CampbellReith
consulting engineers

5B Prince Arthur Road
London, NW3 6AX

Basement Impact Assessment
Audit

For

London Borough of Camden

Project Number: 13398-31
Revision: F1

December 2020

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Project Name	5B Prince Arthur Road, London, NW3 6AX
Planning Reference	2020/2402/P

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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 5B Prince Arthur Road, London, NW3 6AX (planning reference 2020/2402/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 Basement Impact Assessment (BIA) has been carried out by companies and individuals with suitable qualifications.

1.5. The proposed development will involve the demolition of the existing building and construction of a new detached three-storey dwelling with a single below ground basement.

1.6. Screening and scoping sections for land stability, hydrology and hydrogeology of the site are included in the BIA report, and a site-specific ground investigation was undertaken, in accordance with Camden Planning Guidance (CPG) Basements.

1.7. A Hydrogeological Impact Assessment Report and a Ground Movement Assessment (GMA) Report have been presented. A number of queries raised in previous audit reports, along with a public consultation query regarding the stability of the boundary wall with No 7, have all been addressed. The GMA demonstrated that the potential damage to adjacent buildings and infrastructure will be within the CPG Basements' criteria (no worse than Burland Category 1).

1.8. Preliminary retaining wall calculations, a construction methodology and construction sequence drawings are presented.

1.9. There will be a slight decrease of the hardstanding areas due to the proposed development. It is accepted that the proposed development will not affect the hydrology of the site.

1.10. The GMA outcome is relevant to a sheet pile wall installed by an experienced specialist contractor, with silent and vibration free techniques, with no water jetting permitted but with pre-augering, if required, carried out with care. Should another type of retaining structure or technique be considered then the GMA should be revised and approved prior to construction.

1.11. It can be confirmed that the proposal adheres to the requirements of CPG Basements.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 9/6/2020 to carry out a Category B Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 5B Prince Arthur Road, London, NW3 6AX (planning reference 2020/2402/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:

- Camden Local Plan 2017 - Policy A5 Basements.
- Camden Planning Guidance (CPG): Basements. March 2018.
- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.

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;

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 "*Demolition of existing dwelling house and erection of replacement dwelling house with basement (Use Class C3)*".

The Audit Instruction also confirmed that the proposal does not involve, or is a neighbour to, listed buildings.

2.6. CampbellReith accessed LBC's Planning Portal on 11/6/2020 and 13/11/2020 and gained access to the following relevant documents for audit purposes:

- "Basement Impact Assessment", 29 May 2020, Rev.1, report ref.no. 9634_SL_GB_BIA, Taylor Whalley Spyra consulting civil and structural engineers;
- "Design and Access Statement", May 2020, Rev.00, Charlton Brown Architecture & Interiors;
- "Planning Statement", May 2020, Iceni Projects Ltd;
- "Tree survey and arboricultural method statement", May 2020, Tretec;
- Planning application drawings dated 3/7/2019, 2/2/2020 & 2/4/2020, project reference no.1908, Charlton Brown Architecture & Interiors;
- Planning consultation comments.

2.7. CampbellReith issued a BIA audit report (rev. D1) on 16/7/2020 raising a number of queries on the above relevant documents.

2.8. In response to the queries raised, the following revised report was received on 1/10/2020, from applicant's engineers via LBC:

- "Basement Impact Assessment", 18 September 2020, Rev.1.1, report ref.no. 9634_SL_GB_BIA, Taylor Whalley Spyra consulting civil and structural engineers.

2.9. CampbellReith issued a BIA audit report (rev. D2) on 16/10/2020 raising a number of queries on the above relevant documents.

2.10. In response to the queries raised, the following report was received on 2/11/2020, from applicant's engineers via LBC:

- "Addendum to Basement Impact Assessment", 29 October 2020, Rev.1.1, report ref.no. 9634_SL_GB_ADDENDUM_BIA1.0, Taylor Whalley Spyra consulting civil and structural engineers.

2.11. Further queries were raised on 18/11/2020 by CampbellReith and responses were received by email on 4/12/2020 from applicant's engineers. The queries and responses are attached in Appendix 3.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	Refer to Section 1.3 of the BIA report.
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	
Are suitable plan/maps included?	Yes	Refer to the BIA report.
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	Refer to Section 1.17 of the BIA.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Refer to Section 1.17 of the BIA report.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Refer to Section 1.17 of the BIA report.
Is a conceptual model presented?	Yes	Refer to Section 3 of Appendix J of the BIA report.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	Refer to Section 2 of the BIA report.

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	Refer to Section 3 of the BIA report.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	Refer to Sections 4 and 5 of the BIA report.
Is factual ground investigation data provided?	Yes	Refer to Appendix J of the BIA report.
Is monitoring data presented?	Yes	As above.
Is the ground investigation informed by a desk study?	Yes	Historical OS maps, BGS maps, Environment Agency maps and information and GSD maps are presented in the BIA appendices.
Has a site walkover been undertaken?	Yes	Refer to Section 1.7 of the BIA.
Is the presence/absence of adjacent or nearby basements confirmed?	Yes	The presence of adjacent lower ground floors or basements is confirmed in the BIA. Existing plans of adjacent properties are appended in the BIA.
Is a geotechnical interpretation presented?	Yes	Refer to Appendix J of the BIA.
Does the geotechnical interpretation include information on retaining wall design?	Yes	Refer to Appendix J of the BIA. Stiffness parameters are presented in the GMA in Appendix H.
Are reports on other investigations required by screening and scoping presented?	Yes	A Ground Movement Assessment and a Hydrogeological Impact Assessment are presented in Appendix H of the BIA. An arboricultural survey is presented in Appendix M of the BIA.
Are the baseline conditions described, based on the GSD?	Yes	
Do the base line conditions consider adjacent or nearby basements?	Yes	

Item	Yes/No/NA	Comment
Is an Impact Assessment provided?	Yes	
Are estimates of ground movement and structural impact presented?	Yes	A Ground Movement Assessment (GMA) is provided but shall be revised in accordance with the comments of this audit in Section 4.
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	However, any mitigation required should be revisited based on the comments of this audit in Section 4.
Has the need for monitoring during construction been considered?	Yes	However, suggested monitoring trigger levels should be reviewed based on the comments of this audit in Section 4.
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	
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	
Does report state that damage to surrounding buildings will be no worse than Burland Category 1?	Yes	Refer to Section 2.14 of the BIA report and Section 6.1 of the GMA (Appendix H of the BIA). Additional comments also provided in email response attached in Appendix 3 of this audit.
Are non-technical summaries provided?	Yes	Refer to the executive summary to the front of the BIA report.

4.0 DISCUSSION

4.1. The Basement Impact Assessment (BIA) has been carried out by 'tws consulting civil & structural engineers'. The BIA included a Ground Movement Assessment (GMA) and a Hydrogeological Impact Assessment in Appendix H, both prepared by the 'Geotechnical Consulting Group'. All reports have been prepared and reviewed by individuals with suitable qualifications.

4.2. The site is located within the Fitzjohns Netherhall Conservation Area and is currently occupied by a detached three-storey residential dwelling, with private rear garden, with no basement.

4.3. The proposed development will involve the demolition of the existing building and construction of a new detached three-storey dwelling with a single below ground basement. The proposed basement excavation will be about 4.30m deep. Stairs are proposed to the front and a lightwell to the rear of the dwelling. A propped/braced sheet pile wall will be used around the perimeter of the basement to facilitate its construction in the short term, with a reinforced concrete basement box and a raft basement slab designed for the long term.

4.4. The proposed construction methodology including the temporary works sequence is discussed in Sections 2.17 & 2.18, and further presented in drawings in Appendix D of the BIA. The proposed wall for the front stairs has been included in the construction methodology and the outline sequence drawings, and a previous query is now closed.

4.5. Preliminary structural retaining wall calculations are presented in Appendix N of the BIA. Outline drawings with preliminary assumptions and the outcome of Wallap calculations for the proposed sheet pile wall are also presented in Appendix P, thus closing out a previous query. It is understood that any detailed calculations for the proposed sheet pile wall will comprise part of the final design.

4.6. Screening charts for the land stability, hydrology and hydrogeology of the site are included in Section 1.17 the BIA report. Scoping sections are covered in Sections 2 to 5 and the appendices of the BIA report. The BIA is supported by desk study information including OS maps, BGS, GSD and Environment Agency information and maps, and site walkovers.

4.7. According to the arboricultural report (page 7), the existing tree T5 to the front of the property, is proposed to be felled. There are still some contradictory references in the BIA report that no trees will be felled (refer to Sections 2 and 8 of the GMA in Appendix H). However, it is accepted that the removal of tree T5 will not have any impact on the stability of the site due to the presence of granular ground conditions, as discussed in the following section. Hence, this query is not considered any further and is closed.

4.8. A site-specific ground investigation (GI) was undertaken with the results presented in Appendix J of the BIA. The GI comprised two boreholes to 4.50m and 11m depth and two hand-dug foundation inspection pits within the existing building footprint. The GI recorded Made Ground up to 1.10m depth over medium dense gravel and sand of Bagshot Formation to 6.40m depth over clayey and sandy layers of Claygate Member proved to 11m depth. With the exception of a thin sandy clay layer encountered locally at 1.10m-2.20m in one borehole only, it is evident that the proposed basement will be excavated within the sandy and gravelly layers of the Bagshot Formation. A 'soft to firm' sandy clay layer of the Claygate Member was encountered below the proposed basement excavation at 6.40m-9.50m depth.

4.9. Groundwater was encountered during the GI at 9.50m depth. No further records of groundwater monitoring during the site work are reported and subsequent monitoring visits from July to September 2019, indicated groundwater at about 7.60m depth (deep borehole) and at 3.20m (shallow borehole). The former is possibly associated with the groundwater encountered at 9.50m depth; the latter is interpreted in the BIA as being possibly associated with rainwater, i.e. not being representative of groundwater level at the site.

4.10. The Hydrogeological Impact Assessment presented in Appendix H of the BIA, concluded that the deeper groundwater records (c.7.60m) represent 'perched water'. Whilst this may not be the case, it is accepted that the proposed basement excavation will likely be above any permanent groundwater level. Further, in the D1 audit report it was noted that the Claygate Member is considered susceptible to internal erosion. Comments have been provided in the revised Hydrological Impact Assessment (Sections 5 and 6) that loss of passive resistance due to piping or loss of passive resistance in front of the wall is not expected, thus closing out a previous query. In any case, it is recommended that the finally designed sheet piles remain well above the permanent groundwater level and potential piping phenomena and loss of passive resistance be thoroughly considered during the final design stage.

4.11. Geotechnical interpretation including parameters for retaining wall design and a ground movement assessment (GMA) were presented in Appendices J and H of the BIA report respectively.

4.12. The GMA used linear elastic analysis, proprietary software (PDisp, XDisp) and CIRIA C760 methodology for 'stiff clay', which is intended for embedded retaining walls. However, based on the GI results, the ground conditions mainly comprise sand and gravel of Bagshot Formation underlain by a 'soft to firm' sandy clay layer of Claygate Member encountered well below the proposed basement excavation at 6.40m-9.50m depth. The revised BIA confirmed that the use of 'stiff clay' curves is appropriate for the encountered ground conditions. In the light of the additional information provided in the revised BIA this query has been closed.

4.13. The ground movements due to demolition of the existing building have been estimated in the GMA using specialist PDisp software. The detailed input and output of the software has been provided thus closing out a previous query.

4.14. In the GMA (Section 5.2.2), it was stated that the installation of the sheet piles using silent and vibration free techniques is expected to cause only localised, immediately behind the wall, upward ground movements up to about 5mm. Further, it was recommended that if pre-augering is required, this should be carried out with care to avoid uncontrolled ground settlements. Water jetting is not recommended. Reference is also made to a basement extension development at the Victoria and Albert Museum where this construction technique was used but no information was presented. Further, use of CIRIA C760 curves was presented in the additional information attached in Appendix 3, thus closing out a previous query. The length of the proposed sheet piles has been confirmed in the BIA report, thus partly closing out a previous query.

4.15. In the GMA (Section 5.2.3) ground movements due to excavation were estimated using XDisp software assuming 'stiff clay' (there is a reference in Figure 10 of the GMA) is present on site. The detailed input and output of XDisp software was partly provided but the damage assessment output of XDisp was missing. Brief calculations and discussion for the building damage assessment according to the Burland methodology have been provided in the Addendum BIA and the correspondence attached in Appendix 3. The GMA confirmed that structural damage will be within Category 1 or less of the Burland Scale for the neighbouring buildings.

4.16. Contour plans were previously requested to be included in the GMA, for the anticipated total horizontal and vertical movements due to both wall installation and excavation. The additional information presented in Appendix 3 closed out this query.

4.17. A sketch/plan showing the structural wall elements considered in the building damage assessment for the neighbouring properties was provided and this query was closed.

4.18. The potential impact to surrounding structures and infrastructure presented in Section 6.1.3 of the GMA, appeared to consider only the ground movements due to excavation in front of the wall; the additional information provided and attached in Appendix 3 has further considered ground movements due to wall installation, thus closing out a previous query. The GMA (Section 6.1.3) and the additional information provided in Appendix 3, confirmed that limited impact is anticipated to Prince Arthur Road. A utility search has been provided in the revised BIA indicating that telecommunication and electricity utilities are present under the footpath pavement outside the site. The utility owners should be consulted prior to the design of the works being finalised to satisfy any requirements they might have with regard to ground movement acceptable criteria.

4.19. The proposed in the revised GMA (Section 6.2) ground movement trigger levels are now consistent with the trigger levels proposed in the Appendix G of the BIA report. The additional information provided in Appendix 3 confirmed that the trigger levels are appropriate for the proposed scheme and compliant with the outcome of the GMA which predicts up to Category 1 maximum damage.

4.20. In response to a public consultation comment with regard to the potential impact to the boundary wall with No 7 Prince Arthur Road, the applicant's engineers have confirmed that negligible ground movements are anticipated at the location of this wall (refer to correspondence in Appendix 3).

4.21. An allowable bearing pressure of 150kN/m^2 is proposed for a basement slab at 3m depth, in the GI report attached in Appendix J of the BIA. This bearing pressure value is adopted by the outline structural calculations presented in Appendix N but for a deeper basement slab founded at 4.30m depth. According to the GI data (BH1), a 'soft to firm' sandy clay (with a low recorded SPT N raw value of 6) is noted at 6.40m-9.50m depth, within the bulb of pressure of the proposed raft slab, which may give rise to undue settlement and ground instability. According to the revised BIA (Appendix R) the quoted allowable bearing pressures refer to a standard pad foundation whilst the new basement will be founded on a raft that will mobilise a significantly larger volume of soil to contribute to the capacity. The additional explanation provided in the GMA clarifies and closes out the previous query. Further, any anticipated settlement issues of the proposed raft should be considered during the final design and is not expected to affect the stability of the neighbouring structures.

4.22. Based on the information presented in Section 5 of the BIA, there will be a slight decrease of the hardstanding areas due to the proposed development. It is accepted that the proposed development will not affect the hydrology of the site.

4.23. The GMA outcome and results assume that the support of the basement excavation will be undertaken with the installation of a sheet pile wall by an experienced specialist contractor, using silent and vibration free techniques, with no water jetting permitted. Any pre-augering, if required, should be carried out with care to avoid uncontrolled ground settlements. Should another type of retaining structure or technique be proposed during the detailed design stage then the GMA should be revisited, audited and approved by the local planning authority prior to construction commencing, to confirm that it is compliant with CPG Basements' damage criteria.

5.0 CONCLUSIONS

5.1. The Basement Impact Assessment (BIA) has been carried out by companies and individuals with suitable qualifications.

5.2. The proposed development will involve the demolition of the existing building and construction of a new detached three-storey dwelling with a single below ground basement.

5.3. The proposed wall for the front stairs has been included in the construction methodology and the outline sequence drawings thus closing out a previous query.

5.4. Outline drawings and the outcome of Wallap calculations have been presented for the proposed sheet pile wall thus closing out a previous query.

5.5. It is accepted that the removal of tree T5 will not have any impact on the stability of the site due to the presence of granular ground conditions.

5.6. Comments have been provided in the revised Hydrological Impact Assessment that loss of passive resistance in front of the wall is not expected. A previous query has been closed.

5.7. Further to additional information provided in the revised BIA about the ground conditions considered in the GMA, a previous query has been closed.

5.8. Queries raised in previous audit reports about the GMA, and a recent public consultation query regarding the impact to the boundary wall with No 7 Prince Arthur Road, have all been closed out following receipt of the additional information attached in Appendix 3.

5.9. Clarifications with regard to the proposed allowable bearing pressure value have been provided and this query has been closed.

5.10. It is accepted that the proposed development will not affect the hydrology of the site.

5.11. The GMA outcome and results are relevant to a sheet pile wall installed by an experienced specialist contractor, with silent and vibration free techniques, with no water jetting permitted but with pre-augering, if required, carried out with care. Should another type of retaining structure or technique be considered during the detailed design stage then the GMA should be revised and approved prior to construction.

5.12. Based on the comments above, it can be confirmed that the proposal adheres to the requirements of CPG Basements.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Thompson & Corrigan	Flat 5, 9 Prince Arthur Road	Unknown	Risk of subsidence and damage to neighbouring structures at 7/9. Groundwater risk.	Queries have been raised in Section 4 of this audit.
Willoughby, Stylianou	Unknown	2/7/2020	Monitoring towards the rear of 5 Prince Arthur Road during construction.	Monitoring during construction is addressed in the BIA and will be further addressed and agreed during party wall agreements.
Savvidis	7 Prince Arthur Road	3/7/2020	Risk of potential damage to boundary wall. 7 Prince Arthur Road does not have a basement. Monitoring of potential subsidence.	Negligible impact is anticipated by the GMA, as discussed in Appendix 3. Plans and sections of this property have been considered in the BIA and GMA. Monitoring during construction is addressed in the BIA and will be taken forward during party wall agreements.
Berman	Flat 2, 5 Prince Arthur Road	3/7/2020	Basement affecting the water table. Ground subsidence.	A Hydrogeological Impact Assessment has been presented in Appendix H of the BIA. Queries have been raised and responded. Queries have been raised in Section 4 of this audit and responded in the GMA and in the further information attached in Appendix 3.

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Stability	The proposed wall for the front stairs shall be included in the construction methodology and the outline sequence drawings.	Closed	1/10/2020
2	Stability	Outline calculations for the proposed sheet piled wall are not presented and are requested.	Closed	1/10/2020
3	Stability	Contradictory references in the BIA report and the arboricultural report about felled trees should be revised.	Closed	1/10/2020
4	Stability	The GMA shall be reviewed in accordance with the comments in Sections 4.12 to 4.19 of this audit. D2 update: Queries of Sections 4.14 to 4.19. F1 update: A new query regarding a boundary wall with No 7 has been raised following recent public consultation.	Closed	4/12/2020
5	Stability	The allowable bearing pressure value shall be checked and revised if necessary for the proposed foundation depth.	Closed	1/10/2020
6	Hydrogeology / Stability	The Hydrogeological Impact Assessment shall be reviewed as per the comments in Section 4.10 of this audit.	Closed	1/10/2020
7	Stability	F1 update: The GMA outcome and results are relevant to a sheet pile wall installed by an experienced specialist contractor, with silent and vibration free techniques, with no water jetting permitted but with pre-augering, if required, carried out with care. Should another type of retaining structure or technique be considered during the detailed design stage then the GMA should be revised and approved prior to construction commencing.	Note	8/12/2020

Appendix 3: Supplementary Supporting Documents

Email response of 4/12/2020 to audit queries by applicant's engineers

9634 _ 2020/2402/P - 5b Prince Arthur road
Graham Boston to: ChristosBotsialas@campbellreith.com 04/12/2020 14:22
Cc: "Apollonia Liana Gasparre", "Melissa Tait", "Simon Lane", "Chris Martin"
History:
This message has been replied to and forwarded.

Hi Christos,

Further to your conversation with Apollonia of GCG on the comments and responses, as discussed below is the additional verification to cover these items as per the discussion.

I would be grateful if you could now confirm this covers the remainder of the queries.

Thank you for taking the time to discuss directly with Apollonia the queries and responses.

Many Thanks

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From: Apollonia Liana Gasparre <a.gasparre@gcg.co.uk>
Sent: 04 December 2020 12:36
To: Graham Boston <graham.boston@tws.uk.com>
Cc: Chris Martin <chris.martin@simpsoneng.com>; Simon Lane <simon.lane@tws.uk.com>; Melissa Tait <m.tait@gcg.co.uk>
Subject: RE: 9634 _ 2020/2402/P - 5b Prince Arthur road

Hi Graham

Last Wednesday I discussed with Christos our replies to the points he raised and I summarise below our discussion, as he requested. I don't have his email, could you please pass this to him.

I trust this closes the issues.

Regards
Apollonia

Section/Query 4.14
In the Addendum BIA, reference to research projects is made where it is stated that the press-in piling induces up to 10-15 times less ground vibration compared to traditional sheet pile installation techniques and, as such, significantly lower ground movements are expected. While this may be true for soft clays or very loose fine granular deposits, it may not be the case for dense granular deposits and ground conditions like the ones existing at the subject site. Further, CIRIA C760 refers to at least one case study located in Central London, where press-in sheet piles wall installation resulted in monitored ground movements of some 20mm to 30mm

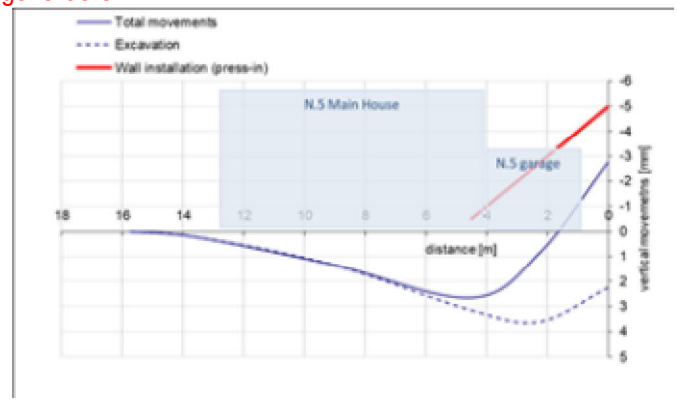
uplift along all four sides of the planned excavation. The ground heave reported in CIRIA's report was due to water jetting used to assist driving during the sheet piles installation and because the water could not permeate through the dense gravels fast enough resulting in build-up of pressure and ground heave. It is noted that a considerable thickness (at least 4.20m thick) of medium dense sand and gravel layers are present at the subject site which means that driving assistance of the sheet piles via water jetting or pre-augering cannot be ruled out during construction. Further, CIRIA C760 report (published at a later date than the research papers quoted in the Addendum BIA) although discusses the press-in technique, it does not make any allowance or suggestion to consider reduced ground movements due to wall installation when this particular technique is used. In the light of the above and with the view of adopting a conservative approach as required by CPG Basements, the GMA and damage assessment is requested to be revised in order to consider ground movements due to wall installation as per CIRIA C760. This will close out this query, subject to potential damage being within the acceptable by LBC guidance criteria or mitigation measures being proposed as required. An alternative way of closing out this query would be to provide a statement from a well-known specialist contractor that press-in piles will not cause any ground disturbance/movement during application of the press-in piling at this particular site.

CIRIA C760 attributes the 20-30mm of uplift observed in the unpublished case of press-in pile technique to the adoption of water jetting to loosen the ground. Section 5.2.2 of GCG's GMA report states "*If pre-auger is required, this should be carried out with care to avoid uncontrolled ground settlements. Water jetting is not recommended.*"
We are happy to further enforce this statement and ask that Client to include this as a requirement in the specifications of the piling works, although specialised contractors using press-in piling installation are fully aware of the issues related to water jetting.
Berryrange, who has been approached for the installation of the sheet pile walls at 5b Prince Arthur Road, has kindly provided the following statement:
"Berryrange have extensive experience of vibration-free sheet piling techniques and currently own and operate 4no WP150 Silent Pilers, as well as the JZ100 Zero Piler, (only one in Europe). In our experience, it has proved a relatively low-impact method for the construction of basement structures and retaining walls in close proximity to existing structures. No method of basement construction can completely eliminate the risk, so there will inevitably be some ground movement from the installation process due to displacement of the soil. In this instance, we aim to minimise that displacement by pre-augering the ground in advance to loosen the soil and aide installation. We are proposing the use of an excavator mounted dangle drill, ensuring that all heavy plant can be situated away from the exiting retaining wall. The use of a "crawling" pile press to install the piles prevents surcharge from piling equipment in a similar manner. Historic issues with ground movement have tended to have been rooted in more poorly constructed structures – such as where buildings have been founded at shallow depth on made ground or in the actions of overly enthusiastic excavator operators prior to our arrival on site. With regards to the former, the condition of the existing wall will need to be fully investigated and is likely to govern the extent of movement experienced in practice. With regards to the latter, a high level of site supervision is recommended."

The database in CIRIA C760 does not include movements related to the installation of sheet pile walls. We shall point out that the unpublished case of 20—30mm uplift mentioned above is not reported in Figure 6.6, neither as horizontal nor as vertical non-normalised ground movement, nor it is reported as normalised vertical movement in Figure 6.8b; but it is reported in Figure 6.8a as normalised horizontal movement. Being a case of uplift, it is unclear what the reported horizontal movement in Figure 6.8a are and their reliability is questionable. We shall also point out that excluding this questionable case and the Bell Common data, also notoriously unreliable, all data of horizontal movements induce by pile installation scatter around zero. The most recent publication by Ball et al. 2014 confirm that this is the case.

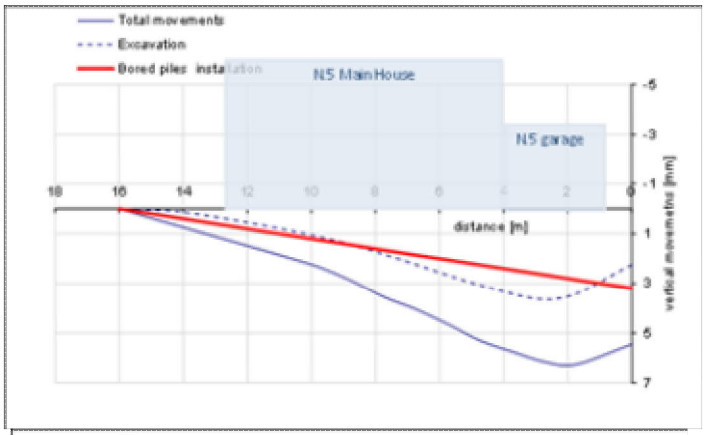
We are reluctant to adopt the envelopes in Figure 6.8 for the assessment of movements induced by the installation of sheet piles using press-in techniques, because the database in Figure 6.8 is for bored piles, whose mechanism causing ground movements is different from the mechanism of driving or press-in piles. In fact heave rather than settlements could be more reasonably expected from a press-in mechanism, which

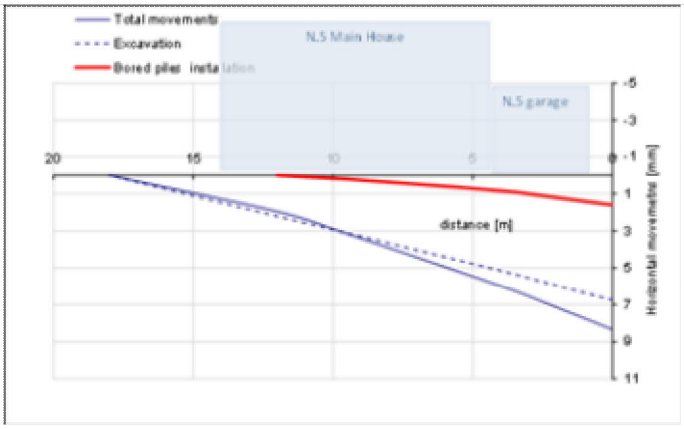
would be compensated by settlements due to pre-augering, if any. Section 5.2.2 of GCG's GMA states: *"Provided that a competent and experienced contractor is employed, the installation of sheet pile walls is not expected to cause significant ground movements [….] these would be localised immediately behind the wall and could be expected to cause upward ground movements that can be conservative estimated to be up to about 5mm"*. We stand by this statement. We believe that the wall installation carried out by competent contracts will cause negligible movements. If we considered 5mm heave at the back of the wall and conservatively assumed that it would reduce linearly within 5m distance (although we believe that this distance would be much shorter), then the vertical movements on No.5 would be predicted to be as in the figure below:



The wall installation could cause some minor uplift of the garage of N.5, which would tend to tilt away from the site. This might in fact result in some shearing of the walls that could cause cracks at the wall junctions and might cause a potential damage at this stage that classifies well within Category 1. The excavation for the new basement could then cause settlement that would compensate the initial heave, so that the garage would tend to return to its original position. The main house is unlikely to be affected by the installation of the retaining walls and the vertical and horizontal movements discussed in the GCG's GMA report apply. I shall point out that the movements across the garage estimated above are less conservative than those reported in GCG's GMA, which had considered a more conservative approach to the issue.

Should the auditor still request an assessment based on the CIRIA database for bored piles, we would produce the curves below:





(dashed lines used in GCG's GMA)

Again the movements due to pile installation would induce no more than a slight tendency of the structures on No.5 to tilt towards the site, but when added to the settlements due to the excavation in front of the wall, these would alter the curve reducing the deflection ratio, although only slightly. The estimated potential damage is still well within Category 1 (in fact it is Category 0 but it could increase to category 1 when cracks due to shearing of the walls as an effect of tilting is considered). The assessment discussed in GCG's GMA still remains more conservative in the estimate of the maximum deflection ratio across No5. The envelopes for horizontal movements in the CIRIA figure 6.8 is only an indicative upper bound and the data clearly show that the measured movements in fact only scatter around zero. Conservatively, a maximum nominal displacement of 0.02% has been added to the figure above. We want to reiterate though that in our opinion this approach is not correct because it is based on data related to bored piles and we disagree with using this at this site.

It should be noted that N.7-9 is founded at lower ground level than N.5b and is not affected by any potential movements caused by wall installation.

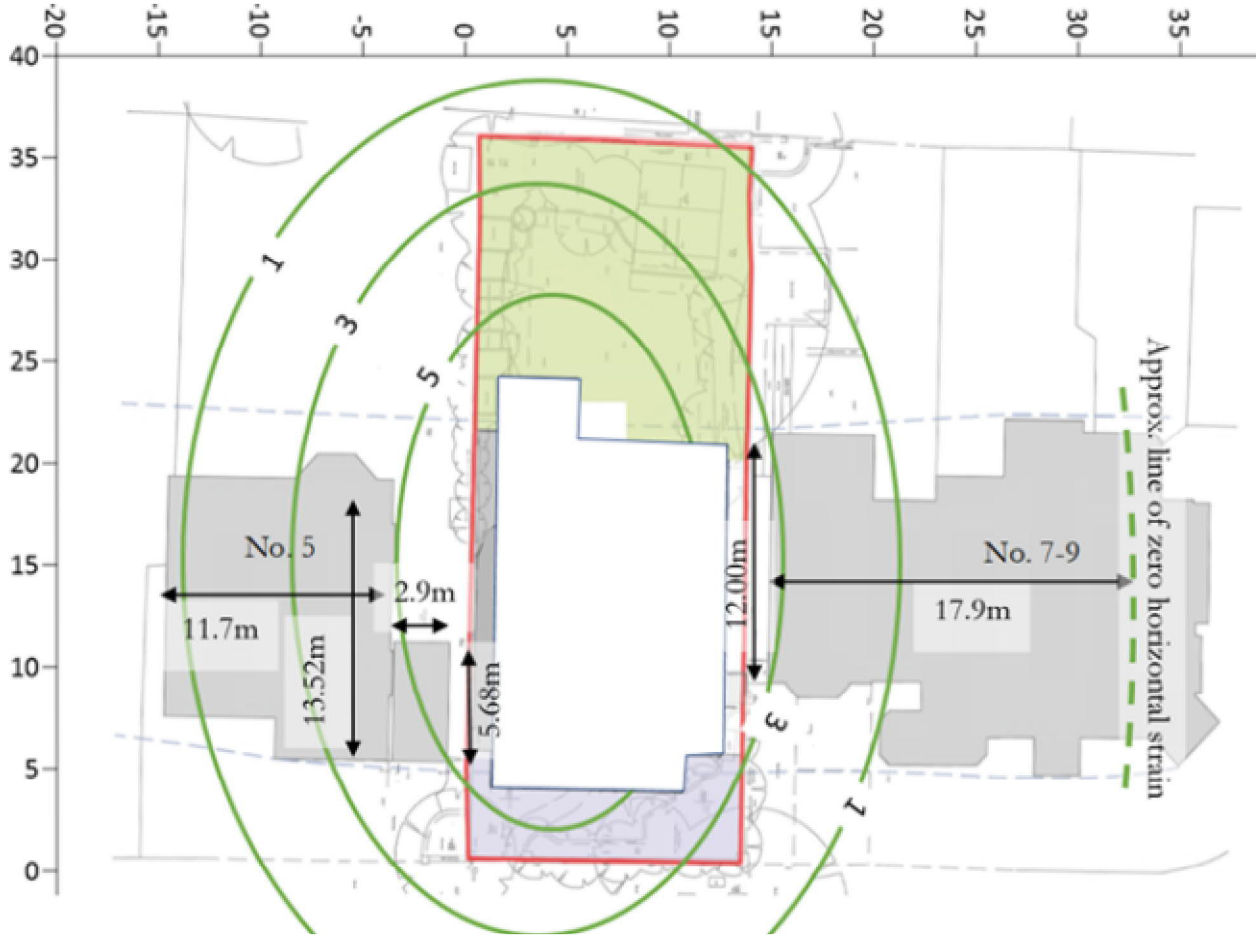
To conclude, we believe that GCG's GMA conservatively assesses the potential impact of the proposed development at N.5b on the adjacent structures. However, should movements due to pile installation be added to Figures 11 and 12 of GCG's GMA, either as uplift or settlements, the potential damage on No.5 is still estimated to remain well within Category 1. Ground movements associated to pile installation are not expected to affect N.7-9 and the discussion in GCG's GMA and the associated figures remain valid. The potential damage inon this property is still well within Category 1. Good workmanship is paramount to all engineering works and will be required at this site too. We trust that the Client will ensure that competent and specialised contractors will be employed on this job.

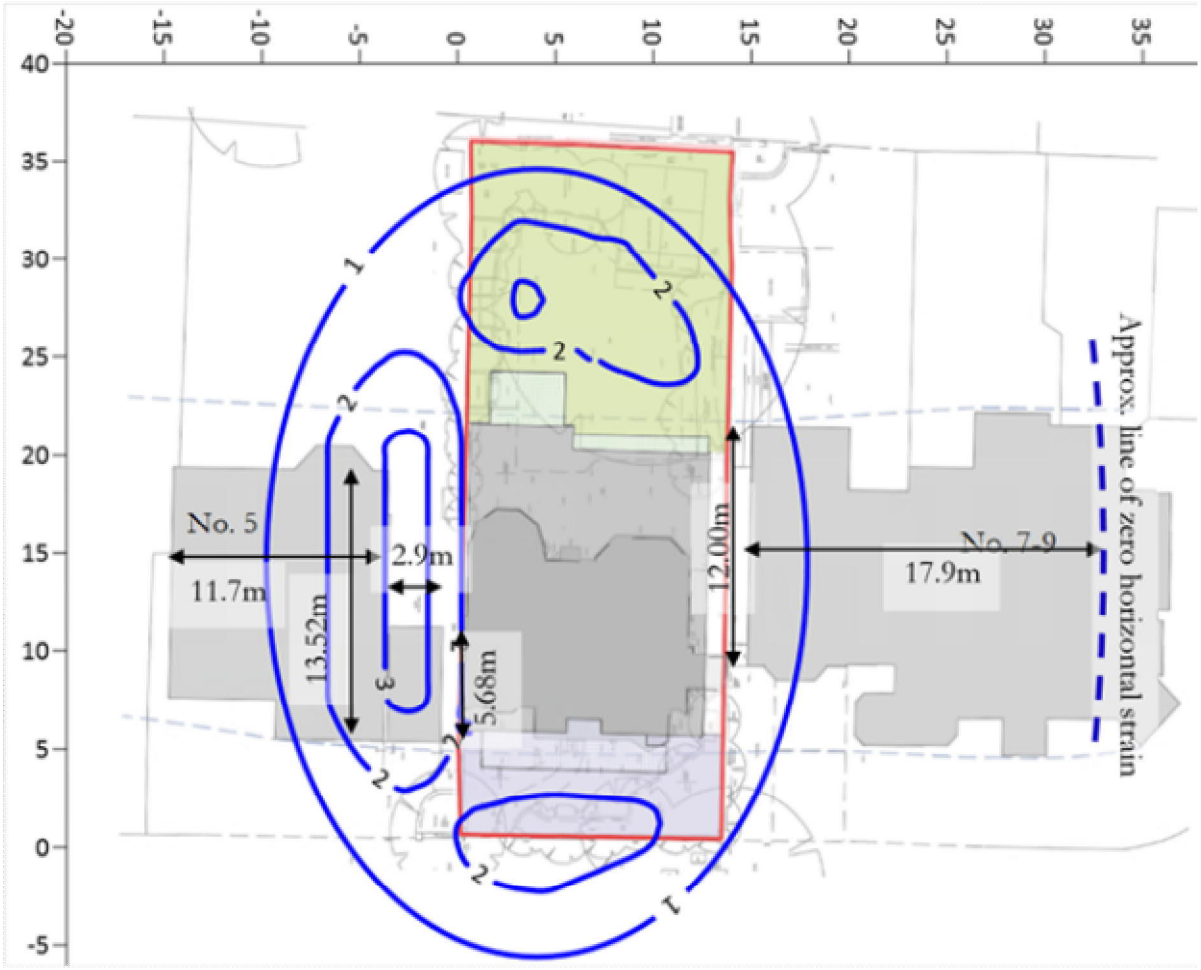
Section/Query 4.15

Brief calculations for the building damage assessment according to Burland methodology have been provided

in the Addendum BIA, however, these calculations should be updated to include ground movement due to wall installation as requested in the previous Section above. These calculations include wall lengths but it is not clear to which wall elements these lengths refer to. A sketch plan,as further discussed below (Query 4.17), has been previously requested and is still pending.

Please see below





Section/Query 4.16

Figures 11 and 12 of the GMA present contour plans due to excavation in front of the wall only. As discussed above, these Figures should be updated to include ground movement due to wall installation.This query is still pending.

See response above.

Section/Query 4.17

As previously discussed,a sketch/plan showing the structural wall elements considered in the building damage assessment for the neighbouring properties at No. 5 and No. 7-9 is still pending. The explanation provided in the Addendum BIA that the damage assessment has been carried out considering the entire extent of the neighbouring houses is not sufficient.

See response above.

Section/Query 4.18

The potential impact to surrounding structures and infrastructure presented in Section 6.1.3 of the GMA, appears to consider only the ground movements due to excavation in front of the wall; it should also include anticipated ground movements due to wall installation as previously discussed.

See response above

Section/Query 4.19

The GMA and the proposed trigger levels should be rechecked and revised, as required, in accordance with the comments of this audit to include wall installation effects.
See response above. No changes to the trigger levels are requested. The values in the GCG's GMA are conservative and fix trigger levels at smaller values than would be expected if the wall movements due to pile installation were included.

Section/Query 4.20(new query following recent public consultation comment)
The GMA should consider the potential impact to the boundary wall with no 7 Prince Arthur Road, as public consultation has raised concerns due to its current poor status of repair. Any other boundary walls that may be affected should also be included in the BIA.
The boundary wall is founded at the same level of the property 7-9 Prince Arthur Road, approximately 2m below the ground level of No.5b.
With reference to Figure 11 and 12 of GCG's GMA and the discussion above, we estimate the following impact of the proposal on the wall for the different stages of construction:

- The boundary wall is not expected to experience other than negligible ground movements as a consequence of the installation of the new retaining wall for N.5b, particularly in consideration of the arguments related to the noise and vibration free technique to be adopted.
- The upper part of the excavation at No.5b would result in a relief of pressures at the back of this boundary wall, which would have positive impact on its stability. The lowest part of the excavation, below the toe of the wall (approximately additional 2.5m), could induce the wall to settle up to 1-2mm and move horizontally towards N.5b up to 3.5mm. Due to 3D effects, the wall could experience some longitudinal distortions of less than 0.01% (calculated assuming a wall length of 30m) both in the horizontal and in the vertical direction. This is unlikely to cause other than negligible damage to the boundary wall. It should be noted that the props for the new retaining wall of N.5b will be installed at the level of the toe of the boundary wall in order to restrict its movements in the horizontal direction without applying unduly pressure on it.

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