MACC International Ltd, Camilla Court, Nacton, Ipswich, Suffolk, IP10 0EU, UK

Lauren Wenham
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Soiltechnics Ltd

Your Reference:

Our Reference: JM/3536/305

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Date: 22/01/2018

Unexploded Ordnance Preliminary Risk Review
1 Steele's Studios, Haverstock Hill, London NW3 4RN

MACC International Ltd (MACC) has conducted a preliminary risk review for the site footprint. The review has drawn on open source and in-house information, references have been provided where available (See Annex A).

The review has been conducted to provide Soiltechnics Ltd with a review of the risk which may be posed by UXO while conducting investigations on the site.

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Records indicate that at least one HE bomb narrowly missed the site footprint during WWII. Whilst considering the history of the site and the level of post-war development, the following conclusions have been reached:

It is considered that there is a credible likelihood of encountering UXO on the site. The UXO risk is considered to be MEDIUM within the site boundary.

It is recommended that a detailed UXO study is conducted or alternatively; the stated preliminary risk level is accepted and the following mitigation procedures are implemented:

1. All site personnel are provided with a UXO Safety Awareness Talk before intrusive works are commenced.
2. All intrusive investigations into post war un-worked ground should be supported by specialist EOD services.

I trust this document has provided you with sufficient information to meet your immediate needs, should you require anything further, please do not hesitate to contact me.

Yours Sincerely

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Operations Manager

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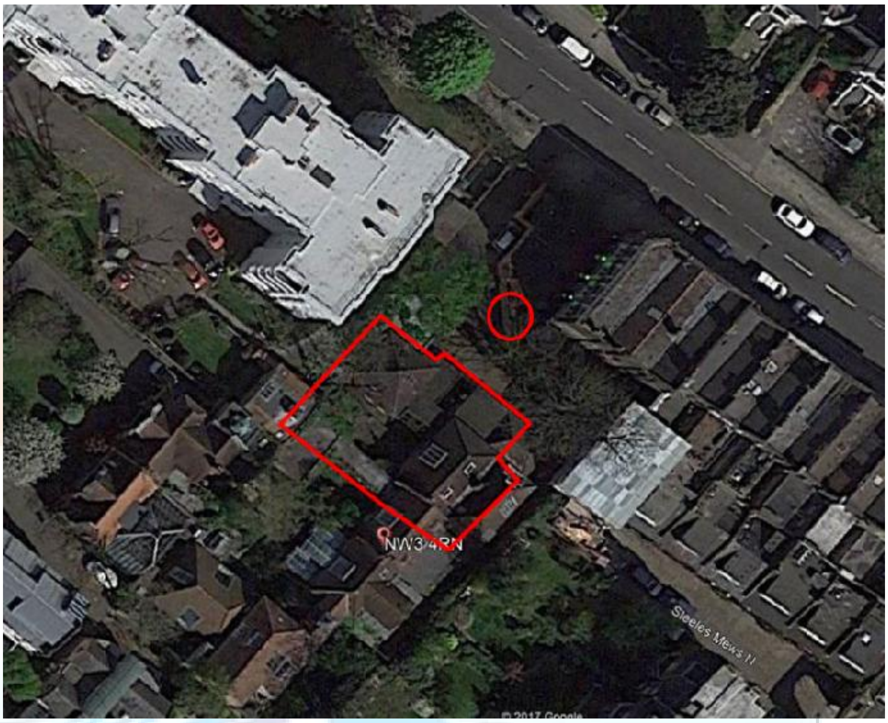
Annex ‘A’ to
Document JM/3536/305
Dated 22/01/18

Unexploded Ordnance Preliminary Risk Review

Site location	Site Address: 1 Steele’s Studios, Haverstock Hill, London NW3 4RN Grid Reference: 527739, 184693 
Scope of Intended works	Preliminary review of the risk that may be posed by UXO to geotechnical investigations.
History	• No records were found to indicate military activity within the site footprint.
Wartime History	• At least one HE bomb strike was recorded within c.a.30m of the site footprint. • HAA gun sites were located in the area to defend against air attacks and combat engagements with enemy aircraft did take place.
Unexploded Ordnance (UXO) Finds	• No reports were found to indicate that items of UXO have been found within the site footprint.
Post War Development	• The majority of the site footprint appears to have undergone a limited level of post-war development.

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Appendix D1

Proposed redevelopment
Steele's Studios, London

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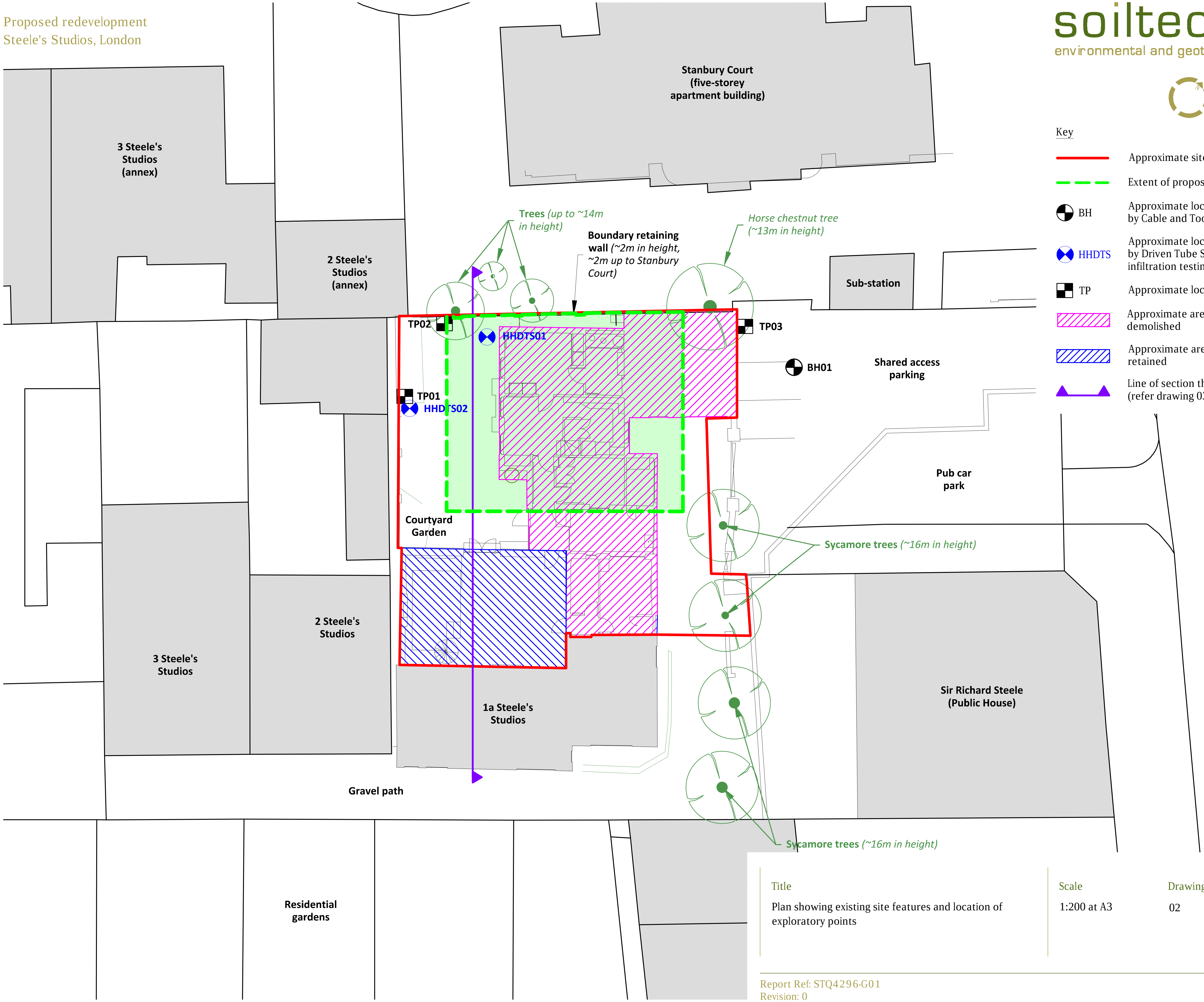

Key

(red line)	Approximate site boundary
(green dashed line)	Extent of proposed basement
BH	Approximate location of borehole formed by Cable and Tool percussive techniques
HHDTS	Approximate location of borehole formed by Driven Tube Sampling techniques with infiltration testing
TP	Approximate location of trial pit excavation
(magenta hatching)	Approximate area of structures to be demolished
(blue hatching)	Approximate area of structures to be retained
(purple line with triangles)	Line of section through proposed basement (refer drawing 03)

Title	Scale	Drawing number
Plan showing existing site features and location of exploratory points	1:200 at A3	02

Key to legends

Composite materials, soils and lithology

Topsoil	Made Ground	Boulders
Chalk	Clay	Coal
Cobbles	Cobbles & Boulders	Concrete
Gravel	Limestone	Mudstone
Peat	Sand	Sand and Gravel
Sandstone	Silt	Silt / Clay
		Siltstone

Note: Composite soil types are signified by combined symbols.

Key to 'test results' and 'sampling' columns

Test result

Depth	Records depth that the test was carried out (i.e.: at 2.10m or between 2.10m and 2.55m)
Result	PP – Pocket penetrometer result reported as an equivalent undrained shear strength (kN/m^2) SV – Hand held shear vane result reported as an undrained shear strength (kN/m^2) PP result converted to an equivalent undrained shear strength by applying a factor of 50. Where at least 3 results obtained at same depth then an average value may be reported.
	SPT – Standard Penetration Test result (N value) (uncorrected)[1,2,3] SPT(c) – Standard Penetration Test result (solid cone) (N value) (uncorrected)[1,2,3]
	UT – Undisturbed sample 100mm diameter sampler with number of blows of driving equipment required to obtain sample

Sampling

From (m) To (m)	Records depth of sampling	
Type	D	Disturbed sample
	B	Bulk disturbed sample
	ES	Environmental sample
	W	Water sample
	UT	Undisturbed thin walled sample 100mm diameter sampler

Note [1]: Seating blows recorded in brackets.
Note [2]: Casing depth records depth of casing when SPT or SPT(c) was carried out.
Note [3]: Water depth records depth of water when SPT or SPT(c) was carried out.

Water observations

Described at foot of log and shown in the 'water strike' column.

▼	= water level observed after specified delay in drilling
▽	= water strike

Standpipe details

- Gravel filter
- Arisings
- Bentonite
- Slotted pipe
- Unslotted pipe

Proposed redevelopment
Steele's Studios, London

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WELL	STRATA: DESCRIPTION	DEPTH (m)	REDUCED LVL (m OD)	LEGEND	WATER STRIKES	SPT TESTING: TYPE / DEPTH (m)	SPT: RESULT	SPT: CASING DEPTH (m)	SPT: WATER LEVEL (m)	OTHER IN SITU TESTING: TYPE / DEPTH (m)	OTHER IN SITU: RESULT	SAMPLING: FROM (m)	SAMPLING: TO (m)	SAMPLING: TYPE
	Bituminous bound material onto brown very sandy very gravelly CLAY. Gravel consists of brick, flint, bituminous coated material and concrete. (MADE GROUND)	0.30												
	Stiff orange brown slightly gravelly sandy CLAY. Gravel consists of flint, brick, timber and sandstone. (MADE GROUND)											0.50 0.60	0.80	D B
	Stiff high strength orange brown slightly sandy CLAY with some rootlets. (LONDON CLAY FORMATION)	1.00								PP 1.00	PP=71	1.00		D
										PP 1.50	PP=79	1.50		D
	Stiff high strength brown slightly sandy CLAY. (LONDON CLAY FORMATION)	2.00				S 2.00-2.45	(2) 10	0.00	DRY	PP 2.00	PP=71	2.00	2.45	D
										PP 3.00	PP=121 UT=18	3.00 3.00	3.45	D UT
										PP 3.50	PP=100	3.50		D
						S 4.00-4.45	(3) 18	1.50	DRY	PP 4.00	PP=175	4.00	4.50	D
	from 5m depth, occasional gravels of selenite.									PP 5.00	PP=129 UT=45	5.00 5.00	5.45	D UT
										PP 5.50	PP=196	5.50		D

CONTINUED ON NEXT SHEET

Key

D Small Disturbed Sample
B Bulk Disturbed Sample
ES Environmental Sample
W Water Sample
C Core sample
UT Undisturbed Sample

S Standard Penetration Test
C Standard Penetration Test (solid cone)

PP Pocket Penetrometer test
SV Shear Vane test
PID Photo Ionisation Detector test

Notes

Hand dug service pit completed to 1.2m depth. Trial pit sides remained upright and stable upon completion.

Groundwater observations

No groundwater encountered.

Chiselling details

Depth (m)	Duration (hh:mm)

Water added details

Depth (m)	Water Added (l)

Title

Borehole record

Casing details

Diameter (mm)	Base depth (m)
150	1.50

Method Shell and auger	**Logged by** GE	**Date(s)** 26/01/2018
Level (m OD) -	**Compiled by** KM	**Sheet number** Sheet 1 of 3
Co-ordinates -	**Checked by** MH	**BH01**

Report ref: STQ4296-G01 **Revision:** 0

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WELL	STRATA DESCRIPTION	DEPTH (m)	REDUCED LVL (m OD)	LEGEND	WATER STRIKES	SPT TYPE / DEPTH (m)	SPT RESULT	SPT CASING DEPTH (m)	SPT WATER LEVEL (m)	OTHER IN SITU TYPE / DEPTH (m)	OTHER IN SITU RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
	Stiff high strength brown slightly sandy CLAY. (LONDON CLAY FORMATION) *...from 6m depth, becoming brown.*					S 6.00-6.45	(4) 22	1.50	DRY	PP 6.00	PP=158	6.00	6.45	D
										PP 7.00	PP=200	7.00	7.45	D
											UT=50	7.00		UT
										PP 7.50	PP=200	7.50		D
										PP 8.00	PP=208	8.00		D
	Very stiff high strength dark grey CLAY. (LONDON CLAY FORMATION)	8.80												
											UT=55	9.00	9.45	UT
										PP 9.50	PP=225	9.50		D
										PP 10.50	PP=167	10.50		D
											UT=55	11.00	11.45	UT
										PP 11.50	PP=225	11.50		D

CONTINUED ON NEXT SHEET

Key
D Small Disturbed Sample
B Bulk Disturbed Sample
ES Environmental Sample
W Water Sample
C Core sample
UT Undisturbed Sample

S Standard Penetration Test
C Standard Penetration Test (solid cone)

PP Pocket Penetrometer test
SV Shear Vane test
PID Photo Ionisation Detector test

Notes
Hand dug service pit completed to 1.2m depth. Trial pit sides remained upright and stable upon completion.

Groundwater observations
No groundwater encountered.

Chiselling details

Depth (m)	Duration (hh:mm)

Water added details

Depth (m)	Water Added (l)

Casing details

Diameter (mm)	Base depth (m)

Title
Borehole record

Method Shell and auger	**Logged by** GE	**Date(s)** 26/01/2018
Level (m OD) -	**Compiled by** KM	**Sheet number** Sheet 2 of 3
Co-ordinates -	**Checked by** MH	**BH01**

Report ref: STQ4296-G01 **Revision:** 0

Proposed redevelopment
Steele's Studios, London

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WELL	STRATA: DESCRIPTION	DEPTH (m)	REDUCED LVL (m OD)	LEGEND	WATER STRIKES	SPT TESTING: TYPE / DEPTH (m)	SPT: RESULT	SPT: CASING DEPTH (m)	SPT: WATER LEVEL (m)	OTHER IN SITU TESTING: TYPE / DEPTH (m)	OTHER IN SITU: RESULT	SAMPLING: FROM (m)	SAMPLING: TO (m)	SAMPLING: TYPE
	Very stiff high strength dark grey CLAY. (LONDON CLAY FORMATION)									PP 12.50	PP=192	12.50		D
											UT=65	13.00	13.45	UT
										PP 13.50	PP=225	13.50		D
						S 14.00-14.45	(6) 33	1.50	DRY	PP 14.00	PP=225	14.00	14.45	D
											UT=75	15.00	15.45	UT
	BOREHOLE TERMINATED AT 15.50m	15.50								PP 15.50	PP=225	15.50		D

Key
D Small Disturbed Sample
B Bulk Disturbed Sample
ES Environmental Sample
W Water Sample
C Core sample
UT Undisturbed Sample

S Standard Penetration Test
C Standard Penetration Test (solid cone)

PP Pocket Penetrometer test
SV Shear Vane test
PID Photo Ionisation Detector test

Notes
Hand dug service pit completed to 1.2m depth. Trial pit sides remained upright and stable upon completion.

Groundwater observations
No groundwater encountered.

Chiselling details

Depth (m)	Duration (hh:mm)

Water added details

Depth (m)	Water Added (l)

Title
Borehole record

Casing details

Diameter (mm)	Base depth (m)

Method
Shell and auger

Logged by
GE

Date(s)
26/01/2018

Level (m OD)
-

Compiled by
KM

Sheet number
Sheet 3 of 3

Co-ordinates
-

Checked by
MH

BH01

Report ref: STQ4296-G01 **Revision:** 0

Key to legends

Composite materials, soils and lithology		
Topsoil	Made Ground	Boulders
Chalk	Clay	Coal
Cobbles	Cobbles & Boulders	Concrete
Gravel	Limestone	Mudstone
Peat	Sand	Sand and Gravel
Sandstone	Silt	Silt / Clay
		Siltstone

Note: Composite soil types are signified by combined symbols.

Key to 'test results' and 'sampling' columns

Test result	
Depth	Records depth that the test was carried out (i.e.: at 2.10m or between 2.10m and 2.55m)
Result	PP – Pocket penetrometer result (kN/m^2) SV – Hand held shear vane result (kN/m^2) PP result converted to an equivalent undrained shear strength by applying a factor of 50. Where at least 3 results obtained at same depth then an average value may be reported.
	SPT – Standard Penetration Test result (uncorrected)[1,2,3] SPT(c) – Standard Penetration Test result (solid cone) (uncorrected)[1,2,3]
	UT – Undisturbed sample 100mm diameter sampler with number of blows of driving equipment required to obtain sample

Sampling		
From (m) To (m)	Records depth of sampling	
Type	D	Disturbed sample
	B	Bulk disturbed sample
	ES	Environmental sample comprising plastic and/or glass container
	W	Water sample
	UT	Undisturbed sample 100mm diameter sampler

Water observations

Described at foot of log and shown in the 'water strike' column.

▼	= water level observed after specified delay in drilling
▽	= water strike

Standpipe details

- Gravel filter
- Arisings
- Bentonite
- Slotted pipe
- Unslotted pipe

Density

Density recorded in brackets inferred from density testing and soil descriptions from across the site (i.e.: [Medium dense]).

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WELL	STRATA: DESCRIPTION	DEPTH (m)	REDUCED LVL (m OD)	LEGEND	WATER STRIKES	SPT TESTING: TYPE / DEPTH (m)	SPT: RESULT	SPT: CASING DEPTH (m)	SPT: WATER LEVEL (m)	OTHER IN SITU TESTING: TYPE / DEPTH (m)	OTHER: RESULT	SAMPLING: FROM (m)	SAMPLING: TO (m)	SAMPLING: TYPE
	Brick paving onto light grey unreinforced CONCRETE with aggregates of flint up to 5mm and approximately 1-2% air voids. (MADE GROUND)	0.09												
	Stiff orange brown slightly gravelly CLAY with occasional rootlets. Gravel consists of rounded flint, quartz and occasional brick. (MADE GROUND)											0.20		ES
										PP 0.50	PP=58			
	Stiff high strength brown mottled orange brown and grey CLAY with occasional gravel sized pockets of orange brown sand and occasional gravels of siltstone. (LONDON CLAY FORMATION)	0.70										0.70	1.00	D
										PP 0.80	PP=71			
										PP 1.00	PP=54			
										PP 1.20	PP=71			
										PP 1.40	PP=92			
												1.50	2.00	D
										PP 1.60	PP=100			
										PP 1.70	PP=108			
										PP 1.90	PP=121			
										PP 2.00	PP=113			
										PP 2.10	PP=100			
										PP 2.30	PP=104			
										PP 2.50	PP=108			
										PP 2.70	PP=92			
												2.80		D
	BOREHOLE TERMINATED AT 2.90m	2.90												

Key
D Small Disturbed Sample
B Bulk Disturbed Sample
ES Environmental Sample
W Water Sample
C Core sample
UT Undisturbed Sample

S Standard Penetration Test
C Standard Penetration Test (solid cone)

PP Pocket Penetrometer test
SV Shear Vane test
PID Photo Ionisation Detector test

Notes
Trial pit hand dug to 0.7m depth to check for presence of services. Trial pit sides remained upright and stable upon completion.

Groundwater observations
No groundwater encountered.

Title
Driven tube sampler record

Recovery details: Range (m)	Recovery (%)
	100

Method Hand-held DTS	**Logged by** GE	**Date(s)** 26/01/2018
Level (m OD) -	**Compiled by** KM	**Sheet number** Sheet 1 of 1
Co-ordinates -	**Checked by** MH	**HHDTS01**

Report ref: STQ4296-G01 **Revision:** 0

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WELL	STRATA				WATER STRIKES	SPT TESTING				OTHER IN SITU TESTING		SAMPLING		
	DESCRIPTION	DEPTH (m)	REDUCED LVL (m OD)	LEGEND		TYPE / DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	TYPE / DEPTH (m)	RESULT	FROM (m)	TO (m)	TYPE
	Dark brown slightly gravelly silty sandy CLAY with frequent rootlets and roots up to 20mm in diameter. Gravel consists of flint, quartz and brick. (MADE GROUND)	0.60										0.10		ES
	Stiff brown sandy gravelly CLAY. Gravel consists of flint, brick and quartz (pea gravel). (MADE GROUND)	0.70												
	Stiff high strength orange brown slightly sandy CLAY with occasional rootlets. (LONDON CLAY FORMATION)	1.60								PP 0.90	PP=58	1.00	1.50	D
	Stiff high strength brown mottled grey CLAY. (LONDON CLAY FORMATION)	2.85			▼ (2.00)					PP 1.70	PP=71			
										PP 1.90	PP=92			
										PP 2.00	PP=88	2.00	2.50	D
										PP 2.10	PP=79			
										PP 2.30	PP=88			
										PP 2.40	PP=79			
										PP 2.60	PP=83			
										PP 2.70	PP=79			
	BOREHOLE TERMINATED AT 2.85m													

Key
D Small Disturbed Sample
B Bulk Disturbed Sample
ES Environmental Sample
W Water Sample
C Core sample
UT Undisturbed Sample

S Standard Penetration Test
C Standard Penetration Test (solid cone)

PP Pocket Penetrometer test
SV Shear Vane test
PID Photo Ionisation Detector test

Notes
Trial pit hand dug to 0.7m depth to check for presence of services. Trial pit sides remained upright and stable upon completion.

Groundwater observations
Groundwater level at 2m on completion of borehole.

Title
Driven tube sampler record

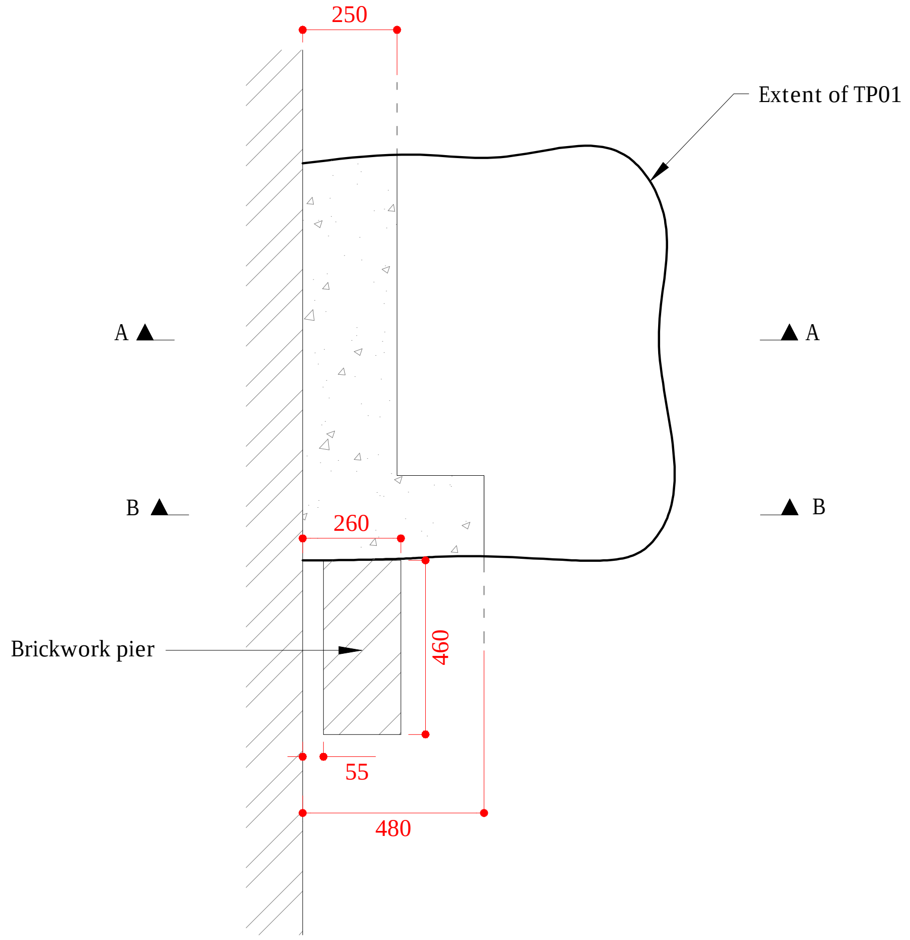
Recovery details

Range (m)	Recovery (%)
	100

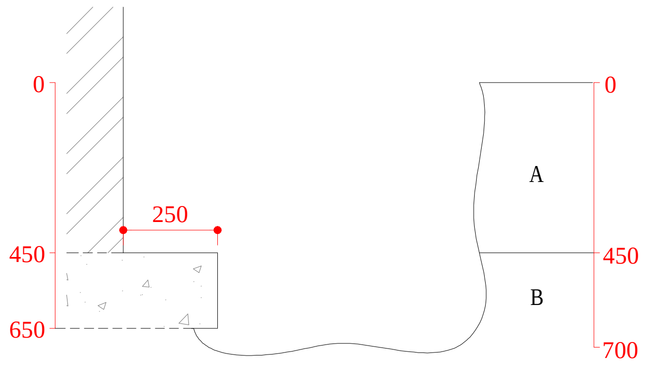
Method	**Logged by**	**Date(s)**
Hand-held DTS	GE	26/01/2018
Level (m OD)	**Compiled by**	**Sheet number**
-	KM	Sheet 1 of 1
Co-ordinates	**Checked by**	**HHDTS02**
-	MH	

Report ref: STQ4296-G01 **Revision:** 0

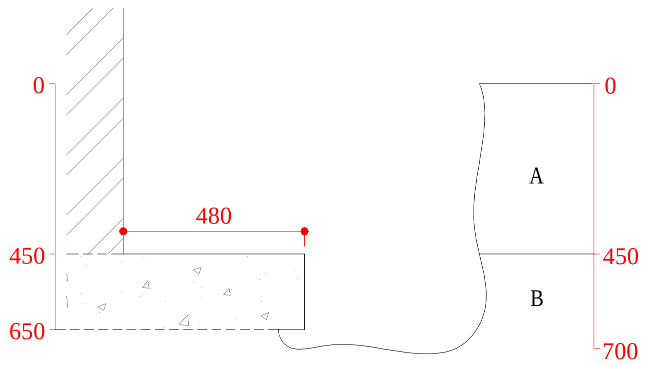
Plan



Section A-A



Section B-B



Photographic record

Key

A. Stiff dark brown slightly gravelly silty sandy CLAY with frequent rootlets and roots up to 20mm in diameter. Gravel consists of flint, quartz and brick.
(MADE GROUND)

B. Firm brown sandy gravelly CLAY. Gravel consists of flint, brick, quartz (pea gravel).
(MADE GROUND)

Observed features
Assumed features

Denotes brickwork
Denotes concrete

Notes

1. All dimensions shown in millimetres.
2. Disturbed sample taken from 2m depth.
3. Trial pit excavated by others.

Method of excavation	Title	Location reference
Hand tools	Trial pit record	TP01
Dimensions	Date of works	Location plan on drawing number
As shown	26/01/2018	02
Groundwater observations	Scale	Appendix
No groundwater encountered.	1:20 at A3	D

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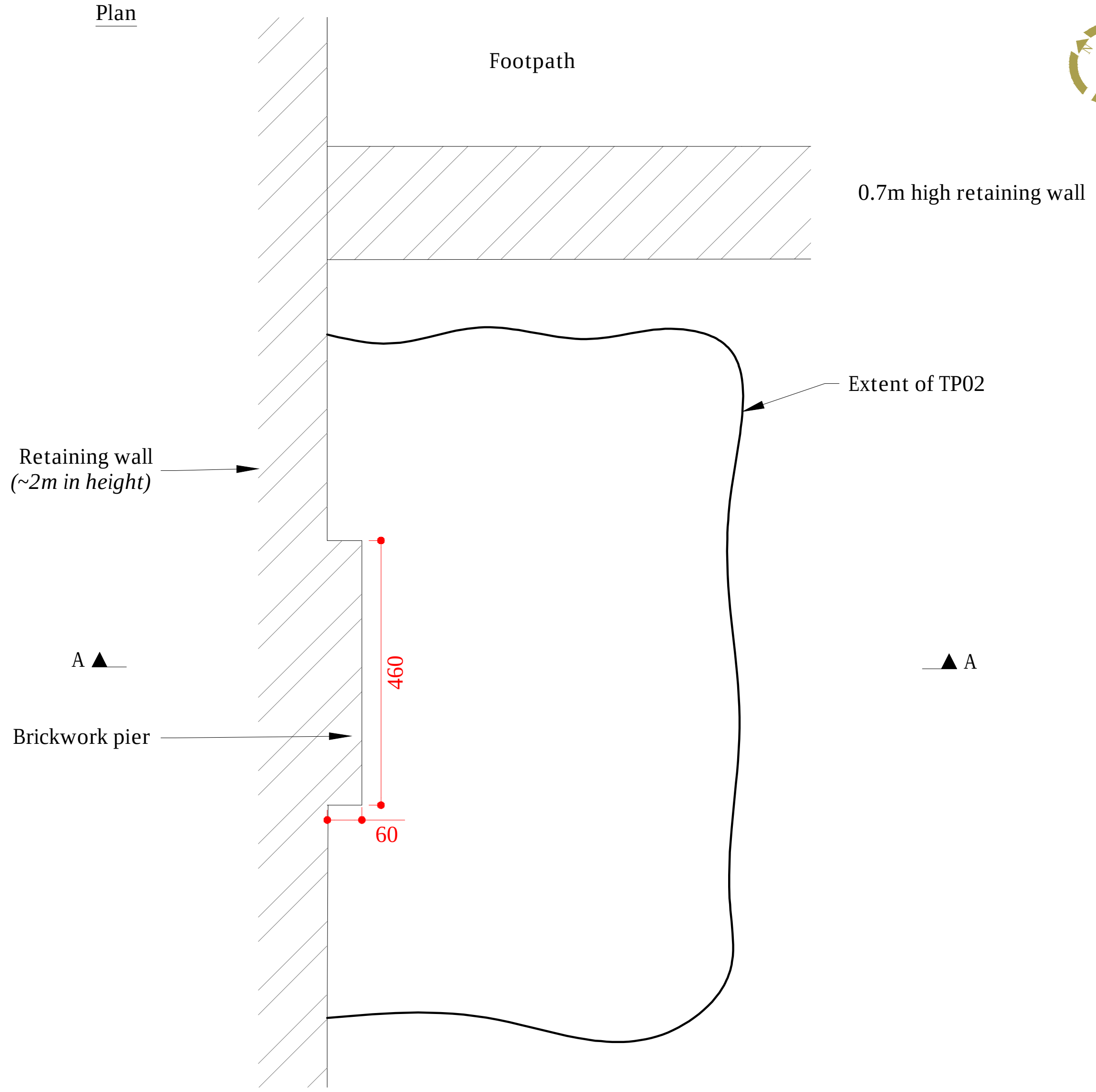
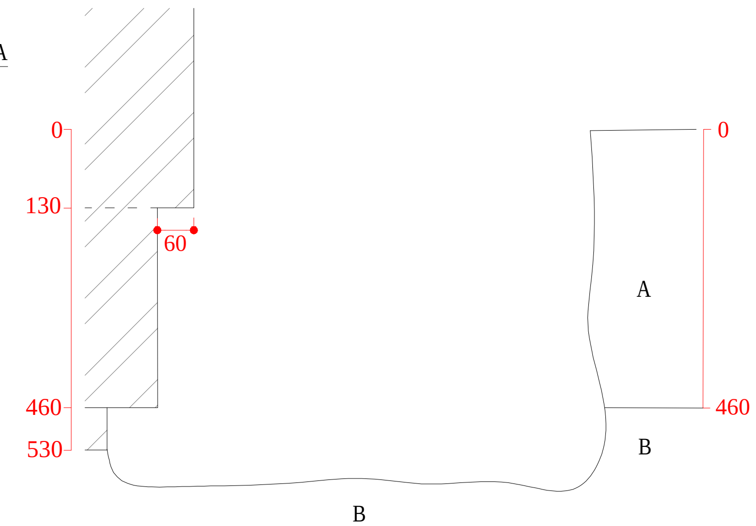
Plan



Section A



Photographic record

Key

A. Stiff dark brown slightly gravelly silty sandy CLAY with frequent rootlets and roots up to 20mm in diameter. Gravel consists of flint, quartz and brick.
(MADE GROUND)

B. Firm brown sandy gravelly CLAY. Gravel consists of flint, brick, quartz (pea gravel).
(MADE GROUND)

——— Observed features
– – – – Assumed features

Denotes brickwork
Denotes concrete

Notes

1. All dimensions shown in millimetres.
2. Disturbed sample taken from 0.5m depth.
3. Environmental sample taken from 0.2m depth.
4. Trial pit excavated by others. Foundation not seen (instructed not to extend trial pit).

Method of excavation	Title	Location reference
Hand tools	Trial pit record	TP02
Dimensions	Date of works	Location plan on drawing number
As shown	26/01/2018	02
Groundwater observations	Scale	Appendix
No groundwater encountered	1:12.5 at A3	D

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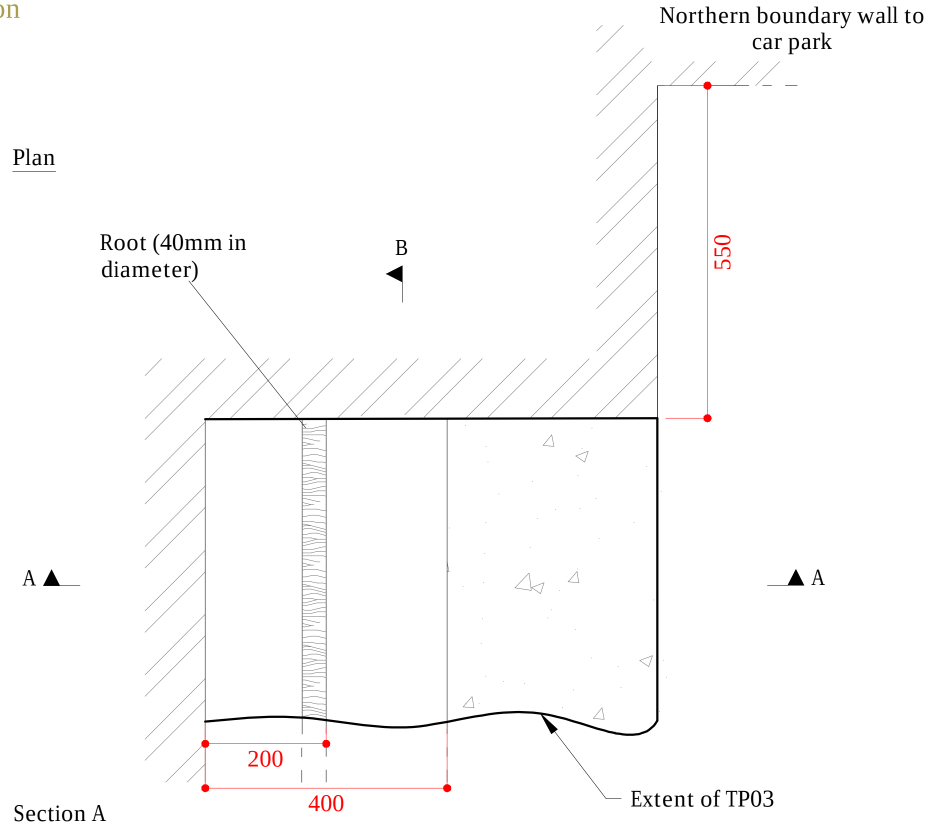
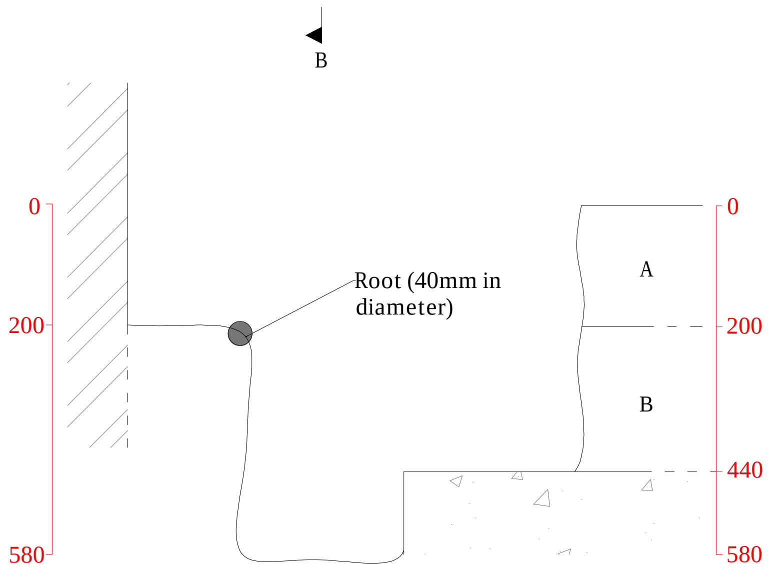
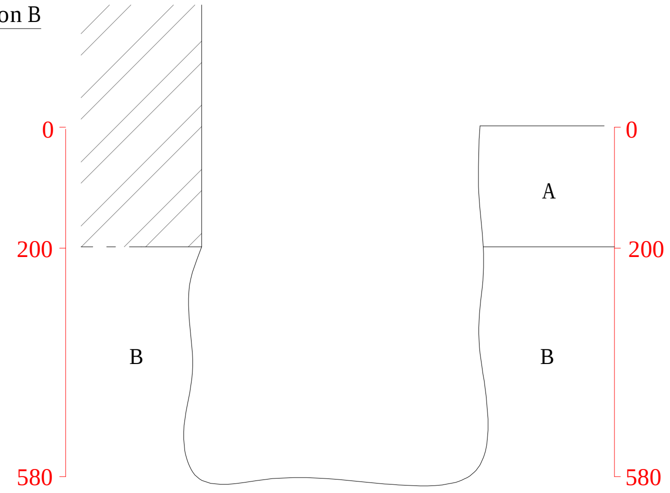
Plan



Section A



Section B



Photographic record

Key

A. Bituminous bound material.
(MADE GROUND)

B. Brown very sandy very gravelly CLAY. Gravel consists of brick, flint, bituminous coated material and concrete.
(MADE GROUND)

——— Observed features
– – – – Assumed features

Denotes brickwork

Denotes concrete

Denotes timber

Notes

1. All dimensions shown in millimetres.
2. Trial pit excavated by others.

Method of excavation	Title	Location reference
Hand tools	Trial pit record	TP03
Dimensions	Date of works	Location plan on drawing number
As shown	26/01/2018	02
Groundwater observations	Scale	Appendix
No groundwater encountered	1:00 at A3	D

Appendix D2

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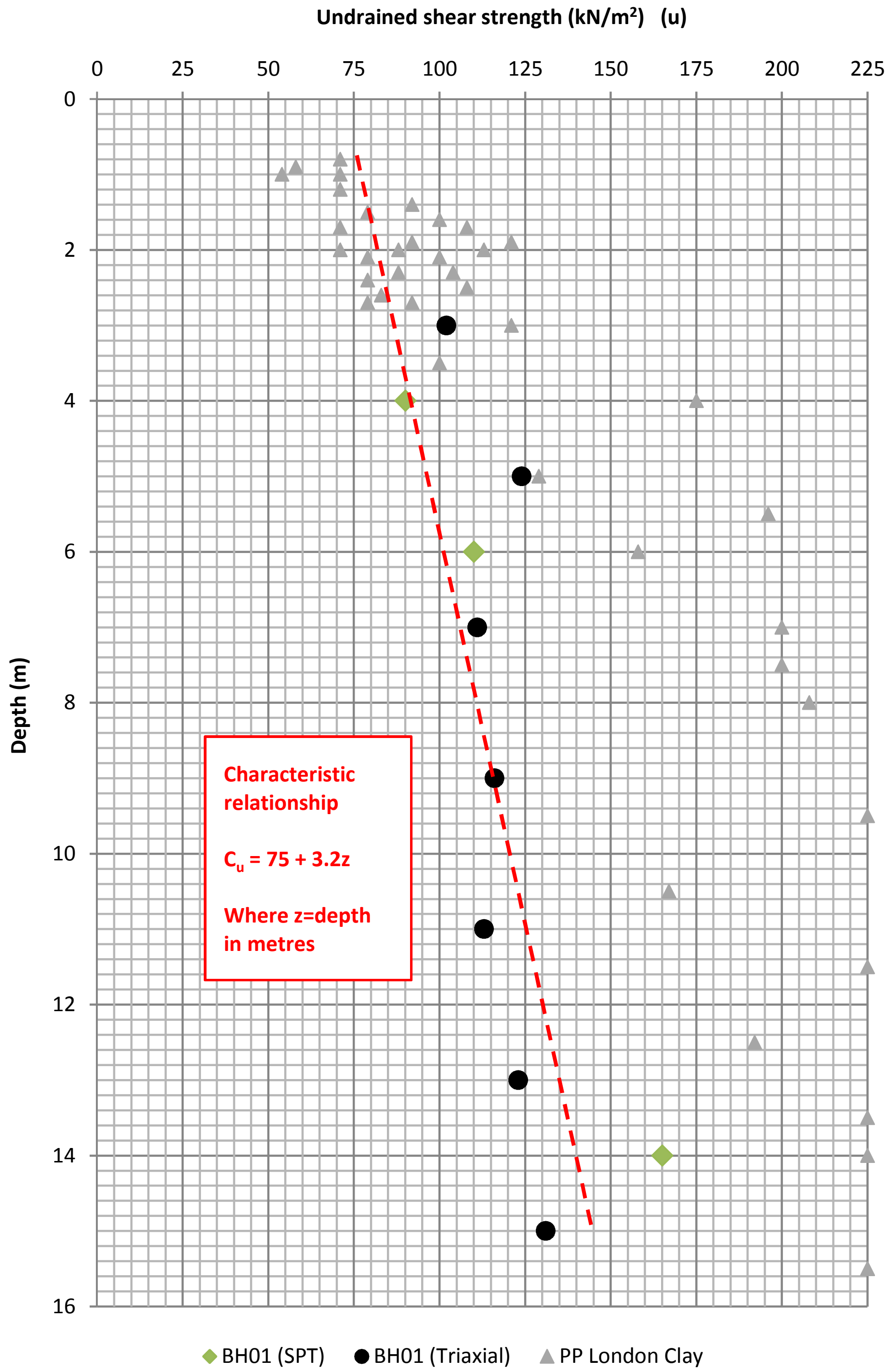

Notes

1) Equivalent undrained shear strength derived by multiplying Pocket Penetrometer (PP) results by 50
2) SPT 'N' values in London Clay converted to undrained shear strength using triaxial data

Title	Scale	Drawing number
Plot summarising shear strength determinations	As shown	04

Appendix F

Curriculam Vitae
Nigel Thornton
B.Sc, C.Eng, MICE, MCIHT, FGS.

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Qualifications

- Awarded degree in Civil Engineering., City University, London in 1980
- Elected Member of the Institution of Civil Engineers in 1983 (Chartered Civil Engineer)
- Member of the Chartered Institution of Highways and Transportation since 1984
- Fellow of the Geological Society since 1986

Employment History

• Northampton Borough Council	1975 - 1980
• Northamptonshire County Council	1980 - 1989
• The John Parkhouse Partnership	1989 - 1989
• Associate Partner	1989 - 1993
• Partner	1993 - 2005
• JPP Consulting (Director)	2005 to date
• Soiltechnics (Director)	1993 to date

Note

- In 2005, the John Parkhouse Partnership was incorporated into JPP Consulting Ltd (current complement 45 staff)
- Founding Director of Soiltechnics Ltd, a company specialising in geotechnical and geo-environmental matters. (Current complement 45 staff)

Relevant Experience

Bridgeworks	General design, contract administration and site supervision of various highway bridges and retaining structures.
Geotechnical and Geo-environmental	As Geotechnical Project Manager for Engineering Services Laboratory at NCC (ESL). (1985 - 1989) Control of ground investigations for major highway schemes for local authority including implementation of fieldwork, direction of laboratory testing and production of factual and interpretative reports, following and satisfying geotechnical certification procedures for Department of Transport (schemes up to £15m) Generally, at ESL, Soiltechnics and JPP. Design and specification of earthworks, including determination of slope stability. Investigation and remediation of unstable slopes. Control, implementation of fieldwork and production of geotechnical reports for industrial and commercial developments, housing schemes and water authority infrastructure (scheme values up to £80m). Investigations for outline designs of landfill sites. Investigations for redevelopment of chemically contaminated sites, assessment of the same, design and verification of remediation works. Production of tender and contract documents for ground investigations.

	Investigations into mine workings and assessment of their stability. Specifications for ground improvement works (vibrotreatment) and piling. Investigations and reporting on a wide range of basement constructions for commercial and residential buildings 1 to 4 stories deep. Producing basement impact reports. Lecturing to other professionals on the investigation assessment and remediation of contaminated land, and EPA part IIA Lectures to local ICE branch on geotechnical aspects.
Materials Management	Production of construction material specifications, primarily in concrete, aggregates and bituminous mixtures, but including masonry, timber, steel and protective systems. Control and implementation of investigations into failures of construction materials including scheduling and analysing test data, and production of technical reports providing specifications for appropriate remedial measures.
Building Structures	Structural inspections and surveys on a wide range of commercial, domestic, industrial and military buildings including direction of appropriate investigations and production of details repairs/construction specifications. Design and checking of building structures in timber, steel, concrete and masonry including supervision of works on site. Design works carried out both manually and using computerised systems following current British Standards and other recognised design standards.
Road Pavement Structures	Direction and implementation of condition surveys and investigations of road pavement using falling weight deflectometer, deflectograph bump integrator and coring. Direction of testing regimes for bituminous and cement bound and unbound pavement materials. Production of reports on condition and assessment of load carrying capacity of existing roadways and specification and structural design for new roadways for both highway and industrial use. Design of various road pavement structures (flexible and rigid) using Highways Agency and British Ports Federation guidelines.
Drainage and Flood Risk Assessments	Design of main (adoptable) and private foul and stormwater infrastructure for housing, commercial and industrial schemes, including detention basins, infiltration systems, pumping stations etc. Production of flood risk assessment reports.
Quality Assurance	Assisting in production of main laboratory procedures to obtain NAMAS accreditation for large spectrum of soils and materials testing. Geotechnical contributions to Quality Assurance Manual for Soiltechnics/JPP and implementation of procedures.
CPD and Health and Safety	Attendance of in house CPD Seminars and production of Health and Safety Plans/files for building works. Author of in house risk assessment and Practice policies.
Litigation	Acting as expert witness on numerous construction related matters.
Publications	Co-author of a book entitles 'Cracking and Building Movement' published by the Royal Institution of Chartered Surveyors, in late 2004.

Statement of experience on basements

Soiltechnics have carried out a large number of investigations for basement constructions throughout the UK and in more recent years outside the UK

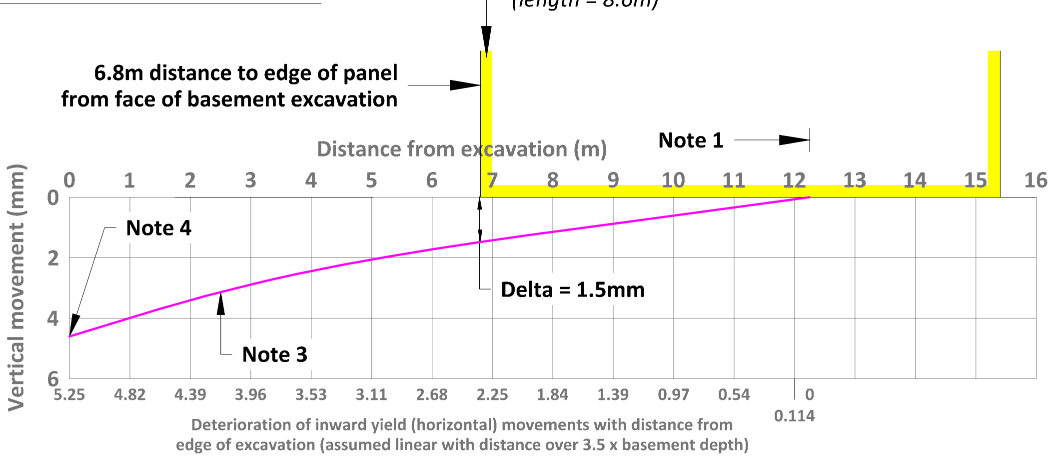
The following table provides a limited number examples (for illustration purposes) of investigations carried out for basements which include interpretative reports providing parameters for detailed design such as settlement / heave, ground movements around basements, hydrological effects and in some cases preliminary design of piles.

Location	ground conditions	Basement	Approx size (m)	Date
Northamptonshire	Glacial Till	Single storey archive store for Rolls Royce. Part open excavation for construction of reinforced concrete box subsequently backfilled	10 x 8	Circa 1992
Central London (Kings Road)	Terrace sands and gravels over London Clays	Two storey deep car park with gardens at ground level. Contiguous pile wall with subsequent insitu concrete box	40 x 20	Circa 2000
Central London (Finsbury square)	Terrace sands and gravels over London Clays	Two storey deep basement below multi storey building with adjacent buildings. Contiguous pile wall with subsequent insitu concrete box	30 x 20	Circa 2002
Central London (Union Street)	Terrace sands and gravels over London Clays	Two storey deep basement below multi storey building with adjacent buildings including tube tunnels. Contiguous pile wall with subsequent insitu concrete box	40 x 30	2009
Central London (Blackfriars)	Terrace sands and gravels over London Clays	Two storey deep basement below multi storey building with adjacent buildings including railway viaduct . Contiguous pile wall with subsequent insitu concrete box	40 x 20	2005
Central London (Imperial College)	Terrace sands and gravels over London Clays	Single storey deep basement below multi storey residential block. Sheet pile walls with subsequent insitu concrete box	60 x15	2005
Coventry University	Mercia Mudstones	Single storey deep basement with three storey building over. Part cut and part sheet piled with subsequent insitu concrete box	50 x50	2010
Rabat Grand theatre Bouregrerg Morrocco	Alluvial gravels over sandstone	Single storey deep basement. Open excavations and sheet piles walls with subsequent insitu concrete box. Piled foundation for super structure. Area subject to earthquakes and liquefaction. Outline design of piles, specification for piling and testing.	50 x50	2012
Central London (various locations)	London Clays occasionally overlain with terrace sands and gravels	Various existing terraced semi and detached domestic properties. New single and two storey deep basements under building foot prints and extending into gardens. Construction using traditional underpinning techniques and contiguous / secant piled walls	Various	2000 to date

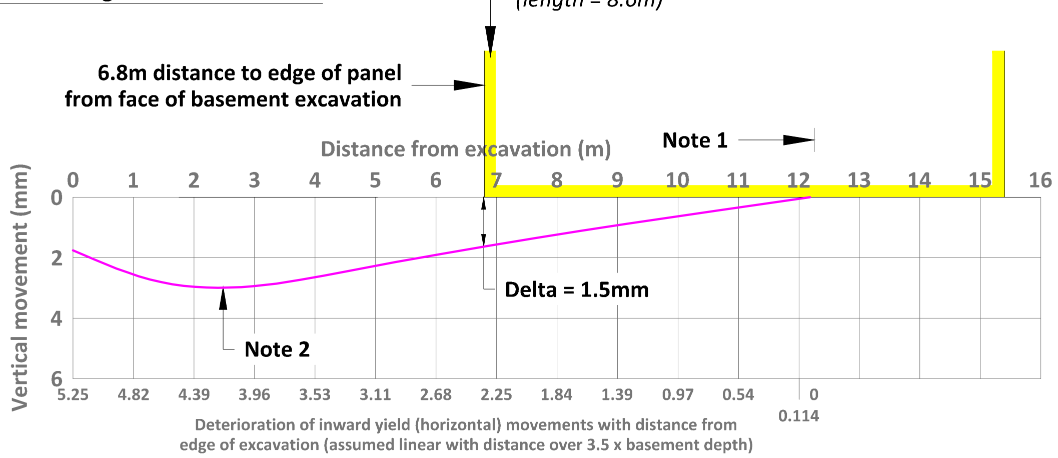
Central London (Holland Park)	London Clays	Two locally three storey deep basement below new four storey block of flats. Secant piled walls and insitu concrete box	70 x 20	2015
Camden (Carol Street)	London Clays	Single storey basement beneath four-storey mixed-use building. Stand alone new build, sheet piled retaining wall construction.	19 x 10	2018
Camden (Fordwych Road)	London Clays	Single storey basement beneath existing semi-detached property. Construction using traditional underpinning techniques	21 x 7	2017
Chiswick	Terrace Gravels over London Clay	Residential scheme (demolition of existing detached property followed by new build). Contiguous pile wall with subsequent insitu concrete box	20 x 12	2015
Oxford	Terrace Gravels over Oxford Clay	Residential scheme. Extension of existing basement and deepening of semi-basement. Construction using traditional underpinning techniques	15 x 6	2015
Central London (Grosvenor Place)	Terrace Gravels over London Clay	Addition of two further levels to a single-storey basement. Mix of underpinning and piled retaining walls.	20 x 20	2016
West London (Westbourne Grove)	London Clay	Single storey basement beneath existing terraced property. Construction using traditional underpinning techniques	20 x 6	2015
Camden (109 King Henry's Road)	London Clay	Single storey basement beneath existing terraced property. Construction using traditional underpinning techniques	12 x 9	2017
Central London (St John's Wood)	London Clay	Demolition of existing dwelling followed by construction of new build with single storey deep basement	5 x 10	2017
Princes Gate mews	London Clay	Single storey basement beneath existing terraced property. Construction using traditional underpinning techniques	8 x 4	2017
Camden (Croftdown Road)	London Clay	Single storey basement beneath existing terraced property. Construction using traditional underpinning techniques	10 x 4	2016
Camden High Street	London Clay	Depth extension of single storey basement below commercial property over LUL station box	10 x 4	2015
Camden, (Gray's Inn Road)	London Clay	Single storey basement beneath existing terraced property. Construction using traditional underpinning techniques	5 x 5	2018

Appendix G

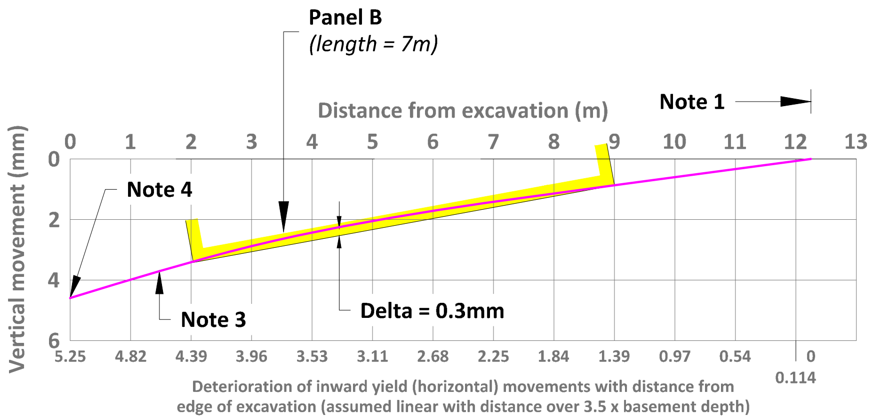
Panel A - Low stiffness conditions



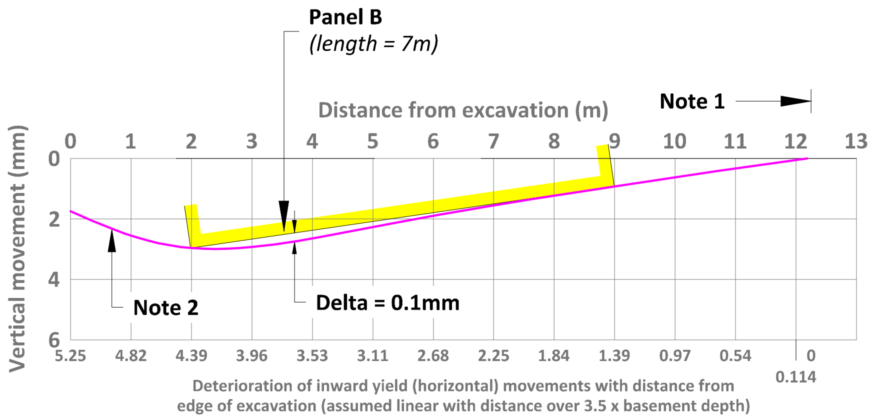
Panel A - High stiffness conditions



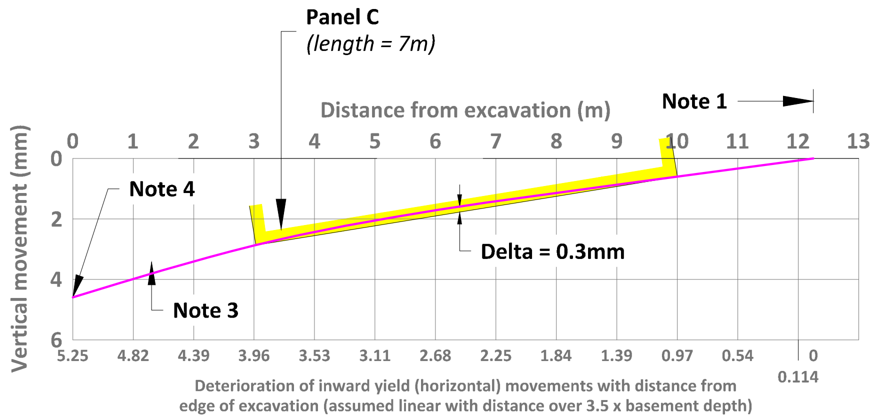
Panel B - Low stiffness conditions



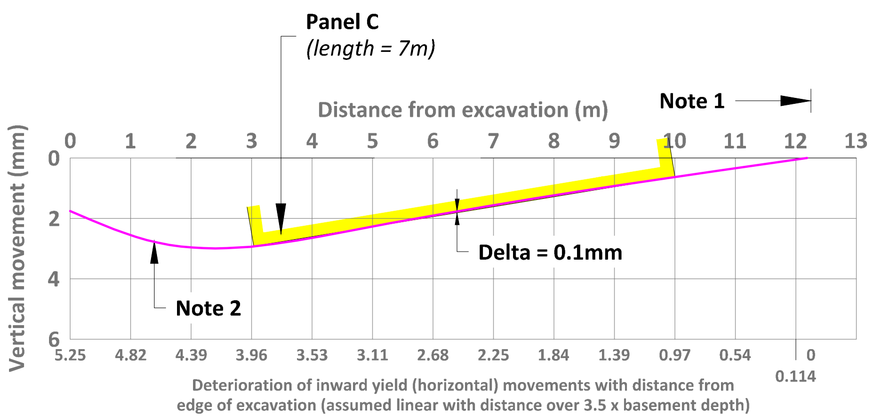
Panel B - High stiffness conditions



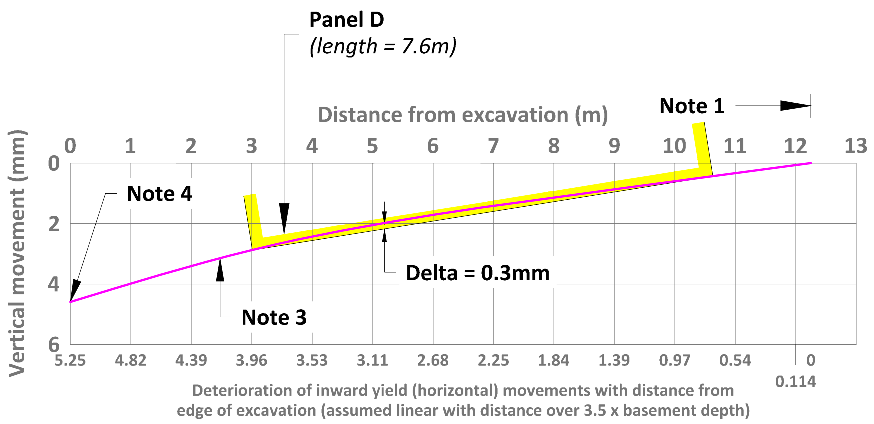
Panel C - Low stiffness conditions



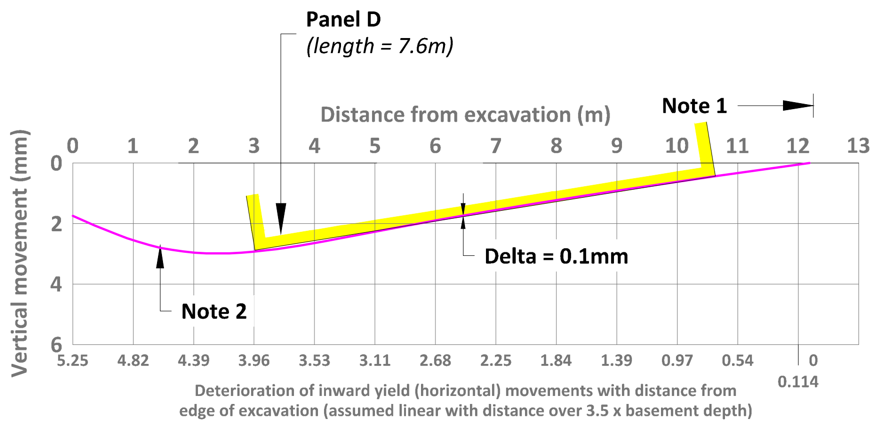
Panel C - High stiffness conditions



Panel D - Low stiffness conditions



Panel D - High stiffness conditions



Notes

1. 3.5 x basement excavation depth (3.5 x 3.5m = 12.25m) from figure 6.15b of CIRIA report C760.

2. Ground settlement profile for inward yielding taken from figure 6.15b (high stiffness support conditions).

3. Ground settlement profile for inward yielding taken from figure 6.15b (low stiffness support conditions).

4. For low stiffness support conditions, maximum settlement associated with props limiting inward yield to 5.25mm determined as follows:

From fig6.15a(C760) max inward yield for 3.5m deep basement (low stiffness): δh = 0.4 x 3500/100 = 14mm.

Similarly, for vertical movements (fig 6.15b): δv = 0.35 x 3500 /100 = 12.25mm.

Proportion of δv/ δh = 0.875. Then for 5.25mm (δh') of controlled horizontal movement: δv' = 0.875 x 5.25 = 4.6mm

Title	Scale	Drawing number
Sections of neighbouring wall panels showing assessed ground movements due to ground settlement associated with inward yielding	As shown	BIA02

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By NLT Chkd Date October 2019 Sheet 1 of 17

Determine horizontal inward yield and associated vertical settlement movements

Consider HIGH stiffness support conditions and refer to CIRIA report C760 figures 6.15a and 6.15b for basement depth of 3.5m.

Horizontal inward yield movement = $0.15 \times \frac{3500}{100}$ = 5.25 mm

Maximum vertical surface settlement = $0.08 \times \frac{3500}{100}$ = 2.8mm

Calculations to assess strains in masonry panels and thus category of damage are presented on calculation sheets 2 to 9.

Note we have assumed a linear deterioration in inward yield movements over a distance of 3.5x depth of basement excavation (ie 3.5x 3.5m = 12.25m)

Consider LOW stiffness support conditions and refer to CIRIA report C760 (figs 6.15a and 6.15b)

Horizontal inward yield movement = $0.4 \times \frac{3500}{100}$ = 14mm

Maximum vertical surface settlement = $0.35 \times \frac{3500}{100}$ = 12.25mm

These values are considered high and will yield strains of which will produce damage greater than Burland category 1. On this basis limit inward yielding equivalent to high support conditions (5.25mm) and determine equivalent class of damage. Movement limited by adjustable props and monitoring during construction. Refer calculation sheets 10 - 17.

Consider panel A Refer drawing BIA01A High stiffness support conditions

Panel size $L = 8.6$, $H = 16.8$ Panel located 6.8m from excavation

$\frac{L}{H} = \frac{8.6}{16.8} = 0.511$

From drawing BIA 02 delta = 1.5 = Δ

$\frac{\Delta}{L} = \frac{1.5}{8600} = 1.744 \times 10^{-4}$

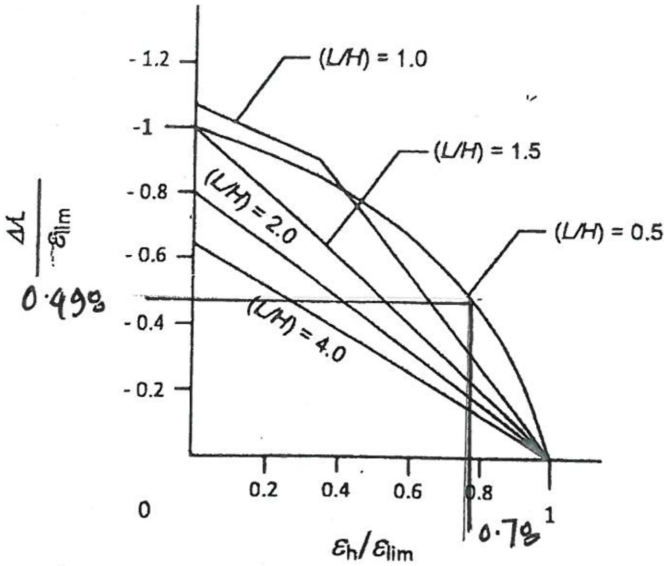
Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

Thus interpolated inward yield at distance D = 6.8 m

$= \frac{(12.25 - 6.8)}{12.25} \times 5.25 = 2.34\text{mm} = \delta h$

Choose $\varepsilon_{lim} = 0.035\ \%$

Then $\frac{\Delta / L}{\varepsilon_{lim}} = \frac{1.744 \times 10^{-4}}{0.035} \times 100 = 0.498$



b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0{\cdot}78$

$\delta_h = 0{\cdot}78 \times 0{\cdot}035 \times \frac{8600}{100}$

$= 2{\cdot}34\text{mm}$

Thus chosen strain is correct and equates to Burland category 0 ∴ OK.

Consider panel B Refer drawing BIA01A High stiffness support conditions

Panel size L = 7m, H = 6.6m Panel located 2m from excavation

$\frac{L}{H} = \frac{7000}{6600} = 1.06$

From drawing BIA 02 delta = 0.1mm = Δ

$\frac{\Delta}{L} = \frac{0.1}{7000} = 1.429 \times 10^{-5}$

Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

Thus interpolated inward yield at distance D = 2 m

$= \frac{(12.25 - 2)}{12.25} \times 5.25 = 4.39\text{mm} = \delta h$

Choose $\varepsilon_{lim} = 0.063$ %

Then $\frac{\Delta / L}{\varepsilon_{lim}} = \frac{1.429 \times 10^{-5}}{0.063} \times 100 = 0.023$

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Calculation sheet

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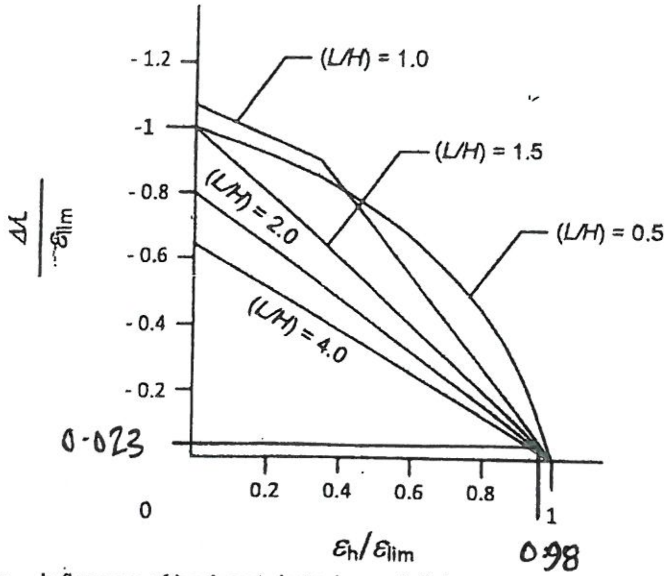
By	WLT	Chkd		Date	October 2018	Sheet	5 of 17



b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0{\cdot}98$

$\delta_h = 0{\cdot}98 \times 0{\cdot}063 \times \frac{7000}{100}$

$= 4{\cdot}32\,mm \simeq 4{\cdot}39\,mm$

Thus chosen strain is correct and equates to Burland category 1 ∴ OK.

Consider panel C Refer drawing BIA01A high stiffness support conditions

Panel size L = 7m , H = 3.2m Panel located 3m from excavation

$$\frac{L}{H} = \frac{7000}{3200} = 2.19$$

From drawing BIA 02 delta = 0.1mm = Δ

$$\frac{\Delta}{L} = \frac{0.1}{7000} = 1.429 \times 10^{-5}$$

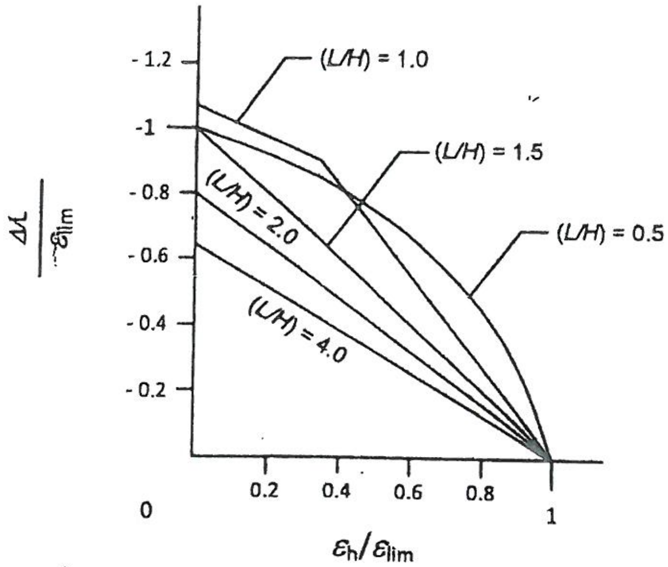
Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

Thus interpolated inward yield at distance D = 3 m

$$= \frac{(12.25-3)}{12.25} \times 5.25 = 3.96 \text{ mm} = \delta h$$

Choose ε_{lim} = 0.058 %

Then $$\frac{\Delta/L}{\varepsilon_{lim}} = \frac{1.429 \times 10^{-5} \times 100}{0.058} = 0.0246$$



b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.98$

$\delta_h = 0.98 \times 0.058 \times \frac{7000}{100}$

$= 3.98mm \simeq 3.96mm$

Thus chosen strain is correct and equates to Burland Category 1 ∴ OK.

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Calculation sheet

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By NCT Chkd Date October 2018 Sheet 8 of 17

Consider panel D Refer drawing BIA01A High stiffness support conditions

Panel size L = 7.6, H = 4.02 Panel located 3m from excavation (ignoring 'offset' - gives worst case)

$\frac{L}{H} = \frac{7.6}{4.02} = 1.89$

From drawing BIA 02 delta = 0.1mm = Δ

$\frac{\Delta}{L} = \frac{0.1}{7600} = 1.316 \times 10^{-5}$

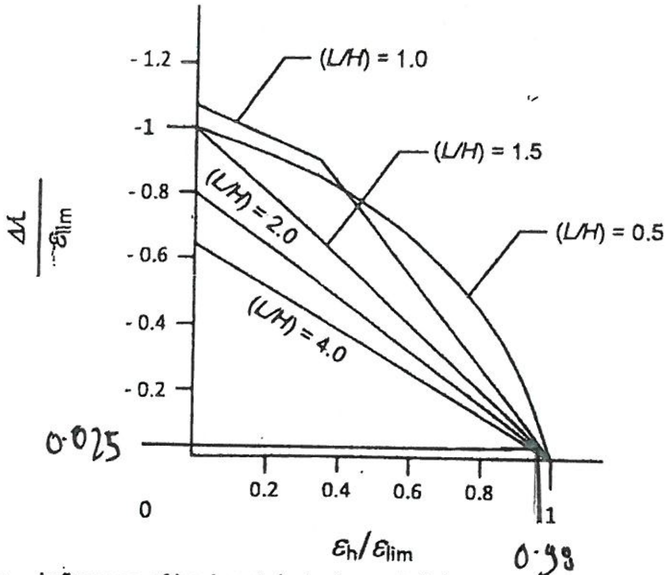
Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

Thus interpolated inward yield at distance D = 3 m

$= \frac{(12.25 - 3)}{12.25} * 5.25 = 3.96\text{mm} = \delta h$

Choose $\varepsilon_{lim} = 0.053\ \%$

Then $\frac{\Delta/L}{\varepsilon_{lim}} = \frac{1.316 \times 10^{-5}}{0.053} \times 100 = 0.025$



b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.98$

$\delta_h = 0.98 \times 0.053 \times \frac{7600}{100}$

$= 3.94m \simeq 3.96m$

Thus chosen strain is correct and equates to Burland category 1 ∴ OK.

Consider panel A Refer drawing BIA01A Low stiffness support conditions

Panel size L = 8.6, H = 16.8 Panel located 6.8m from excavation

$\frac{L}{H} = \frac{8.6}{16.8} = 0.511$

From drawing BIA 02 delta = 1.5mm = Δ

$\frac{\Delta}{L} = \frac{1.5}{8600} = 1.744 \times 10^{-4}$

Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

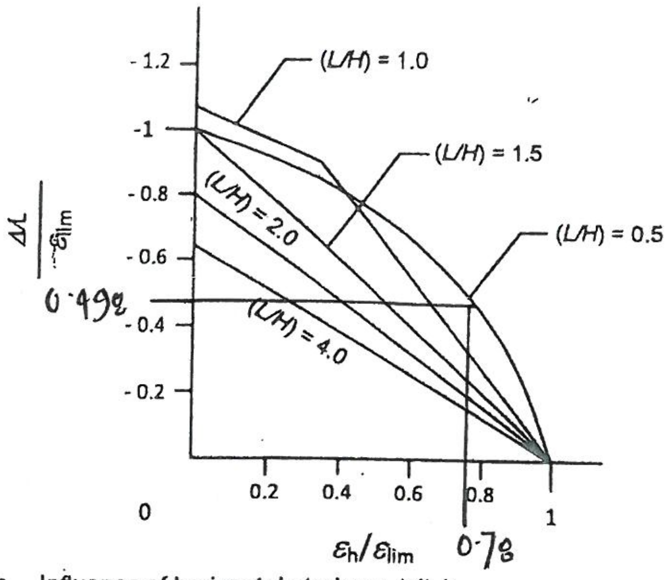
Thus interpolated inward yield at distance D = 6.8 m

$= \frac{(12.25 - 6.8)}{12.25} \times 5.25 = 2.34\text{mm} = \delta h$

Choose $\varepsilon_{lim} = 0.035$ %

Then $\frac{\Delta/L}{\varepsilon_{lim}} = \frac{1.744 \times 10^{-4} \times 100}{0.035} = 0.498$

By WLT Chkd Date October 2018 Sheet 11 of 17



b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.78$

$\delta_h = 0.78 \times 0.035 \times \frac{8600}{100}$

$= 2.34mm$

Thus chosen strain is correct and equates to Burland category 0 ∴ OK.

Consider panel B Refer drawing BIA01A low stiffness support conditions

Panel size L = 7m , H = 6.6m Panel located 2m from excavation

$\frac{L}{H} = \frac{7000}{6600} = 1.06$

From drawing BIA 02 delta = 0.3mm = Δ

$\frac{\Delta}{L} = \frac{0.3}{7000} = 4.286 \times 10^{-5}$

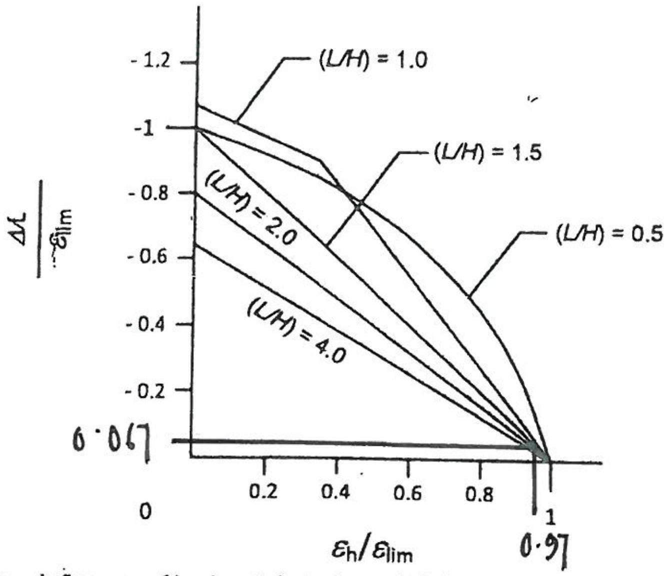
Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

Thus interpolated inward yield at distance D = 2 m

$= \frac{(12.25-2)}{12.25} \times 5.25 = 4.39mm = \delta h$

Choose $\varepsilon_{lim} = 0.064$ %

Then $\frac{\Delta/L}{\varepsilon_{lim}} = \frac{4.286 \times 10^{-5} \times 100}{0.064} = 0.067$



b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.97$

$\delta_h = 0.97 \times 0.064 \times 7000$

$= 4.35mm \approx 4.39mm$

Thus chosen strain is correct and equates to Burland category 1 ∴ OK.

Consider panel C Refer drawing BIA01A Low stiffness support conditions

Panel size L = 7m, H = 3.2 Panel located 3m from excavation

$$\frac{L}{H} = \frac{7}{3.2} = 2.19$$

From drawing BIA 02 delta = 0.3mm = Δ

$$\frac{\Delta}{L} = \frac{0.3}{7000} = 4.286 \times 10^{-5}$$

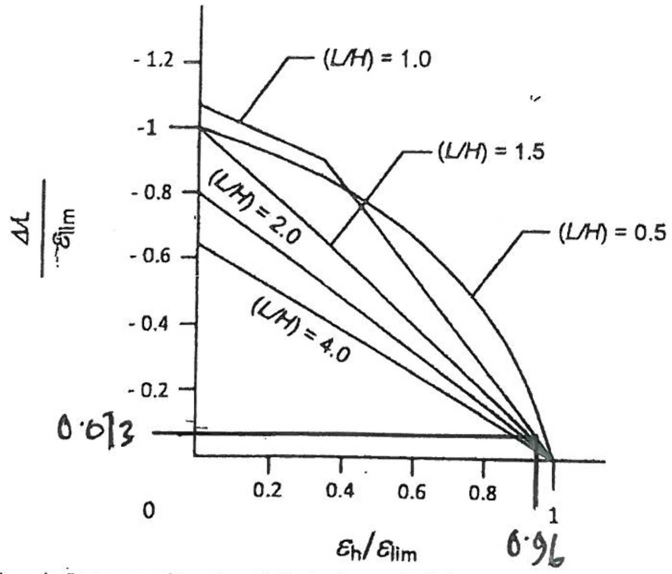
Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

Thus interpolated inward yield at distance D = 3 m

$$= \frac{(12.25 - 3)}{12.25} \times 5.25 = 3.96\text{ mm} = \delta h$$

Choose $\varepsilon_{lim} = 0.059\ \%$

Then $$\frac{\Delta/L}{\varepsilon_{lim}} = \frac{4.286 \times 10^{-5}}{0.059} \times 100 = 0.073$$



b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.96$

$\delta_h = 0.96 \times 0.059 \times \frac{7000}{100}$

$= 3.96$ mm

Thus chosen strain is correct and equates to Burland category 1 ∴ OK.

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Calculation sheet

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By NLT Chkd Date October 2018 Sheet 16 of 17

Consider panel D Refer drawing BIA01A low stiffness support conditions

Panel size L = 7.6, H = 4.02 Panel located 3m from excavation (ignoring 'offset' – gives worst case)

$\frac{L}{H} = \frac{7.6}{4.02} = 1.89$

From drawing BIA 02 delta = 0.3mm = Δ

$\frac{\Delta}{L} = \frac{0.3}{7600} = 3.95 \times 10^{-5}$

Maximum inward yield at face of excavation = 5.25 mm
Assume linear deterioration of inward yield with distance from excavation at say 3.5 x basement depth.

Thus interpolated inward yield at distance D = 3 m

$= \frac{(12.25 - 3)}{12.25} \times 5.25 = 3.96mm = \delta h$

Choose $\varepsilon_{lim} = 0.054\ \%$

Then $\frac{\Delta/L}{\varepsilon_{lim}} = \frac{3.95 \times 10^{-5} \times 100}{0.054} = 0.073$

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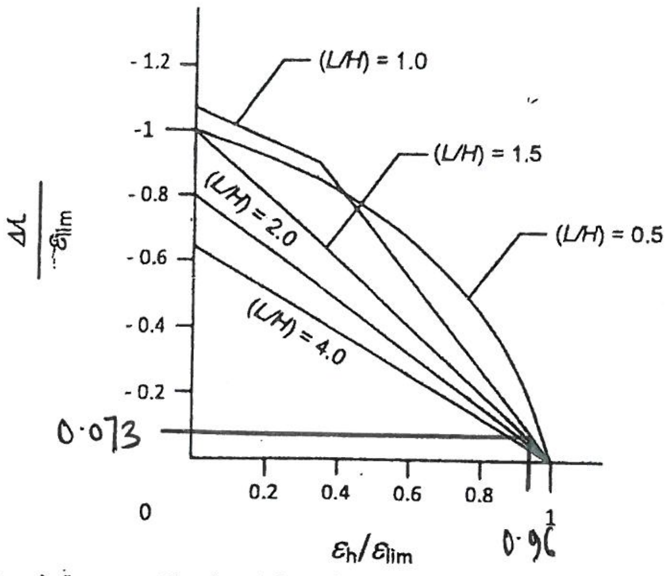

b Influence of horizontal strain on $\Delta/L/\varepsilon_{lim}$

From chart $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0{\cdot}96$

$\delta_h = 0{\cdot}96 \times 0{\cdot}054 \times 7600$

$= 3{\cdot}93mm \simeq 3{\cdot}96mm$

Thus chosen strain is correct and equates to Burland category 1 ∴ OK.

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Appendix H