Providing Ground Solutions

Oakwood International Investment Corporation

Land to the Rear of 222 Euston Road

Basement Impact Assessment

October, 2018

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1. INTRODUCTION

Card Geotechnics Limited (CGL) has been instructed by TP Bennet (the Architect) on behalf of Oakwood International Investment Corporation ('the Client') to undertake a site investigation and Basement Impact Assessment (BIA) for the proposed development at Land to the rear of 222 Euston Road, within the London Borough of Camden. The proposed development comprises a new student residence with seven above ground storeys and a basement level over the majority of the site.

The London Borough of Camden's guidance document "*Camden Planning Guidance Basements*"[1] requires a Basement Impact Assessment (BIA) to be undertaken for new basements in the Borough and sets out 5 stages for a BIA to "enable the Council to assess whether any predicted damage to neighbouring properties and the water environment is acceptable or can be satisfactorily ameliorated by the developer". The five stages are set out below:

1. Screening
2. Scoping
3. Site investigation
4. Impact assessment
5. Review and decision making

A Screening and Scoping report[2] was previously undertaken for the site; this showed that further investigation would be required to support the detailed design stage, with a basement impact assessment also required at this time. This report is therefore intended to address the site investigation and impact assessment stages identified above. It identifies the key issues relating to land stability, hydrogeology and hydrology as part of the screening process (Stage 1) and includes a review and interpretation of existing site investigation data to establish a conceptual site model (Stages 2 and 3).

The report provides an impact assessment (Stage 4) of potential ground movements on adjacent structures and the hydrogeology of the surrounding area for the purposes of planning.

This report therefore includes details of the ground investigation undertaken at the site and the basement impact assessment for the proposed development.

[1] London Borough of Camden (2018) *Camden Planning Guidance Basements.* March 2018
[2] CGL (2018) 24 to 32 Stephenson Way, NW1 2HD *BIA Phase 1 – Screening and Scoping Report*. Ref CG/28583. May 2018

2. SITE CONTEXT

2.1 Site Location

The site is located to the rear of 222 Euston Road, Kings Cross, London, NW1 2HD, within the London Borough of Camden. The approximate Ordnance Survey grid reference for the site is 529414E, 182445N. A site location plan is presented in Figure 1.

2.2 Site Description

The site comprises a rectangular area of land some 12.5m wide and 32.4m long. It is bounded by the highway of Stephenson Way to the northwest, 210 Euston Road (the Institute of Ismaili Studies) to the northeast, the lower ground floor level buildings and open car park/bin store of 222 Euston Road (the UCL Farr Institute) to the southeast and 152 to 156 North Gower Street (the Euston Square Hotel) to the southwest. The northeastern half of the site consists of an open car park at lower ground floor level (22.67mOD and 22.82mOD), with an access ramp leading along the southeastern and southwestern site boundaries up to street level (24.48mOD to 24.78mOD).

The remaining area, in the northwest of the site, comprises a disused asphalted area with six cycle racks and five mature trees. Additionally, a steel frame is present in this area, which provides support to the site-facing façade of 152 to 156 North Gower Street.

The street and area of trees are at a level of 24.48mOD to 24.78mOD and are supported along the northwestern and southwestern sides of the car park by a concrete retaining wall. A further retaining wall supports the access ramp along the boundary with 222 Euston Road to the southwest.

Reference to the London Borough of Camden's planning portal demonstrates that the majority of the buildings in the immediate vicinity of the site have basements/lower ground floors. The buildings on the opposing side of Stephenson Way (22 and 24-32 Stephenson Way and 158-164 North Gower Street) all have single storey basements (assumed to be at approximately 21.5mOD), as does 152 to 156 North Gower Street to the southeast. Drawings for the hotel indicate that a small area along the boundary with the study site may comprise a single storey infill and it is possible that there is no existing basement in this area.

The car park/bin store of 222 Euston Road to the southeast of the site is at lower ground floor level (approximately 22.6mOD), with direct access to the building from this level. 210 Euston Road is shown to have two below-ground storeys, with the basement supported by a secant piled wall, with the lower storey at a typical level of 17.5mOD, locally deepening to approximately 16.5mOD along the boundary with the study site. A site layout plan is presented in Figure 2.

2.3 Tunnels and buried infrastructure

The "Sandy Street Sewer" is located approximately 17m southwest of the site. Thames Water sewer records show that there is an existing combined sewer at Stephenson Way to the north of the site. A manhole is present in the car park area on site, although it is not clear where it drains to.

It is noted that a stairwell leading to Euston Square underground station is present some 13m south of the site. The closest running tunnels are some 30m south of the site (the London Underground Limited (LUL) Piccadilly Line) and are present at approximately 1m below street level. Additional infrastructure is present between 30m and 50m of the site including the LUL Victoria line tunnel and a passenger link tunnel from Euston Station to Euston Square underground station. The locations of these are shown in Figure 2.

The proposed development does not affect LUL infrastructure.

2.4 Topography

With the exception of the access ramp, the site area is relatively flat although the car park area slopes slightly towards the south, from 22.82mOD to 22.67mOD.

Topographical maps of the surrounding area in the Camden Strategic Flood Risk Assessment[3] (SFRA) indicate the local topography to be generally flat, with an upwards slope approximately 600m north west of the site from around 25mOD to 39mOD towards *Regents Park*.

[3] URS. (2014). *London Borough of Camden Strategic Flood Risk Assessment (SFRA).* Ref. 47070547

2.5 Proposed Development

The proposed development will comprise the construction of a student residence with seven above ground storeys, and a single storey basement level – at close to the existing lower ground floor level. A ramp will lead from ground level at Stephenson Way to the basement level. Proposed development plans are included as Appendix A.

The Scheme Design Report[4] produced by Walsh is included as Appendix B and shows that two foundation options have been considered at scheming stage, however it is likely that piled foundations will be required to avoid surcharging the neighbouring basement at 210 Euston Road. The ground movement assessment in this report has therefore been undertaken on the assumption that the proposed buildings will be founded on piles a minimum of 15m deep, with a secant mini-piled wall around the northeastern, northwestern and southwestern perimeters of the site.

The basement slab is proposed to be 300mm thick with 1000mm thick pile caps, giving a formation level of 20.5mOD, some 2.1m below existing LGF level, and approximately 4m below street level.

[4] Walsh (2018) Scheme Design Report *Stephenson Way*

3. SUMMARY OF REQUIREMENTS FROM SCREENING AND SCOPING REPORT

The Screening and Scoping Report[2] recommended that further investigation and a basement impact assessment should be undertaken. The investigation would be used to confirm ground conditions and groundwater levels on site, along with inspection of the foundations of the surrounding buildings. The Basement Impact Assessment would be used to find the impact of the proposed development on properties that will form party walls with the proposed development and to predict the ground movements at the road of Stephenson Way.

4. GROUND INVESTIGATION

4.1 Fieldwork

An intrusive investigation was undertaken by CGL between 28th August and 3rd September 2018 and comprised one cable percussive borehole (BH1) to 25 metres below ground level (mbgl) and three foundation inspection pits (TP1 to TP3). The borehole was excavated within the car park, with the foundation inspection pits excavated around the perimeter of this area, against the adjoining buildings and structures. Due to access restrictions it was not possible to excavate trial pits at the boundary to 152 & 156 North Gower Street.

The exploratory hole arisings were logged and representatively sampled by a suitably qualified engineer from CGL. Standard Penetration Tests (SPTs) were undertaken at regular intervals within the borehole. Prior to the commencement of the intrusive investigation, service clearance was carried out by a specialist utilities detection contractor. Upon completion of the borehole, a groundwater monitoring well was installed.

The borehole logs, foundation inspection pit records and groundwater monitoring record are provided in Appendix C, Appendix D and Appendix E, respectively, and the exploratory hole locations are presented n Figure 2.

4.2 Geotechnical Laboratory Testing

Representative soil samples were sent to i2 Analytical Limited for geotechnical testing. The geotechnical tests have been undertaken in accordance with BS1377[5]. The geotechnical analysis included the following:

- Atterberg Limits;
- Moisture Content;
- Triaxial testing; and
- Geotechnical pH and sulfate (to BRE SD1).

The results of geotechnical laboratory analysis are presented in Appendix F.

[5] British Standards Institution. (2016). Methods of Test for Soils for Civil Engineering Purposes. BS1377:2016.

5. GROUND AND GROUNDWATER CONDITIONS

5.1 Ground conditions

The ground conditions encountered during the investigation were generally consistent with the published geology for the site and are summarised below in Table 1.

Table 1. Summary of ground conditions

Stratum	Depth to top of stratum (mOD) [mbgl][a]	Thickness (m)
MADE GROUND Asphalt over very dense dark red brown very gravelly fine to coarse sand. Gravel is fine to coarse subrounded to subangular of brick, concrete, flint and occasional asphalt.	22.66 [0.0]	0.65 to 0.77
MADE GROUND Reinforced concrete. 8mm and 18mm diameter rebar noted at 0.8mbgl	21.89 to 22.01 [0.65 to 0.77]	0.8 to 0.95
Medium dense light brown slightly clayey gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to subangular of flint. [LYNCH HILL GRAVEL MEMBER] *Base of stratum proven in BH1 only*	21.1 to 21.06 [1.57 to 1.6]	1.5
Firm dark brown slightly silty CLAY. Occasional fine to coarse selenite crystals noted. [WEATHERED LONDON CLAY FORMATION] *Encountered in BH1 only*	19.56 [3.1]	0.5
Stiff to very stiff dark grey silty CLAY with occasional thin laminations of fine sand. Frequent fine to medium selenite crystals, fine light brown bioturbations and rare white to light grey shell fragments. [LONDON CLAY FORMATION] *Encountered in BH1 only*	19.06 [3.6]	17.1
Very stiff light grey mottled dark brown and red CLAY [LAMBETH GROUP] *Encountered in BH1 only*	1.96 [20.7]	1.6
Very dense dark yellow grey fine SAND. [LAMBETH GROUP] *Encountered in BH1 only*	0.36 [22.3]	Proven to 25mbgl

a. metres below lower ground floor level

Plots of SPT 'N' value and undrained shear strength, c_u, are presented as Figure 3 and Figure 4, respectively.

5.2 Made Ground

The Made Ground across the site was found to comprise asphalt surfacing over 0.65m to 0.77m of gravelly sand. This was followed by a layer of concrete which was proven to be present across the whole of the car park area. Probing and coring of the concrete within borehole BH1 and trial pits TP1, TP2 and TP3 proved the concrete to be between 0.5m to 0.95m thick.

5.3 Lynch Hill Gravel Member

The Lynch Hill Gravel Member was encountered in BH1 and TP2 at 1.57mbgl to 1.6mbgl and comprised medium dense light brown slightly clayey gravelly sand. The results of in-situ Standard Penetration

Testing (SPTs) undertaken in the borehole recorded a value of 19 within the Lynch Hill Gravel Member (or a relative density of 'medium dense'[6]).

5.4 London Clay Formation

A thin layer (0.5m) of Weathered London Clay Formation, comprising firm silty clay, was encountered beneath the Lynch Hill Gravel at 19.56mOD (3.1mbgl). This was followed, at 19.06mOD (3.6mbgl), by the unweathered London Clay Formation which comprised stiff to very stiff silty clay.

In-situ and geotechnical laboratory analysis on samples of weathered and unweathered London Clay Formation demonstrated the following parameters;

- Moisture content: 21% to 33%;
- Liquid Limit: 64% to 82%;
- Plastic Limit: 25% to 33%; and
- Plastic Index: 38% to 52%

The above results indicate that the stratum is a clay of high to very high plasticity[6], with a medium to high volume change potential[7].

Standard Penetration Testing (SPTs) undertaken in the borehole recorded uncorrected 'N' values of between 10 and 41 in the London Clay Formation, correlating[8] to undrained shear strengths, c_u, of between 45kPa and 184.5kPa (where f_1=4.5). These generally correspond to the results of laboratory triaxial testing, which recorded values of c_u of between 33kPa and 183kPa between 2mbgl and 18mbgl. It is noted that the value of c_u at 9mbgl (33kPa) is anomalous; a water strike was noted at this depth and it is anticipated that the clay in this sample may therefore have been softened by the groundwater or otherwise disturbed prior to testing.

[6] British Standards Institution. (2015). *Code of practice for site investigations*. BS5930:2015.
[7] NHBC (2018) *NHBC Standards Chapter 4.2: Building near trees*
[8] Stroud, M.A. (1975). The standard penetration test in insensitive clay and soft rock. *Proceedings of the European Symposium on Penetration Testing,* 2, 367-375.

5.5 Lambeth Group

The Lambeth Group at the site was encountered at 1.96mOD (20.7mbgl) and was found to comprise 1.6m of very stiff mottled clay followed, at 0.36mOD (22.3mbgl), by very dense fine sand.

In-situ and geotechnical laboratory analysis on samples of cohesive Lambeth Group demonstrated the following parameters;

- Moisture content: 21%;
- Liquid Limit: 54%;
- Plastic Limit: 26%; and
- Plastic Index: 28%

The above results indicate that the cohesive part of the stratum is a clay of high plasticity[6], with a high volume change potential[7].

5.6 Groundwater Conditions

Three groundwater strikes were noted during drilling and are summarised in Table 2.

Table 2. Summary of groundwater strikes

Strike depth (mOD) [mbgl]	Depth after 20 minutes (mOD) [mbgl]	Stratum	Notes
19.86 [2.8]	20.01 [2.65]	Lynch Hill Gravel Member	
12.76 [9.9]	12.86 [9.8]	London Clay Formation	Strike noted as seepage only
0.36 [22.3]	0.16 [22.5]	Lambeth Group (granular)	

Three subsequent monitoring visits were undertaken on 3rd, 10th and 17th September to record the groundwater levels in the borehole, which was installed with a response zone across the Lynch Hill Gravel Member between 21.16mOD and 19.16mOD (1.5mbgl to 3.5mbgl). The groundwater monitoring records are included in Appendix E and are summarised in Table 3.

Table 3. Summary of groundwater monitoring results

Monitoring date	Groundwater level (mOD) [mbgl]
03/09/2018	20.21 [2.45]
10/09/2018	20.15 [2.51]
17/09/2018	20.15 [2.51]

The above results indicate that groundwater rests approximately 0.5m above the top of the Weathered London Clay Formation.

5.7 Geotechnical Design Parameters

Geotechnical design parameters and design levels for the ground conditions encountered in the intrusive investigation have been derived based on the soil descriptions, in-situ testing and typical values for the well-studied London Clay Formation. The parameters are outlined below in Table 3.

Table 4. Geotechnical design parameters

Stratum	Design level to top (mOD)	Bulk Unit Weight γ_b (kN/m³)	Friction Angle ϕ' (°)	Undrained Cohesion c_u (kPa) [c']	Young's Modulus E_u (MPa) [E']
Made Ground	22.6	18	32	-	[20]
Lynch Hill Gravel Member	21.06	19	33	-	[35]
London Clay Formation	19.56	20	24[a]	45+8.4z[b] [5]	27+5.04z[d] [20.25+3.78z][c]
Lambeth Group (cohesive)	1.96	20	24[a]	170 [5]	102[d] [81.6][e]
Lambeth Group (granular)	0.36	20	38[f]	-	[120]

Notes

a. Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.Based on 600 Cu

b. z = depth below surface of the London Clay Formation

c. Based on 600c_u

d. Based on 0.75Eu – Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.

e. Based on 0.8Eu. Burland et. al (2001), CIRIA Special Publication 200, Building response to tunnelling, Case studies from the Jubilee Line Extension, London.

f. Peck, R.B., Hanson, W.E., and Thornburn, T.H., Foundation Engineering, 2nd Edn, John Wiley, New York, 1967.

These values are considered to be characteristic and are unfactored (Serviceability Limit State) parameters.

5.8 Buried Concrete

In accordance with BRE SD1 Guidance[9] the design sulfate (DS) and Aggressive Chemical Environmental for Concrete (ACEC) classes for the different strata onsite are presented below in Table 4, based on the results of the geotechnical sulfate and pH testing.

The availability of total potential sulfate (TPS) in pyritic soils is dependent on the extent to which the soils are disturbed, and the level to which the soils may oxidise, resulting in sulfate ions that may reach the concrete. In this regard, BRE SD1 guidance states that *"Concrete in pyritic ground which is initially low in soluble sulfate does not have to be designed to withstand a high potential sulfate class unless it is exposed to ground which has been disturbed to the extent that contained pyrite might oxidise and the resultant sulfate ions reach the concrete. This may prompt redesign of the structure or change to the construction process to avoid ground disturbance; for example, by using precast or cast-in-situ piles instead of constructing a spread footing within an excavation"*. Values have therefore been provided based on pyritic soils remaining undisturbed (WSS), such as during piling, and for disturbed soils (TPS), such as during open excavations into the London Clay Formation.

Table 5. Summary of BRE concrete design sulfate class

Strata	Based on WSS		Based on TPS	
	DS class	ACEC class	DS class	ACEC class
Made Ground	DS-1	AC-1	-	-
Lynch Hill Gravel Member	DS-1	AC-1	-	-
London Clay Formation	DS-1	AC-2s	DS-5	AC4-s
Lambeth Group	DS-1	AC-1s	-	-

[9] Building Research Establishment Construction Division. (2005). *Concrete in aggressive ground*. Special Digest 1, 3rd Edition.

5.9 Foundation Inspection Pits

CGL excavated three foundation inspection pits in the car park area, against the buildings associated with 222 Euston Road to the southeast, 210 Euston Road to the northeast and against the retaining wall along Stephenson Way (TP1 to TP3, respectively).

A layer of concrete was encountered at 0.65mbgl to 0.77mbgl in all three locations. The concrete was probed using a Hilti drill at trial pits TP1 and TP3 and was estimated to be 0.5m and 0.7m thick in these locations, respectively. The concrete was also cored out at trial pit TP2 and was proved to be 0.8m thick in this location. Once cored, the underlying ground was probed and the foundation of the adjacent building (210 Euston Road) was found to continue vertically below the slab. This finding is consistent with information recovered from the London Borough of Camden planning portal which shows 210 Euston Road to have double storey basement supported by secant piles (see Section 2.2).

The foundation inspection pit logs are presented in Appendix D.

6. SUBTERRANEAN (GROUNDWATER) FLOW

6.1 Introduction

This section addresses outstanding considerations raised by the screening process regarding groundwater flow, as summarised in Section 5 of the Screening and Scoping Report[2].

6.2 Impact on Groundwater Flow

Based on the findings of the site investigation and follow up monitoring visit, groundwater is expected to be present at 20.09mOD to 20.15mOD. As noted in Section 2.5, the proposed basement formation level is expected to be approximately 20.5mOD for the raft option, or 21.355mOD (locally deepening to 20.655mOD) at pile cap locations for the mini pile option. It is understood that the perimeter walls will either be secant or contiguous, depending on formation level. Groundwater is some 2.5m below the level of adjacent buildings. As the change in level for the proposed basement will be minor, obstruction to groundwater flow is anticipated to be minor and not likely to affect neighbouring buildings.

6.3 Recommendations for Ground Control

Final design dewatering requirements will depend on the formation level. A contiguous or secant piled wall will be required and the basement box may require dewatering. This should be confirmed once the proposed scheme is finalised.

7. LAND STABILITY

7.1 Introduction

This section provides calculations to determine ground movements that may result from the installation of the secant pile walls and the basement excavation and to assess how these may affect the adjacent boundary walls and structures.

For the purpose of this assessment, it is assumed that a secant piled retaining wall will be installed around the northeastern, northwestern and southwestern perimeters of the site. Following the installation of these piles, which are assumed to extend to 15mbgl (9.5mOD), the basement will be excavated to formation level. In the area of the car park, an excavation of 2.2m will be required, with 4m excavation required in the tree area.

Ground movements are derived from:

- Heave movements: The London Clay Formation is susceptible to short term heave and time dependant swelling on unloading, which will occur as a result of basement excavation, generating upward ground movements.
- Long term ground movement: The net loading on formation soils will generate ground movement, which could affect adjacent foundations. This takes into account existing stress conditions, additional loads from the basement structure and the weight of soil removed.
- Pile installation: Ground disturbance during pile installation may cause ground settlement.
- Piled wall deflection: Deflection of the piled wall during excavation may cause settlement behind the wall, which could impact the neighbouring properties.
- It is note that a frame is present on site, supporting the façade to 152 – 156 North Gower Street. Details of the temporary works required to re-support the façade during the construction are not currently available, however will be considered and provided for review to party wall engineers at Detailed Design stage.

The assessment is based on development plans supplied by the client, included as Appendix A.

7.2 Conceptual Site Model

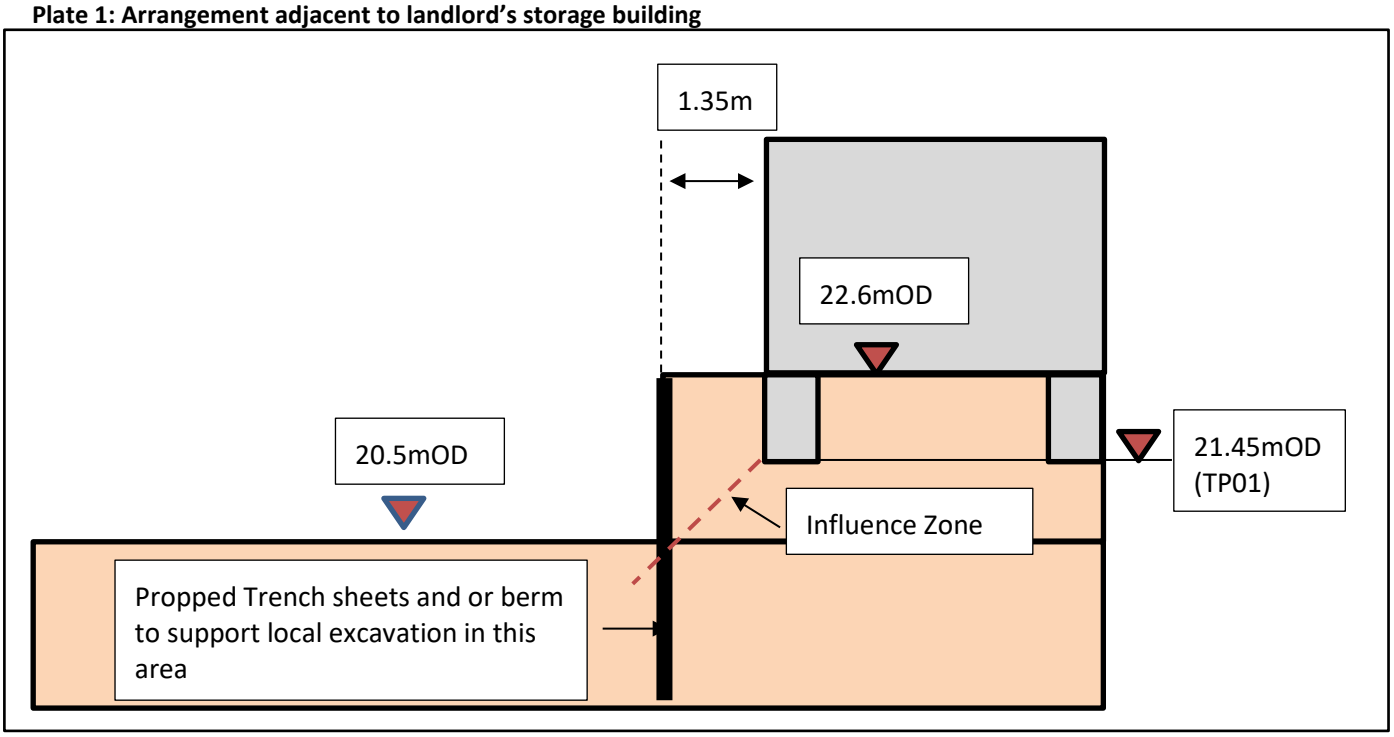
A conceptual site model (CSM), relating to potential ground movement, has been developed based on the available data. The CSM comprises a plan (Figure 5) and a section (Figure 6) indicating the basement construction and the location of neighbouring properties in relation to the proposed development.

The figures highlight the locations of the critical sections, which have been taken at the areas of the neighbouring properties closest to the proposed basement and are considered to represent 'worst-case' conditions;

- Critical Section 1: through the highway of Stephenson Way and 24-32 Stephenson Way, on the opposing side of the street;
- Critical Section 2: through 210 Euston Road;
- Critical Section 3: through 222 Euston Road; and
- Critical Section 4: through 152 to 156 North Gower Street

It is noted that a single storey building is present along the southeastern site boundary at the level of the existing car park. No development is proposed along the frontage of this building, with the basement wall situated some 1.35m from this building. Excavation in this area (some 2.2m to formation level), temporary works are limited in this area and it is assumed that propped trench sheets or similar would be required to provide excavation support in the short term. These measures will be designed to support nominal surcharge pressures as derived from the structure and illustrated in Plate 1 below, it is noted that, based on the concrete depth recorded in trial pit TP01, the proposed excavation does not undermine the storage structure.

Plate 1: Arrangement adjacent to landlord's storage building



7.3 Ground Movement due to Piled Wall Deflection

A secant piled wall is to be installed around the northeastern, northwestern and southwestern perimeters of the site, along the boundaries with 210 Euston Road, the highway of Stephenson Way and 152 to 156 North Gower Street, respectively. It is noted that a sheet piled wall has also been proposed as an option along the boundary with Stephenson Way. For the purposes of this assessment, it has been assumed that sheet piles, if used, will be pre-augured and install movements would therefore be anticipated to mirror those caused by secant piling.

Anticipated ground movements due to the installation of the piled wall have been modelled using guidance from CIRIA C760[10]. This guidance provides recommendations on the amount of vertical and lateral (horizontal) ground movements at the face of the pile wall and the distance from the wall to negligible movements. The recommended values for secant pile walls are presented in Table 5, provided the piles are installed to a good level of workmanship.

Work by Ball, Langdon & Creighton (2014)[11] has shown that the ground movements due to pile installation can be reduced by 50% if the wall is constructed to a good standard in a hit and miss construction sequence. Based on this the horizontal and vertical ground movements have been

[10] CIRIA C760 (2017), *Guidance on embedded retaining wall design,* CIRIA.
[11] Ball, R., Langdon, N., Creighton, C. (2014). *Prediction of party wall movements using CIRIA C580.* Ground Engineering, pp 25-29.

reduced to 0.04% and 0.025% of the wall depth, respectively. The ground movements away from the wall face were then extrapolated using a parabolic function. The ground movements at the wall face and beneath the nearest wall of the neighbouring buildings are presented in Table 6.

Table 6. Secant pile wall installation ground movements (values taken from CIRIA C760 Table 6.1, revised for modern construction techniques and hit and miss construction sequence)

Horizontal Movements		Vertical Movements	
Surface movement at wall (% of wall depth)	Distance behind wall to negligible movement (multiple of wall depth)	Surface movement at wall (% of wall depth)	Distance behind wall to negligible movement (multiple of wall depth)
0.04[11]	1.5	0.025[11]	2

Table 7. Secant pile movements due to installation

Location	Maximum vertical ground movement (mm)[1]	Maximum horizontal ground movement (mm)[1]	Level at base of neighbouring wall (mOD)
Critical Section 1: Highway and 24-32 Stephenson Way	1.47	2.16	21.5
Critical Section 2: 210 Euston Road	2.23	6.0	17.5
Critical Section 3: 222 Euston Road	2.02	2.49	22.6
Critical Section 4: 152 to 156 North Gower Street	2.4	3.23	21.5

1. A positive number denotes heave and a negative number denotes settlement

7.4 Ground Movements due to Excavation to Basement Level

The soils at formation level will be subject to stress relief during excavation, as overburden is removed to form the basement. This is likely to give rise to a degree of elastic heave over the short term and potential heave or settlement over the longer term as pore pressures recover in the London Clay Formation. The magnitude of these movements has been assessed using OASYS Limited PDISP (Pressure Induced Displacement Analysis), a numerical analysis software, which calculates the movements caused by vertical pressures in an elastic half-space. The programme can use both linear elastic and non-linear soil conditions. In this analysis only linear elastic conditions were considered.

The proposed development gives rise to a net unloading of the underlying strata, both during construction and over the long term, of some 44kPa in the northeast of the site and 80kPa in the southwest. This value assumes that some 2.2m of soil will be removed in the northeast and 4.0m in the southwest during the basement excavation, at a typical bulk unit weight of 20kN/m^3. The combined heave of both the immediate undrained unloading and the long-term drained recovery of pore pressures has been calculated.

The maximum short term heave due to excavation to basement level is predicted to be of the order of 10mm, occurring in the northwestern half of the site (the tree area). This movement decreases to a maximum of 7mm of heave around the basement perimeter, occurring along the boundary with the highway of Stephenson Way. Ground movements at the remaining site boundaries range from 0.5mm to 2.5mm of heave. Total heave within the basement is predicted to be some 13mm, occurring in the northwestern half of the site (the tree area), decreasing to a maximum of 9mm of heave around the basement perimeter, occurring along the boundary with the highway of Stephenson Way. Ground movements at the remaining site boundaries range from 1mm to 4mm of heave.

Contour plots showing the variation of both short term and total heave for the whole basement are presented in Figure 7 and Figure 8, respectively.

The excavation works will cause the pile walls to deflect laterally towards the excavation and the ground behind the pile wall to settle. The ground movements have been calculated based on guidance from CIRIA C760[10] and recommended values for secant pile walls are presented in Table 7, assuming that the pile wall will be propped at the top of the wall (e.g. 'High Support Stiffness'). The ground movements due to this action are presented in Table 8. The results presented in this table are in superimposed on the ground movements mentioned in the paragraphs above.

Table 8. Secant pile wall ground movements due to excavation works (values taken from CIRIA C760 Table 6.2)

Horizontal Movements		Vertical Movements	
Surface movement at wall (percentage of max excavation depth)	**Distance behind wall to negligible movement (multiple of max excavation depth)**	**Surface movement at wall (percentage of max excavation depth)**	**Distance behind wall to negligible movement (multiple of max excavation depth)**
0.15	4	0.1	3.5

Note: Ground movements are for the case of high support stiffness, such as high propped pile wall

Table 9. Secant pile ground movements due to excavation

Location	Maximum vertical ground movement beneath neighbouring wall (mm)[1]	Maximum horizontal ground movement beneath neighbouring wall (mm)[1]	Level at base of neighbouring wall (mOD)
Critical Section 1: Highway and 24-32 Stephenson Way	0.13	0.29	21.5
Critical Section 2: 210 Euston Road	-3.9	-4.35	17.5
Critical Section 3: 222 Euston Road	0.0	0.027	22.6
Critical Section 4: 152 to 156 North Gower Street	1.31	2.34	21.5

1. A positive number denotes settlement and a negative number denotes heave

8. DAMAGE CATEGORY ASSESSMENT

8.1 Introduction

The calculated ground movements have been used to assess potential 'damage categories' that may apply to neighbouring properties due to the proposed lower ground floor construction. The methodology proposed by Burland and Wroth[12] and later supplemented by the work of Boscardin and Cording[13] has been used, as described in *CIRIA Special Publication 200*[14] and *CIRIA C580*[15].

General damage categories are summarised in Table 9 below:

Table 10. Classification of damage visible to walls (reproduction of Table 2.5, CIRIA C580)

Category	Description
0 (Negligible)	Negligible – hairline cracks
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm)
2 (Slight)	Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm)
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks <3mm)
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15mm to 25mm but depends on number of cracks)
5 (Very severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks)

8.2 Damage assessment of boundary walls

The results of the predicted ground movement below the critical sections due to the proposed basement development have been compiled to determine the overall lateral deflection and vertical deflection of the structure.

Figure 9 to Figure 16 show the combined vertical and horizontal ground movement profiles across each of the critical sections and their respective damage categories are summarised in Table 10.

[12] Burland, J.B., and Wroth, C.P. (1974). *Settlement of buildings and associated damage*, State of the art review. Conf on Settlement of Structures, Cambridge, Pentech Press, London, pp611-654

[13] Boscardin, M.D., and Cording, E.G., (1989). *Building response to excavation induced settlement.* J Geotech Eng, ASCE, 115 (1); pp 1-21.

[14] Burland, Standing J.R., and Jardine F.M. (eds) (2001), *Building response to tunnelling, case studies from construction of the Jubilee Line Extension London*, CIRIA Special Publication 200.

[15] CIRIA C580 (2003) *Embedded Retaining Walls – guidance for economic design*

Table 11. Summary of ground movements and corresponding damage category

Critical Section	Horizontal Movement (mm)	Vertical Deflection (mm)	Horizontal Strain ε_h (%)	Deflection ratio Δ/L (%)	Damage category	Corresponding Figures
Critical Section 1: 24-32 Stephenson Way	2.45	0.3	0.008	0.001	Category 0 ('negligible')	Figure 9 & Figure 10
Critical Section 2: 210 Euston Road	0.15	4.0	0.0004	0.012	Category 0 ('negligible')	Figure 11 & Figure 12
Critical Section 3: 222 Euston Road	2.52	0.5	0.015	0.003	Category 0 ('negligible')	Figure 13 & Figure 14
Critical Section 4: 152 to 156 North Gower Street	5.57	0.5	0.039	0.004	Category 0 ('negligible')	Figure 15 & Figure 16

The damage categories for these critical sections were determined by plotting the horizontal strain and deflection ratio values as summarised in Table 10 and presented graphically in Figure 17.

Assuming a good standard of workmanship and controlling lateral deflection of the walls to within the limiting values provided, the predicted damage categories for all critical sections are expected to fall within Category 0 ('negligible') damage. This assessment assumes that the pile wall along the northeastern, northwestern and southwestern perimeters will be propped in the short term with temporary supports and in the long term using the internal structural slabs.

Detailed design of the retaining wall and temporary propping will be required using WALLAP or similar soil structure interaction software will be required to control movements through design.

9. MONITORING STRATEGY

The results of the ground movement analysis suggest that with good construction control, damage to adjacent boundary walls generated by the assumed construction methods and sequence are likely to not exceed Category 0 ('negligible' damage) for all critical sections. A formal monitoring strategy should be implemented on site in order to observe and control ground movements during construction, and in particular movements of the adjacent properties.

The system should operate broadly in accordance with the 'Observational Method' as defined in CIRIA Report 185[16]. Monitoring can be undertaken by installing survey targets to the top of the wall and face of the adjacent buildings. Baseline values should be established prior to commencement of works. Monitoring of these targets should be carried out at regular time intervals and the results should be analysed to determine if any horizontal translation of the wall or tilt/settlement of the neighbouring walls is occurring. Regular monitoring of these targets will allow ground movement trends to be detected in a timely manner such that mitigation strategies may be implemented if required.

Monitoring data should be checked against predefined trigger limits and reviewed regularly to assess and manage the damage category of the adjacent buildings as construction progresses.

It is recommended that a condition survey is undertaken on all adjacent walls and property facades prior to the works commencing and ideally when monitoring baseline values are established. Existing cracks or structural defects should be carefully recorded, documented and regularly inspected as construction progresses.

[16] Nicholson, D., Tse, Che-Ming., Penny, C., The Observational Method in ground engineering: principles and applications, CIRIA report R185, 1999.

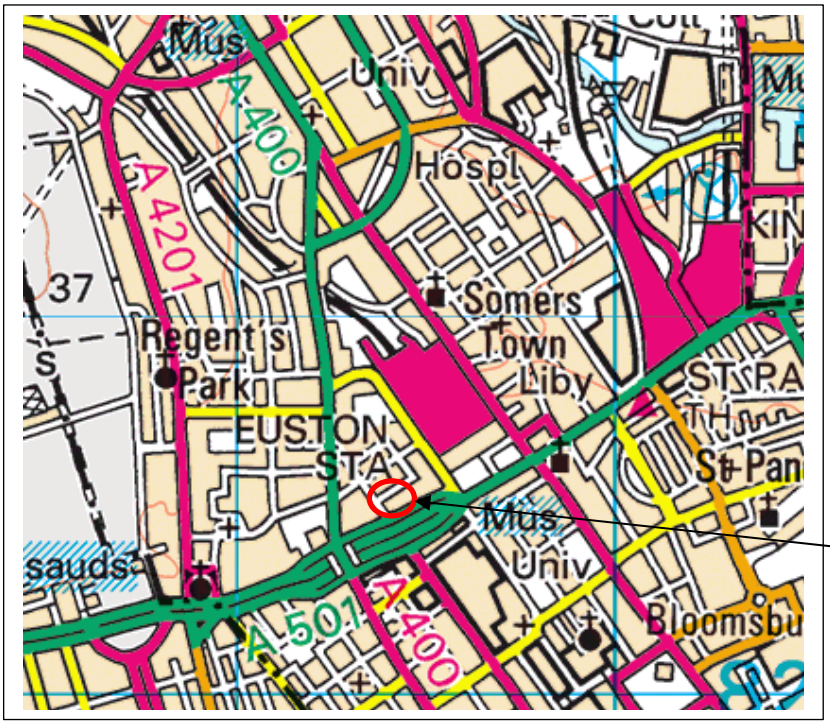
10. CONCLUSIONS AND RECOMMENDATIONS

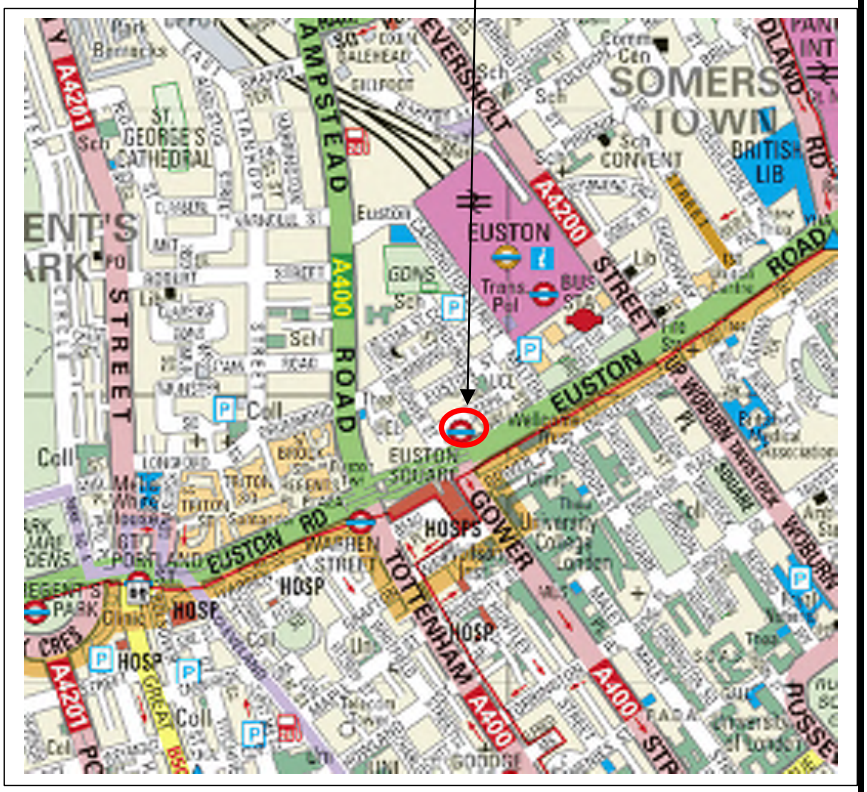
The findings of this report are informed by site investigation data and information regarding construction methods, sequence and loading provided by the Structural Engineer. The analysis is undertaken on the assumption of high quality workmanship during the construction of the basement.

The construction of the basements will generate ground movements due to a variety of causes including heave, settlement, pile construction and piled wall deflection during and after excavation. Calculations indicate that, with good construction control, movements can be restricted such that damage categories remain within Category 0 ('negligible' damage) for all critical sections. The above assumes a good standard of workmanship during construction. Construction of the secant pile wall should follow a hit and miss construction sequence in order to minimise installation movements. Additionally, temporary props should be used to support the retaining wall during excavation works and the internal floor slabs should be used to support the walls in the long term along the northern perimeter of the site. The temporary works scheme developed in detail for the site will be required to take into consideration the re-support of the façade to 152 – 156 North Gower Street.

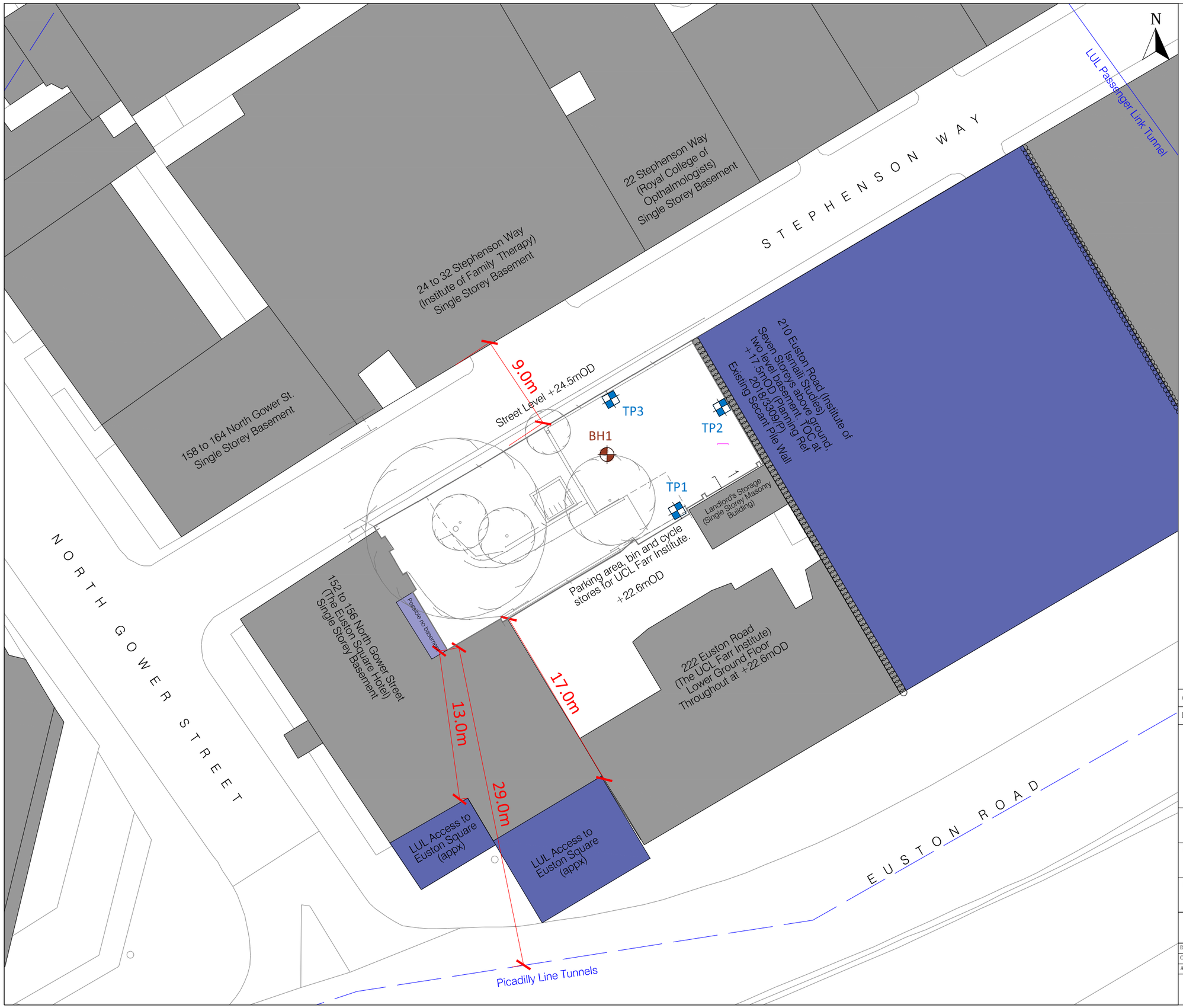
It is recommended that a condition survey is undertaken and an appropriate monitoring regime is adopted to manage risk and potential damage to the neighbouring structures as construction progresses onsite.

FIGURES





Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title **Site Location Plan**	**Figure 1**



KEY

Cable Percussive Borehole

Foundation Inspection Pit

HOLE ID	Easting	Northing
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TP1	529424.82	182444.18
TP2	529428.75	182453.30
TP3	529418.95	182454.00

Rev	Date	Comments
0	09/10/18	

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4 Godalming Business Centre
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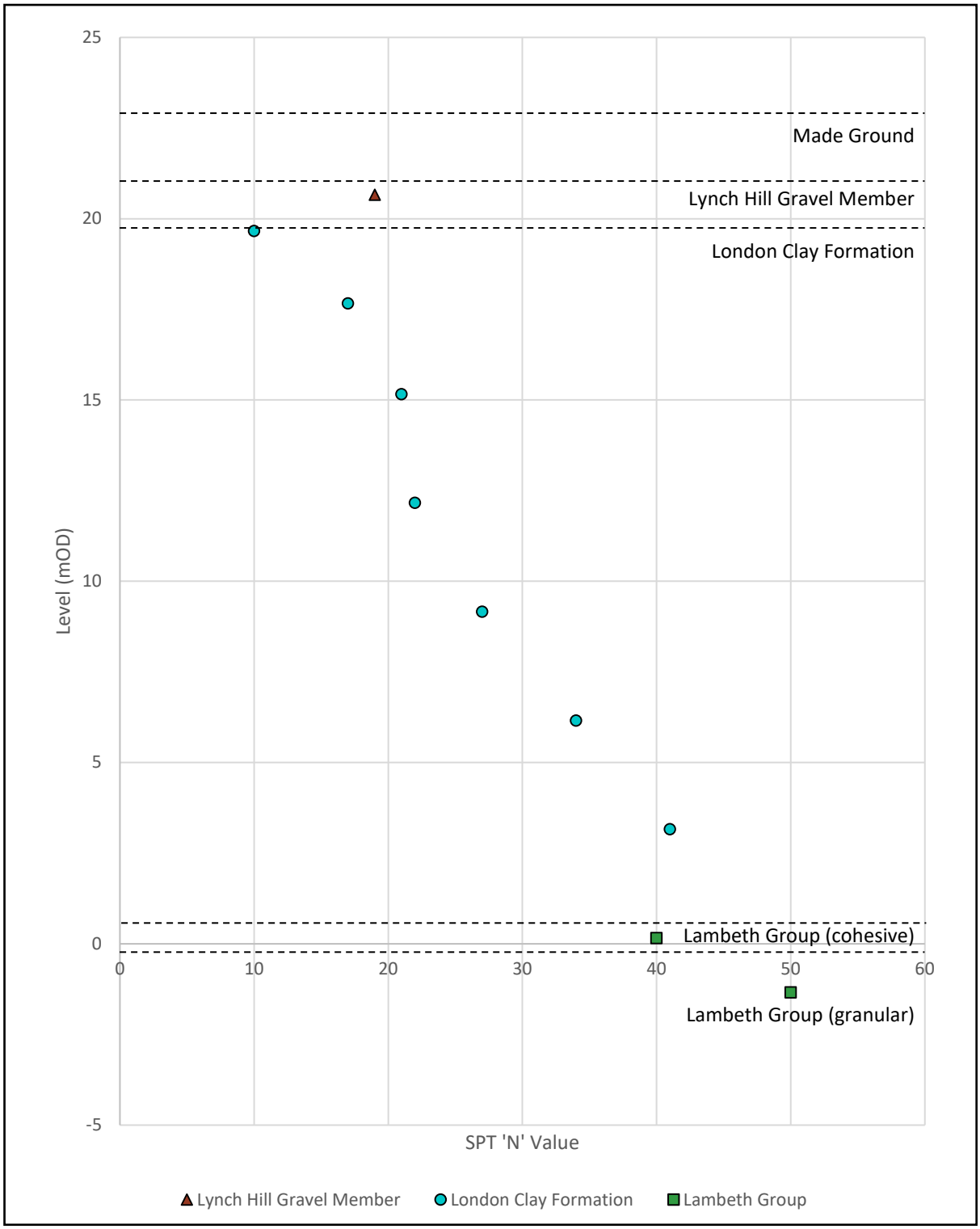
GU7 1XW
T: 01483 310600

Project: Land to the Rear of 222 Euston Road

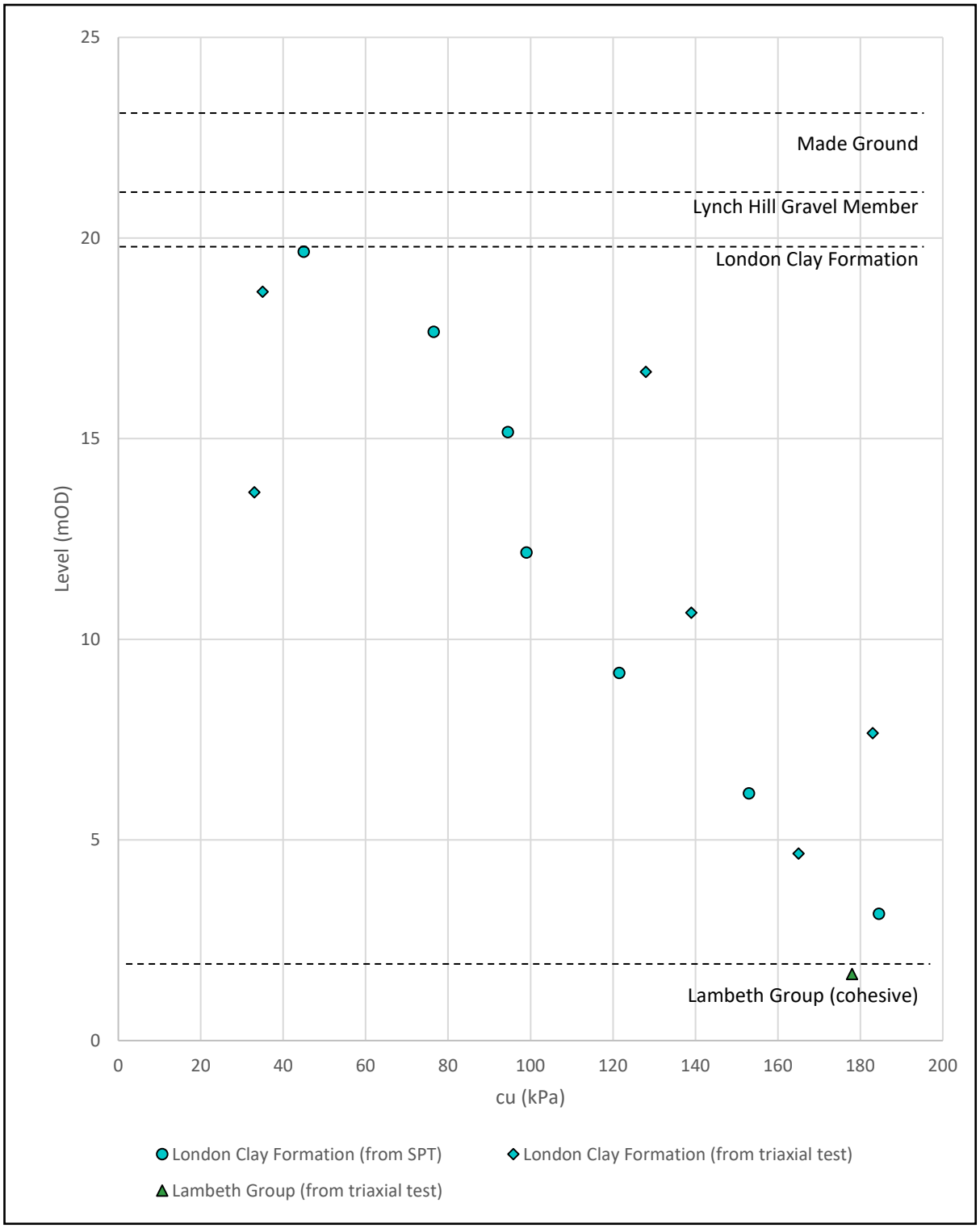
Client: Oakwood International Investment Corporation

Drawing title: Figure 2 - Site Layout & Exploratory Hole Location Plan

Scale(s)	Job No.	
NTS	CG/28583	
Drawn TSB 09/10/18	Dwg No. CG/28583-001	Rev. 0
Checked RJB 09/10/18		
Approved IMM 09/10/18		



Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title **Plot of SPT 'N' Value Against Level**	**Figure 3**



Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title: **Plot of c_u Against Level**	**Figure 4**

Rev	Date	Comments
0	09/10/18	

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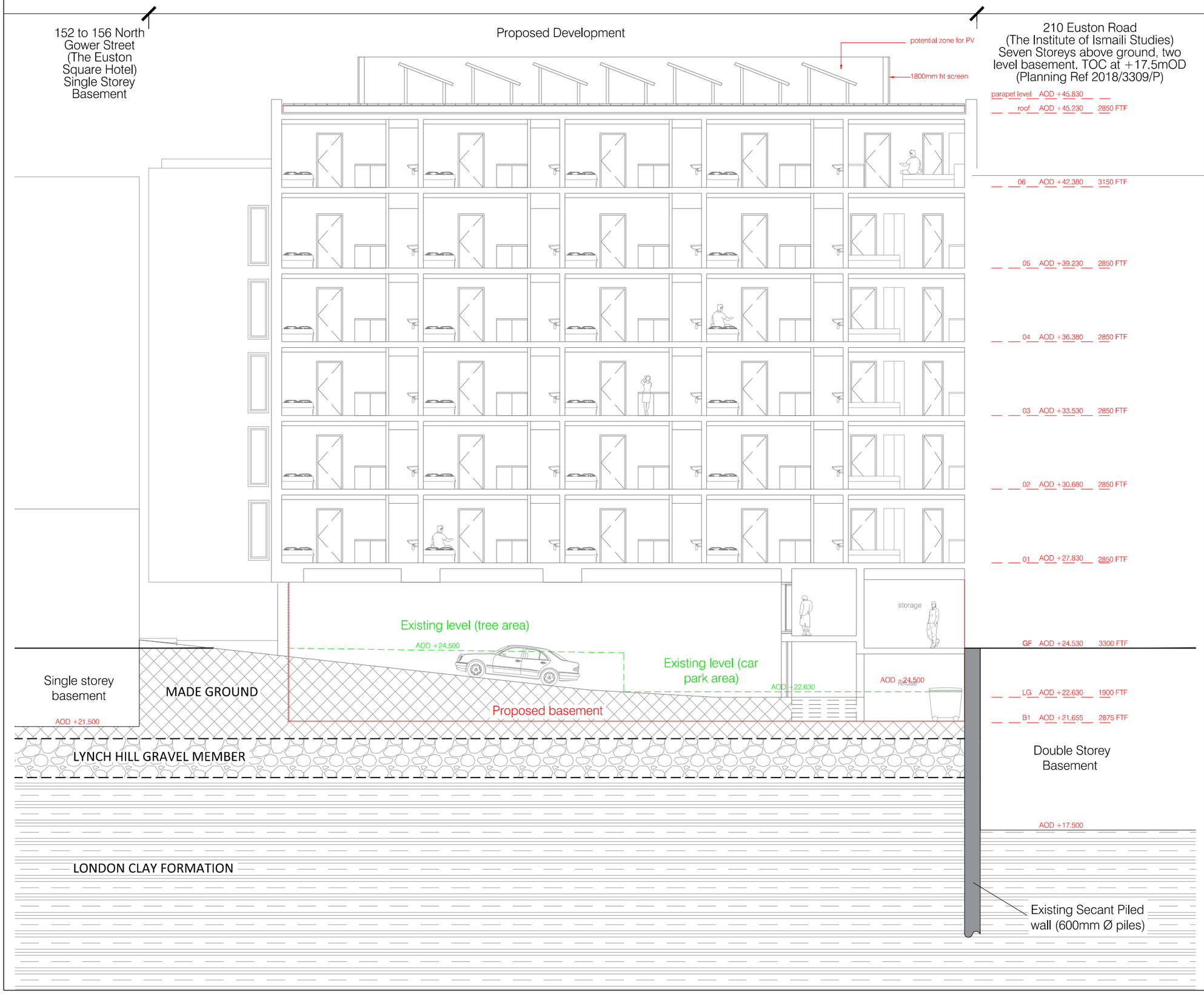
Project: Land to the Rear of 222 Euston Road

Client: Oakwood International Investment Corporation

Drawing title: Figure 5 - Conceptual Site Model (Plan)

Scale(s)	Job No.	
NTS	CG/28583	
Drawn TSB 09/10/18	Dwg No.	Rev.
Checked RJB 09/10/18	CG/28583-002	0
Approved IMM 09/10/18		



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Rev	Date	Comments
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Project: Land to the Rear of 222 Euston Road

Client: Oakwood International Investment Corporation

Drawing title: Figure 6 - Conceptual Site Model (Section)

Scale(s): NTS

Job No.: CG/28583

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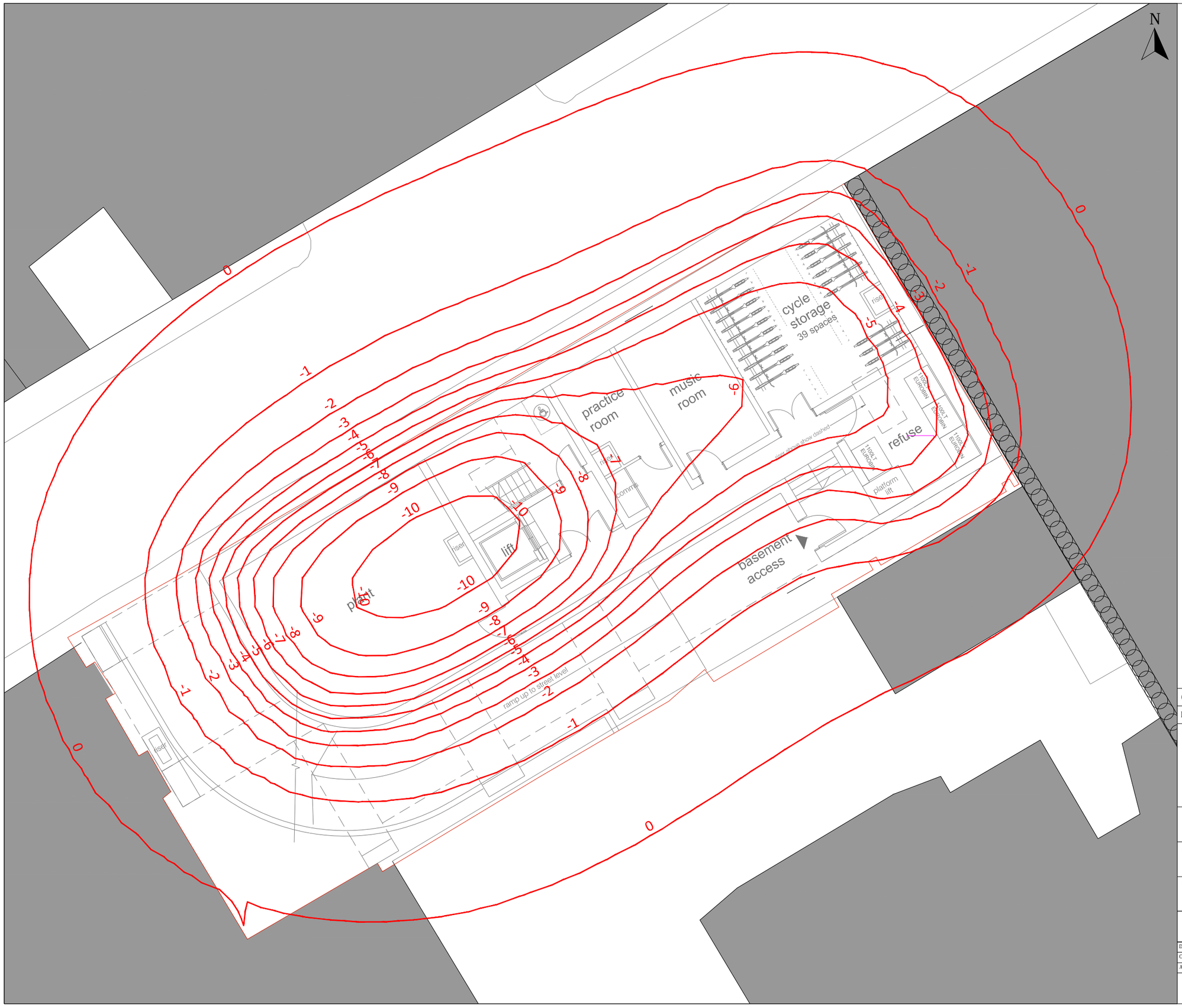
Checked	RJB	09/10/18
Approved	IMM	09/10/18

Dwg No.: CG/28583-003

Rev.: 0



KEY

Notes

1. Contours are in mm.
2. Contour intervals are 1mm.
3. Negative contour values indicate heave.

Rev	Date	Comments
0	09/10/18	

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Project: Land to the Rear of 222 Euston Road

Client: Oakwood International Investment Corporation

Drawing title: Figure 7 - Plot of Short Term Ground Movements

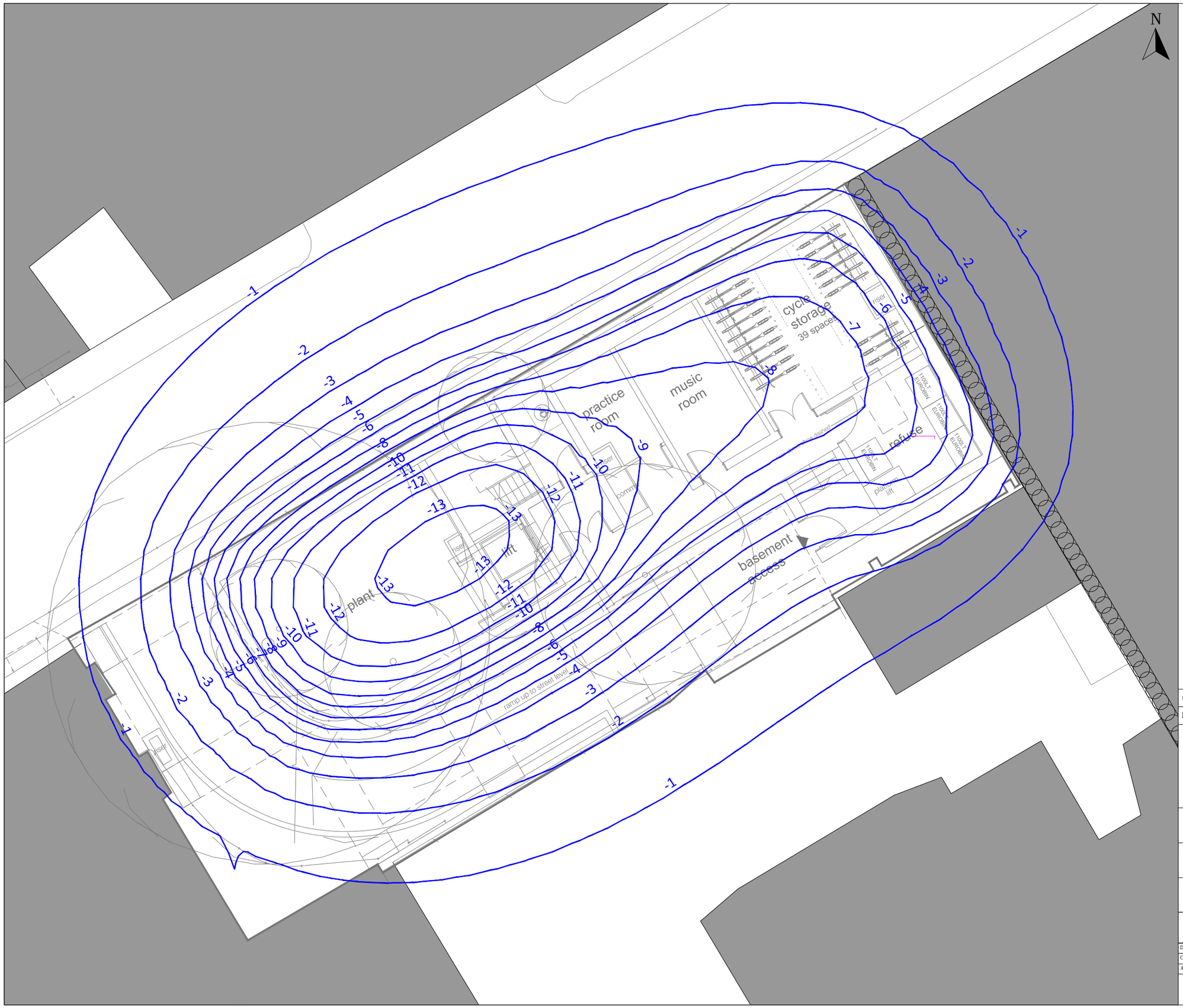
Scale(s): NTS

Job No.: CG/28583

Drawn	TSB	09/10/18
Checked	RJB	09/10/18
Approved	IMM	09/10/18

Dwg No.: CG/28583-004

Rev.: 0



KEY

Notes

1. Contours are in mm.
2. Contour intervals are 1mm.
3. Negative contour values indicate heave.

Rev	Date	Comments
0	09/10/18	

Card Geotechnics Ltd
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Project: Land to the Rear of 222 Euston Road

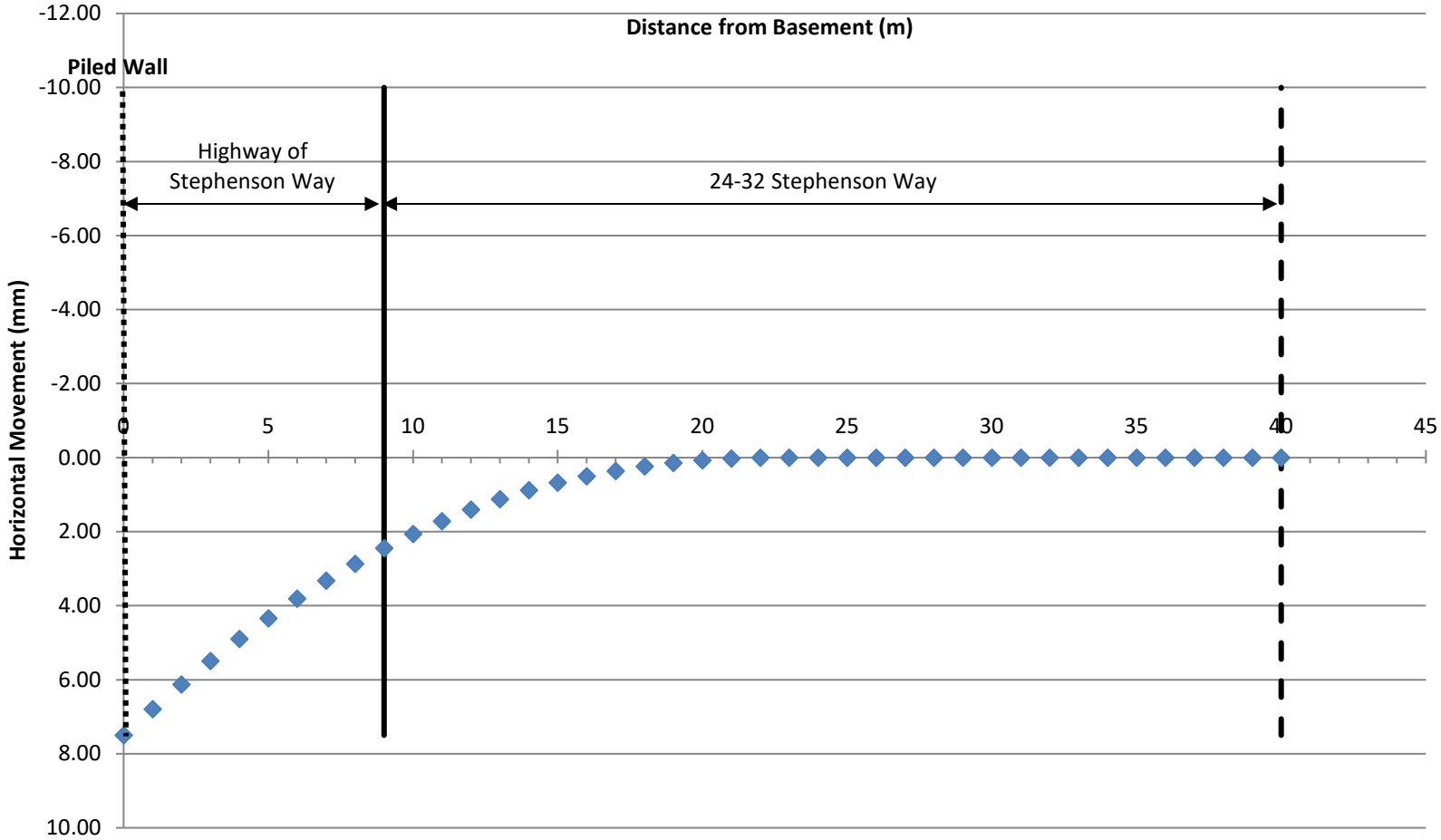
Client: Oakwood International Investment Corporation

Drawing title: Figure 8 - Plot of Total Ground Movements

Scale(s)	Job No.
NTS	CG/28583

Drawn	TSB	09/10/18
Checked	RJB	09/10/18
Approved	IMM	09/10/18

Dwg No. CG/28583-005 Rev. 0



Client	Project	Job No
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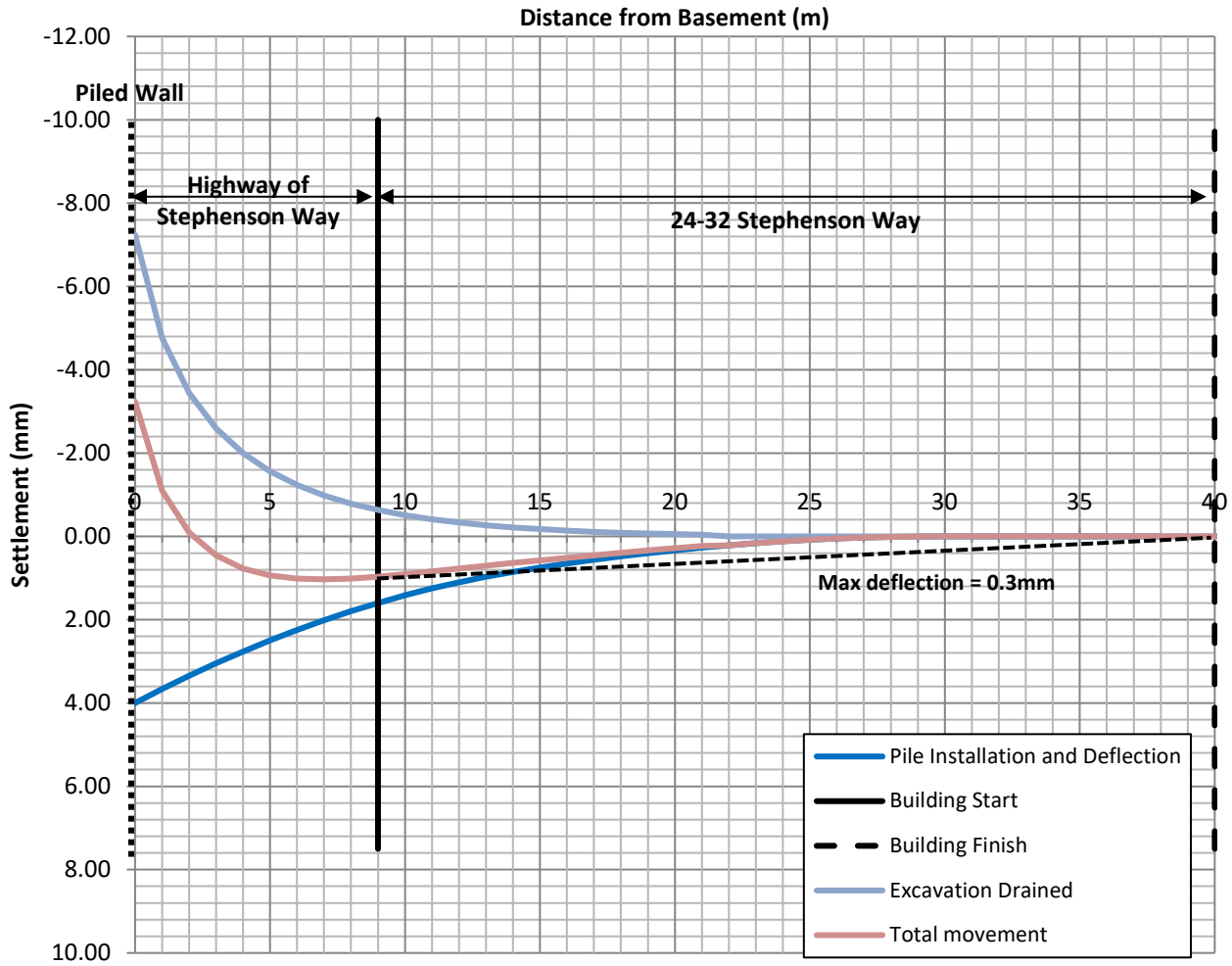
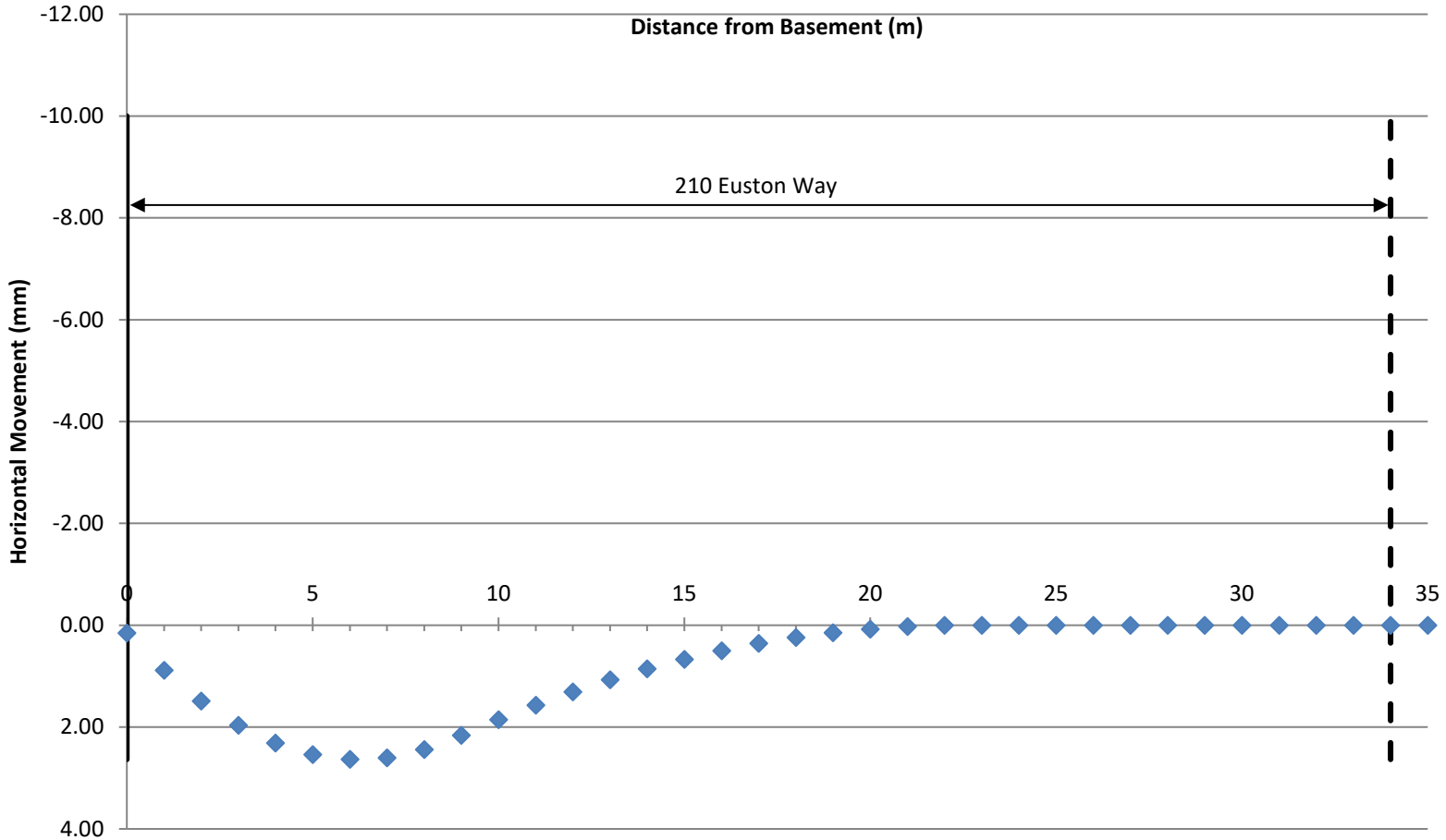
CGL	Title: **Horizontal Ground Movements (Critical Section 1: 24-32 Stephenson Way)**	**Figure 9**



Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title: **Vertical Ground Movements (Critical Section 1: 24-32 Stephenson Way)**	**Figure 10**



Client	Project	Job No
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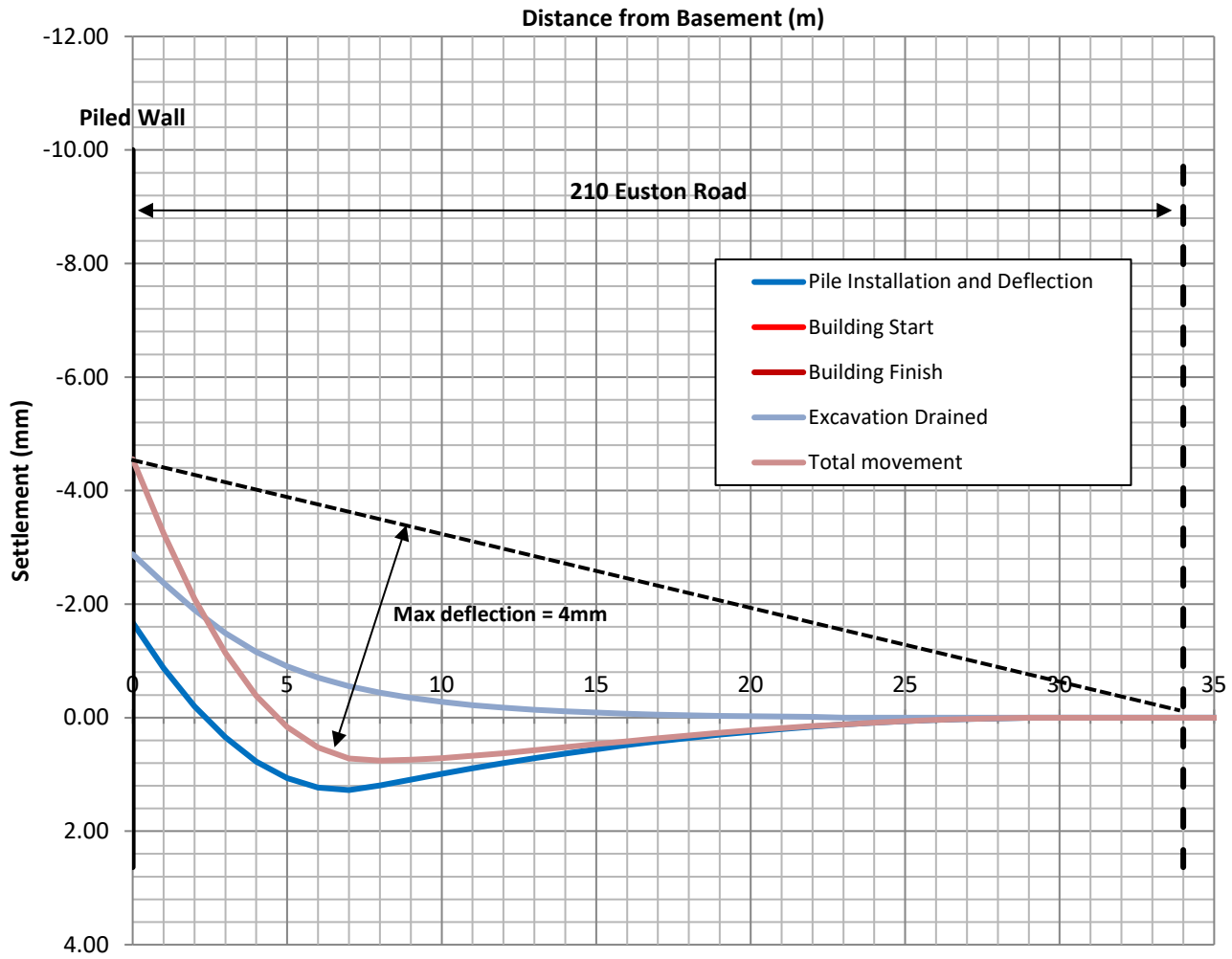
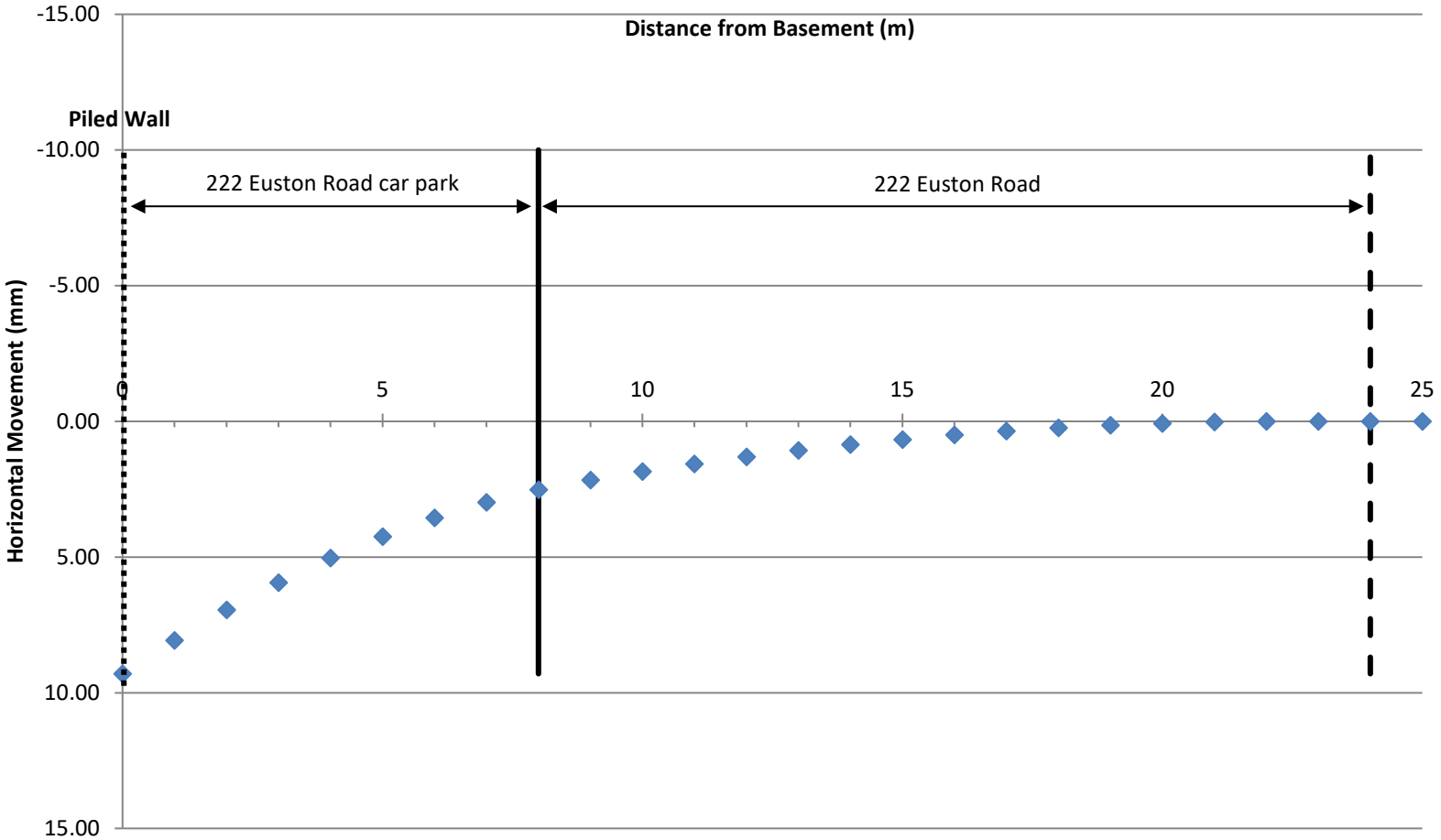
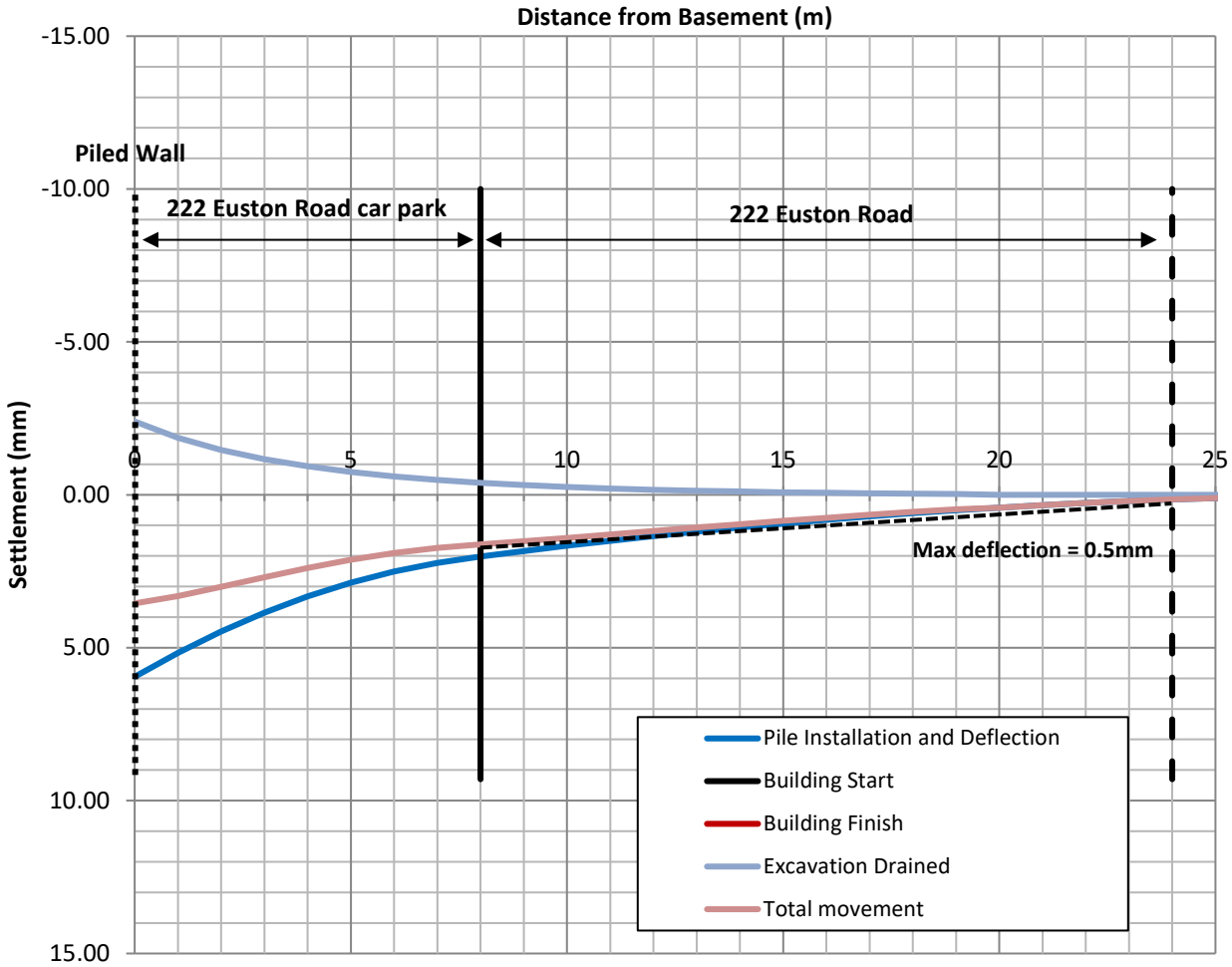
CGL	Title **Horizontal Ground Movements (Critical Section 2: 210 Euston Way)**	**Figure 11**



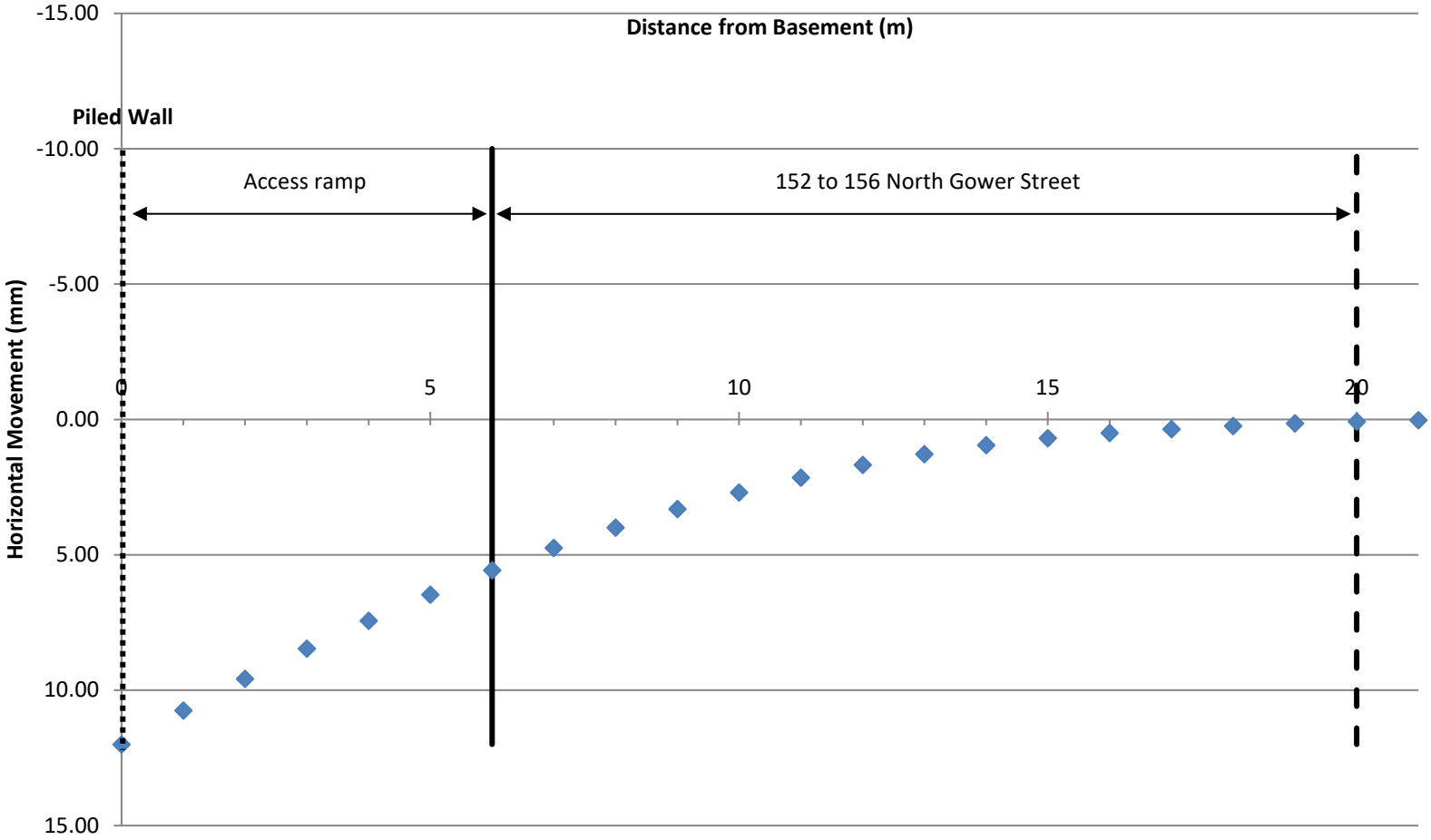
Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title: **Vertical Ground Movements (Critical Section 2: 210 Euston Way)**	**Figure 12**



Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title: **Horizontal Ground Movements (Critical Section 3: 222 Euston Way)**	**Figure 13**



Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title **Vertical Ground Movements (Critical Section 3: 222 Euston Way)**	**Figure 14**



Client	Project	Job No
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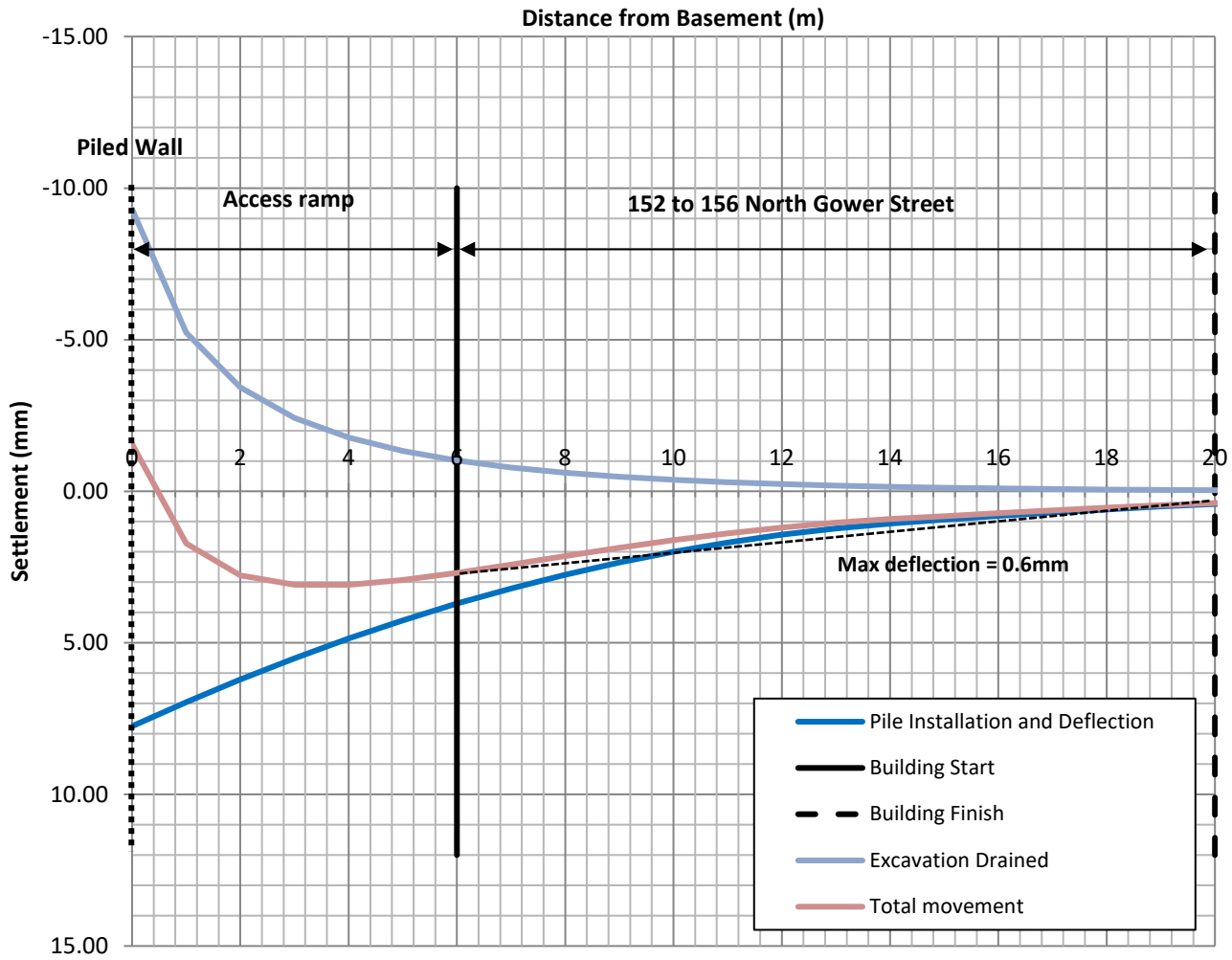
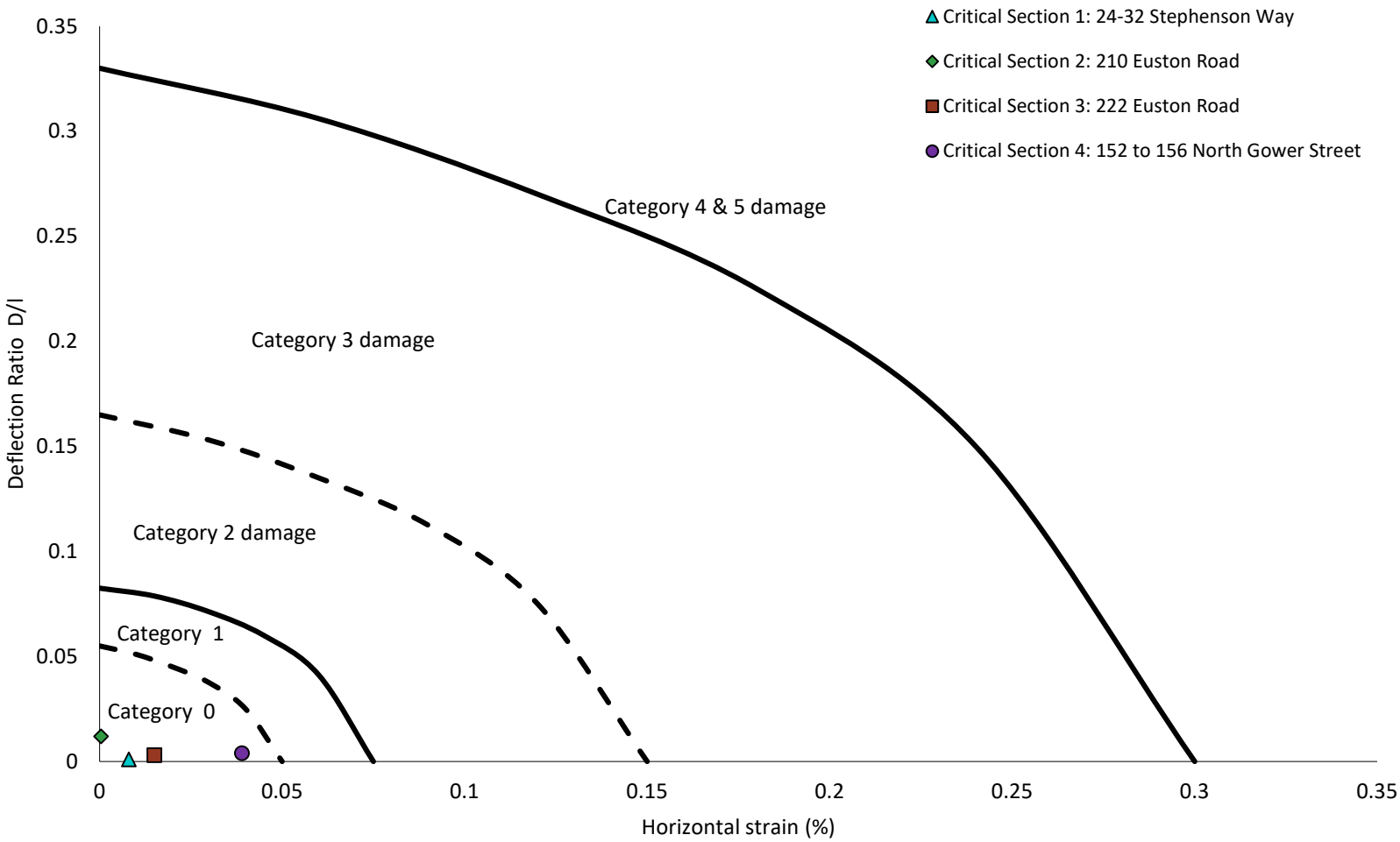
CGL	Title **Horizontal Ground Movements (Critical Section 4: 152 to 156 North Gower Street)**	**Figure 15**



Client	Project	Job No
Oakwood International Investment Corporation	**Land to the Rear of 222 Euston Road**	**CG/28583**
CGL	Title **Vertical Ground Movements (Critical Section 4: 152 to 156 North Gower Street)**	**Figure 16**



Client	Project	Job No
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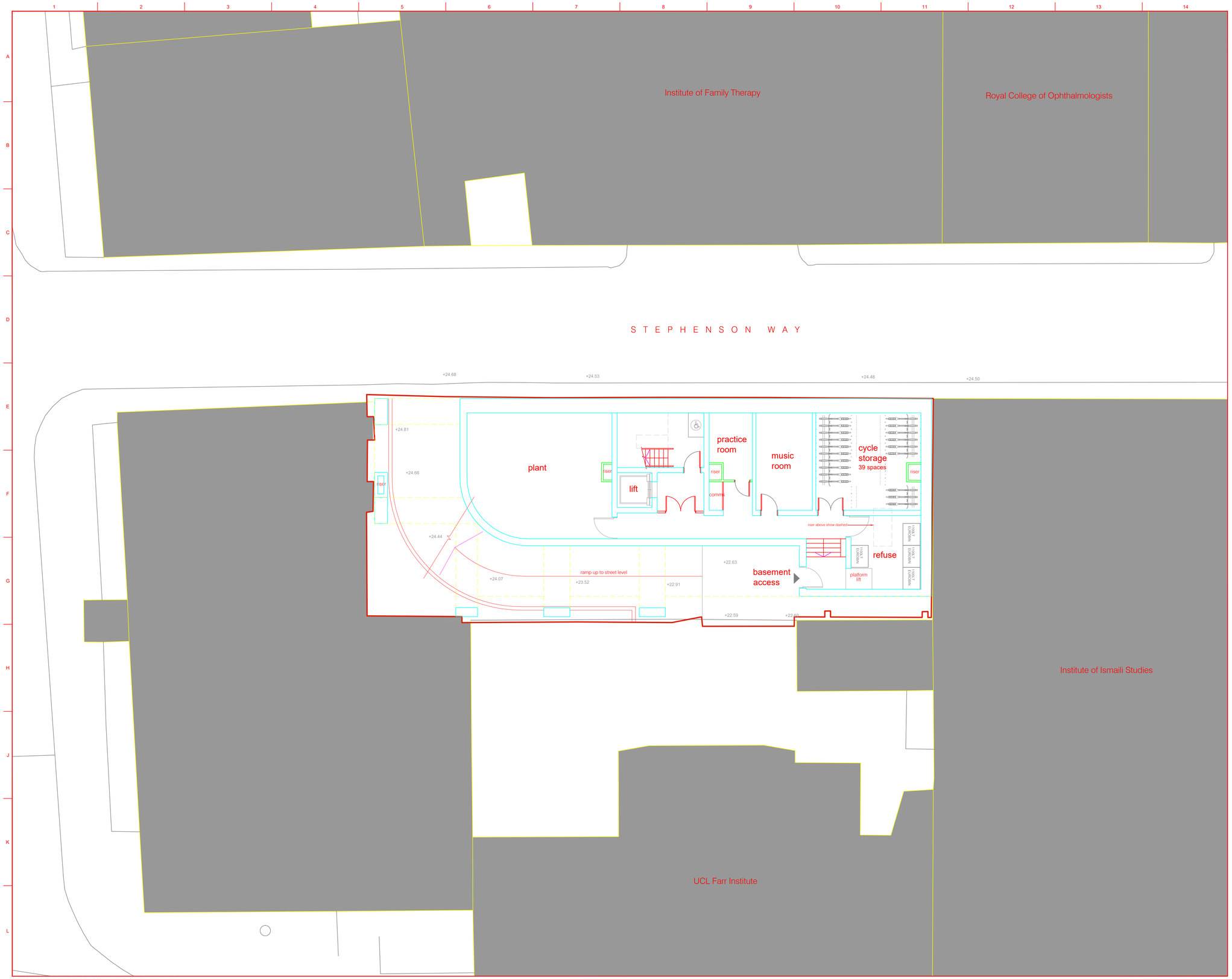
CGL	Title: **Building Interaction Chart**	**Figure 17**

APPENDIX A

Proposed Development Plans



CLIENT

STRUCTURAL ENGINEER

SERVICES ENGINEER

CONSULTANT

KEY PLAN

N

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NOTES:

DO NOT SCALE: FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING. CHECK DIMENSIONS ON SITE AND REPORT DISCREPANCIES TO THE ARCHITECT.

ALL AREAS HAVE BEEN MEASURED FROM CURRENT DRAWINGS. THEY MAY VARY BECAUSE OF (EG) SURVEY, DESIGN DEVELOPMENT, CONSTRUCTION TOLERANCES, STATUTORY REQUIREMENTS OR RE-DEFINITION OF THE AREAS TO BE MEASURED.

No.	Date	Comment	Drawn	Chk'd
Revisions				
D2	03/08/18	Revised in accordance with LPA comments	ETR	RM
D1	01/05/18	Submit for Planning Application	DK	NM

Issue Status
PLANNING

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One America Street London SE1 0NE UK +44 (0) 20 7208 2000 www.tpbennett.com

Project
Stephenson Way
London

Drawing Title
Proposed Basement Floor Plan

Drawn	Date	Scale @ A1	Alt. Ref.
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tp bennett Project No.	Drawing Number	Rev
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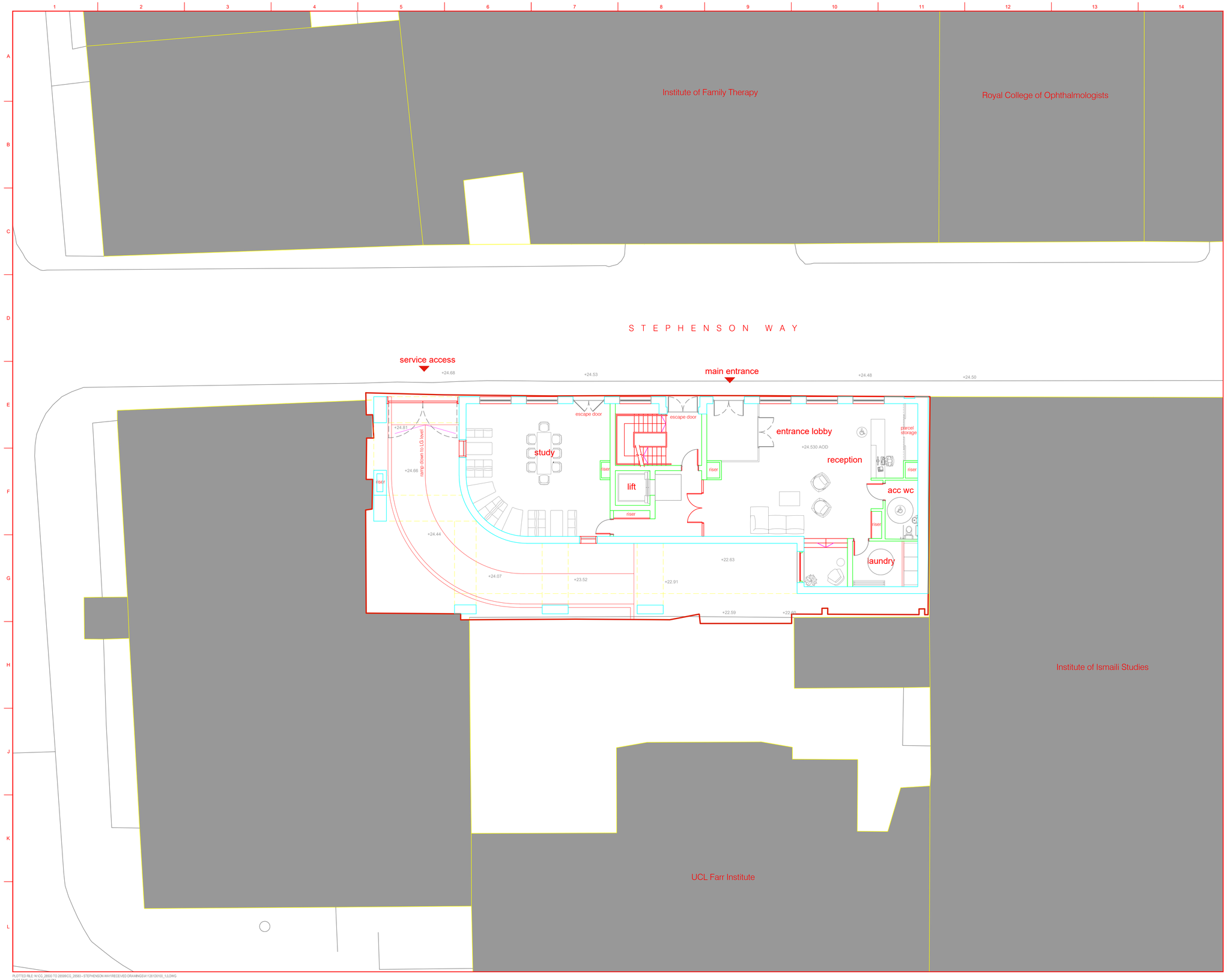

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STRUCTURAL ENGINEER

SERVICES ENGINEER

CONSULTANT

KEY PLAN

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NOTES:

DO NOT SCALE: FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING. CHECK DIMENSIONS ON SITE AND REPORT DISCREPANCIES TO THE ARCHITECT.

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No.	Date	Comment	Drawn	Chkd
D2	03.08.18	Updated in accordance with LPA comments	ETR	RM
D1	01/05/18	Submit for Planning Application	DK	NM

Revisions

Issue Status

PLANNING

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Project

Stephenson Way
London

Drawing Title

Proposed Ground Floor Plan

Drawn	Date	Scale @ A1	Alt. Ref.
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tp bennett Project No.	Drawing Number	Rev
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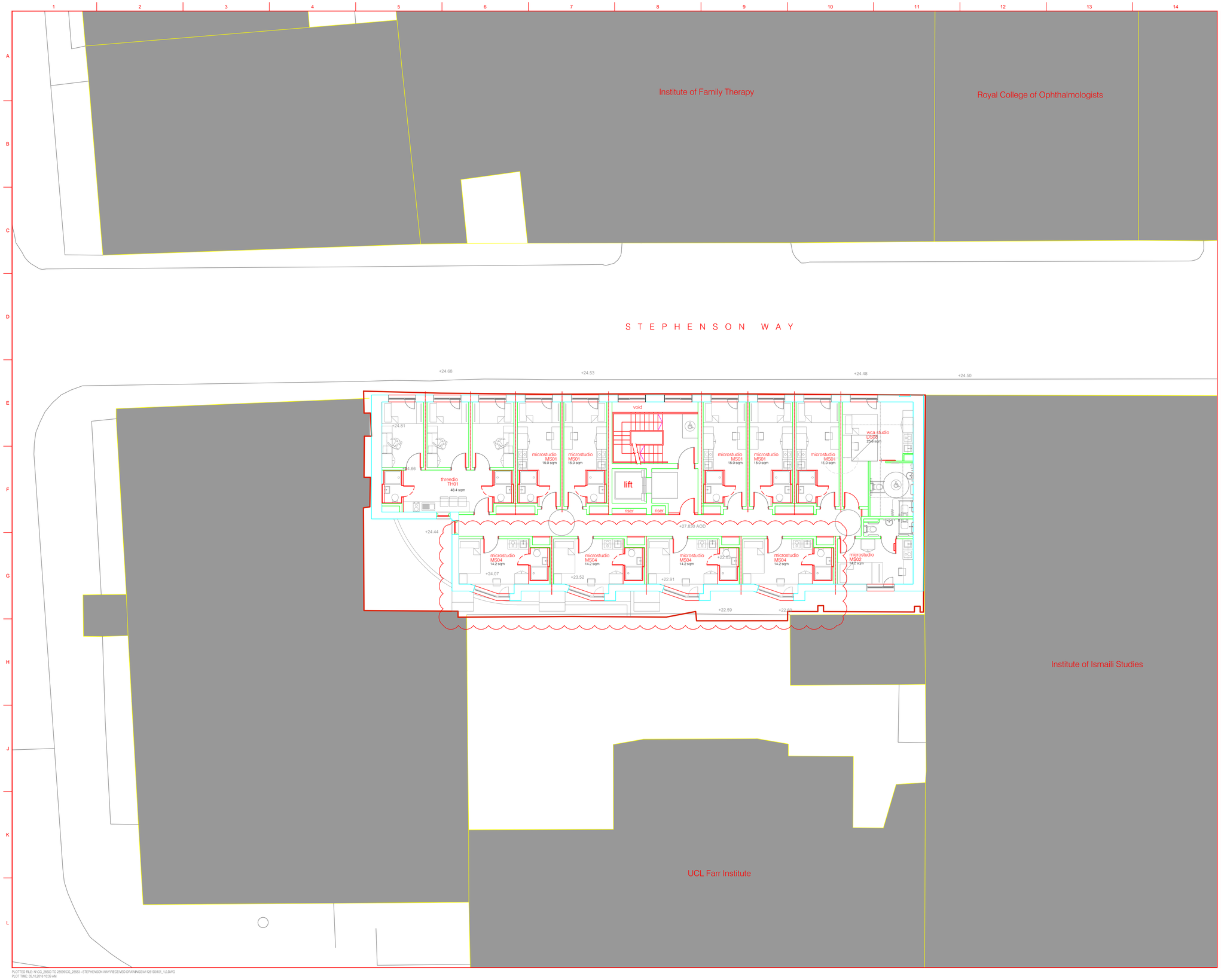

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STRUCTURAL ENGINEER

SERVICES ENGINEER

CONSULTANT

KEY PLAN

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NOTES:

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ALL AREAS HAVE BEEN MEASURED FROM CURRENT DRAWINGS. THEY MAY VARY BECAUSE OF (EG) SURVEY, DESIGN DEVELOPMENT, CONSTRUCTION TOLERANCES, STATUTORY REQUIREMENTS OR RE-DEFINITION OF THE AREAS TO BE MEASURED.

No.	Date	Comment	Drawn	Chk'd
D3	05.09.18	Microstudio's MS04 amended	ETR	RM
D2	03.08.18	Updated in accordance with LPA comments	ETR	RM
D1	01/05/18	Submit for Planning Application	DK	NM

Revisions

Issue Status

PLANNING

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Project

Stephenson Way
London

Drawing Title

Proposed Level 01 Floor Plan

Drawn	Date	Scale @ A1	Alt. Ref.
DK	07.03.2018	1:100	--

tp bennett Project No.	Drawing Number	Rev.
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CLIENT

STRUCTURAL ENGINEER

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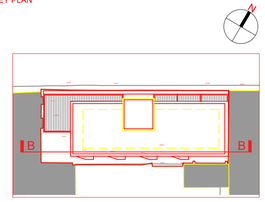
CONSULTANT

KEY PLAN



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DO NOT SCALE. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING. CHECK DIMENSIONS ON SITE AND REPORT DISCREPANCIES TO THE ARCHITECT.

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No.	Date	Comment	Drawn	Chk'd
D3	05.09.18	Amended to revised plans	ETR	RM
D2	03/08/18	Revised in accordance with planning comments	ETR	RM
D1	01/05/18	Submit for Planning Application	DK	NM

Revisions

Issue Status
PLANNING

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planning

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Project
Stephenson Way
London

Drawing Title
Proposed Section BB

Drawn	Date	Scale @ A1	Alt. Ref.
DK	07.03.2018	1:100	--

tp bennett Project No.	Drawing Number	Rev
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APPENDIX B

Scheme Design Report

Structural and Civil Engineers

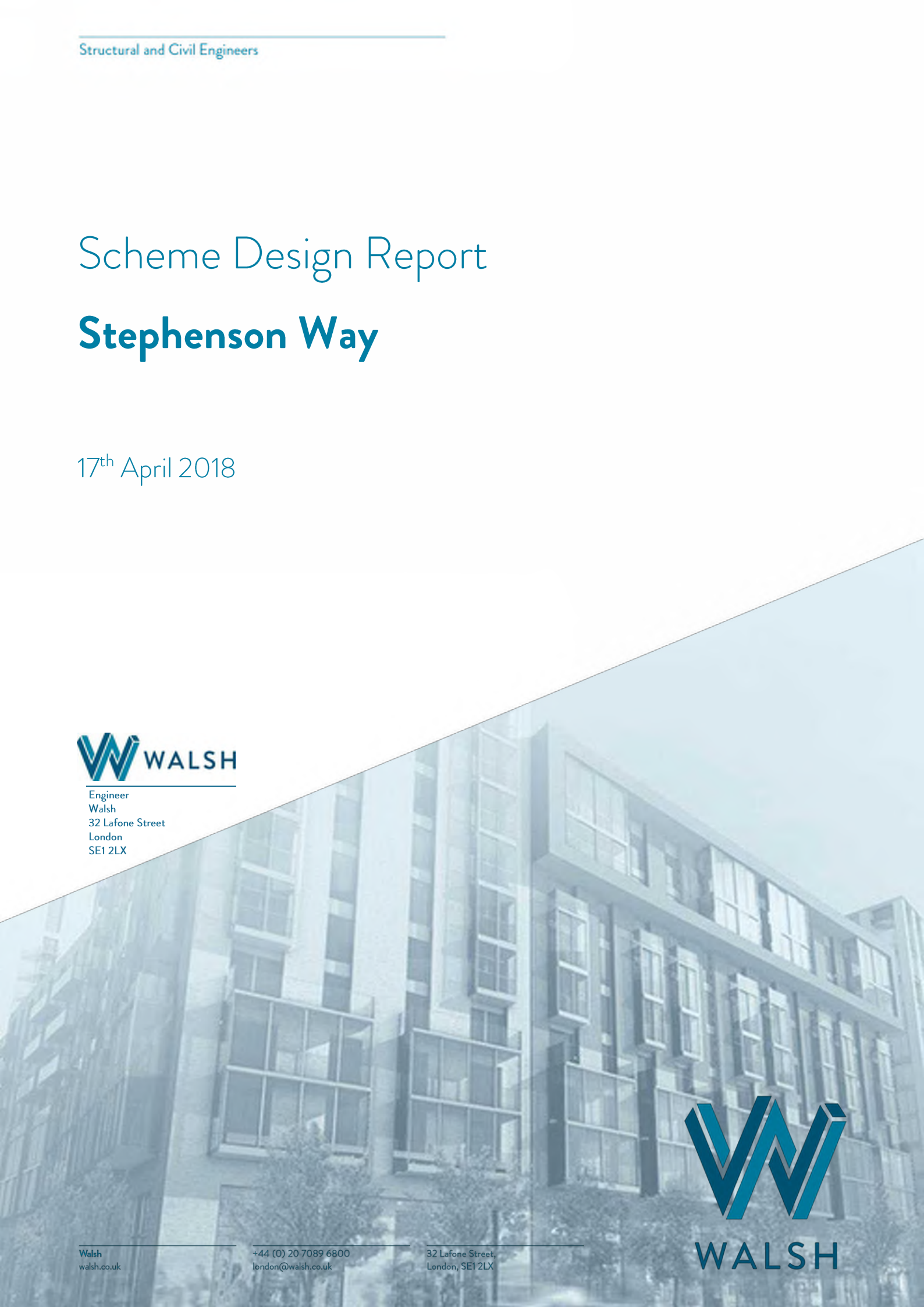
Scheme Design Report

Stephenson Way

17th April 2018

WALSH

Engineer
Walsh
32 Lafone Street
London
SE1 2LX



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london@walsh.co.uk

32 Lafone Street,
London, SE1 2LX

WALSH

Scheme Design Report

Stephenson Way

Walsh have prepared this report in accordance with the instruction of our client, T.P Bennett.

The report is for the sole and specific use of the client, and Walsh shall not be responsible for any use of the report or its contents for any purpose other than that for which it was prepared and provided. Should the Client require to pass copies of the report to other parties for information, then no professional liability or warranty shall be extended to other parties by Walsh in this connection without the explicit agreement thereto by Walsh.

Revision	Date	Notes	Prepared by	Checked by	Approved by
1	17/04/2018	First Issue	JW	HM	TF

Introduction

The following report will present two scheme design proposals for Stephenson Way, a 7 storey structure located in Euston. It is proposed that a basement is included as part of the design. At the 5th and 6th levels the building footprint steps in and floor plans will alter accordingly. The site contains a ramp of which it is understood will be maintained throughout the construction process giving access to the building on the opposite side of the site to Stephenson Way road. Above the ramp (1st floor) a transfer structure will be required.

The following will set out the key information concerning each scheme. Please refer to Appendix A for drawings relating to proposal 1 and Appendix B for proposal 2

Summary of Scheme Proposal 1 :

Summary

- Reinforced Concrete (RC) scheme proposal
- Hit-and-miss RC retaining wall to party wall boundaries
- Raft foundation slab
- Metsec structure to roof

Basement & Foundations

- Sheet piling to highway boundary with 300thk RC retaining wall
- 300thk hit-and-miss RC retaining wall to party wall boundaries
- 750thk raft slab supporting majority of structure, potential to reduce with local thickenings for columns
- 2No columns on pad footings
- 250thk RC walls to lift/stair core and basement wall

Ground Floor

- 250thk RC slab
- Columns typically 250x700, or 450sq.
- 250thk RC walls to lift/stair core
- Grid typically 6.5m sq

First Floor (Transfer level)

- 600thk RC transfer slab (with the possibility of designing this out using girder beams)
- Columns typically 250x700, or 450sq.
- Blockwork walls to lift/stair core
- Grid typically 6.5m square

Upper Floors (Typically)

- 225thk RC transfer slab
- Columns typically 250x700, or 450sq.
- Blockwork walls to lift/stair core

- Grid typically 6.5m square

Sixth Floor

- 250thk RC transfer slab
- 203UC Steel columns over
- Assumed blockwork and timber construction to walls
- Grid typically 6.5m square

Roof

- Metal decking to roof

Pro's

- Shorter lead in times
- Quicker slab turnaround.
- Better acoustic properties for resi.
- Good fire resistance
- Lighter structure

Cons

- Lower spans achievable
- Thicker slabs could affect ceiling heights
- Curing times etc. may have effect programme
-

Summary of Scheme Proposal 2:

Summary

- Precast scheme proposal (from 1st – 6th floor)
- Mini-pile and liner wall to party wall boundaries
- Pile caps and pile option
- Metsec structure to roof

Basement & Foundations

- 250thk RC liner wall to party wall boundaries with 300/400mm diameter mini-piles
- 300thk RC basement slab
- 1000mm deep pile caps supported on 300/400mm diameter pile
- 250thk RC walls to lift/stair core

Ground Floor

- 250thk RC slab
- Columns typically 250x700, or 450sq.
- 250thk RC walls to lift/stair core

- Grid typically 6.5m sq

First Floor (Transfer level)

- 750thk RC transfer slab
- Structure extends over ramp to transfer columns
- 250thk RC walls to lift/stair core

Upper Floors (Typically)

- 165thk Precast Slab
- 140thk internal precast walls
- 120thk edge precast walls
- 254 UKB tie beams over corridors
- 250thk RC walls to lift/stair core
- Grid typically 7m x 2.75m

Sixth Floor

- 250thk RC transfer slab
- 203UC Steel columns over
- 250thk RC walls to lift/stair core
- Grid typically 6.5m square

Roof

- Metal decking to roof

Pro's

- Larger spans achievable and walls fall exactly into partions
- Higher quality product and no curing times
- Total construction time is quicker
- Thinner slabs at typical level
- Cheaper option compared to RC

Cons

- Heavier structure (higher foundation loads)
- Much larger transfer structure required at first
- Potential issue with storage space on small site

Appendix A

Proposal 1 – Reinforced Concrete Scheme

STEPHENSON WAY

IF RAMP IS TO BE RETAINED, THEN CONSTRUCT IN HIT & MISS

'TEMPORARY' SHEET PILING TO HIGHWAY BOUNDARY

'PERMANENT' RC RETAINING WALL, 300THK

SUBJECT TO SITE INVESTIGATION, ALTERNATIVELY PILED OPTION

250THK RC WALL

HIT & MISS RC RETAINING WALL/ UNDERPIN. 300THK.

music room

cycle storage 39 spaces

750THK RC RAFT SLAB

refuse

platform lift

ramp up to street level

basement access

HIT & MISS RC RETAINING WALL/ UNDERPINNING. 300THK

COLUMNS ON PAD FOOTINGS

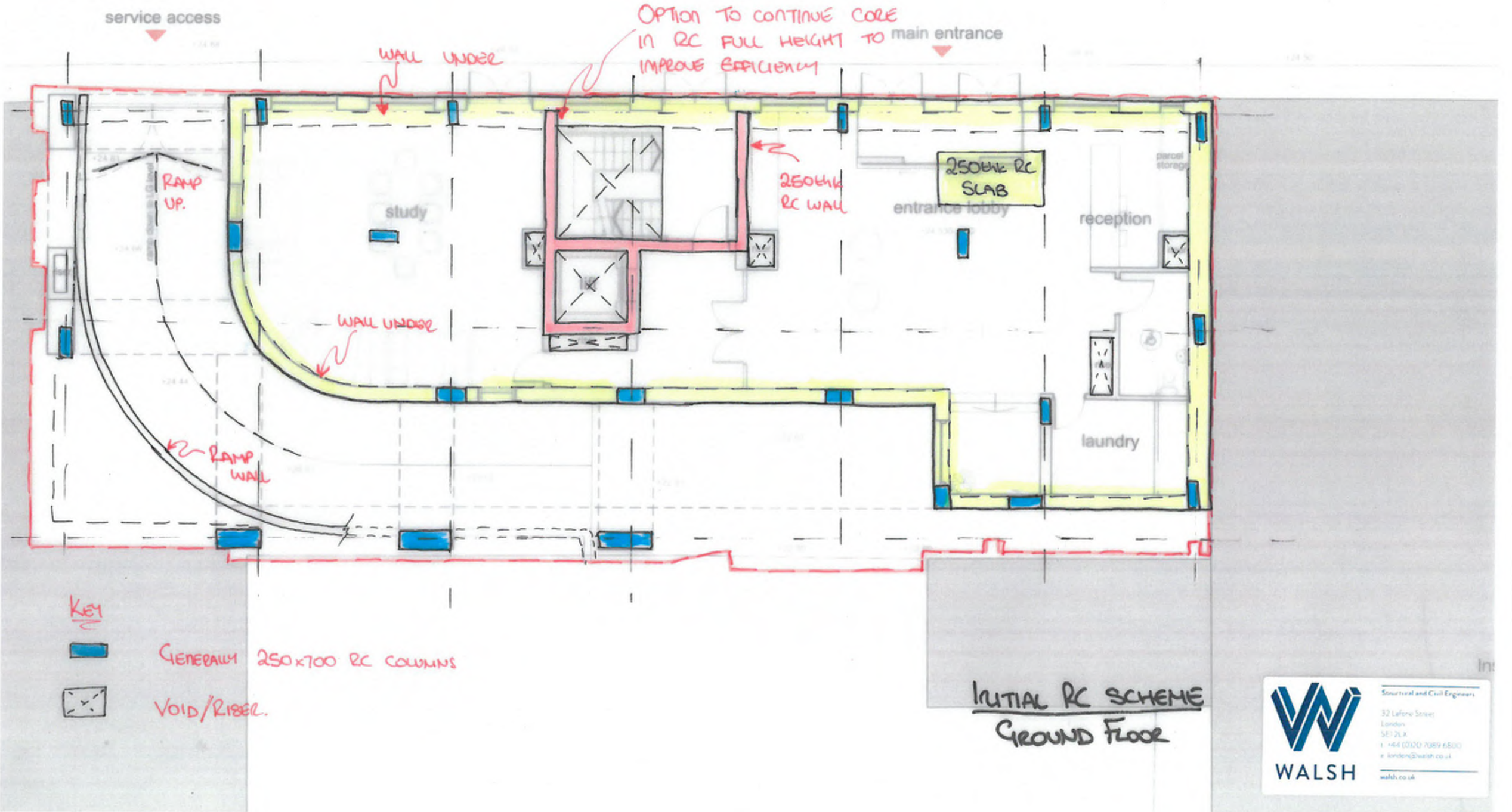
RC WALL 250THK

INITIAL RC SCHEME

BASEMENT

WALSH
Structural and Civil Engineers
92 Lafone Street
London
SE1 2LX
t +44 (0)20 7089 6800
e london@walsh.co.uk
walsh.co.uk

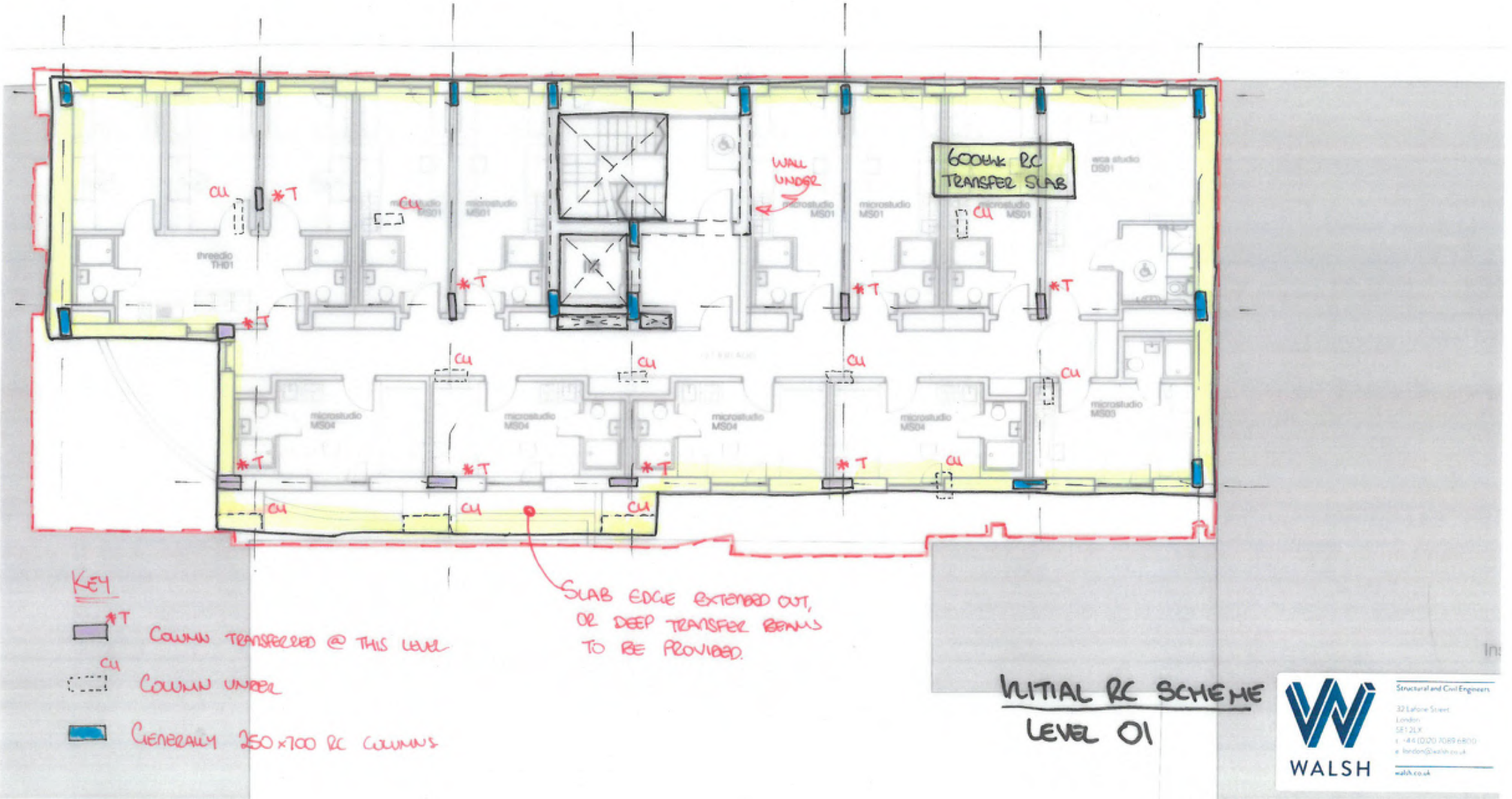
STEPHENSON WAY



INITIAL RC SCHEME
GROUND FLOOR

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t: +44 (0)20 7089 6800
e: london@walsh.co.uk
walsh.co.uk

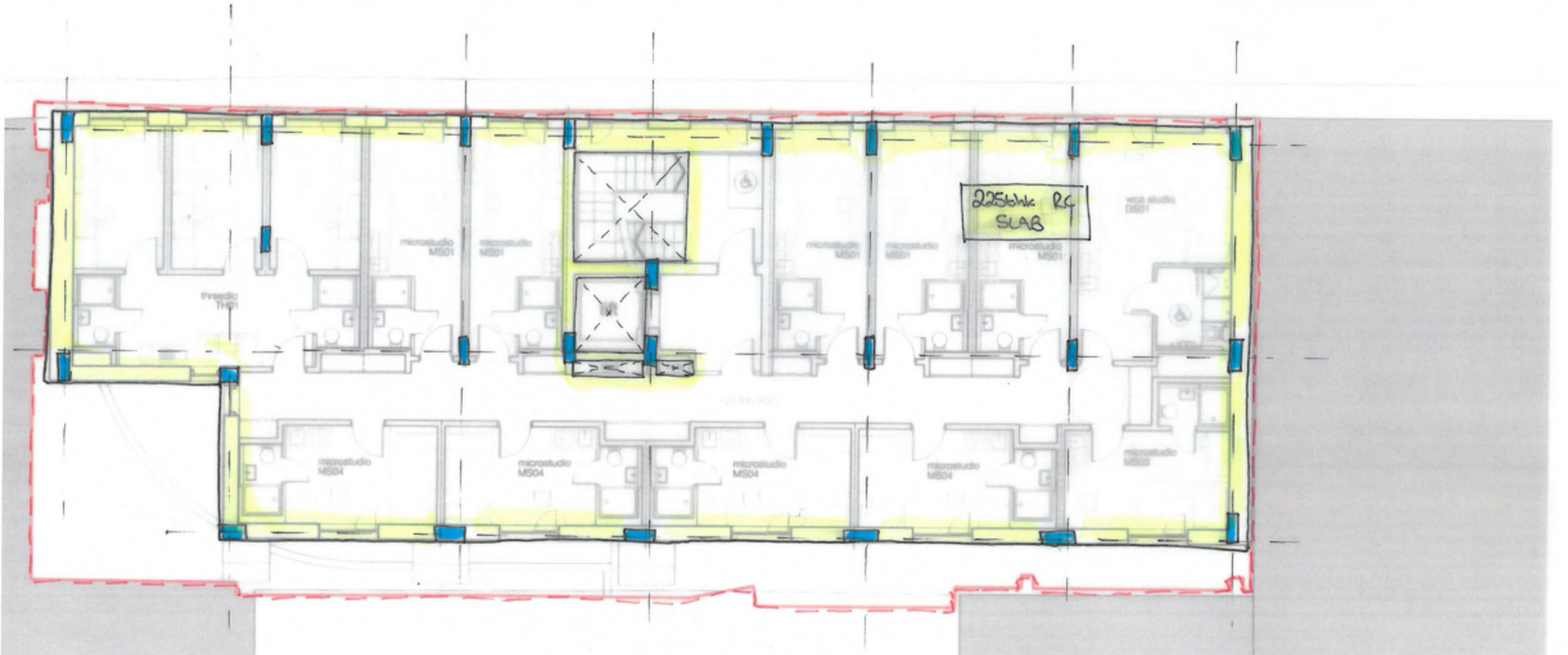
STEPHENSON WAY



INITIAL RC SCHEME
LEVEL 01

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t +44 (0)20 7089 6800
e london@walsh.co.uk
walsh.co.uk

STEPHENSON WAY



Key

GENERALLY 250x700 RC COLUMNS

INITIAL RC SCHEME

TYPICAL FLOOR (LEVEL 02-04)

WALSH
Structural and Civil Engineers
walsh.co.uk

STEPHENSON WAY

COLUMNS TO BE CORBELLED BACK AT FLOORS BELOW ON THIS FACE TO ALLOW STEP BACKS (MIN 2 FLOORS)

225thk RC SLAB

KEY

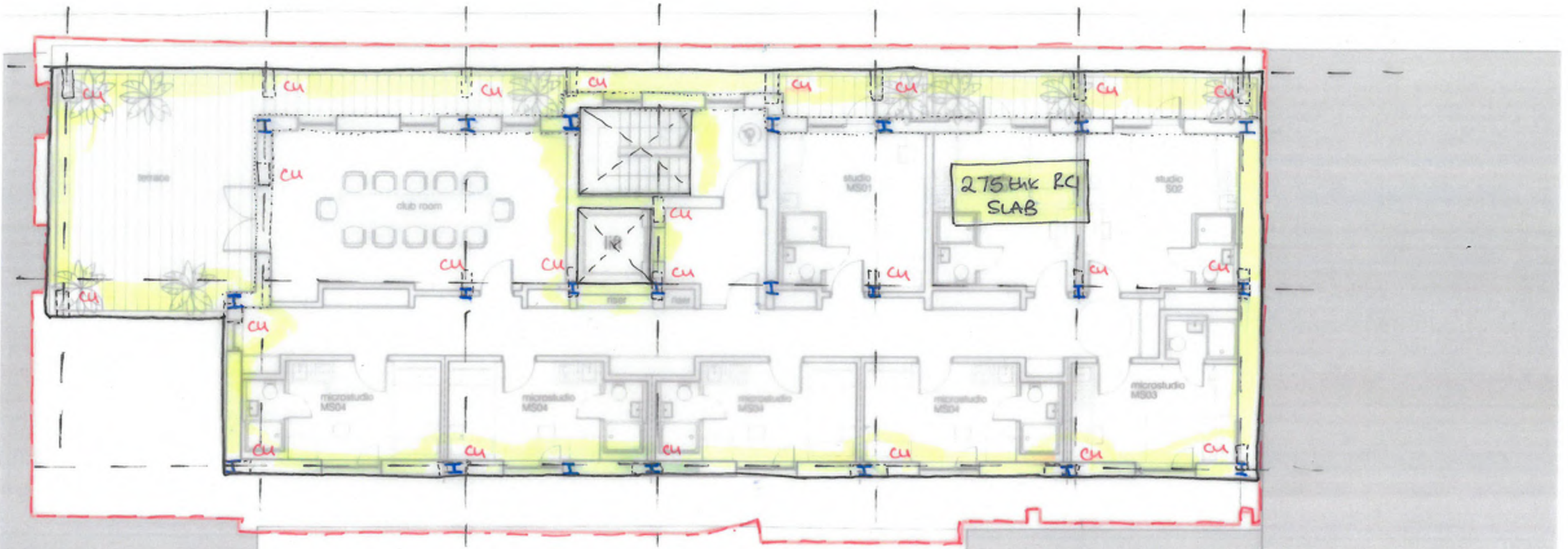
GENERALLY 250 x 700 RC COLUMNS

INITIAL RC SCHEME

Level 05

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t: +44 (0)20 7089 6810
e: london@walsh.co.uk
walsh.co.uk

STEPHENSON WAY



KEY

CU — COLUMN UNDER

I — 203 UC STEEL COLUMN.

INITIAL RC SCHEME

LEVEL 06

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t +44 (0)20 7089 6810
e london@walsh.co.uk
walsh.co.uk

STEPHENSON WAY

ALLOW FOR STEEL GRILLAGE OR BIG-FOOT SYSTEM TO SUPPORT ANY PLANT.

potential zone for PV

KEY

I 203 UC COLUMN UNDER

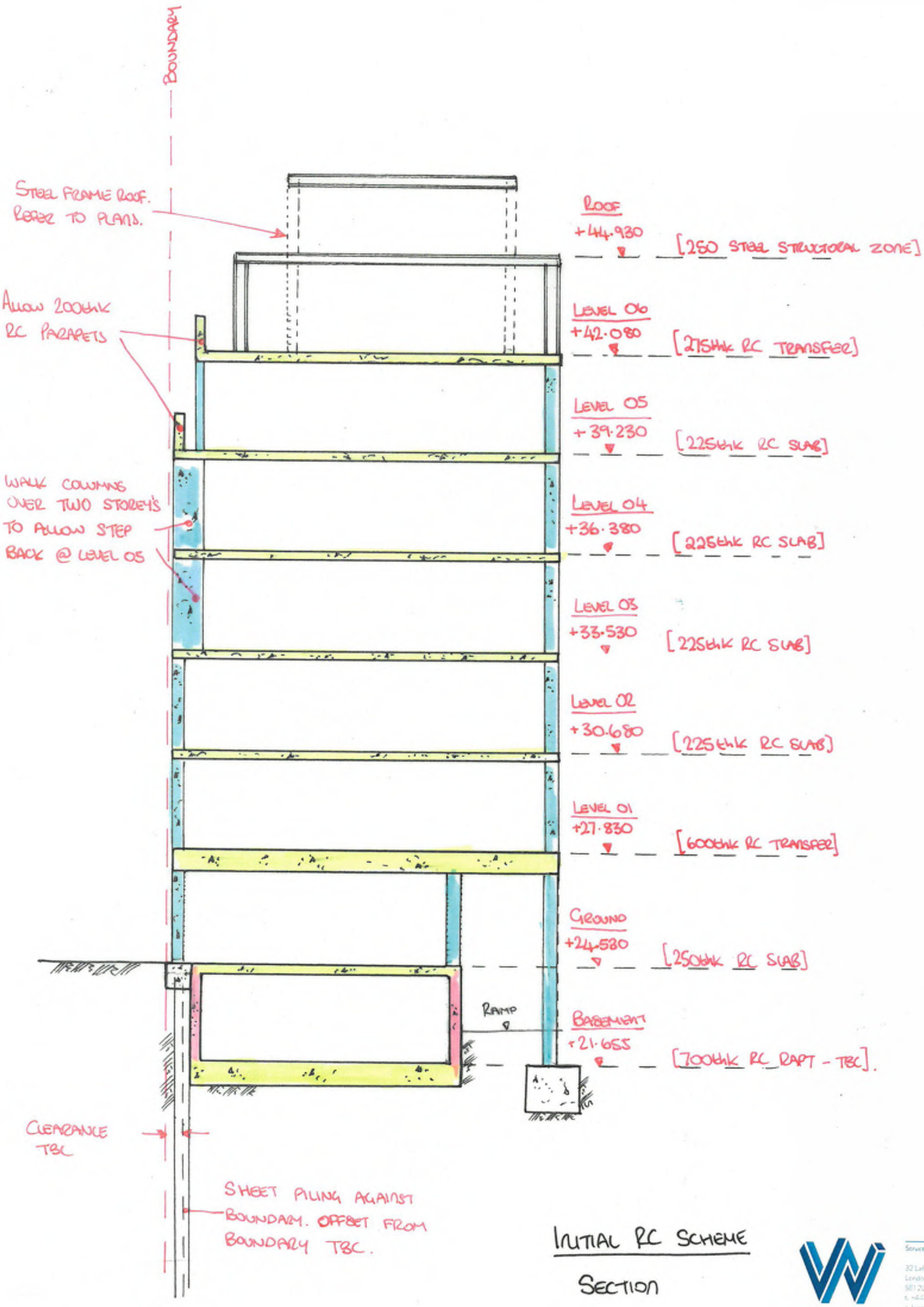
305 UB BEAMS

METSEC 142Z PURLINS, OR SIMILAR.

INITIAL RC SCHEME

ROOF

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t: +44 (0)20 7089 6800
e: london@walsh.co.uk
walsh.co.uk



INITIAL RC SCHEME

SECTION

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t. +44 (0)20 7089 6800
e. london@walsh.co.uk
walsh.co.uk

Appendix B

Proposal 2 – Precast Concrete Scheme

INITIAL PRECAST SCHEME

BASEMENT

COLUMNS SUPPORTED ON 1000mm DEEP PILE CAPS AND PILES (3No. & 4No. PILE CAPS)

MINI PILES (400mm DIA) WITH 200mm thk LINER WALL

1200mm DEEP CORE CAP ON 300mm DIA PILES

STEPHENSON WAY

plant

practice room

music room

cycle storage 39 spaces

300mm thk RC BASEMENT SLAB

refuse

ramp up to street level

basement access

RAMP

MINI PILES (400mm DIA) WITH 200mm thk LINER WALL

250mm thk CORE WALLS

WALSH
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32 Lafone Street
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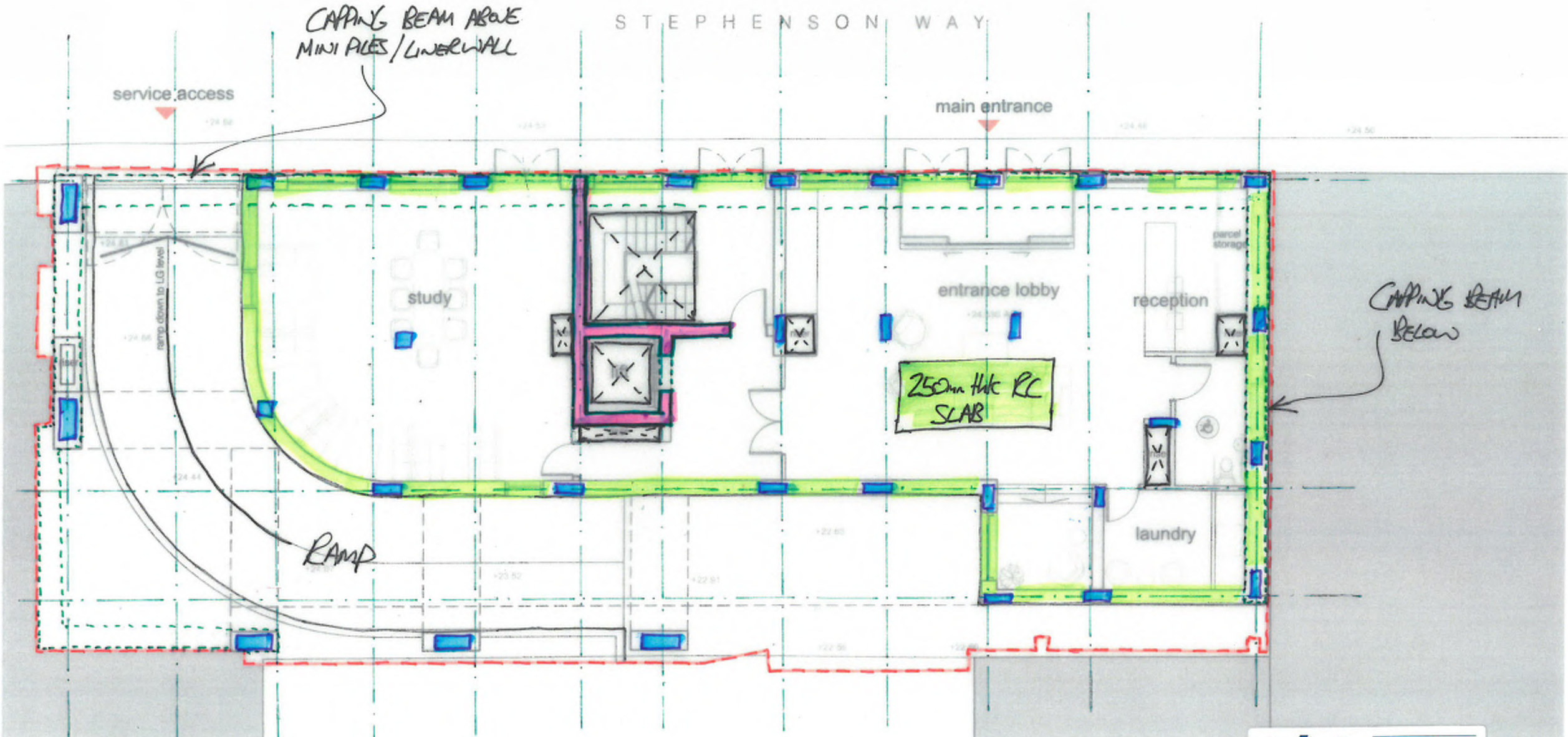
SE1 2LX
t. +44 (0)20 7089 6800
e. london@walsh.co.uk
walsh.co.uk

4836 - STEPHENSON WAY

INITIAL PRECAST SCHEME

GROUND



KEY

- RC COLUMNS (GENERALLY 200 x 700mm)
- 250mm thk CORE WALLS
- VOID/RISER

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t. +44 (0)20 7089 6800
e. london@walsh.co.uk
walsh.co.uk

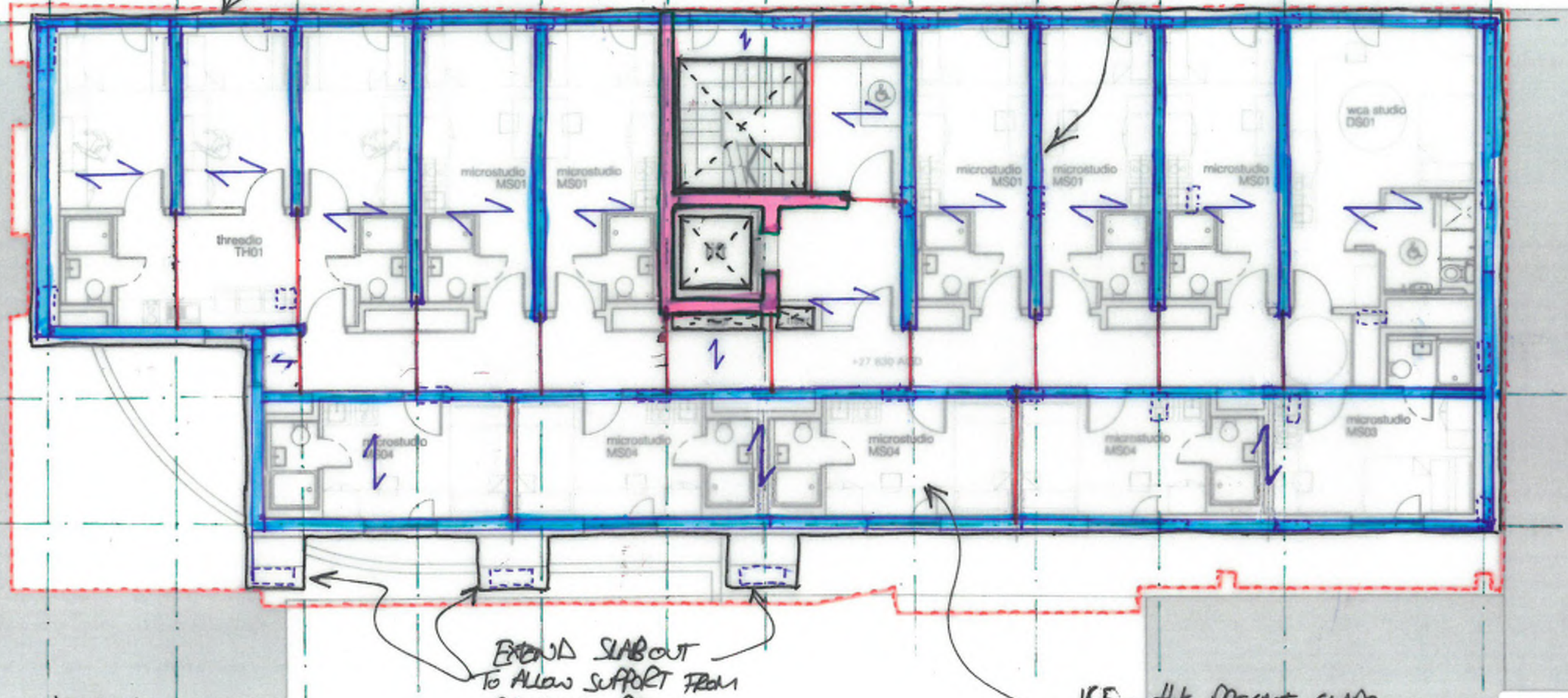
4836 - STEPHENSON WAY

INITIAL PRECAST SCHEME

TYPICAL FLOOR

120mm thk EDGE PRECAST WALLS BETWEEN 1st-6th FLOOR

160mm thk INTERNAL PRECAST WALLS BETWEEN 1st-6th FLOOR



EXTEND SLAB OUT TO ALLOW SUPPORT FROM COLUMNS BELOW

165mm thk PRECAST SLABS SPANNING BETWEEN WALLS

KEY

- PRECAST WALL
- RC COLUMN BELOW (1st FLOOR ONLY)
- TIE BEAM (254 UKB)
- SPAN OF PRECAST SLAB
- CORE WALL (250mm thk)
- VOID/RISER

WALSH
Structural and Civil Engineers
32 Lefone Street
London
SE1 2LX
t: +44 (0)20 7089 6800
e: london@walsh.co.uk
walsh.co.uk

4886 - STEPHENSON WAY

INITIAL PRECAST SCHEME

6th FLOOR

STEPHENSON WAY

OUTLINE OF LEVEL BELOW

OUTLINE OF LEVEL ABOVE

PRECAST WALL BELOW

250mm thk RC SLAB

350mm thk RC SLAB

club room

studio MS01

studio MS01

microstudio MS04

microstudio MS04

microstudio MS04

microstudio MS04

microstudio MS03

KEY

PRECAST WALL BELOW

METSEC COLUMN ABOVE

CORE WALL (250mm thk)

WALSH
Structural and Civil Engineers
32 Lafone Street
London
SE1 2LX
t. +44 (0)20 7089 6800
e. london@walsh.co.uk
walsh.co.uk

4836 - STEPHENSON WAY

Contact

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Structural and Civil Engineers
32 Lafone Street
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+44 (0)20 7089 6800
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walsh.co.uk

WALSH

APPENDIX C

CGL Borehole Log

BOREHOLE LOG

Project				BOREHOLE No
Land to the Rear of 222 Euston Road				BH1
Job No	Date	Ground Level (m)	Co-Ordinates (m)	
CG/28583	28-08-18 30-08-18	22.66	E 529,418.6 N 182,449.1	
Client				Sheet
Oakwood International Investment Corporation				1 of 2

SAMPLES & TESTS			Water	STRATA				
Depth (m)	Type No	Test Result		Reduced Level	Legend	Depth (m) (Thick-ness)	DESCRIPTION	Instrument /Backfill
0.30-0.40	B			22.01		(0.65) 0.65	Asphalt over dense dark red brown very gravelly fine to coarse sand. Gravel is fine to coarse subrounded to angular of brick, concrete, flint and occasional asphalt. [MADE GROUND]	
				21.06		(0.95) 1.60	Reinforced concrete. 8mm and 18mm diameter rebar at 0.8mbgl [MADE GROUND]	
1.60-1.70	B						Medium dense light brown slightly clayey gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to subangular of flint. [LYNCH HILL GRAVEL MEMBER]	
2.00-2.45	B							
2.00		N19	1			(1.50)		
				19.56		3.10		
3.00-3.45	B							
3.00-3.45	D			19.06		3.60	Firm dark brown slightly silty CLAY. Occasional fine to coarse selenite crystals noted. [WEATHERED LONDON CLAY FORMATION]	
3.00		N10						
3.60-3.70	B							
4.00-4.45	U	67 blows 100					Stiff to very stiff dark grey silty CLAY with occasional thin laminations of fine sand. Frequent fine to medium selenite crystals, fine light brown bioturbations and rare white to light grey shell fragments noted. [LONDON CLAY FORMATION]	
4.45-4.50	B							
5.00-5.45	B							
5.00-5.45	D							
5.00		N17						
6.00-6.45	U	77 blows 100						
6.45-6.50	B							
7.50-7.95	B							
7.50-7.95	D							
7.50		N21						
9.00-9.45	U	98 blows 100						
9.45-9.50	B		2					
10.50-10.95	B							
10.50-10.95	D							
10.50		N22						
12.00-12.45	U	103 blows 100				(17.10)		
12.45-12.50	B						12.45 Becoming slightly sandy. Sand is fine. No shells or bioturbations	

Boring Progress and Water Observations

Date	Comment	Strike Depth	Casing Depth	Casing Dia. mm	Standing Depth
		2.80			2.65
	Seepage	9.90			9.80

General Remarks

1. D= small disturbed samples, B= bulk disturbed sample, U= U100 sample, N= SPT 'N' value.
2. Groundwater encountered at 2.8mbgl, 9.9mbgl and 22.3mbgl, rising to 2.65mbgl, 9.8mbgl and 22.5mbgl, respectively.
3. Installation details: 0.0-1.5mbgl: plain pipe with bentonite backfill; 1.5-3.5mbgl: slotted pipe with gravel backfill; 3.5-4mbgl: bentonite backfill; 4-25mbgl: arisings backfill. Gas tap, bung and flush cover installed.

Method/ Plant Used	Field Crew	Logged By	Checked By
Cable percussion	Bainbridge Brothers Limited	JJM	RJB

BOREHOLE LOG

Project				BOREHOLE No
Land to the Rear of 222 Euston Road				BH1
Job No	Date	Ground Level (m)	Co-Ordinates (m)	
CG/28583	28-08-18 30-08-18	22.66	E 529,418.6 N 182,449.1	
Client				Sheet
Oakwood International Investment Corporation				2 of 2

SAMPLES & TESTS			Water	STRATA				Instrument /Backfill
Depth (m)	Type No	Test Result		Reduced Level	Legend	Depth (m) (Thick-ness)	DESCRIPTION	
							noted. Stiff to very stiff dark grey silty CLAY with occasional thin laminations of fine sand. Frequent fine to medium selenite crystals, fine light brown bioturbations and rare white to light grey shell fragments noted. [LONDON CLAY FORMATION] *(continued)*	
13.50-13.95	B							
13.50-13.95	D							
13.50		N27						
15.00-15.45	U	115 blows 100						
15.45-15.50	B							
16.50-16.95	B						16.50 Becoming very stiff silty CLAY.	
16.50-16.95	D							
16.50		N34						
18.00-18.45	U	124 blows 100						
18.45-18.50	B						18.45 - 18.50 Occasional fine sand laminations and light brown bioturbations.	
19.50-19.95	B							
19.50-19.95	D							
19.50		N41						
				1.96		20.70		
20.70-20.80	B						Very stiff light grey mottled dark brown and red CLAY. [LAMBETH GROUP]	
21.00-21.45	U	150+ blows 78						
21.45-21.50	B					(1.60)		
			3	0.36		22.30		
22.30-22.40	B						Very dense dark yellow grey fine SAND. [LAMBETH GROUP]	
22.50-22.95	B							
22.50-22.95	D						22.50 - 22.95 Slightly clayey.	
22.50		N40/ 75 mm						
						(2.70)	23.50 Black medium to coarse rounded gravel of flint noted.	
24.00-24.45	B							
24.00-24.45	D							
24.00		N50/ 20 mm						
				-2.34		25.00		
							(Borehole terminated at 25m)	

Boring Progress and Water Observations

Date	Comment	Strike Depth	Casing Depth	Casing Dia. mm	Standing Depth
		22.30			22.50

General Remarks

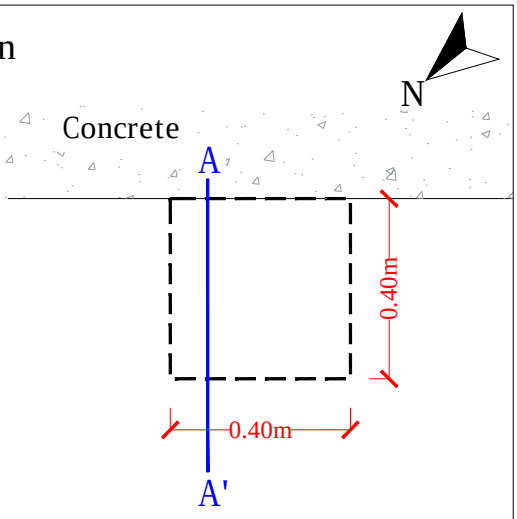
1. D= small disturbed samples, B= bulk disturbed sample, U= U100 sample, N= SPT 'N' value.
2. Groundwater encountered at 2.8mbgl, 9.9mbgl and 22.3mbgl, rising to 2.65mbgl, 9.8mbgl and 22.5mbgl, respectively.
3. Installation details: 0.0-1.5mbgl: plain pipe with bentonite backfill; 1.5-3.5mbgl: slotted pipe with gravel backfill; 3.5-4mbgl: bentonite backfill; 4-25mbgl: arisings backfill. Gas tap, bung and flush cover installed.

Method/ Plant Used	Field Crew	Logged By	Checked By
Cable percussion	Bainbridge Brothers Limited	JJM	RJB

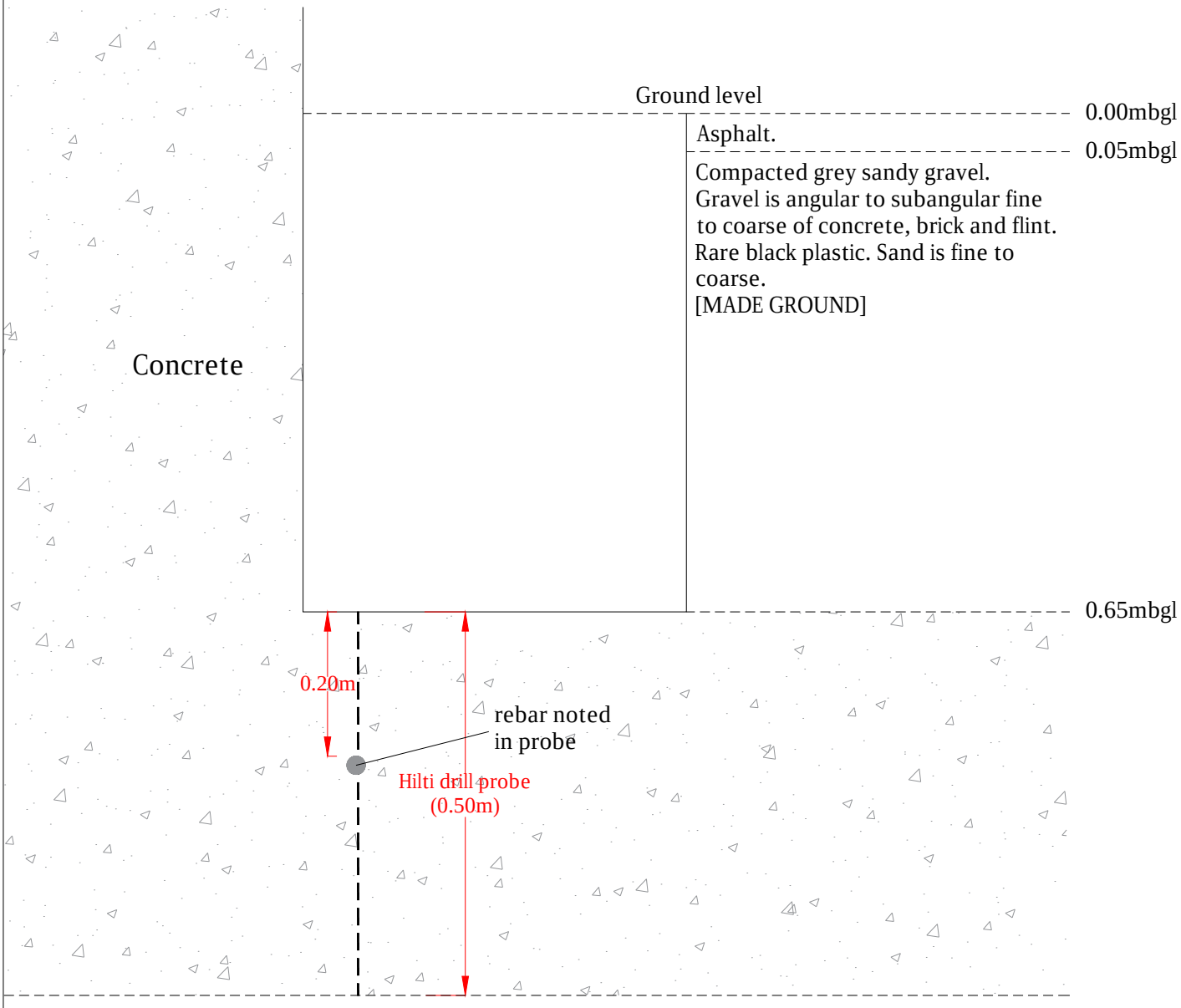
APPENDIX D

CGL Foundation Inspection Pit Records

TP1 Plan

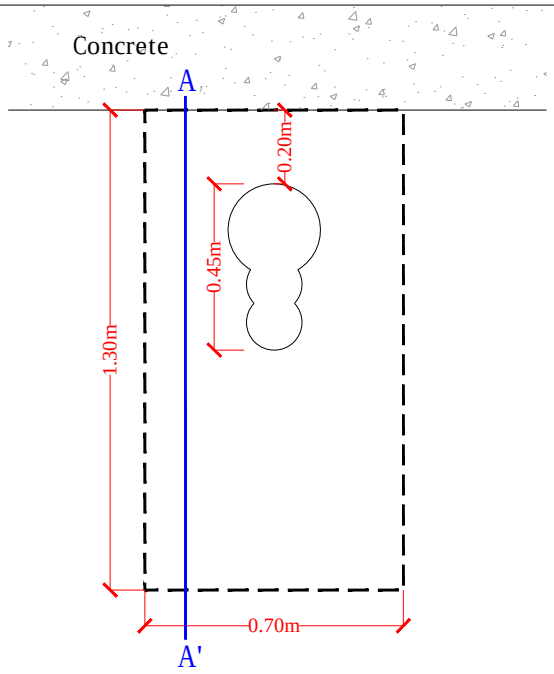


TP1
Section A-A'

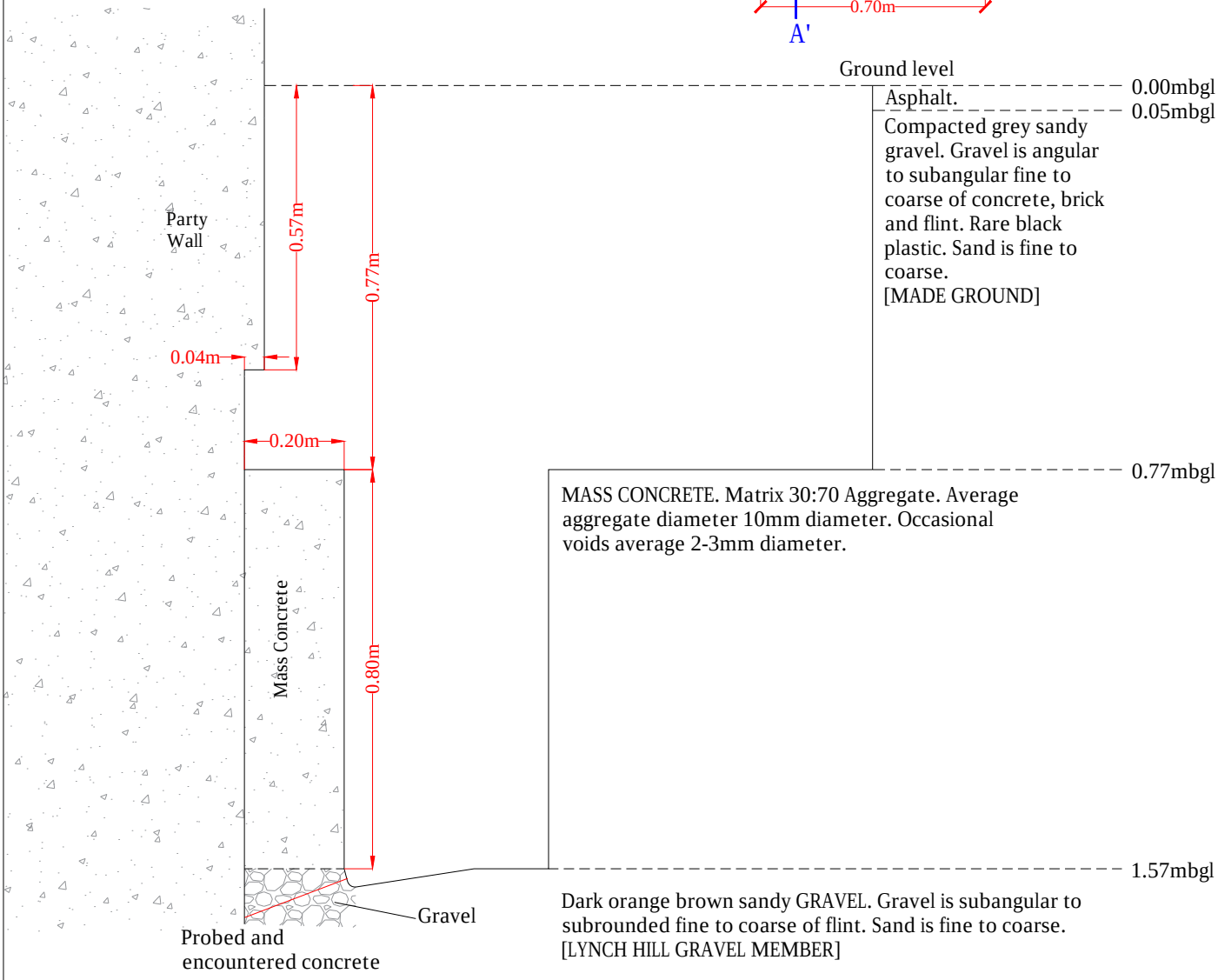


Client: Oakwood International Investment Corporation	Project: Land to the Rear of 222 Euston Road	Job No: CG/28583
CGL	Title: TP1 Foundation Inspection Pit Plan & Section A-A'	Drawn by: JJM Checked by: RJB Approved by: IMM Appendix D

TP2 Plan

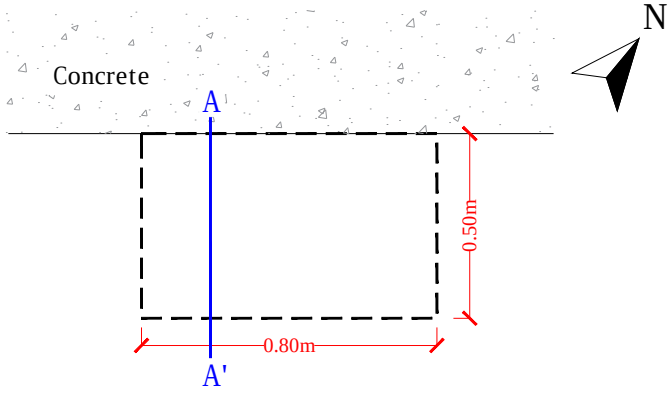


TP2
Section A-A'

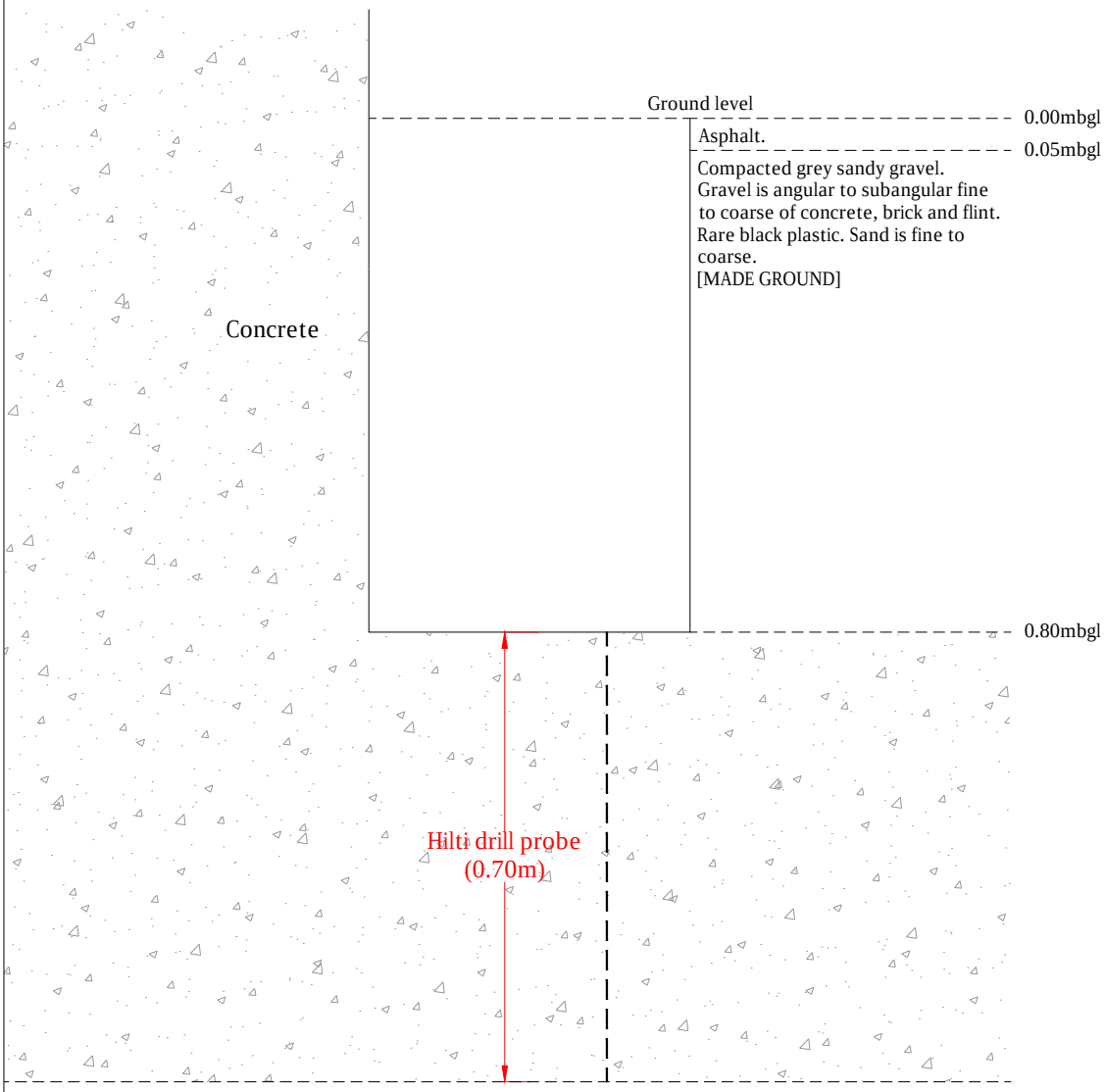


Client Oakwood International Investment Corporation	Project Land to the Rear of 222 Euston Road	Job No CG/28583
CGL	Title TP2 Foundation Inspection Pit Plan & Section A-A'	Drawn by: KJP Checked by: RJB Approved by: IMM Appendix D

TP3 Plan



TP3
Section A-A'



Client Oakwood International Investment Corporation	Project Land to the Rear of 222 Euston Road	Job No CG/28583
CGL	Title TP3 Foundation Inspection Pit Plan & Section A-A'	Drawn by: JJM Checked by: RJB Approved by: IMM Appendix D

APPENDIX E

CGL Groundwater Monitoring Record

GROUNDWATER MONITORING RECORD SHEET

JOB DETAILS			
Site:	Land to the Rear of 222 Euston Road	Job No:	CG/28583
Client	Oakwood International Investment Corporation	Engineer:	EJS

MONITORING & SAMPLING DETAILS			
Date:	03/09/2018	10/09/2018	17/09/2018
Time:	11:00-11:30	10:00-10:15	09:00-09:15
Weather:	Sunny, warm, dry	Cloudy, warm, dry	Cloudy, warm, dry
Well / Borehole reference:	BH1	BH1	BH1
Monitoring details			
Ground elevation (+mOD)	22.66	22.66	22.66
Groundwater depth (mbgl)	2.45	2.51	2.51
Groundwater elevation (+mOD)	20.21	20.15	20.15
Depth to base of well (mbgl)	3.66	3.68	3.67
Diameter of well (m)	0.05	0.05	0.05
Condition of well	Good	Good	Good
Top of response zone (mbgl)	1.5	1.5	1.5
Base of response zone (mbgl)	3.5	3.5	3.5
Free product thickness (m)	None	None	None
Hydrocarbon sheen noted (Y/N)	None	None	None
Purging details			
Purge method	NA	NA	NA
Purged volume (litres)	NIL	NIL	NIL
Recharge (good / poor)	NA	NA	NA
Sampling details			
Sampling method	NA	NA	NA
Volume of water sample taken (litres)	NIL	NIL	NIL
Volume of free product sample taken (litres)	NIL	NIL	NIL
Colour / odours noted*	NA	NA	NA
In-situ measurements			
pH	NA	NA	NA
Temperature (^{o}C)	NA	NA	NA
Dissolved oxygen (mg/l)	NA	NA	NA
Redox potential (mV)	NA	NA	NA
Electrical conductivity (µS/cm)	NA	NA	NA
Total dissolved solids (ppt)	NA	NA	NA

* Respiratory protective equipment to be worn if odours are noted during initial monitoring & on sites which are potentially contaminated

NOTES

APPENDIX F

Geotechnical Laboratory Results

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

UKAS TESTING 4041

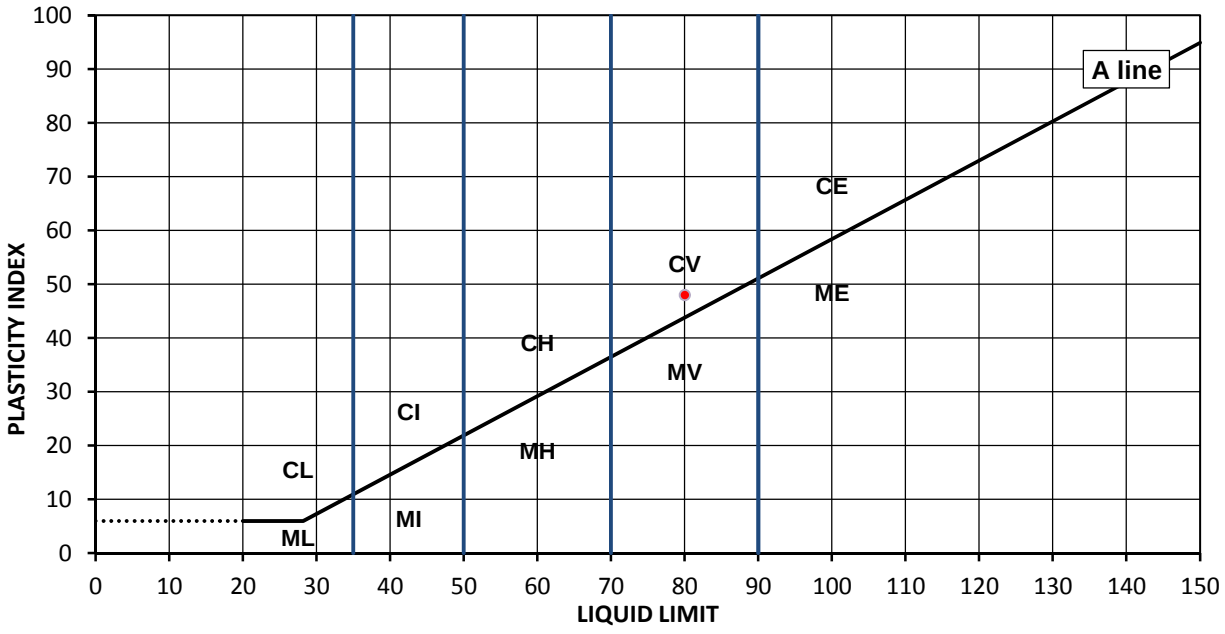
i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Results

Laboratory Reference:	1037174	Depth Top [m]:	4.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Soil Description:	Brown CLAY		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
29	80	32	48	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

UKAS TESTING 4041

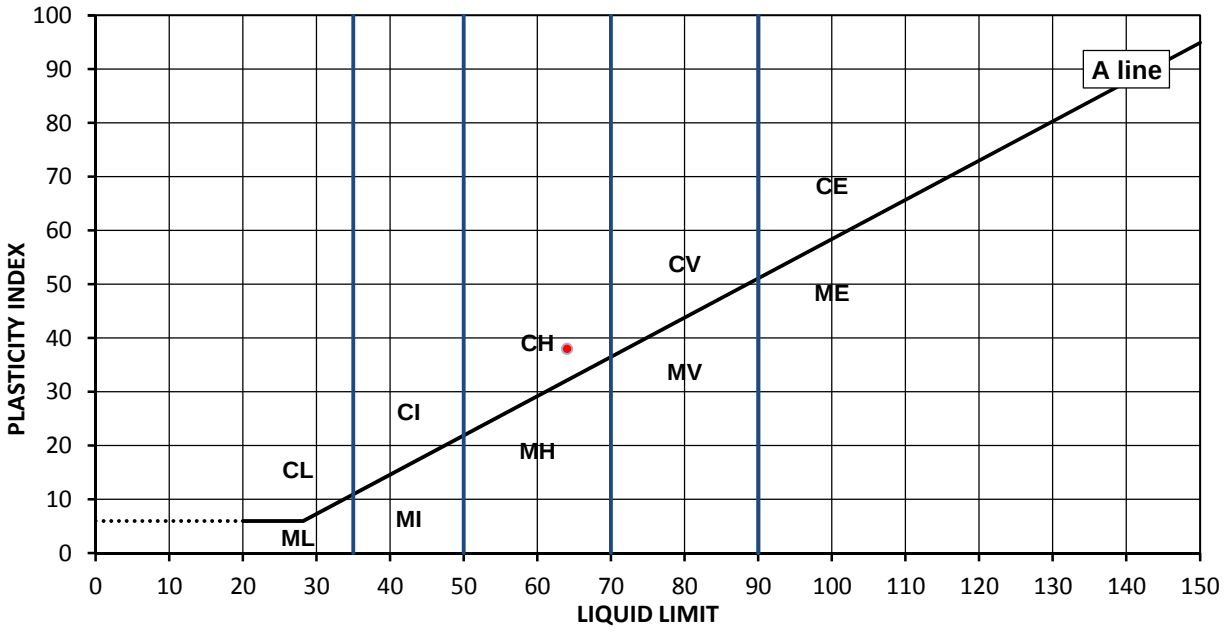
i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Results

Laboratory Reference:	1037177	Depth Top [m]:	6.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Soil Description:	Dark brown CLAY		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
25	64	26	38	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

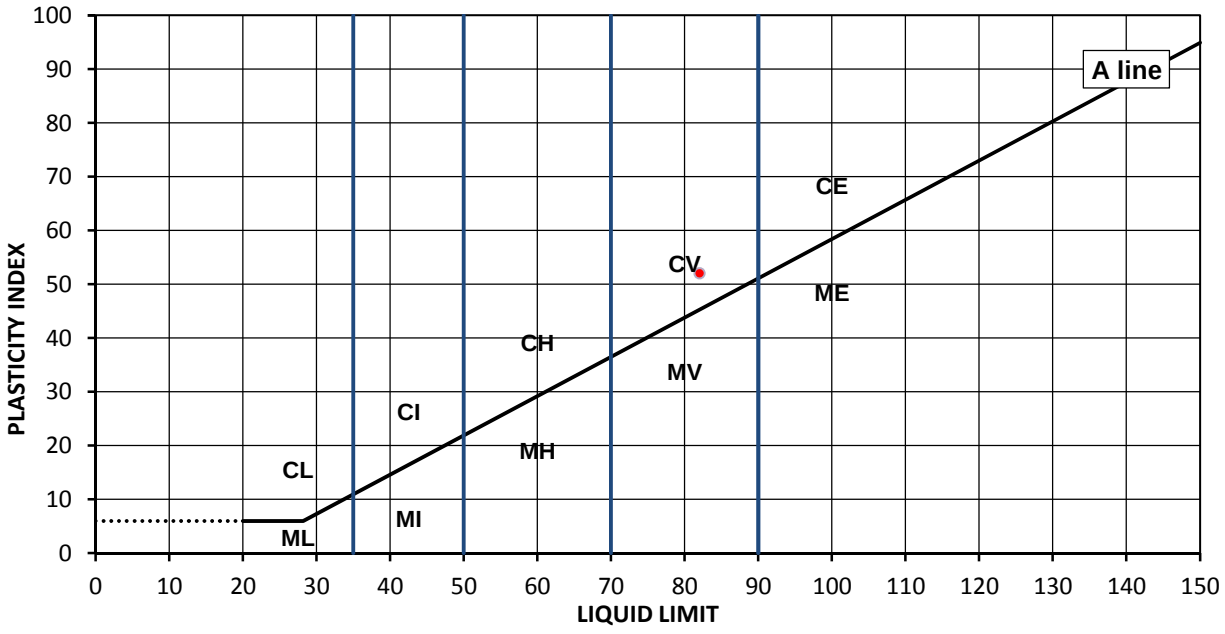
4041

Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Results

Laboratory Reference:	1037178	Depth Top [m]:	9.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Soil Description:	Brown CLAY		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
30	82	30	52	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

4041

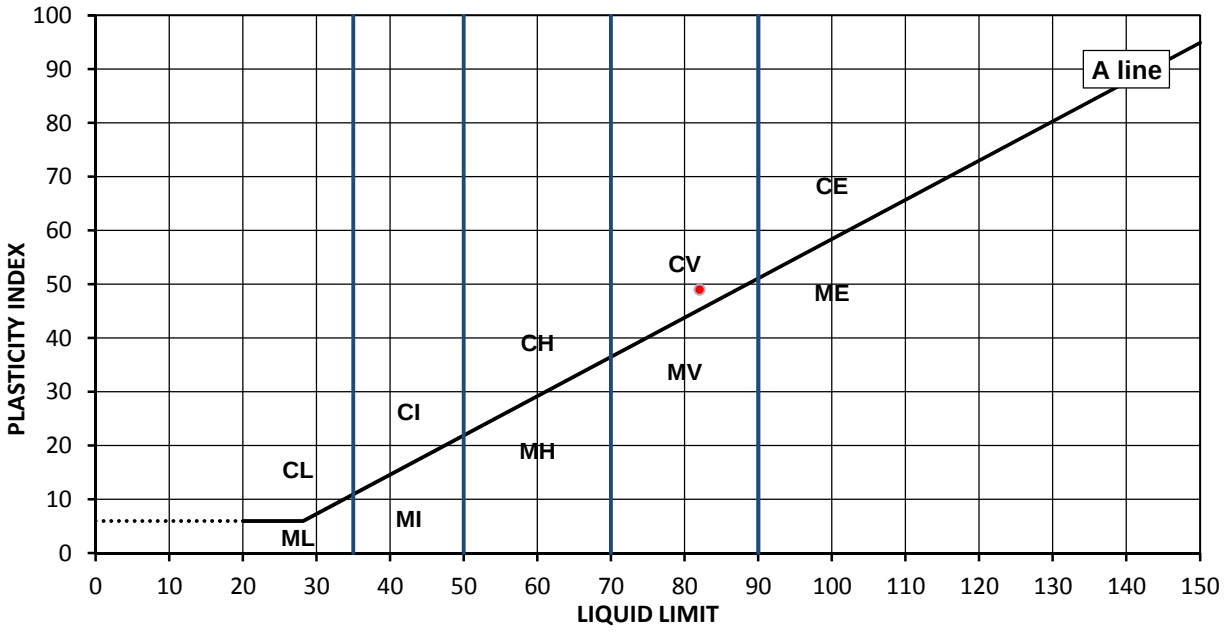
i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Results

Laboratory Reference:	1037179	Depth Top [m]:	12.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Soil Description:	Brown CLAY		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
28	82	33	49	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 17/09/2018

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Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

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Determination of Liquid and Plastic Limits

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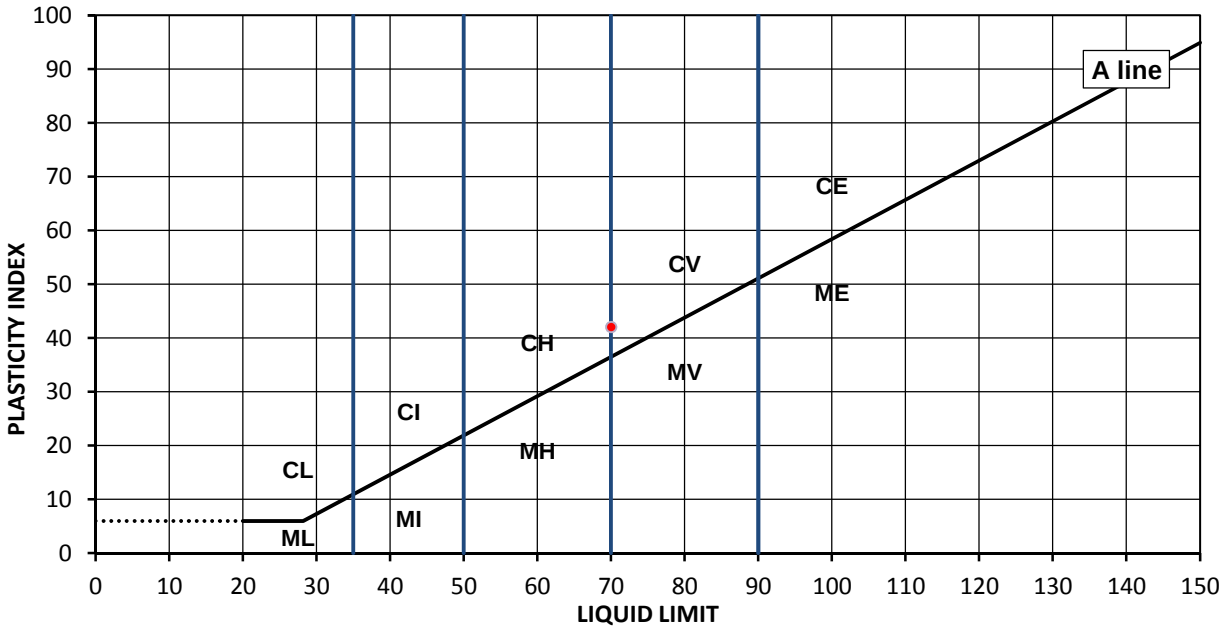
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Results

Laboratory Reference:	1037180	Depth Top [m]:	15.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Soil Description:	Dark brown slightly gravelly CLAY		
Sample Preparation:	Tested after >425um removed by hand		

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
25	70	28	42	99



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

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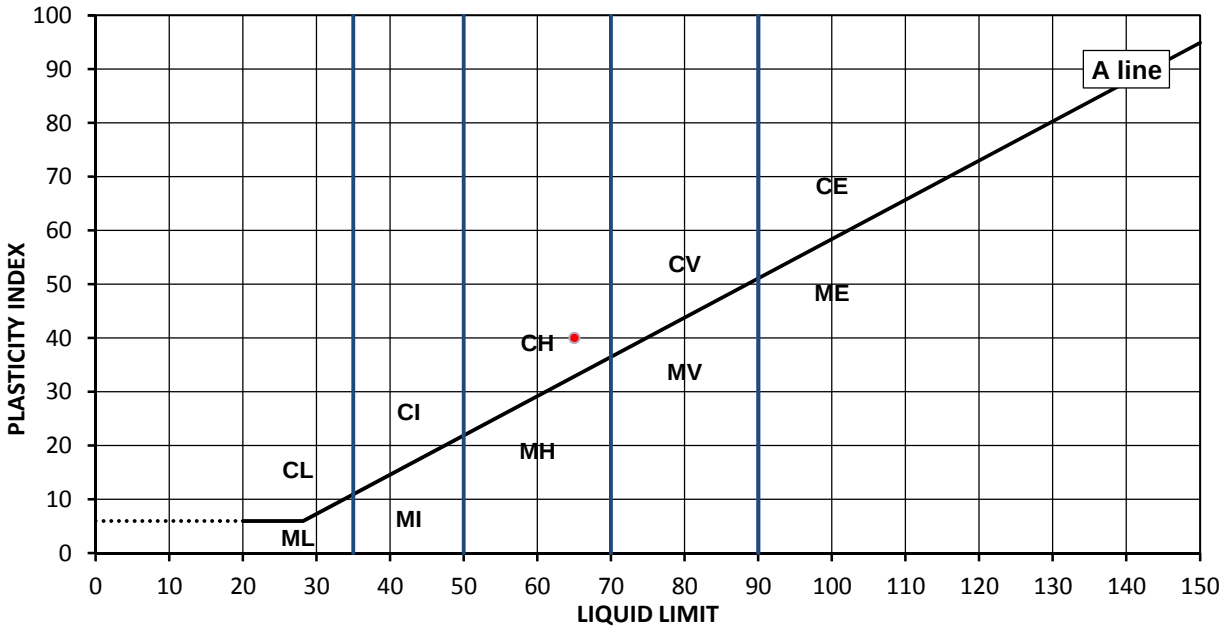
Croxley Green Business Park
Watford Herts WD18 8YS

Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	30/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Results

Laboratory Reference:	1037181	Depth Top [m]:	18.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Soil Description:	Dark brown CLAY		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
24	65	25	40	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

UKAS TESTING 4041

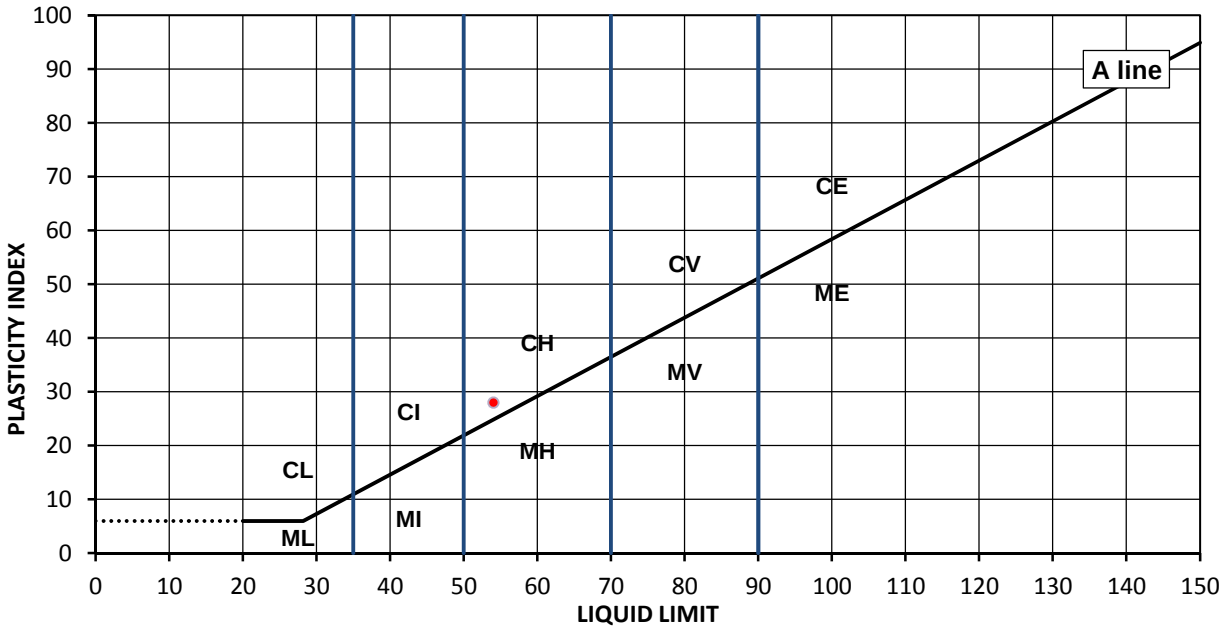
i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	30/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Results

Laboratory Reference:	1037182	Depth Top [m]:	21.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Soil Description:	Red mottled grey slightly sandy CLAY		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
21	54	26	28	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Summary of Classification Test Results

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Client: Card Geotechnics Ltd
Client Address: 4 Godalming Business Centre
Woolsack Way
Godalming
Surrey
GU7 1XW
Contact: James Morrice
Site Name: Stephenson Way
Site Address: Not Given

Client Reference: CG-28583
Job Number: 18-98735
Date Sampled: 29/08 - 30/08/2018
Date Received: 29/08/2018
Date Tested: 11/09/2018
Sampled By: driller

Test results

Laboratory Reference	Hole No.	Sample				Soil Description	M/C	Atterberg				Density		Total Porosity
		Reference	Top depth [m]	Base depth [m]	Type			% Passing 425um	LL	PL	PI	bulk	PD	
							%	%	%	%	%	Mg/m3	Mg/m3	Mg/m3
1037172	BH1	Not Given	3.00	Not Given	D	Brown slightly gravelly CLAY	25							
1037173	BH1	Not Given	3.60	Not Given	D	Brown CLAY	33							
1037174	BH1	Not Given	4.00	Not Given	U	Brown CLAY	29	100	80	32	48			
1037175	BH1	Not Given	4.45	Not Given	D	Brown CLAY	30							
1037176	BH1	Not Given	5.00	Not Given	D	Brown CLAY	29							
1037177	BH1	Not Given	6.00	Not Given	U	Dark brown CLAY	25	100	64	26	38			
1037178	BH1	Not Given	9.00	Not Given	U	Brown CLAY	30	100	82	30	52			
1037179	BH1	Not Given	12.00	Not Given	U	Brown CLAY	28	100	82	33	49			
1037180	BH1	Not Given	15.00	Not Given	U	Dark brown slightly gravelly CLAY	25	99	70	28	42			
1037181	BH1	Not Given	18.00	Not Given	U	Dark brown CLAY	24	100	65	25	40			

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Summary of Classification Test Results

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Client: Card Geotechnics Ltd
Client Address: 4 Godalming Business Centre
Woolsack Way
Godalming
Surrey
GU7 1XW
Contact: James Morrice
Site Name: Stephenson Way
Site Address: Not Given

Client Reference: CG-28583
Job Number: 18-98735
Date Sampled: 30/08/2018
Date Received: 29/08/2018
Date Tested: 11/09/2018
Sampled By: driller

Test results

Laboratory Reference	Hole No.	Sample				Soil Description	M/C	Atterberg				Density		Total Porosity
		Reference	Top depth [m]	Base depth [m]	Type		%	% Passing 425um %	LL %	PL %	PI %	bulk Mg/m3	PD Mg/m3	Mg/m3
1037182	BH1	Not Given	21.00	Not Given	U	Red mottled grey slightly sandy CLAY	21	100	54	26	28			

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Unconsolidated Undrained Triaxial Compression

Tested in Accordance with BS1377: Part 7: 1990, clause 8, single specimen

UKAS TESTING 4041

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

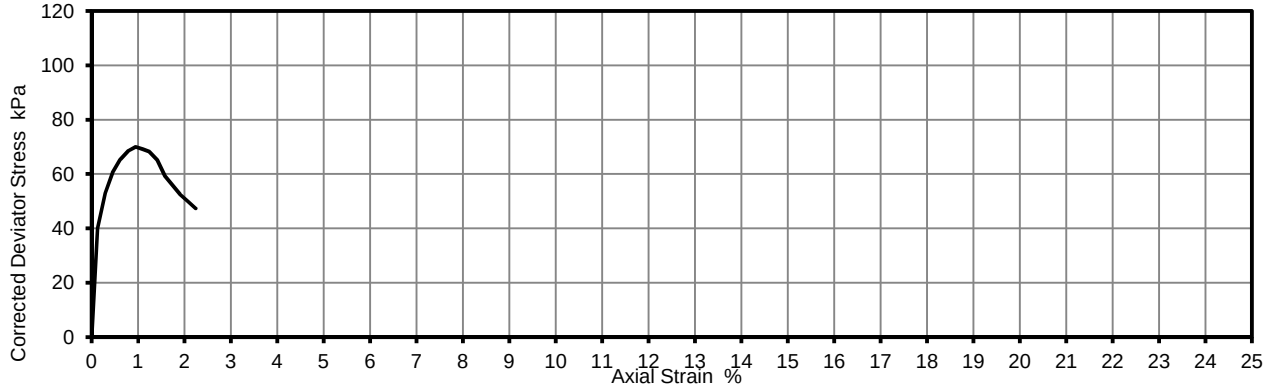
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Result

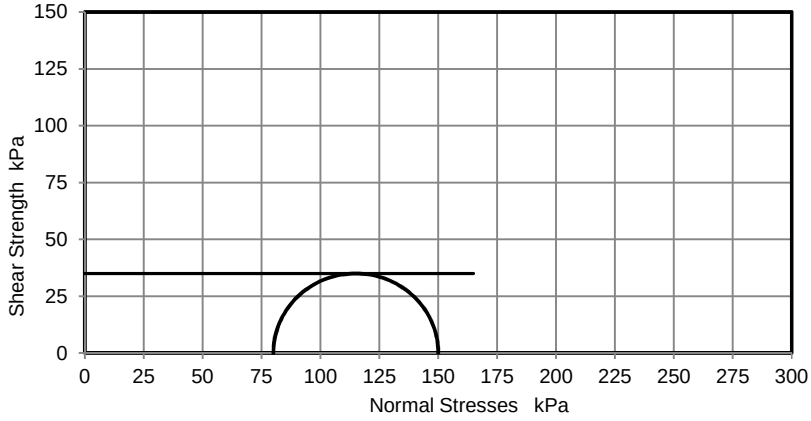
Laboratory Reference:	1037174	Depth Top [m]:	4.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Sample Description:	Brown CLAY		

Test Number	1		Rate of Strain	2.00	%/min	
Length	139.60	mm	Cell Pressure	80	kPa	
Diameter	69.70	mm	Axial Strain at failure	0.9	%	
Bulk Density	1.94	Mg/m3	Deviator Stress, (σ1 - σ3)f	70	kPa	
Moisture Content	29	%	Undrained Shear Strength, cu	35	kPa	½(σ1 - σ3)f
Dry Density	1.50	Mg/m3	Mode of Failure	Brittle		
Membrane Correction	0.13	kPa	Membrane thickness	0.34	mm	

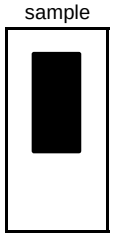
Deviator Stress v Axial Strain



Mohr Circles



Position within sample



Notes:

Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Unconsolidated Undrained Triaxial Compression

Tested in Accordance with BS1377: Part 7: 1990, clause 8, single specimen

UKAS TESTING 4041

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

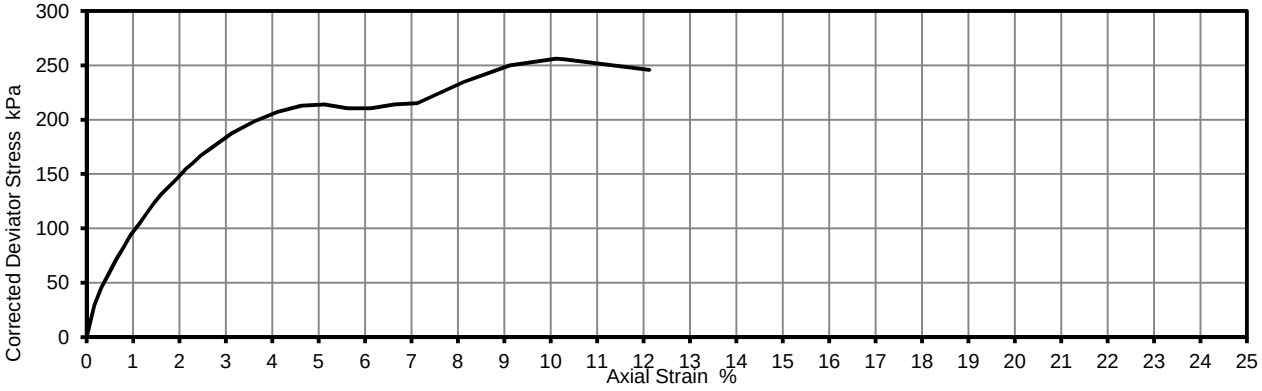
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Result

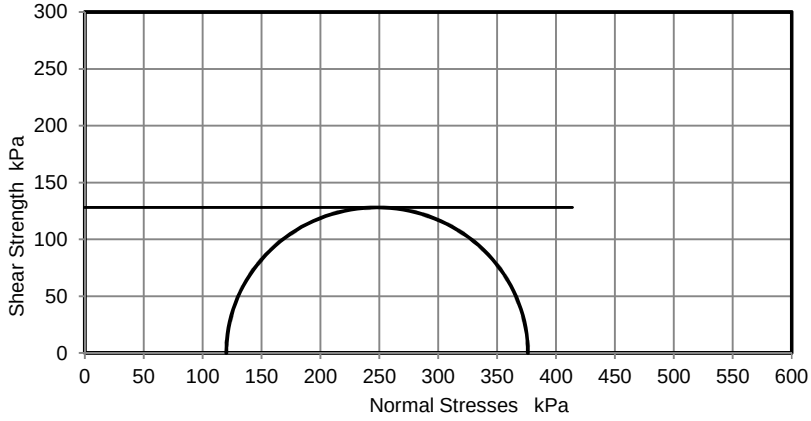
Laboratory Reference:	1037177
Hole No.:	BH1
Sample Reference:	Not Given
Sample Description:	Dark brown CLAY
Depth Top [m]:	6.00
Depth Base [m]:	Not Given
Sample Type:	U

Test Number	1		Rate of Strain	2.00	%/min
Length	194.67	mm	Cell Pressure	120	kPa
Diameter	101.25	mm	Axial Strain at failure	10.1	%
Bulk Density	2.05	Mg/m3	Deviator Stress, (σ1 - σ3)f	256	kPa
Moisture Content	25	%	Undrained Shear Strength, cu	128	kPa ½(σ1 - σ3)f
Dry Density	1.63	Mg/m3	Mode of Failure	Brittle	
Membrane Correction	0.69	kPa	Membrane thickness	0.31	mm

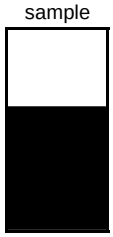
Deviator Stress v Axial Strain



Mohr Circles



Position within sample



Notes:

Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Unconsolidated Undrained Triaxial Compression

Tested in Accordance with BS1377: Part 7: 1990, clause 8, single specimen

UKAS TESTING 4041

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

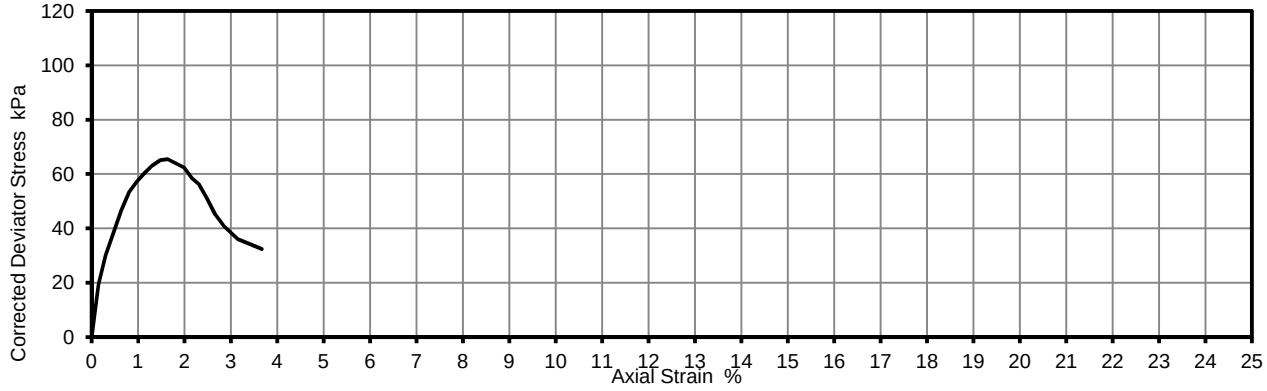
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Result

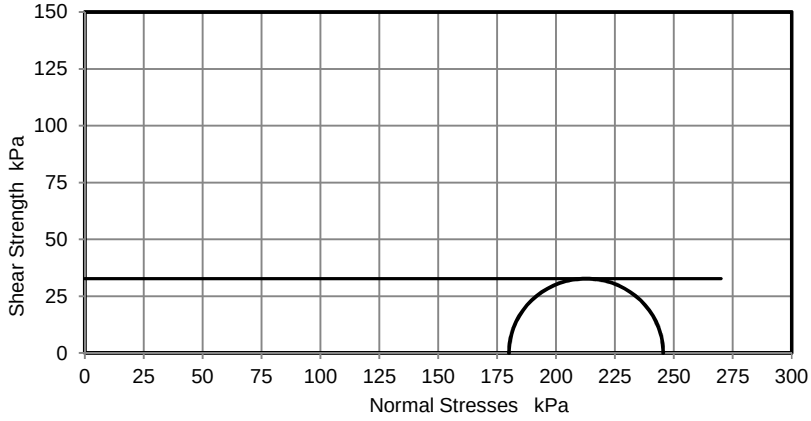
Laboratory Reference:	1037178	Depth Top [m]:	9.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Sample Description:	Brown CLAY		

Test Number	1		Rate of Strain	2.00	%/min	
Length	137.52	mm	Cell Pressure	180	kPa	
Diameter	70.03	mm	Axial Strain at failure	1.6	%	
Bulk Density	1.90	Mg/m3	Deviator Stress, (σ1 - σ3)f	65	kPa	
Moisture Content	30	%	Undrained Shear Strength, cu	33	kPa	½(σ1 - σ3)f
Dry Density	1.47	Mg/m3	Mode of Failure	Compound		
Membrane Correction	0.19	kPa	Membrane thickness	0.29	mm	

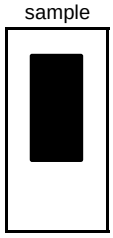
Deviator Stress v Axial Strain



Mohr Circles



Position within sample



Notes:

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Remarks:

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Unconsolidated Undrained Triaxial Compression

Tested in Accordance with BS1377: Part 7: 1990, clause 8, single specimen

UKAS TESTING 4041

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7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

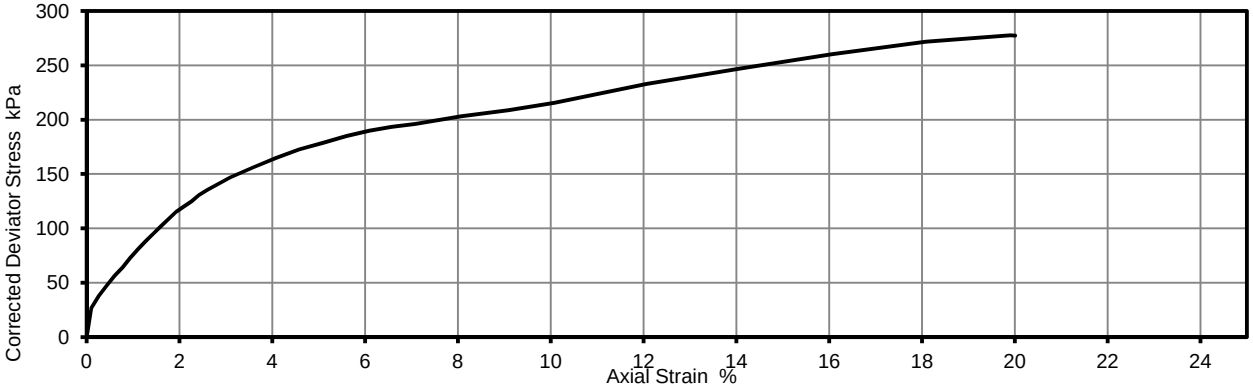
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Result

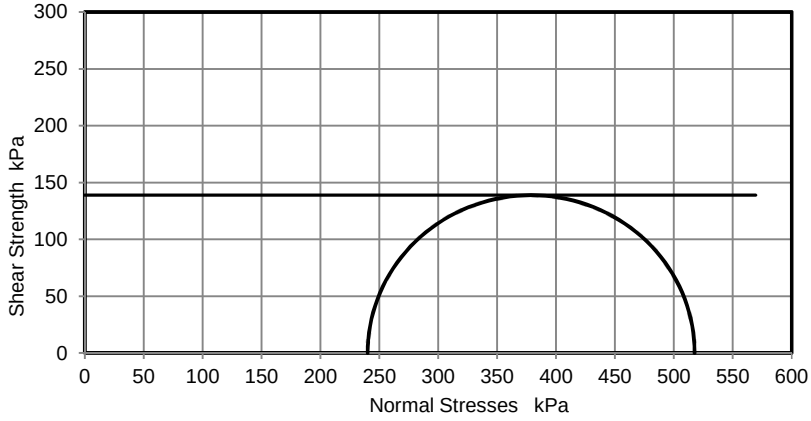
Laboratory Reference:	1037179
Hole No.:	BH1
Sample Reference:	Not Given
Sample Description:	Brown CLAY
Depth Top [m]:	12.00
Depth Base [m]:	Not Given
Sample Type:	U

Test Number	1		Rate of Strain	2.00	%/min
Length	179.71	mm	Cell Pressure	240	kPa
Diameter	100.26	mm	Axial Strain at failure	19.9	%
Bulk Density	1.98	Mg/m3	Deviator Stress, (σ1 - σ3)f	278	kPa
Moisture Content	28	%	Undrained Shear Strength, cu	139	kPa ½(σ1 - σ3)f
Dry Density	1.55	Mg/m3	Mode of Failure	Compound	
Membrane Correction	1.41	kPa	Membrane thickness	0.37	mm

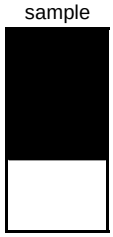
Deviator Stress v Axial Strain



Mohr Circles



Position within sample



Notes:

Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Unconsolidated Undrained Triaxial Compression

Tested in Accordance with BS1377: Part 7: 1990, clause 8, single specimen

UKAS TESTING 4041

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

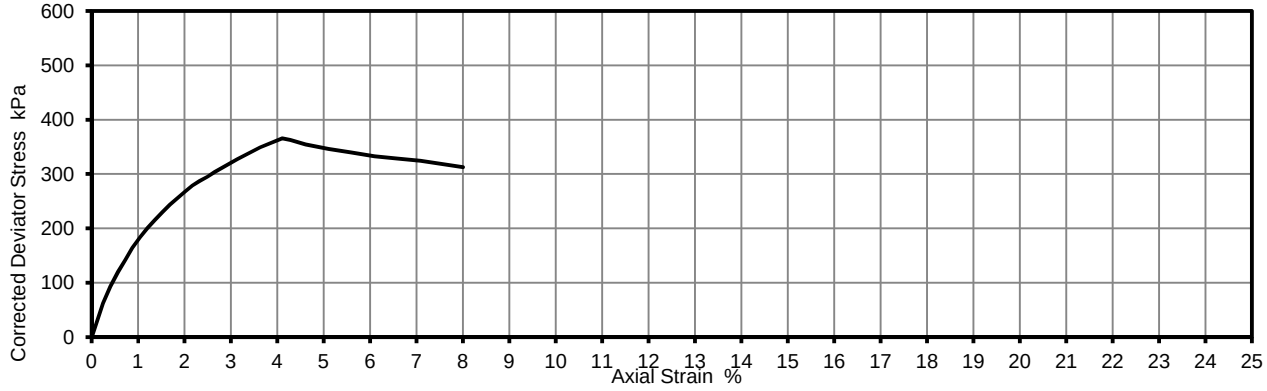
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	29/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Result

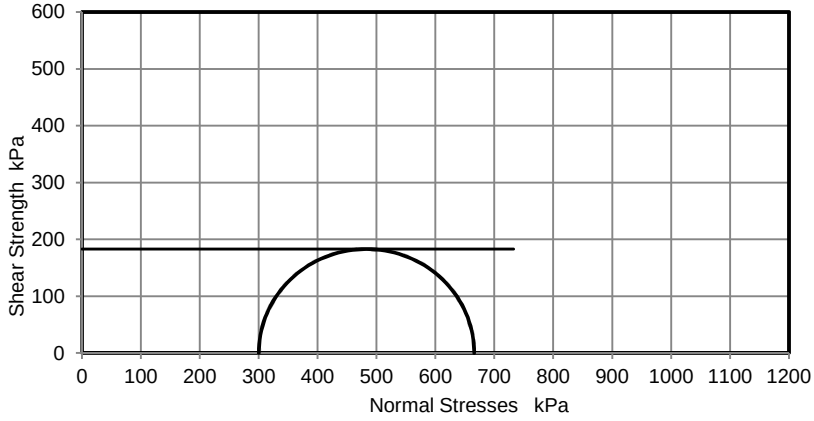
Laboratory Reference:	1037180	Depth Top [m]:	15.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Sample Description:	Dark brown slightly gravelly CLAY		

Test Number	1		Rate of Strain	1.97	%/min	
Length	203.16	mm	Cell Pressure	300	kPa	
Diameter	103.80	mm	Axial Strain at failure	4.1	%	
Bulk Density	1.96	Mg/m3	Deviator Stress, (σ1 - σ3)f	366	kPa	
Moisture Content	25	%	Undrained Shear Strength, cu	183	kPa	½(σ1 - σ3)f
Dry Density	1.56	Mg/m3	Mode of Failure	Brittle		
Membrane Correction	0.37	kPa	Membrane thickness	0.34	mm	

Deviator Stress v Axial Strain



Mohr Circles



Position within sample

Notes:

Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Unconsolidated Undrained Triaxial Compression

Tested in Accordance with BS1377: Part 7: 1990, clause 8, single specimen

UKAS TESTING 4041

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

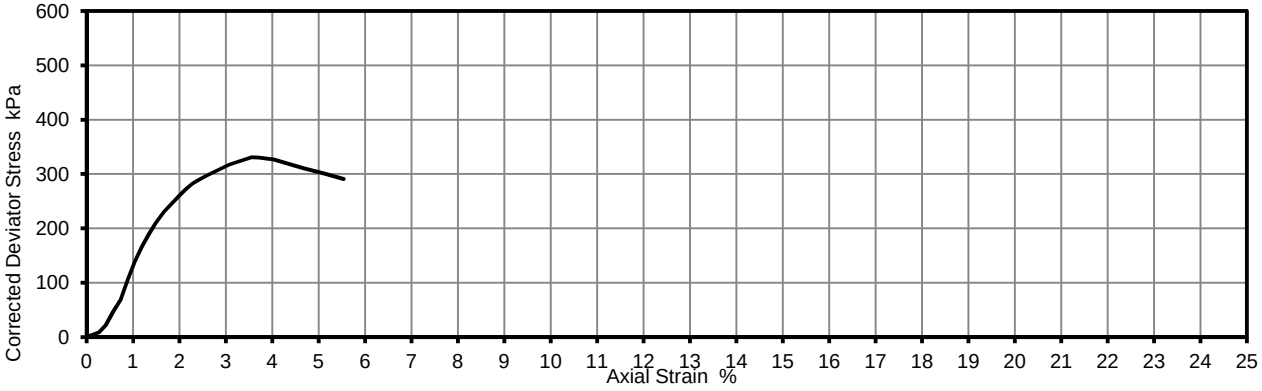
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	30/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Result

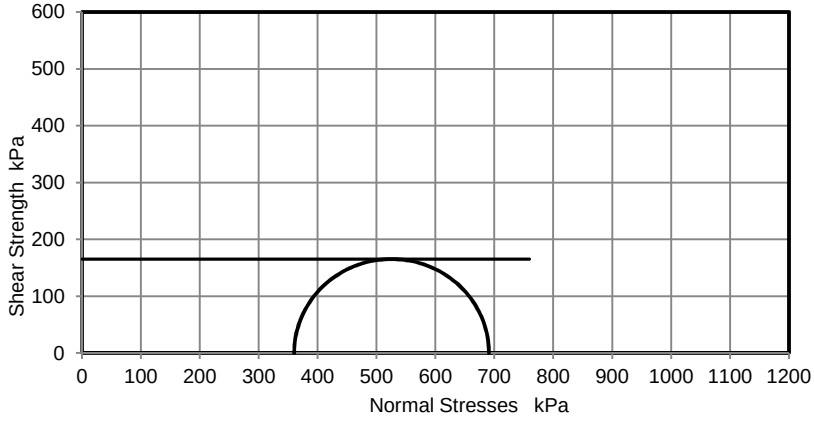
Laboratory Reference:	1037181	Depth Top [m]:	18.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Sample Description:	Dark brown CLAY		

Test Number	1		Rate of Strain	1.91	%/min	
Length	208.92	mm	Cell Pressure	360	kPa	
Diameter	103.02	mm	Axial Strain at failure	3.5	%	
Bulk Density	2.00	Mg/m3	Deviator Stress, (σ1 - σ3)f	331	kPa	
Moisture Content	24	%	Undrained Shear Strength, cu	165	kPa	½(σ1 - σ3)f
Dry Density	1.61	Mg/m3	Mode of Failure	Brittle		
Membrane Correction	0.30	kPa	Membrane thickness	0.32	mm	

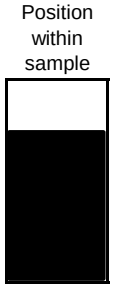
Deviator Stress v Axial Strain



Mohr Circles



Position within sample



Notes:

Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 17/09/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Unconsolidated Undrained Triaxial Compression

Tested in Accordance with BS1377: Part 7: 1990, clause 8, single specimen

UKAS TESTING 4041

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

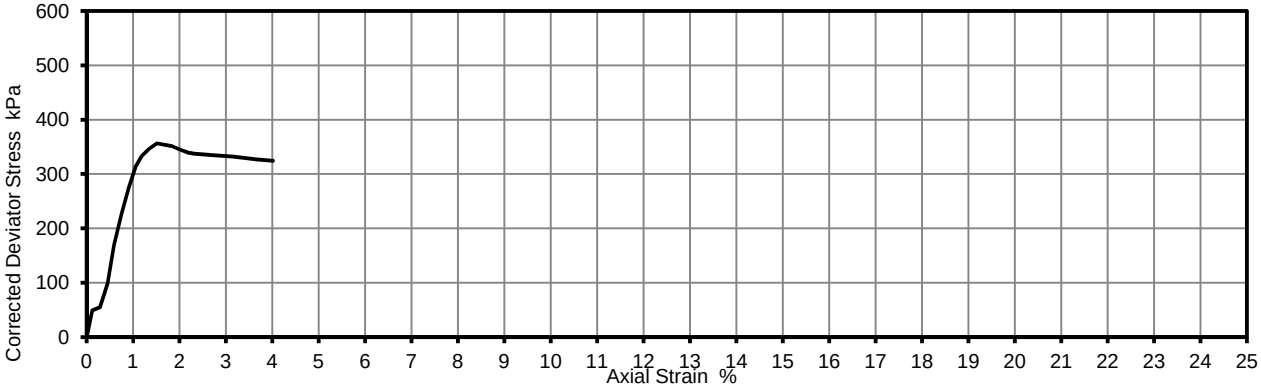
Client:	Card Geotechnics Ltd	Client Reference:	CG-28583
Client Address:	4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW	Job Number:	18-98735
		Date Sampled:	30/08/2018
		Date Received:	29/08/2018
Contact:	James Morrice	Date Tested:	11/09/2018
Site Name:	Stephenson Way	Sampled By:	driller
Site Address:	Not Given		

Test Result

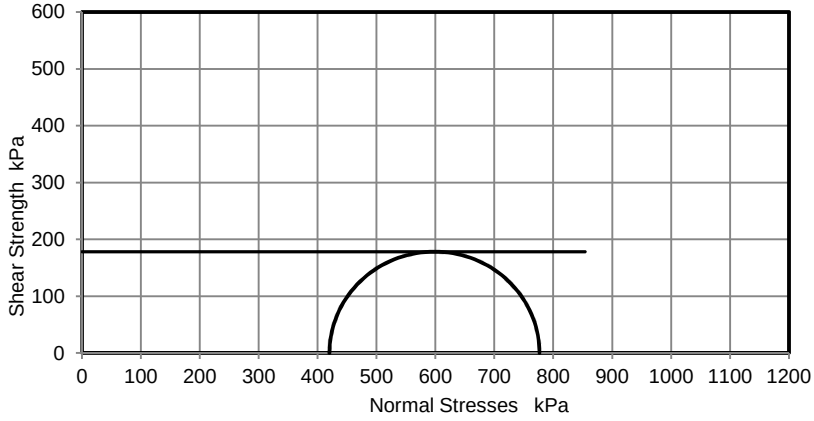
Laboratory Reference:	1037182	Depth Top [m]:	21.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	U
Sample Description:	Red mottled grey slightly sandy CLAY		

Test Number	1		Rate of Strain	2.00	%/min	
Length	131.79	mm	Cell Pressure	420	kPa	
Diameter	69.93	mm	Axial Strain at failure	1.5	%	
Bulk Density	2.12	Mg/m3	Deviator Stress, (σ1 - σ3)f	357	kPa	
Moisture Content	21	%	Undrained Shear Strength, cu	178	kPa	½(σ1 - σ3)f
Dry Density	1.75	Mg/m3	Mode of Failure	Brittle		
Membrane Correction	0.19	kPa	Membrane thickness	0.33	mm	

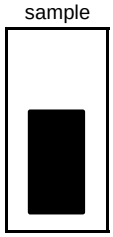
Deviator Stress v Axial Strain



Mohr Circles



Position within sample



Notes:

Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General Manager

Date Reported: 17/09/2018

for and on behalf of i2 Analytical Ltd

James Morrice
Card Geotechnics Ltd
4 Godalming Business Centre
Woolsack Way
Godalming
Surrey
GU7 1XW

t: 01483 310600
f: 01483 527285
e:

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7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 18-98742

Project / Site name:	Stephenson Way	**Samples received on:**	29/08/2018
Your job number:	CG-28583	**Samples instructed on:**	03/09/2018
Your order number:	POP001291	**Analysis completed by:**	14/09/2018
Report Issue Number:	1	**Report issued on:**	14/09/2018
Samples Analysed:	9 soil samples		

Signed:

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical Report Number: 18-98742

Project / Site name: Stephenson Way
Your Order No: POP001291

Lab Sample Number				1037200	1037201	1037202	1037203	1037204
Sample Reference				BH1	BH1	BH1	BH1	BH1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.30	2.00	4.00	6.00	9.00
Date Sampled				29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	5.0	9.7	18	17	22
Total mass of sample received	kg	0.001	NONE	0.42	0.47	0.38	0.40	0.38
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.9	10.8	8.5	8.3	8.6
Total Sulphate as SO_4	mg/kg	50	MCERTS	-	-	900	620	870
Water Soluble Sulphate (Soil Equivalent)	g/kg	0.0025	MCERTS	0.062	0.43	-	-	-
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	62	430	-	-	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.031	0.21	0.38	0.31	0.36
Total Sulphur	mg/kg	50	MCERTS	-	-	2900	2400	3600

Analytical Report Number: 18-98742

Project / Site name: Stephenson Way
Your Order No: POP001291

Lab Sample Number				1037205	1037206	1037207	1037208	
Sample Reference				BH1	BH1	BH1	BH1	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				12.00	15.00	18.00	21.00	
Date Sampled				29/08/2018	29/08/2018	30/08/2018	30/08/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	20	15	15	14	
Total mass of sample received	kg	0.001	NONE	0.39	0.37	0.39	0.33	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.5	8.4	8.4	9.3	
Total Sulphate as SO_4	mg/kg	50	MCERTS	820	1200	1700	190	
Water Soluble Sulphate (Soil Equivalent)	g/kg	0.0025	MCERTS	-	-	-	-	
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	-	-	-	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.30	0.53	0.81	0.020	
Total Sulphur	mg/kg	50	MCERTS	3000	6600	9900	140	

Analytical Report Number : 18-98742

Project / Site name: Stephenson Way

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1037200	BH1	None Supplied	0.30	Brown loam and clay with gravel and vegetation.
1037201	BH1	None Supplied	2.00	Light brown sandy clay with gravel.
1037202	BH1	None Supplied	4.00	Brown clay.
1037203	BH1	None Supplied	6.00	Brown clay.
1037204	BH1	None Supplied	9.00	Brown clay.
1037205	BH1	None Supplied	12.00	Brown clay.
1037206	BH1	None Supplied	15.00	Brown clay.
1037207	BH1	None Supplied	18.00	Grey clay.
1037208	BH1	None Supplied	21.00	Grey clay.

Analytical Report Number : 18-98742

Project / Site name: Stephenson Way

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.