SOIL CONSULTANTS LTD

Ground investigation Geotechnical analysis Environmental appraisal

Tel: 01494 712494 Fax: 01494 713922 mail@soilconsultants.co.uk

Chiltern House
Earl Howe Road
Holmer Green
High Wycombe
Bucks HP15 6QT

GROUND INVESTIGATION REPORT

ST MARY SOMERSET TOWER
CASTLE BAYNARD STREET
LONDON EC4

GERARD HUGUENIN
Ground Works Specialist
19 Dunstans Road
Hanwell
London W7 2EY

4051/KB/AW

11 November 2005

www.soilconsultants.co.uk
Registered No. 1814762 at
35/37 Belmont Road, Uxbridge,
Middlesex UB8 1RH
VAT No 491 8249 15

CONTENTS

1.0 INTRODUCTION

It is proposed to construct an extension to the Tower of St Mary Somerset. An exploratory borehole has therefore been constructed to assist in the design of the planned piled foundations.

This report presents the data obtained from a single exploratory borehole and then provides parameters to assist in the design of a piled foundation.

2.0 EXPLORATORY WORK

The borehole was constructed by cable percussive techniques in the position shown on the appended site plan. The borehole was taken to a depth of 25m during which in-situ Standard Penetration Tests (SPT) were carried out in the made ground and natural gravel and both SPT tests and undisturbed samples were obtained in the underlying London Clay. Small disturbed samples were obtained throughout and all the samples were taken to our laboratory for examination and testing.

Laboratory testing comprised quick undrained triaxial compression tests on all the undisturbed samples of clay and sulphate/pH determinations on selected samples of made ground and natural clay.

The results of this testing and the borehole record are presented in the Appendix.

3.0 GROUND CONDITIONS

The Geological Survey map of the area indicates that alluvium is present overlying London Clay with London Clay shown to outcrop immediately to the north. The borehole has encountered a significant depth of made ground overlying a thin deposit of gravel and then London Clay.

3.1 Made Ground

The measured thickness of made ground at the borehole position is 5.55m. Beneath the paving slab/concrete sub-base, soft/loose grey sandy clay with brick, chalk, concrete and stones is present to around 5.55m. At 3.3m depth, however, an obstruction, believed to be old foundations was met. Chiselling techniques were employed and made some progress to 3.7m after 1.5 hours but the obstruction was not penetrated. Thus, the decision was made to abandon the position and the rig was moved over a short distance and the borehole re-drilled.

Standard Penetrations Tests produced 'N' values of between 1 and 3 which is indicative of soft/loose conditions.

3.2 Gravel

At 5.55m depth, gravel with grey sand is present, containing thin clay lenses which extends to 6.15m. An SPT 'N' value of 19 was measured which indicates a medium dense condition.

3.0 GROUND CONDITIONS

The Geological Survey map of the area indicates that alluvium is present overlying London Clay with London Clay shown to outcrop immediately to the north. The borehole has encountered a significant depth of made ground overlying a thin deposit of gravel and then London Clay.

3.1 Made Ground

The measured thickness of made ground at the borehole position is 5.55m. Beneath the paving slab/concrete sub-base, soft/loose grey sandy clay with brick, chalk, concrete and stones is present to around 5.55m. At 3.3m depth, however, an obstruction, believed to be old foundations was met. Chiselling techniques were employed and made some progress to 3.7m after 1.5 hours but the obstruction was not penetrated. Thus, the decision was made to abandon the position and the rig was moved over a short distance and the borehole re-drilled.

Standard Penetrations Tests produced 'N' values of between 1 and 3 which is indicative of soft/loose conditions.

3.2 Gravel

At 5.55m depth, gravel with grey sand is present, containing thin clay lenses which extends to 6.15m. An SPT 'N' value of 19 was measured which indicates a medium dense condition.

3.3 London Clay

A weathered zone of firm to stiff becoming stiff brown fissured clay is present between 6.15m and 9.45m before typical stiff becoming very stiff grey fissured clay with occasional fine sand lenses is met and proved to at least 25m depth. A strength versus depth graph is given in the Appendix which should be used to derive pile design parameters.

3.4 Ground Water

Ground water was met initially as a seepage at 3.7m depth and then as a fast inflow within the gravel stratum. Temporary steel lining tubes driven a short distance into the London Clay achieved a seal although at 13m depth a further seepage of water was noted.

Upon completion of the borehole, a 6m deep standpipe was installed to permit further observations of the water table to be made.

4.0 DISCUSSION

It is evident from the ground conditions encountered that shallow foundations will not be viable and hence piled foundations are likely to be the most suitable solution to support a new structure.

4.1 Pile Design Parameters

The piles will need to penetrate the significant depth of made ground and derive load capacity from the London Clay. Negative skin friction could develop on the upper levels of the pile shaft if the soft/loose made ground was to undergo long-term settlement. The risk of such

settlement occurring would depend to some extent on the degree of disturbance the fill may undergo during the development as well as other factors. This aspect should therefore be assessed by experienced piling contractors.

Some form of rotary augered or continuous flight augered (cfa) type of bored pile is likely to be appropriate. For open hole drilling techniques temporary lining will be necessary to exclude the ground water encountered at around 6m depth. The restricted access conditions are also likely to be an important factor in choosing a suitable piling technique.

The following parameters may be used for the design of bored piles:

Ultimate Adhesion (incorporating Alpha = 0.45)		kN/m²
Existing GL to 6m	Made Ground	see text
6m to 25m	London Clay	54 increasing linearly to 108

Ultimate End Bearing (incorporating Nc = 9) for pile diameters up to 600mm

In London Clay	between 10m and 25m	1310 increasing linearly to 2160

These parameters are based upon 38mm diameter laboratory test specimens for which an Alpha Factor of 0.45 is appropriate; this value should not be varied.

We recommend that a factor of safety of 3 should be adopted with these parameters to derive the working load of a single pile. Final design should be formulated in consultation with specialist contractors.

4.2 Ground Floor Slab

We recommend that the ground slab for the extension is designed as a fully suspended unit to avoid reliance on the weak made ground.

4.3 Foundation Concrete

Low concentrations of soluble sulphate were measured in selected soil samples in association with near-neutral/slightly alkaline pH values. The design class is DS-1 and in accordance with BRE Special Digest 1 (3rd Edition: 2005), the ACEC site classification for buried concrete is shown to be AC-1 for a mobile ground water condition. However, further consultation of this digest is recommended before any particular design is adopted.

FOREWORD - GUIDANCE NOTES

GENERAL

The Borehole Records are compiled from the driller's description of the strata encountered, an examination of the samples by our Geotechnical Engineer and the results of in-situ and laboratory tests. Based on this data, the report presents an opinion on the configuration of strata within the site. However, such reasonable assumptions are given for guidance only and no liability can be accepted for changes in conditions not revealed by the boreholes.

BORING METHODS

The Cable Percussion technique of boring is normally employed and allows the ground conditions to be reasonably well established. However, some disturbance of the ground is inevitable, particularly some "softening" of the upper zone of clay immediately beneath a granular soil. The presence of thin layers of different soils within a stratum may not always be detected.

GROUND WATER

The depth at which ground water was struck is entered on the Borehole Records. However, this observation may not indicate the true water level at that period. Due to the speed of boring and the relatively small diameter of the borehole, natural ground water may be present at a depth slightly higher than the water strike. Moreover, ground water levels are subject to variations caused by changes in the local drainage conditions and by seasonal effects. When a moderate inflow of water does take place, boring is suspended for at least 10 minutes to enable a more accurate short-term water level to be achieved. An estimate of the rate of inflow is also given. This is a relative term and serves only as a guide to the probable flow of water into an excavation.

Further observations of the water level made during the progress of the borehole are shown including end of shift and overnight readings and the depth at which water was sealed off by the borehole casing, if applicable.

Whilst drilling through granular soils, it is usually necessary to introduce water into the borehole to permit their extraction. When additional water has been used a remark is made on the Borehole Record and the implications are discussed in the text.

SAMPLES

Undisturbed samples of the predominantly cohesive soils are obtained using a 100mm diameter open-drive sampler. In granular soils, disturbed bulk samples are taken and placed in polythene bags. Small jar samples are taken at frequent intervals in all soils for subsequent visual examination. Where ground water is encountered in sufficient quantity, a sample of the ground water is also taken.

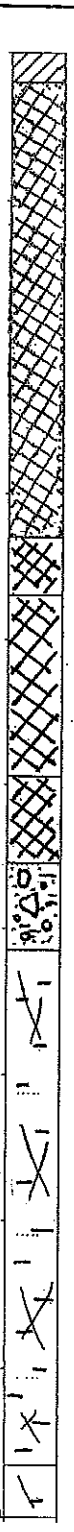
IN-SITU STANDARD PENETRATION TESTS

This test is performed in accordance with the procedure given in B.S.1377:1990. The individual blow count record for each test is given on a separate table. The 'N' value is normally the number of blows to achieve a penetration of 0.3m following a seating distance of 0.15m and is quoted at the mid-depth of the test zone. However if a change of stratum occurs within the test zone then a revised 'N' value is calculated to assess one layer in particular. In hard strata full penetration may not be obtained. In such cases the suffix + indicates that the result has been extrapolated from the limited penetration achieved. Where ground water has affected the measured values, the resultant 'N' values has been placed in brackets since it is unlikely to represent the true in-situ density of the soil.

Contract & Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	BOREHOLE No	BH 1
Client	Gerard Huguenin (Ground Works Specialists)	Sheet 1 of 3	
Engineer		Report No	4051-KB

Comments	Samples Type	Depth	SPT (N)	Depth m	Strata Description
Borehole dia. 150mm Started on 14 Oct 2005				0.20	Paving slab over concrete.
	B	0.60			Made Ground – loose dark brown/grey sandy clay with fragments of brick, chalk, lime mortar, concrete, occasional roots, stones and oyster shell.
	B	1.00			
	B	1.70			
	S J	1.80	3		
	S J	2.80	2		
Chiselled on footings 3.3-3.7 for 1.5hrs Unable to penetrate ; BH moved & redrilled Seepage inflow - 3.70	B	3.70		3.30 3.70	Made Ground – footings (driller's description) – not penetrated. Made Ground – soft grey clay with stones, brick fragments and traces of carbonaceous matter.
Water sealed at 5.00	S J	4.85	1	4.95	Made Ground – firm dark grey clay with scattered stones and brick fragments.
Fast inflow at 5.60	J	5.30		5.55	Medium dense gravel with grey sand and thin lenses of grey clay.
Standpipe tip at 6.00	C B	5.85	19	6.15	Firm to stiff initially then stiff brown fissured clay with blue staining on fissures.
Water sealed at 6.80	J	6.50			
	U	7.05			
Water level p.m. dry. Casing at 6.80 BH continued 17 Oct Water level a.m. dry.	J	8.00			
	S J	8.85	28		
	J	9.50		9.65	Stiff grey fissured clay.

Legend



Constructed by Cable Percussion Techniques U + Undisturbed B = Bulk J = Jar W = Water Scale = 1:50

Remark :-

BOREHOLE No	BH 1

Contract & Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	BOREHOL No	BH 1
Client	Gerard Huguenin (Ground Works Specialists)	Sheet 2 of 3	
Engineer		Report No	4051-KB

Borehole dia. 150mm	Samples Type	Depth	SPT (N)	Depth m	Strata Description	Legend
	U	10.05		10	Stiff grey fissured clay.	
	J	11.00		11		
	S J	11.85	33	12		
	J	12.50		12.35		
Seepage Inflow - 13.00 Inflow not sealed	U	13.05		13	Very stiff grey fissured clay with occasional light grey fine sand lenses mainly between 12.35m and 18m.	
	J	14.00		14		
	S J	14.85	38	15		
	J	15.50		16		
	U	16.05				
	J	17.00		17		
Chiselled for 1 Hr on claystone	S J	17.85	38	18	Claystone at 18.1m.	
	J	18.50		19		
	U	19.05				
	J	20.00		20		

Constructed by Cable Percussion Techniques U = Undisturbed B = Bulk J = Jar W = Water Scale = 1:50

Remark :-

BOREHOLE No	BH 1

Contract & Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	BOREHOL No	BH 1
Client	Gerard Huguenin (Ground Works Specialists)	Sheet 3 of 3	
Engineer		Report No	4051-KB

Borehole dia. 150mm	Samples Type	Depth	SPT (N)	Depth m	Strata Description	Legend
				20	Very stiff grey fissured clay with occasional light grey fine sand lenses mainly between 12.35m and 18m.	
	S J	20.85	45	21		
	J	21.50				
	U	22.05		22		
	J	23.00		23		
Chiselled for 1 Hr on claystone	S J	23.85	48	24	Claystone at 24.05m.	
	J	24.30				
	U	24.55				
				25.00 25	End of Borehole	
				26		
				27		
				28		
				29		
				30		

Constructed by Cable Percussion Techniques U + Undisturbed B = Bulk J = Jar W = Water Scale = 1:50

Remark :- Borehole backfilled with soil arisings 25m to 7m; Bentonite seal 7m to 6.4m; 38mm dia standpipe tip at 6m, slotted 6m to 5m with gravel filter 6.4m to 2m; concrete plug 2m to 1.8m; spoil to GL with cover cemented at GL.

BOREHOLE No BH 1

SITE & Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	Report No.	4051-KB

STANDARD PENETRATION TEST

Borehole No.	Depth at start	Type of Test	Blows per 75 mm penetration							
1	1.50	S	1---->		1	1	1---->			
	2.50	S	1---------->			1---->		1		
	4.55	S	1---------->				1---->			
	5.55	C	6	8	8	5	3	3		
	8.55	S	3	5	6	6	7	9		
	11.55	S	3	4	7	8	8	10		
	14.55	S	3	5	7	9	10	12		
	17.55	S	4	5	8	8	10	12		
	20.55	S	4	7	9	10	12	14		
	23.55	S	5	6	9	11	13	15		

Test Type C = Cone S = Spoon

SOIL CONSULTANTS LTD

Site Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	Report No.	4051-KB

TRIAXIAL COMPRESSION TEST

Borehole No.	Depth m	Test Type	Lateral Pressure kN/m^2	Compress. Strength kN/m^2	Bulk Density Mg/m^3	Moisture Content %	Cohesion kN/m^2	Ø Deg.	Remarks
1	7.05	38U	100	228	1.98	29	128	0	
			200	283	1.99	30			
			300	258	1.99	31			
	10.05	38U	200	211	2.00	29	107	0	
			300	239	2.00	29			
			450	192	1.98	29			
	13.05	38U	200	488	2.03	22	212	0	
			300	519	2.06	23			
			450	266	2.05	24			
	16.05	38U	200	528	2.06	24	225	0	
			300	322	2.03	24			
			450	498	2.08	25			
	19.05	38U	200	323	2.04	26	168	0	
			300	322	2.05	27			
			450	362	2.05	26			
	22.50	38U	450	257	2.03	27	129	0	
			600	268	2.04	27			
			750	249	2.04	27			
	24.05	38U	450	785	2.05	28	285	0	
			600	515	2.01	27			
			750	408	1.99	27			

Test Type U = Undrained M = Multi-stage QD = Quick Drained NMC = Moisture Content 38,102 = diameter in mm

SOIL CONSULTANTS LTD

SOIL CONSULTANTS LTD.

Chiltern House
Earl Howe Road
Holmer Green
High Wycombe
Bucks HP15 6QT

Tel 01494 712494
Fax 01494 713922

Site Investigation Specialists
Geotechnical Engineers
Environmental Appraisal

Site Location	ST MARY SOMERSET TOWER, CASTLE BAYNARD STREET LONDON EC4	Report No. 4051/KB

LABORATORY TEST CERTIFICATE - Sulphate Analysis

Sample Location	Depth (m)	Sample Description	SOIL 2:1 SO_4 gm/litre	WATER SO_4 gm/litre	pH	Remarks
1	0.80	Made Ground – clay fill, sandy rubble.	0.15		8.6	
	2.50	Made Ground – clay fill with stones, brick and concrete.	0.05		8.3	
	3.50	Made Ground – sandy clay fill with stones and chalk fragments.	0.32		9.8	
	7.05	Brown fissured clay.	0.10		8.5	
	19.05	Grey fissured clay.	0.11		8.3	

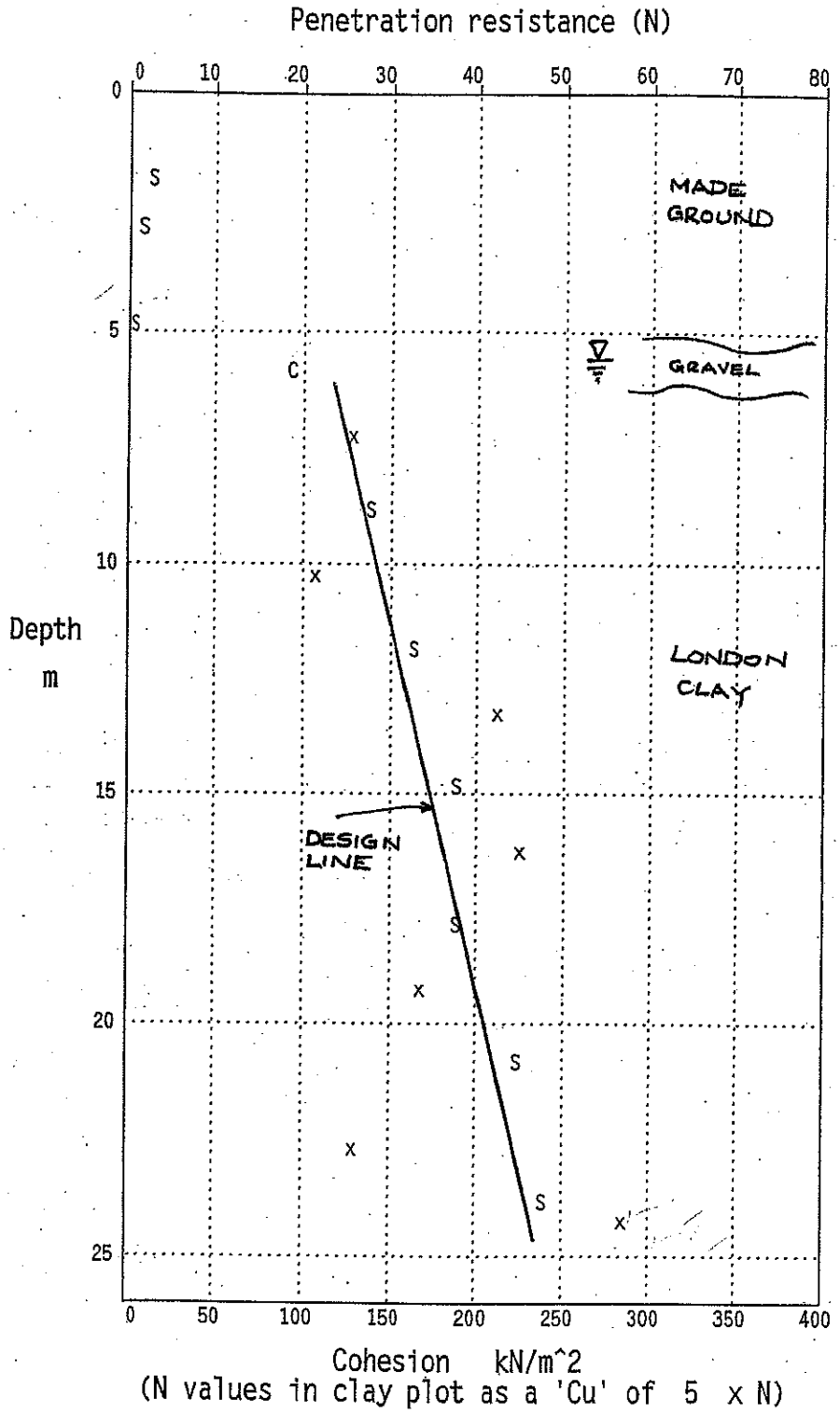
Tests carried out to the following standards

Soil and Water Sulphate Analysis	- BS 1377: Part 3: 1990	- Clause 5
Determination of pH value	- BS 1377: Part 3: 1990	- Clause 9

Sample examined by KB (Engineer)

Results Checked by KB (Engineer) Certificate date : 11 November 2005

Site Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	Report No.	4051-KB

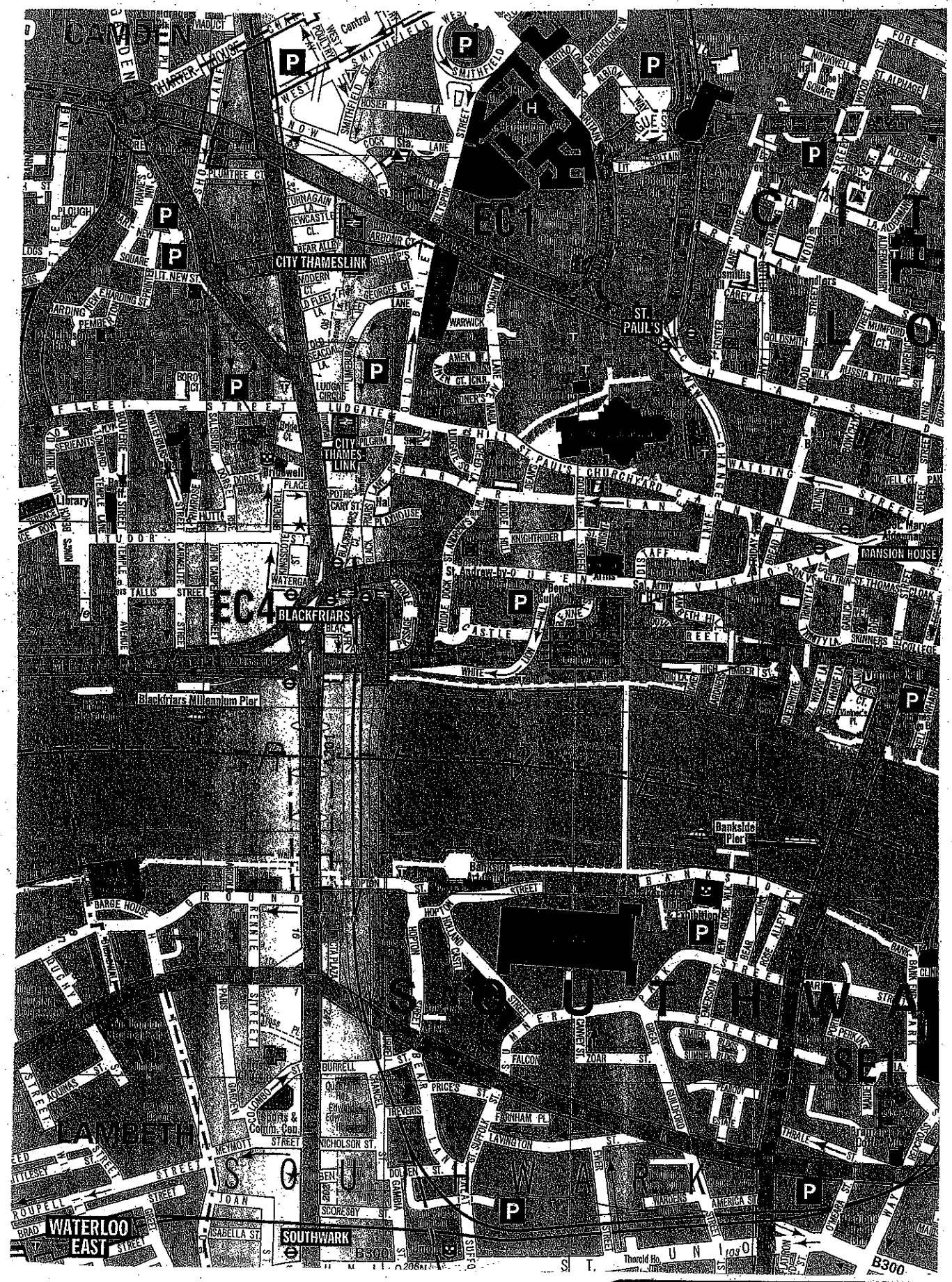


s = SPT (spoon) c = SPT (cone) x = 38mm triaxial

SOIL CONSULTANTS LTD

SITE & Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	Report No.	4051-KB

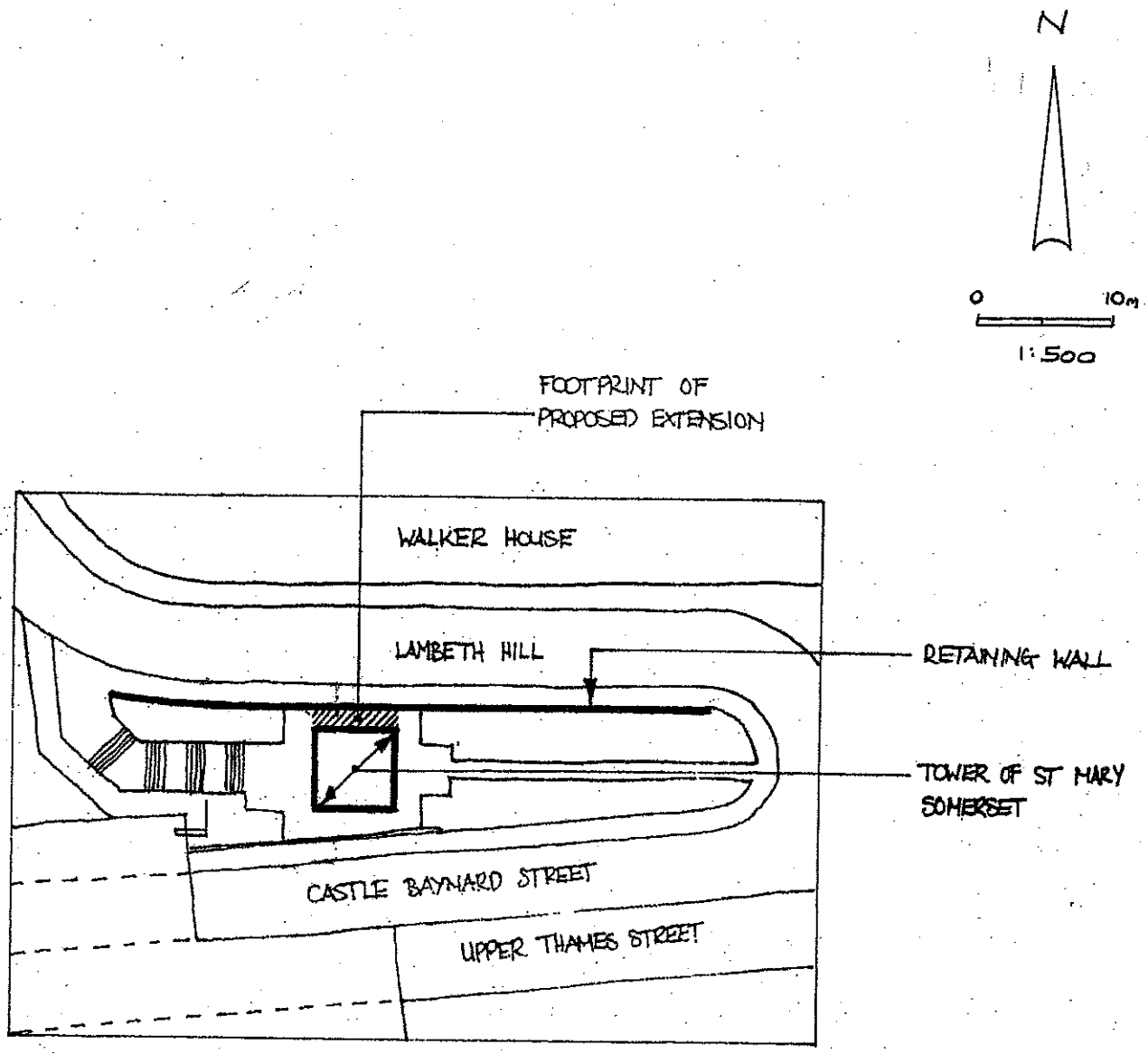
LOCATION PLAN



SOIL CONSULTANTS LTD

SITE & Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	Report No.	4051-KB

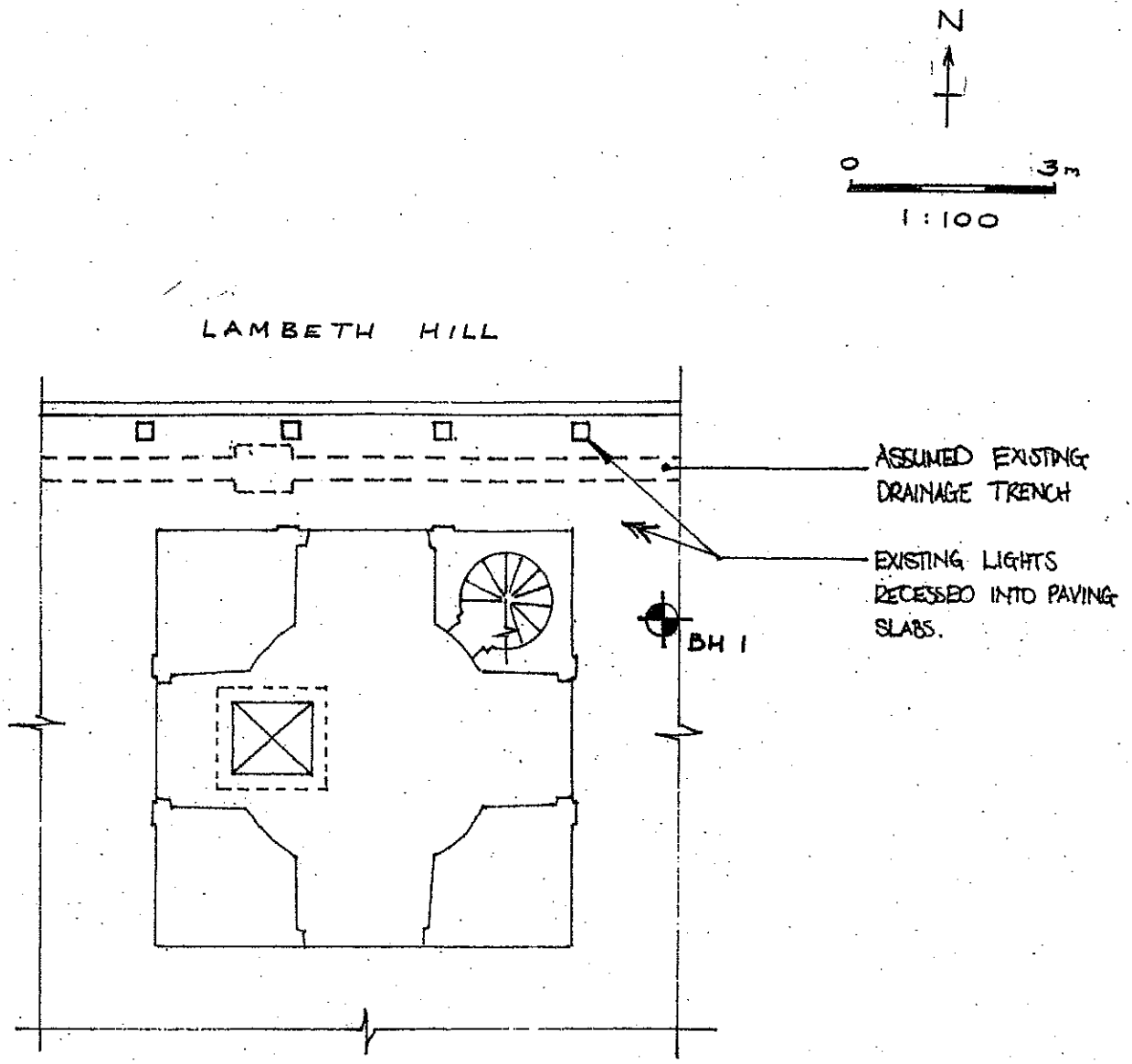
LOCATION PLAN



SOIL CONSULTANTS LTD

SITE & Location	St Mary Somerset Tower, Castle Baynard Street, London EC4.	Report No.	4051-KB

SITE PLAN



SOIL CONSULTANTS LTD