain separated until they combine at the separated last manhole prior to entering the Thames Water combined sewer in Finchley Road.

4.9. The proposals presented in the Drainage Strategy Report reduce the surface water discharge to 5l/s (the lowest practicable rate). This provides 50% betterment from the existing surface water runoff from the site and an acceptable method of restricting the discharge.

4.10. The LBC Planning Portal includes a consultee comment from Thames Water identifying '*an inability of the existing wastewater infrastructure to accommodate the needs of this application*" and requests a 'Grampian style' condition be imposed should the Local Planning Authority look to approve the application. CampbellReith contacted Webb Yates, the authors of the BIA and Drainage Strategy Report, regarding this letter dated 27th June 2016 who confirmed that TW's comments predated the availability of the DSR. An updated response from Thames Water, following their review of the DSR should be made available via Webb Yates or the Planning Condition invoked.

4.11. At the time of writing this report, no additional response from Thames Water has been received via Webb Yates. It is assumed the Planning Condition should be invoked unless otherwise advised by Thames Water.

4.12. It is accepted that the BIA has shown that the surrounding slopes to the development are stable and that the installation of bored piles to a depth of 25 metres will minimise this potential impact.

4.13. It is accepted that no known ponds, wells or aquifers are in close proximity to the site and that the site is outside the Hampstead pond chain catchment area.

4.14. This BIA correctly identifies that Finchley Road flooded in 2002 but does not mention that Arkwright Road, on the opposite side of Finchley Road, flooded in both the 1975 and 2002 events. The BIA identifies the site as being in Flood Zone 1 and it is accepted to be at low risk

from surface water flooding. The BIA suggests that any flood water would be diverted down Billy Fury Way pedestrian footpath due to the site's topography.

4.15. A ground movement analysis was undertaken using the Oasys FREW software. Movements behind the wall were based on the approach to *correlations between wall horizontal wall deflections and ground movements behind the wall* given in CIRIA C580, however, this was based on a top down sequence with a diaphragm wall embedded in stiff clay with a significant overlying thickness of coarse grained soils.

4.16. The movements from the FREW analysis were used in the assessment of building damage although this will only account for the excavation and it appeared movements from pile installation had not been considered. Negligible (Category 0) to Very Slight (Category 1) damage was predicted for the neighbouring residential properties located to the south. Very Slight (Category 1) damage was predicted for the Finchley and Frognal Overground Station with Slight (Category 2) damage indicated for the Network Rail retaining walls to the north. The impact on the roadway did not appear to have been considered although it is acknowledged with proper control of the works, damage should be limited.

4.17. Queries were raised on approach used in the GMA, the installation movements and the foundation levels of the neighbouring properties (assumed to be at 4.50m bgl) as it was unclear how these were determined.

4.18. Justification for the approach used was given in the supplementary information provided (dated 4 August 2016, Appendix 3) together with the neighbouring property foundation depths. The response indicates the foundation depths were assumed based on discussions with the neighbours and that a sensitivity check on the basis of shallower foundation depths did not alter the damage categories predicted. It is accepted the use of Frew and reference to Figure 2.16 of CIRIA C580 to calculate movements behind the wall is broadly applicable for this stage of assessment, however, it was requested via email that the horizontal movements due to pile installation be included as these did not appear to have been considered in the revised ground movement assessment.

4.19. Further information was received from Webb Yates on 5 October 2016 (Appendix 3) and it is stated the ground movements and the resulting damage assessment now included both the horizontal and vertical movements from the installation of the 25m long piles. Category 1 (Very Slight) damage is predicted for 335 Finchley Road and Petros Gardens with Category 2 (Slight) damage for 315 Finchley Road and 2A Lithos Road, the neighbouring properties to the south. CPG4 requires mitigation measures where damage Category 1 or higher is predicted. It is stated in the Webb Yates response that mitigation measures have already been implemented in the design undertaken to date and that further measures to reduce the ground movements are not

considered feasible. It is further stated that an agreement on the movements and the suitability of the mitigation measures will be reached with the neighbours as part of the Party Wall award. These negotiations are indicated to be currently underway.

4.20. Category 2 (Slight) damage is indicated for the Finchley and Frognal Overground Station and the Network Rail retaining walls to the north. It was stated in the BIA that Network Rail had been advised of the predicted settlements. Although this is subject to a separate approvals process, it is recommended that Network Rail are advised of the revised ground movements.

4.21. Matters such as ground movement are highly dependent on the construction and propping sequences which will be determined by the Contractor. Due to the predicted damage category to the neighbouring properties indicated as Category 1 or higher, it is recommended a refined GMA and building damage assessment be undertaken once a Contractor has been appointed. This should use appropriate methods of analysis and be agreed as part of the Party Wall award.

4.22. Movement monitoring of the neighbouring properties and the Network Rail assets is proposed. It is stated a full monitoring scheme is being agreed with Network Rail. Details of the monitoring and trigger values should be agreed as part of the Party Wall award for the neighbouring properties.

5.0 CONCLUSIONS

5.1. The BIA has been prepared and revised by personnel who have suitable qualifications.

5.2. Following demolition of the existing building, the proposal is to deepen and extend the existing basement to the rear from 2.85 to 7.50m below Finchley Road. The site is bounded by Finchley & Frognal Overground Station, Finchley Road, and the residential buildings adjacent to Billy Fury Way.

5.3. Ground investigations have identified that the site has varying depths of Made Ground overlying the London Clay to depth. Perched water was encountered within the Made Ground which will be removed during excavation.

5.4. It is proposed to install a secant bored pile retaining wall with the softer female piles terminated at just below basement level. An indicative temporary works propping solution has been provided as requested, however, final design details should reconsider potential prop deflections.

5.5. The proposals recognise that uplift forces due to heave and groundwater flotation effects will occur and proposes suitable mitigation measures.

5.6. Increases in areas of hard landscaping and roofs have been mitigated by the introduction of an attenuation storage tank and roof terrace container gardens to increase the rainfall interception storage capability.

5.7. The Drainage Strategy Report proposes an acceptable solution to restrict the surface water discharge from site to 5l/s which is a betterment of 50% from the existing situation.

5.8. Thames Water consultee comments requesting a condition be imposed upon the application, if successful, have been investigated with the BIA author who has confirmed his belief that Thames Water have not taken account of a Drainage Strategy Report contained in the BIA. An updated response from Thames Water has been requested via the applicant, but has not been received for review. It is assumed the Planning Condition should be invoked unless otherwise advised by Thames Water.

5.9. It is accepted that the surrounding slopes to the development are stable, that no known ponds, wells or aquifers are in close proximity and that the site is outside the Hampstead pond chain catchment area. The site is identified as being in Flood Zone 1 and it is accepted to be at low risk from surface water flooding.

5.10. A ground movement assessment was undertaken using Oasys Frew for the movements due to excavation and the CIRIA C580 for the movements due to pile installation. A number of queries were raised on the initial GMA and these together with the responses from Webb Yates are discussed in Section 4.

5.11. The revised GMA predicts Category 1 (Very Slight) and Category 2 (Slight) damage to the neighbouring properties, which in accordance with CPG4 requires mitigation measures. Webb Yates have indicated mitigation measures had already been implemented into the analysis undertaken to date and that further measures are not considered feasible.

5.12. It is acknowledged that the assessment has demonstrated ground stability can be maintained and building damage controlled although the analysis is required to be refined and, where necessary, revised once the final construction sequence and methodology are agreed. The GMA and building damage assessments should be reviewed as part of the party wall award.

5.13. Whilst acceptable damage to the Network assets are part of a separate approvals process, it is recommended the revised ground movements are submitted to Network Rail.

5.14. Movement monitoring is proposed, however, no details are given. It is understood a monitoring scheme is being agreed with Network Rail. Details of the monitoring and trigger values for the neighbouring residential properties are subject to agreement at the Party Wall award stage.

5.15. It is accepted that the BIA and supplementary documents adequately identify the potential impacts of the proposed basement and subject to agreement of the Party Wall award, describe suitable mitigation.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Thames Water	N/A	27.6.16	Waste Water – inability of existing infrastructure to accommodate application, Surface Water attenuation.	See Audit paragraphs 4.8 to 4.11.
Network Rail	N/A	28.6.16	Safe Operation of the railway.	See Audit paragraphs 4.15 to 4.22.

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Stability	Indicative temporary works propping solution was received within requested additional information.	Closed - but see comment in Audit paragraph 4.6.	05/10/2016
2	Stability	Queries on the ground movement assessment.	Closed – see Audit paragraphs 4.15 to 4.22.	05/10/2016
3	Stability	Movement monitoring.	Details and trigger values to be agreed with Network Rail and as part of Party Wall award for neighbouring residential properties.	N/A
4	Drainage	No updated response from Thames Water received so Planning Condition should be invoked.	Closed - but see comment in Audit paragraph 4.11.	05/10/2016

Appendix 3: Supplementary Supporting Documents

Webb Yates BIA Supplementary Information dated 4 August 2016

Webb Yates Supplementary BIA Information dated 5 October 2016

Basement Impact Assessment – Supplementary Information

J2680 317 Finchley Road

Ref: J2680-Doc-10
Revision: X1

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GENERAL NOTES

Only construction status documentation is to be constructed from. If you do not have a construction issue document and you are about to build something, please contact Webb Yates Engineers. Ensure that you have the latest revision prior to construction.

REVISION HISTORY

Revisions indicated with line in margin.

Revision status: P = Preliminary, T = Tender, C = Construction, X = For Information

Revision	Date	Author	Reviewer	Approver	Description
X1	04/08/16	PCW	TW	TW	Issued for information

1 INTRODUCTION

A Basement Impact Assessment (including Site Investigation), referenced J2680-Doc-04, Revision X1 has been submitted as part of a planning application for a proposed development at 317 Finchley Road, London, NW3 EP. The Basement Impact Assessment (BIA) was prepared by Webb Yates Engineers Ltd (WYE) and BRD Environmental Limited (BRD).

Campbell Reith Hill LLP (CampbellReith) has undertaken a draft Basement Impact Assessment Audit, Rev D1, dated July 2016, which identified items to be addressed in order to complete the audit.

This document provides supplementary information which addresses the items identified by CampbellReith. This document shall be read in conjunction with the original BIA, referenced J2680-Doc-04, Revision X1.

This document does not address items relating to Thames Water submissions, which will be addressed separately.

2 SLOPE STABILITY

2.1 TEMPORARY PROPPING SCHEME

An indicative temporary propping scheme was requested by CampbellReith and is included as Appendix A with supporting calculations.

2.2 GROUND MOVEMENT ANALYSIS

CampbellReith has advised that further information is required to justify the ground movement calculation approach, provide a basis for the neighbouring foundation depths, and to consider ground movements due to pile installation.

2.2.1 BASIS OF CALCULATION

The approach used was to determine the vertical ground movements of the surrounding area based on the lateral deflection profile of the retaining wall, as described in CIRIA C580 [Ref 1] and reproduced in Figure 1. CampbellReith identify that this relationship was determined from a "top down sequence with a diaphragm wall embedded in stiff clay with a significant overlying thickness of coarse grained soils". This is considered applicable for the following reasons:

- Away from the corners of the excavation, where the dominant behaviour is that of a vertically spanning wall, the behaviour of a secant piled wall would be similar to that of a diaphragm wall.
- The proposed temporary propping scheme will result in a high stiffness system, similar to that achieved by a top down construction sequence. The excavation required to install the first line of piles (approximately 1-1.5 m) is similar to that which would be required for a top down sequence. This is further validated by the shape of the deflection profiles from the Oasys FREW analysis, which closely resemble that of a top down construction sequence.
- The case histories used to determine the above relationship consisted of 16 m and 18 m deep excavations, retaining up to 10 m of course grained soils overlying the stiff clay. The proposed retaining walls are also embedded entirely into stiff clay, and support between 0 – 4.7 m of coarse made ground overlying London Clay with a maximum

excavation depth of approximately 8.5 m. While the proposed depths are less than the case histories, the soil profiles contain sufficient similarity to indicate that the calculation method will provide a suitably accurate approximation for this scenario.

- Data shown in Figure 2.11(b) of CIRIA C580 (reproduced as Figure 2) and subsequent correlation, is based on a range of sites which included bored pile, diaphragm and sheet pile walls wholly embedded in stiff clay. A comparison is shown in Appendix B between this correlation and the more detailed calculation approach undertaken, and verifies the choice of calculation method.

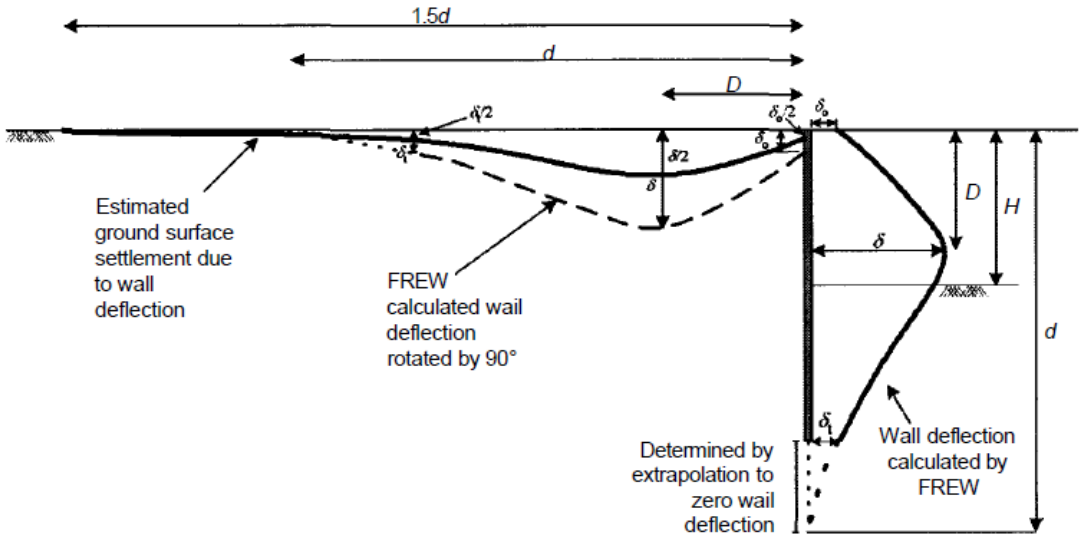


Figure 1: Vertical settlement due to horizontal movement of wall [Ref 1]

2.2.2 ADJACENT BUILDING DETAILS

The building at 315 Finchley Road is known to contain a basement, based on the information available in previous planning applications and party wall discussions with the owners. The presence of the basement has been verified by external site walkovers, although it is noted that no measurements or intrusive works have been undertaken.

The depth of 4.5 m is then based on the assumption that the underside of the basement floor is 3.5 m below ground floor FFL, with a strip footing founded an additional 1 m further down. It is accepted that this may be an overestimate of the depth and as such a check has been undertaken if the surcharge is applied at 3 mBGL, resulting in the a similar maximum horizontal displacement due to wall movement of approximately 17 mm.

2A Lithos Road has been assumed to have a similar depth of foundation, however it is accepted that it is possible that the depth is as shallow as 1.5 mBGL.

A sensitivity check has been undertaken on the Burland Scale results, and indicates that whether the foundations are as shallow as 1.5 mBGL or as deep as 4.5 mBGL, the damage category does not change. Burland Scale results are provided in Section 2.2.4.

Once the demolition contractor has been engaged, but well in advance of when piling commences, further investigation in the form of internal inspection and external trial pits will be undertaken to confirm the foundation construction. The FREW analysis and Burland Scale calculations will then be repeated based on the confirmed foundation details and the temporary works and/or pile design modified if necessary.

2.2.3 PILE INSTALLATION MOVEMENTS

Predicted ground movements due to pile installation have now been considered, with calculations included in Appendix B. The calculations are based on CIRIA C580, Table 2.2 and Figure 2.8(b) [Ref 1], reproduced as Figure 2 below. It is noted that the correlations are based on secant piled walls embedded into clay, and are therefore considered to be a suitable (albeit limited in size) sample set.

The computed values are expected to be conservative on the basis that the correlation is not based on the mean of the case study values, but that it appears to be based upon the largest measured deflections across all of the studies. Furthermore the case studies are based on pile diameters of 0.75 m to 1.2 m in diameter (although note that not all case studies listed the diameter) and therefore it is expected that for a 0.6 m diameter piled wall the ground movements would be less than suggested by Figure 2.

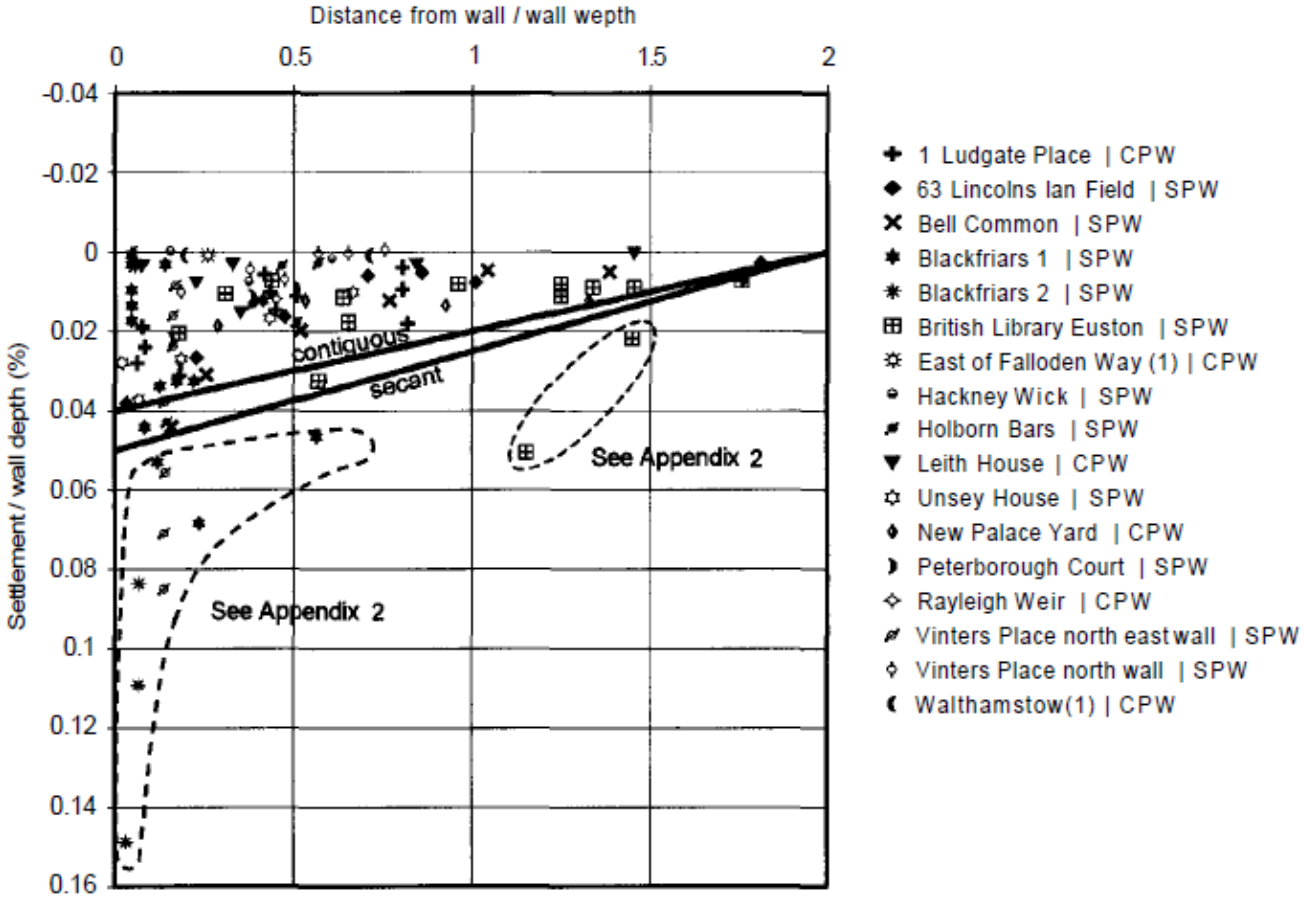


Figure 2: Vertical settlement due to piled wall installation [Ref 1]

2.2.4 RESULTS

The revised anticipated ground movements, subject to final temporary works design, are shown in Figures 3 and 4. Figure 3 shows the ground movements due to horizontal movement of the retaining walls, while Figure 4 shows the total vertical ground movements due to piled wall installation and horizontal movement of the retaining walls.

In reality, it is considered that the actual settlement profile will be somewhere in between these values due to the likelihood that the movements due to piled wall installation are an overestimate, for the reasons discussed in Section 2.2.3.

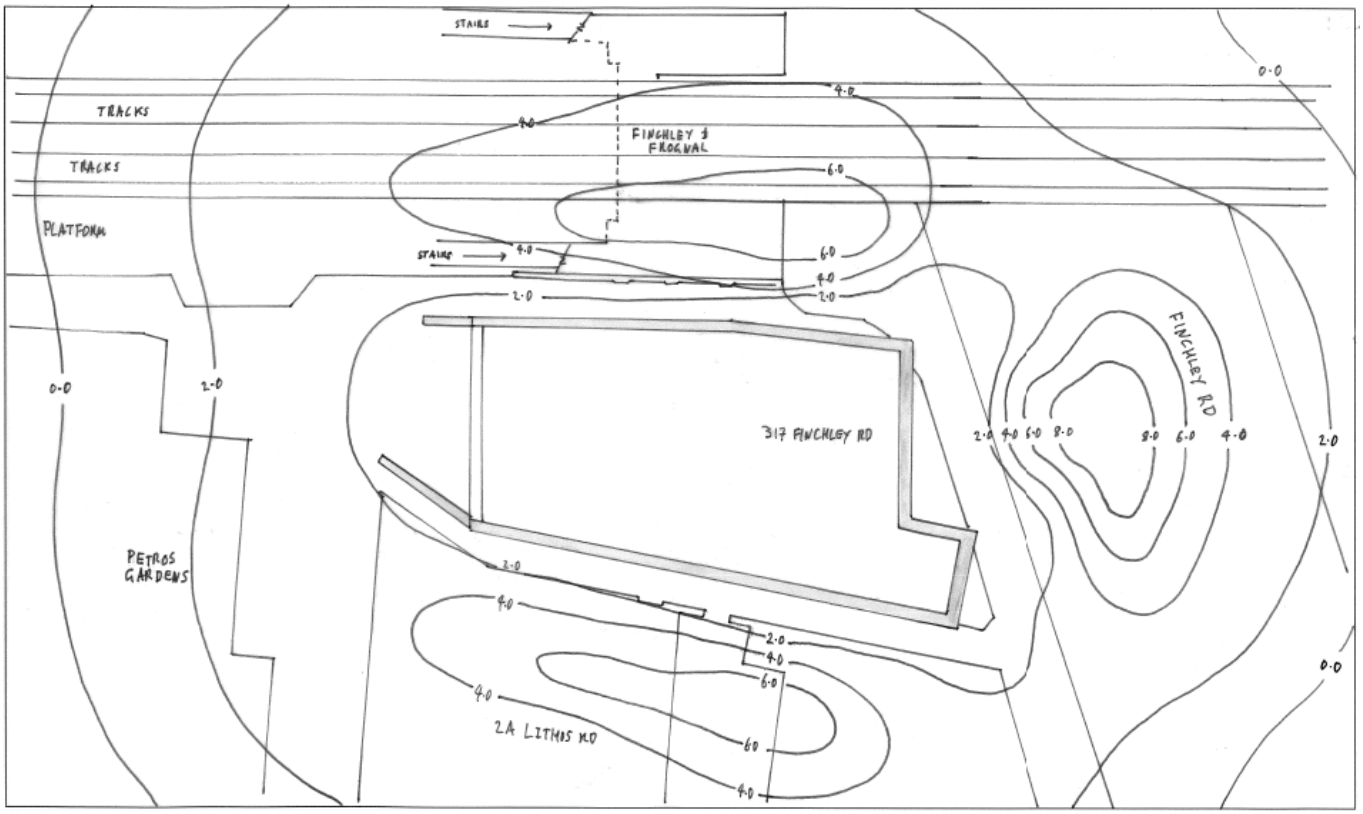


Figure 3: Predicted vertical ground movements due to horizontal movement of retaining walls

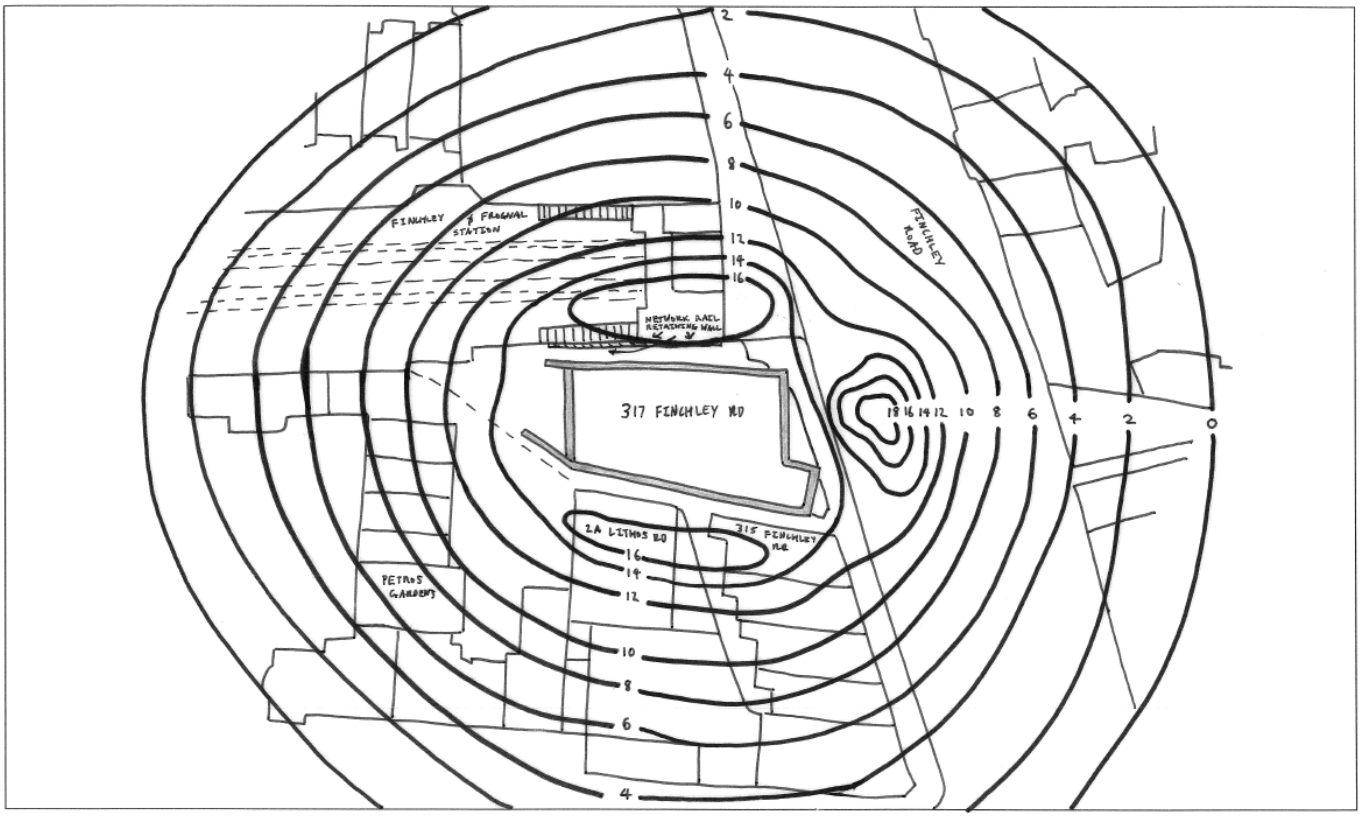


Figure 4: Total predicted vertical ground movements

The impact on the adjacent structures has been assessed, based on the total ground movements, with the results shown in Table 1.

Table 1: Predicted Burland Scale categories

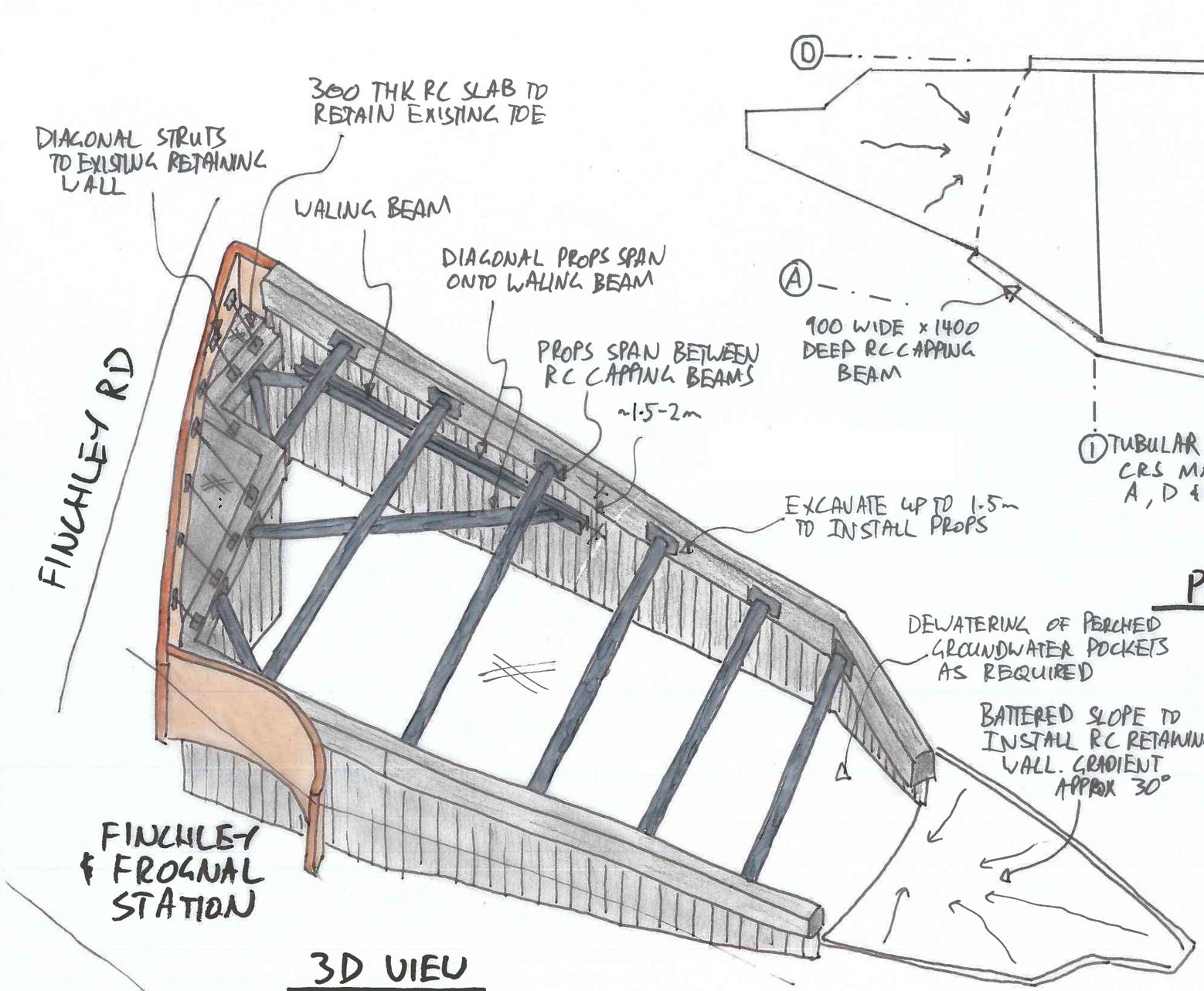
Structure	Burland Scale Category	Approximate Crack Width
315 Finchley Road	1 Very Slight	< 1 mm
2A Lithos Road	1 Very Slight	< 1 mm
Petros Gardens	0 Negligible	< 0.1 mm
335 Finchley Road	0 Negligible	< 0.1 mm
Finchley & Frognal Overground Station	1 Very Slight	< 1 mm
Network Rail Retaining Walls	2 Slight	< 5 mm

Table 1 indicates that the damage categories for adjacent buildings are less than or equal to Category 1, indicating that the settlements are acceptable and any very slight damage is easily repairable. The retaining wall, which is anticipated to be subject to Category 2, will only be subject to superficial damage which will be easily repairable, should it occur. Buildings which are located further away from those listed above are expected to have negligible differential settlement.

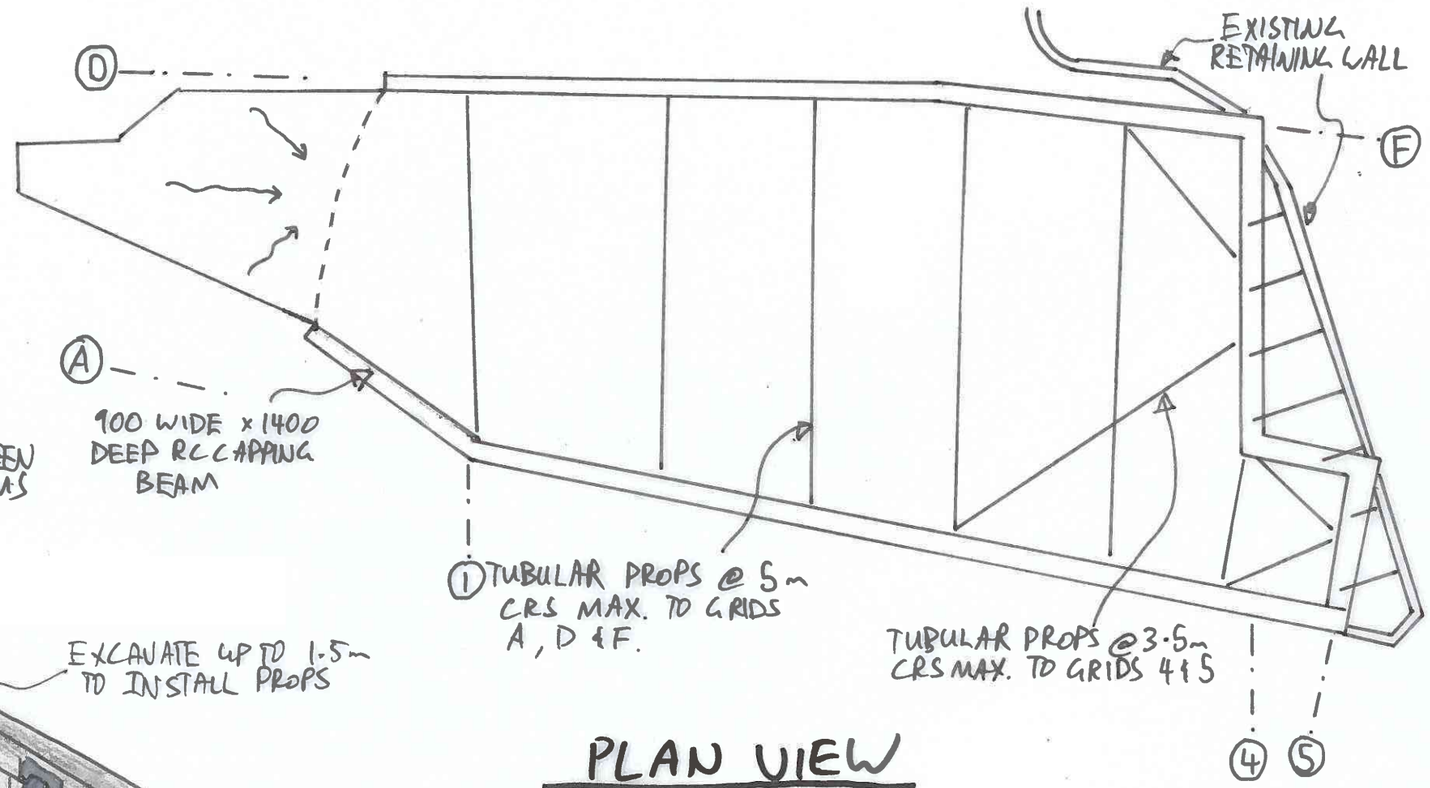
3 REFERENCES

1. Ciria C580 London 2003: Embedded retaining walls – guidance for economic design. A.R Gaba, B. Simpson, W. Powrie, D. R. Beadman

APPENDIX A: INDICATIVE TEMPORARY PROPPING SCHEME



3D VIEW



PLAN VIEW

NOTES:

1. FINAL DESIGN OF PILED RETAINING WALLS & TEMPORARY PROPPING SCHEME TO BE BY SPECIALIST CONTRACTOR.
2. TUBULAR PROPS TO BE APPROX 800 ϕ x 25mm THK AT LOCATIONS WITH GREATEST LOAD.
3. WALING BEAMS TO BE APPROX UC 356x406x551 OR 900x1400 RC CAPPING BEAM.
4. TO BE READ IN CONJUNCTION WITH ALL STRUCTURAL DRAWINGS, BASEMENT IMPACT ASSESSMENT & GROUND MOVEMENT ANALYSIS

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Drawing No	J2680-SK-022		
Project	317 FINCHLEY RD	Status	INFO
Drawing Title	INDICATIVE PROPPING SCHEME		
Date	01/08/16	Drawn by	PCW
Scale	N/A	Revision	X1

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Project	317 FINCHLEY RD		
Part of structure	TEMPORARY WORKS		
Date	01/08/2016	Job number	J2680
Engineer	Checked by	Checked date	Sheet number
PCW			1

From FREW analysis, prop stiffness = 100,000kN/m/m

Say max 5.0m prop spacing along sides & max 3.5m prop spacing along Finchley Rd elevation.

Initially assume 50% beam deflection & 50% props, so:

SIDE WALLS

$$EI_{BEAM} \geq \frac{5wL^4}{384\Delta}$$

$$\geq \frac{5 \times 100 \times 10^3 \times 5000^4}{384 \times 500}$$

$$\geq 1.628 \times 10^{15}\ N mm^2$$

For capping bean, $E \simeq 25{,}000\ N/mm^2$

$\therefore I \geq 65.10 \times 10^9\ mm^4$

and considering a 900 x 1400 capping beam:

$$I = \frac{1400 \times 900^3}{12}$$

$$= 85.05 \times 10^9\ mm^4 \quad \therefore \text{OK}$$

RC BEAM:
900 x 1400

And so the maximum permissible deflection in props is:

$$\Delta_{max} = 1000mm - \frac{5 \times 100 \times 10^3 \times 5000^4}{384 \times 25{,}000 \times 85.05 \times 10^9}$$

$$= 617\ mm$$

$$\therefore A_{PROP} \geq \frac{PL}{E\Delta}$$

L = Length

$$\geq \frac{500 \times 10^6 \times 14000}{617 \times 200 \times 10^3}$$

$$\geq 56{,}730\ mm^2$$

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Part of structure: TEMPORARY WORKS			
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Engineer: PCW	Checked by:	Checked date:	Sheet number: 2

So use an 800ϕ x 25 thk circular section,

$A_{prop} = 60,870 mm^2$ ∴ OK

PROPS:
800ϕ x 25

FRONT WALL

Say steel waling beam:

$$EI_{BEAM} \geq \frac{5 \times 100 \times 10^3 \times 3500^4}{384 \times 500}$$

$$\geq 390.8 \times 10^{12} N mm^2$$

$E = 200,000 N/mm^2$ for steel

$\therefore I \geq 1.954 \times 10^9 mm^4$

So use a UC 356 x 406 x 551 kg/m:

$I = 2.270 \times 10^9 mm^4$

WALER:
UC 356 x 406 x 551

(OR RC capping beam also OK per side wall)

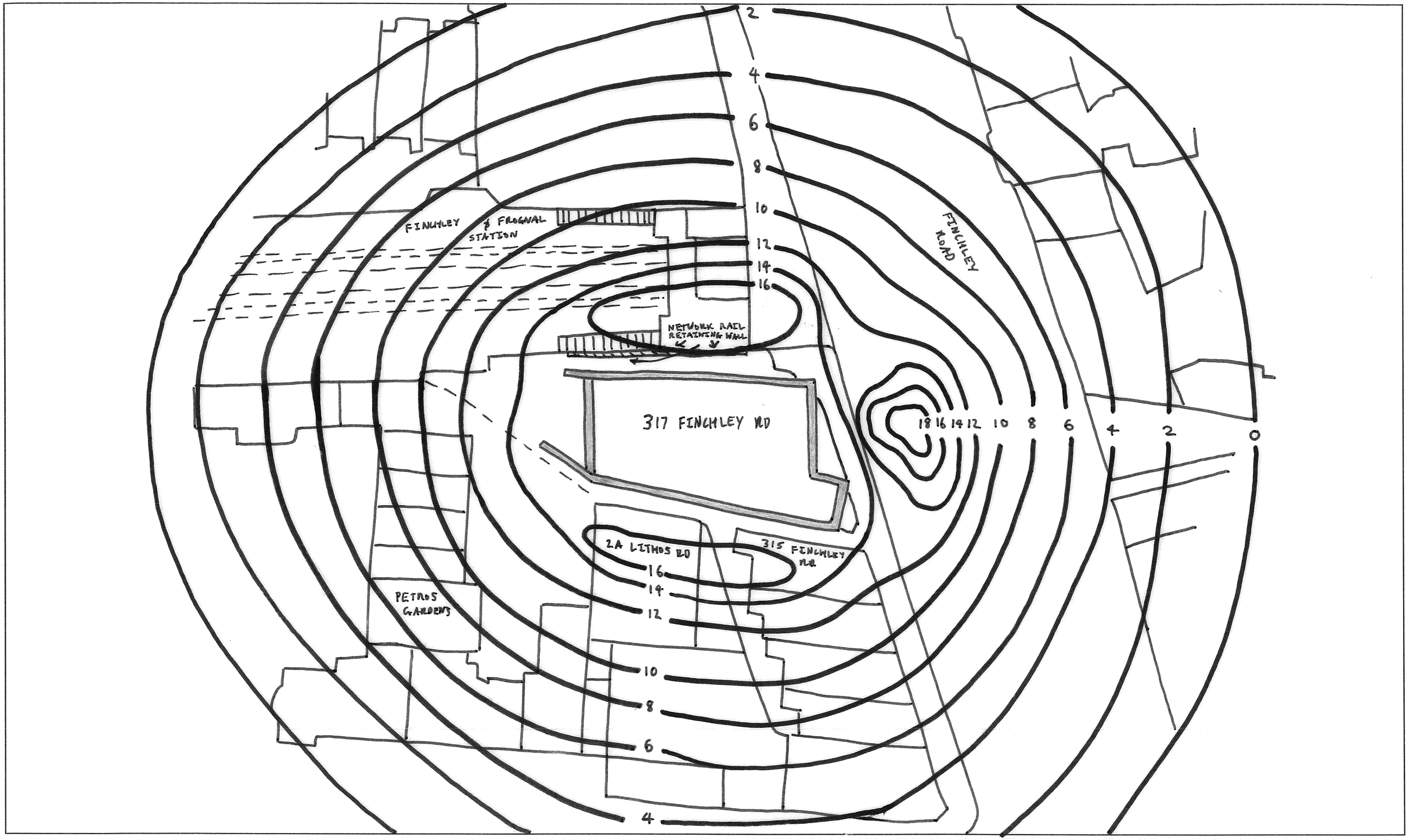
And so by inspection / comparison w/ side walls, ϕ800 x 25 props will also be sufficient.

· PROPPING SCHEME:

- SIDE WALLS: SINGLE HIGH LEVEL PROPS @ 5m CRS
- FINCHLEY RD WALL: SINGLE HIGH LEVEL PROPS @ 3.5m CRS (DIAGONAL TO SIDE WALLS)
- EXISTING WALL: DIAGONAL PROPS TO NEW SLAB/BEAM. SMALL DIAMETER ∴ EASILY DESIGNED BY CONTRACTOR, ~2m CRS.

* FINAL TEMPORARY WORKS DESIGN BY CONTRACTOR

APPENDIX B: SUPPORTING CALCULATIONS



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Drawing No	J2680-SK-023		
Project	317 FINCHLEY RD	Status	INFO
Drawing Title	TOTAL GROUND MOVEMENTS		
Date	01.8.16	Drawn by	S.M.
Scale	~1:900	Revision	X1

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Part of structure: VERIFICATION OF SETTLEMENTS.			
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Engineer: PCW	Checked by:	Checked date:	Sheet number: 1

Consider wall adjacent to 315 Finchley Rd as typical example:

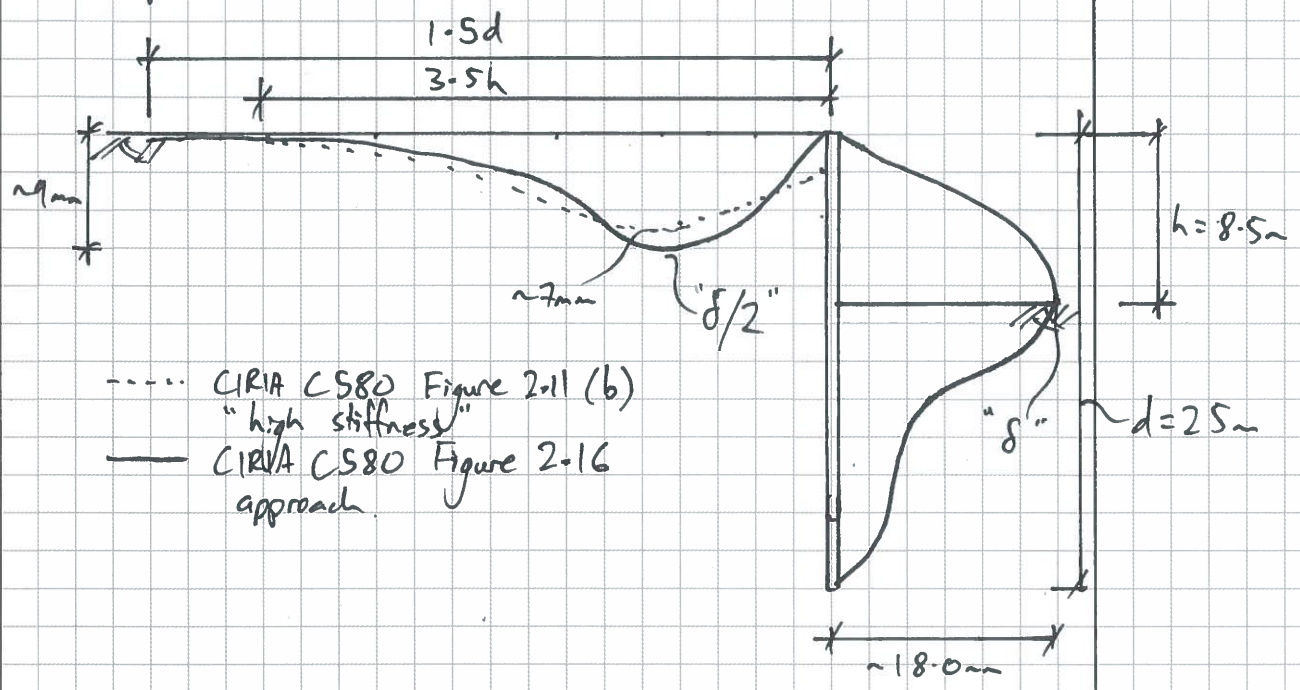

Figure 2.16 approach will produce worst case differential settlements & is therefore more appropriate for calculating Burland Scale categories.

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Engineer	Checked by	Checked date	Sheet number
S.H.			1

BURLAND SCALE ASSESSMENT

① RETAINING WALL IN NETWORK RAIL

② FINCHLEY & FROGNAL STATION

③ 2A LITHOS ROAD - 1.5m foundation depth

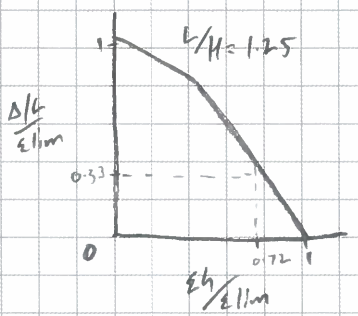
④ 2A LITHOS ROAD - 4.5m foundation depth

⑤ 315 FINCHLEY ROAD - 1.5m foundation depth

⑥ 315 FINCHLEY ROAD - 4.5m foundation depth

① RETAINING WALL IN NETWORK RAIL - 2m Foundation depth

- MAX VERTICAL DEFLECTION = $\Delta = 1.5$ mm
- MAX HORIZONTAL DEFLECTION = $\delta_h = 3$ mm
- LENGTH OF STRUCTURE = $L = 3$m
- HEIGHT OF STRUCTURE = $H = 2.4$m
- $L/H = 1.25$
- $\Delta/L = 5 \times 10^{-4}$
- $\varepsilon_h = \delta_h/L = 3/3000 = 1 \times 10^{-3}$



CAT 2 : ASSUME $\Delta/L/\varepsilon_{lim} = 0.33$ ∴ $\varepsilon_h/\varepsilon_{lim} = 0.72$

ACTUAL $\varepsilon_h/\varepsilon_{lim} = 0.66 < 0.87$ ∴ CAT 2: SLIGHT

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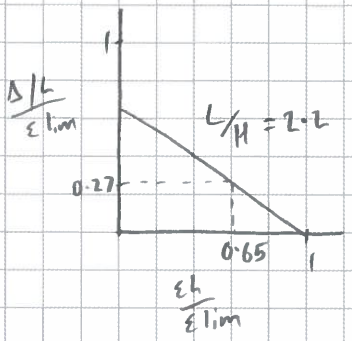
(2) FINCHLEY & FROGNAL STATION

- Δ = 2 mm
- δh = 4.5 mm
- L = 10m
- H = 4m
- L/H = 2.2
- Δ/L = 2×10^{-4}
- $\varepsilon h = \delta h / L = 4.5/10000 = 4.5 \times 10^{-4}$



CAT 1 : ASSUME : $\Delta/L / \varepsilon_{lim} = 0.27$ ∴ $\varepsilon h / \varepsilon_{lim} = 0.65$

ACTUAL : $\varepsilon h / \varepsilon_{lim} = 0.6 < 0.65$

∴ CAT 1 : VERY SLIGHT

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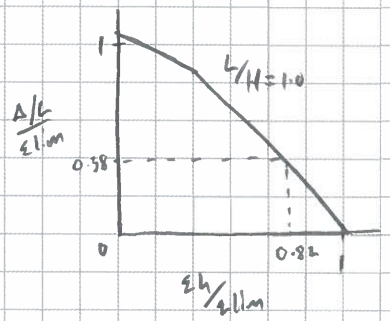
③ 2A LITHOS ROAD - Foundation at 1.5m

- Δ = 4mm
- δ_h = 7.25
- L = 14m
- H = 14m
- L/H = 1.0
- $\Delta/L = 2.86 \times 10^{-4}$
- $\varepsilon_h = \delta_h/L = 7.5/14000 = 5.36 \times 10^{-4}$

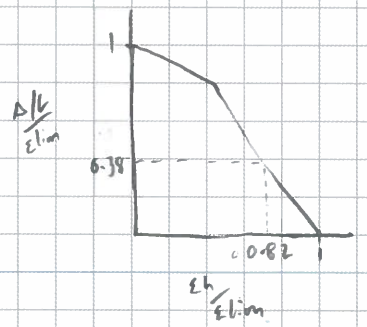


CAT 1: ASSUME: $\Delta/L/\varepsilon_{lim} = 0.38$ ∴ $\varepsilon_h/\varepsilon_{lim} = 0.82$

ACTUAL: $\varepsilon_h/\varepsilon_{lim} = 0.71$ ∴ CAT 1: VERY SLIGHT

④ 2A LITHOS ROAD - Foundation at 4.5m

- Δ = 4mm
- δ_h = 7.5mm
- L = 14m
- H = 14m
- L/H = 1.0
- $\Delta/L = 2.86 \times 10^{-4}$
- $\varepsilon_h = \delta_h/L = 5.36 \times 10^{-4}$



CAT 1 ASSUME: $\Delta/L/\varepsilon_{lim} = 0.38$ ∴ $\varepsilon_h/\varepsilon_{lim} = 0.82$

ACTUAL: $\varepsilon_h/\varepsilon_{lim} = 0.71$ ∴ CAT 1: VERY SLIGHT

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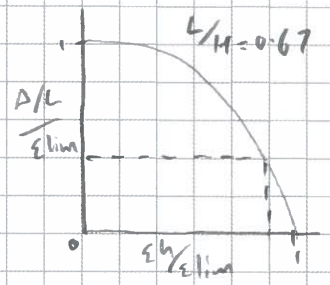
⑤ 315 FINCHLEY ROAD - Foundation at 3m

- Δ = 3mm
- δh = 4.5mm
- L = 8m
- H = 12m
- L/H = 0.67
- $\Delta/L = 3.75 \times 10^{-4}$
- $\varepsilon h = \delta h/L = \frac{4.5}{8000} = 5.63 \times 10^{-4}$



CAT 1

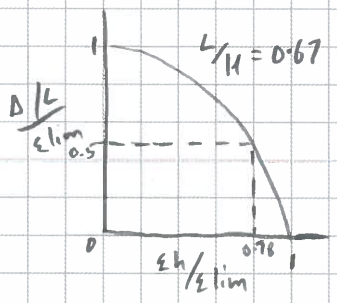
Assume: $\varepsilon h/\varepsilon lim = 0.85$ at $\Delta/L = 3.08 \times 10^{-4}$

Actual: $\varepsilon h/\varepsilon lim = 0.75 < 0.85$ ∴ OK

∴ 315 FINCHLEY ROAD = CAT 1 : VERY SLIGHT

⑥ 315 FINCHLEY ROAD - Foundation at 4.5m

- Δ = 3mm
- δh = 4mm
- L = 8m
- H = 12m
- L/H = 0.67
- $\Delta/L = 3.75 \times 10^{-4}$
- $\varepsilon h = \delta h/L = 5 \times 10^{-4}$



CAT 1 : Assume: $\Delta/L\ /\varepsilon lim = 0.5$ & $\varepsilon h/\varepsilon lim = 0.78$

Actual: $\varepsilon h/\varepsilon lim = 0.67 < 0.78$ ∴ CAT 1 : VERY SLIGHT

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5th October, 2016

Ref: J2680/L-161005-PCW-CAM

Campbell Reith
Friars Bridge Court
41-45 Blackfriars Road
London SE1 8NZ
Attention: Fatima Drammeh

Dear Fatima,

317 Finchley Road: Supplementary information for Basement Impact Assessment

Following your email of 22nd September and our subsequent conversations, I am writing in relation to the Basement Impact Assessment (BIA) for the proposed development at 317 Finchley Road.

Horizontal ground movements due to pile installation

We have now considered horizontal ground movements due to pile installation, using CIRIA C580 *Embedded retaining walls – guidance for economic design* Figure 2.8(a), reproduced below as Figure 1.

The horizontal movements due to pile installation, based on 25 m deep piles, are therefore approximately 20 mm at the secant piled wall location, reducing to 0 mm at a distance of approximately 37.5 m from the piled wall.

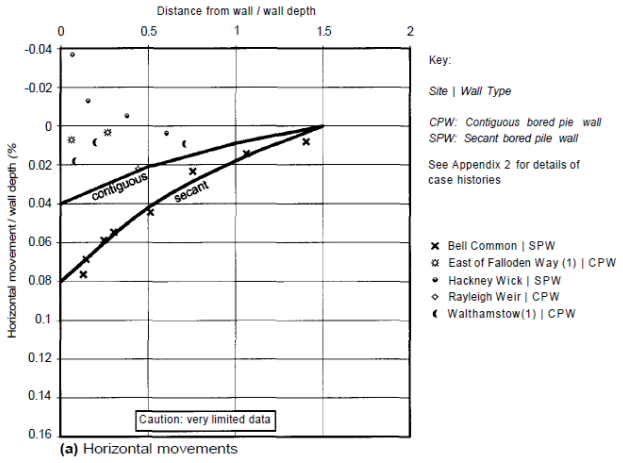

Figure 1: Horizontal ground movements due to pile installation [source: CIRIA C580]

We have now considered these movements in combination with the horizontal movement of the piled wall due to excavation, as well as the vertical ground movements previously provided, with Burland Scale calculations appended.

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Registered in England + Wales: 5393930

Burland Scale Categories

Revised Burland Scale results are provided in Table 1. It is noted that these are considered to be very conservative for the reasons identified in the BIA supplement, referenced J2680-Doc-10, revision X1.

Table 1: Predicted Burland Scale categories

Structure	Burland Scale Category	Approximate Crack Width
315 Finchley Road	2 Slight	< 5 mm
2A Lithos Road	2 Slight	< 5 mm
Petros Gardens	1 Very Slight	< 1 mm
335 Finchley Road	1 Very Slight	< 1 mm
Finchley & Frognal Overground Station	2 Slight	< 5 mm
Network Rail Retaining Walls	2 Slight	< 5 mm

Ground Movement Mitigation Measures

It is noted that Section 3.30 of *CPG4 Basements and Lightwells* requires mitigation measures to be provided where Burland Scale categories are greater or equal to Category 1: Very Slight. This mitigation of ground movements has already been undertaken during design when determining the piled retaining wall diameter/depth and temporary propping stiffness. Initial calculations for the scheme, which have not been submitted for planning approval, included smaller diameter piles and lesser offsets to the neighbouring structures, resulting in greater ground displacements. The pile diameter has subsequently been increased as far as possible and the building set back from all boundaries as far as possible, significantly reducing the basement footprint. Further reduction of the footprint by increasing pile diameters is not considered feasible due to loss of floor area.

Party wall negotiations are currently underway with all of the neighbours affected by the development. As part of this process, agreement between the engineer for the neighbouring parties and Webb Yates will be reached regarding the ground movements and suitability of the mitigation measures. As a minimum, the mitigation measures will be those provided in the BIA and submitted for planning, and any changes will only further reduce the impacts on the neighbouring properties.

Please do not hesitate to contact me should you have any queries.

Yours sincerely,

Paul Connor-Woodley
for Webb Yates Engineers Ltd.

encl. Burland Scale calculations

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Engineer	Checked by	Checked date	Sheet number
S.H.			1

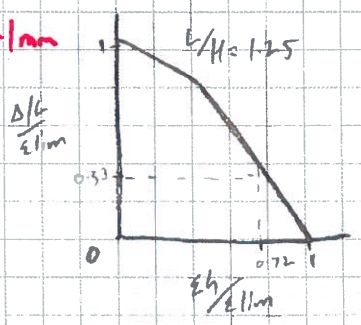
REVISED BY PCW 05/10/2016.

BURLAND SCALE ASSESSMENT

① RETAINING WALL IN NETWORK RAIL
② FINCHLEY & HENDON STATION
③ 2A LITHOS ROAD - 1.5m foundation depth
④ 2A LITHOS ROAD - 4.5m foundation depth
⑤ 315 FINCHLEY ROAD - 1.5m foundation depth
⑥ 315 FINCHLEY ROAD - 4.5m foundation depth

① RETAINING WALL IN NETWORK RAIL - 2m Foundation depth

- MAX VERTICAL DEFLECTION = Δ = 1.5mm
- MAX HORIZONTAL DEFLECTION = δ_h = 3mm +1mm = 4mm
- LENGTH OF STRUCTURE = L = 3m
- HEIGHT OF STRUCTURE = H = 2.4m
- L/H = 1.25
- $\Delta/L = 5 \times 10^{-4}$
- $\varepsilon_h = \delta_h/L = 4/3000 = 1.3 \times 10^{-3}$



CAT 2 : ASSUME $\Delta/L/\varepsilon_{lim}$ = 0.33 ∴ $\delta_h/\varepsilon_{lim}$ = 0.72

ACTUAL $\delta_h/\varepsilon_{lim}$ = 0.87 ∴ CAT 2: SLIGHT

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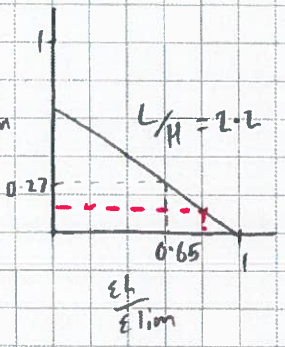
Project: 317 FINCHLEY ROAD			
Part of structure: BUILDING DAMAGE ASSESSMENT			
Date: 1/8/16		Job number: J2680	
Engineer: S.H.	Checked by:	Checked date:	Sheet number: 2

REVISED BY PCW 05/10/2016.

(2) FINCHLEY & FROGNAL STATION

- Δ = 2mm
- δh = 4.5mm + 6mm = 10.5mm
- L = 10m
- H = 4m
- L/H = 2.2
- $\Delta/L = 2 \times 10^{-4}$
- $\varepsilon h = \delta h / L = \frac{10.5}{10000} = 1.05 \times 10^{-3}$



CAT 1: ASSUME: $\Delta/L/\varepsilon_{lim} = 0.27$ ∴ $\varepsilon h/\varepsilon_{lim} = 0.65$

ACTUAL: $\varepsilon h/\varepsilon_{lim} = 1.4 > 0.65$ ∴ EXCEEDS CAT 1.

~~∴ CAT 1: VERY SLIGHT~~

CAT 2: ASSUME: $\Delta/L/\varepsilon_{lim} = 0.133$ ∴ $\varepsilon h/\varepsilon_{lim} = 0.80$

ACTUAL: $\varepsilon h/\varepsilon_{lim} = 0.70 < 0.80$

∴ CAT 2: SLIGHT

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S.Wi			3

REVISED BY PDW 05/10/2016.

③ 2A LITHOS ROAD - Foundation at 1.5m

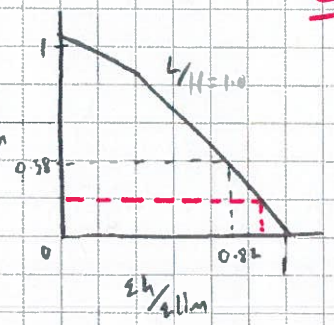
CAT 2: ASSUME $\Delta/L/\varepsilon_{lim} = 0.19$

∴ $\varepsilon_h/\varepsilon_{lim} \leq 0.90$

ACTUAL $\varepsilon_h/\varepsilon_{lim} = 0.83$

∴ CAT 2: SLIGHT

- Δ = 4mm
- δ_h = 7.25 +10mm = 17.25mm
- L = 14m
- H = 14m
- L/H = 1.0
- $\Delta/L = 2.86 \times 10^{-4}$
- $\varepsilon_h = \delta_h/L = 17.5/14000 = 1.25 \times 10^{-3}$ ~~5.36×10^{-4}~~



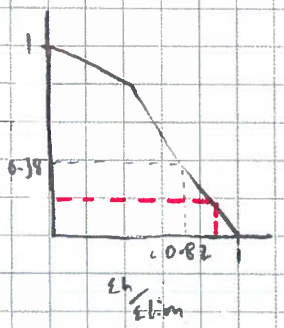
CAT 1: ASSUME: $\Delta/L/\varepsilon_{lim} = 0.38$ ∴ $\varepsilon_h/\varepsilon_{lim} = 0.82$

ACTUAL: $\varepsilon_h/\varepsilon_{lim}$ = ~~0.71~~ 1.67 ∴ ~~CAT 1: VERY SLIGHT~~

∴ EXCEEDS CAT 1.

④ 2A LITHOS ROAD - Foundation at 4.5m

- Δ = 4mm
- δ_h = 7.5mm +10mm = 17.25mm
- L = 14m
- H = 14m
- L/H = 1.0
- $\Delta/L = 2.86 \times 10^{-4}$
- $\varepsilon_h = \delta_h/L = 5.36 \times 10^{-4}$ ~~$\times 10^{-4}$~~ 1.25×10^{-3}



CAT 1 ASSUME: $\Delta/L/\varepsilon_{lim} = 0.38$ ∴ $\varepsilon_h/\varepsilon_{lim} = 0.82$

ACTUAL: $\varepsilon_h/\varepsilon_{lim} = 0.71$ ∴ ~~CAT 1: VERY SLIGHT~~

∴ EXCEEDS CAT 1.

CALC FOR CAT 2 AS ABOVE, ∴ CAT 2: SLIGHT.

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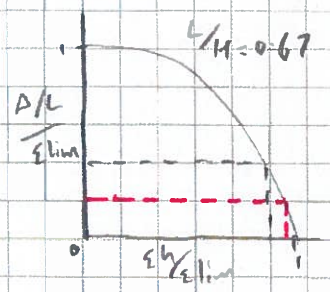
Engineer	Checked by	Checked date	Sheet number
S.H.			4

REVISED BY PCW 05/10/2016.

⑤ 315 FINCHLEY ROAD - Foundation at 3m

- Δ = 3mm
- δh = 4.5mm + 6mm = 10.5mm
- L = 8m
- H = 12m
- L/H = 0.67
- $\Delta/L = 3.75 \times 10^{-4}$
- $\varepsilon_h = \delta h/L = \frac{10.5}{8000} = 1.31 \times 10^{-3}$



CAT 2: ASSUME $\varepsilon_h/\varepsilon_{lim}$ = 0.205

∴ $\varepsilon_h/\varepsilon_{lim}$ = 0.92

& ACTUAL $\varepsilon_h/\varepsilon_{lim}$ = 0.87

∴ CAT 2: SLIGHT

CAT 1

Assume: $\varepsilon_h/\varepsilon_{lim}$ = 0.85 at $\Delta/L = 3.08 \times 10^{-4}$

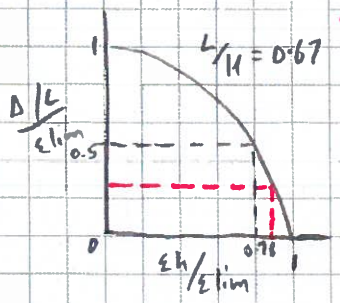
Actual: $\varepsilon_h/\varepsilon_{lim}$ = ~~0.75~~ 1.75 > 0.85 ∴ OK.

∴ EXCEEDS CAT 1.

~~∴ 315 FINCHLEY ROAD = CAT 1 : VERY SLIGHT~~

⑥ 315 FINCHLEY ROAD - Foundation at 4.5m

- Δ = 3mm
- δh = 4mm + 6mm = 10mm
- L = 8m
- H = 12m
- L/H = 0.67
- $\Delta/L = 3.75 \times 10^{-4}$
- $\varepsilon_h = \delta h/L = \frac{10}{8000} = 1.25 \times 10^{-3}$



CAT 2: ASSUME $\varepsilon_h/\varepsilon_{lim}$ = 0.25

∴ $\varepsilon_h/\varepsilon_{lim}$ = 0.88

& ACTUAL $\varepsilon_h/\varepsilon_{lim}$ = 0.87

∴ CAT 2: SLIGHT

CAT 1: Assume: $\Delta/L / \varepsilon_{lim}$ = 0.5 & $\varepsilon_h/\varepsilon_{lim}$ = 0.78

Actual: $\varepsilon_h/\varepsilon_{lim}$ = ~~0.67~~ 1.67 > 0.78 ~~∴ CAT 1 : VERY SLIGHT~~

∴ EXCEEDS CAT 1.

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