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BIA G1808-RP-01-E4
Supplementary Note G1808-SN-01-E1

Project	**31 Willoughby Road NW3 1RT**	**Project Ref**	**G1808**
Subject	**Response to Campbell Reith Audit D3**	**Date**	**02/21**

Introduction

1. Headings refer to paragraph references in the Campbell Reith document and provide brief notes of their subjects. The audit document should be consulted for complete details.
2. Geotechnical Consultants Group (GCG) reported to residents of Willow Cottages on 27th May 2020. This predated the current edition of the BIA which was issued in October 2020. Relevance and validity of the GCG comments cited by the Campbell Reith audit as pertinent to consideration of the BIA have been considered in this document.
3. Appended figures 34 to 37, together with Cording damage curves and revised damage risk assessment form part of this note, which shall be read in conjunction with BIA report G1808-RP-01-E4. In case of conflict, this note shall have precedence.

4.7 GCG: groundwater flow due to probable inclusion of Claygate material in shallow ground.

4. Dr Michael de Freitas has commented upon the GCG concerns; the following is an extract directed towards the supposed risk associated with the proximity of the Claygate Member.
5. "*There are good reasons for believing that the ground profile above 83mOD is Made Ground. The content of this Made Ground will, of course, reflect the immediate geology and can thus be expected to contain components derived from the Bagshot and Claygate deposits, as reflected in the grain size distributions and recognised by the GCG report, however these components have been disturbed and that is something grain size analysis alone does not reveal.*
6. *Stratigraphically continuous horizons of Claygate sediments which provide a potential for erosion by flowing ground water through an unprotected free face of an excavation are thus not considered to exist. Evidence for such horizons was not seen in the bag samples from either BH and does not conflict with the interpretation that Made Ground extends to between 2.5m and 3.0m below existing ground level.*

7. *Permeable and possibly erodible portions of ground may well exist in the top 3m, but all the samples suggest they would be isolated lumps of ground disturbed from their original stratigraphy and deposited as fill for Made Ground. As such they would not provide the circumstance for erosion to cause voids of concern to either the stability of an excavation or to settlement of ground behind an excavation."*

4.11 1:100 surface water flood risk in part of rear access to Willow Cottages.

8. It is accepted that the Camden SFRA indicates that the probability of surface water flood in part of the rear access of Willow cottages currently varies from 1:100 to 1:1000 rather than 1:1000 throughout. The difference is, however, immaterial to planning policy CC3 which is to seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible. The BIA satisfies that requirement at sections 5 and 11, and amplification is provided by items 4.15-4.17 below.

4.13 & 4.14 Route of the Fleet stream

9. The final sentence of paragraph 4.13 and hence the first sentence of 4.14 are incorrect. The BIA describes in detail how new groundwater and historical construction information prompted revision of the previous assumption that the former stream had been culverted by the drain serving the cottages. The main flow of the stream source of the Fleet was diverted into the sewer system during construction of the Gayton estate. Figure 16 of appendix E shows the subsequently assessed line of confluence of groundwater flow from the valley sides passing beneath the terrace of Willow cottages.
10. It is no longer considered that the former stream flows through the Willow cottages drainage system.

4.15 & 4.16 Drainage and impact of groundwater variation on phreatic storage capacity above groundwater level.

11. Use of the geocomposite drainage system originally proposed has been omitted from the current scheme because the more detailed numerical analysis undertaken for the current BIA has shown that it is no longer required. Concerning the Campbell Reith and GCG criticism of the proposal, it may be that like many other types of construction it is not feasible in the sense of something easily done. It is however perfectly practicable using the good standard of workmanship always assumed for BIA reviews.

12. The GCG comment about loss of aquifer storage and its potential effect upon both flood risk and sewer loads referred to a previous version of the BIA. The inference was that the basement construction will displace a volume of groundwater, causing the level of groundwater elsewhere to rise. GCG considered that in so rising the groundwater would reduce the volume of ground above the water table which is currently available to store rainwater draining down to the water table. It was supposed that in consequence more water would remain at the surface, increasing the risk of groundwater flood and sewer overload. GCG also supposed that groundwater level in Willow Cottages would be critically just below the rear access passage.
13. According to the Camden SFRA the groundwater flood risk for property in the region considered for the BIA is negligible. Using new groundwater information from within Willow Cottages, analyses predict that groundwater level varies from 0.9m to 1.3m below the passageway and that construction of the basement will reduce those depths by an average of only 0.08%. The probability of the situation depicted by GCG occurring in practice is also negligible.

4.17` Impact of groundwater variation due to the development on existing basements and impact of existing basements upon assessed groundwater variation.

14. Section 3.2 of the BIA identifies adjacent or nearby basements, several basement planning consents and postulates the presence of many coal cellars in older properties in the general area. Section 11.4 of the document uses the results of analysis to conclude that the impact of the proposed basement on groundwater affecting adjacent and nearby basements will be negligible and that it would not impact at all on other basements considered.
15. Urban development including existing basements, foundations, sewer trenches, drain and sewer defects, together with both natural and anthropological ground conditions have created the groundwater regime measured and accounted for by the analyses undertaken for the BIA.
16. The BIA thus accounts for the impact of the proposed basement upon its built environment and the impact of the existing built environment upon the basement proposed.
17. Audit D3 also cites anecdotal comment that water ingress affects many basements in the area. If that is so, it is a feature of the built environment and subject to the conclusions set out above. Public record also suggests that it is most unlikely to have

resulted from groundwater flood. Within an area of approximately 95hectares encompassing the site, the Camden SFRA records 4 instances of groundwater flood, none of which affected buildings or their basements. The nearest incident was about 250m distant from the site and on the opposite side of the valley.

4.24 Modelling questions

18. The five un-numbered bullet pointed paragraphs of this section are referenced 1 to 5 below.

1 - 3 Structure wished into place.

19. Essential parts of the basement construction sequence shown by BIA item 9.3.2, together with effects of their inclusion and provisions of the analyses, are set out in the following table. Settlement associated with the notional lateral movement of the sides of underpin excavations was not previously allowed for in the damage risk assessment. This has now been included by adding the notional 5mm vertical movement requested by the auditor. Uniform dissipation of the notional vertical and lateral movement over a distance equal to 4 x basement depth has been allowed in accordance with CIRIA C760 provision for excavation in front of a wall and to permit the impact to reach Willow Cottages.

Method item	Description	Effect of inclusion	Provisions made in analysis sequence.
4	0.5m excavation for piling	Negligible	Included in 24, not separately
14	Piling	Negligible	Included in 24, not separately
17	Reduce level & install struts	Negligible	152x152 UC struts @ 3m c/c & walings included in 24; (max expected reduction of level by items 4 &17 < 1m).
18-22	Underpinning	Lateral ground movement with consequent vertical movement.	Hit & miss sequence not possible in 2D modelling; 5mm lateral movement added to 24; (5mm vertical movement now included: see note below).
24a	Basement excavation	Drained result reported for max. settlement & excav'n. heave	Items 4 to 24a analysed as one in 10 excavation stages + gradual dewatering.
24b	Final long term state	Partial reverse of 24a	Basement floor installed; groundwater recovery

Vertical shrinkage to be expected in a 4m deep plain concrete underpin is about 0.3-0.4mm after a year (BS EN 1992-1-1) and less for reinforced concrete. Drypack mortar contains anti-shrink additive. Considering the approximations made for installation displacements it is reasonable to consider they also include the effects of shrinkage.

4 Dewatering settlement

20. It is assumed that this matter is now concluded as noted in 4.18 & 4.19 of the audit.

5 Damage risk assessment

21. The auditor found the presentation of the modelled displacement data and damage risk assessment difficult to follow, was concerned to know if the effect of concrete shrinkage on underpinning had been allowed for and considered that transparency was lacking. A GCG report for the neighbouring residents suggested that the Burland method of assessing damage risk is unsuitable for use in conjunction with Willow Cottages and commented on interpretation of the table of risk classifications attributed to him. GCG also considered that since the Willow Cottages sewer had been assumed to carry the culverted former watercourse, it should be included in the risk assessment.

Reference auditor comments:

22. Whilst there has been no concealment of analytical input, method or results in the BIA it is accepted that graphical presentation will greatly improve their ease of assimilation. Referring to appended Figures 34 to 37 and tables:

    (i). The scheme of monitoring illustrated was designed principally to examine the predicted structural displacements from existing condition due to basement excavation, construction, groundwater drawdown and recovery. Footing data points were generally located at 1m below local ground level, lateral wall movements correspond to the tops of walls.

    (ii). Analysed displacements are all very small, typically 0.0 to 1.0mm. Point values and derived contours of vertical movement show the expected influence of draw down and heave. Lateral movements are more complex and on the north side of No.31 are influenced by the topography of existing structures.

    (iii). Added in the manner described by items1-3 above, the notional allowance for 5mm vertical and lateral movement at underpin locations effectively masks all

soil/water/structure displacements resulting from the basement construction (Figures 35, 37).

(iv). More detailed annotation of tabulated risk assessment calculations has been provided. Risk to neighbouring property has been re-evaluated using the method of Cording et al (BIA reference [7]), which uses a different method of evaluating risk but employs the Burland concept of damage category. The calculations attached to this note briefly describe its main features.

(v). These calculations show the rear wall of 33 Willoughby Road at risk of category 1 damage. Also, following the simple assumption that the notional displacements are not diminished by built topography, Willow Cottages too are at risk of category 1 damage on the line of Section F2. All other cases considered fall in category 0.

With reference to GCG comments:

23. GCG initial reference to misunderstanding of the purpose of the Burland damage risk table is irrelevant to planning requirements. The table provided a scaled classification of damage risk severity. Perhaps with the plight of insurers in the 1970s in mind, Burland chose to illustrate the published scale then by reference to ease of repair. Camden and other public authorities seem to have chosen it as a gauge of the consideration due from basement developers to neighbouring owners. Thus, it is simply the requirement not to exceed risk category 1 of the table which has significance for Camden policy A5n.

24. Burland has made it clear that his method of calculating risk is only a screening tool in a progressive sequence of assessment. If it predicts unacceptable risk, further consideration is required. If a satisfactorily low risk is predicted, nothing further is needed.

25. In the present case, and relative to the Burland table, the rear façade of Willow Cottages is well below the risk category 0 boundary. The wall is 80mm out of plumb over 8.5m height which, although not acceptable for new buildings, is far from exceptional for terraced Victorian dwellings. And it is tied back by both closer than usual party walls and by floor level ties. It requires no further investigation at this stage.

26. In the area sampled by Section F2, it appears that the party wall falls into category 1. That is quite acceptable but in reality, category 0 will apply. The wall would need to stretch only 0.24mm less than calculated for that to happen; the concrete footing would provide the necessary restraint.

27. Considering the small and evenly graded displacements calculated at Willow Cottages, the assessment provides ample reassurance that the sewer in that property will not be harmed.

4.25 - 4.27 Comment relevant to 4.24

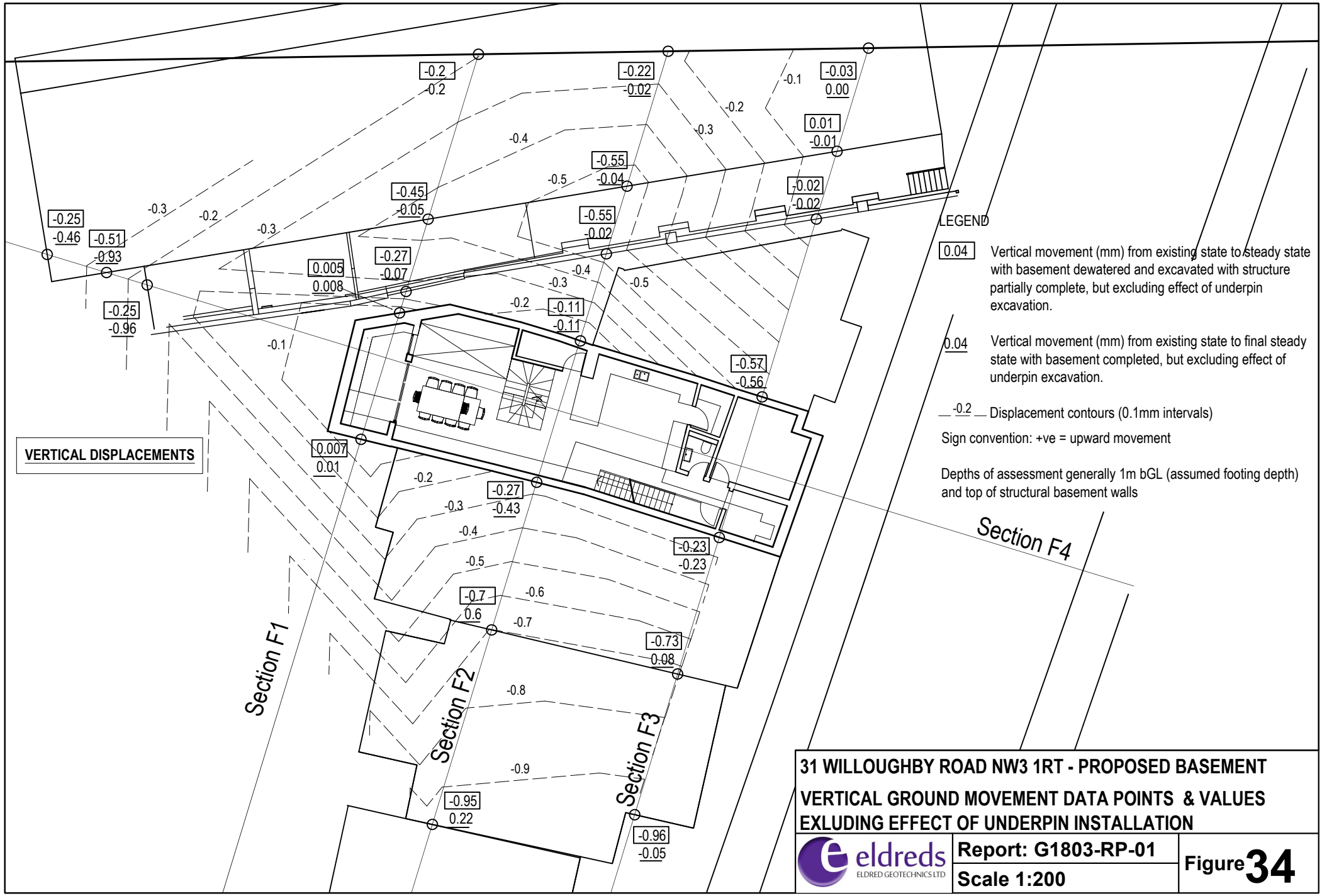
28. Refer to the above bullet point item 5 of 4.24.

4.28 - 4.32 Confirmation that further matters have been addressed by the BIA.

29. It is assumed that these items require no further comment.

APPENDED ITEMS

Figure 34	Vertical ground movement data points & values excluding the effect of underpin installation
Figure 35	Vertical ground movement: Addition of analysis results and notional allowance for underpin installation.
Figure 36	Lateral ground movement data points & values excluding the effect of underpin installation
Figure 37	Lateral ground movement: Addition of analysis results and notional allowance for underpin installation.
	Damage risk assessment (Cording) including dame category chart (3 pages)



31 WILLOUGHBY ROAD NW3 1RT - PROPOSED BASEMENT

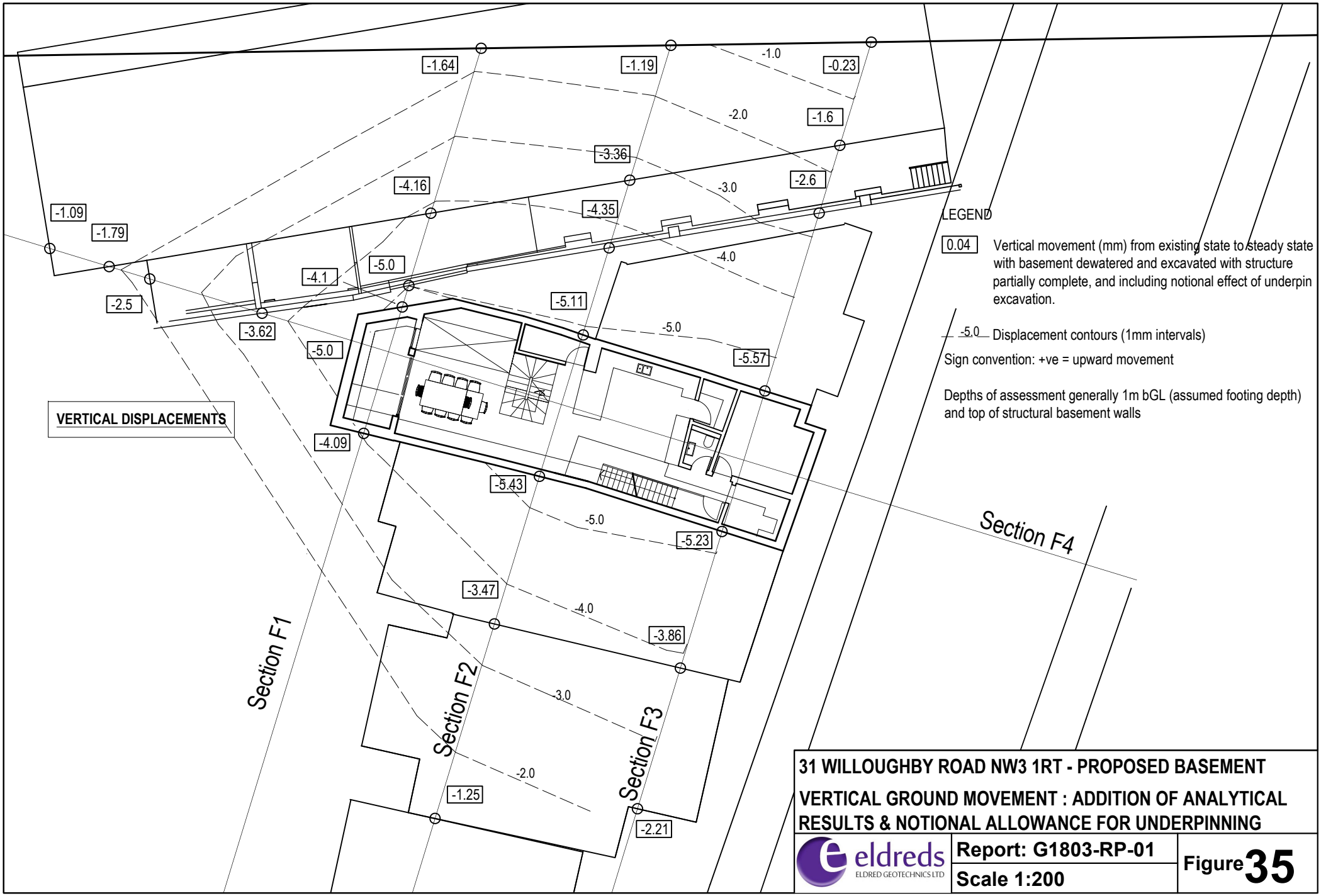
VERTICAL GROUND MOVEMENT DATA POINTS & VALUES EXLUDING EFFECT OF UNDERPIN INSTALLATION

eldreds ELDRED GEOTECHNICS LTD

Report: G1803-RP-01

Scale 1:200

Figure 34



31 WILLOUGHBY ROAD NW3 1RT - PROPOSED BASEMENT

VERTICAL GROUND MOVEMENT : ADDITION OF ANALYTICAL RESULTS & NOTIONAL ALLOWANCE FOR UNDERPINNING

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ELDRED GEOTECHNICS LTD

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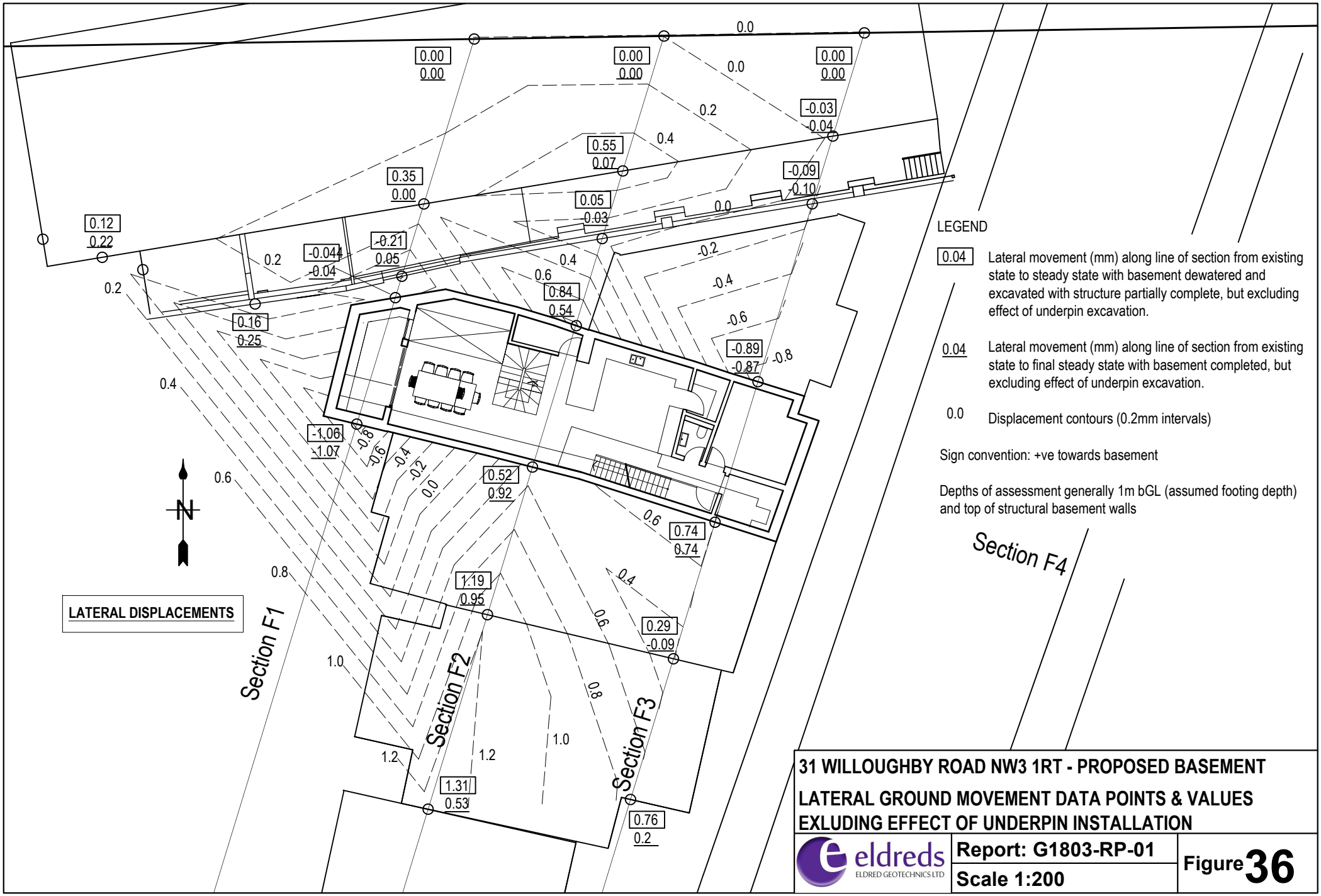
Scale 1:200

Figure 35



31 WILLOUGHBY ROAD NW3 1RT - PROPOSED BASEMENT

LATERAL GROUND MOVEMENT DATA POINTS & VALUES EXLUDING EFFECT OF UNDERPIN INSTALLATION

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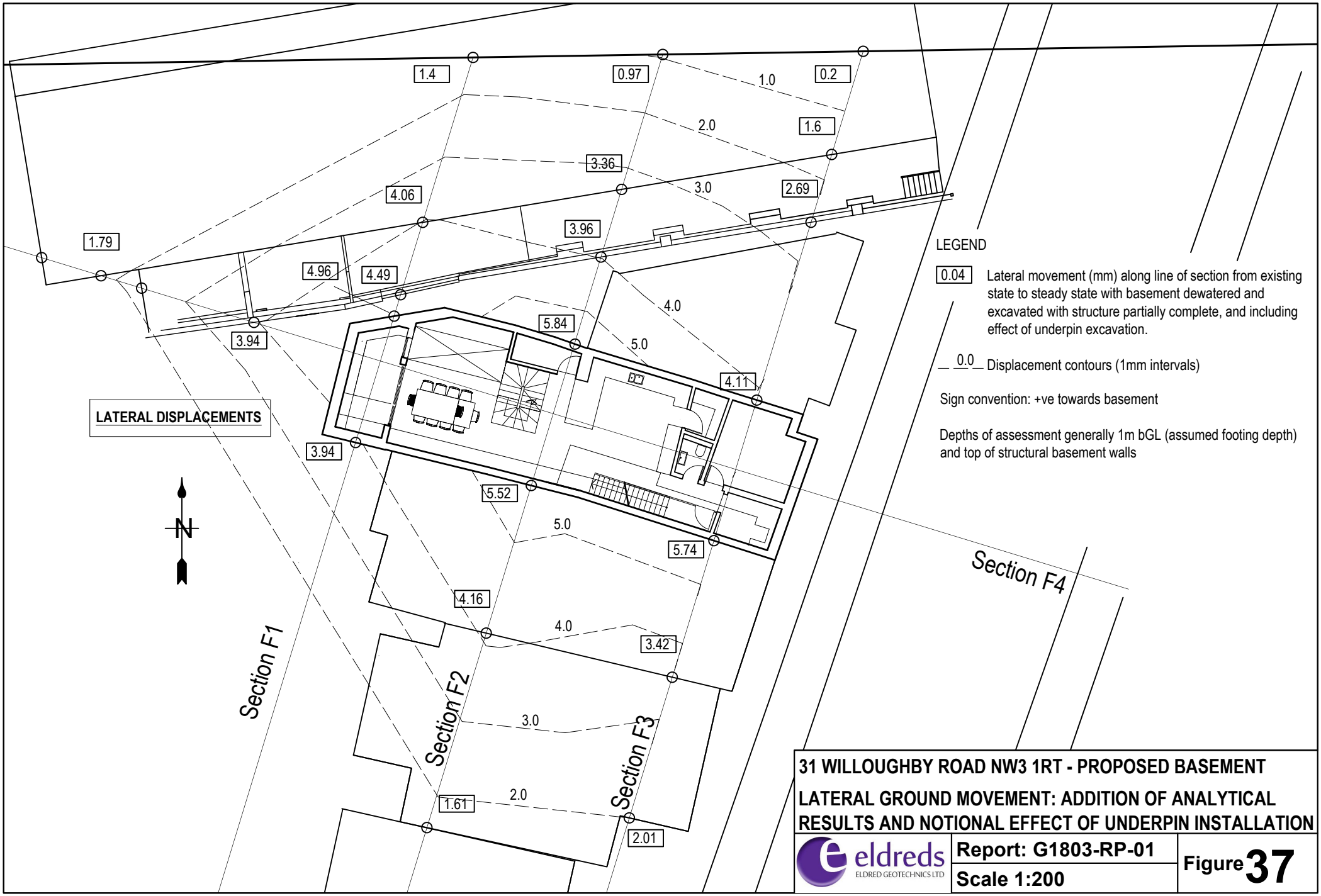
Figure 36


1.4
0.97
1.0
0.2
2.0
1.6
3.36
3.0
2.69
4.06
3.96
1.79
4.96
4.49
4.0
5.84
5.0
3.94
4.11
LATERAL DISPLACEMENTS
3.94
5.52
5.0
5.74
N
Section F4
4.16
4.0
3.42
Section F1
Section F2
Section F3
3.0
2.0
1.61
2.01
LEGEND
0.04
Lateral movement (mm) along line of section from existing state to steady state with basement dewatered and excavated with structure partially complete, and including effect of underpin excavation.
0.0
Displacement contours (1mm intervals)
Sign convention: +ve towards basement
Depths of assessment generally 1m bGL (assumed footing depth) and top of structural basement walls
31 WILLOUGHBY ROAD NW3 1RT - PROPOSED BASEMENT
LATERAL GROUND MOVEMENT: ADDITION OF ANALYTICAL RESULTS AND NOTIONAL EFFECT OF UNDERPIN INSTALLATION
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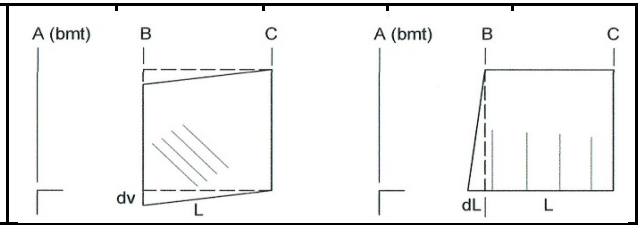
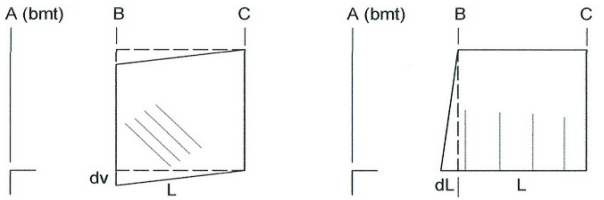
Report: G1803-RP-01
Scale 1:200
Figure 37

Damage risk assessment for brick walls accords with BIA ref [7]. Damage categories correspond to Burland's scale for brickwork but are defined by constant values of principal strain at a point which are imposed directly by displacements of supporting ground or structure. Neither strength nor stiffness of the wall and footing materials are considered. Results are thus conservative and the method is suited to perforate walls and to intact fragments of walls. Any distorsionless tilt judged to occur due to differential settlement relieves shear strain but has not been considered here. The diagrams provide a key to the tabulated values which are further illustrated by Figures 34-37



Item	Alignment	Property/ element	Strain source	A - B (m)	B - C (m)	Vertical disp. B (mm)	Vertical disp. C (mm)	Lateral disp.B (mm)	Lateral disp.C (mm)	Shear strainx10^3	Lateral strainx10^3 & sense; T or C (tension/comp'n)		Damage category (Pge 3)
1	Section F1	Willow cotts	U/pin exc'n	4.12	7.28	-3.71	-1.44	3.71	1.44	-0.31	0.31	T	0
		rear wall - bound'y	Bmt exc'n			-0.45	-0.20	0.35	0.00	-0.03	0.05	T	
						-4.16	-1.64	4.06	1.44	-0.35	0.36	T	0
2	Section F2	Willow cotts	U/pin exc'n	7.00	5.93	-2.81	-0.96	2.81	0.96	-0.31	0.31	T	0
		rear wall - bound'y	Bmt exc'n			-0.55	-0.22	0.55	0.00	-0.06	0.09	T	
						-3.36	-1.18	3.36	0.96	-0.37	0.41	T	1
3	Section F2	No. 33 rear wall	U/pin exc'n	0.00	3.50	-5.00	-3.91	5.00	3.91	-0.31	0.31	T	0
			Bmt exc'n			-0.11	-0.55	0.84	0.05	0.13	0.23	T	
						-5.11	-4.46	5.84	3.96	-0.19	0.54	T	1
4	Section F2	No.29 width	U/pin exc'n	0.00	6.49	-5.00	-2.97	5.00	2.97	-0.31	0.31	T	0
			Bmt exc'n			-4.30	0.60	0.52	1.19	-0.76	-0.10	T	
						-9.30	-2.37	5.52	4.16	-1.07	0.21	T	0
5	Section F2	No.27 width	U/pin exc'n	6.49	8.54	-2.97	-0.30	2.97	0.30	-0.31	0.31	T	0
			Bmt exc'n			0.60	0.22	0.95	0.53	0.04	0.05	T	
						-2.37	-0.08	3.92	0.83	-0.27	0.36	T	0
6	Section F3	Willow cotts	U/pin exc'n	10.79	4.58	-1.63	-0.20	1.63	0.20	-0.31	0.31	T	0
		rear wall - bound'y	Bmt exc'n			-0.01	0.00	-0.04	0.00	0.00	-0.01	T	
						-1.64	-0.20	1.59	0.20	-0.31	0.30	T	0

Damage risk assessment for brick walls accords with BIA ref [7]. Damage categories correspond to Burland's scale for brickwork but are defined by constant values of principal strain at a point which are imposed directly by displacements of supporting ground or structure. Neither strength nor stiffness of the wall and footing materials are considered. Results are thus conservative and the method is suited to perforate walls and to intact fragments of walls. Any distorsionless tilt judged to occur due to differential settlement relieves shear strain but has not been considered here. The diagrams provide a key to the tabulated values which are further illustrated by Figures 34-37



Item	Alignment	Property/ element	Strain source	A - B (m)	B - C (m)	Vertical disp. B (mm)	Vertical disp. C (mm)	Lateral disp.B (mm)	Lateral disp.C (mm)	Shear strainx10^3	Lateral strainx10^3 & sense; T or C (tension/comp'n)		Damage category (Pge 3)
7	Section F3	No. 33 Front wall	U/pin exc'n	0.00	7.07	-5.00	-2.79	5.00	2.60	-0.31	0.34	T	0
			Bmt exc'n			-0.57	-0.02	-0.89	-0.09	-0.08	-0.11	T	
						-5.57	-2.81	4.11	2.51	-0.39	0.23	T	0
8	Section F3	No.29 width	U/pin exc'n	0.00	6.00	-5.00	-3.13	5.00	3.13	-0.31	0.31	T	0
			Bmt exc'n			-0.23	-0.73	0.74	0.29	0.08	0.08	T	
						-5.23	-3.86	5.74	3.42	-0.23	0.39	T	0
9	Section F3	No.27 width	U/pin exc'n	6.00	6.00	-3.13	-1.25	3.13	1.25	-0.31	0.31	T	0
			Bmt exc'n			-0.73	-0.96	0.29	0.76	0.04	-0.08	T	
						-3.86	-2.21	3.42	2.01	-0.27	0.23	T	0
10	West - east F2-F3	Willow Cottages Length rear wall	U/pin exc'n	0.00	8.95	-2.81	-1.63	0.00	0.00	-0.13	0.00		0
			Bmt exc'n			-0.55	0.01	0.00	0.00	-0.06	0.00		
						-3.36	-1.62	0.00	0.00	-0.19	0.13*	T	0
11	West - east F2-F3	As 10, but calc. vert. disp.taken to occur at 4m c/c party walls	U/pin exc'n	0.00	4.00	-2.81	-1.63	0.00	0.00	-0.30	0.00		0
			Bmt exc'n			-0.55	0.01	0.00	0.00	-0.14	0.00		
						-3.36	-1.62	0.00	0.00	-0.44	0.13*	T	0
12	West - east F2-F3	Willow Cottages Length ret'ng wall	U/pin exc'n	0.00	8.95	-3.80	-2.60	0.00	0.00	-0.13	0.00		0
			Bmt exc'n			-0.55	-0.02	0.00	0.00	-0.06	0.00		
						-4.35	-2.62	0.00	0.00	-0.19	0.04*	T	0

* Net component of lateral strain acting along walls

Damage risk assessment for brick walls accords with BIA ref [7]. Damage categories correspond to Burland's scale for brickwork but are defined by constant values of principal strain at a point which are imposed directly by displacements of supporting ground or structure. Neither strength nor stiffness of the wall and footing materials are considered. Results are thus conservative and the method is suited to perforate walls and to intact fragments of walls. Any distorsionless tilt judged to occur due to differential settlement relieves shear strain but has not been considered here.
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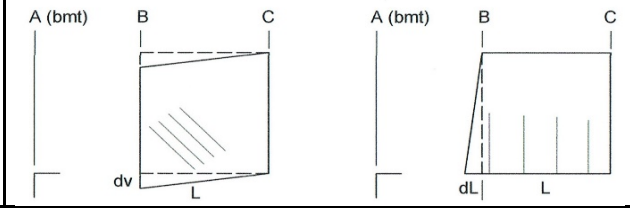
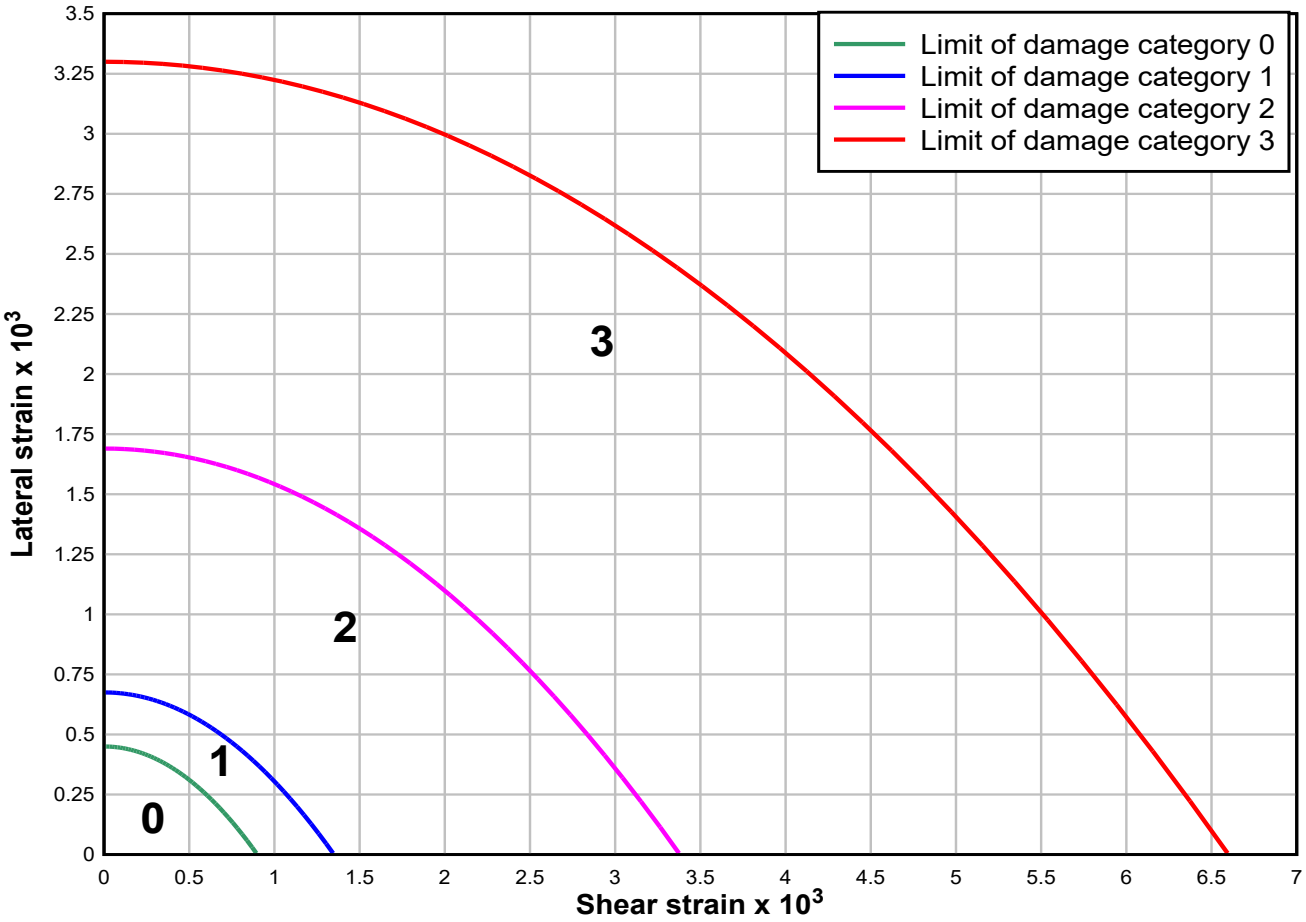


Cording Damage Curves



Cording damage curves.grf