Whitehall Park

85 Camden Mews

GROUND MOVEMENT REPORT
05 March 2015

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0	03 March 2015	Draft issue
0	05 March 2015	Initial issue

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EXECUTIVE SUMMARY

It is proposed to redevelop the site of 85 Camden Mews, London NW1 9BU. The proposed works includes partial demolition of the existing structure, and re-construction, including new structural elements above ground, plus a new basement level.

The site is part of a mews terrace, but is structurally separate to the properties either side. Most surrounding properties appear to be residential, with many showing signs of having been redeveloped relatively recently. However, one adjacent structure is used as a single storey triple-garage.

Likely ground movements from the proposed works have been determined, using the computer programme PDISP, combined with guidance from CIRIA guide C580. These ground movements have then been used to establish the likely damage category of the surrounding structures.

It is predicted that the adjacent structures will experience damage category 1: Very Slight. Other nearby structures will experience category 0: negligible, damage.

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1 INTRODUCTION

It is proposed to redevelop 85 Camden Mews, London NW1 9BU. The proposed works include partial demolition of the existing mews structure and extending it to the rear, with a new single story basement to be constructed under the new building footprint and slightly beyond the new rear wall. Geotechnical Consulting Group LLP (GCG) has been instructed by Whitehall Park to undertake an assessment of likely ground movements resulting from the proposed development, and the resulting building damage classifications for the neighbouring properties.

This report presents the findings of the ground movement assessment.

GCG have been supplied with information on the proposed development by Cullinan studio, the architect for the project.

2 DESCRIPTION OF SITE & PROPOSED DEVELOPMENT

The site is located on the north-west side of Camden Mews (Fig. 1, Fig 2). Camden Mews runs approximately 60m to the south of and parallel with Camden Road, with a south-west to north-east alignment.

The existing property consists of a two-storey residential mews property, with a single storey garage on its south-western side, and a small single storey rear extension.

83 Camden Mews is immediately adjacent to number 85, to the south-west. Directly across the Mews to the south-east, and lying about 6m away, is 60 Camden Mews. Immediately adjacent to the site, to the north-east, is a single storey brick building forming a block of three garages, with open space (a garden) beyond. To the north-west of the site lies 236 Camden Road, which is a four storey brick built residential structure with rear garden extending back to the site boundary.

Ground level in Camden Mews outside the site is believed to lie at just below 45m OD.

It is proposed to partially demolish the existing structures on the site, removing the garage and rear extension. The existing body of the main structure is to be refurbished and extended to cover the area currently occupied by the single storey garage, and a new single storey basement is to be constructed beneath. The basement will extend beyond the rear wall of the refurbished structure, creating a sunken courtyard to the rear of the structure. Basement floor level is to be 2.75m below ground floor level, so allowing for slab thickness, the basement formation level is estimated to be about 3.2m below ground level (bgl). It is understood from trial pitting undertaken that the party wall to 83 Camden Mews bears at 0.85m bgl. The footings to the existing structure on the site appear to be at 0.5m bgl. In both cases, the trial pits indicated that the footings were bearing on natural clay.

The basement will be constructed by the installation of reinforced concrete underpins, temporarily propped during construction, with the new basement slab acting as a base prop, the walls acting as cantilever, in the permanent condition. The new basement wall alongside number 83 will be a reinforced concrete stem wall, constructed using underpinning sequence and techniques, but will not be directly under the party wall. Temporary works will be undertaken as necessary to support the rear and side walls during demolition and basement construction.

A plan of the proposed works is presented in Figure 3 and sections of the proposed scheme are shown in Figure 4.

3 GROUND CONDITIONS

The geology of the area is shown on the Geological Survey of England and Wales Edition of 1920 1:10560 sheet NV NW (Fig. 5), and British Geological Survey 1:50000 map sheet 256: North London. The site is shown to be underlain by the London Clay Formation. The 1920 map indicates the presence of Boyn Hill Gravel (part of the River Terrace Deposits, RTD) above the London Clay about 80m to the east of the site. However, the more recent map shows the RTD, with a partial layer of Langley Silt above, lies in excess of 1km to the east.

A borehole shown on the 1920's map about 425m to the south west shows London Clay at ground surface, which is at about 30m above Ordnance Datum (OD). The London Clay is shown as being approximately 46m thick, and underlain by about 23m of Lambeth Group. No Thanet Sand is shown in the borehole, with Chalk indicated as directly underlying the Lambeth Group. This borehole is also available on the BGS on-line database, and it is apparent that Thanet Sand is present but has not been accurately differentiated from the Lambeth Group.

Other boreholes on the 1920 map, 650 to 700m to the east of the site, indicate a varying thickness of Made Ground over 30 to 35m of London Clay. Around 15m of Lambeth Group is shown present under the Lambeth Group, with 9-10m of Thanet Sand beneath, then the Chalk.

Based on two third party boreholes completed in Oseney Crescent approximately 300m to the north of the site (from BGS on-line database), a thin (0.3m) layer of topsoil directly overlies London Clay to 12 and 15m bgl (limit of boreholes).

A site specific ground investigation report has been completed by Southern Testing, consisting of four light percussion window sample holes, plus hand-excavated trial pits to examine existing foundations. The window sample holes showed up to 0.5m thickness of Made Ground, overlying clay. The clay was described as initially firm or firm to stiff, becoming stiff to very stiff silty clay. Two of the boreholes indicated the presence of a <200mm thick layer of gravelly clay (gravel being flint), at 3.2m bgl and 4.2m bgl. A third borehole placed between these two holes did not detect such a layer, and given the difference in depth of the gravelly clay recorded in the two boreholes, it is not considered to be a discreet layer, but rather isolated pockets.

The ground investigation report identifies the clay as the London Clay, but then indicates that the gravelly clay and overlying clays are head deposits. It is not certain that the upper layer of clay is truly a head deposit though it does seem clear that the material is weathered, and it is possible that this upper material could have been soliflucted (or drifted downslope during a Quaternary interglacial stage). The description of the clay as firm or firm to stiff, however, suggests that it is now relatively undisturbed. The site specific intrusive investigations indicated clay to 6m bgl, the maximum depth of the boreholes undertaken.

Based on the site specific ground investigation and the third party data from the surrounding area, the geology at the site was assumed consist of 0.5m thickness Made Ground, overlying 40m of London Clay. Lambeth Group was assumed beneath the London Clay, but given the depth and stiffness of this stratum, the base of the London Clay was taken as the rigid base to the ground movement analysis carried out as part of this study.

Groundwater

The site specific ground investigations included four groundwater monitoring installations at depths of about 5-6m bgl. All showed the presence of groundwater, rising to about 0.5 to 1.0m bgl. However, the rate at which the monitored groundwater levels rose indicates that the permeability of the clay is low, and that if excavations are open for short periods, little groundwater inflow is to be expected. Due to the low permeability anticipated for the London Clay, lateral sub-surface flow through the clay is anticipated to be low, and the new basement construction should have no significant impact on groundwater conditions.

It is likely that there will be perched groundwater within the Made Ground, and some minor seepage from this layer may occur as excavation proceeds through it. The thinness of the Made Ground, its clay nature, and the effect of neighbouring buildings cutting through it to their founding level, will all combine to make it unlikely that here is any significant lateral water flow through the Made Ground. Hence inflows other than minor seepage are not considered likely, and the proposed works should have no noticeable effect on hydrogeological conditions within the Made Ground.

4 GROUND MOVEMENTS

It is understood that the ground level at the site is approximately 45m OD, and that the topography slopes downwards to the south-west. However, overall gradients appear to be shallow (less than 2°), and there is not considered to be any likelihood that the proposed works could generate issues of reduced slope stability.

There is the potential for ground movements due to the proposed development from the underpin construction and excavation process, and from the changes in vertical stress within the soil resulting from the changes in loading from the development.

The effect of excavating soil is to cause a reduction in stress at the new formation level, due to the weight of the soil removed. Since typically, construction follows on shortly after excavation, this unloading of the ground is normally modelled as producing a short term (undrained) response. However, if there is a delay in the construction phase, a fully drained response to the unloading may develop. In the case of the proposed development, it is assumed that basement excavation will be quickly followed by construction and hence modelling an undrained response is applicable.

The loading that results from the new construction will apply in the long term, over the structure’s lifetime. Hence there will be both a short term and long term response. Generally, the long term behaviour shows a softer response (higher movements). The overall movement of the ground following construction is, however, driven by the total changes in loading that have occurred; thus it is a combination of the unloading caused by demolition and excavation of soil and the imposed loading from the new structure.

Given that the development involves underpinning existing walls, whereby existing loads will be transferred to greater depth as the excavation proceeds, and much of the new structure will be retained, there is no clear distinction between short term and long term activities, and therefore only the long term case, for which movements are at a maximum, has been modelled.

4.1 Modelling of movements due to vertical stress changes

The predicted ground response due to vertical unloading of the ground through excavation for the proposed new basement, and then the reloading of the ground by construction of the new development was modelled using the OASYS program PDISP. This program assumes a linear elastic behaviour of the soil and a flexible structure. In reality, the finite stiffness of the structures will tend to redistribute or smooth out the movements, when compared to those predicted by PDISP. The settlement calculations therefore represent free field movements unaffected by the stiffness of the structures and are likely to be conservative (i.e. the distortions of the structure would be less than those obtained from the predicted movements).

The assessments were undertaken using selected soil parameters representing long term (drained) stiffness behaviour, as discussed above. The soil parameters used are presented in Appendix A. The rigid base to the analysis was taken as 4.5m OD, the estimated depth at which the top of the Lambeth Group occurs.

No estimates of the existing or new building loads were available at the time of this assessment. It was assumed therefore that the existing building generates loads of 15kPa per floor. The main existing structure is 7m wide and 6m deep, so the load from the existing two story structure was therefore assumed to be 1260kN, distributed evenly through the perimeter shallow footings. The existing garage is a single storey building, assumed to be applying a 10kPa load at ground level, similar loads were assumed from the existing rear extension.

New structure load was similarly assumed to be 15kPa per floor from three floors (including the basement), acting over a 10m wide by 8m deep plan footprint, with 10kPa acting over the area of the rear sunken courtyard. Load was applied uniformly over the building footprint, through the ground bearing slab.

4.1.1 Movements following construction of the new development

The movements of the ground following construction were also analysed for the long term (drained) case, see Figures 6 and 7. The analyses were undertaken for the combination of the unloading due to demolition / excavation and then the reloading for the new construction.

The PDISP analysis indicated that at 44.5m OD (approximate current footing level of the surrounding structures), heave of the existing wall to the garage that forms part of No.83 of about 2mm is predicted. Heave of the garages at No.87 is slightly greater, at about 7mm. Movements of the front of No.60 consist of about 1mm of heave. In practice, it is believed that PDISP tends to over predict movements that occur outside the new basement box construction, so actual movements due to vertical stress change will likely be less than indicated.

At new formation level (41.8m OD, Figure 7), heave of the front and side walls of the rebuilt structure are predicted to be 3mm, and to be relatively uniform around the perimeter of the structure. Increased heave is predicted to occur under the rear sunken courtyard, since this is the area of the largest net unload.

It should be reiterated that the movements due to vertical stress changes do not occur in isolation to the other movements resulting from the basement construction process, and the actual ground movements, particularly around and beyond the perimeter of the proposed basement, will reflect this.

4.2 Movements due to underpin construction and basement excavation.

In addition to the changes in vertical stress caused by demolition of the existing structure, excavating soil and constructing the new structure, the construction of the basement beneath the house and garden requires the construction of underpins; such activities will generate both horizontal and vertical movement in the ground.

Ground movements resulting from underpinning are not well documented, and there is no specific method for assessing their magnitude. When underpinning is carried out in a well-controlled manner, movements are typically small; settlements of up to 5mm of the underpinned wall are typically quoted. The ground conditions at Camden Mews consist of a thin layer of Made Ground (clay) over London Clay, so should be well suited to underpinning.

To provide some basis of estimating likely movements and damage resulting from excavating the basement in front of the underpinning, and in the absence of underpinning-specific guidance, the underpinned sections of the new basement have been treated as a piled retaining wall. It has been assumed that the movements resulting from excavation in front of the underpins also incorporate the movements resulting from the construction of the underpins, since, unlike for the piles, the construction process requires an excavation prior to the pins being formed.

Assessment of the ground movements resulting from the underpin installation and the excavation to form the basement has thus been undertaken with reference to CIRIA guide C580, "Embedded retaining walls – guidance for economic design". This provides guidance on the horizontal and vertical movements of the soil adjacent to an embedded retaining wall as a result of pile installation and of excavation in front of the wall based on numerous case histories, for the case of a high stiffness (propped) retaining wall and a low stiffness (cantilevered) retaining wall. It is noted that the guidance is empirically based, and is for piled walls embedded in stiff clays, but that most of the case studies from which the data has been gathered are for London sites with geology consisting of RTD over London Clay. The ground conditions from which the empirical data in C580 apply therefore appear to be a reasonable match to the ground conditions present at Camden Mews.

The underpins will be constructed in a typical underpinning 'hit-and-miss' sequence. It is assumed that the use of reinforced underpins and the action of the basement slab and the ground floor slab will act to provide a high-stiffness system, despite the underpins being designed to act in cantilever.

Ground movement guidance in C580 is divided into movements resulting from pile installation and from the mass excavation in front of the wall. However, with underpinning, the process of creating the underpins also involves excavation. Ground movements have therefore been based on the guidance given by C580 for excavations in front of the wall.

The vertical ground movement has been assumed to be maximum at the wall, decreasing linearly with distance. Since this maximises the differential settlement across the walls of the neighbouring buildings, this is also considered to be a conservative approach.

The excavation to create the new basement requires 3.2m of excavation; from CIRIA C580, this is predicted to generate a maximum of 3mm of settlement at the wall. Settlements are anticipated to become negligible at about 12m from the wall.

Horizontal movements in towards the excavation are likely to be about 5mm, reducing linearly to zero at 13m from the wall.

The movements given by CIRIA are for excavations with straight walls; corners tend to restrict movements, such that horizontal deflections towards an excavation in the vicinity of a corner to the excavation are typical reduced to about half that predicted from 'plane strain' movements, though this does not apply for re-entrant corners.

4.3 Impact of ground movements

There are four structures surrounding 85 Camden Mews that might be subject to ground movements from the scheme (see figure 2), and for which, therefore, the impact of ground movements need to be considered.

236 Camden Road.

236 Camden Road lies to the rear of 85 Camden Mews. It is believed that the structure of 236 Camden Road lies in excess of 15m from the rear-most element of the proposed works. As such, it lies beyond the distance to which ground movements are predicted to occur. It is therefore considered that proposed works will have no impact on 236 Camden Road.

87 Camden Mews

87 Camden Mews consists of a single story block of three garages. The PDISP analysis indicates a possible 7mm of heave along the near side wall, though in practice, actual movements are likely to be lower. The garage block is believed to be about 8m wide, at which distance, negligible heave is likely to occur.

Ground movements as a result of the underpinning process are likely to involve about 3mm of settlement adjacent to the new basement, and are unlikely to exceed 5mm assuming well controlled works, reducing to about 1mm of settlement of the far wall. When combined with the predicted heave movements, the garages are shown to have a predicted 1mm settlement of the far wall, and 4mm heave adjacent to the works. In practice, the heave movement is likely to be less than predicted, which will result in less differential movement across the structure. Horizontal movements of the garages are anticipated to be about 5mm adjacent to the boundary, reducing to 2mm at the far wall. The combination of horizontal strain and sagging vertical deflection indicates that the garages will experience damage category 1: very slight damage

60 Camden Mews

60 Camden Mews lies across the public highway from the site, lying approximately 6m away. It is believed that the property is about 9 - 10m from front to back, placing the back wall of number 60 around 15m from the excavation, beyond the distance of any anticipated ground movement. Horizontal displacements of the front wall are therefore predicted to be approximately 3mm, with zero movement of the rear wall. Strain across the building is therefore anticipated to be 0.03%. Slight vertical movement of the front of the building may lead to a slight increase in the potential for damage, with the PDISP analysis suggesting the possibility of 1mm heave of the front of the structure, creating a slight 'sagging' deflection mode across the structure, but the building appears to be a newly constructed or re-constructed building, in good condition. It is therefore considered that the building will experience damage category 0 (negligible) conditions.

83 Camden Mews

83 Camden Mews consists of a 2 storey brick built residential structure, with an integral 1 storey high brick built garage which extends to the boundary with the site at 85 Camden Mews. The proposed development of the site at No.85 includes construction of two new residential floors above ground, replacing a previous single storey garage that lay alongside the property boundary, so the net change in loading over this section of the site is less than elsewhere, and as a result, predicted heave of the boundary wall to No.83 is quite small, at 2mm.

It is understood that the plot of No.83 is about 12m wide, with the single storey garage occupying about 4m of that width. Under the party wall, movements due to the basement construction are assessed to be 3mm of settlement (up to 5mm, assuming good workmanship) and 5mm of horizontal movement. On the far side of the garage, this will reduce to about 2mm of settlement and 3mm of horizontal displacement, while the far side of the plot should experience no ground movements. When combined with the predicted heave movements, vertical displacements will be very small; less than 2mm everywhere. Based on the calculated strain across the building, predicted damage is border-line between categories 0 and 1 (negligible and very slight). However, there is the potential that the single storey garage may be more sensitive to movements, and assessing this section of the structure in isolation indicates that the structure falls within category 1, very slight damage. It is noted that the structure of No.83 appears to be in good condition overall, and shows no signs of being particularly sensitive to ground movements.

85 Camden Mews

In addition to considering the impact of the works on neighbouring structures, the works must be undertaken in a manner that preserves the structural stability of the existing building. The PDISP analysis showed that the underpinned front façade and site boundary walls will experience uniform and low magnitudes of heave. A greater magnitude of heave is predicted under the line of the new rear wall and under the existing external wall facing onto No83, and measures to control this movement may be required; however, the differential heave movements are small, so this should be tolerable, and is not considered to pose a threat to structural stability. Horizontal movements of the new basement walls will tend to be inwards, estimated as 5mm on each wall, for a net shortening of 10mm over the width of the structure, though the basement and ground floor slab will tend to resist and reduce this movement. No significant tensile forces should be induced by this movement, and therefore no significant damage is predicted, with the effects of the partial demolition and redevelopment of the above ground structure masking any minor distress caused by the basement works.

5 COMMENTS

The proposed development of 85 Camden Mews requires partial demolition of the existing structure, excavation of a new basement level under and a little beyond the footprint of the existing structure, and re-construction of a new residential property on the site. The works are to be undertaken in close proximity to a number of adjacent structures. Some ground movements during such works are inevitable.

A PDISP analysis of the likely ground movements combined with an assessment based on the guidance in CIRIA guide C580 has shown that the adjacent properties within Camden Mews are anticipated to experience damage category 1: very slight, conditions; the property directly across the mews should be largely unaffected (damage category 0).

No other properties appear to be close enough to be affected by ground movements resulting from the works.

It is therefore concluded that the damage experienced by the surrounding structures should in all cases be within generally accepted limits.

The ground movements predicted herein are all based on the assumption that the existing buildings are currently in good condition and that works will be undertaken to a high standard, adequately supervised, with movements being well controlled.

This report was completed by Dr Phil Smith on behalf of GCG LLP; the report was peer reviewed by Dr Apollonia Gasparre and Dr Jackie Skipper (Section 3 only), both of GCG.

The author’s and reviewers’ technical and professional qualifications are as follows:
Phil Smith: BEng, MSc, PhD, DIC
Apollonia Gasparre: PhD, DIC, Dott. Ing., MICE
Jackie Skipper: BSc, PhD, DIC, CGeol, FGS.

6 REFERENCES

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FIGURES

Approximate North

Figure 1: Site location.
(Image from Bing Maps, Copyright: Microsoft corporation)

Figure 2: Site location Plan.

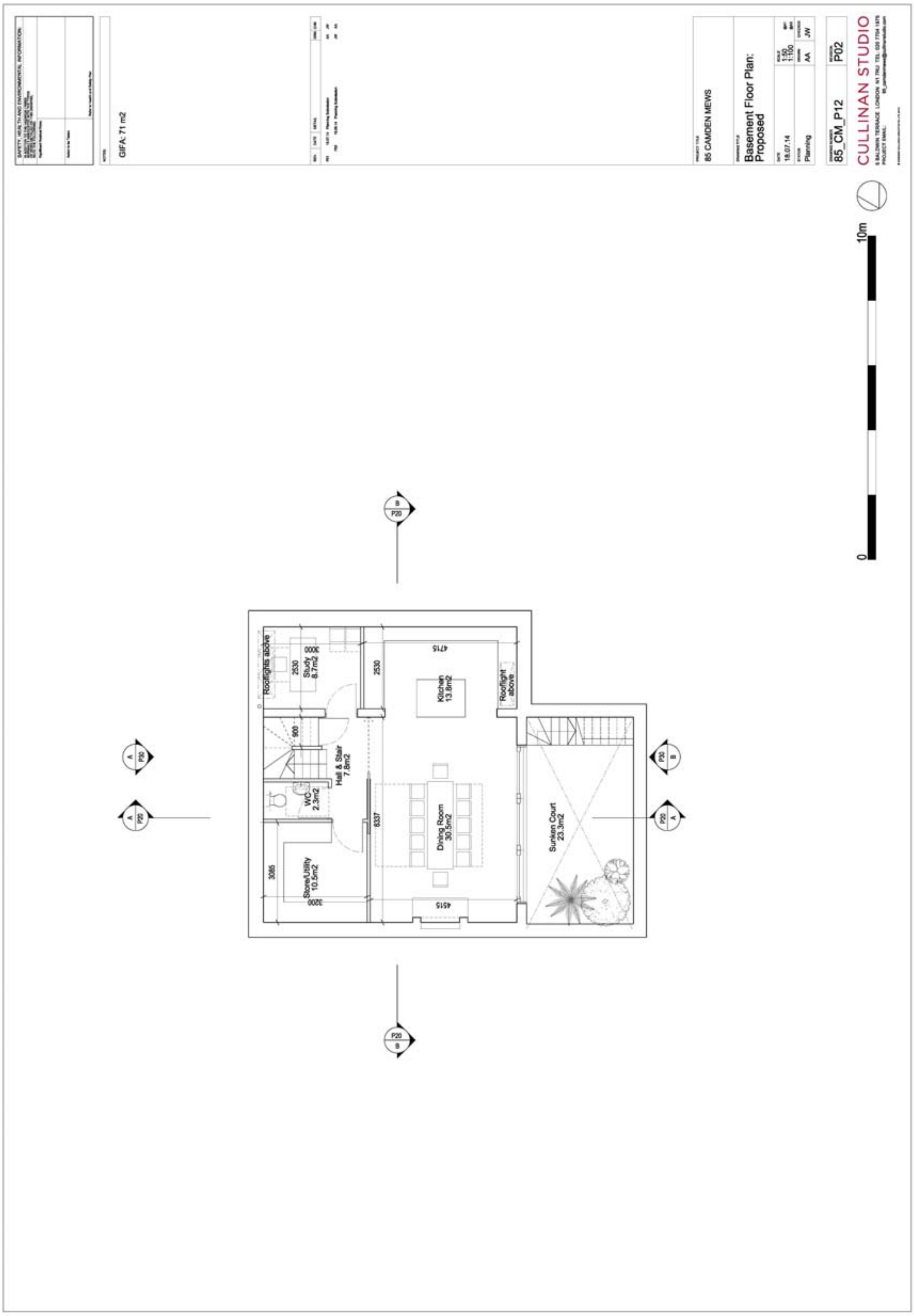

Figure 3: Proposed basement plan layout.

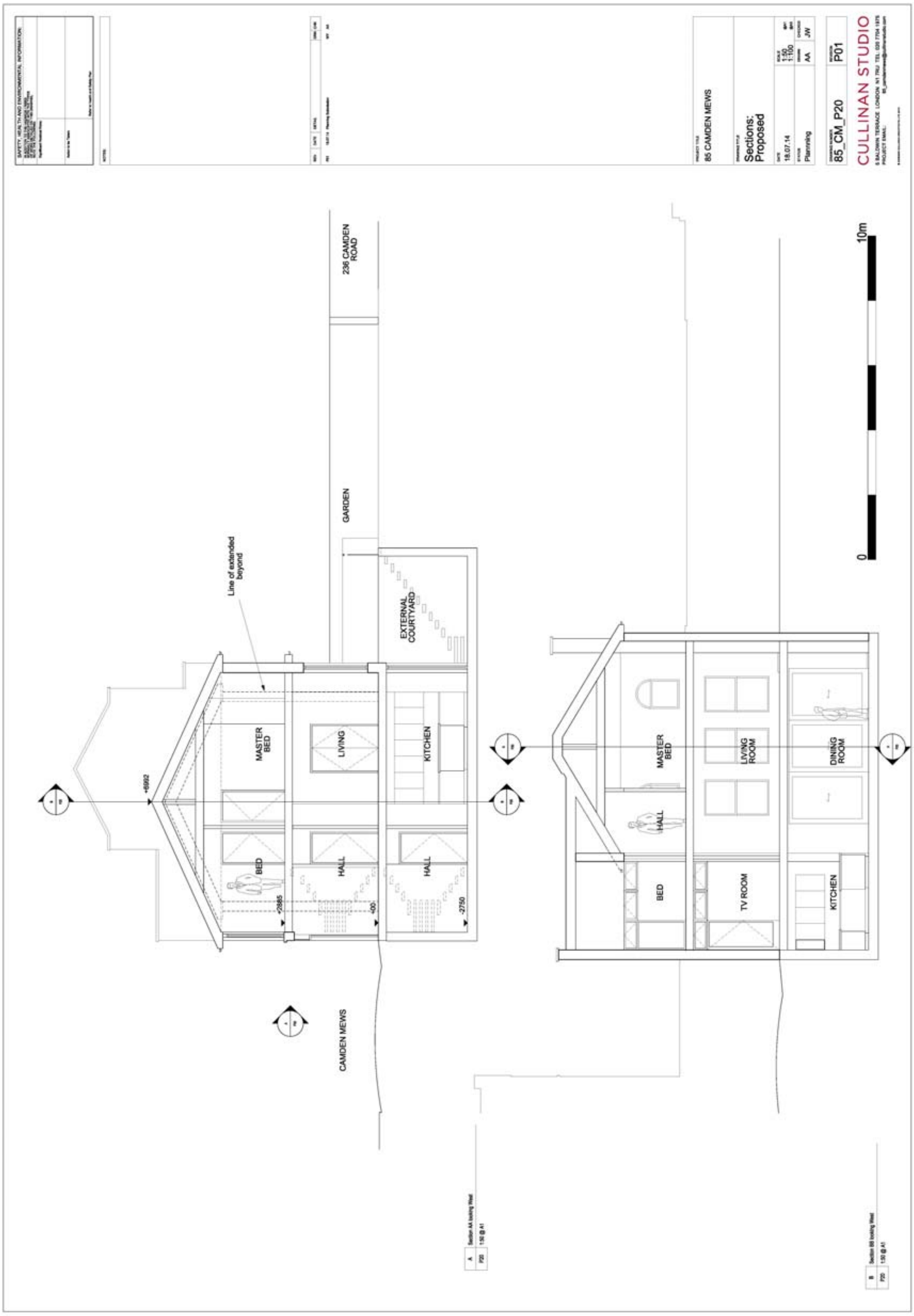

Figure 4: Sections through the proposed new basement.

Figure 5: Geology of the area - extract from the Geological Survey of England and Wale, Edition of 1920 1:10560 sheet London NV NW.

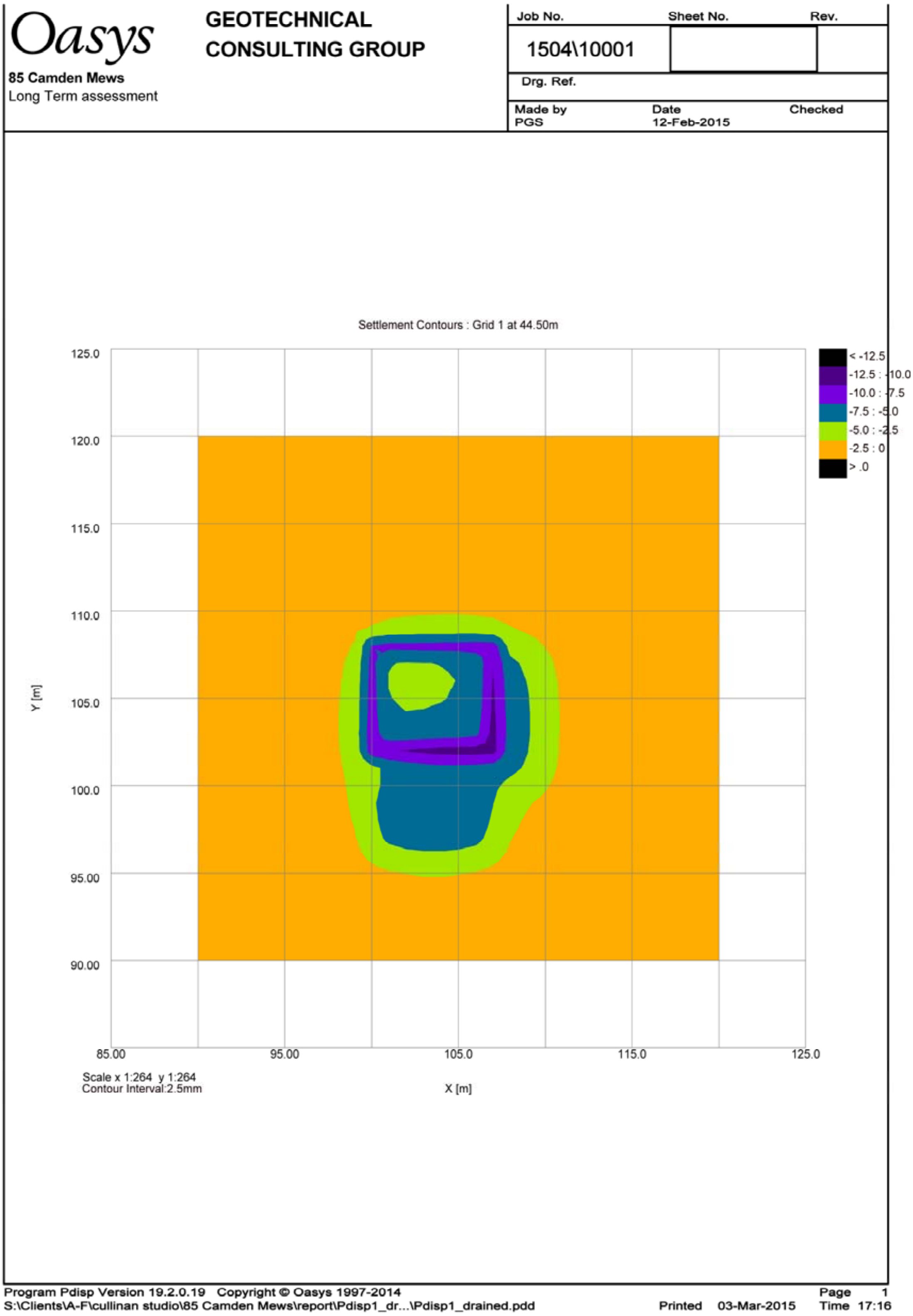

Figure 6: PDISP analysis: Long term, Movements at estimated existing footing level (44.5m OD)

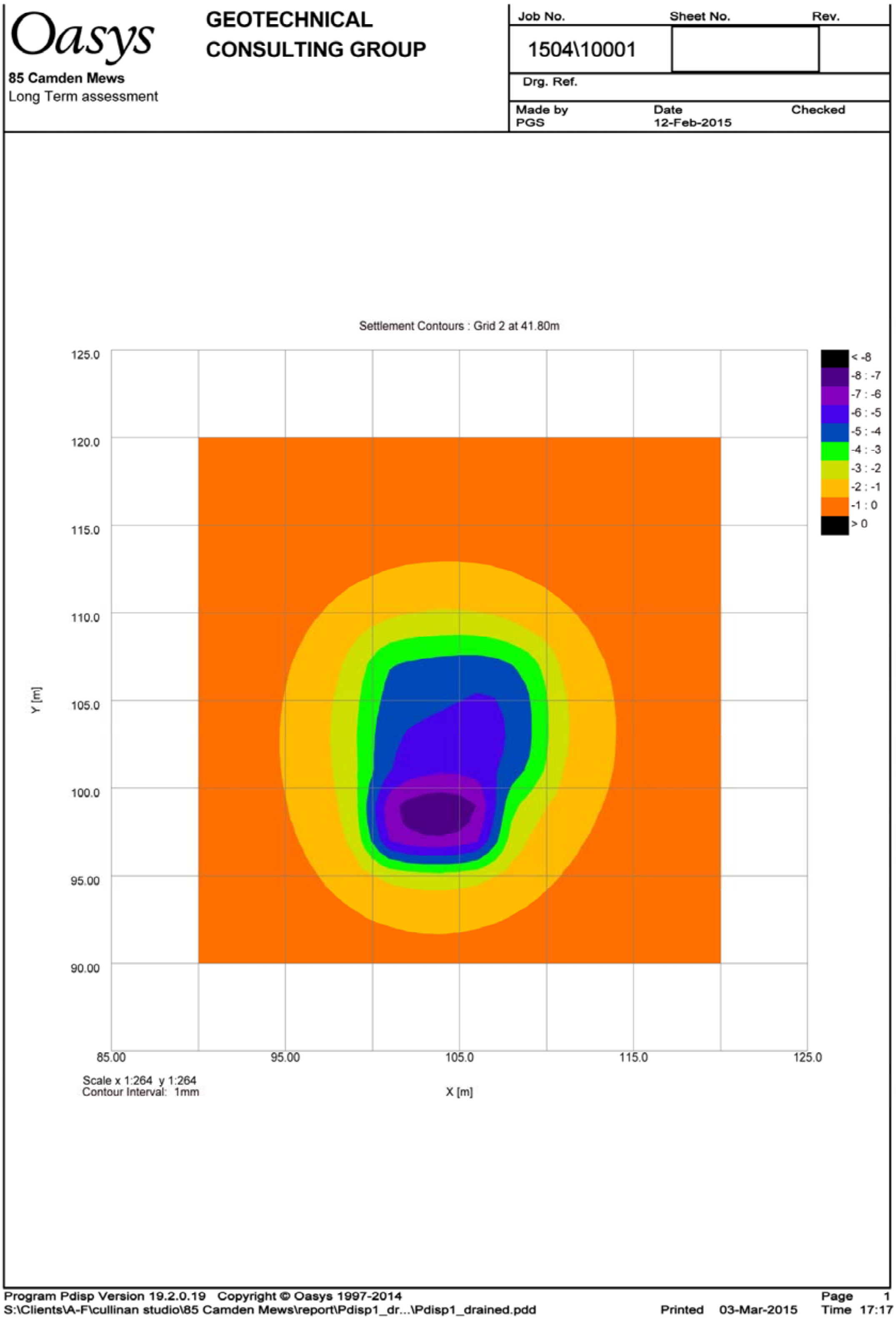

Figure 7: PDISP analysis: Long term, Movements at new formation footing level (41.8m OD).

APPENDIX A

Details of PDISP analysis

85 Camden Mews – Soil Stratigraphy and Properties

Drained analysis

Strata	Level at top (mOD)	Young's Modulus (kPa)		Poisson's ratio
		Top	Bottom	
Made Ground	45	5,000	5,000	0.2
London Clay	44.5	16,000	172,000	0.125

Rigid boundary taken as 4.5m OD (Approximate base of London Clay horizon)