99 FROGNAL

STRUCTURAL OVERVIEW AND DESIGN CRITERIA

STRUCTURE
WORKSHOP

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CONTENTS

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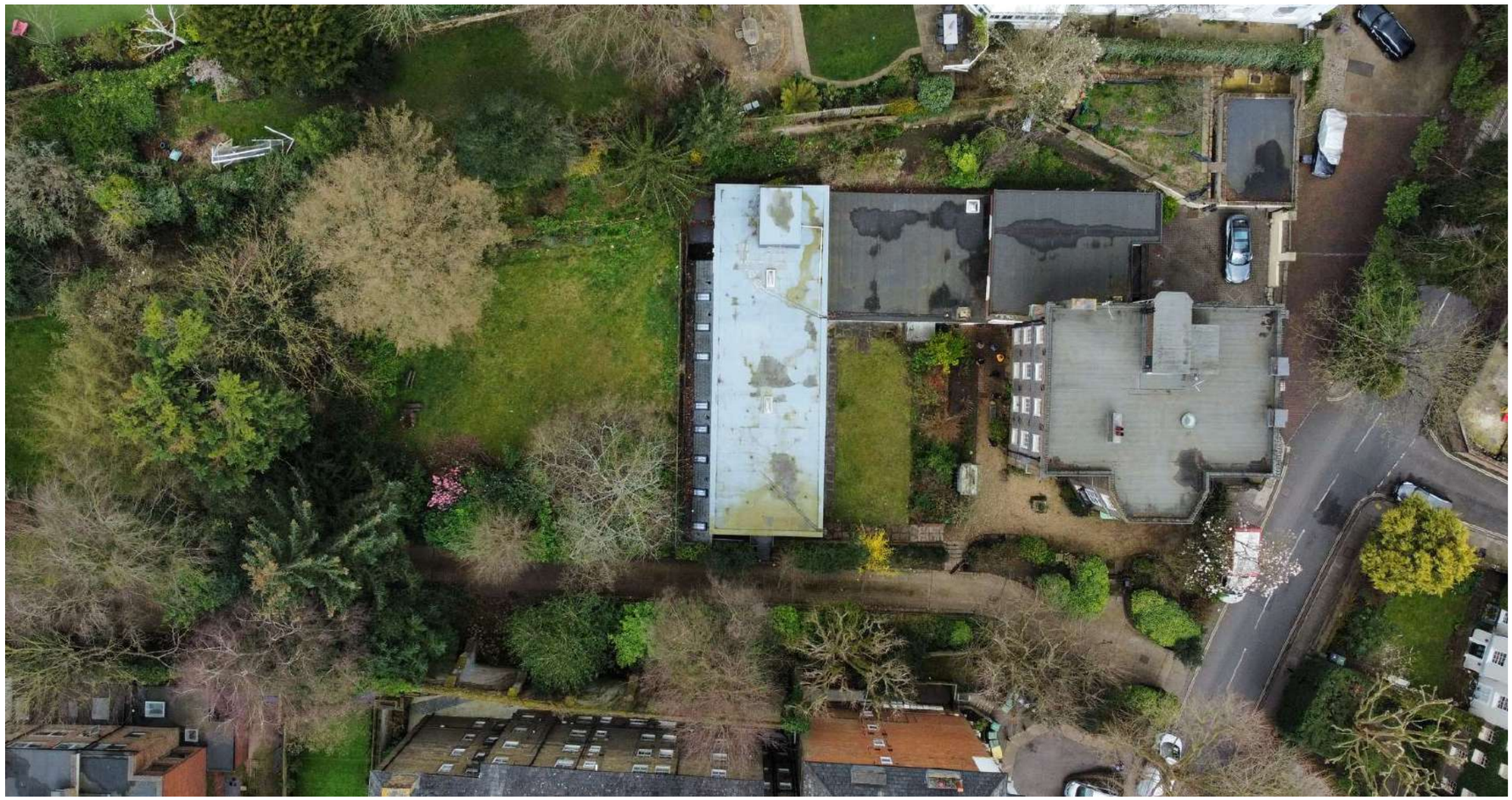
1 INTRODUCTION

This report outlines the structural design criteria for 99 Frognal, led by Hayhurst and Co Architects. The project is currently at RIBA Stage 3, which has involved developing the strategy for the primary building structure across the site and organising the site investigations and opening up works to inform the detailed design.

The site is in Hampstead within the London Borough of Camden. The existing property is a large three-storey main house constructed in circa 1740. The main house has been extended with a two-storey L-shaped building in the back garden constructed in the 1970s. This project involves restoration of the main house, adding new roof extension. The existing extension will be taken down and replaced with new extension buildings and new basement. The existing garage space in the northeast corner of the site will be extended to provide new dwellings that are partially buried into the landscape.

A Basement Impact Assessment (BIA) prepared by A2 Site Investigation (A2-SI) for the basement has been carried out based on a preliminary proposed sequence of construction for the safe construction of the basement. The BIA concludes that the impacts identified can be mitigated by appropriate design and good construction practice. Refer to Structure Workshop ‘Basement Construction Structural Report’ for details.

A ground investigation has been carried out by A-SI, which included extensive trial pits and boreholes across the site to provide quantitative data on the ground conditions. Following this, A2-SI carried out a Ground Movement Assessment to assess the impact of the proposed works on existing structures and neighbouring properties.



2 ARCHITECT’S PROPOSALS

The proposal is to restore the main house to its original intended use as a single-family dwelling, undoing some of the non-original alterations including removal of 20th century partition walls and non-original staircases, and reinstating the original plan. The also includes construction of a new mansard roof, providing an additional floor level with a roof terrace.

The 1970s L-shaped extension to the west of the house is to be carefully demolished and a new extension built in its place that integrates with the landscape. The new extension includes a large basement to be constructed roughly within the footprint of the existing 1970s building. The basement will contain a pool, sauna, utilities and plant space.

The proposals also include the construction of three additional housing units on the property. Two housing units will be located below the raised vegetable garden north of the main house, and the other will form part of the new extension to the main house.

PRE-APPLICATION, HAYHURST & CO ARCHITECTS

3 SITE OVERVIEW

3.1 EXISTING BUILDING

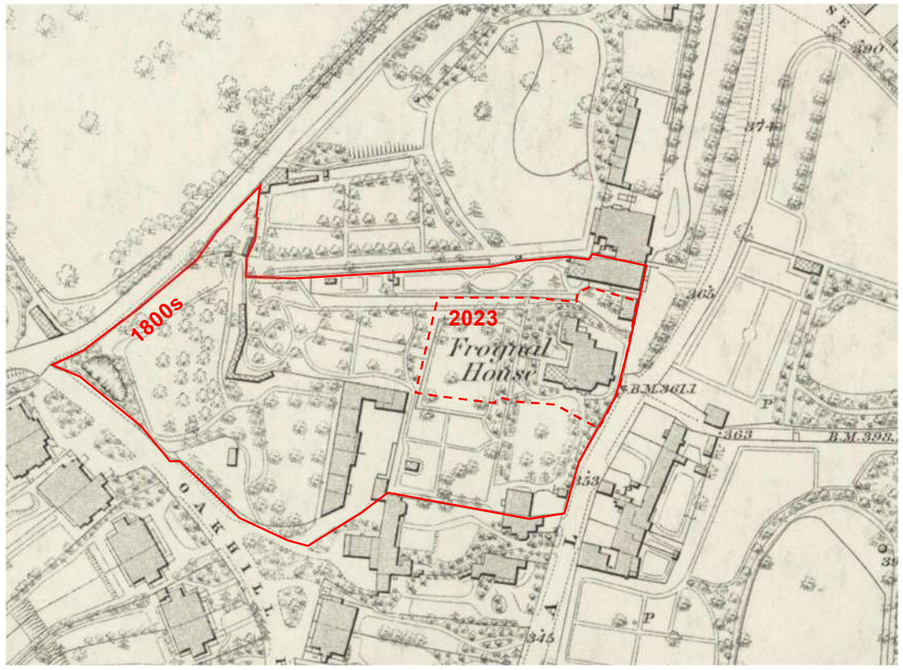
The property is located in Hampstead, North London, just west of Hampstead Village and southwest of Hampstead Heath, within the London Borough of Camden. No. 99 is close to the northern end of Frognal, a steep road that runs from Finchley Road up to Branch Hill / West Heath.

‘Frognal House’ (now 99 Frognal) is thought to have been constructed in circa 1740, and the estate to have originally included Upper Frognal Lodge (No. 103) and a small mews terrace to the south west. The main house was used as a private residence for many years, between the years of 1862 to 1869 it housed the Sailors’ Orphan Girls’ School and Home, between the years of 1942 and 1944 it was a wartime residence to General Charles de Gaulle, and between the years of 1968 and 2021 it was home to the Sisters of St Dorothy convent.

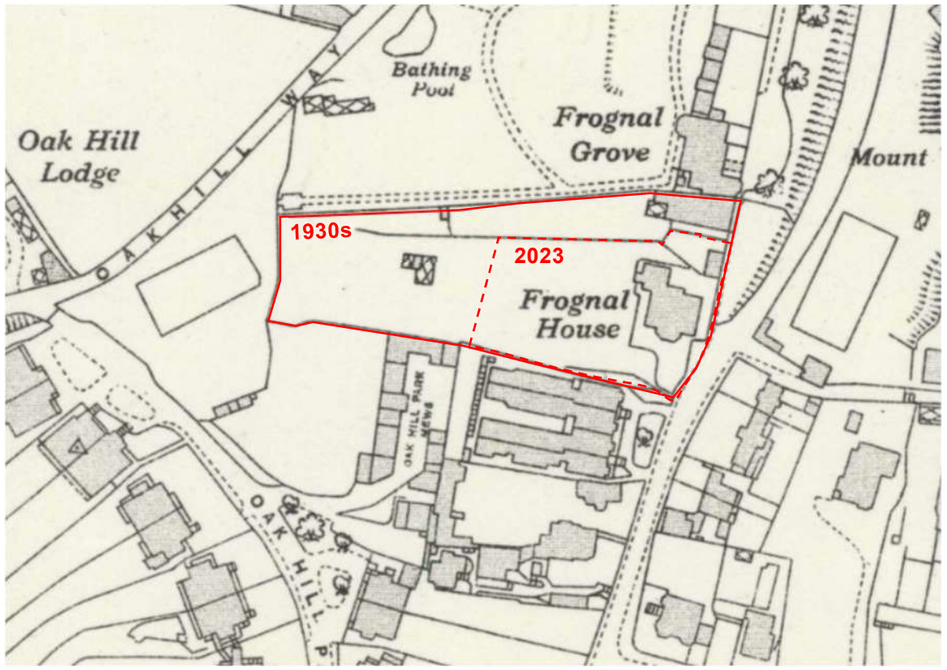
Historic maps indicate that there was previously an extension on the south west corner of the main house that has since been removed. To the north east of the house, an existing garage exists bounded by a series of stepped brick walls that resolve the changes in ground level and also form the boundary with no. 103 Frognal. There are no other known historic building structures in the gardens of the main house that fall within the current site boundary, which is much smaller than it once.

The existing house is three storeys with a roof terrace and small basement. Historic records show there was previously a mansard roof level which is thought to have been removed in the 1930s. The main house is built of solid load-bearing brick walls, with timber floors and a timber roof. It is understood to have originally been built with a rectangular plan, with the canted bay on the south elevation added later in the 18th century. Some of the brickwork on the main house was refaced in 1890. The reinforced concrete art deco style staircase and glazed bay was added as part of the renovations undertaken in the 1930s.

A large L-shaped two-storey extension to the north and west of the main house was constructed in phases in the 1970s-80s, purpose-built for student accommodation. This brick faced structure is framed in reinforced concrete with concrete slabs, columns and foundations. There is a reinforced concrete wall retaining a level change of approximately 4m on the north, west and south sides of the western wing.



ORDNANCE SURVEY MAP 1866



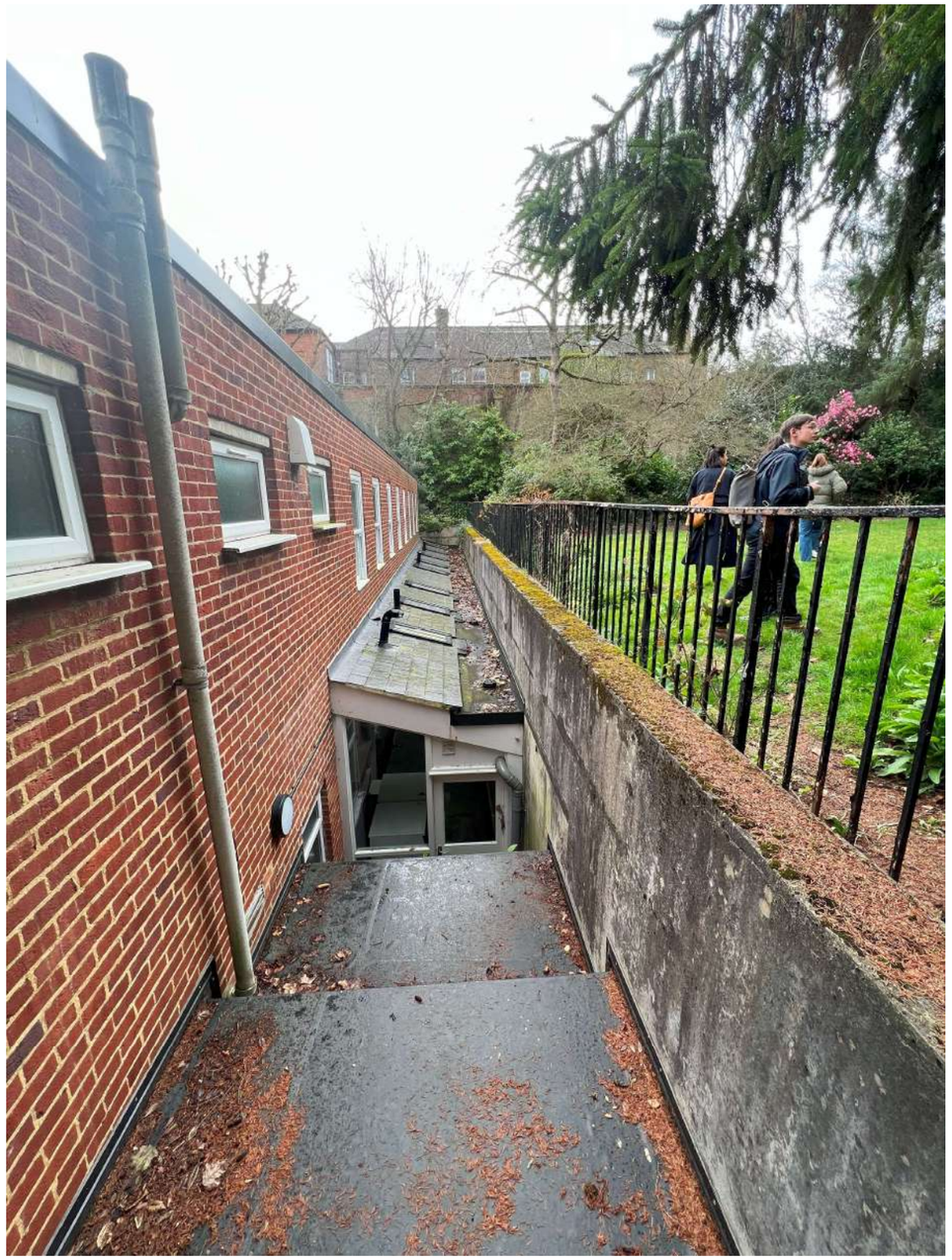
ORDNANCE SURVEY 1934

ORDNANCE SURVEY 1895

SATELLITE IMAGERY 2020

SW

MAIN HOUSE VIEW FROM WEST



RETAINING WALL IN UPPER REAR GARDEN

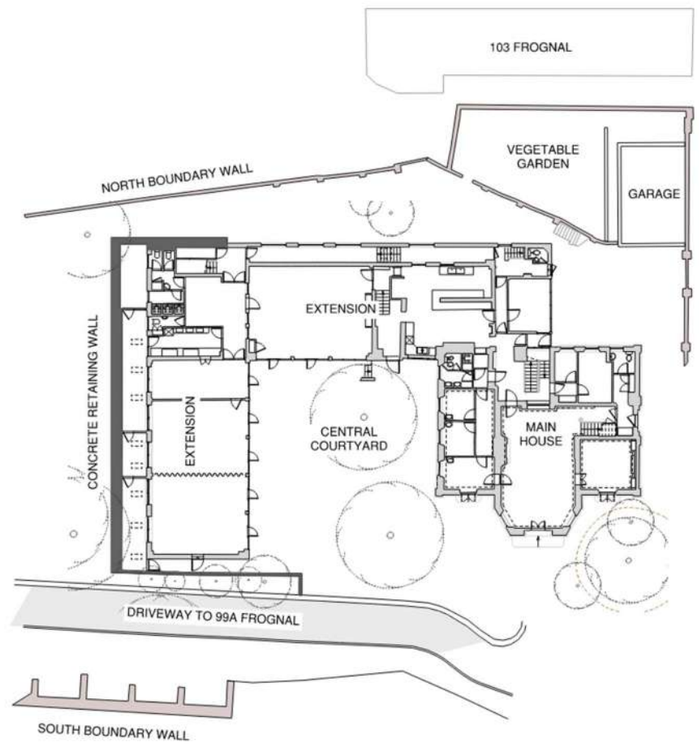
3.2 SITE BOUNDARIES

There is a large freestanding brick wall along the property's southern boundary, built in 1896 by the owner at the time to shield his view of the adjacent flats being built. It was claimed to be 'the highest independent wall in London, 42ft high and 6ft thick at the bottom". This wall has large chamfered buttresses and is partially concealed by vegetation. Adjacent to this walls is a driveway within the property boundary that provides access to 99A Frognal to the west.

Along the northern boundary there is a historic brick retaining wall that separates 99 Frognal from no.103. The top of the wall is 2-3m above ground level on the 99 Frognal side. This boundary wall retains the neighbouring land, with the closest point of the neighbouring building being approximately 2m away. The wall is bulging in areas, has been previously extended upwards and has some buttresses toothed in.

At the eastern boundary is Frognal (the road) and a driveway up to no.103, separated from 99 Frognal with a freestanding brick wall with piers and black-painted railing along the frontage.

At the western boundary there is a low brick garden wall with wooden fencing above to separate the property from 99A.



SITE BUILDING PLAN

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SOUTHERN BOUNDARY WALL

NORTHERN BOUNDARY WALL

3.4 TOPOGRAPHY

A topographic survey has been undertaken which covers all areas within the property boundary including the adjacent footpath and road. The land is sloping up to the north and west, from a level of 109m AOD at the eastern extent up to 119m AOD at the north-western corner. Behind the northern wall of the extension building the land slopes up from a level of around 112.5m AOD to a level of 114m AOD at the boundary wall.

99 FROGNAL TOPO SURVEY MAP

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3.5 BOMB DAMAGE

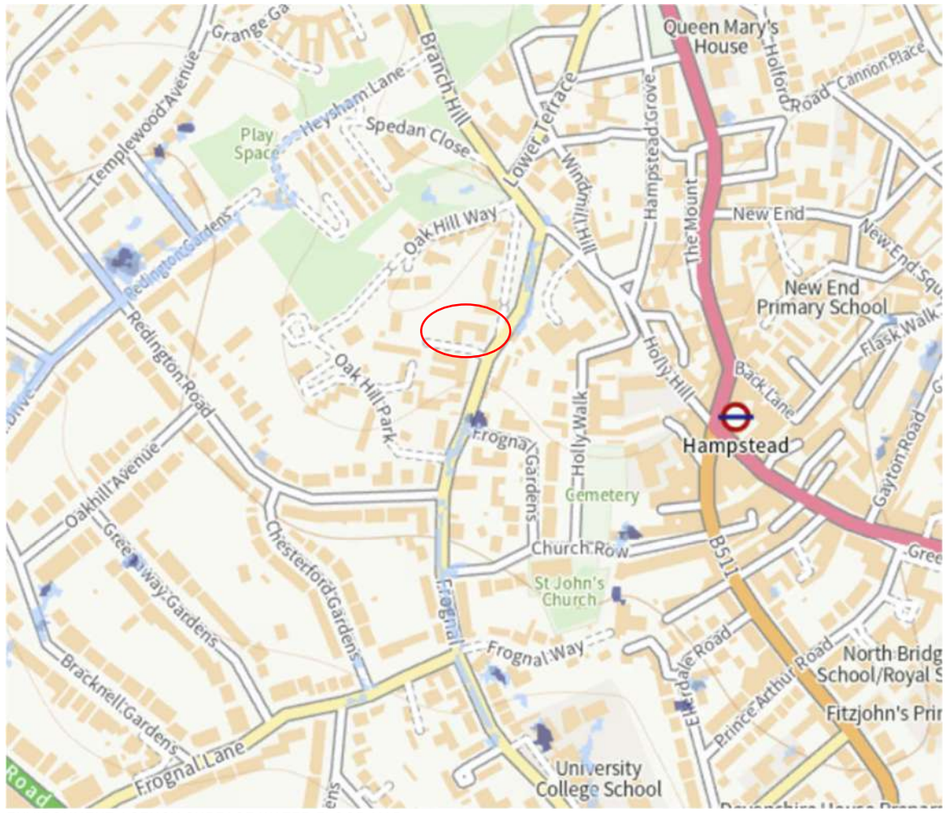
London bomb census records suggest that there was no bomb damage to 99 Frognal (then ‘Frognal House’) or to any of the properties immediately adjacent. Across the road approximately 25m from the property there was general blast damage recorded at one property.

A preliminary UXO assessment has been carried out by Brimstone Site Investigations. The assessment found a potential bombing incident on site and as such it is recommended that a Stage 2 Detailed Risk Assessment is undertaken before any construction activities take place.

LONDON WWII BOMB DAMAGE MAP

3.6 FLOOD RISK

The property is at very low risk of fluvial flooding and very low risk of surface water flooding, meaning there is less than 0.1% (1 in 1000) annual probability of flooding.



ENVIRONMENT AGENCY SURFACE WATER FLOOD MAP

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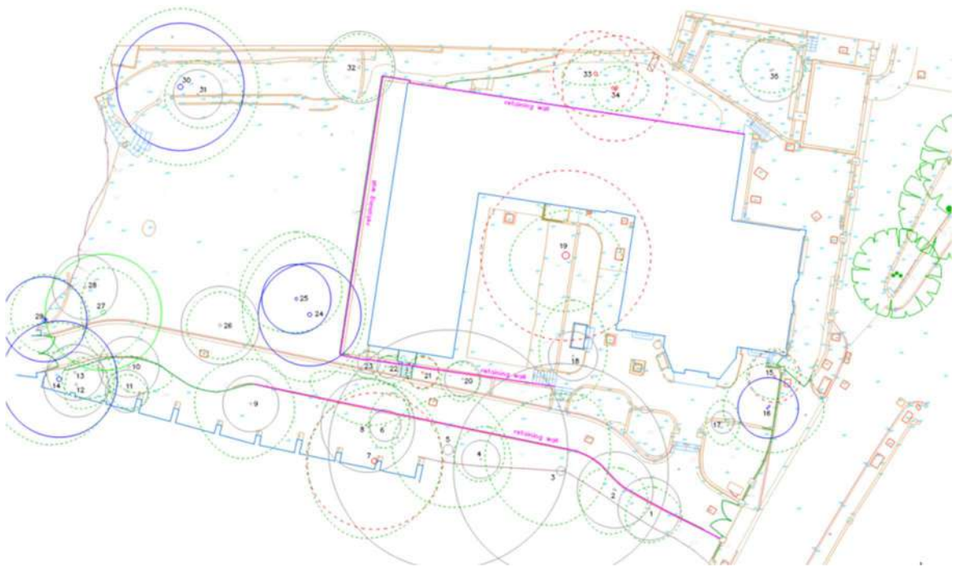
3.7 SURROUNDING VEGETATION

Refer to the Architect's plan for the locations of existing vegetation and root protection areas.

The arboriculturist's survey was undertaken in February 2022. At the time of survey there was a total of 35 trees recorded on the property, most of which were located towards the south along the driveway, and mostly all sound and healthy. 5 of the 35 were found to be in poor condition and recommended for removal: one large Beech along the southern boundary wall; one Winter cherry between the driveway and the concrete retaining wall; one Goat willow in the central courtyard, and two Cherry trees behind the north wall of the extension. These are indicated in red in the figure below.

There are several trees in close proximity to the concrete retaining wall which may be affected by any proposed construction works here. However, given that the trees are at a raised ground level approximately 4m above the ground level at the top of the excavation, and given that the existing concrete retaining wall is not being removed as part of the works, it is not expected that works will clash with any root protection areas. The proposed basement foundations will extend below the influence of any existing and future planting.



99 FROGNAL ARBORICULTURIST SURVEY PLAN, 2022

3.8 GROUND CONDITIONS

The British Geological Survey (BGS) mapping shows that site is underlain by Bagshot Formation, with no superficial deposits. The Claygate Member and the London Clay Formation are also shown in close proximity to the site and are thought to underlay the Bagshot Formation.

A number of historic borehole record on the BGS website within the surrounding area show the presence of made ground in the top layers.

BGS MAPS – BEDROCK GEOLOGY

KEY

- BAGSHOT FORMATION - SAND
- CLAYGATE MEMBER – CLAY, SILT AND SAND
- LONDON CLAY FORMATION – CLAY, SILT AND SAND

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3.9 SITE INVESTIGATION

A site investigation was carried out by A2-SI in June 2023 to provide site-specific information to support the design of the proposed development. The investigative works comprised:

- 3no. cable percussion boreholes to depths 15-25m
- 1no. window sampling borehole to depth 5m
- 16no. hand-dug trial pits with in-situ strength testing
- 2no. CBR tests
- 1no. dynamic probing to confirm the geometry of the existing retaining wall (TP17)
- Falling head tests to provide an indication of soakage rates
- Installation of 4no. standpipes for groundwater monitoring
- Laboratory testing of soil properties and contamination

Refer to the Interpretive Report prepared by A2-SI for full findings.

The ground conditions discovered on site are summarised in the table below:

DESCRIPTION OF GROUND	START (M BGL)	END (M BGL)
Made Ground	0.00 - 0.30	0.50 - 1.20
Bagshot Formation	0.50 - 1.20	3.80 - 9.20
London Clay Formation – Claygate Member	3.80 - 9.20	> 20.60

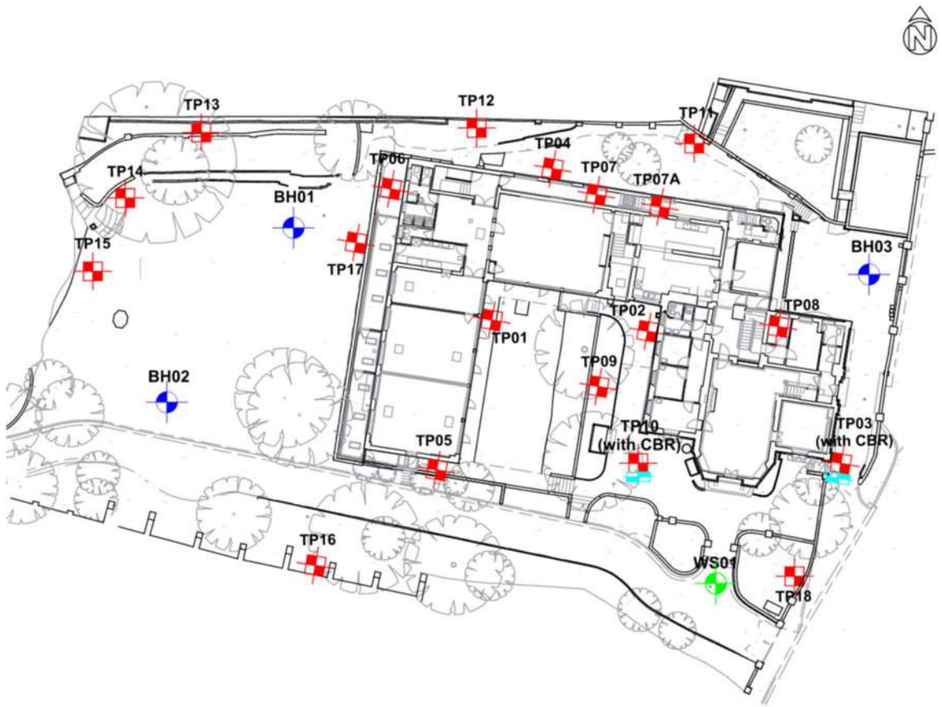
The trial pits were located to identify structural footings of the existing buildings and boundary walls.

- Concrete footings to external masonry walls of main house, bearing at depths 870mm (TP02) and 1300mm (TP03) below ground level.
- Suspected concrete raft foundation to extension building, approx. 750mm thick (TP06)
- North boundary wall founded on brick corbels over concrete strip foundation, bearing at 640mm below ground level.
- South boundary wall footing is more than 1700mm below ground level on 99 Frognal side.
- The existing RC retaining wall around the west-wing of the existing extension has a toe projecting approx. 700mm from outside edge, encountered at 3800mm below existing ground level in rear garden (TP17).

The groundwater monitoring readings taken in June and July 2023 encountered groundwater between +106.74 and +109.99m AOD across the site, which is considered to be perched water within the Bagshot Formation. It is recommended that a design water table 1.0m bgl is adopted for structural design in the long-term condition.

EXPLORATORY HOLE	GROUNDWATER DEPTH (M BGL)	GROUNDWATER LEVEL (mOD)
BH01	5.65 - 5.70	109.85 - 109.99
BH02	5.82 - 5.87	109.77 - 109.82
BH03	3.50 - 3.56	107.18 - 107.24
WS01	2.09 - 2.47	106.74 - 107.12

Some exceedances for lead concentration were detected at two locations and an exceedance of asbestos concentration at one location, within the made ground stratum. From the dataset retrieved it is not possible to determine whether these contaminants are localised or more widespread. Additional testing is proposed in advance of any site works to ensure suitable protection is provided to site workers if required.



SITE INVESTIGATION PLAN

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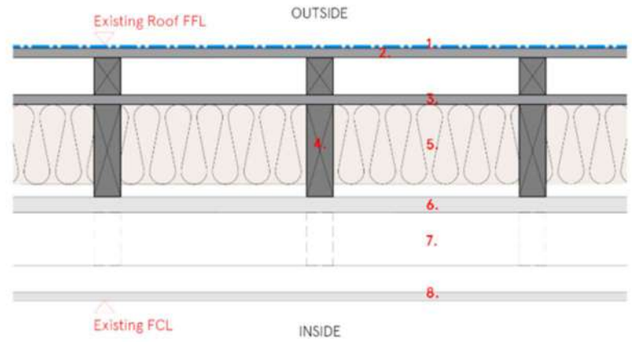
3.10 STRUCTURAL INVESTIGATIONS

A first round of targeted opening up works in the main house were carried out in April 2022 to collect information on the existing wall, floor and ceiling build-ups. These helped identify the original loadbearing structure and vertical load path through the building.

In order to retain as much of the existing fabric as possible and for design development in subsequent stages it is proposed that further structural investigations are undertaken to confirm the nature and condition of key existing structural elements to be relied upon for the proposed main house works. This will include confirming some assumptions made at second floor level around existing beams and columns, some of the joists spans at roof level, and confirming the structure around the north staircase.

Existing Flat Roof Build-up:
Main Roof

1. Roofing felt
2. Roof deck to nominal falls on timber furrings (assumed)
3. Roof deck
4. Timber roof joists
5. Between joist insulation
6. Lathe and plaster ceiling (extent and condition unknown - potentially partial)
7. Ceiling void
8. Plasterboard ceiling with paint finish on suspended sub-frame



EXISTING ROOF BUILD UP, HAYHURST & CO ARCHITECTS

FLOOR BUILD UP OBSERVED AT FIRST FLOOR LEVEL

PHOTOGRAPH FROM EXISTING ROOF LEVEL, MAR 2023

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4 MAIN HOUSE

4.1 SUBSTRUCTURE

The external brick walls to the main house are founded on shallow strip footings that bear on the clay soils. There is a small basement level at the north side of the house, accessed from the north stairwell. The underside of the basement foundation shave not been fully exposed, but probing undertaken during site investigation works found them to be at least 550mm below the basement floor level.

No changes to the existing foundations of the main house are proposed. The structural works to the house are not extensive and the new roof level extension is proposed in light-weight timber, adding an approximate 3% increase in total load. This, in addition to the knowledge that there was previously a historic roof extension for a portion of the roof that has since been removed, has satisfied us that the foundations do not require a structural upgrade as part of these works.

4.2 SUPERSTRUCTURE

The structural works to the main house are intended to be light-touch in order to safeguard historic fabric. Where alterations are made conservation principles have been favoured to retain the character of the original building. The existing building is three storeys above ground with brick load-bearing walls and timber floors. Internal walls are also in loadbearing brick, with some additional partition walls in timber stud or blockwork. There are 3no. existing brick chimneys at roof level that are bonded into load-bearing walls.

Some previous alterations to the building have been made including installing a new full height reinforced concrete staircase and works to the adjacent façade in the 1930s. Some non-original beams have also been installed to facilitate localised removal of internal walls.

Proposed internal alterations include taking down the majority of non-loadbearing partitions, returning rooms to their original volume. Demolition of the east stair at second floor level and the 1930s north staircase is also proposed. This will be replaced with a new stone stair from first floor up to roof level.

Where exposed the primary structure of the main house was found to be in fair condition, however some historic movement of the west external wall is apparent. This wall has been previously stabilised with decorative pattress plates tied into the floors. Inspection of the condition of these repairs has not yet taken place. Allowance for temporary lateral propping and protection to the wall during the site works has been made. As part of the works all external walls are to have any loose mortar raked out and repointed in a suitable lime mortar. Some additional masonry repairs may be required.

A new mansard roof extension is proposed to add an additional storey over the majority of the building. The entirely timber roof structure has sloping timber stud walls below a traditional hipped timber roof. The proposed design is such that the timber studs and rafters provide intermediate propping support to the long span timber eaves and ridge beams. Timer is thought to be most appropriate to limit embodied carbon of the construction, and also to limit additional weight on the building below, thereby reducing the requirement for strengthening.

This new structure is to be supported off the existing roof structure as much as possible. Some new steel beams are proposed within the depth of the existing roof joists to support the mansard walls where they do not align with loadbearing walls below. Some additional opening work to the roof structure is proposed including a timber decay survey for retained roof timbers. Should replacement timbers be required, these would be sized to match the existing joist depth to avoid interference with the hung ceilings below.

At ground floor a connection will be made to a new replacement extension. This will require adjusted openings through the brick walls. The foundations for the extension are to be set back from the main house so as not to interfere with the existing retained foundations.

5 EXTENSION

5.1 SUBSTRUCTURE

The basement structure is proposed in reinforced concrete with a secant piled perimeter wall. Refer to Structure Workshop ‘Basement Construction Structural Report’ for further details.

The basement formation level is approximately 6.5 metres below existing ground level due to the added depth for the swimming pool (not including localised sumps). The rear garden to the west of this building is approximately 4m above the existing ground floor level, so it is proposed that the existing concrete retaining wall remains in place during the works so the basement can be constructed from the lower level. Site inspections have revealed that this existing retaining wall does not rely on support from the building itself but will likely require additional stabilising measures prior to breaking out the concrete base slab. It is proposed that this could take the form of ground anchors to free up working space, which would be designed for temporary loading but become redundant once the final structure and landscaping is in place. To batter back behind the existing wall for basement construction would require a ~13.6m wide berth, and with spatial limitations due to the north boundary wall and the driveway to 99a this was not considered a practical option.

Due to high measured groundwater levels in this location, a secant piled wall is proposed to the perimeter of the basement to control groundwater during construction. In the permanent case water-resistant concrete lining walls are also proposed around the perimeter in addition to an internal drained cavity for waterproofing.

A piled ground beam within the basement footprint will break up the span of the basement ground slab and, together with the perimeter walls, resist uplift forces. The slab is to be cast on a void former to mitigate against heave forces on the underside of the basement slab being transmitted to the building.

The RC roof slab will provide a propping force to the top of the secant piles. An internal upper basement slab provides a services zone underneath for storage of pool-associated plant, which is proposed to be precast hollowcore panels suspended on blockwork walls, for ease of construction.

The perimeter and internal piles will be installed from existing ground level, and the pile capping beam and basement roof slab cast in-situ will provide lateral propping at the top of the piles. There is a large opening proposed in the roof slab at the south end of the basement, which will provide access and egress between the basement and gardens at ground level, and which can also be used to facilitate a ‘top-down’ construction sequence.

5.2 SUPERSTRUCTURE

The proposed structure above ground will be largely timber framed with some natural stone elements to limit embodied carbon. Along the northern edge of the proposed extension the surrounding ground level is raised above the ground floor level, therefore some concrete retaining walls are required at heights to match the landscaping.

There are two feature roof areas, one at ground floor and one at first floor level. These will comprise timber joists spanning onto a large, forked glulam timber ridge beams that bear on to cantilevering post-tensioned stone beams. These in turn are supported on loadbearing stone external walls and propped with circular stone columns. The remainder of the roof is proposed to be green roof, which will be a supported a largely exposed timber structure.

6 GARAGE HOUSES

6.1 SUBSTRUCTURE

The two housing units proposed in the north-east corner of the site are to be at ground level to match the driveway and existing garage. This will require excavation of the existing raised vegetable garden. This means that the perimeter walls must be designed as retaining structures to maintain stability of the neighbouring property and adjacent land.

The existing garden walls here are proposed to be retained in the interest of heritage protection, therefore these will be underpinned with mass concrete and stabilised with temporary internal lateral propping prior to excavation works. Underpinning is proposed in two vertical lifts to reduce the depth of excavations, to be carried out in sequence with the temporary lateral propping.

The ground slab will be suspended on piled ground beams, similar to the proposed basement construction. Permanent lateral stability to the existing walls and adjacent retained earth will be provided by reinforced concrete walls that are propped in the permanent case by the ground and roof slabs.

6.2 SUPERSTRUCTURE

The garage houses are proposed in reinforced concrete to provide permanent lateral stability for the retained earth behind the north, east and west walls. The reinforced concrete walls will be propped at the top by the concrete roof slab, and some additional internal shear walls will reduce spans. A green roof is proposed for these two units, which will be supported on the roof slab spanning between the concrete walls and some additional internal concrete columns.

There are a number of openings proposed in the roof slab to provide natural light to the dwellings. A concrete upstand is proposed around the roof perimeter for waterproofing. Two small, lightweight timber ‘pop-out’ roof structures will extend beyond the green roof surface.

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7 DESIGN CRITERIA

7.1 DESIGN CODES

The following codes have been used in the structural design:

Eurocode - Basis of Structural Design	BS EN 1990
UK National Annex to Eurocode	NA to BS EN 1990
Eurocode 1: Actions on Structures – Imposed loads	BS EN 1991-1-1
UK National Annex to Eurocode 1 – Imposed loads	NA to BS EN 1991-1-1
Eurocode 1: Actions on Structures – Snow loads	BS EN 1991-1-3
UK National Annex to Eurocode 1 – Snow loads	NA to BS EN 1991-1-3
Eurocode 1: Actions on Structures – Wind actions	BS EN 1991-1-4
UK National Annex to Eurocode 1 – Wind actions	NA to BS EN 1991-1-4
Eurocode 1: Actions on Structures – Accidental actions	BS EN 1991-1-7
UK National Annex to Eurocode 1 – Accidental actions	NA to BS EN 1991-1-7
Eurocode 2:Design of Concrete Structures	BS EN 1992-1
UK National Annex to Eurocode 2	NA to BS EN 1992-1
Eurocode 6: Design of Steel Structures	BS EN 1993-1
UK National Annex to Eurocode 3	NA to BS EN 1993-1
Eurocode 5: Design of Timber Structures	BS EN 1993-1
UK National Annex to Eurocode 5	NA to BS EN 1995-1
Eurocode 6: Design of Masonry Structures	BS EN 1996-1
UK National Annex to Eurocode 6	NA to BS EN 1996-1

7.2 DESIGN LIFE

The design life is to be 50 years for the determination of wind and snow loads and the durability of materials.

7.3 ROBUSTNESS

The building will be designed for robustness in accordance with BS EN 1991-1-7 General actions: Accidental actions and Part A of the Building Regulations. The main house is classified in a lower risk group as Building Class 2A given it is a single occupancy residence exceeding four storeys.

7.4 FIRE PROTECTION

Fire protection is to the Architect's details and will be provided in accordance with Approved Document B of the Building Regulations. A preliminary fire strategy has been provided by Marshall Fire consultants. The current strategy is for the main house to be sprinklered with a protected staircase, separated from the lower extension with a 60min compartment wall. The floor between the ground floor of the extension will also provide a 60min compartment floor.

Fire protection and durability for concrete elements will be achieved by providing cover to the reinforcement and minimum concrete section sizes as recommended in BS EN 1992.

Timber elements will be boarded to provide fire protection or will be designed for charring where left exposed. Exposed steelwork will require intumescent paint.

7.5 DESIGN ACTIONS

DEAD LOADS

Detailed self-weights will be calculated from unit weights supplied in BS EN 1991-1-1 or from known material densities. Refer to architectural build-ups.

IMPOSED LOADS

Variable actions are in accordance with the categories noted in Tables NA.2-NA.5 of the National Annex to BS EN 1991 Part 1-1: General actions – Densities, self-weight, imposed loads for buildings, where appropriate. The following variable actions have been used in the design:

AREA	DISTRIBUTED LIVE LOAD	CONCENTRATED POINT LOAD
Floors (typical)	1.5 kN/m^2	2.0 kN
Basement floor (utilities/plant)	5.0 kN/m^2	4.5 kN
Green roofs / roof terrace	1.5 kN/m^2	2.0 kN
Basement roof (buried)	5.0 kN/m^2	4.5 kN
Extension roofs (typical)	1.5 kN/m^2	2.0 kN
Mansard roof	0.6 kN/m^2	0.9 kN

WIND LOADING

Wind loads will be calculated to BS EN 1991-1-4 and the UK National Annex. The following values will be used for calculating wind loads:

PARAMETER	VALUE	REFERENCE
Basic Map Velocity, v_{bmap}	21.5 m/s	BS EN 1991-1-4 UK NA (Figure NA.1)
Altitude Factor, C_{alt}	1.11	BS EN 1991-1-4 UK NA (NA.2.5, A = 115m)
Probability Factor, c_{prob}	1.00	BS EN 1990 and 1991 (based on 50 years)
Basic Wind Pressure, q_b	0.35 kN/m^2	BS EN 1991-1-4, 4.5 (1)
Peak Velocity Pressure, q_p	0.52 kN/m^2	BS EN 1991-1-4, 4.5 (1) ($C_e(z)$=2.1)

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7.6 DEFLECTIONS

VERTICAL DEFLECTION LIMITS

New slabs and beams

- Deflection under dead and live loads span/250
- Deflection under live load only span/360 or 20mm, whichever is lesser

New roofs and floors

- Deflection under dead and live loads span/250
- Final total deflection after creep span/180

HORIZONTAL DEFLECTION LIMITS

Horizontal deflection of vertical elements occurring under notional horizontal loads and / or wind loads will be limited to H/300, where H is the height of the building.

GENERAL

All finishes, cladding, services etc. should be detailed to accommodate the movements indicated above. Attention must be given to the specification of glazing systems and precast elements in the elevations.

All finishes, cladding, services etc. should also be detailed to accommodate the movements caused by the drying shrinkage of timber, and the long-term creep deflection of timber which is not instantaneous.