Appendix 2: Site Invetigation Data

Albury S.I. Ltd Report Ref 22/12510/GO

REPORT ON A SITE INVESTIGATION

Site

20 HOWITT ROAD, BELSIZE PARK, LONDON NW3 4LL

Client

JOSHUA FAITH

Consulting Engineer

BAXTER GLAYSHER CONSULTING LIMITED

Report Ref	Issued
22/12510/GO	**JANUARY 2023**

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DOCUMENT CONTROL			
Report Title	Report on a Site Investigation		
Contract	Howitt Road, Belsize Park		
Report Reference	22/12510/GO		
Client	Joshua Faith		
Prepared by	**G C D Owens** BSc MSc FGS MIEnvSc Director		
Approved by	**K J Clark** BSc Hons Director		
Revision No.	Status	Date of Issue	Final Issue Check
0	Final	17/01/2023	

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The recommendations made and opinions expressed in this Report are based on the strata conditions revealed by the fieldworks as indicated on the exploratory records, together with an assessment of the data from in situ and laboratory tests. No liability can be accepted for conditions which have not been revealed by the fieldworks, for example, between exploratory positions. While this Report may offer opinions on the possible configuration of strata, both between the excavations and below the maximum depth achieved by the investigation, these comments are for guidance only and no liability can be accepted for their accuracy. The data obtained relate to the conditions which are relevant at the time of the investigation.

The groundwater observations entered on exploratory records are those noted at the time of the investigation. The normal rate of progress does not usually permit the recording of any equilibrium water level for any one water strike. It should be noted that groundwater levels are prone to seasonal variation and to changes in local drainage conditions. The word 'none' indicates that groundwater was sealed off by the borehole casing or that no water was observed in the exploratory hole upon completion.

REPORT REF: 22/12510/GO
CONTRACT: HOWITT ROAD, BELSIZE PARK

TABLE OF CONTENTS

1 INTRODUCTION

The Client proposes to construct a basement beneath the existing mid-terraced property at 20 Howitt Road, Belsize Park, London ("the site"). Accordingly, a site investigation has been undertaken in order to ascertain the nature and engineering properties of the soils underlying the proposed development site and to obtain data which will assist in the formulation of a safe and economical foundation solution. In addition, a geo-environmental appraisal of the site has also been carried out. At the time of the works the property was occupied and the existing buildings were present.

The programme of this investigation comprised the construction of two trial pits formed using manual techniques to expose the existing foundations and one borehole using hand-held window sampling techniques. One of the trial pits was also extended by window sampling and upon completion a standpipe was installed to facilitate long-term groundwater level monitoring. During this work samples were recovered for further examination and laboratory testing. In addition, a number of in situ hand shear vane tests were also performed.

This report describes the work undertaken, presents the information obtained and discusses the ground conditions with respect to foundation design and basement construction.

2 FIELDWORKS

2.1 Site Works

The borehole and trial pits were constructed on 19th December 2022 at locations as shown on the site layout plan, indicating the proposed ground floor layout, drawing no. 22/12510/1, which is presented as Figure 1. The exploratory positions were located taking into account site constraints and the extent of the proposed basement at the rear. The details of the existing foundations exposed in the trial pits are given on the sectional drawings which form Figure 2 to this report.

The depths and descriptions of the strata encountered in the boreholes and trial pits are given on the records which comprise Appendix 1 to this report. These records note the depths at which samples were taken, the results of in situ tests and the groundwater observations noted at the time of the fieldworks. Photographs which give a general impression of the site at the time of the fieldworks are included below.

Front

Rear

2.2 Installations

Upon completion of the extended trial pit B a standpipe was installed in order to carry out long-term groundwater level monitoring. This comprised of plain pipe between ground level and 1.00m depth extended to a depth of 5.00m with slotted pipe. The installation is protected by a lockable metal cover at surface.

3 GROUND CONDITIONS

3.1 Geology

Reference has been made to the published 1:50,000 scale British Geological Survey (BGS) mapping of the area. The site is indicated as being underlain by the London Clay Formation of the Eocene epoch.

3.2 Stratigraphy

Consideration of the exploratory records indicates that either concrete or made ground from surface in the form of dark brown slightly gravelly to gravelly, clayey sand with roots was proved to depths of 0.60m, 0.90m and 0.95m. Further possible disturbed or made ground in the form of orangish brown gravelly clay was noted to 1.30m at borehole 1. Brown slightly gravelly silty clay was also noted below 0.90m at trial pit A, this position was concluded within these soils at 1.25m. The presence of flint gravel is suggestive that the upper levels of the cohesive soils at this site are a locally reworked Head or downwash deposit of recent geological origin.

Orangish brown becoming brown silty clay with grey veining was exposed beneath the made ground described above. These cohesive soils, which were noted to contain occasional selenite crystals below 3.50m within the extended trial pit B, are typical of the weathered margins of the London Clay Formation. The exploratory positions 1 and B were concluded within this deposit at depths of 4.10m and 5.10m.

3.3 Groundwater

During the construction of the exploratory positions a solitary groundwater strike was recorded at 1.00m depth within trial pit A, with a corresponding short-term standing water level also observed at this depth upon completion. The remaining positions were observed to be dry upon completion.

3.4 In Situ Testing

During the construction of the exploratory positions a series of in situ hand shear vane tests were performed using the Geonor Shear Vane test equipment. Shear strengths corrected for the effects of plasticity of 90, 100 and 105kPa were recorded, which reflect a stiff or high strength condition in situ for a cohesive soil.

3.5 Monitoring

A return visit was made on 3rd January 2023 to monitor the standpipe installed as part of the intrusive investigation and a standing water level of 1.28m below ground level was recorded on this occasion.

3.6 Existing Foundations

The existing foundations exposed in the trial pits are depicted in the sectional drawing no's. 22/12510/2 and 3 presented in Figure 2 to this report. The excavations revealed that the existing foundations comprise corbelled brickwork, which extended to 1.10m and 1.25m below ground level. Photographs of the trial pit excavations are included below.

A

B

4 LABORATORY TESTING

A programme of laboratory testing has been undertaken and the results are presented as Appendix 2 to this report. Each type of test is summarised below and the results obtained have been used to assist in the formulation of the discussion.

4.1 Water Content

The water contents of samples of the soils encountered at this site have been determined. Water contents within the range 22.4% to 32.9% have been recorded.

4.2 Index Properties

The liquid and plastic limits of samples of the clay soils have been determined. The results of this work indicate that the samples of Head or downwash taken from 1.00m depth can generally be described as inorganic clays of intermediate plasticity and of medium shrinkage potential. The London Clay Formation is of very high plasticity and high shrinkage potential.

4.3 Chemical Testing – Soluble Sulphates & pH

Samples of the soils and groundwater encountered at this site have been subjected to chemical analyses in order to determine their soluble sulphate contents and pH values. Under the conditions of this work generally low results were noted. However, in one instance a high concentration of soluble sulphate has been recorded. Slightly acidic to near neutral pH values have been established.

5 GEOTECHNICAL DISCUSSION

5.1 Foundations

The Client proposes to construct an extension at the rear ground level and basement beneath the entire footprint of the existing mid-terraced property. The proposed layout and sections are shown in Figure 3. The existing property has a partial cellar accessed from the front and it is understood that the neighbouring properties also have basements and cellars. At the time of the preparation of this report the anticipated structural loads were not known.

It cannot be recommended that major structural foundations be located within any made ground revealed by this investigation. Soils of this origin are frequently present in a weak and variable condition such that unacceptable settlement could occur even under the action of light loading intensities

It is known that a number of trees are present in the vicinity of the structure. A discussion of the causes, effects and classification of desiccation in clay soils is included in Appendix 3 to this report. Consideration of the results of the laboratory testing indicates that some moisture reduction may have developed at depths of 2.50m and 3.00m at borehole 1 and from 1.50m to 3.00m at trial pit B. It would be prudent, therefore, to consider founding at a depth of 3.50m.

The proposal to include a basement will result in excavations being made to depths of the order of 3.00m below surface. This investigation has shown that stiff London Clay Formation will be revealed in basement excavations and interpretation of the data obtained from this investigation indicates that these soils are competent to accept a maximum increase in load of 125kPa. At this loading intensity a factor of safety of at least 3 against general shear failure will be operative. Moreover, settlements should remain within tolerable limits.

5.2 Retaining Wall Parameters

The walls to the basement structure should be designed to resist any earth pressures generated by the surrounding ground and surcharge loads, for example adjacent foundations. The earth pressures can be calculated using the following soil parameters which are quoted in terms of effective stress and, therefore, reflect the long-term conditions.

Table 1 - Retaining Wall Design			
Soil Parameter	**Effective Cohesion c' kPa**	**Effective Angle of Friction Ø'**	**Soil Density kg/cum**
Made ground/Downwash	0	15	1850
London Clay Formation	0	20	1950

5.3 Heave

The release in overburden caused by the basement excavation could result in long-term heave or swelling of the London Clay Formation. Therefore, these uplift forces should be taken into consideration when designing the proposed basement. The excavation of approximately 3.00m will result in a release in overburden pressure of approximately 57kPa. Depending upon the loads reapplied by construction, this figure may be replaced and significant heave is unlikely to be generated. Nevertheless, it will be necessary to take account of any potential heave of the London Clay Formation, within the basement design, by careful consideration of the pressures applied by the proposed structure, particularly at the rear where the basement may be unconfined and heave is a significant risk. A detailed ground movement analysis may also be required to satisfy the Local Authority.

5.4 Groundwater

The groundwater level of 1.28m in the standpipe suggests that there may be perched groundwater present within the made ground at this site. It should be appreciated, however, that the monitoring was undertaken during the winter period of heavy rainfall. It is likely that these minor quantities can be dealt with through the use of sumps and pumps. However, this should be confirmed by a further monitoring visit in advance of the groundworks being undertaken. It would be prudent to ensure that the basement is designed and constructed as a water-tight element to ensure that problems relating to damp associated with transient groundwater seepages do not occur.

It should be appreciated that the London Clay Formation is susceptible to rapid softening in the unconfined state. Where excavations are to be left open for extended periods then a blinding layer of leanmix concrete should be applied to prevent their deterioration.

5.5 Stability of Excavations

It is evident that support will have to be given to the surrounding ground and the foundations of adjacent structures which will be exposed as part of the construction works. It is anticipated that traditional underpinning techniques will be employed, whereby panels or bays of convenient width are excavated and mass concrete underpins are cast in sequence to retain the soils exposed. Temporary props and shoring are likely to be required to maintain stability during excavation. The advice of a specialist underpinning contractor should be sought in this regard.

5.6 Ground Floor Slabs

The proposed extension is likely to be constructed upon naturally occurring soils and it is envisaged that a ground bearing slab could be employed. However, the foregoing discussion regarding heave may have implications for the design of the floor slab.

5.7 Buried Concrete

The information obtained from this investigation has been compared with the criteria proposed in BRE Special Digest 1, 2005 Edition, Concrete in Aggressive Ground. Using the information in Table C1 (natural ground) of this publication the Aggressive Chemical Environment for Concrete Classification (ACEC) is AC-4, which coincides with a Design Sulphate Class DS-4. The ACEC Class above can be used to determine the Design Chemical Class for concrete for general cast-in-situ use as required Part D of the Digest.

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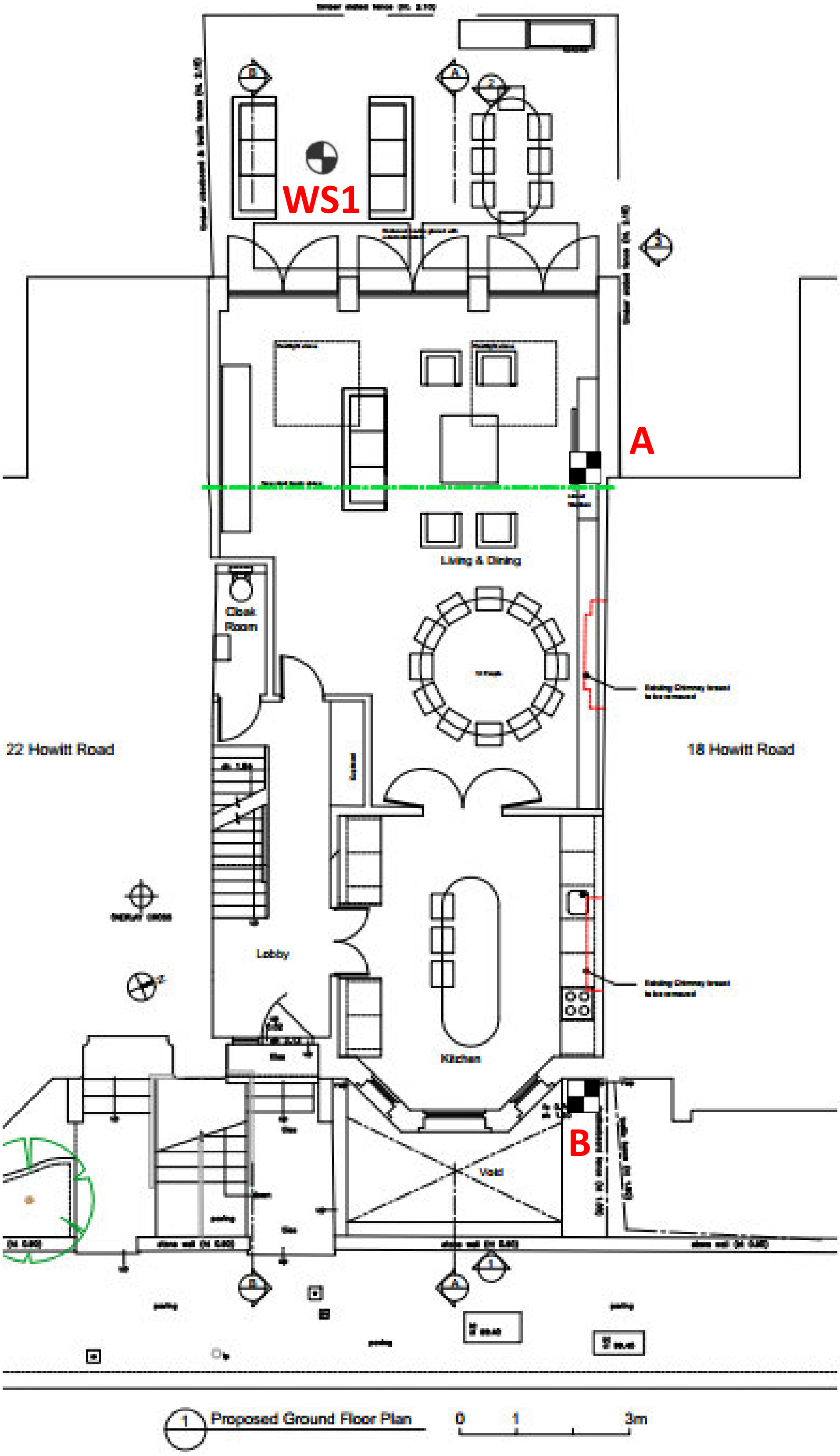
LIST OF ABBREVIATIONS

AOD	-	Above Ordnance Datum
ACM	-	Asbestos-containing Material
AST	-	Above-ground Storage Tank
BGS	-	British Geological Survey
BH	-	Borehole
BRE	-	Building Research Establishment
BSI	-	British Standards Institution
BS	-	British Standard
C4SL	-	Category Four Screening Level
CIRIA	-	Construction Industry Research and Information Association
CP	-	Cable Percussive
DPH	-	Dynamic Probing Heavy
DPSH	-	Dynamic Probing Super Heavy
EA	-	Environment Agency
GAC	-	Generic Assessment Criteria
LL	-	Liquid Limit
mAOD	-	Metres Above Ordnance Datum
mBGL	-	Metres Below Ground Level
mOD	-	Metres Ordnance Datum
OS	-	Ordnance Survey
PAH	-	Polycyclic Aromatic Hydrocarbons
PCB	-	Polychlorinated Biphenyl
PID	-	Photo Ionisation Detector
PL	-	Plastic Limit
PSD	-	Particle Size Distribution
SGV	-	Soil Guideline Value
SOM	-	Soil Organic Matter
SPT	-	Standard Penetration Test
SPZ	-	Source Protection Zone
SVOC	-	Semi-volatile Organic Compounds
TPH	-	Total Petroleum Hydrocarbon
UST	-	Underground Storage Tank
UXB	-	Unexploded Bombs
UXO	-	Unexploded Ordnance
VOC	-	Volatile Organic Compound

FIGURE 1

SITE LAYOUT PLAN



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Dwg No:	22/12510/1
Client:	Joshua Faith
Contract:	Howitt Road, Belsize Park
Job Ref:	22/12510/GO
Scale:	NTS
Revision:	0
Issue Date:	17/01/2023

Legend:

- Borehole Location
- Trial Pit Location
- Site Boundary

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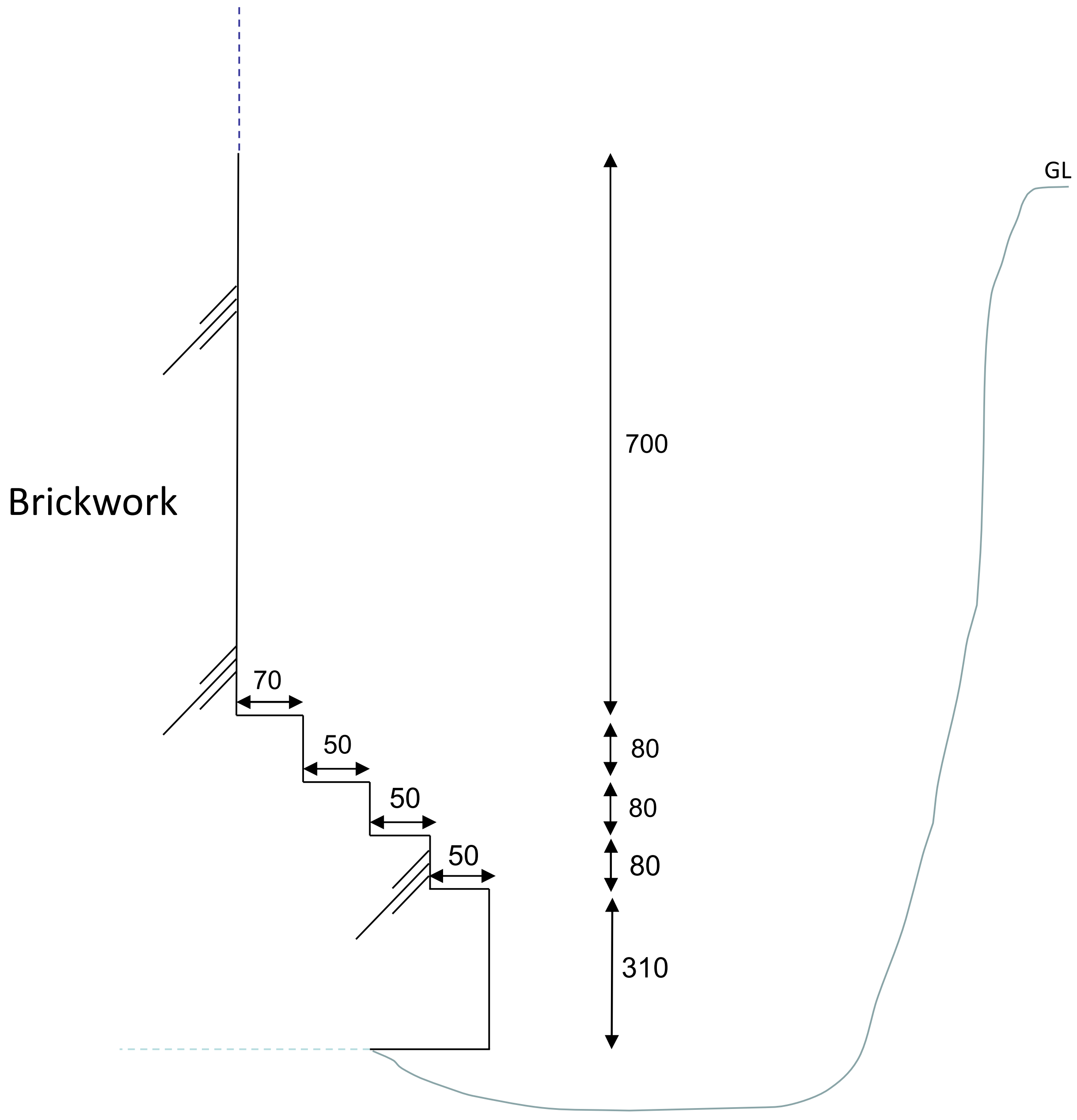
FIGURE 2

TRIAL PIT SECTIONS



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Dwg No:	22/12510/2
Contract:	Howitt Road, Belsize Park
Scale:	NTS – all dimensions in mm
Revision:	0
Issue Date:	21/12/2022

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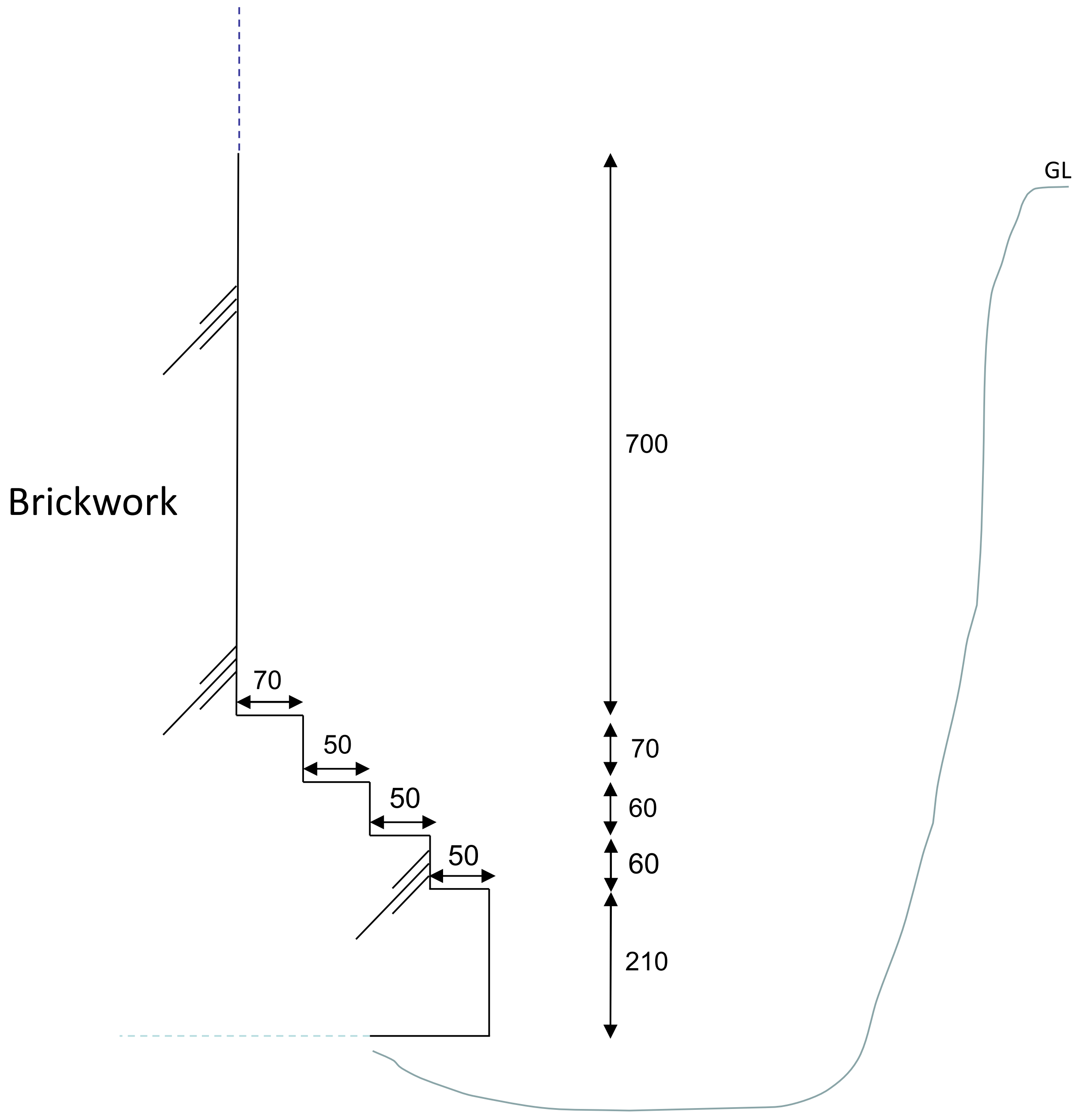

Title:	Trial Pit B Section
Dwg No:	22/12510/3
Contract:	Howitt Road, Belsize Park
Scale:	NTS – all dimensions in mm
Revision:	0
Issue Date:	21/12/2022

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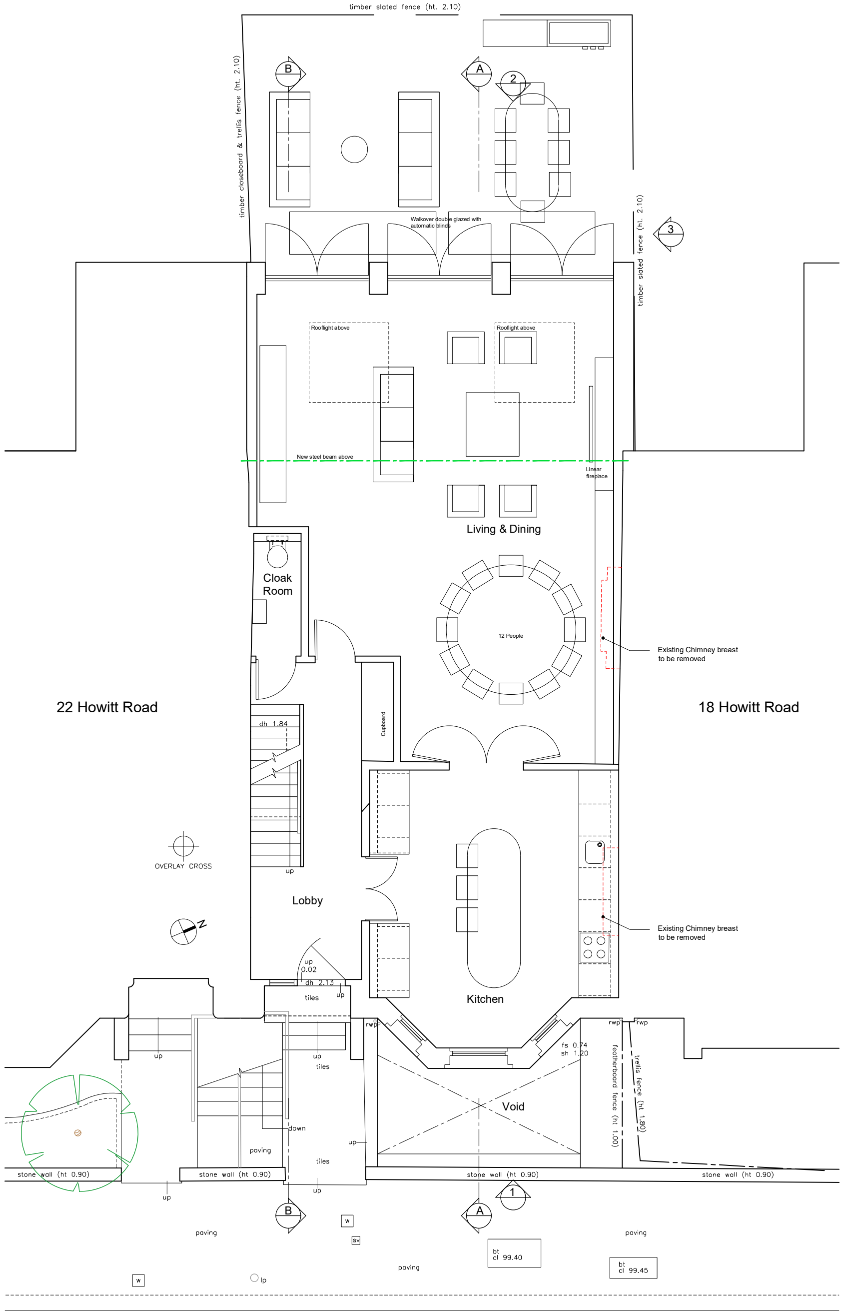
FIGURE 3

PROPOSED PLANS AND SECTIONS



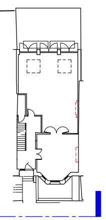
1 Proposed Ground Floor Plan

0 1 3m

2 Proposed Front Elevation 1

0 1 3m

Location Plan Scale 1:1250



Planning (Preliminary)

Revisions

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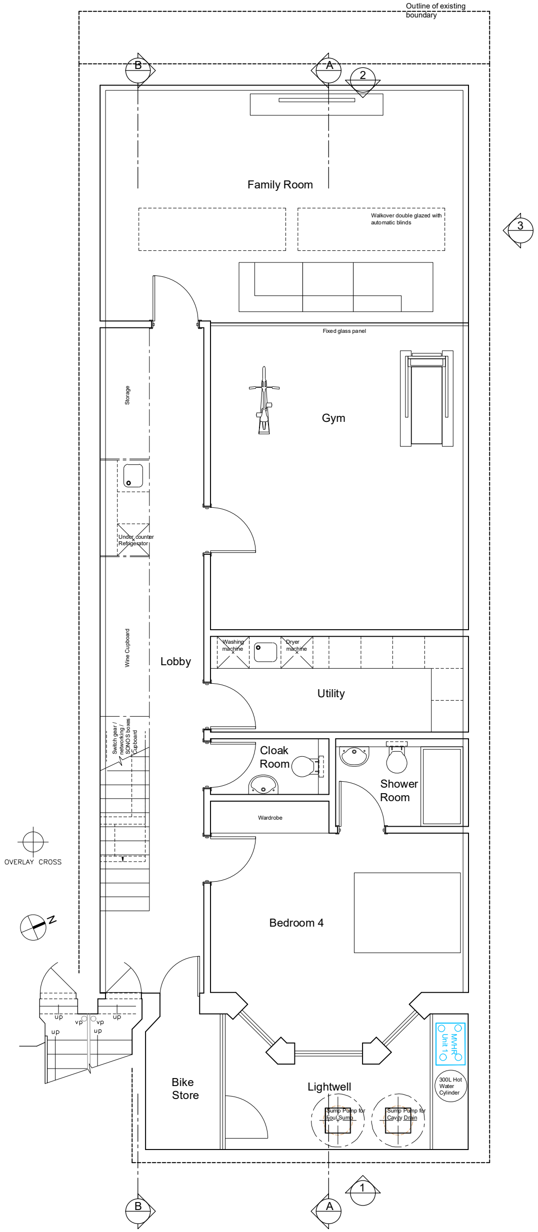
Client: **J Faith**
Project: **20 Howitt Road, London, NW3 4LL**
Dwg: LOCATION PLAN, PROPOSED FRONT ELEVATION AND GROUND FLOOR PLANS
Dwg No: 522-A01 Revision: -
Date: OCT 2022
Scale: 1:50 @A1

Location Plan Scale 1:1250

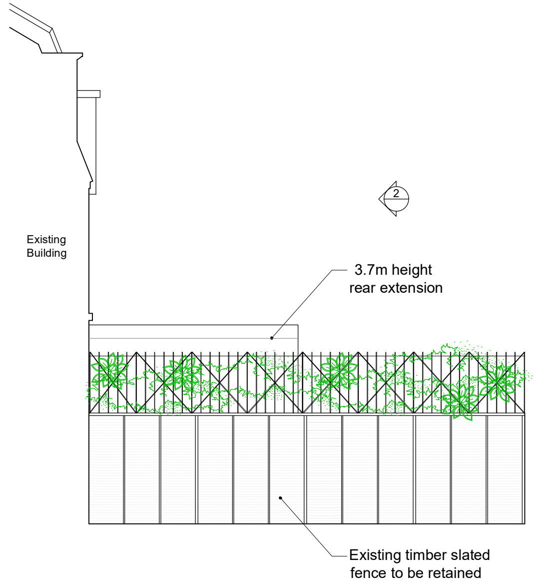


1 Proposed Basement Plan

0 1 3m

2 Proposed Rear Elevation 2

0 1 3m



3 Proposed Side Elevation 3

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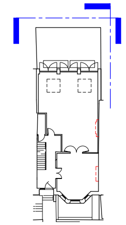

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Client: J Faith
Project: 20 Howitt Road, London, NW3 4LL
Dwg: LOCATION PLAN, PROPOSED REAR & SIDE ELEVATIONS AND BASEMENT PLAN
Dwg No: 522-A02
Revision: -
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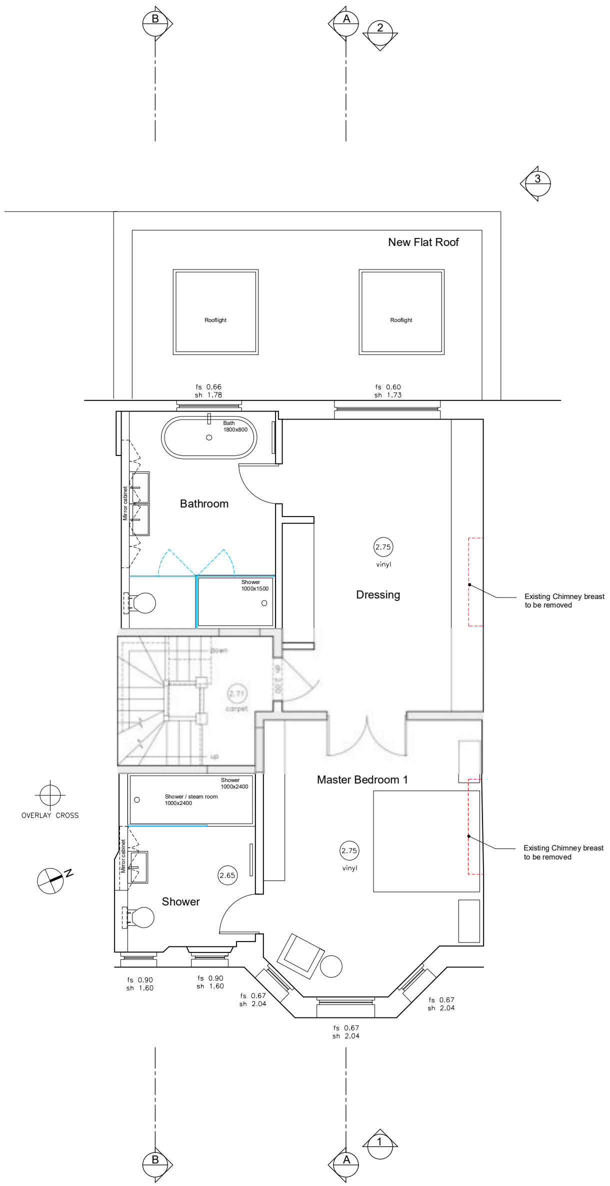
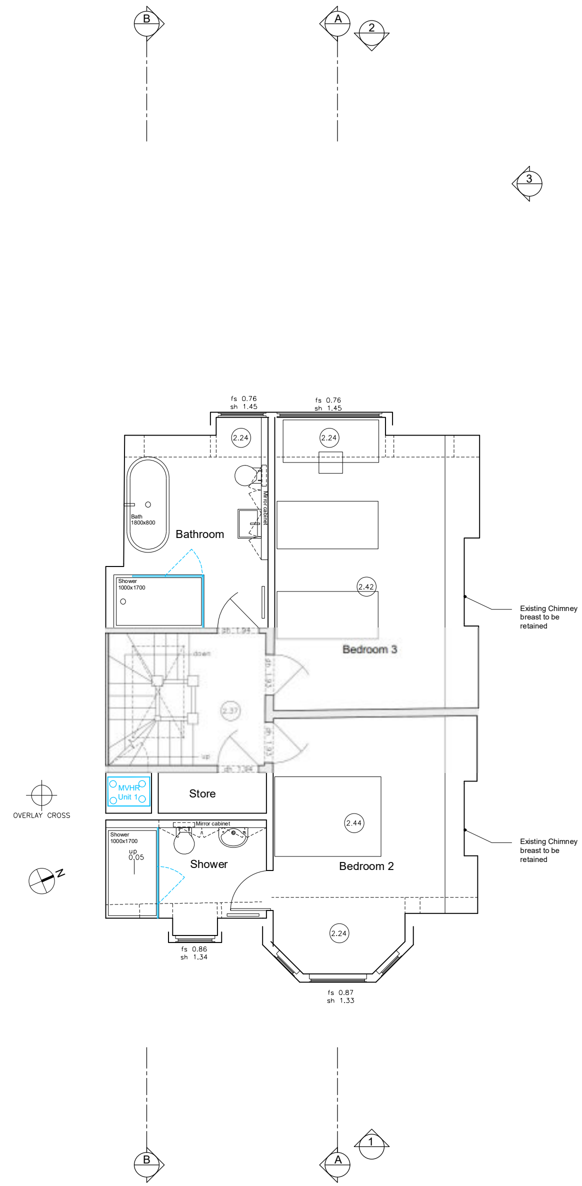


1 Proposed First Floor Plan

0 1 3m



2 Proposed Second Floor Plan

0 1 3m

Location Plan Scale 1:1250

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Client: **J Faith**
Project: **20 Howitt Road, London, NW3 4LL**
Dwg: LOCATION PLAN, PROPOSED FIRST AND SECOND FLOOR PLANS
Dwg No: 522-A03 Revision: -
Date: OCT 2022
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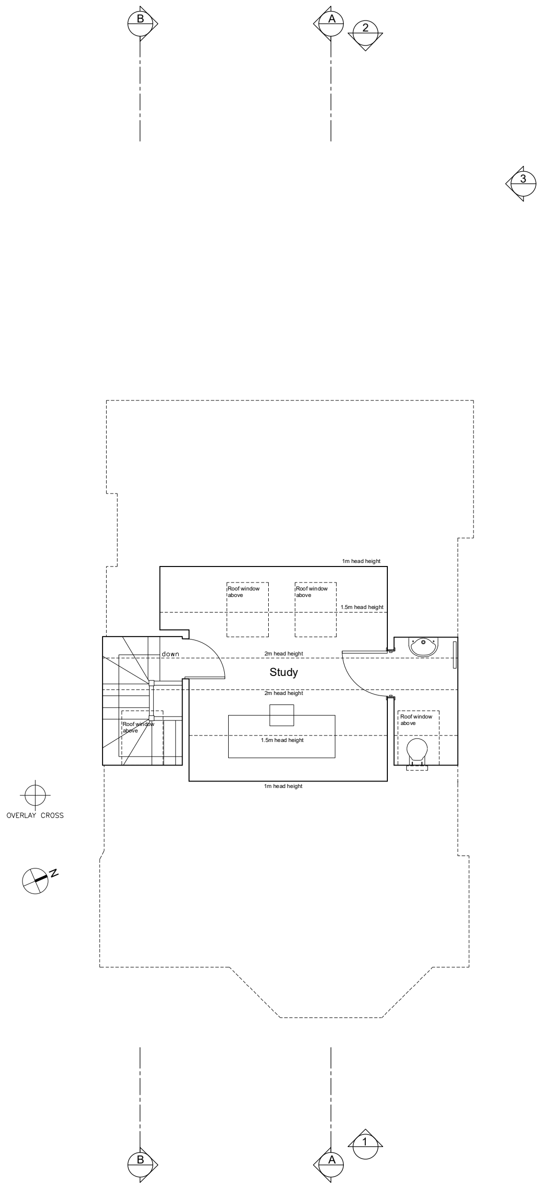
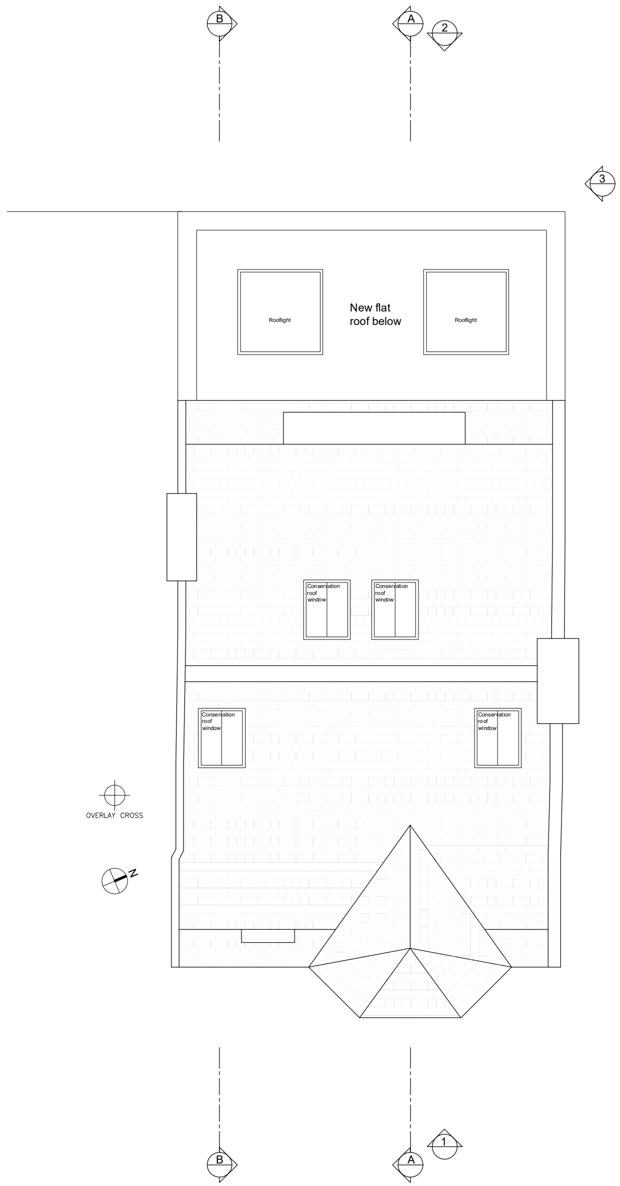


1 Proposed Loft Plan

0 1 3m



2 Proposed Roof Plan

0 1 3m

Location Plan Scale 1:1250

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Client: **J Faith**
Project: **20 Howitt Road, London, NW3 4LL**
Dwg: LOCATION PLAN, PROPOSED LOFT FLOOR AND ROOF PLANS
Dwg No: 522-A04 Revision: -
Date: OCT 2022
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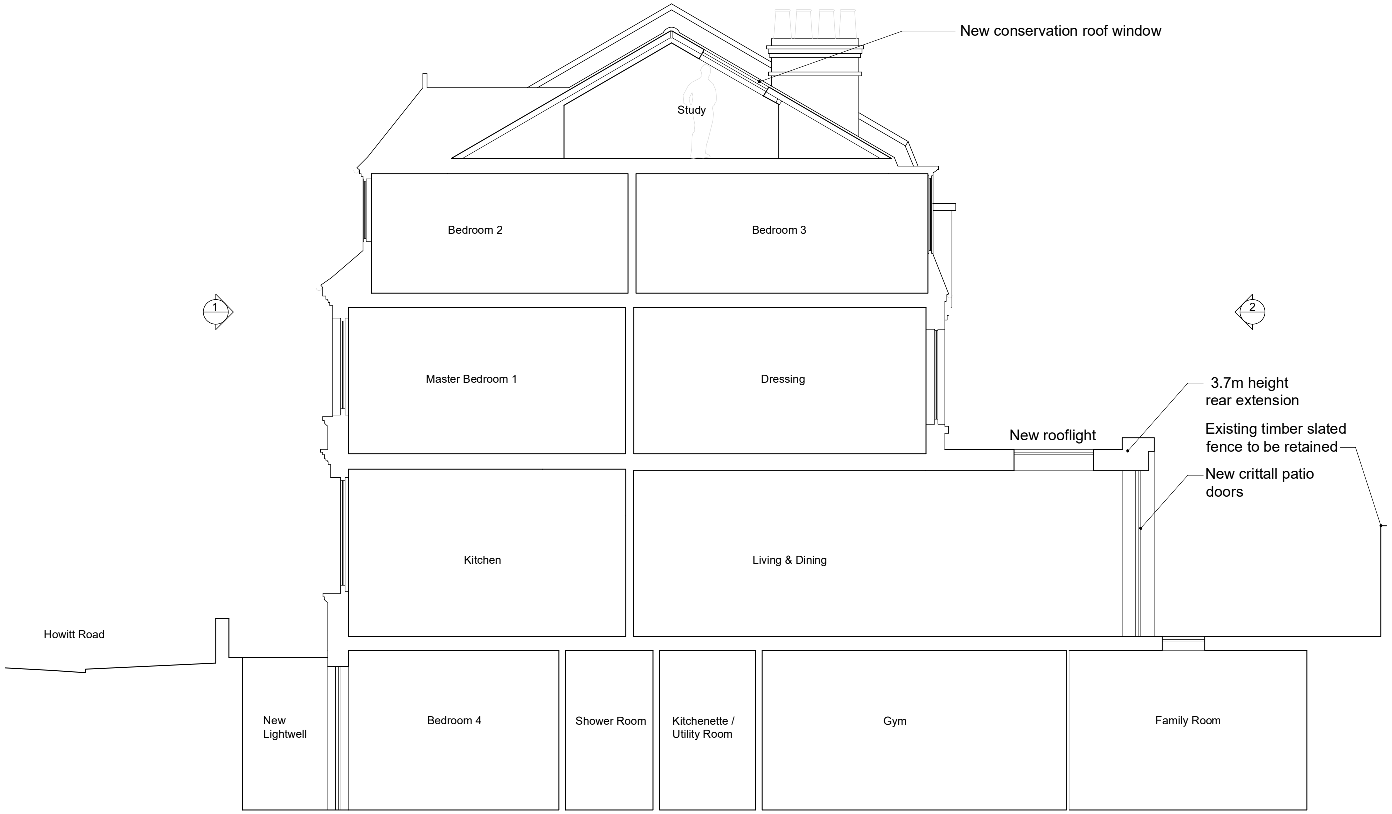
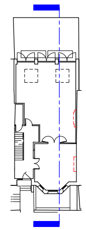
Location Plan Scale 1:1250





1 Proposed Section A

0 1 3m

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Client: **J Faith**
Project: **20 Howitt Road, London, NW3 4LL**
Dwg: LOCATION PLAN, PROPOSED SECTION A

Dwg No: 522-A05 Revision: -
Date: OCT 2022
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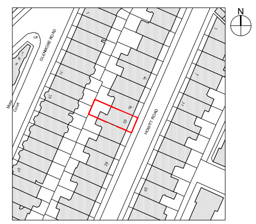

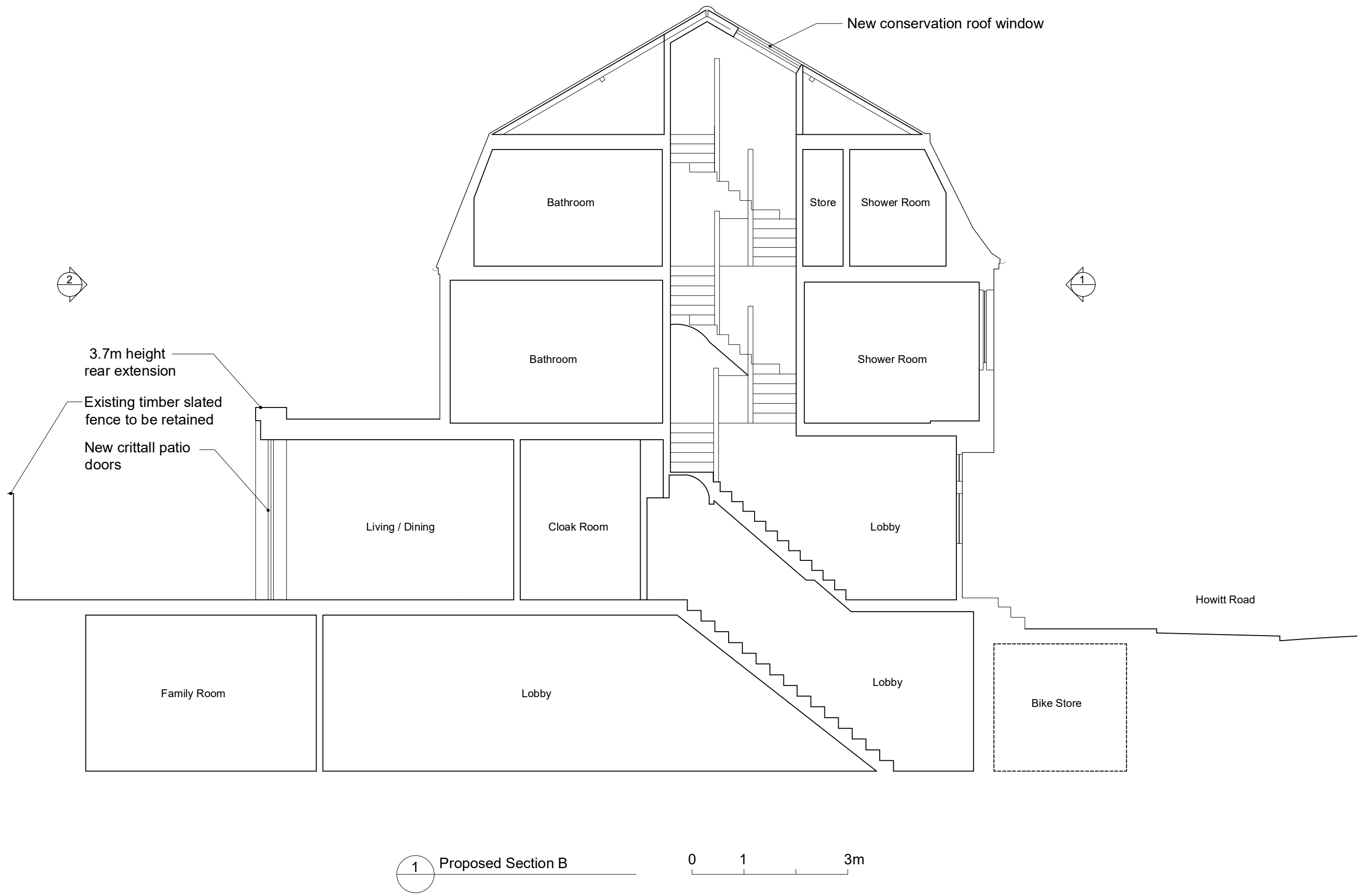

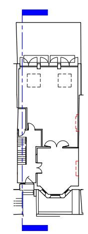

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Client:	J Faith
Project:	20 Howitt Road, London, NW3 4LL
Dwg:	LOCATION PLAN, PROPOSED SECTION B
Dwg No:	522-A06 Revision: -
Date:	OCT 2022
Scale:	1:50 @A1

APPENDIX 1

EXPLORATORY RECORDS

ALBURY S.I. LTD Miltons Yard, Petworth Road, Witley, Surrey GU8 5LH		**BOREHOLE**	1
Contract	Howitt Road, Belsize Park	**Report Ref**	22/12510/GO
Client	Joshua Faith	**Date**	19/12/2022
Site Address	20 Howitt Road, Belsize Park, London NW3 4LL	**Ground Level**	

Type of excavator	Window Sampler	**Water level after completion, m**	dry

Water strikes, m	**Dimensions, m**	**Ease of excavation, m**	
1 none	Diameter 0.06	Very easy	Difficult 0.80-1.30
2		Moderate GL-0.80, 1.30-4.10	Very hard

Remarks

Samples or tests		**Shear Strength kPa**	**Depth**	**Legend**	**Strata Description**
Type	**Depth, m**				
D	0.10				MADE GROUND (dark brown slightly gravelly clayey SAND with roots. Gravel is of flint and brick fragments, becoming gravelly at depth)
D	0.30				
D	0.50				
			0.60		MADE GROUND (brown gravelly CLAY with roots. Gravel is of flint and occasional brick fragments)
D	0.75				
			0.90		Orangish brown gravelly CLAY. Gravel is of flint (possible disturbed or MADE GROUND)
D	1.00				
			1.30		Stiff orangish brown silty CLAY with grey veining (traces of root hairs at 2.00m)
D	1.50	90			
D	2.00	105			
			2.20		Brown silty CLAY with grey veining
D	2.50				
D	3.00				
D	3.50				
D	4.00				
			4.10		END OF BOREHOLE

Sample Code: B - Large Disturbed D - Small Disturbed W - Water Sample R - Root Sample T - Tube Liner

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TRIAL PIT	A		
Contract	Howitt Road, Belsize Park	**Report Ref**	22/12510/GO
Client	Joshua Faith	**Date**	19/12/2022
Site Address	20 Howitt Road, Belsize Park, London NW3 4LL	**Ground Level**	
Type of excavator	Manual/WS	**Water level after completion, m**	1.00

Water strikes, m		**Pit Dimensions, m**		**Ease of excavation, m**			
1	1.00	Length	0.45	Very easy		Difficult	GL-1.25
2		Breadth	0.35	Moderate		Very hard	

Remarks
Trial pit not extended due to close proximity of adjacent basement and fence

Samples or tests: Type	Samples or tests: Depth, m	Shear Strength kPa	Depth	Legend	Strata Description
D	0.20		0.15		MADE GROUND (crazy paving over concrete)
D	0.50				MADE GROUND (dark brown gravelly SAND. Gravel is of brick and chalk)
D	1.00		0.90		Brown slightly gravelly silty CLAY. Gravel is of flint
			1.25		END OF TRIAL PIT

Sample Code: B - Large Disturbed D - Small Disturbed W - Water Sample R - Root Sample

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TRIAL PIT	B		
Contract	Howitt Road, Belsize Park	**Report Ref**	22/12510/GO
Client	Hjoshua Faith	**Date**	19/12/2022
Site Address	20 Howitt Road, Belsize Park, London NW3 4LX	**Ground Level**	
Type of excavator	Manual/WS	**Water level after completion, m**	dry

Water strikes, m		**Pit Dimensions, m**		**Ease of excavation, m**		
1	none	Length	0.55	Very easy		Difficult
2		Breadth	0.45	Moderate	GL-5.10	Very hard

Remarks Trial pit extended below 1.2m using window sampling techniques

Standpipe installed to 5m upon completion. 03/01/23 - depth to water = 1.28m

Samples or tests: Type	Samples or tests: Depth, m	Shear Strength kPa	Depth	Strata Description
				MADE GROUND (concrete)
D	0.20		0.15	MADE GROUND (dark brown slightly gravelly clayey SAND. Gravel is of brick, concrete and mortar fragments)
D	0.50		0.40	MADE GROUND (brown clayey SAND and GRAVEL of bricks)
D	1.00	100	0.95	Stiff orangish brown and grey silty CLAY
			1.20	Stiff brown silty CLAY with grey veining and occasional selenite crystals below 3.50m
D	1.50	90		(roots and root hairs noted at 1.50m)
D	2.00	90		
D	2.50			
D	3.00			
D	3.50			(decayed root hair remain noted at 3.50m)
D	4.00			
D	4.50			

(continued on next sheet)

Sample Code: B - Large Disturbed D - Small Disturbed W - Water Sample R - Root Sample

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TRIAL PIT	B
Report Ref	22/12510/GO

Contract	Howitt Road, Belsize Park

Samples or tests		Shear Strength kPa	Depth	Legend	Strata Description
Type	Depth, m				
D	5.00		5.10		Stiff brown silty CLAY with grey veining and occasional selenite crystals
					END OF BOREHOLE

Sample Code: B - Large Disturbed D - Small Disturbed W - Water Sample R - Root Sample

APPENDIX 2

LABORATORY TEST RESULTS

INDEX PROPERTIES AND WATER CONTENTS

BS 1377 : Part 2 : 1990

Report Ref	22/12510/GO	Contract	Howitt Road, Belsize Park

BH/TP No.	Sample Depth m	Sample Description	Water Content W %	Liquid Limit W_L %	Plastic Limit W_P %	Plasticity Index IP %	% Passing 425 Micron Sieve	Corrected Plasticity Index IPc %	Soil Classification	Remarks
1	1.00	Orangish brown gravelly CLAY (possible disturbed or MADE GROUND)	22.4	47	19	28	68	19	CI	
	1.50	Orangish brown silty CLAY with grey veining	36.1							
	2.00	Orangish brown silty CLAY with grey veining	31.2	77	26	51	100	51	CV	
	2.50	Brown silty CLAY with grey veining	30.7							
	3.00	Brown silty CLAY with grey veining	28.7	75	27	48	100	48	CV	
	3.50	Brown silty CLAY with grey veining	31.7							
	4.00	Brown silty CLAY with grey veining	31.2							
A	1.00	Brown slightly gravelly silty CLAY	30.6	43	18	25	94	24	CI	
B	1.50	Brown silty CLAY with grey veining	31.0							
	2.00	Brown silty CLAY with grey veining	30.0							
		(continued on next sheet)								

KEY: *Soil Type:* **C** - Clay, **M** - Silt, **O** - Organic, **NP** - Non Plastic
Plasticity: **L** - Low, **I** - Intermediate, **H** - High, **V** - Very High, **E** - Extremely High

INDEX PROPERTIES AND WATER CONTENTS

BS 1377 : Part 2 : 1990

Report Ref	22/12510/GO	Contract	Howitt Road, Belsize Park	*Continuation Sheet*	*1*

BH/TP No.	Sample Depth m	Sample Description	Water Content W %	Liquid Limit W_L %	Plastic Limit W_P %	Plasticity Index IP %	% Passing 425 Micron Sieve	Corrected Plasticity Index IPc %	Soil Classification	Remarks
B	2.50	Brown silty CLAY with grey veining	29.9							
	3.00	Brown silty CLAY with grey veining	32.9	85	29	56	100	56	CV	
	3.50	Brown silty CLAY with grey veining and occasional selenite crystals	32.1							
	4.00	Brown silty CLAY with grey veining and occasional selenite crystals	32.2	80	28	52	100	52	CV	

KEY:						
	Soil Type:	**C** - Clay	**M** - Silt	**O** - Organic	**NP** - Non Plastic	
	Plasticity:	**L** - Low	**I** - Intermediate	**H** - High	**V** - Very High	**E** - Extremely High

SUMMARY OF CHEMICAL ANALYSES

Determination of Soluble Sulphate Contents of Soil and Groundwater, Organic Matter Content and pH Value

Report Ref	22/12510/GO	**Contract**	Howitt Road, Belsize Park

BH/TP No.	**Sample**			**Concentration of Sulphates expressed as SO_4**		**pH Value**	**Organic Content %**
	Depth m	Soil Type	% passing 2mm sieve	2:1 Water:Soil Extract mg/l	Groundwater mg/l		
1	1.50	Clay	100	<250		5.6	
	2.50	Clay	100	<250		6.6	
	3.50	Clay	100	<250		7.7	
B	1.00	Clay	100	<250		6.7	
	2.00	Clay	100	<250		7.4	
	3.50	Clay	100	3317		7.2	
	(1.28)	Water			<80	7.3	

APPENDIX 3

DESICCATION

DESICCATION

Classification

The removal of moisture from a soil as a result of external influences with a constant stress regime, results in shrinkage or settlement of the soil. The magnitude of shrinkage is dependent upon the geological stress history of the soil, its clay content and the composition of the clay minerals. Under normal climatic conditions, there is a seasonal cyclic variation in soil moisture and, hence, volume change, which extends to depths of approximately 1m. When the soil moisture deficit attains a critical value, the shrinkage of the soil can become significant. In these circumstances, the soil can be regarded as being present in a desiccated state.

Causes

A common cause of desiccation consists of the reduction in soil moisture by tree root action. In the absence of a water table at shallow depth, root action of trees will reduce the soil moisture level in order to maintain growth. In general terms, the increase in rainfall which occurs during winter periods will allow for some replacement of the moisture content of the soil, particularly where isolated or immature trees are concerned.

However, when drought summer conditions or limited winter rainfall occurs, desiccated zones will develop within the zone of influence of tree roots. In woodland, desiccation develops as it is not possible for rainfall to overcome the soil moisture deficit. Other causes of desiccation, which have created problems to structures, include incorrectly installed and insulated heating pipes or ducts and industrial processes, ie furnaces or brick kilns.

Effects

The development of desiccation in clay soils will result in an increase in strength of the material. In addition, negative pore water pressure or soil suction will develop. Any foundation system located within soil which is subject to a reduction in soil moisture can experience structural distress, which results from the loss in volume or shrinkage of the ground. Also, if the source of the desiccation is removed, there will be heave of the soils as a result of an increase in equilibrium water content

It is evident, therefore, that foundation systems founded in soils which are actively experiencing an increase or decrease in soil moisture, will be subject to either heave or settlement, which can induce stresses within the structure. It should also be appreciated that a desiccated soil, which is experiencing an increase in equilibrium water content, will attempt to increase its volume in a horizontal as well as vertical plane. It is important, therefore, to ensure that horizontal movements do not apply differential stresses to structural elements, by incorporating collapsible membranes within remedial works.

Identification

A soil in a state of equilibrium is present in a semi-solid state. At the onset of desiccation, the condition of the soil moves towards the boundary between a solid and semi-solid state, this boundary being defined as the plastic limit of the soil. It follows, therefore, that when the natural water content of a soil lies close to, or falls below, the value of the plastic limit, the soil can be considered to be desiccated.

An alternative proposal was made by Driscoll (1983), who related the soil suction induced by desiccation to a function of the liquid limit of the soil. In general terms, desiccation is assumed to be present when the moisture content falls below a level of 40% liquid limit. The arbitrary factor of 0.4 relates to a soil suction value proposed by Croney (1977) and may vary with the composition and mineralogy of different soil types. This approach is only considered to be valid over a limited depth range as the overburden effect will result in a natural reduction in soil moisture and result in the development of negative pore pressures.

A further approach, which considers the shear strength of the clay, Pugh et al (1995), recognises the fact that a reduction in soil moisture will result in an increase in undrained shear strength as well as the development of negative pore pressures. Whilst this approach has a considerable amount of merit, care is required in establishing the value of the soil's in situ shear strength, particularly if it is not possible to obtain representative "undisturbed" samples from cable percussion boreholes. The proposal made in the Pugh paper that the simple pocket penetrometer will provide accurate consistent results should be treated with care, as the pocket penetrometer can take no account of the effects of disturbance and remoulding that are inevitable when completing a trial pit with a mechanical excavator. It is for this reason that this Company attempts to establish the shear strength of clay soils by using the Geonor Field Vane. With this test equipment the appropriate-sized vane is pushed into the side of the pit, through the thin disturbed zone which is caused by the teeth of the bucket during excavation. Furthermore, by use of the 'blank' probe, it is possible to take account of any skin friction which builds up on the shaft of the vane and thus provide a more accurate assessment of the shear strength of the soils.

Hence, a combination of the methods discussed above should be considered in order to confirm whether the development of soil moisture reduction to achieve a desiccated state has occurred within a particular site. The data for affected areas should, where possible, be compared with soils which lie outside the influence of tree root bulbs and may, therefore, be considered to be present in a stable and equilibrium state.

References

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