COPPER BEECH HOUSE
5b PRINCE ARTHUR ROAD
LONDON
NW3 6AX

BASEMENT IMPACT ASSESSMENT

Report Ref	Revision	Notes	Issued by	Date
9634_SL_GB_BIA	1.0	Issued for Planning	GB	29th May 2020

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APPENDICES

EXECUTIVE SUMMARY

The Basement Impact Assessment (BIA) is prepared in accordance with London Borough of Camden's Local Plan 2017, Camden Local Planning Policy A5 Basements, Camden Planning Guidance Basements March 2018, London Borough of Camden SFRA URS July 2014 and London Borough of Camden, Camden Geological, Hydrogeological and Hydrological Study.

The Basement Impact Assessment is separated into six sections covering 1.0 Introduction, 2.0 Structural Appraisal, 3.0 Hydrogeological Review, 4.0 Drainage and Surface Water Flow Appraisal 5.0 Flood Risk Assessment and 6.0 Conclusions.

The Introduction provides the screening aspect with Figures 1, 2 and 3 noting Yes or No if the basement is likely to have any effect on the surrounding area and referenced to each of the relevant sections 2.0, 3.0, 4.0 and 5.0, within which are provided the scoping and details of potential impact and any mitigation measures with Recommendations and Conclusions within section 6.0.

A topographic survey is available and Taylor Whalley Spyra have also undertaken works on similar sites in the area. The trial hole and soil investigation and ground water monitoring from site were reviewed against the site requirements along with local BGS borehole records. These provide the necessary site specific data to undertake the Basement Impact Assessment and to allow for the detailed design to be undertaken following Planning Approval.

The type of construction for the basement and building over in the temporary and permanent stages has been reviewed with an outline methodology included to demonstrate feasibility.

Existing site material is being recycled and utilised within the new construction with demolition material to be used as hard-core and bricks salvaged for re-use to assist in the construction process. Existing top soil will be retained and reused.

The BIA concludes that the proposed basement construction and redevelopment works may be carried out safely and without adverse effect on the adjacent structures, local hydrogeology, and surface water flow or increase local flooding risk. The risks noted within the BIA, even though they are only slight, can be further mitigated by diligent detailed design and implementation to include the installation of additional surface water drainage, careful detailed installation of temporary works, a suitable on site monitoring procedure and use of experienced contractors and an experienced design consultant team.

1.0 INTRODUCTION

1.1 This Basement Impact Assessment has been prepared by Taylor Whalley Spyra as requested by Charlton Brown Architects as part of the Planning Application for the proposed redevelopment of 5b Prince Arthur Road.

1.2 The information contained within this Basement Impact Assessment (BIA) is prepared in accordance with London Borough of Camden's Local Plan 2017, Camden Local Planning Policy A5 Basements, Camden Planning Guidance Basements March 2018, London Borough of Camden SFRA URS July 2014 and London Borough of Camden, Camden Geological, Hydrogeological and Hydrological Study.

1.3 The BIA report is authored by Simon Lane who is qualified as BSC(Eng), CEng, FICE, FIStructE. The attached Hydrogeological Assessment is reviewed by J. A. Davis who is qualified as EuroGeol, CGeol, BSC, MSc, DIC, FGS. The Ground Movement Impact Assessment is Reviewed by Dr Apollonia Gasparre who is qualified as Dott. Ing, PhD, DIC, CEng, MICE.

1.4 The purpose of this Basement Impact Assessment document is to review and outline the key points for the safe construction of the proposed redevelopment of 5b Prince Arthur Road.

1.5 It also sets out how the construction of the basement and upper floors, neighbouring buildings and the local environment and amenity will be protected.

1.6 The topics covered within the BIA are Structural Stability and Movement Assessment, Method of Construction, Hydrogeological, Drainage & Surface Water Flow, Flood Risk and Phased Construction forming part of the Temporary Works during basement construction.

1.7 We have visited site on a number of occasions to review feasibility of the proposed works, undertaken trial holes and opening up work to the existing building, a site walk around the surrounding area and undertaken desktop reviews of information by third parties.

1.8 This BIA document is not the final design information but is intended to demonstrate that each of the aspects of the design and construction has been carefully considered. All aspects will be subject to detailed design once Planning Approval is granted.

1.9 The existing property is located on Prince Arthur Road near the corner of Ellerdale Road and consists of a detached property (refer to Appendix A).

1.10 The existing building is approximately 10m x 12m wide consisting of three storeys ground, first and second, with the ground floor level raised above the adjoining buildings of No. 5 and No. 7. The front drive is set back 5m from the main building elevation and the rear garden extends 20m back from the rear building wall (refer to Appendix B).

1.11 The site is 34.2m long and 14.0m wide being rectangular in shape and orientated approximately Northwest to Southeast. The nearest adjoining properties are No. 5 Prince Arthur Road to the Northeast boundary and No. 7 Prince Arthur Road to the Southwest boundary. To the Southeast boundary along the rear garden is Devonshire House Preparatory School and along the Northwest boundary is Prince Arthur Road (refer to Appendix A & B).

1.12 The proposed works will involve the demolition of the existing building and construction of a new detached property with Grd, 1st, 2nd and 3rd floors with a single basement set below ground. The basement will have stepped access at the front, a rear lower stepped terrace to the rear and rear light well. The basement will extend 1.7m at the front of the main building façade and 1.6m at the rear (refer to Appendix C & D).

1.13 The floor level of the proposed basement is approximately 96.395 SSL with the ground floor level approximately 100.200 SSL (refer to Appendix D).

1.14 The existing building is to be demolished and sheet piling is to be installed around the perimeter of the basement, this will be braced at high level and mid-level with temporary waling and adjustable hydraulic propping beams as the ground is excavated to basement formation level. This will form an open construction for the basement, which will form the watertight RC basement structure (refer to Appendix D).

1.15 The new reinforced concrete basement box structure is designed to form the permanent support works for the retaining walls. Once the basement structure is completed the proposed new structure over will then be built supported off the new ground floor slab with down stand beams and internal RC columns/walls.

1.16 The following screening stages in Figures 3, 4, and 5 taken from CPG4 are reviewed to see the effect of the basement works on the surrounding area and the relevant scoping stages are noted in the adjacent contents items referenced to within this BIA report, which then outlines any possible impacts and any mitigation necessary to reduce the impact of the basement on the surrounding area.

1.17

Figure 3 - Subterranean (ground water) flow screening chart

Q 1a: Is the site located directly above an aquifer?	Yes	See Content 3.0, 4.0, 5.0
Q 1b: Will the proposed basement extend beneath the water table surface?	No	See Content 2.0, 3.0, 4.0
Q 2: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	No	See Content 3.0,
Q 3: Is the site within the catchment of the pond chains on Hampstead Heath?	No	See Content 3.0
Q 4: Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	Yes	See Content 3.0, 4.0
Q 5: As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	Yes	See Content 3.0, 4.0
Q6: Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line.	No	See Content 2.0, 3.0, 4.0

Figure 4 - Slope stability screening chart

Q 1: Does the existing site include slopes, natural or manmade, greater than 7° ? (approximately 1 in 8)	No	See Content 2.0, 3.0
Q 2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7° ? (approximately 1 in 8)	No	See Content 2.0, 3.0
Q 3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7° ? (approximately 1 in 8)	No	See Content 2.0, 3.0
Q 4: Is the site within a wider hillside setting in which the general slope is greater than 7° ? (approximately 1 in 8)	No	See Content 2.0, 3.0
Q 5: Is the London Clay the shallowest strata at the site?	No	See Content 2.0, 3.0,
Q 6: Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree zones where trees are to be retained?	No	See Arboriculture Report
Q 7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	No	See Content 2.0
Q 8: Is the site within 100m of a watercourse or a potential spring line?	No	See Content 3.0, 4.0
Q 9: Is the site within an area of previously worked ground?	No	See Content 2.0, 3.0
Q 10: Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No	See Content 3.0, 4.0
Q 11: Is the site within 50m of the Hampstead Heath ponds?	No	See Content 3.0
Q12: Is the site within 5m of a highway or pedestrian right of way?	Yes	See Content 2.0
Q 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	See Content 2.0
Q 14: Is the site over (or with the exclusion zone of) any tunnels e.g. railway lines?	No	See Content 2.0

Figure 5 - Surface flow and flooding screening chart

Q 1: Is the site within the catchment of the pond chain on Hampstead Heath?	No	See Content 3.0, 5.0
Q 2: As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No	See Content 4.0
Q 3: Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes	See Content 3.0, 4.0
Q 4: Will the proposed basement result in changes to the profile of the inflows	No	See Content 2.0, 3.0, 4.0,

(instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?		5.0
Q 5: Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	See Content 3.0, 4.0, 5.0
Q 6: Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy of the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	No	See Content 3.0, 4.0, 5.0

1.18 The Client will appoint a Project Manager to oversee the nominated building contractor and will liaise with London Borough of Camden and local residents to ensure the impact of the proposals are fully understood and mitigated as far as possible.

1.19 Safety both on site and adjacent to the site is of paramount importance and the method of construction proposed has taken this into account.

1.20 Taylor Whalley Spyra are retained as consulting civil and structural engineers for the project. The company was formed in 1955 and is a private company wholly owned by the directors. Our expertise covers all building types and we have particular experience of working in Central London locations where sites have tight urban constraints.

2.0 STRUCTURAL APPRAISAL

2.1 A review of how best to construct the basement was undertaken and it was concluded that the most efficient form of construction would be an open excavation construction with sheet piling, suitably propped along no.5 by installing high level propping braced back to the front and rear s sheet piling walls and along no.7mid-level propping. This is then followed by the construction of a rigid reinforced concrete basement box with additional temporary propping as works progress.

2.2 In order to control ground movement proposed high level propping is at -0.5m (ground floor slab) and mid-level propping at -2.0m below the top of the ground floor slab. At -3.8m level is the 450mm thick RC basement slab. After this has reached the required design strength and perimeter walls constructed then the -0.5m and -2.0m props are removed. The internal columns/walls and RC walls are cast below the underside of the high and mid-level propping. Once these have gained the required design strength then additional diagonal propping is installed against the slab and new RC wall and propping can be removed and the ground floor slab and perimeter wall down stands cast. The diagonal bracing can be removed once the ground floor slab has gained the required design strength (refer to Appendix D).

2.3 To the Northeast Boundary, No. 5 Prince Arthur Road is a detached property of solid masonry construction with timber floors and timber pitched roof. It consists of a lower ground floor and upper ground with 1st and 2nd floors. The main wall of No. 5 is set back 4.2m from the site boundary and the lower ground floor is set approximately 500mm below that of No. 5b. with a single story garage between. The main house is set 5.1m away from the proposed basement. Section 2_2 on drawing 9634_BIA_05 shows the permanent and temporary works (refer to Appendix D & E).

2.4 To the Southwest Boundary, No. 7 Prince Arthur Road is a semi-detached property constructed of brick and block cavity construction built in the late 1980's. It consists of Grd, 1st, 2nd and 3rd floors with two garages set beneath the building at Grd floor. The main wall of No. 7 is set back 1.3m from the boundary wall and the ground floor of no. 7 set 2.0m below that of no. 5b with a retaining wall between. The main house is set 1.9m away from the proposed basement. Section 2_2 on drawing 9634_BIA_05 shows the permanent and temporary works (refer to Appendix D & E).

2.5 To the Southeast Boundary, Devonshire House Preparatory School with the nearest building set 3m from the rear garden site boundary with the rear boundary approximately 13.5m away from the proposed basement (refer to Appendix D & E).

2.6 To the North West Boundary, Prince Arthur Road is set 3.6m away from the proposed basement. Section 1_1 on drawing 9634_BIA_04 shows the permanent and temporary works (refer to Appendix D & E).

2.7 The nearest TfL or Network Rail tunnels are the Northern line approximately 260m away to the Northeast and Overground line approximately 210m away to the South of the site and will not be affected by the works as shown on TWS drawing 9634_BIA_06 (refer to Appendix F).

2.8 The Utilities in the public pavement along Prince Arthur Road will not be affected by the works as they are set back from the basement 3.6m and are outside the zone of influence of the proposed works. The only utilities on site are those that serve the existing building and these will be dealt with as part of the works, maintained as necessary as part of the contractor site setup, temporarily capped and or diverting as required.

2.9 All properties that are adjacent to the proposed development will fall within The Party Wall Act 1996 which will require building condition surveys to be undertaken.

2.10 The design of the basement and temporary support works is to be undertaken to minimise any structural disturbance to the adjoining properties or infrastructure. The nearest buildings adjacent to the proposed basement are Nos 5 and 7 Prince Arthur Road. The design of the sheet piling and basement RC box structure will incorporate an allowance for a surcharge loading to take into account the location and loads from the adjacent building foundations. An allowance will also be included to allow for any future surcharging of the adjacent ground along the site boundary next to the new basement. The sheet piling will be designed by a specialist contractor and will be installed using a suitable piling rig to minimise noise, vibration and any structural disturbance to the adjoining properties, existing building or infrastructure as shown on TWS drawing 9634_BIA_04 & 05 (refer to Appendix D & E).

2.11 As part of the design and to control ground movement, a scheme will be agreed as part of the Party Wall Agreements to install a movement monitoring system to monitor movement during the course of the basement works. This will involve the location of monitoring nodes to be located along the surrounding ground, on the retained garden walls and also on adjacent property walls, where allowed, as part of the Party Wall Agreements. Readings will be taken at regular intervals and additional readings undertaken when specific works are planned as shown on TWS drawing 9634_BIA_07 (refer to Appendix G).

2.12 An analysis of the basement retaining walls and required temporary works scheme has been undertaken using Wallap Version 6.5 for this stage of the planning application.

2.13 The initial analysis of the wall design has confirmed that the movement can be limited to the adjoining properties as Very Slight, as categorised by Damage Category Chart (CIRCA C580). The initial design undertaken confirms that the category of movement indicated above can be achieved for the basement and with further detailed design improved upon.

2.14 The estimated movements inside and outside the proposed basement are considered on basis of structural loads, preliminary calculations, soil investigation design parameter, site levels and are considered to be minimal.

2.15 All the proposed works are within the normal type of construction that any competent contractor can undertake. From our experience of similar works undertaken in the area movement can be limited to the existing building and adjoining properties as Very Slight, as categorised by Category of Damage Table (CIRIA C760) Table 1.1 below.

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain, ε_{lim} (%)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0 to 0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05 to 0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	<5	0.075 to 0.15
3 Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5 to 15 or a number of cracks >3	0.15 to 0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted.	15 to 25, but also depends on number of cracks	>0.3
5 Very severe	This requires a major repair, involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	Usually >25, but depends on numbers of cracks	

Table 1.1

2.16 The process for installing sheet piling, temporary works and RC box is as shown below and as shown on TWS drawings 9634_BIA_04 & BIA_05 (refer to Appendix D & E).

2.17 **PROPOSED SEQUENCE OF WORKS**

- Install within the site area around the basement zone and surrounding area a number of fixed monitoring nodes to monitor possible movement during the works.
- The existing house is to be demolished and all foundations and drainage runs are to be grubbed out.
- The existing top soil on site situated around the proposed basement area is it to be scraped off and stored on site for re-use at a later stage.
- The sheet piling is to be installed with a Silent Piler similar to a Giken Rig which presses the sheet piles into the ground using the resistance of the adjoining installed sheet piles.
- The ground is to be locally excavated by 0.6m to allow installation of the high level steel waling beams, adjustable hydraulic corner props along No. 5 boundary.
- The ground is then to be locally excavated to 2m to allow installation of the mid-level steel waling beams, adjustable hydraulic corner props and raker prop along No. 7-9 boundary.
- The ground is then to be locally excavated to allow installation of the steel waling beams and adjustable hydraulic props at low level.
- The ground is then to be excavated to formation level.
- The drainage pipes and granular drainage channels are to be installed.
- The basement RC slab build-up is to be installed and then the basement slab cast with 150mm high kickers for all the RC basement walls and internal columns.

- Install and cast all internal RC walls and columns to underside of ground floor slab.
- Once the RC basement slab has gained the required design strength the basement RC walls are then to be cast to 400mm below the underside of the high and mid-level waling beams.
- Once the basement RC walls have gained the required design strength, install temporary diagonal adjustable restraint props fixed to the RC wall & RC basement slab and then remove the high and mid-level sheet piling waling beams and props.
- The RC ground floor slab and RC wall down stands can then be cast.
- Once the RC ground floor slab has gained the required design strength the additional diagonal restraint props can be removed.
- During the construction period the sheet piling and surrounding ground will be monitored at regular intervals to confirm the construction tolerance stays within the agreed design parameters.
- The new structure over can now be constructed and will be supported on the new ground floor slab.
- Continue with construction of remainder of the structure over using traditional load bearing brick/blockwork, timber floors and steel framed with timber infill rafters.
- Install external works and reinstate top soil to landscaped areas.

2.18 During detailed design a review of uplift will be undertaken and if necessary tension piles will be designed into the basement slab.

2.19 A soil investigation has been undertaken by Risk Management ref RML 7044 dated August 2019, comprising two boreholes 11m and 4.5m deep and two trial holes. These confirm the ground conditions to be topsoil/made ground between 400 to 1100mm deep over 1-2m of fine to coarse gravel with clayey sand over silty sand clay confirmed to 11m (refer to Appendix J).

2.20 Ground water was initially encountered only within BH1 at 9.5m during installation. During subsequent return visits in July, August and September BH1 7.58m, 7.61m & 7.62m and BH2 dry, 3.23m and 3.31m (refer to Appendix J).

2.21 This indicates that there is some water seepage from the Claygate Beds in the boreholes. The rate of seepage is slow which confirms that any ground water flow on site is considered to be low and will not affect the proposed basement or adjoining properties (refer to Appendix H).

2.22 The soil investigation and ground water monitoring undertaken to date confirm that the main basement area will be above the ground water level and that localised site de-watering may be required as noted in BH02, which will be designed to the specific site requirements with regard to ground water levels and flow rates. Any water pumps will incorporate sediment filters so as not to remove any fines at the point of abstraction. This will not have an effect on the adjoining properties.

2.23 An Arboricultural review by

2.24 TRE-TEC Tree Survey and Arboricultural Method Statement dated May 2020 states that part of the proposed basement is within the outer influence of the existing tree at the rear of the garden and confirms this is part of the fibrous roots area of the Beech, but will not be harmed by the works due to improved permeability at the rear of the garden. Tree protection works are to be undertaken before works start on site and whilst working adjacent to the trees with an Arboriculturalist in attendance (refer to Appendix M).

2.25 A review of Land Stability with reference to The London Borough of Camden Geological, Hydrogeological and Hydrological Study Maps with site location indicated and local topography show the site surrounding area is 4 degrees and not in a slope angle area greater than 7 degrees (refer to Appendix L).

2.26 The Ground Movement Impact Assessment undertaken by Geotechnical Consulting Group dated June 2020 confirms that the works can be undertaken with minimal disturbance to the surrounding area and that anticipated movement is within the design parameters (refer to Appendix H).

3.0 HYDROGEOLOGICAL REVIEW

3.1 The surrounding area site levels along Prince Arthur Road from Fitzjohn's Avenue to Ellerdale Road are in the order of 106.200 to 96.700 OD with an approx. 5 degree slope, the ground levels along Ellerdale Road 96.700 to 94.100 OD with an approx. slope of 1 degree. This confirms the overall surrounding area around the site is in the region of 5 degs and a 1 deg fall across the length of the site (refer to Appendix A & L).

3.2 The geology of the area is well known as summarised on the relevant geological sheets, being London Bagshot Beds, close to the out cropping Claygate beds and confirmed by the site investigation boreholes and trial holes (refer to Appendix H, J & L).

3.3 The current policy implemented by the Environment Agency is to maintain water levels in the lower underlying chalk aquifer to those which currently exist, i.e. approximately -10m OD.

3.4 The site is located within a Secondary A Aquifer (refer to Appendix H & L).

3.5 It is noted that approximately 170m away to the west boundary is a tributary of the old Westbourne River and about 220m Southeast is the old River Tyburn, both Rivers have been culverted and are too far away to be affected by the proposed works (refer to Appendix L).

3.6 Risk Management Ltd confirm ground water was initially encountered only within BH1 at 9.5m during installation. During subsequent return visits in July, August and September BH1 7.58m, 7.61m & 7.62m and BH2 dry, 3.23m and 3.31m (refer to Appendix J).

3.7 This indicates that there is some water seepage from the Claygate Beds in the boreholes. The rate of seepage is slow which confirms that any ground water flow on site is considered to be low and will not affect the proposed basement or adjoining properties.

3.8 By virtue of the basement structure design, which will not restrict ground water flow and will allow ground water to flow around and below, we confirm that the proposed development will not lead to an increase in flood potential or impediment of ground water flow.

3.9 The Hydrogeological Assessment undertaken by Geotechnical Consulting Group dated June 2020 confirms that the proposed works are not expected to have any adverse effects on the local hydrogeology (refer to Appendix H).

3.10 The London Borough of Camden Geological, Hydrogeological and Hydrological Study Maps and the Camden SFRA Maps have been reviewed with site location indicated (refer to Appendix L).

4.0 DRAINAGE AND SURFACE WATER FLOW APPRAISAL

4.1 The existing site area is 480m² consisting of 273² of non-permeable hard standing and 207m² of permeable soft standing (refer to Appendix I).

4.2 The proposed site area is 480m² consisting of 267² of non-permeable hard standing with 18m of brown roof build up and 213m² of permeable soft standing (refer to Appendix I).

4.3 The 6m² of additional soft standing at the rear garden will be offset by the 18m of brown roof which will naturally evaporate and which currently drains into the site drainage system that discharges into the public sewer in Prince Arthur Road.

4.4 The profile of surface water inflow to adjacent properties or water courses will not be materially changed. The additional 6m² of soft standing and 18 m² of brown roof will reduce the surface water discharge into the main drainage system.

4.5 The existing site drainage is a combined FW/SW system that runs from the side of the site to the front of the building and discharges into the public sewer system in Prince Arthur Road.

4.6 The new basement will require new foul and surface water drainage pipework below ground which will collect at a pumping chamber for initial storage and then discharge pumped to high level to the existing gravity fed system manhole at the front of the site. All drainage above ground floor will be gravity fed to the existing manhole at the front of site. The pumping chamber will be twin pumped with alarm system and battery backup in the event of pump failure.

5.0 FLOOD RISK ASSESSMENT

5.1 Reference to the Environment Agency maps confirms that the site is not within a flood zone area and is not at risk of flooding from local rivers/water features and defines the area as having a very low risk of flooding due principally to its geology and topography.

5.2 Thames Water have been consulted and confirm that there are no known incidents of historic flooding within the vicinity of the site from surcharging of the public drain system (refer to Appendix K).

5.3 Review of the GOV.UK maps for surface water flooding indicate no flooding along Prince Arthur Road (refer to Appendix K).

5.4 Review of London Borough of Camden's SFRA confirms the site is within Group 3_010 critical drainage area and not within any Local Flood Risk Zone. There is no increase in surface water or foul water drainage from the site, but a reduction in surface water discharge from site due to reduction in existing hard standing, which will reduce surface water discharge to the existing public sewer system from site (refer to Appendix L).

5.5 The 6m² of additional soft standing at the rear garden will be offset by the 18m of brown roof which will naturally evaporate .The effect of this is to reduce volume of site run off discharging into the main drainage system and reduce the effects of any possible flooding further downstream (refer to Appendix I).

6.0 CONCLUSIONS

6.1 Analysis of the various aspects of construction has been undertaken to demonstrate how the level of sequencing will enable the development to be constructed safely with ground movements within acceptable levels.

6.2 The stability of the adjacent properties and surrounding ground will not be affected by the proposed basement with the influence of adjoining building foundation depths taken into account during the initial design process as indicated on TWS drawings 9634_BIA_04 & BIA_05 (refer to Appendix D, E & H).

6.3 Prior to commencement a full schedule of condition will be carried out to all relevant buildings as defined within The Party Wall Act 1996 where the excavations may be within the influence zone of existing foundations and proposed movement monitoring of site and the surrounding area agreed (refer to Appendix G).

6.4 The soil investigation works and ground water monitoring carried out to date indicates that the construction of the proposed basement will not lead to a cut off of natural ground water flow.

6.5 Geotechnical Consulting Group (GCG) have reviewed the information within the Basement Impact Assessment and provided Ground Movement Impact Assessment (GMA) confirming that damage to adjoining neighbours as being Category 1 (Very Slight) and a Hydrogeological Impact Assessment confirming the proposed works are not expected to have any adverse effects on the local hydrogeology (refer to Appendix H).

6.6 There will not be any increase in foul water flow from the site.

6.7 There is a reduction in hard standing areas as shown on TWS drawing 9634_BIA_08 (refer to Appendix I) this will reduce surface water flow into the existing drainage system for the surrounding area and reduce flooding further downstream.

6.8 Safety both on site and adjacent to the site is of paramount importance and the method of construction proposed has taken this into account (refer to Appendix D & N).

6.9 The selection of the main contractor, sub-contractor and designer of temporary works will be based on having previous experience constructing similar projects and a requirement to provide programmes and method statements detailing the final sequence of construction prior to carrying out works on site. The main contractor is to be registered with The Considerate Constructors Scheme.

6.10 One of the site requirements will be the selection of experienced site supervision staff and selection of plant and machinery based on minimising noise and vibration.

6.11 The project as currently envisaged is feasible in terms of the general construction process, structural stability, long term integrity of adjacent buildings and the existing site and surrounding infrastructure.

For and on behalf of
TAYLOR WHALLEY SPYRA

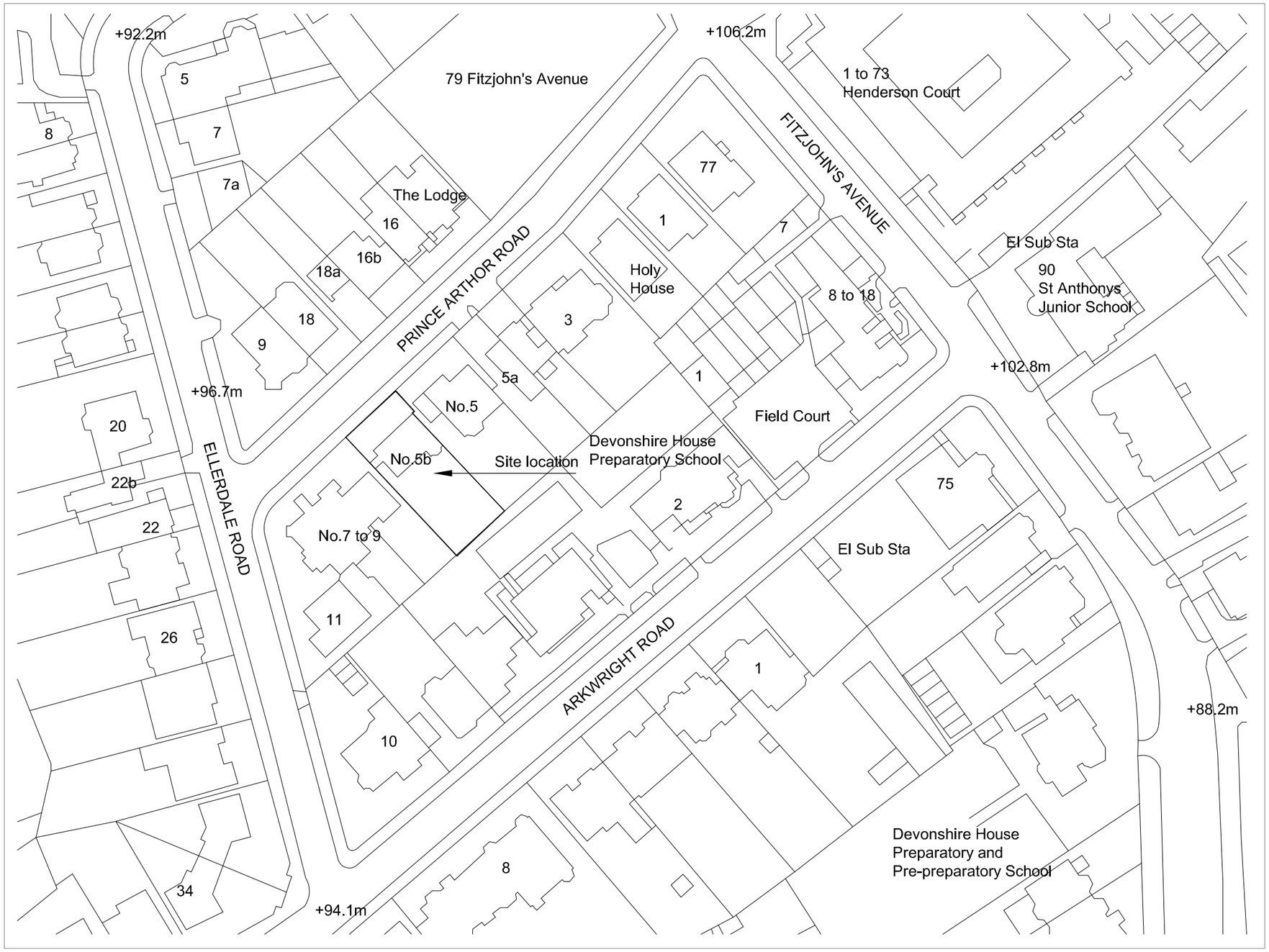
GRAHAM BOSTON

For and on behalf of
TAYLOR WHALLEY SPYRA

SIMON LANE
BSc(Eng), CEng, FICE, FIStruct

Appendix A

TWS - 9634_BIA_01 - Site location plan and surrounding area.



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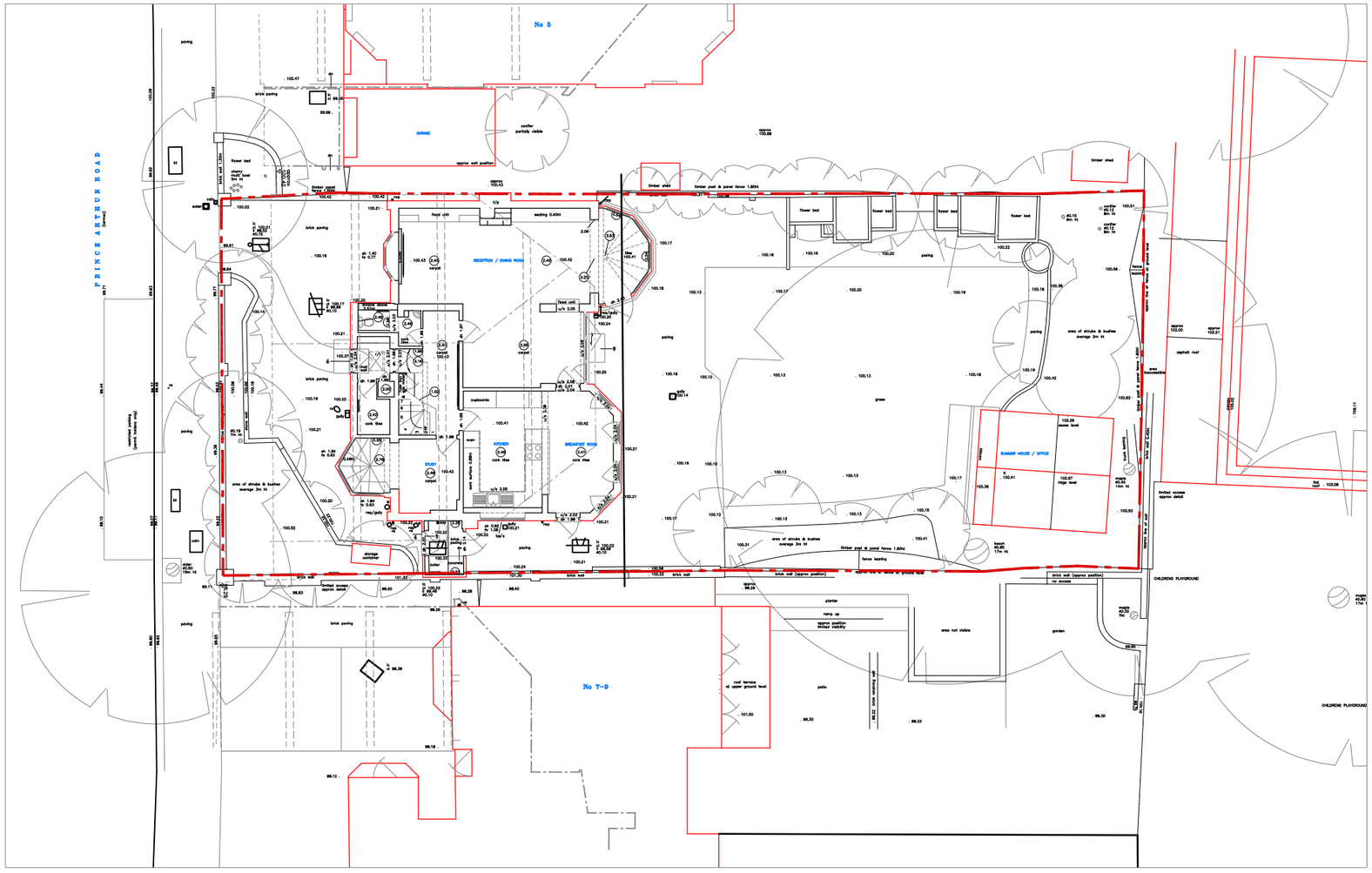
Contract	Title	Scale at A3	Date	Drawn By
COPPER BEECH HOUSE, 5b PRINCE ARTHUR ROAD, HAMPSTEAD, LONDON, NW3 6AX	SITE LOCATION PLAN AND SURROUNDING AREA	NTS	07/01/20	GB
		Job No. 9634	Drawing No. BIA_01	Rev. -

Appendix B

TWS - 9634_BIA_02 – Existing building topographical survey

1. This Drawing to be read in conjunction with all other Engineers, Architects and Specialists drawings and specifications.
2. No dimensions are to be scaled from this drawing.
3. No deviation may be made from the details shown on this drawing without prior agreement of the Engineers.
4. Any discrepancy between this drawing and any other document should be referred immediately to the Engineer.



Ref.	Revisions	By	Date
.	.	.	.

COPPER BEECH HOUSE,
5b PRINCE ARTHUR ROAD,
HAMPSTEAD,
LONDON,
NW3 6AX

EXISTING
TOPOGRAPHICAL SURVEY

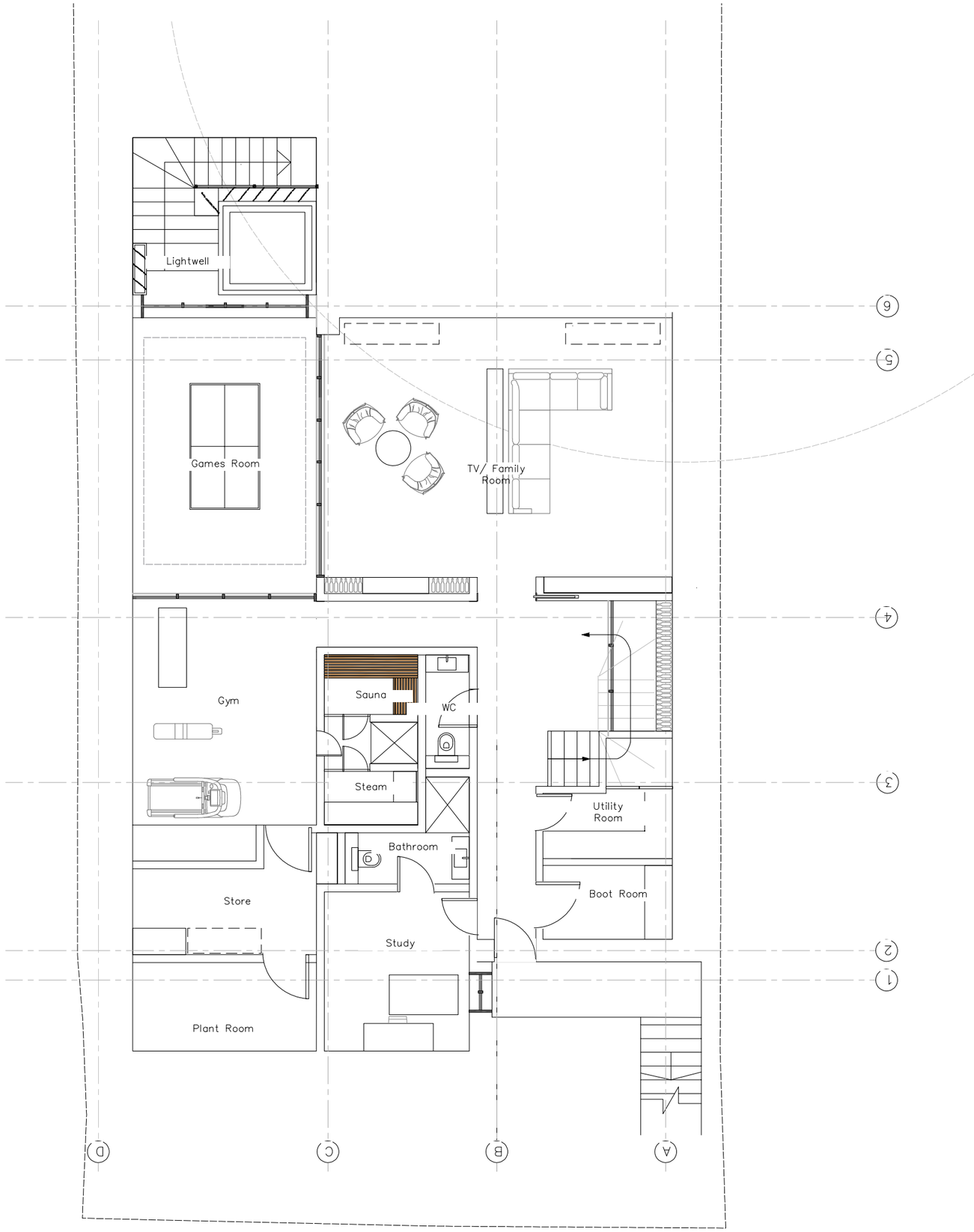
simpson | tws
3 Dufferin Avenue
London EC1Y 8PQ
T.0207 253 2626
www.slmpsoneng.com

Scale at A1	Date	Drawn By	
1:100, 1:40	07/01/20	GB	

Project No.	Drg No.	Rev.
9634	BIA_02	-

Appendix C

Architects drawings floor plans and sections.



Rev	Date	Details	By

Bitmap3670837896.png

The Belvedere, 2 Back Lane, Hampstead, London, NW3 1HL
Telephone +44(0)20 7794 1234
Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rd

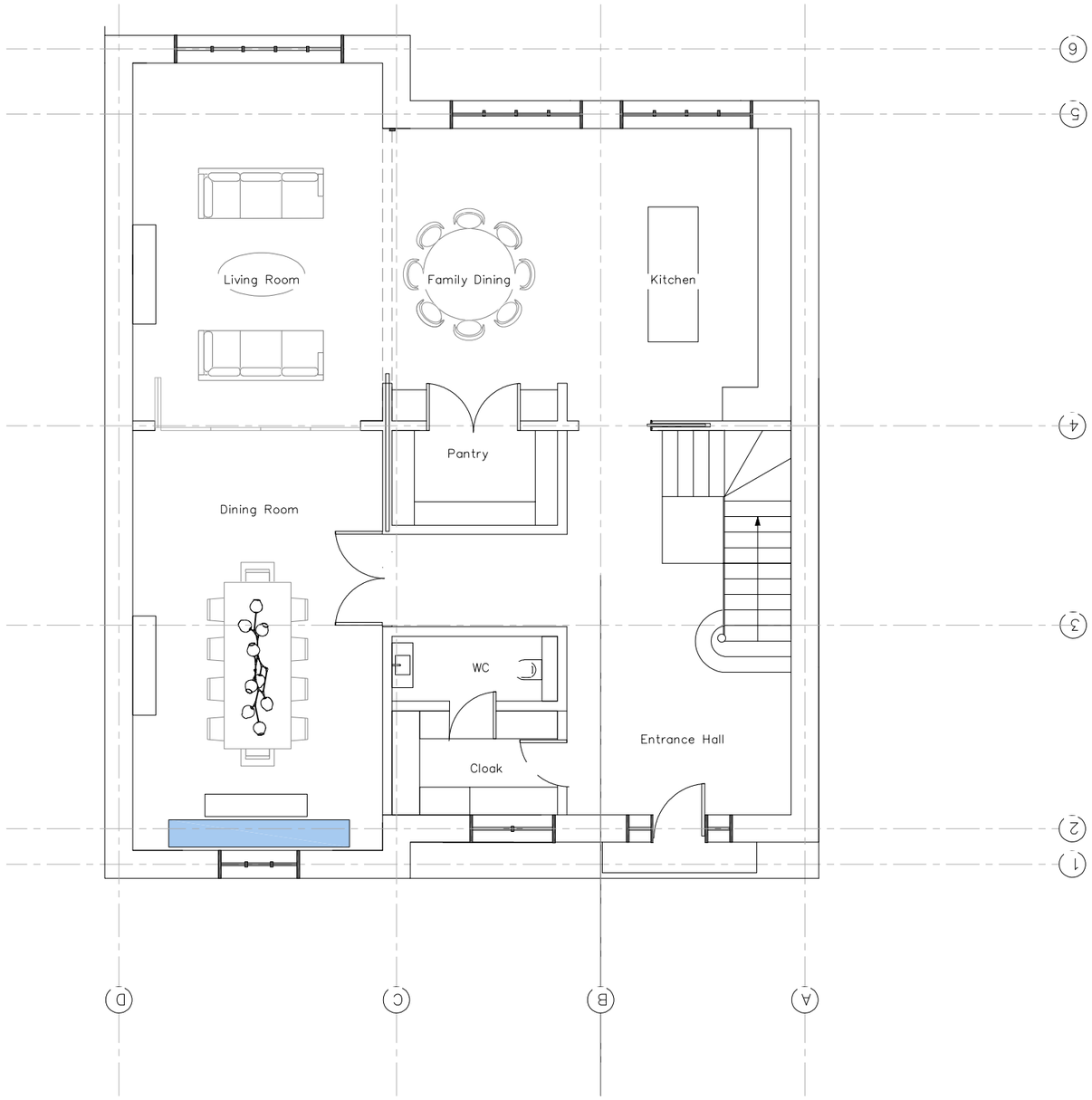
Drawing Title
Proposed Basement Plan

Date	Drawn	Checked
02/02/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Numbe	Drawing Number	Revision
1008	1008	AP



Rev	Date	Details	By

Bitmap3670837894-1.png

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Telephone +44(0)20 7794 1234
Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rc

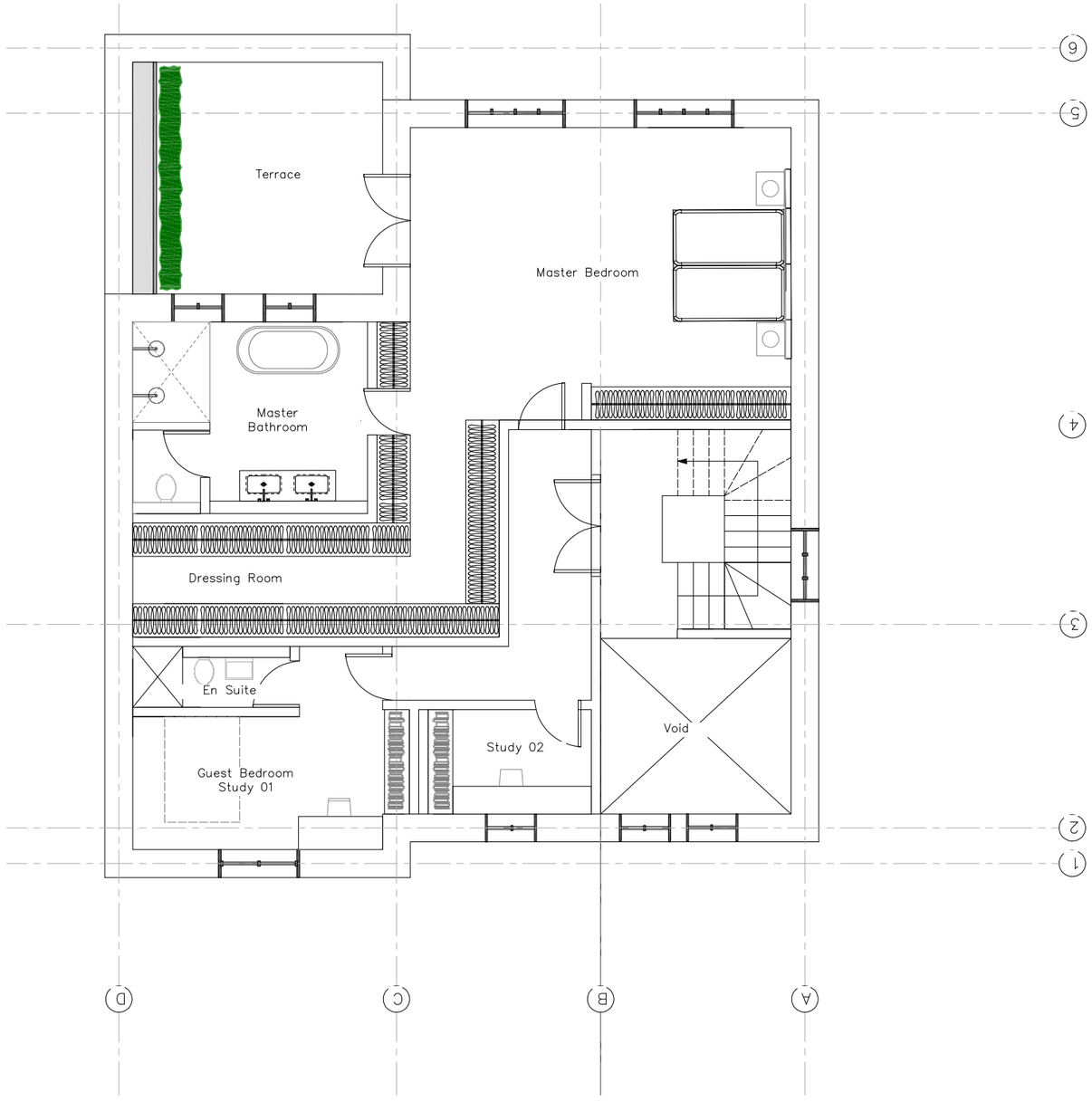
Drawing Title
Proposed Ground. Floor Plan

Date	Drawn	Checked
02/04/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Numbe	Drawing Number	Revision
1008	1008	AP



Rev Date Details By

Bitmap3670837894-2.png

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Telephone +44(0)20 7794 1234
Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rc

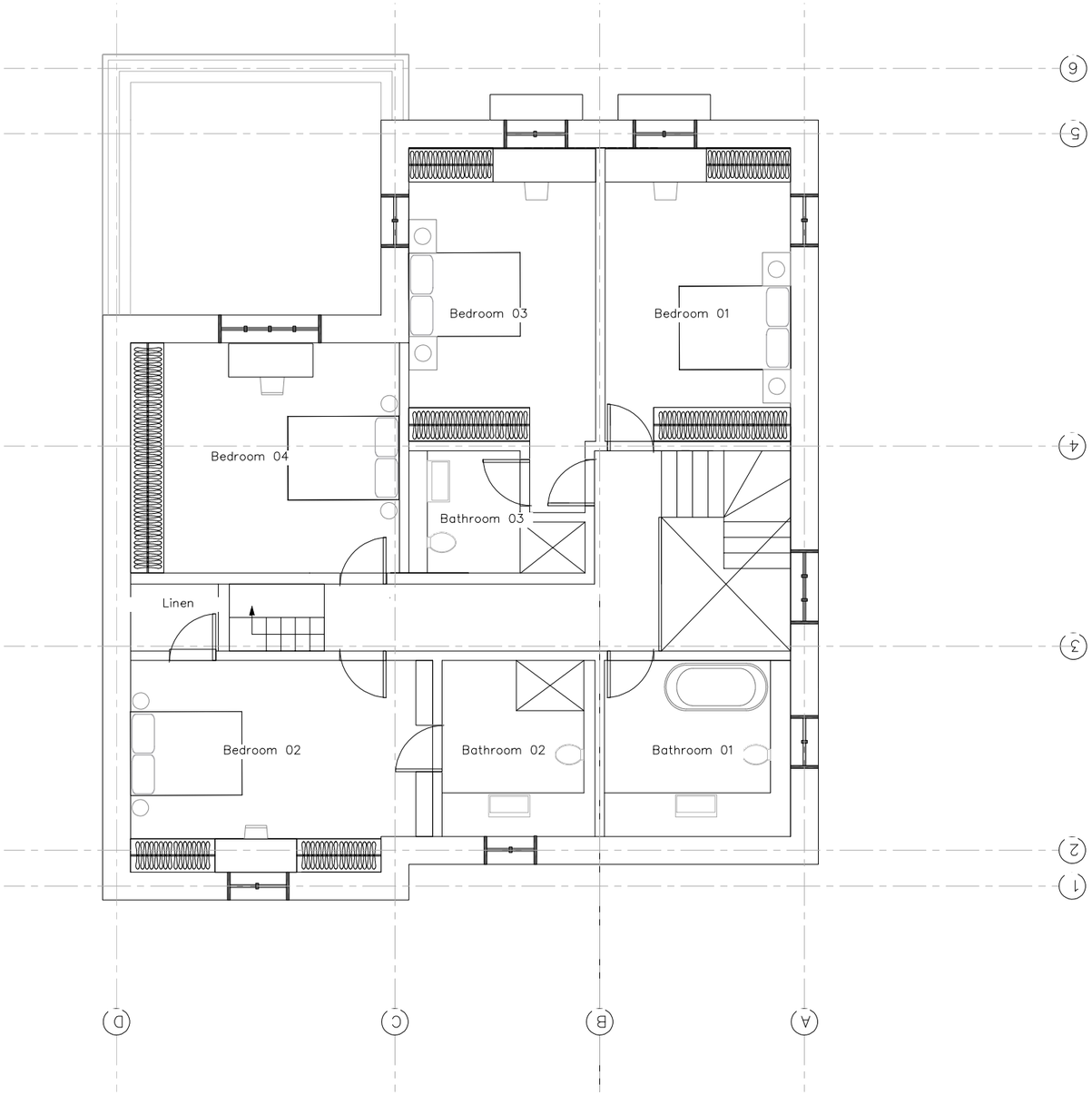
Drawing Title
Proposed First Floor Plan

Date	Drawn	Checked
02/04/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR INFORMATION

Project Numbe	Drawing Number	Revision
1008	1008 - AP	



Rev Date Details By

Bitmap3670837895.png

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Telephone +44(0)20 7794 1234
Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rc

Drawing Title
Proposed Second Floor Plan

Date	Drawn	Checked
02/04/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Numbe	Drawing Number	Revision
1008	1008 - AP	

Rev Date Details By

Bitmap3670837897-11.png

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Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Ro

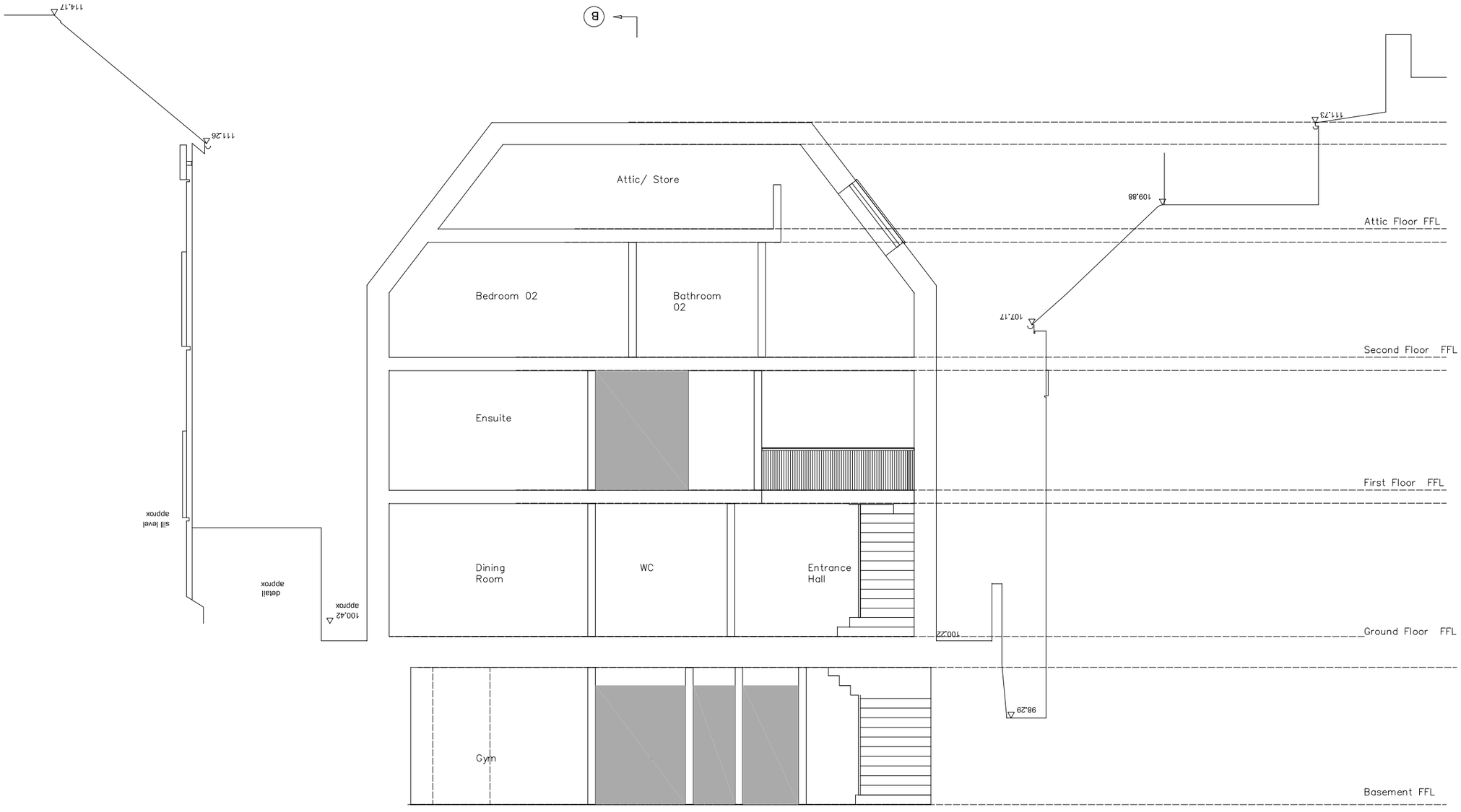
Drawing Title
Proposed Front Elevation

Date	Drawn	Checked
02/04/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Number Drawing Number Revision



Rev Date Details By

Bitmap3670837900-2.png

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Telephone +44(0)20 7794 1234
Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rc

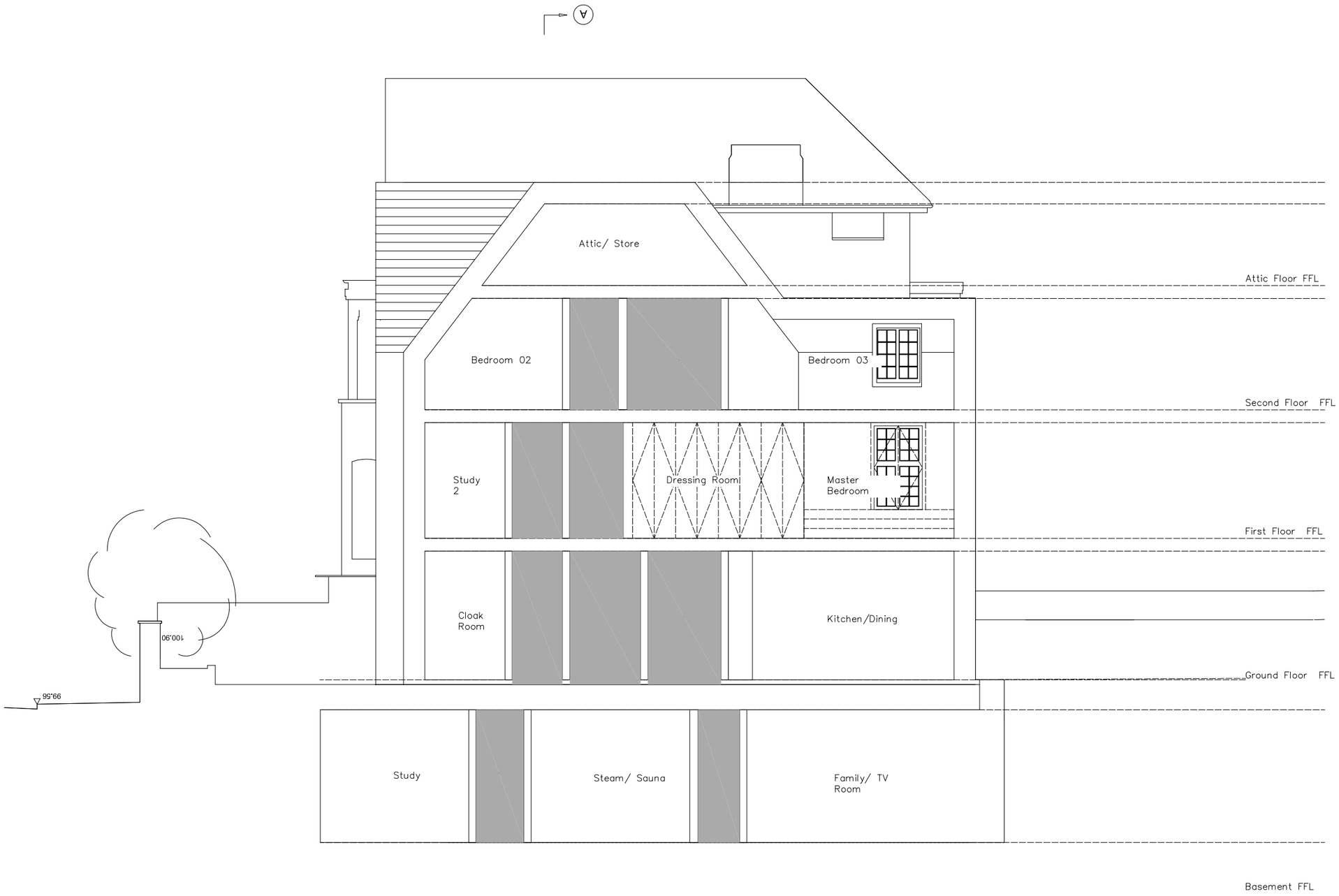
Drawing Title
Proposed Section A–A

Date	Drawn	Checked
02/04/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Numbe Drawing Number Revision
1 0 0 8 1 0 0 8 A P - 1 6



Rev Date Details By

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Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rc

Drawing Title
Proposed Section B–B

Date Drawn Checked
02/04/2020 SI CP

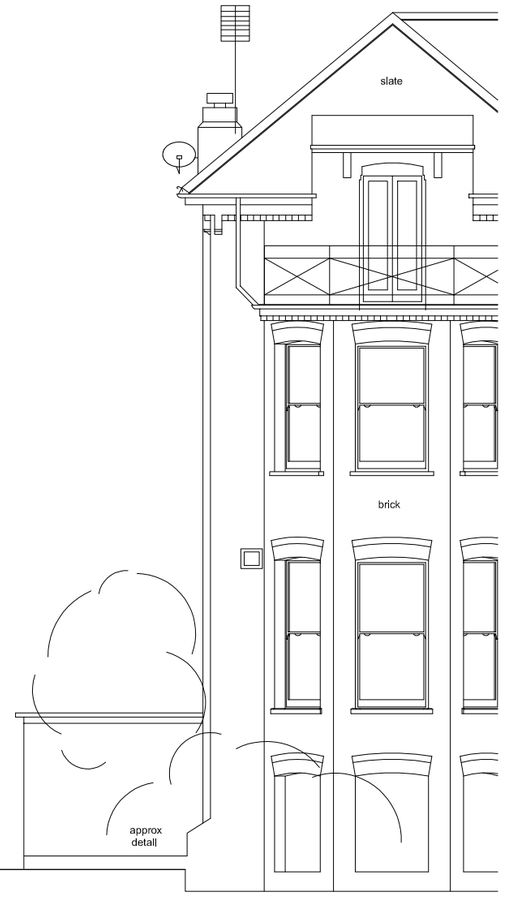
Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Numbe Drawing Number Revision
1 0 0 8 1 0 0 8 A P - 1 -

(No 7-9)

(No 5b)



(No 5)

Rev	Date	Details	By

Bitmap3670837897-12.png

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Telephone +44(0)20 7794 1234
Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rd

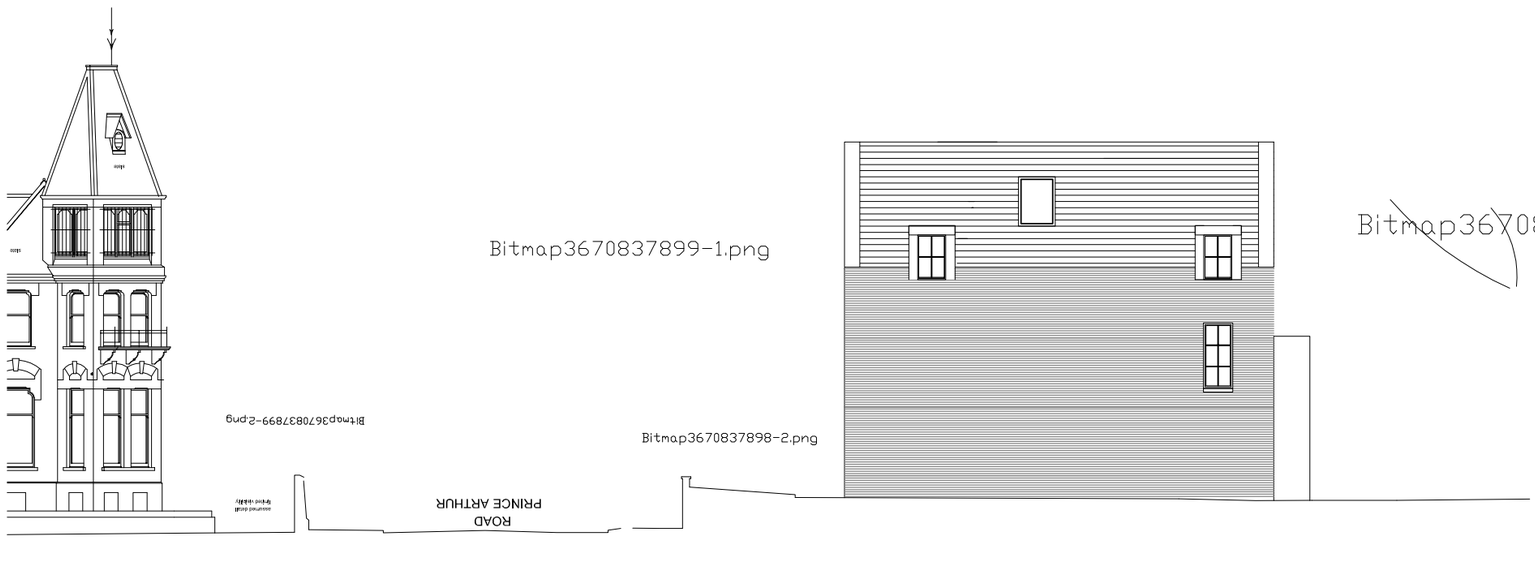
Drawing Title
Proposed Rear Elevation

Date	Drawn	Checked
02/04/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Numbe	Drawing Number	Revision
1008	1008	AP



Rev	Date	Details	By

Bitmap3670837897-13.png

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Telephone +44(0)20 7794 1234
Email office@charltonbrown.com
Website www.charltonbrown.com

Client
Mr & Mrs Palsson

Project
Copper Beech House, 5b Prince Arthur Rd

Drawing Title
Proposed Side Elevations

Date	Drawn	Checked
02/04/2020	SI	CP

Scale
1:100 @A1 / 1:200 @ A3

Issue Status
FOR PLANNING

Project Numbe	Drawing Number	Revision
1008	1008 - A P	

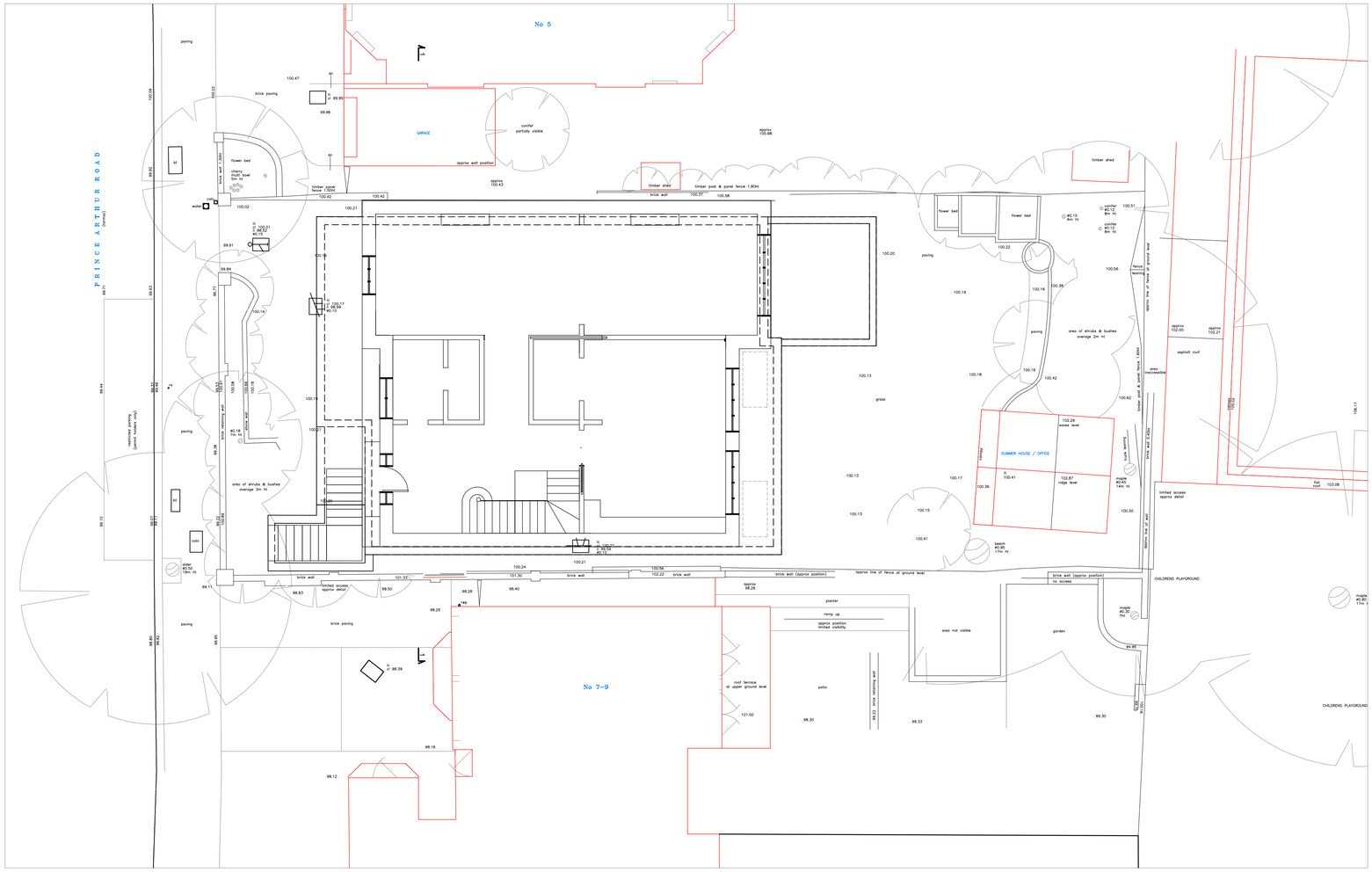
Appendix D

TWS - 9634_BIA_03 – Topographical survey with proposed basement and ground layout

TWS - 9634_BIA_04 _ Proposed basement and ground floor layouts with section 1_ construction sequence

TWS - 9634_BIA_05 _ Proposed basement and ground floor section 2_2 construction sequence

1. This Drawing to be read in conjunction with all other Engineers, Architects and Specialists drawings and specifications.
2. No dimensions are to be scaled from this drawing.
3. No deviation may be made from the details shown on this drawing without prior agreement of the Engineers.
4. Any discrepancy between this drawing and any other document should be referred immediately to the Engineer.



Ref.	Revisions	By	Date
-	-	-	-

COPPER BEECH HOUSE,
5b PRINCE ARTHUR ROAD,
HAMPSTEAD,
LONDON,
NW3 6AX

EXISTING TOPOGRAPHICAL SURVEY WITH PROPOSED BASEMENT AND GROUND FLOOR

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London EC1Y 8PQ
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www.simpsoneng.com

Scale at A1	Date	Drawn By	
1:100, 1:40	07/01/20	GB	

Project No.	Drg No.	Rev.
9634	BIA_03	-

1. This Drawing to be read in conjunction with all other Engineers, Architects and Specialists drawings and specifications.
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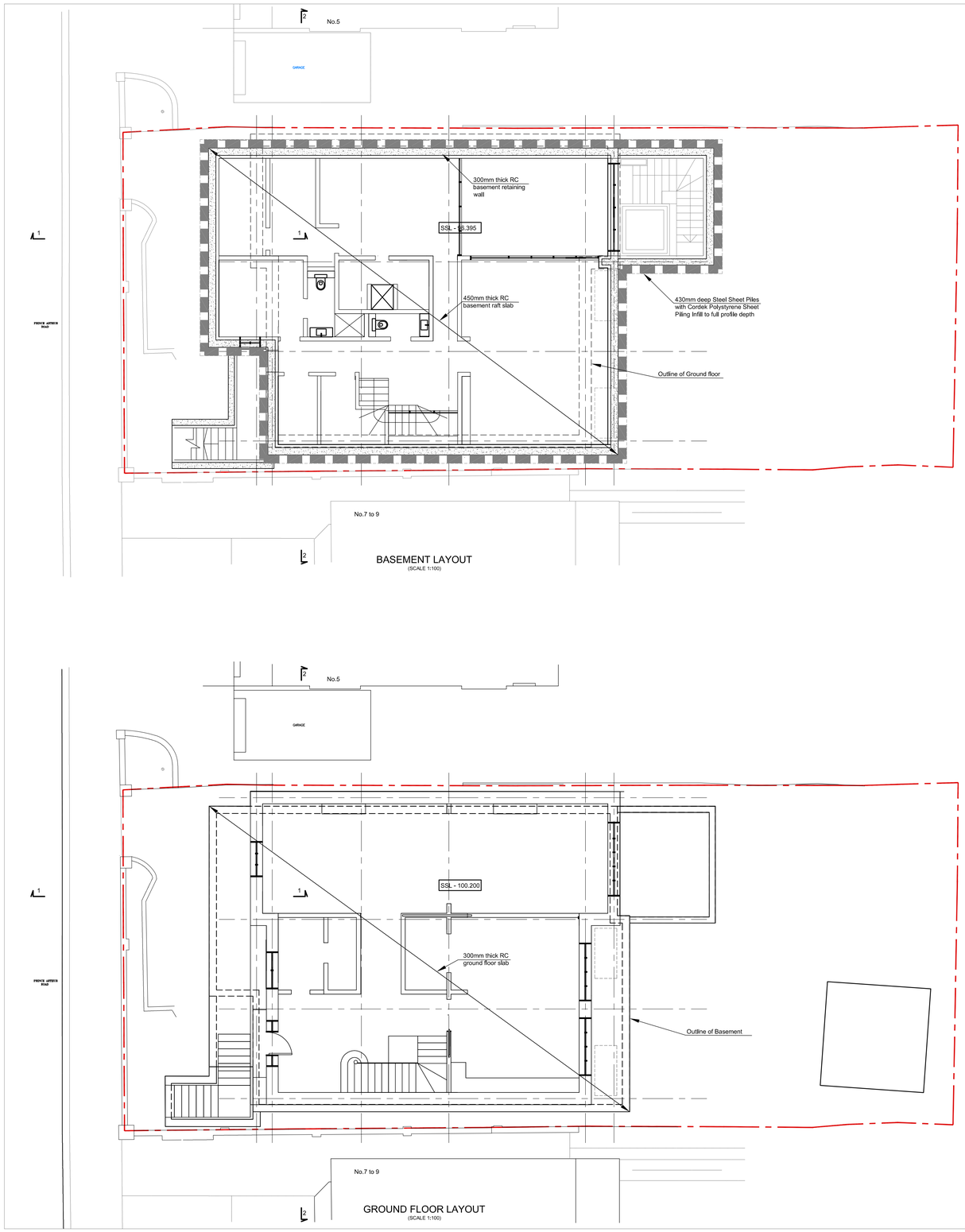
4. Any discrepancy between this drawing and any other document should be referred immediately to the Engineer.

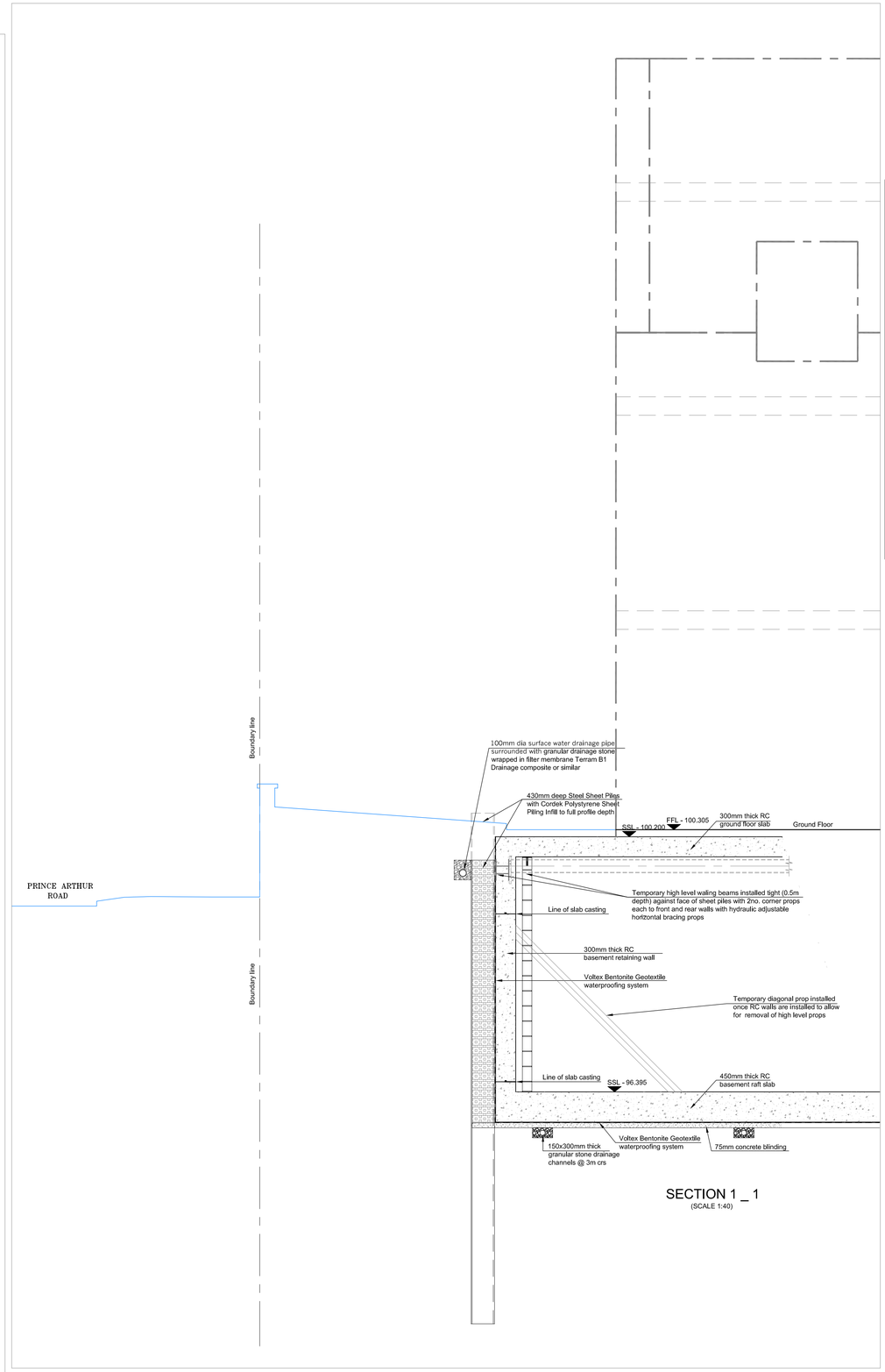


BASEMENT LAYOUT
(SCALE 1:100)

GROUND FLOOR LAYOUT
(SCALE 1:100)

CONSTRUCTION METHOD SEQUENCE

- Install within the site area around the basement zone and surrounding area a number of fixed monitoring nodes to monitor possible movement during the works.
- Install all necessary tree protection measures to retained trees
- The existing building is to be demolished and all foundations and drainage up to the last manhole is to be grubbed out.
- The existing top soil on site situated around the proposed basement area is it to be scrapped off and stored on site for re-use at a later stage.
- The sheet piling is to be installed with a Silent Piler similar to a Giken Rig which presses the sheet piles into the ground using the resistance of the adjoining installed sheet piles.
- The ground is to be locally excavated by 0.6m to allow installation of the high level steel waling beams, adjustable hydraulic corner props along No. 5 boundary.
- The ground is then to be locally excavated to 2m to allow installation of the mid level steel waling beams, adjustable hydraulic corner props and raker prop along No. 7-9 boundary.
- The ground is then to be excavated to basement formation level.
- The drainage pipes and granular drainage channels are to be installed.
- The basement RC slab build-up is to be installed and then the basement slab cast with 150mm high kickers for all the RC basement walls and internal columns.
- Install and cast all internal RC walls and columns to underside of ground floor slab.
- Once the RC basement slab has gained the required design strength the basement RC walls are then to be cast to 400mm below the underside of the high and mid-level waling beams.
- Once the basement RC walls have gained the required design strength, install temporary diagonal adjustable restraint props fixed to the RC wall & RC basement slab and then remove the high and mid-level sheet piling waling beams and props.
- The RC ground floor slab and RC wall down stands can then be cast.
- Once the RC ground floor slab has gained the required design strength the additional diagonal restraint props can be removed.
- During the construction period the sheet piling and surrounding ground will be monitored at regular intervals to confirm the construction tolerances stays within the agreed design parameters.
- The new structure over can now be constructed and will be supported on the new basement ground floor slab
- Continue with construction of remainder of the structure over using traditional load bearing brick/blockwork, timber floors and steel framed roof with timber infill rafters.
- Install external drainage and external works and reinstate top soil to landscaped areas.



SECTION 1 _ 1
(SCALE 1:40)

Ref.	Revisions	By	Date
.	.	.	.

COPPER BEECH HOUSE,
5b PRINCE ARTHUR ROAD,
HAMPSTEAD,
LONDON,
NW3 6AX

PROPOSED BASEMENT AND GROUND FLOOR LAYOUT AND SECTION 1 _ 1 CONSTRUCTION SEQUENCING

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Scale at A1	Date	Drawn By	
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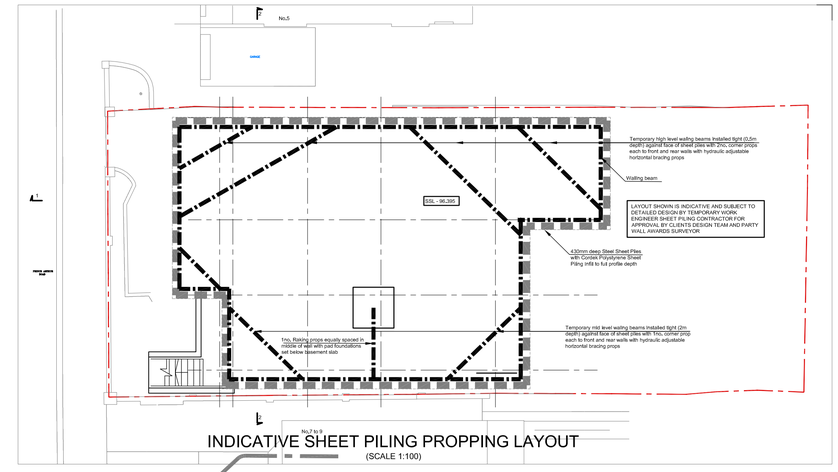
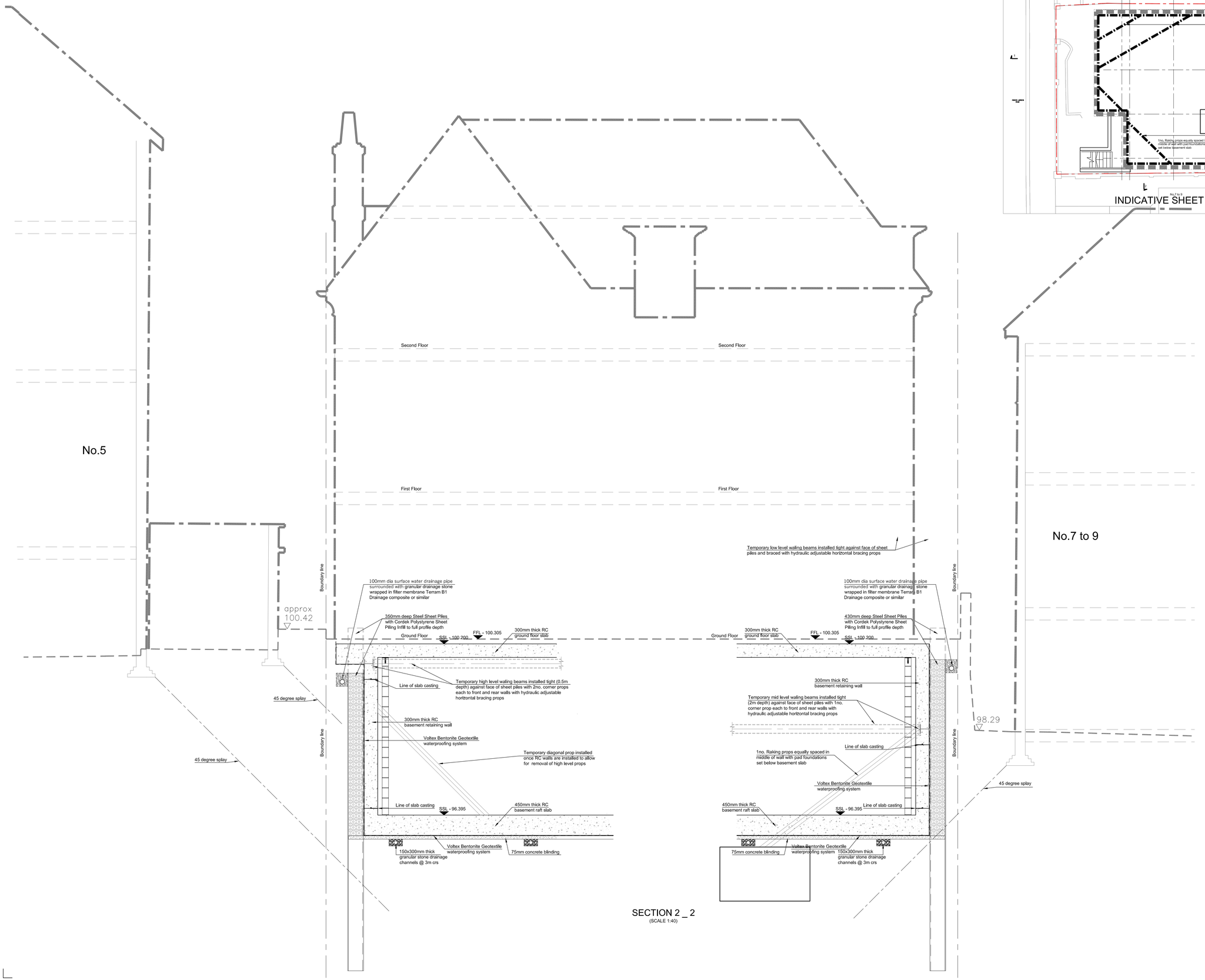
Project No.	Drg No.	Rev.
9634	BIA_04	-



INDICATIVE SHEET PILING PROPPING LAYOUT

(SCALE 1:100)



SECTION 2 _ 2

(SCALE 1:40)

1. This Drawing to be read in conjunction with all other Engineers, Architects and Specialists drawings and specifications.
2. No dimensions are to be scaled from this drawing.
3. No deviation may be made from the details shown on this drawing without prior agreement of the Engineers.
4. Any discrepancy between this drawing and any other document should be referred immediately to the Engineer.

CONSTRUCTION METHOD SEQUENCE

- Install within the site area around the basement zone and surrounding area a number of fixed monitoring nodes to monitor possible movement during the works.
- Install all necessary tree protection measures to retained trees
- The existing building is to be demolished and all foundations and drainage up to the last manhole is to be grubbed out.
- The existing top soil on site situated around the proposed basement area is it to be scrapped off and stored on site for re-use at a later stage.
- The sheet pilling is to be installed with a Silent Piler similar to a Giken Rig which presses the sheet piles into the ground using the resistance of the adjoining installed sheet piles.
- The ground is to be locally excavated by 0.6m to allow installation of the high level steel waling beams, adjustable hydraulic corner props along No. 5 boundary.
- The ground is then to be locally excavated to 2m to allow installation of the mid level steel waling beams, adjustable hydraulic corner props and raker prop along No. 7-9 boundary.
- The ground is then to be excavated to basement formation level.
- The drainage pipes and granular drainage channels are to be installed.
- The basement RC slab build-up is to be installed and then the basement slab cast with 150mm high kickers for all the RC basement walls and internal columns.
- Install and cast all internal RC walls and columns to underside of ground floor slab.
- Once the RC basement slab has gained the required design strength the basement RC walls are then to be cast to 400mm below the underside of the high and mid-level waling beams.
- Once the basement RC walls have gained the required design strength, install temporary diagonal adjustable restraint props fixed to the RC wall & RC basement slab and then remove the high and mid-level sheet piling waling beams and props.
- The RC ground floor slab and RC wall down stands can then be cast.
- Once the RC ground floor slab has gained the required design strength the additional diagonal restraint props can be removed.
- During the construction period the sheet piling and surrounding ground will be monitored at regular intervals to confirm the construction tolerances stays within the agreed design parameters.
- The new structure over can now be constructed and will be supported on the new basement ground floor slab
- Continue with construction of remainder of the structure over using traditional load bearing brick/blockwork, timber floors and steel framed roof with timber infill rafters.
- Install external drainage and external works and reinstate top soil to landscaped areas.

Ref.	Revisions	By	Date
-	-	-	-

COPPER BEECH HOUSE,
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HAMPSTEAD,
LONDON,
NW3 6AX

PROPOSED BASEMENT AND GROUND FLOOR SECTION 2 _ 2 CONSTRUCTION SEQUENCING

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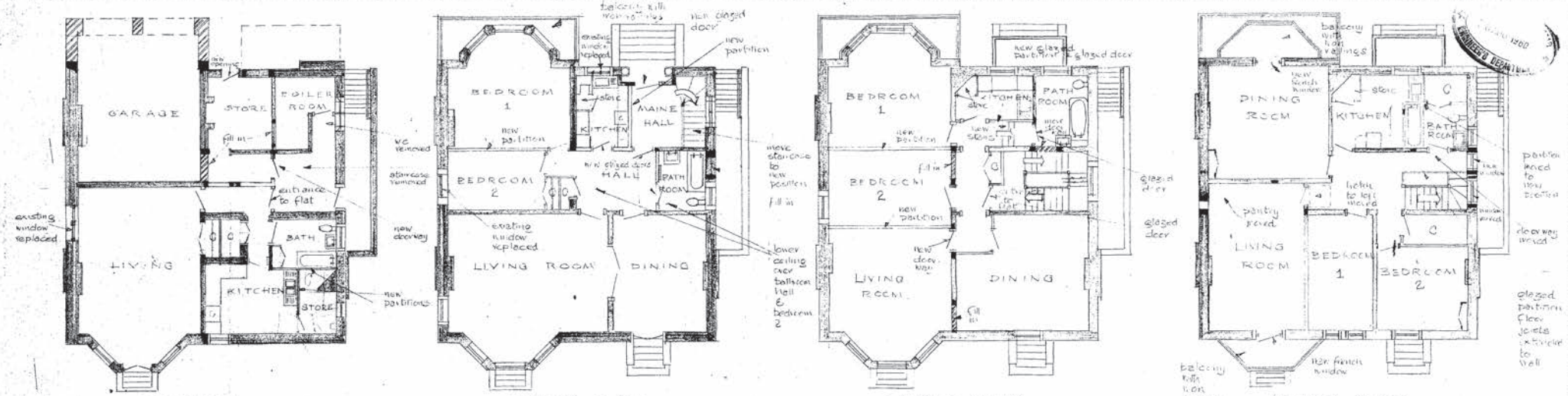
Project No.	Drg No.	Rev.
9634	BIA_05	-

Appendix E

Existing adjoining building drawings for no. 5 and no. 7 Prince Arthur Road



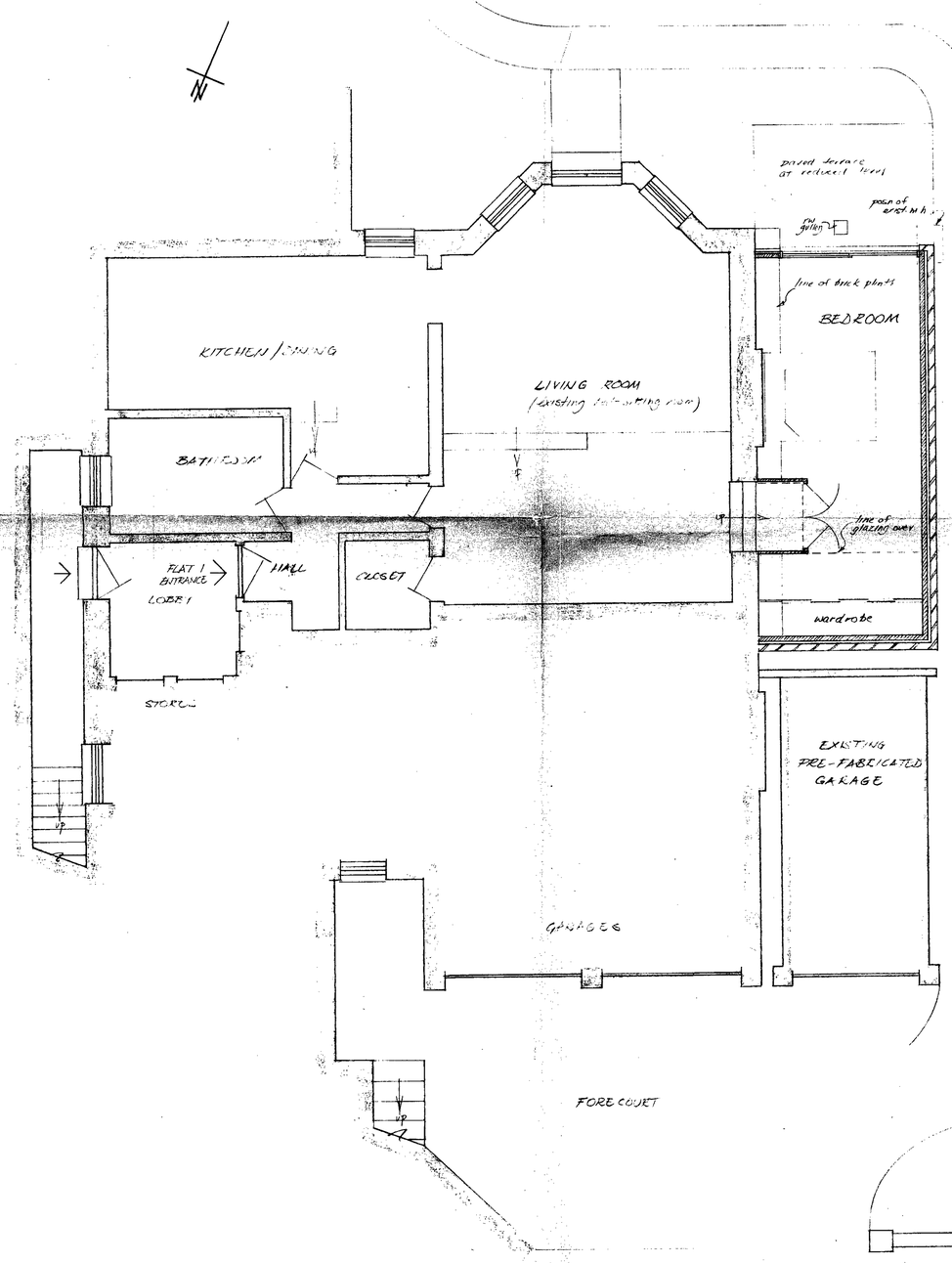
15, PRINCE ARTHUR ROAD, HAMPSTEAD, N.W.3.

Proposed Conversion for Mr P. Bicknell & Mr J.S. Schofield.

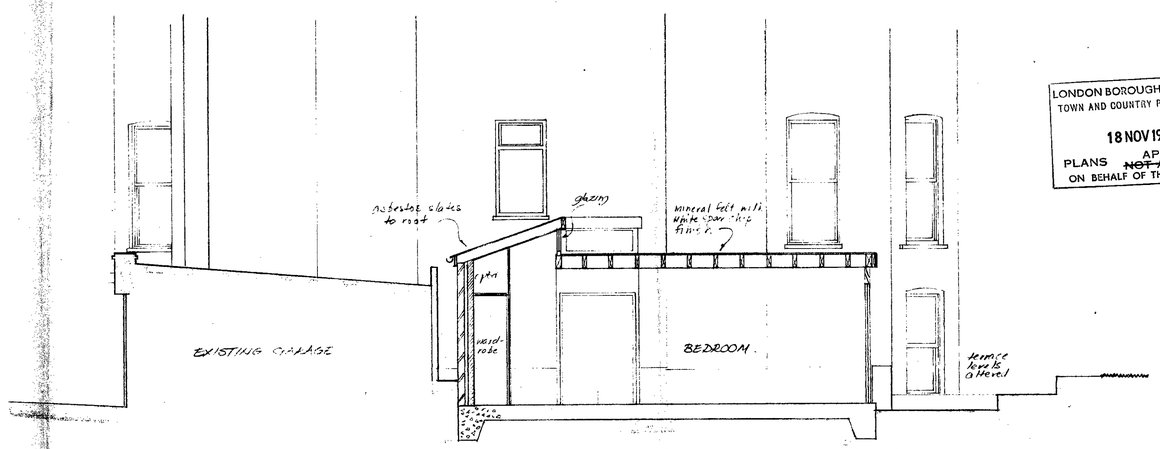
SCALE	1/8" : 1'-0"	DATE	OCT 24th '59	Drawing 60/1/2	JSS

PLAN NO. T.P. 3156
COMMITTEE DATE: SEP 1960

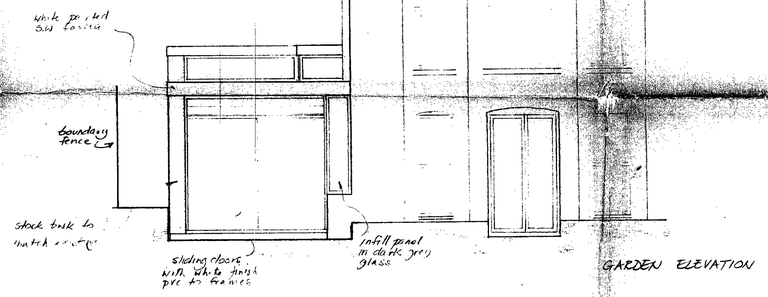
11152



LOWER GROUND FLOOR PLAN
(PART SURVEYED ONLY)



LONG SECTION



GARDEN ELEVATION

LONDON BOROUGH OF CAMDEN
TOWN AND COUNTRY PLANNING ACTS
18 NOV 1975
PLANS APPROVED ~~NOT APPROVED~~
ON BEHALF OF THE COUNCIL

FILE COPY
REF:

CTP/F6/5/C/21499

job title: FLAT 1 5 PRINCE ARTHUR ROAD

drawing type: PROPOSED EXTENSION SCHEME DESIGN

scale: 1 to 50 (metric)

drawn | checked | date: 23/6/75

job no: 224 | drawing no: 1 | revision:

Tyler Design Unit
Bill Tyler ARIBA
Architect
38 Charlotte St
London W1P 1HP
Telephone
01-636 2033

Garden · Maisonette

Garden · Ground Floor

Garden

NEW PLANTING

boundary

12.50

Width as Planning Approval

New House

11.50

EXISTING CHESTNUT

11.30

10.20

10.00

driveway

NEW PLANTING

building line

ELLERDALE ROAD

Garden · Lower Ground Floor

No. 7-11.

2

Δ 1.4.5

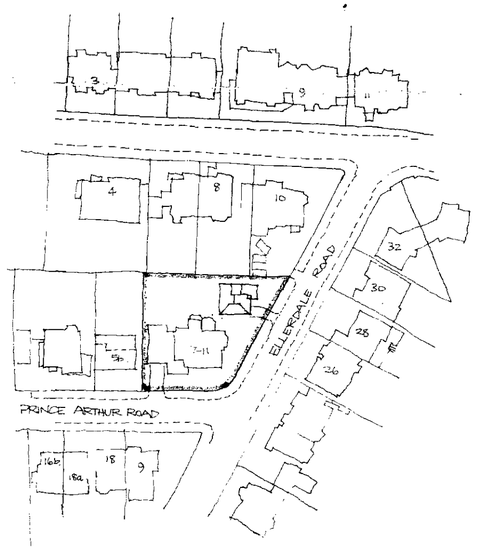
Δ 3

5b.

parking & driveway

PRINCE ARTHUR ROAD

NORTH



LOCATION PLAN · 1·1250

No.	REVISIONS	
D	NEW HOUSE · H/P/RATE	10.85.
C	HOUSE CLOSED / BOUNDARY GARDENS	30.9.83
B	HOUSE REDUCED + CONNECTION	1.7.83
A	HOUSE BOUNDARY	23.5.83

Contractors to check all dimensions on site

CTP/F6/5/1) /17115.

JOB TITLE 7·11 PRINCE ARTHUR ROAD

Client

Sheet title SITE PLAN

Drawn by

Date 5·83.

Scale 1·100 · 1·1250

393

1D

ARCHITECTS **TED LEVY, BENJAMIN & PARTNERS**
16 HOLLY BUSH VALE LONDON NW3 · 01-435 9016-7-8-9

NORTH WEST ELEVATION

LONDON BOROUGH OF CAMDEN
TOWN AND COUNTRY PLANNING ACTS
13 DEC 1983
PLANS APPROVED / NOT APPROVED
ON BEHALF OF THE COUNCIL

CTP/H6/5/1/37115.

7-11 PRINCE ARTHUR ROAD · NW3.

REV. A - MARCH 1984

ARCHITECTS TED LEVY, BENJAMIN & PARTNERS
16 HOLLY BUSH VALE LONDON NW3 01-435 9016-7-8-9

1:100 · 5·83.

393
9.A

New external materials
to match existing

Face brick to approval
Timber windows

Case Copy.

LONDON BOROUGH OF CAMDEN
TOWN AND COUNTRY PLANNING ACTS
13 DEC 1983
PLANS APPROVED ~~NOT APPROVED~~
ON BEHALF OF THE COUNCIL

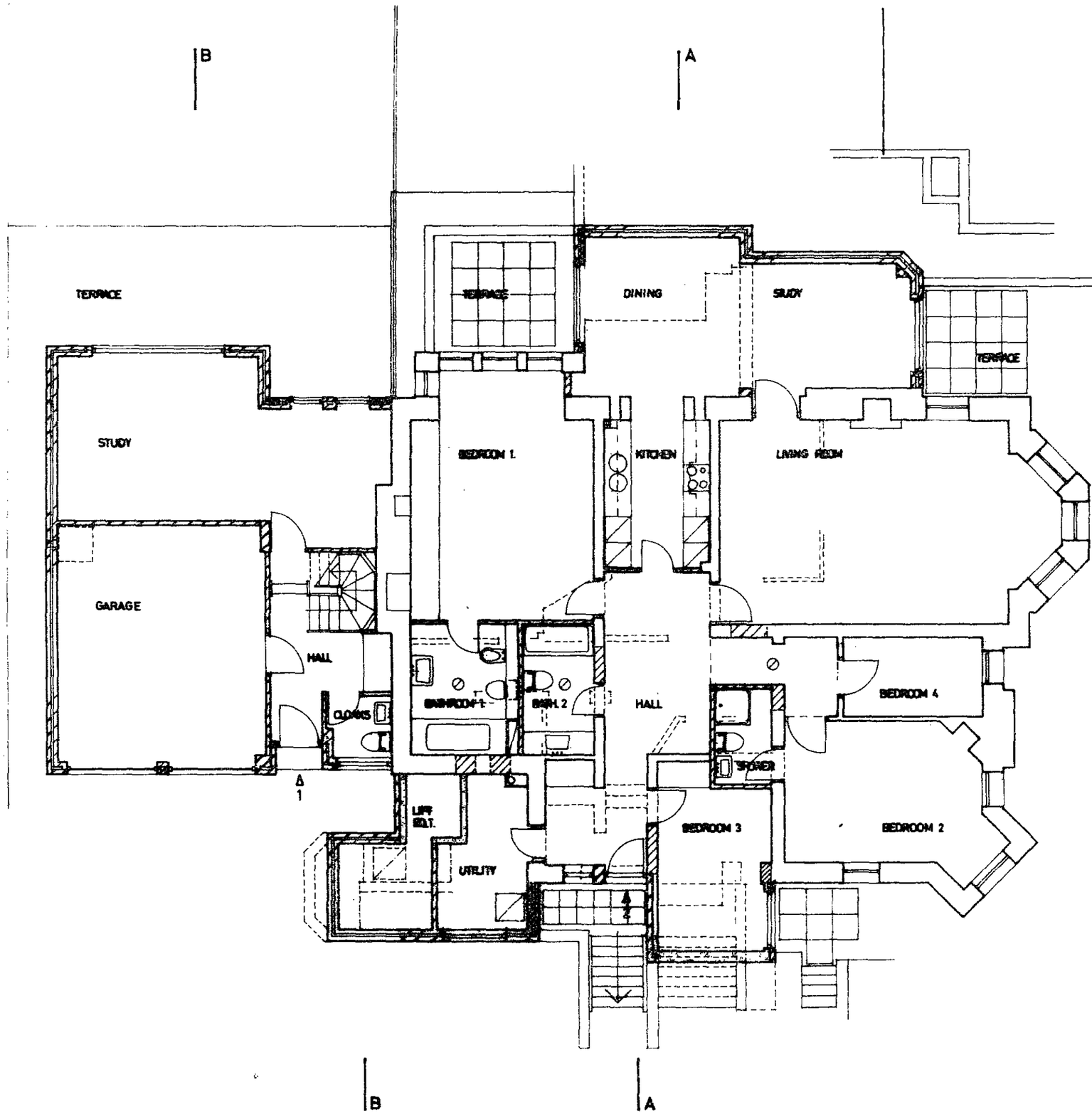
CTP/F6/5/7/17115.

SOUTH WEST ELEVATION

7-11 PRINCE ARTHUR ROAD NW3.

ARCHITECTS **TED LEVY, BENJAMIN & PARTNERS**
16 HOLLY BUSH VALE LONDON NW3 · 01-435 9016-7-8-9

NOTTM. PLAN. REF. 17.83. 393
1:100. 5.83. 10



Case Copy

LONDON BOROUGH OF CAMDEN
TOWN AND COUNTRY PLANNING ACTS

13 DEC 1983

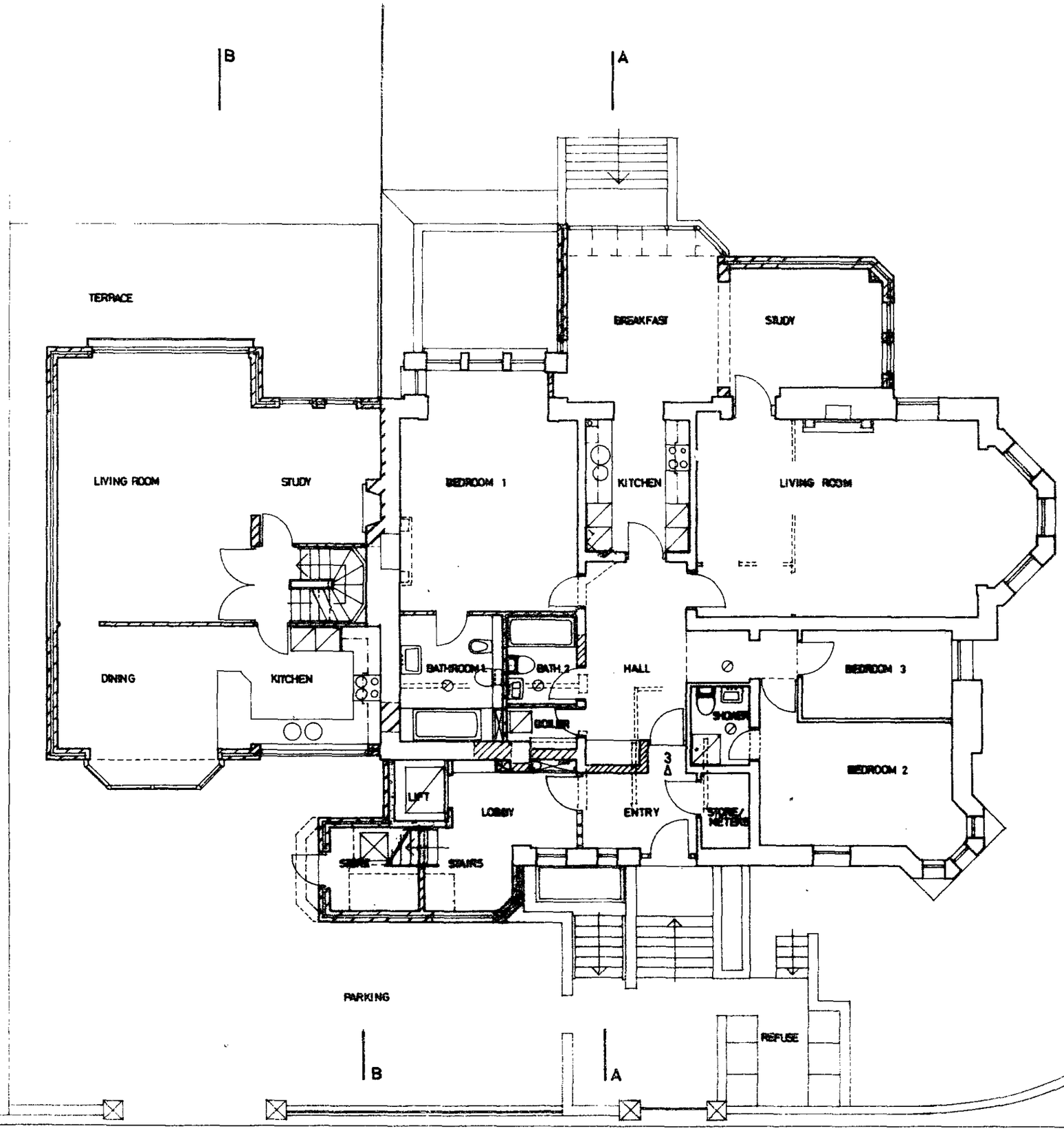
PLANS APPROVED ~~NOT APPROVED~~
ON BEHALF OF THE COUNCIL

CTP/F6/5/1/37115.

LOWER GROUND FLOOR

PRINCE ARTHUR ROAD · 1:100/OCT83. · 393·22 ·

ARCHITECTS **TED LEVY, BENJAMIN & PARTNERS**
16 HOLLY BUSH VALE LONDON NW3 · 01-435 9016-7-8-9



Case Copy

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PLANS APPROVED
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ON BEHALF OF THE COUNCIL

CDP/F6/5/D/3715.

GROUND FLOOR

PRINCE ARTHUR ROAD 1·100 / OCT. 83. 393·23

ARCHITECTS **TED LEVY, BENJAMIN & PARTNERS**
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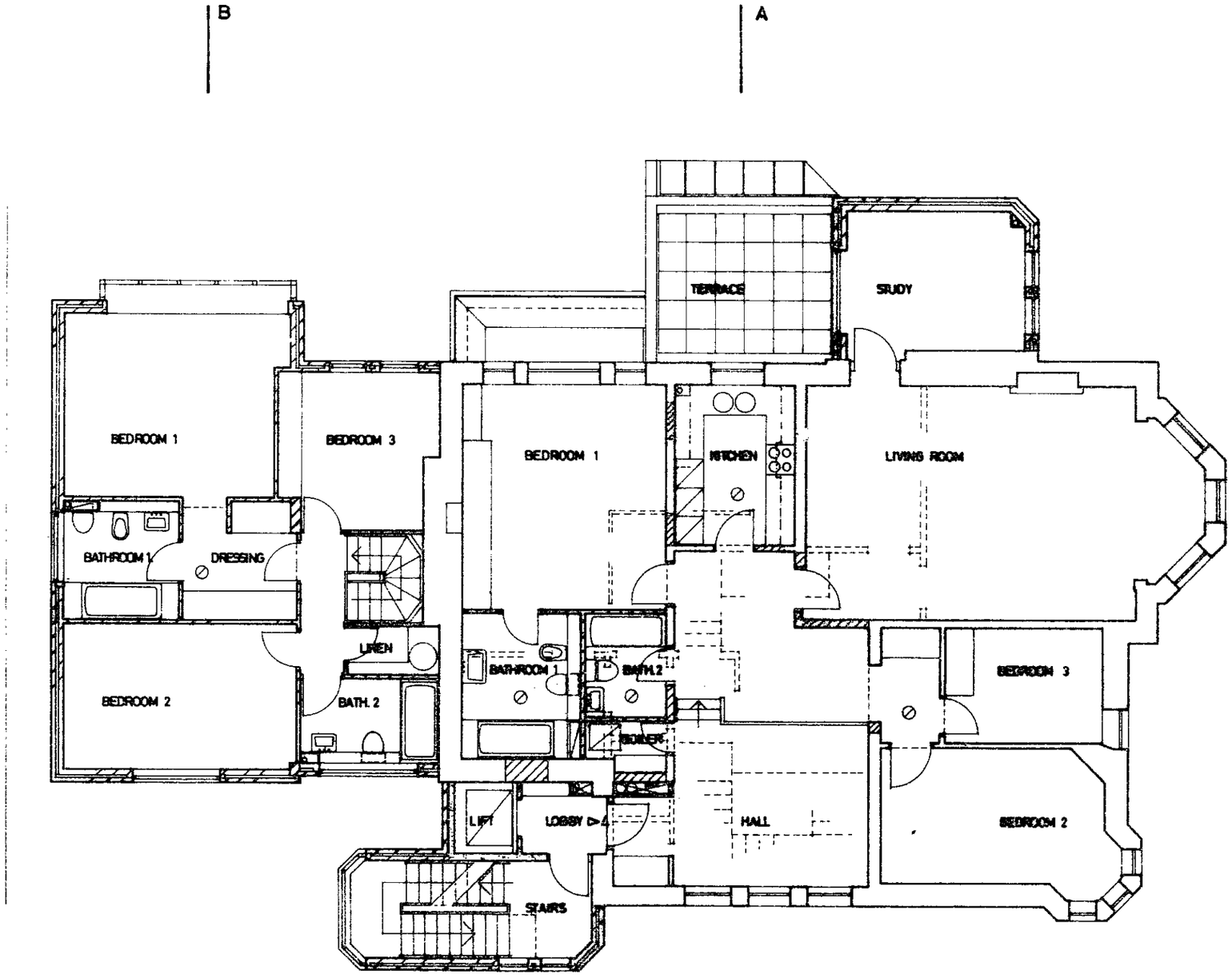

Case Copy

LONDON BOROUGH OF CAMDEN
TOWN AND COUNTRY PLANNING ACTS
13 DEC 1983
PLANS APPROVED ~~NOT APPROVED~~
ON BEHALF OF THE COUNCIL

F6/5/9/37115.

1 ST. FLOOR

PRINCE ARTHUR ROAD 1·100 / OCT. 83 393·24

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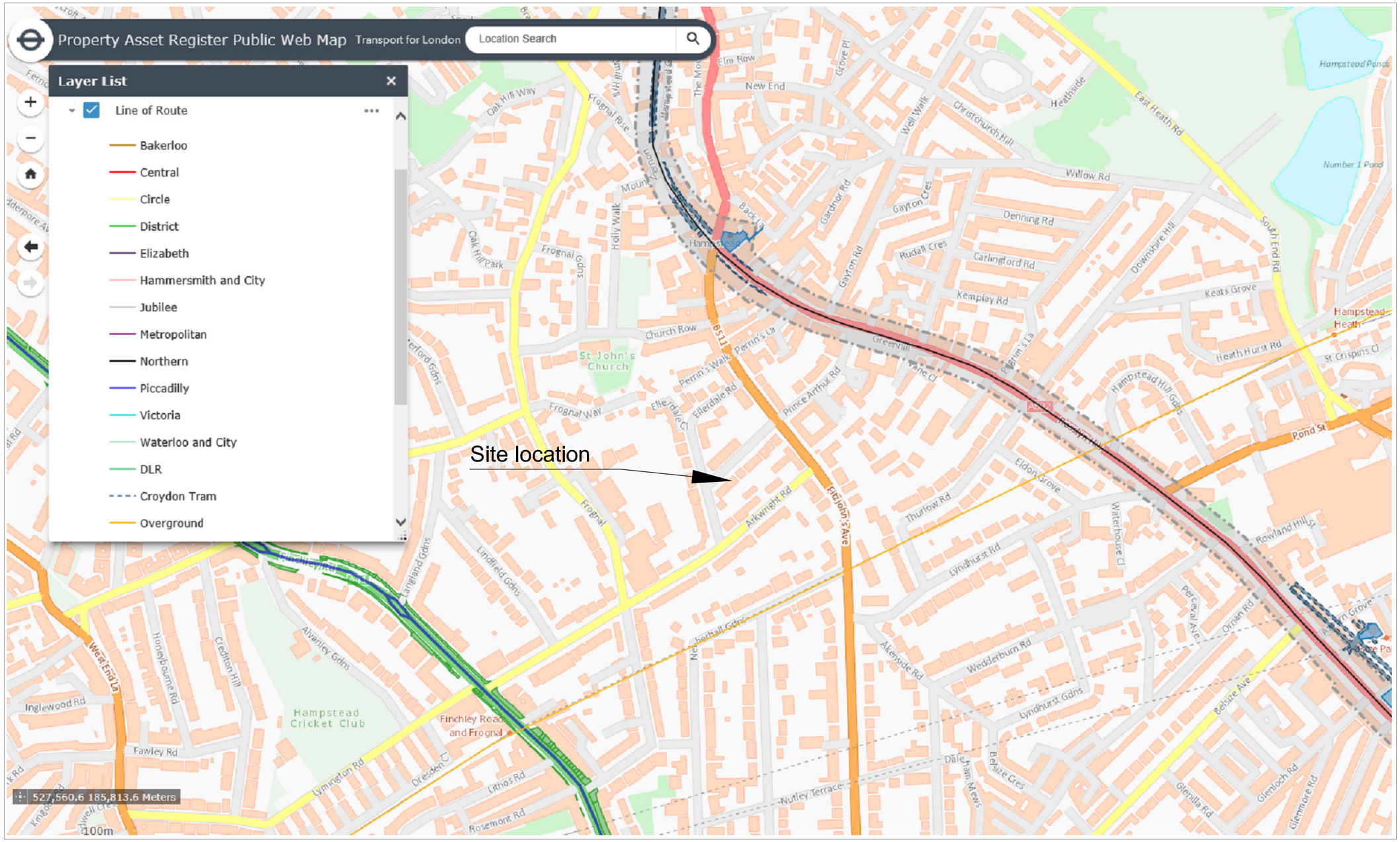
Appendix F

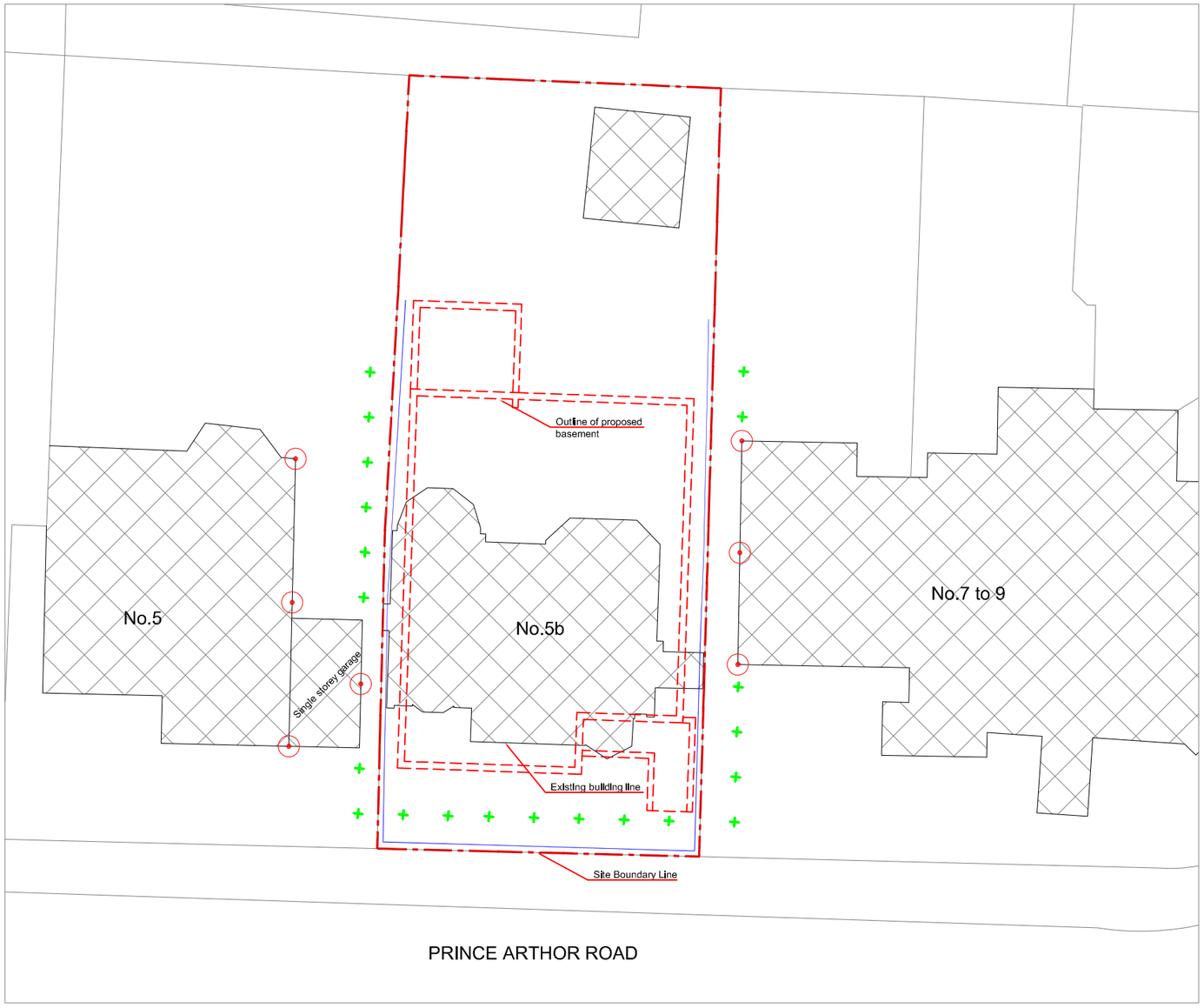
TWS - 9634_ BIA_06 – Transport for London property asset register



simpson | tws 3 Dufferin Avenue London EC1Y 8PQ T.0207 253 2626 www.simpsoneng.com	Contract COPPER BEECH HOUSE, 5b PRINCE ARTHUR ROAD, HAMPSTEAD, LONDON, NW3 6AX	Title TRANSPORT FOR LONDON PROPERTY ASSET REGISTER	Scale at A3 NTS	Date 07/01/20	Drawn By GB
			Job No. 9634	Drawing No. BIA_06	Rev. -

Appendix G

TWS - 9634_ BIA_07 _ Proposed Monitoring of Movement and Settlement to site and surrounding area.



Movement Limits and Responses (No. 5 PRINCE ARTHOR ROAD)

Action Level	Response	Ground Surface Level	
		Vert., mm	*Horiz., mm*
Green	No Action	<5	<5
Green / Amber	Re-assess and agree course of action	5 to 8	5 to 8
Red	Stop works and secure adjoining the area	>8	>8

Stated movement limits and responses are subject to final agreement as part of the party wall process with adjoining party wall surveyors

Movement Limits and Responses (No.7 to 9 PRINCE ARTHOR ROAD)

Action Level	Response	Ground Surface Level	
		Vert., mm	*Horiz., mm*
Green	No Action	<5	<5
Green / Amber	Re-assess and agree course of action	5 to 8	2 to 8
Red	Stop works and secure adjoining the area	>8	>8

Stated movement limits and responses are subject to final agreement as part of the party wall process with adjoining party wall surveyors

All readings are to be reported to the Supervising Officer and additional members of the team (TBC) within 48 hours of them being made.

The surveying company is to provide a movement survey report with all readings to be provided in a spreadsheet format with accompanying graphs indication the development of each observation with time and appropriate suitable profiles. The accompanying text is to be provided highlighting any trends that are or are likely to be encountered and also record against them the type of work undertaken prior to the readings. Each report is to be dated and referenced and have the site location plan included for easy of locating survey points

If any unusual observations or observations suggesting excessive deformation and/or possible instability are made these should be checked and if confirmed, reported to the Contractor and Engineer immediately.

The survey company is to review the positions show are suitable for surveying from agreed base positions and positions are subject to final site survey.

The survey company is to provide a method statement confirming how the works are to be undertaken giving details of all equipment to be used with data sheets confirming up to date equipment calibration.

Timing of readings (grd level, survey & monitoring)
An initial base reading is to be undertaken 1 month prior to and at start on site and then every 2 weeks from start of Excavation,Underpinning and casting of lower ground floor slab.
Readings are to be taken every 2 weeks during Lower Ground excavation works.
If casting of slabs or removal of propping falls within the 2 week period then take additional reading in between at 1 week.
Once the lower basement works are completed level readings are to be taken every 2 weeks for 2 months and if a trend of reducing rate of movement is established then revert to readings every 4 weeks
If during any of the readings excessive movement is noted revert to 1 week readings until 2 weeks after readings show excessive movement has stop. Then revert back to readings every 4 weeks.

KEY

+ Surface levelling studs (~5m c/c)

Wall(s); precise leveling at ground level (2m c/c by excavation)

⊙ Structures(s); 3D Retro-targets top & bottom of wall (Final locations to be agreed)

The movement limits noted on this drawing are taken from basement impact assessment

The contractor is to review this and all other relevant documentation and it is the contractor's responsibility to review the monitoring results and to maintain all ground and building movement within the design parameters and where possible improve upon.

The limits given in the table are the maximum and not to be exceeded and if at any time it is deemed that the movement are likely to be exceeded, the contractor is to make all necessary arrangement to bring the movement back to within the acceptable limits for the relevant phase or works.

The contractor is to immediately notify the Supervising Officer and Design Team of any such situation and the proposed remedial works.

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Contract	Title	Scale at A3	Date	Drawn By
COPPER BEECH HOUSE, 5b PRINCE ARTHUR ROAD, HAMPSTEAD, LONDON, NW3 6AX	PROPOSED MONITORING OF MOVEMENT AND SETTLEMENT TO SITE AND SURROUNDING AREA	NTS	07/01/20	GB
		Job No. 9634	Drawing No. BIA_07	Rev. -

Appendix H

Geotechnical Consulting Group Ground Movement Impact Assessment dated May 2020
Geotechnical Consulting Group Hydrogeological Impact Assessment dated May 2020

TAYLOR WHALLEY SPRYA

5B PRINCE ARTHUR ROAD

GROUND MOVEMENT IMPACT ASSESSMENT

REV 0

June 2020

Attention is drawn to the statement overleaf which should be read prior to using this report. The report has been prepared for the exclusive use of Geotechnical Consulting Group LLP's client and contains privileged information. Use of this report and disclosure of its content by and to unauthorised parties is strictly forbidden.

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Geotechnical Consulting Group LLP is a partnership registered in England No OC356005 the registered address of which is as above.

TAYLOR WHALLEY SPRYA

5B PRINCE ARTHUR ROAD, LONDON NW3 6AX

GROUND MOVEMENT IMPACT ASSESSMENT

REV 0

June 2020

DISCLAIMER

REVISION HISTORY

Revision	Date	Description	Produced by	Reviewed by
Rev 0	1/06/2020	Issued for comments	M.Tait BEng MSc DIC GMICE	A.Gasparre Dott Ing. PhD DIC CEng MICE

TAYLOR WHALLEY SPRYA

5B PRINCE ARTHUR ROAD, LONDON NW3 6AX

GROUND MOVEMENT IMPACT ASSESSMENT

REV 0

JUNE 2020

EXECUTIVE SUMMARY

A ground movement impact assessment has been undertaken for the site at 5b Prince Arthur Road, where the existing house is to be demolished and a new house with a single storey basement is to be built. The proposed basement includes a light well in the front and rear of the house to be created underneath the footprint of the original house and its rear patio.

The proposed basement will be constructed by sheet piling the perimeter walls and excavating with temporary propping. Construction of a watertight reinforced concrete basement box will be followed by removal of the temporary propping system and subsequent construction of the new proposed dwelling.

Ground movements associated with the proposal have been estimated using linear elastic analyses and an empirical method based on records of basement excavations. It is concluded that movements of the ground around the surrounding structures are small and as a result, predicted building damage will not exceed Category 1: very slight.

Negligible impact on the adjacent road and any utilities running along this is expected.

TAYLOR WHALLEY SPRYA

5B PRINCE ARTHUR ROAD, LONDON NW3 6AX

GROUND MOVEMENT IMPACT ASSESSMENT

REV 0

June 2020

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LIST OF FIGURES **Page No.**

1 Introduction

It is proposed to demolish the existing house at 5b Prince Arthur Road and construct a new three-story house with a single-story basement underneath the original footprint of the house and its rear patio.

The Geotechnical Consulting Group LLP (GCG) have been commissioned to assess the impact of the proposed basement construction on the surrounding structures.

The expected movements around the site have been estimated using linear elastic analyses and an empirical approach that is based on field measurements of movements from a number of basement constructions across London (CIRIA C760).

Information on the project has been provided by Taylor Whalley Sprya (TWS), who have been appointed to produce the Basement Impact Assessment (BIA) for this project.

2 The site and the proposed redevelopment

The site lies within the Frognal & Fitzjohns Ward of Camden Administrative Boundary and is located on the south side of Prince Arthur Rd, approximately 50m to the east of Ellerdale Road (Figure 1a).

It stretches approximately 35m along a north-west to south-east direction and it is approximately 14m wide.

It includes a detached house with a 53m^2 paved patio at the front and an 82m^2 patio in the rear of the house. A garden shed is situated in the back garden as well as a large Copper Beach Tree. Figure 1b shows a layout of the site.

The existing house is approximately 13m long and 9m wide, with no basement structure. The lot is approximately level, at an elevation of +100.2m above Ordnance Datum (OD) (Ref. [1]). Prince Arthur Street, at the front of the house, slopes downward from north-east to south-west at a gradient of approximately 1:15. There is a step down from No. 5b to the neighbouring No. 7-9 Arthur Road of about 2m (Figure 4), with the garden at No 7-9 at an approximate level of +98.3mOD. A masonry wall running along the western edge of the site retains the ground of the site above the level of the adjacent 7-9 Arthur Road.

Figure 2 shows a plan of the existing ground floor as well as a side, front, and rear elevations of the existing property.

It is proposed to demolish the existing structure, create a new basement underneath its original footprint and rear patio, and construct a new three-storey dwelling in its place. Figures 3 and 4 show plans of the proposed structure and sections through the site respectively.

The finished floor level of the new basement will be +96.4mOD and will require approximately a 4.3m deep excavation.

The basement will be formed by installing sheet piles around the perimeter using silent and vibration free techniques; subsequently the full basement will be excavated making use temporary props. The props will be arranged in a way to avoid pressures on the western wall at high level because the asymmetry of the conditions behind the retaining walls is such that pressures on the western retaining wall could result in pressures on the masonry wall between 5b and 7-9 Arthur Road behind it. Corner props will therefore be installed against the eastern, front and rear walls from high level, while the western wall will be propped at lower level, when the excavation extends below the ground level on 7-9 Arthur Road.

It is understood that trees within the property will be retained and protected by means of a tree protection fence. An assessment of the impact of the works on the tree has been carried out by tree specialists (Ref. [12]) and these are not expected to be affected by the works. .

3 The surrounding structures

The proposed basement construction could cause ground movements that extend to the surrounding structures. Those that could be most affected are the adjacent dwellings at number 5 and 7-9 Prince Arthur Road (Figure 5).

3.1 5 Prince Arthur Road

This property is to the north east of the site. It includes a four-storey detached masonry house with a cross-gabled roof, a front driveway, a three-car garage, and a rear garden. Elevations and plans of the structure are shown in Figure 6.

The house is approximately 12m x 12m in plan and is set approximately 10m back from Prince Arthur Road. The ground level at its front is approximately +100.5mOD, approximately 0.4m above street level (Ref. [1]). The ground level at the rear of the house is approximately +100.7mOD. The main house at No. 5 is located approximately 4m away from the existing house at No. 5b.

The property does not appear to have a basement. For the purposes of this assessment its walls will be conservatively assumed to be founded at 0.5m below ground level (bgl) and the property will be assumed to be in good structural condition.

The single garage furthest to the south-west (closest to site) appears to be an addition to the original house, constructed after the original house was built. The garage is between the main house of No. 5 and existing dwelling at No. 5b, approximately 1m from the property boundary (Figure 3).

3.2 7-9 Prince Arthur Road

This property is to the south-west of the site. It is located on the corner of Ellerdale Road and Prince Arthur Road and includes a detached masonry house with front driveway towards Prince Arthur Road. The dwelling also includes a lower ground floor and a rear garden.

The house is approximately 23m x 15m in plan and it is set about 9m back from Prince Arthur Road and 10m back from Ellerdale Road. The ground level adjacent to 5b Prince Arthur Road is approximately +98.3mOD, (Ref. [1]). The ground level at the rear of the house steps up to approximately +99.3mOD to the far east. The main house is located approximately 1.25m away from the existing house at 5b Prince Arthur Road.

An elevation, plan, and section through the house is included in Figure 7.

4 Ground Conditions

A detailed assessment of the ground and groundwater conditions across the site is provided in the GCG's Hydrogeological Impact Assessment (Ref. [9]).

The ground stratigraphy under the site includes the gravelly, sandy layers of the base of the Bagshot Formation underlain by interbedded clayey and sandy layers of the upper Claygate Member, proved to 11m depth. This is anticipated to extend to approximately 16m depth and be underlain by the London Clay Formation, expected to extend to depths in excess of 60m (Ref. [2]). A map of the local geology is shown in Figure 8 (Ref. [3]).

Groundwater has been measured at approximately 7.6m depth (+92.6mOD), although perched water could exist at higher levels.

For the purposes of the design of the piles, it should be noted that a wedge of ground at the western end of the site adjacent to the existing masonry wall could be backfilled soil to the depth of the wall toe.

5 Ground movement analyses

5.1 Background

The construction method for the redevelopment envisages that, having demolished the existing structure, sheet pile walls will be installed around the perimeter of the proposed new single story basement. Excavation within the basement footprint will then take place, using temporary props. The new structure will then be constructed bearing onto a raft foundation.

Inside and outside the basement area ground movements during and after the works would be due mainly to:

- Demolition of the existing structure
- Installation of the sheet piles
- Excavation for the new basement, which would induce a reduction of vertical and lateral stresses in the ground along the excavation boundaries.
- Application of permanent structural loads and ong term consolidation

The magnitude and distribution of the ground movements caused by these operations are a function of changes of load in the ground and workmanship. The way that the existing buildings around the site respond to these movements is dependent on their current conditions and the precautions that are taken to reduce the risk of building movements.

Ground movements inside the basement area should be accounted for in the design of the new basement structure.

5.2 Estimated ground movements

5.2.1 Demolition

The demolition of the existing structure would cause upward ground movements inside the building footprint as a result of the vertical change (reduction) of loads on the ground surface. The ground movements due to demolition have been estimated using PDisp.

The program assumes a linear elastic behaviour of the soil and determines the changes in the vertical stresses and settlement/heave using a Boussinesq approach. Elastic vertical strains are calculated on the basis of the calculated stress changes and then integrated to obtain vertical movements. The calculations represent free field movements unaffected by the stiffness of structures and therefore are likely to be conservative. The soil parameters used for the analyses are summarised in Appendix 1.

The pressures removed as a result of demolition are approximately 30kPa across the building footprint. The results of the analyses show that at the end of the demolition the

ground at the level of the existing foundations would move upwards by 4-5mm in the central part of the building footprint and 1-3mm along the perimeter of the site (Figure 9).

The movements only marginally extend outside 5b Arthur Road.

It should be noted that the demolition will relieve the surcharge currently acting on the retaining wall between 5b and 5-7 Arthur Road.

5.2.2 Installation of sheet piles

The sheet pile walls will be installed using silent and vibration free techniques. Provided that a competent and experienced contractor is employed, the installation of sheet pile walls is not expected to cause significant ground movements.

Any ground movement would be expected to be localised immediately behind the wall and could be expected to cause upward ground movements up to about 5mm.

If pre-auger is required, this should be carried out with care to avoid uncontrolled ground settlements. Water jetting is not recommended.

The new sheet pile walls will have to be designed to retain the ground accounting for the surcharge of the structures behind.

5.2.3 Movements due to excavation

The eastern, front and rear sheet pile walls on site are to be propped at high level by means of a stiff temporary propping system including corner props. The western wall will be propped at the level of the toe of the adjacent masonry wall (i.e. 2m depth) using corner and racking props. This will allow to support the excavation below the level of the ground across 7-9 Arthur Road without applying unduly pressures at the top of the existing masonry wall between the two properties.

Upon completion of excavation, the RC concrete box basement will be constructed. This will need to be designed to work as a permanent retaining structure for the eastern wall without applying unduly pressures on the western wall at high level. The temporary propping should be removed after the ground floor slab has gained sufficient stiffness to support the excavation at this level.

Excavation of the basement would cause ground movements around its perimeter due to deflection of the sheet pile walls into the excavation, and upward ground movements at the base of the excavation.

The ground movements outside the excavated area have been estimated using XDisp. The program calculates settlements and horizontal movements using the curves presented in CIRIA C760, which are an envelope to a database of ground movements measured behind retaining walls in basement excavations across London.

The ground behind the retaining walls would settle and move towards the excavation as the walls bend due to the reduction of lateral support in front of them. The CIRIA database (Ref. [4]) shows that these ground movements depend on the propping sequence and on the depth of the excavation (Figure 10).

For the assessment at this site the CIRIA database for clays has been adopted. This is based on a typical stratigraphy in the London area that includes coarse deposits over

London Clay and is considered applicable to the stratigraphy of the site including coarse Bagshot Sand over Claygate Members.

The movements have also been calculated considering the depth of the excavation relative the ground level around the new basement and accounting for the step in ground level to the west of the site. The proposed excavation is therefore 4.5m below the ground to the east of the site, but 2.5m below the ground to its west. As mentioned above, the new basement excavation will relieve pressures behind the masonry wall running along the western edge of the site.

Using the data in Figure 10 (Ref. [4]) for a 4.5m deep excavation the maximum settlements are in the order of 4mm and the maximum horizontal movements are approximately 7mm. For a 2.5m excavation the maximum settlements are about 2mm and the horizontal movements are less than 4mm.

These movements would occur behind long sections, at the corners they would be restricted to about half of the predicted values.

The ground behind the walls would tend to sag and therefore the maximum settlements would occur at approximately 2m behind the eastern basement wall and 1m behind the western basement wall.

Contour plots of the total predicted ground movements due to excavation only around the new basement area have been constructed and are shown in Figures 11 and 12.

5.2.4 Long term movements

The new structural loads will be carried by the new basement raft and will be of a similar magnitude of the loads removed during demolition and excavation. Therefore, the net change of load on the excavated ground surface is small. Movements caused by the new loads will tend the suppress the heave that had occurred at basement level at completion of the excavation and will have small effects on the ground behind the retaining walls.

The redistribution of the new structural loads on the raft should be taken into account for the design of the new raft.

In the long term the ground will continue to move as an effect of the net change of pressures on the ground due to the redevelopment of the site. These movements will be restrained by the new basement box and are not expected to have significant impact on the neighbouring structures.

6 Discussion of results

6.1 Effects of ground movements on adjacent structures

The predicted ground movements due to the redevelopment of the site will cause distortions of the ground that could affect the surrounding structures. The potential damage to these structures can be estimated as suggested in CIRIA C760 by looking at the combined effects of the horizontal strains and the deflection ratio, which is the ratio between the maximum distortion of a structure and its length.

These effects are discussed below:

6.1.1 5 Prince Arthur Road

Figure 9 indicates that the demolition of 5b Arthur Road could induce heave across the garage structure in the order of 1- 2mm. In fact, the stiffness of the structure will tend to restrain movements, which are therefore likely to be smaller than predicted. These might induce a slight tilt of the garage away from the site, with negligible effects. The installation of the new retaining walls is unlikely to cause ground movements that would extend to the structures on 5 Prince Arthur Road.

The movements in Figures 11 and 12 show that the excavation could cause distortions across the garage and a slight tilt of the main house towards the new basement.

The distortions of the garage are estimated to be just under 0.02% measured through the centre of the structure, where strains are anticipated to be at a maximum. The tensile strains will be just under 0.04%. These would induce a potential damage that can be classified well within Category 1 in the Damage Category Table shown in Figure 13.

The main house would tend to tilt towards the site experiencing maximum settlements of 3mm along its western wall. Due to the stiffness of the structure the ground movements are likely be smaller than estimated in Figures 11 and 12 and are likely to result in some shearing of the structure that could result in some cracks forming at the junctions of the walls and around the openings. The house could experience horizontal strains of 0.04%, which classify the potential damage of the structure as 'negligible' in the Damage Category Table shown in Figure 13.

6.1.2 7-9 Prince Arthur Road

The house on 7-9 Prince Arthur Road is not expected to be affected by ground movements due to demolition and the installation of the new retaining walls.

During excavation the expected ground movements would tend to cause minor, negligible distortions of the house (less than 0.01%), which in fact would only tend to tilt slightly towards the new excavation experiencing maximum settlements of its eastern wall of approximately 2mm. The tensile strains across the house are anticipated to be below 0.04%.

These would induce a potential damage of the house and any internal wall that can be classified within Category 0 in the Damage Category Table shown in Figure 13.

6.1.3 Other surrounding structures and infrastructures

The contour plots in Figure 11 and 12 show that limited ground movements are expected across Prince Arthur Road (i.e. approximately 5mm horizontally and <4mm vertically).

There are no known sewers and major utilities around the site that can be adversely affected by the redevelopment.

6.2 Monitoring

It would be prudent to monitor movements during construction. Monitoring targets could be installed on the walls of the adjacent properties and on the retained structures. Base readings should be taken before work commences.

In the different stages of construction, movements could be small and maybe within the limits of the measurement accuracy. Therefore it is suggested that only overall trigger levels are applied to movements of the walls.

Based on the predictions discussed above, the following trigger levels on the horizontal and vertical movements of the retaining structure are suggested:

Trigger Level	Movements [mm]
green	<7
amber	7-10
red	>10

7 Slope stability issues

The Hampstead area and the surroundings are considered to be vulnerable to slope instability due to the ground conditions and the sloping gradient of the ground.

Potential land instability has generally been associated to slopes of 8° or greater both in the London Clay and in the Claygate Member (Ref. [5,6]) although the mechanisms that could drive the potential instability are different in the two types of soils.

Figure 14 shows the areas that are prone to slope stability issues as mapped by the British Geological Survey (BGS) (Ref. [7]). The BGS mapping is based on factors such as geology and groundwater conditions, in addition to the slope angle.

The specific site conditions at 5b Prince Arthur Road do not suggest that issues with general land stability exist.

The slope of the ground across the site is negligible as the site itself is roughly level at a level of +100.2mOD. The maximum slope of the surrounding area is less than 5^{o} sloping downwards in a south westerly direction and will not be altered.

The retaining walls of the new basement will be designed for the surcharge of the existing structures and the ground behind.

During construction the walls will be propped hydraulically and "out of balance forces" will be partly resisted by the ground in direct bearing and sliding ("passive" resistance) through the props or transmitted through the side walls to the soil in shear. In the permanent condition there will be no additional global "out of balance forces" over and above those present in the temporary condition.

Given the hydrological conditions of the site, it is unlikely that pore water pressure increase in the clayey units of the Claygate Member could cause instability of the ground.

8 Conclusions

The impact of the proposed basement construction on the surrounding structures has been assessed using empirical methods and linear elastic analyses.

The site will be subjected to net load changes following demolition, excavation of the basement, and subsequent construction of the proposed dwelling. The design of the basement foundation should be carried out considering these load changes.

Providing that good workmanship and a robust construction sequence are used and that full support is provided to the retaining walls during excavations, the basement construction is unlikely to cause settlements and horizontal strains that would induce other than limited damage to the surrounding structures. The western wall should be propped at a level below the toe of the adjacent masonry wall to avoid unduly pressures on this wall.

The proposal has not impact on the existing trees.

Monitoring of movement during construction is recommended.

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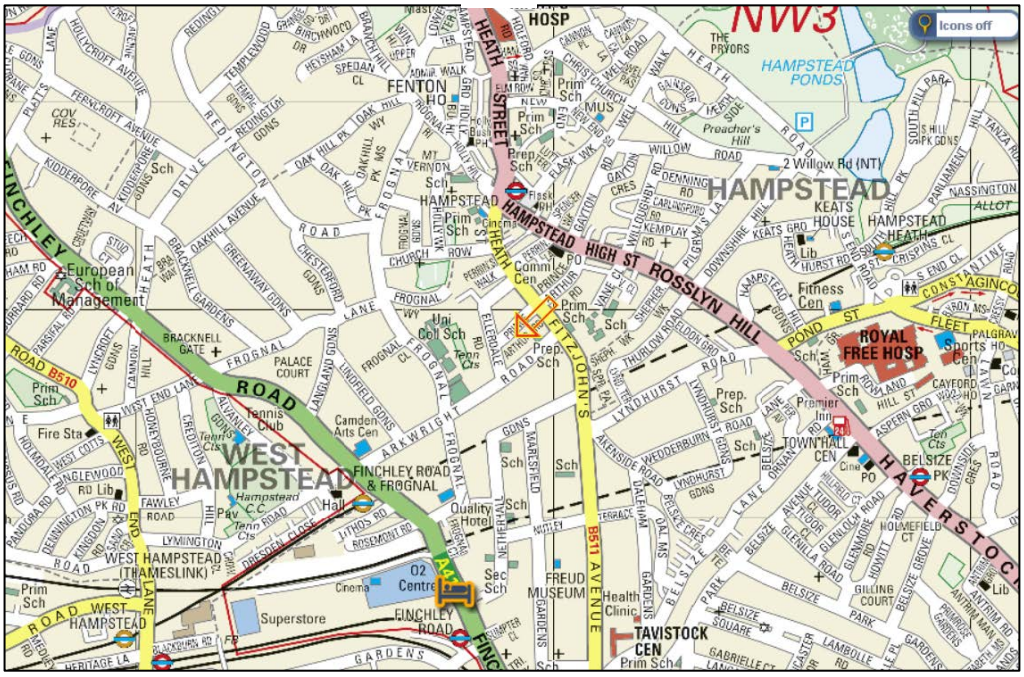
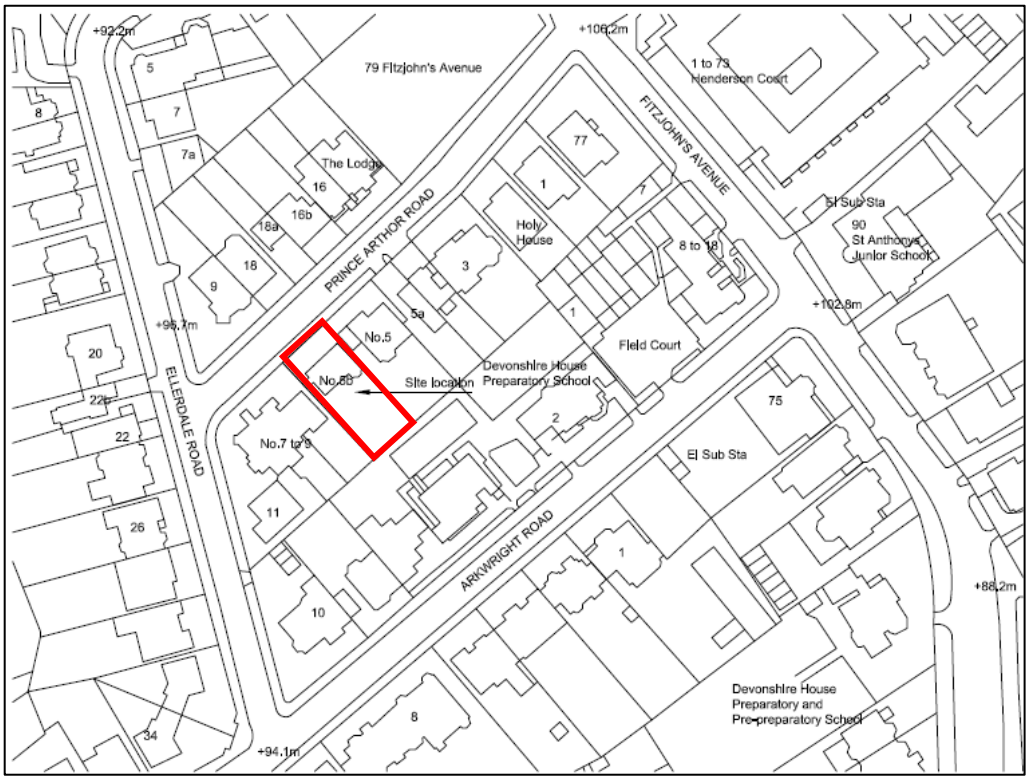
FIGURES

(a)



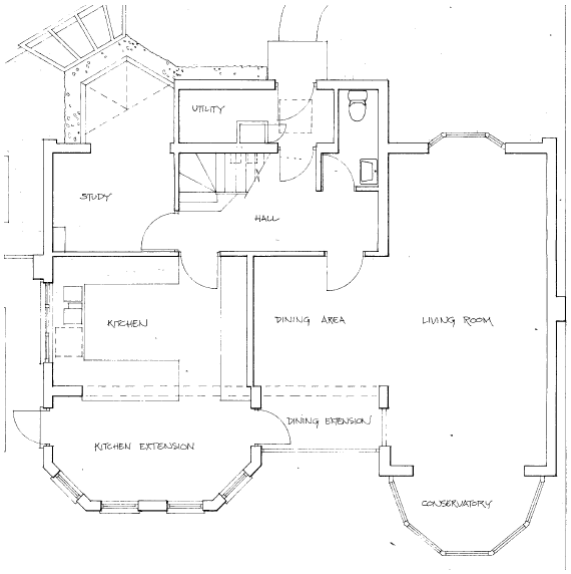
Ordinance survey © Crown Copyright (2018) All right reserved. Licence number

(b)



	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure**
	The Site a) Location b) site layout	**1**

(a)



(b)

SIDE ELEVATION

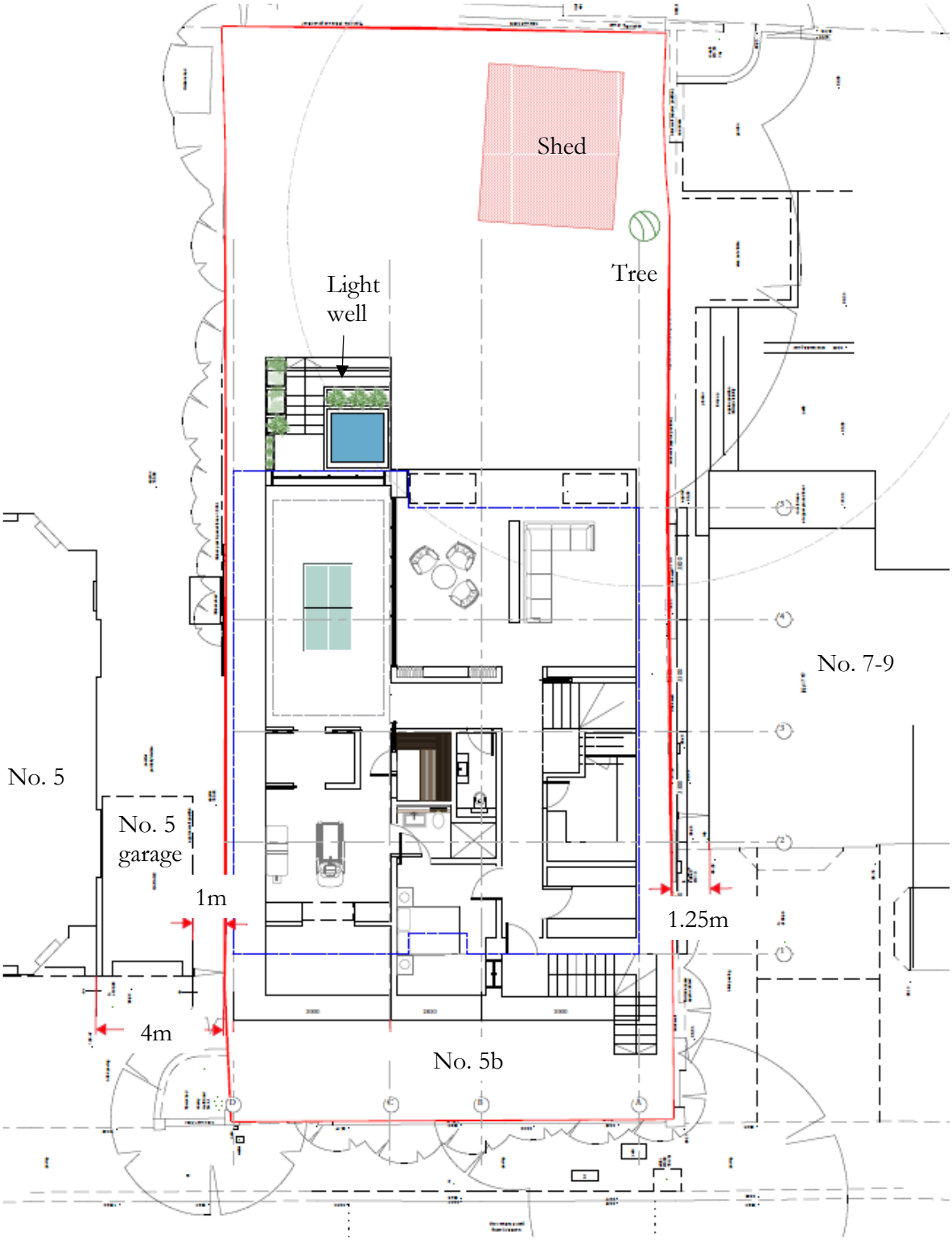
(c)

NORTHWEST ELEVATION (FRONT)

(d)

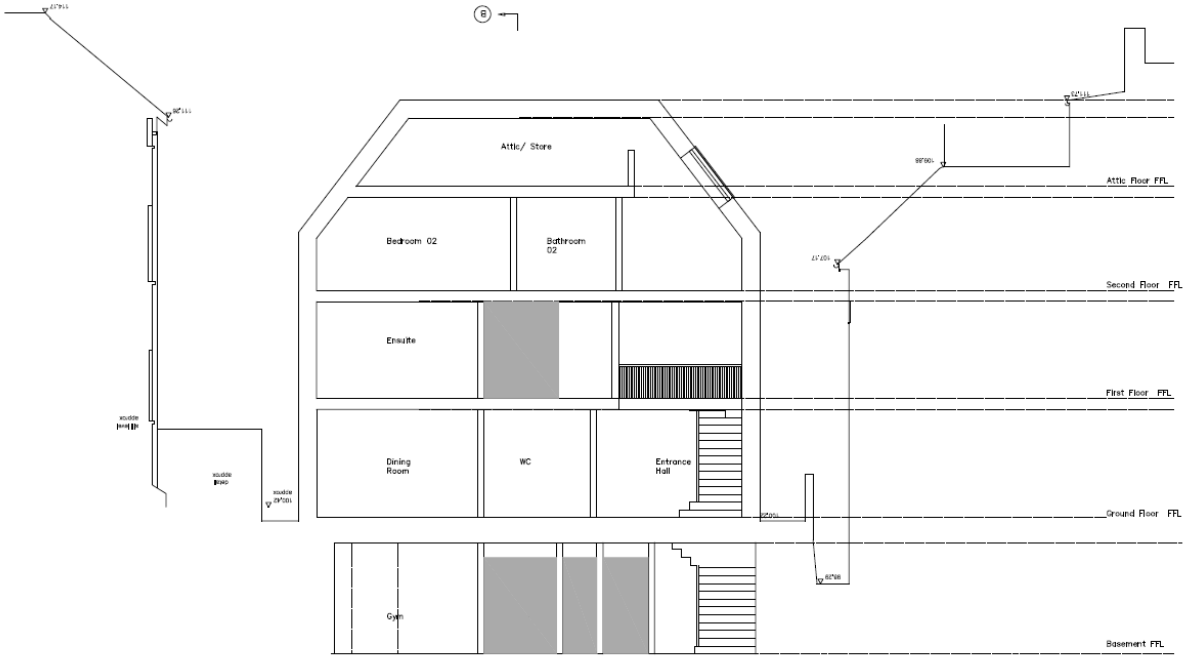
GARDEN (SOUTH WEST) ELEVATION (REAR)

	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **2**
	Existing Structure (a) Plan, (b) Side, (c) Rear, and (d) Front elevation	

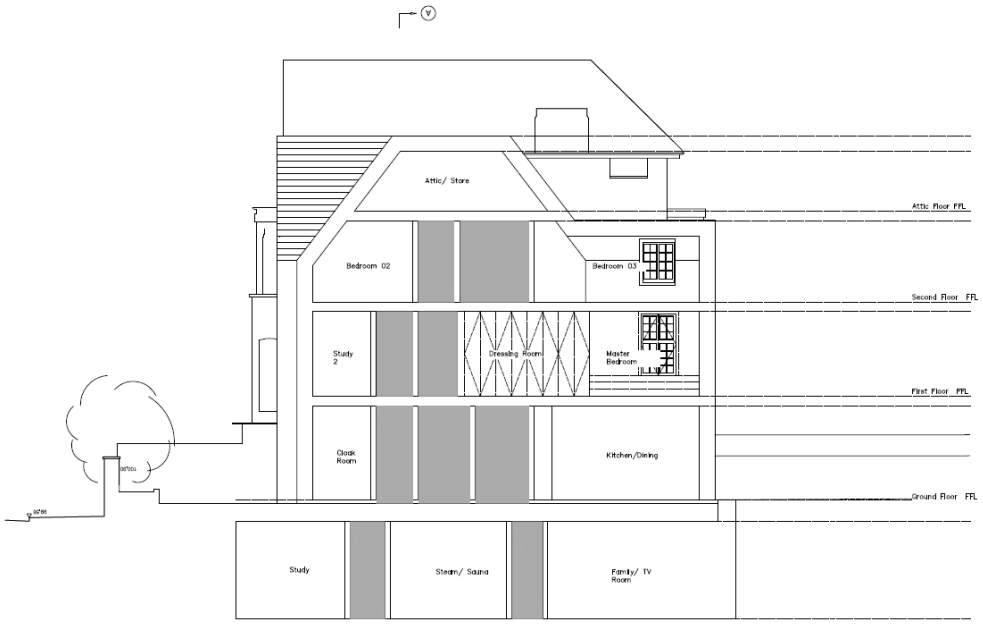


	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **3**
	Proposed basement Plan of the basement and footprint of proposed dwelling	

(a)

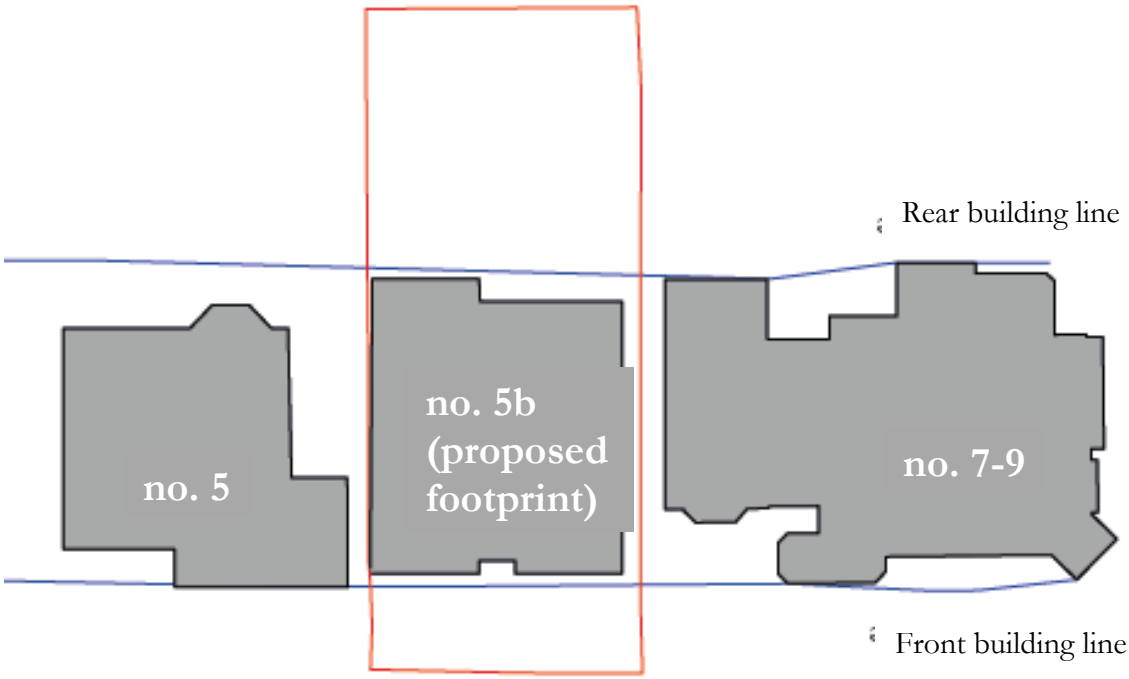


(b)



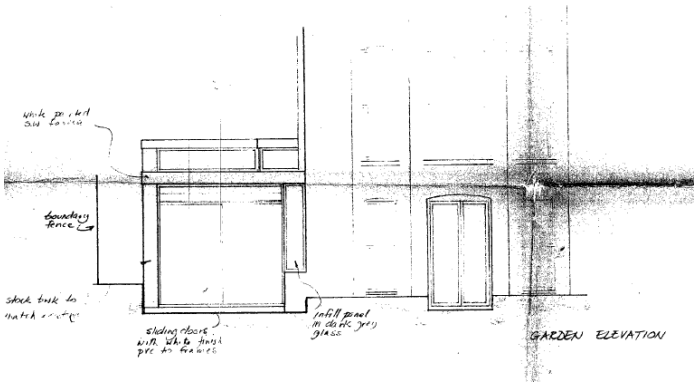
	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **4**
	Proposed basement (a) North-east to south-west and (b) north-west to south-east section	

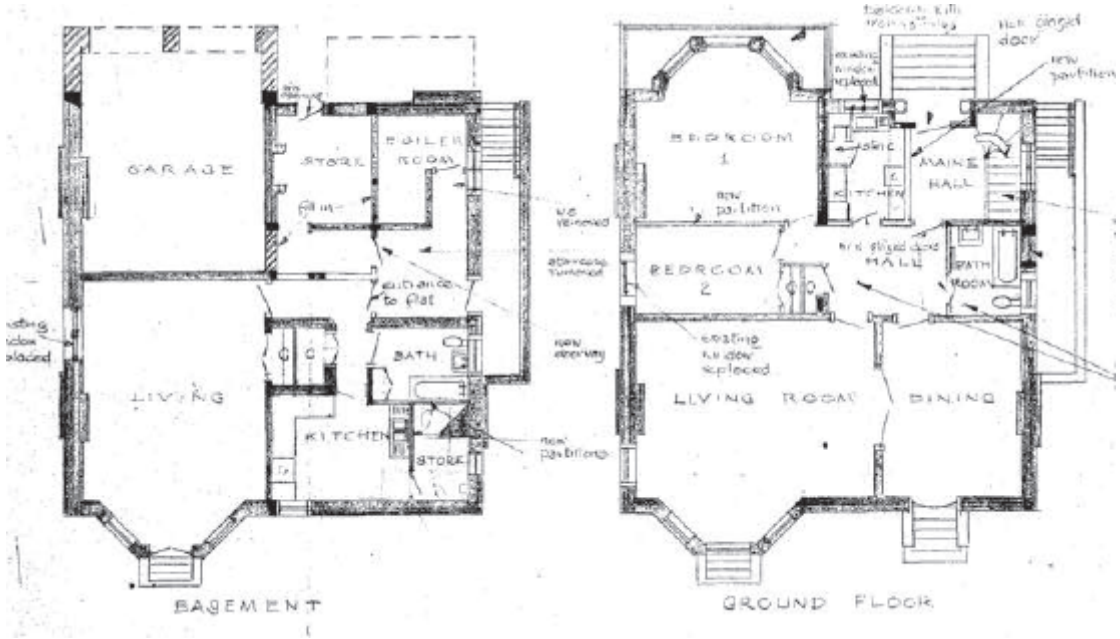
(a)



(b)

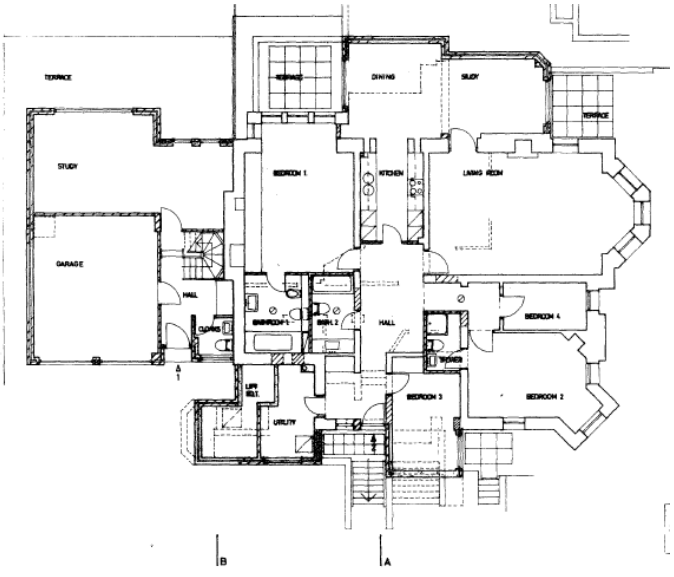
	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **5**
	The adjacent properties on Prince Arthur Road a) Plan b) Elevation	



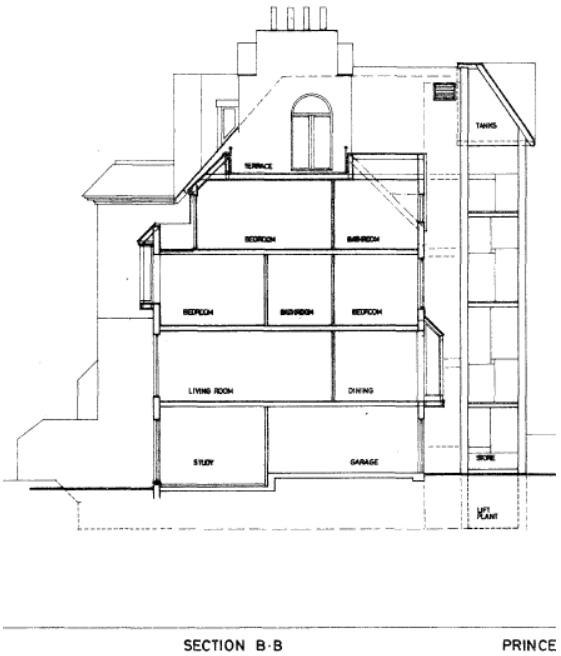


	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **6**
	The adjacent properties on Prince Arthur Road 5 Prince Arthur Road	

SOUTH WEST ELEVATION 7·11

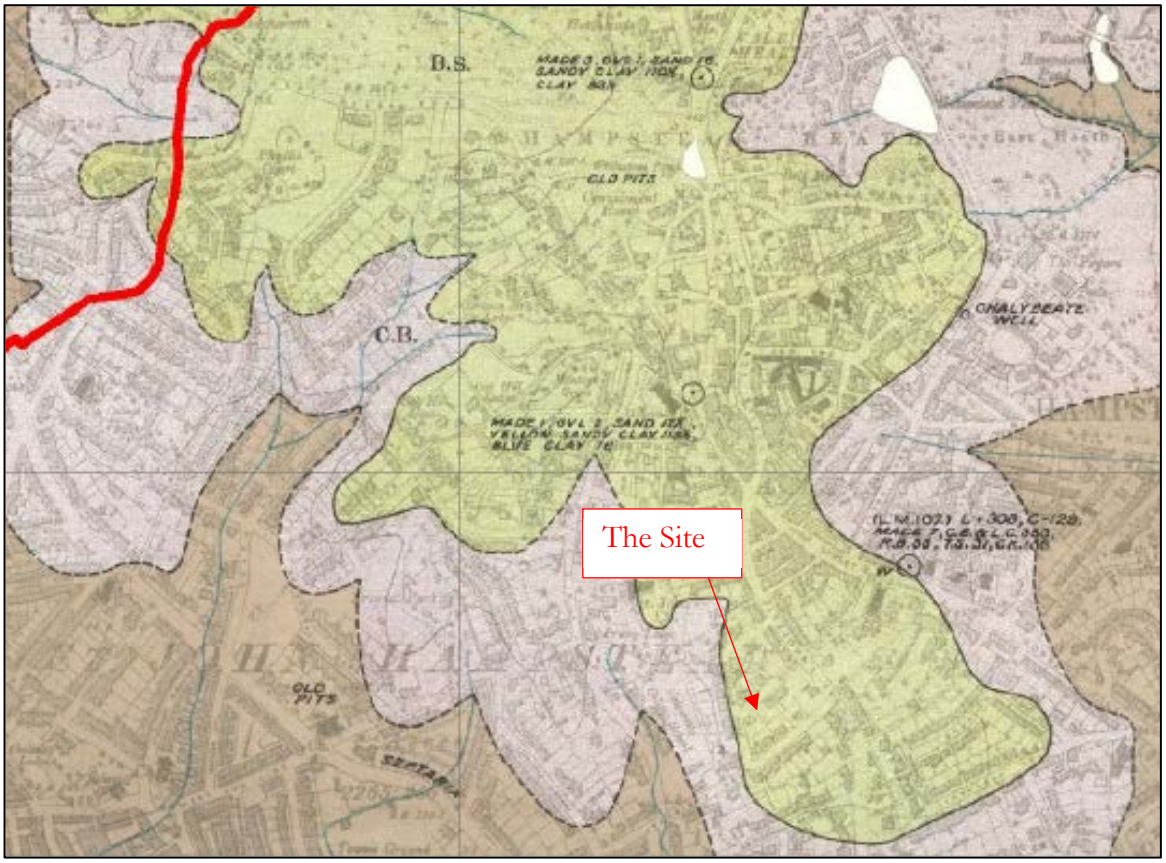


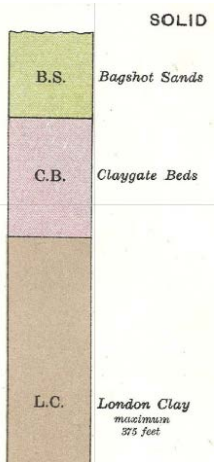
LOWER GROUND FLOOR PRINCE



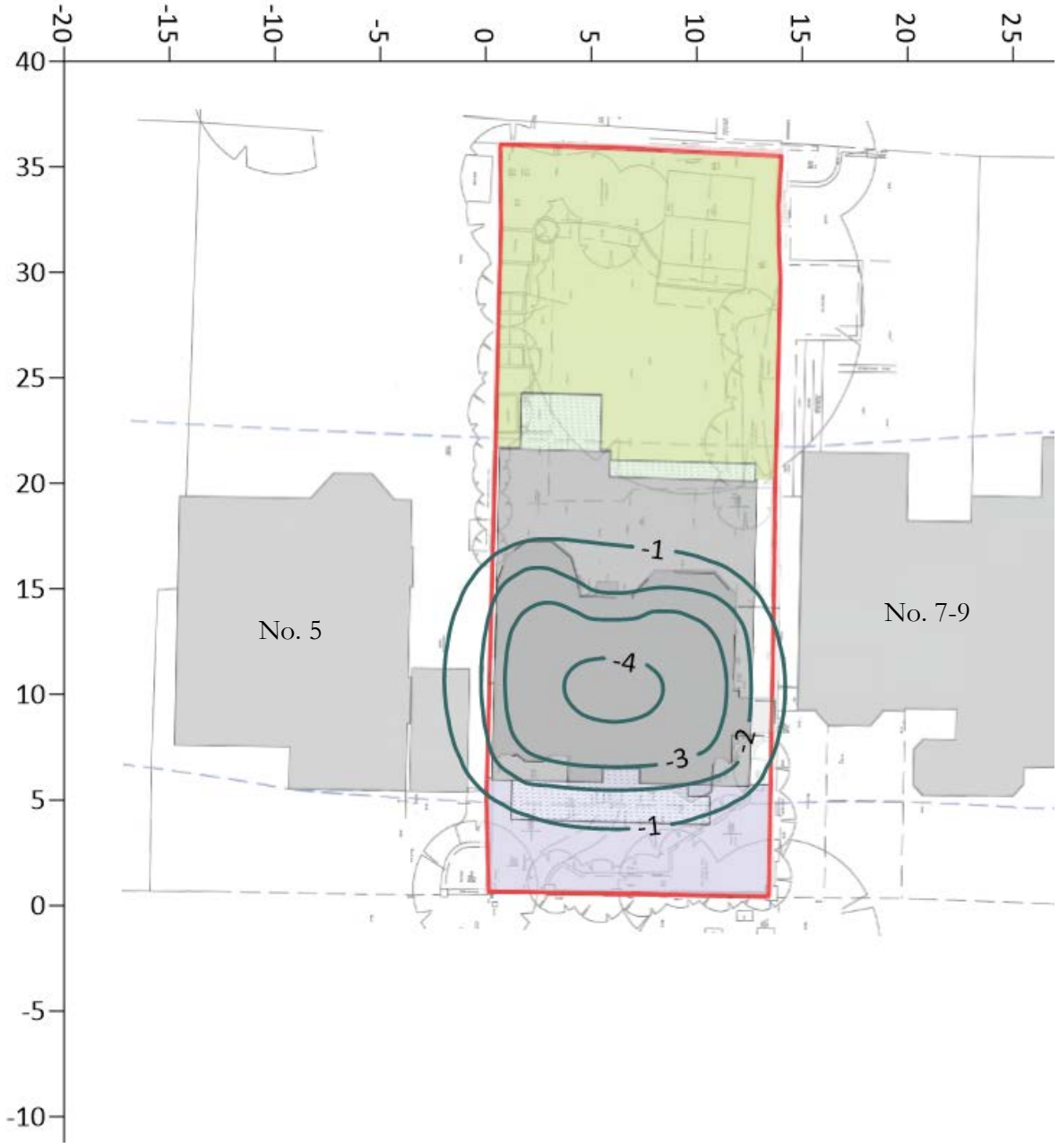
SECTION B·B PRINCE

	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **7**
	The adjacent properties on Prince Arthur Road 7-9 Prince Arthur Road	

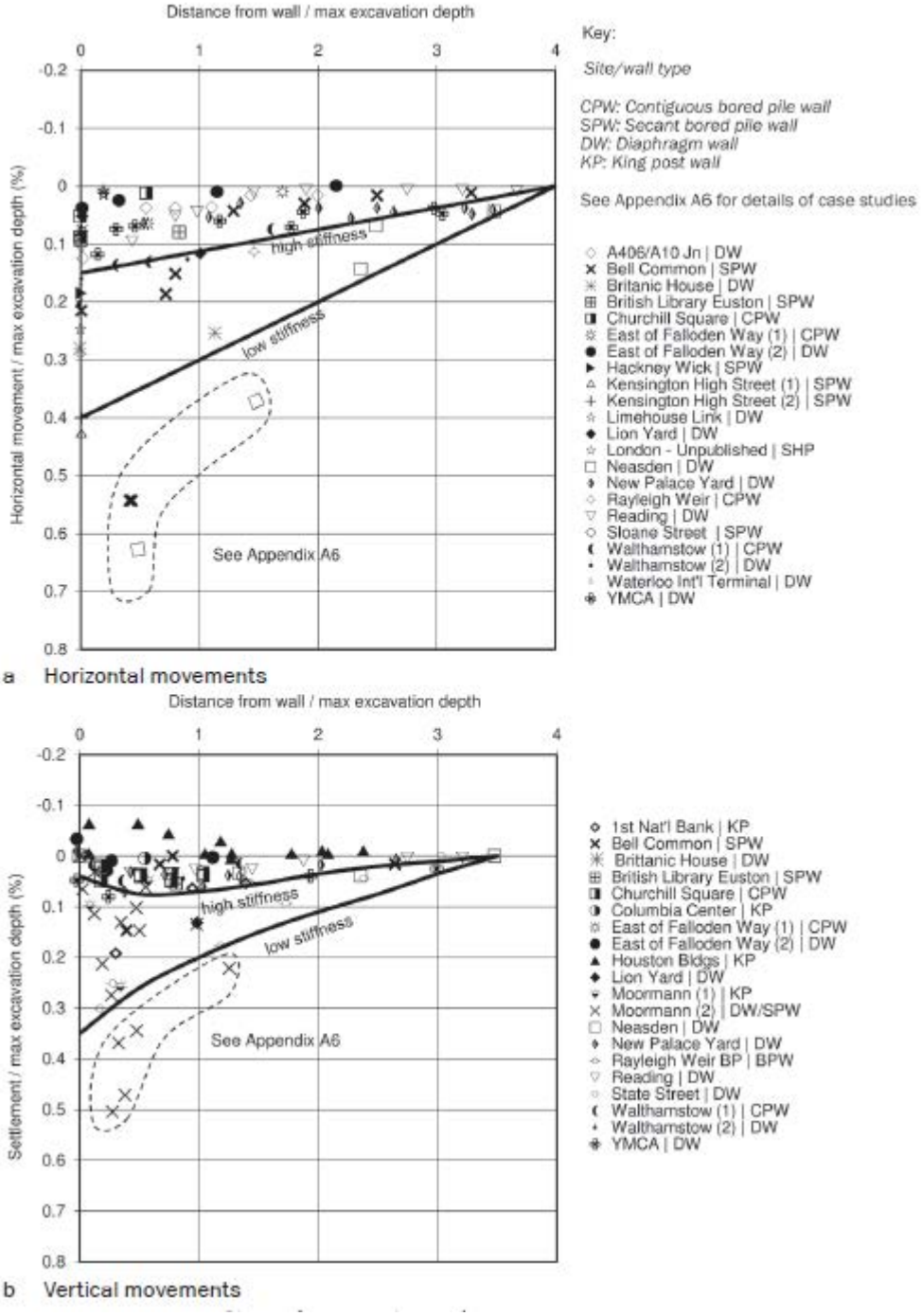




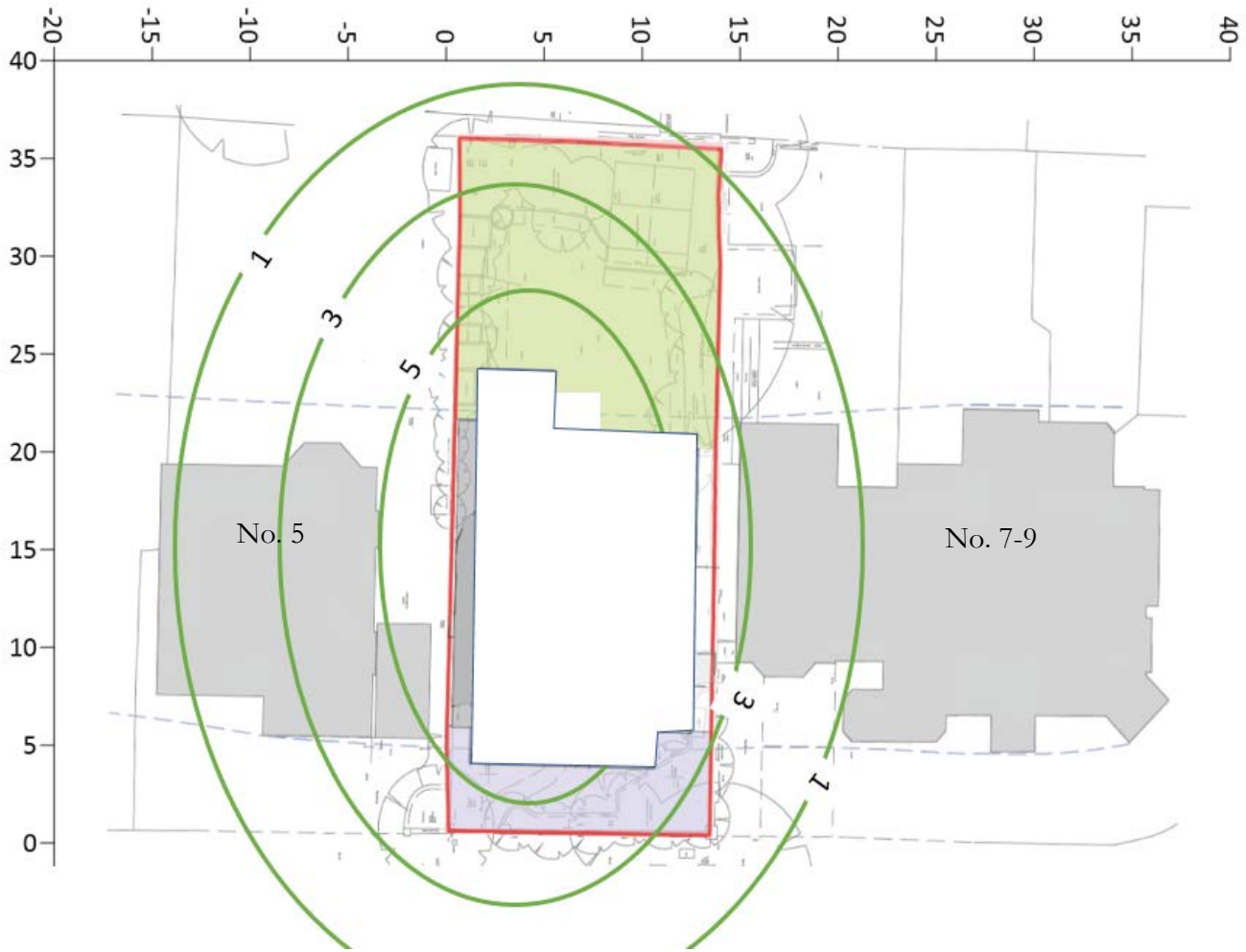
	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **8**
	Extract from The BGS Map (19920) Reference [XX]	



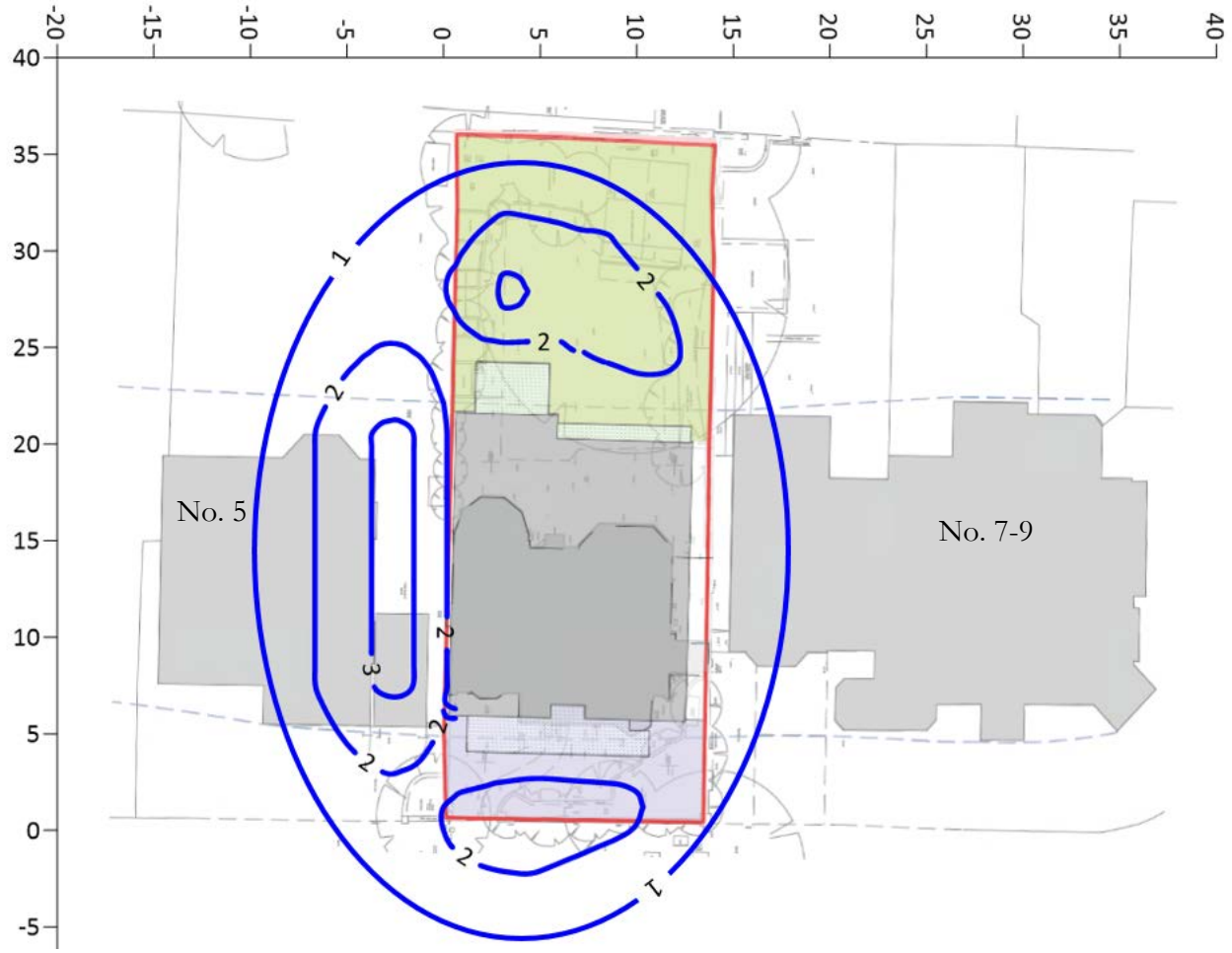
	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure**
	Predicted ground movements due to demolition (mm)	**9**



	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure**
	Field measurements of ground movements due to excavation in front of wall in stiff clay (CIRIA C760)	**10**



	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **11**
	Ground movements induced around the site Total horizontal movements behind retaining walls (mm)	



	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **12**
	Ground movements induced around the site Total vertical settlements (mm)	

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain ε_{lim} (per cent)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.0–0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05–0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	< 5	0.075–0.15
3 Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5–15 or a number of cracks > 3	0.15–0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 but also depends on number of cracks	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	usually > 25 but depends on number of cracks.	

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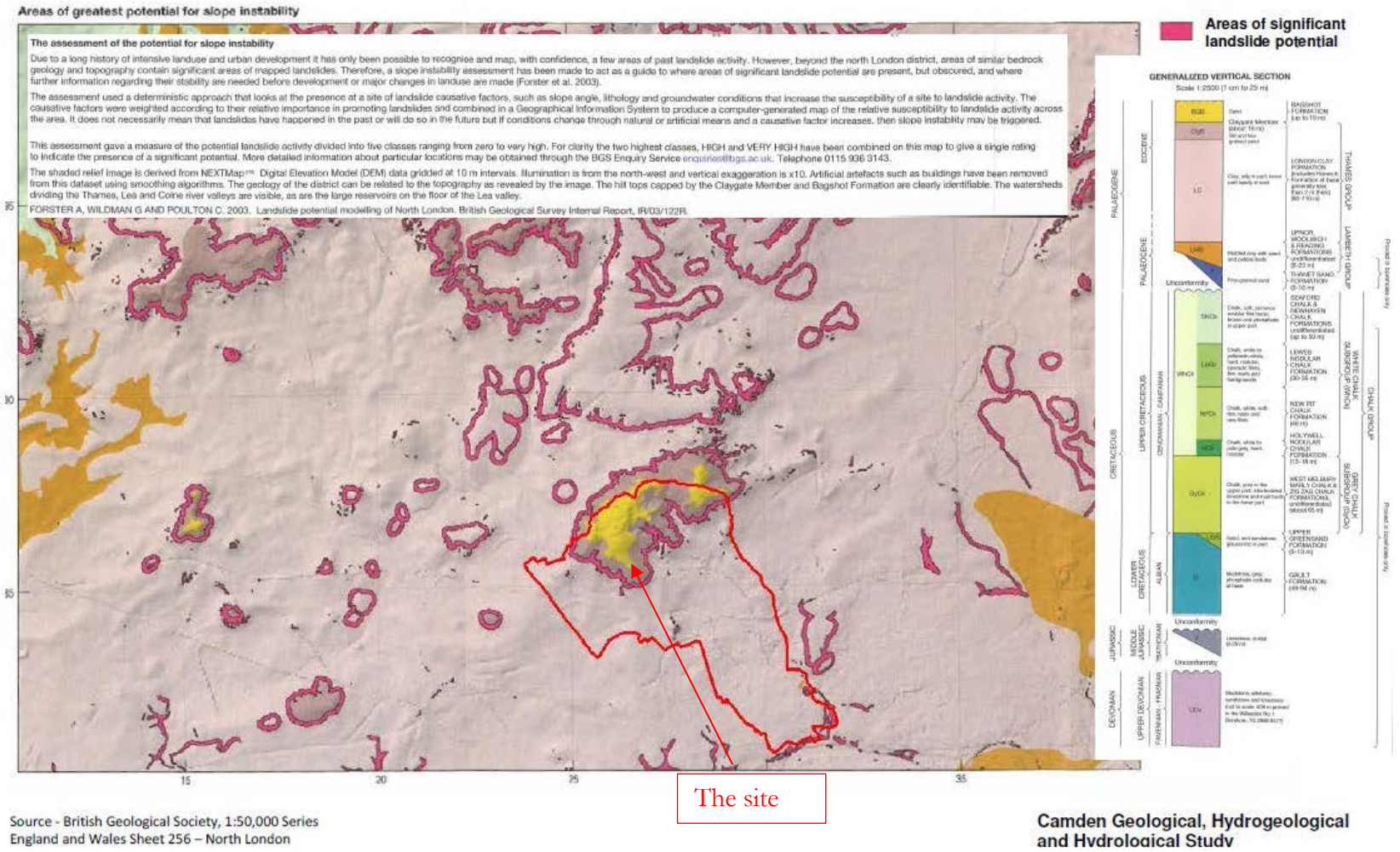
Figure 13

Damage Category Table, CIRIA C760



	Taylor Whalley Sprya 5b Prince Arthur Road, London NW3 6AX	**Figure** **14**
	Areas of significant landslide potential (Arup 2010)	

A.1 Appendix A- Soil parameters used for PDisp calculations

The soil parameters for the ground movements analyses have been selected based on experience and on published information on the mechanical behaviour of the soil at the site (Ref. [10, 11]).

Given the limited information on the stiffness response of the Bagshot sand and the Claygate Members, their stiffness have been conservatively assumed as follows:

Bagshot Sand:
The stiffness has been based on the average SPT response (E'=2N) but it has been increased by a factor of two to account for a reduced tendency of this soil to swell under a reduction of load, which the ground would be mostly subject to for the purposes of this assessment.

Claygate Members:
The stiffness has been based on the response of the upper lithological units of the London Clay Formation.

For the purposes of the ground movement analysis based on an isotropic soil model, the For the purposes of the ground movement analysis based on an isotropic soil model, the elastic (small strain) undrained stiffness of the London Clay (E_{uo}) can be taken as:

$$E_{uo}=800p' \qquad (1)$$

where the mean effective stress p' has conservatively been calculated considering a coefficient of earth pressure at rest Ko equal to 1.

For the analysis it has been assumed that the proposed works will give rise to strains in the more superficial strata of the Bagshot Formation and Claygate Members, which will reduce their elastic stiffness. The stiffness reduction has been calculated based on the magnitude of the anticipated strains.

In summary, the following soil conditions and soil parameters have been assumed in the analyses:

Stratum	Level at top [mOD]	Undrained Unloading Stiffness E_u [MN/m^2]	Drained Stiffness E' [MN/m^2]
Made Ground	+100.2	-	50
Bagshot Formation	+99.0	-	70
Claygate Members	+93.8	17.6+8.1z	0.75 Eu
London Clay	+83.8	98.3+7.4z_1	0.75 Eu
Rigid boundary	+34	-	470

Where z is the depth below the top level of the top of the Claygate Member and z_1 is the depth below the London Clay.

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HYDROGEOLOGICAL IMPACT ASSESSMENT

REV 0

May 2020

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