

APPENDIX A

THAMES WATER SEWER RECORDS

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
821E	n/a	n/a
821F	n/a	n/a
921D	n/a	n/a
921C	n/a	n/a
921B	n/a	n/a
921A	n/a	n/a
9203	91.86	89.88
9256	91.87	90.61
921K	n/a	n/a
921H	n/a	n/a
711D	n/a	n/a
8102	92.22	90.46
7201	92.45	90.3
6254	n/a	n/a
7251	92.36	90.64
921E	n/a	n/a
8253	92.15	90.57
8201	92.2	90.2
8252	92.01	91.34
8255	92.14	91.61
721C	n/a	n/a
721D	n/a	n/a
721B	n/a	n/a
9257	92.06	90.44
621C	n/a	n/a
9204	n/a	n/a
8257	92.25	90.95
821D	n/a	n/a
6251	92.42	n/a
821A	n/a	n/a
8254	92.05	90.2
7252	92.49	90.48
8202	91.98	89.74
621G	n/a	n/a
8258	92.03	90.61
7202	92.47	89.97
8204	92.12	90.56
6153	n/a	n/a
6154	n/a	n/a
6151	92.43	91.07
7152	92.12	89.54
7101	91.98	88.94
7102	92.57	90.74
7151	92.52	90.89
711G	n/a	n/a
711C	n/a	n/a
711B	n/a	n/a
7051	91.35	89.2
711A	n/a	n/a
7103	91.63	88.53
811A	n/a	n/a
8155	n/a	n/a
8101	92.11	90.53
8154	92.16	90.72
8001	90.83	88.18
8156	n/a	n/a
8152	92.22	90.86
9902	88.38	85.93
9051	91.43	89.68
4150	93.13	90.11
4102	n/a	n/a
5155	92.72	89.78
5154	92.77	90.35
5101	n/a	n/a
5202	n/a	n/a
5151	93.24	91.39
5051	92.44	92.05
5152	92.98	n/a
5102	92.93	90.08
521C	n/a	n/a
5153	n/a	n/a
5252	93.14	91.87
521A	n/a	n/a
521D	n/a	n/a
521B	n/a	n/a
611B	n/a	n/a
611A	n/a	n/a
621J	n/a	n/a
621A	n/a	n/a
621H	n/a	n/a
6101	92.79	89.65
6152	92.82	n/a
611C	n/a	n/a
621F	n/a	n/a
621D	n/a	n/a
621I	n/a	n/a
6253	92.86	n/a
621B	n/a	n/a
691I	92.46	90.25
8951	90.5	88.78
9950	89.06	86.56

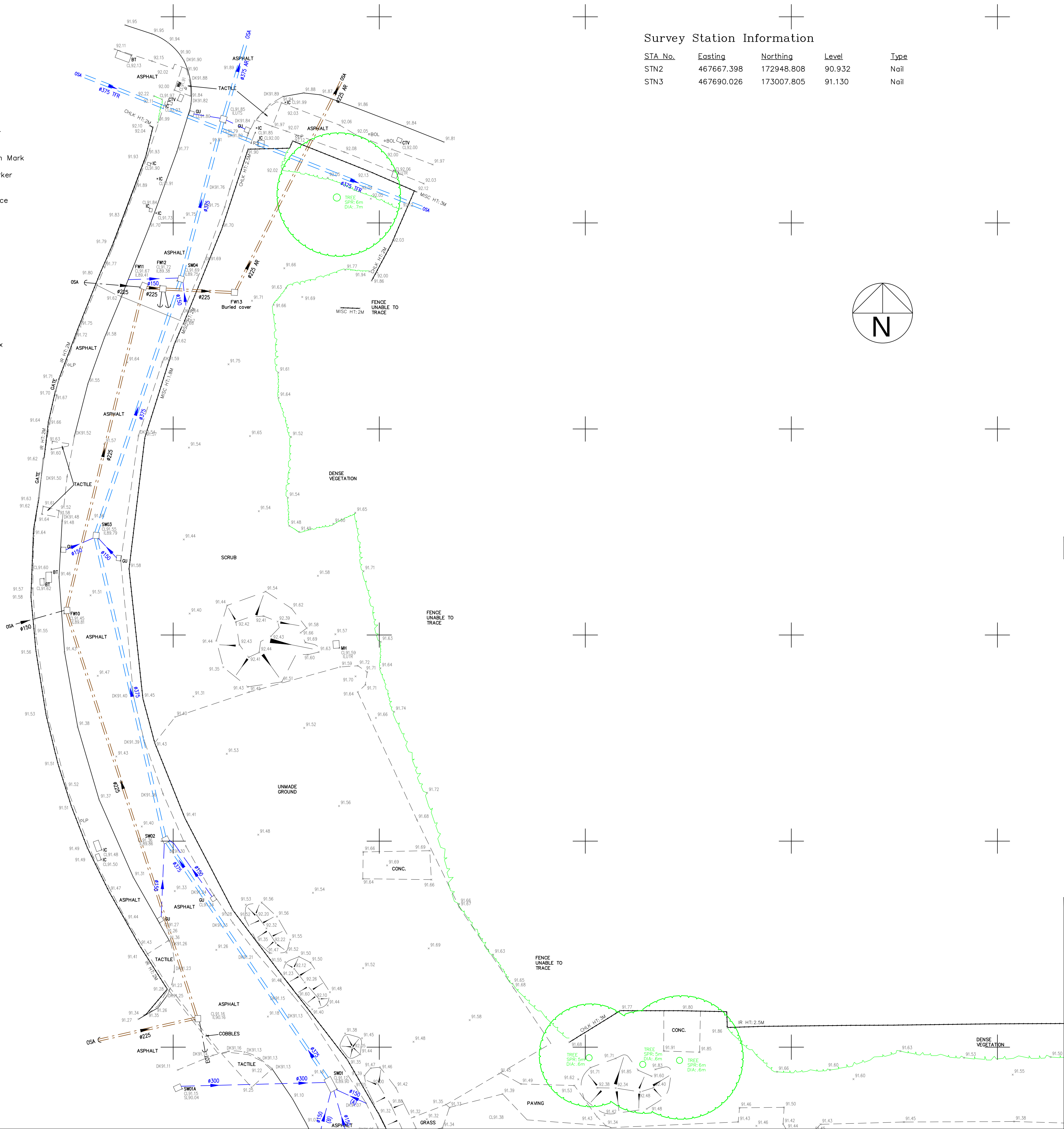
Manhole Reference	Manhole Cover Level	Manhole Invert Level
691D	93.14	91.69
691H	92.86	90.65
601B	92.93	92.07
601A	93.022	91.362
8051	91.18	n/a
5752	89.3	n/a
6853	88.73	86.48
681A	90.61	89.1
681F	n/a	n/a
681E	n/a	n/a
6852	88.67	87.61
6701	88.68	85.8
681B	90.958	89.433
6850	88.31	86.24
681C	90.167	88.717
681G	90.3	88.24
6851	88.2	86.22
691G	n/a	n/a
691A	91.607	90.202
691F	n/a	89.89
691E	n/a	n/a
691B	92.204	90.414
6801	87.5	85.48
691C	92.417	90.612
681H	87.4	86
771H	88.06	86.71
771C	88.01	86.7
771G	87.96	86.6
771D	87.95	86.29
9751	n/a	n/a
8753	n/a	n/a
8701	n/a	n/a
671D	87.75	86.4
8752	n/a	n/a
671B	87.65	86.19
7803	85.61	n/a
681D	89.5	87.21
681I	87.15	85.4
6854	n/a	n/a
7804	86.91	n/a
7801	n/a	85.11
8851	87.86	85.93
8801	88.09	85.41
7802	87.41	85
8850	n/a	n/a
7850	87.64	85.81
8950	89.87	88.23
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.		

APPENDIX B

SITE SURVEY

Topographical Abbreviations

A/R	Assumed Route	MKR	Marker
BH	Borehole	MT	Mercury Telecom Cover
BOL	Bollard	OHC	Overhead Cable
BT	British Telecom Cover	OHP	Overhead Pipe
BW	Barbed Wire Fence	OSBM	Ordinance Survey Bench Mark
BWK	Brickwork	PB	Post Box
CATV	Cable TV Cover	PCM	Permanent Ground Marker
CB	Close Boarded Fence	PR	Post & Rail Fence
CCTV	Closed Circuit TV	PW	Post & Wire Fence
CHLK	Chainlink Fence	PWM	Post & Wire Mesh Fence
CHPL	Chestnut Paling Fence	RE	Rodding Eye
CL	Cover Level	RG	Road Gully
CM	Cable Marker	RN	Road Name
CP	Catch Pit	RS	Road Sign
CPL	Catch Pit Base Level	RW	Retaining Wall
DIA	Diameter	RWP	Rain Water Pipe
DK	Drop Kerb	SAP	Sapling
DP	Down Pipe	SC	Stop Cock
EJB	Electricity Junction Box	SPR	Spread
EC	Electricity Cover	STA	Traverse Station
EP	Electricity Pole	SV	Stop Valve
ER	Earthing Rod	SVP	Soil Vent Pipe
FCL	Finished Ceiling Level	SW	Storm Water
FH	Fire Hydrant	TB	Telephone Box
FIG	Feed Into Ground	TBM	Temporary Bench Mark
FW	Foul Water	TFR	Taken From Records
GU	Gully	TJB	Telephone Junction Box
GV	Gas Valve	TPT	Trial Pit
H	Height	TL	Traffic Light
IC	Inspection Cover	TP	Telephone Pole
IL	Invert Level	UTL	Unable To Lift
IR	Iron Railing Fence	UTT	Unable To Trace
KO	Kerb Outlet	VP	Vent Pipe
LB	Litter Bin	WKH	Water Key Hole
LC	Lamp Column	WM	Water Meter
LP	Lamp Post	WV	Water Valve
MH	Manhole		



Survey Station Information

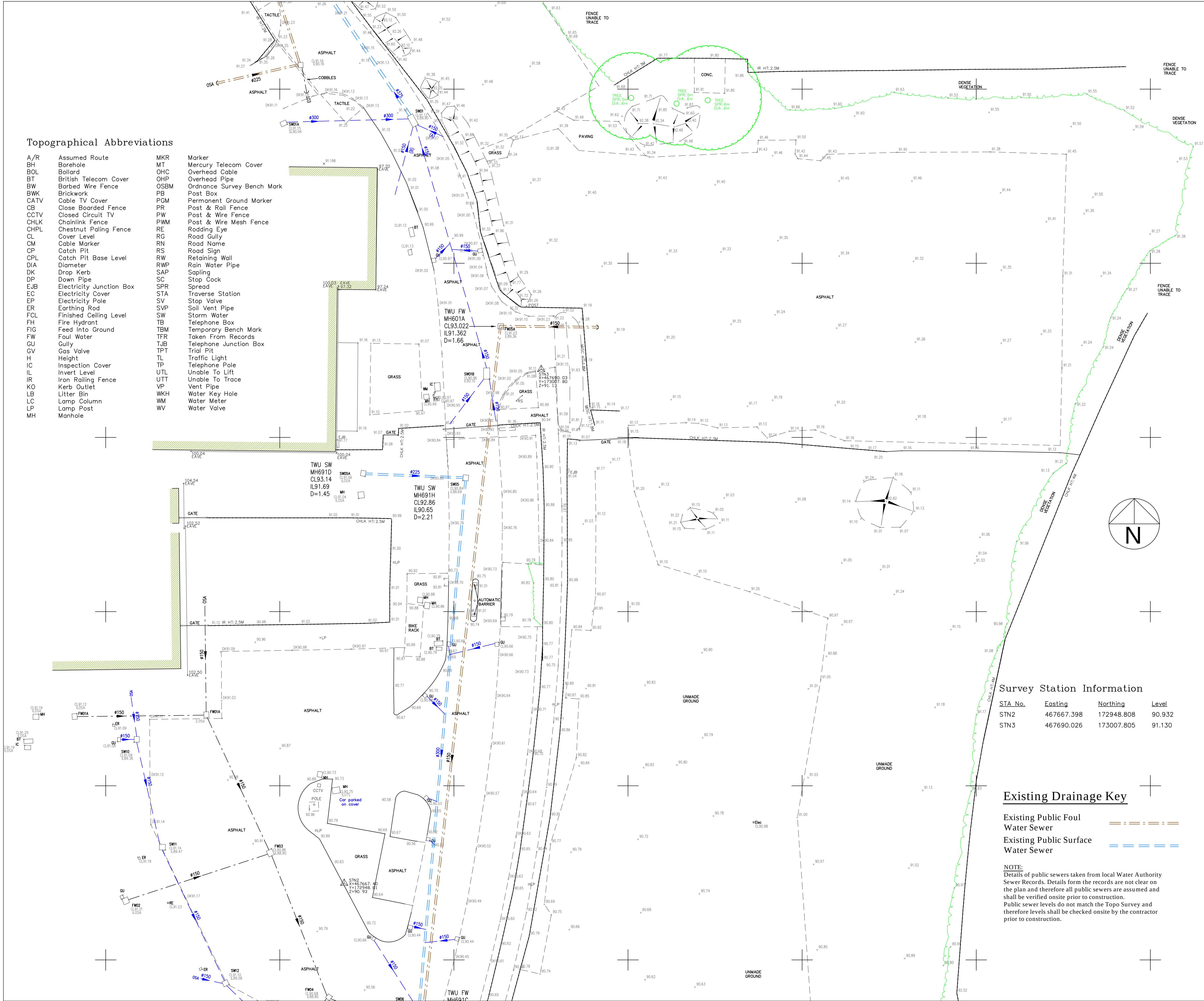
STA No.	Easting	Northing	Level	Type
STN2	467667.398	172948.808	90.932	Nail
STN3	467690.026	173007.805	91.130	Nail

- Notes:
- 1.1 Do not scale from this drawing.
 - 1.2 All dimensions are in m unless otherwise specified.
 - 1.3 In case of any discrepancies in drawings or details refer to engineer for clarification. Unilateral decisions by the contractor will not be accepted.
 - 1.4 This drawing is to be read in conjunction with all related Architects, Consultants & Sub-Contractors drawings and specifications.
 - 1.5 The Contractor is to ensure that all design drawings and information are read concurrently and any discrepancies or omissions reported directly to Aventus Design.
 - 1.6 This drawing is based upon the survey by Warner Surveys, reference S5170412P001 & S5170412P0002, dated 17th August 2017 provided in digital format. Utilities Searches added by Geotechnical Engineering Ltd, Ref:- 33354, dated 25/08/17.
 - 1.7 All Levels are related to OSGB using GPS.
 - 1.8 The grid is related to OSGB using RTK GPS.
 - 1.9 The Contractor must check the levels of all existing drainage outfalls prior to construction of any drainage, unless otherwise agreed, to ensure the proposed design may be achieved. Any discrepancies must be reported immediately to Aventus Design.

Drawing Status	PRELIMINARY ISSUE		
Aventus Design Ltd Unit 5 - Leaches Farm Business Centre Bicester Road Kingswood Aylesbury Bucks HP18 0RF Tel: 01296 770066 Email: mail@aventusdesign.co.uk Web: www.aventusdesign.co.uk			
Client:	Hill		
Site:	107 Conwy Close Tilehurst, Reading, Berks. RG30 4BZ		
Title:	Site Survey - Sheet 1 of 3		
Drawing no.	H894 - 400		
Issue:	Scale: 1:200 @ A1	Checked: -	Date: -
A	Dm: C.U.	Date: Aug 17	Approve: -

Topographical Abbreviations

A/R	Assumed Route	MKR	Marker
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CB	Close Boarded Fence	PR	Post & Rail Fence
CCTV	Closed Circuit TV	PW	Post & Wire Fence
CHLK	Chainlink Fence	PWM	Post & Wire Mesh Fence
CHPL	Chestnut Paling Fence	RE	Rodding Eye
CL	Cover Level	RG	Road Gully
CM	Cable Marker	RN	Road Name
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Drawing Status PRELIMINARY ISSUE



Survey Station Information

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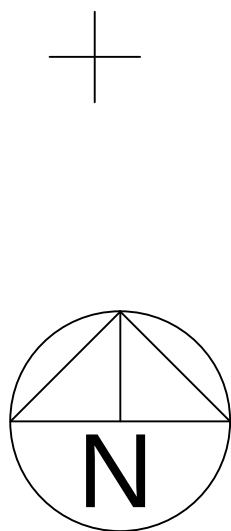
Existing Drainage Key

Existing Public Foul Water Sewer	---
Existing Public Surface Water Sewer	---

NOTE:
Details of public sewers taken from local Water Authority Sewer Records. Details from the records are not clear on the plan and therefore all public sewers are assumed and shall be verified onsite prior to construction.
Public sewer levels do not match the Topo Survey and therefore levels shall be checked onsite by the contractor prior to construction.

A	29.08.17	Services added.	SU	-
REV.	DATE	DESCRIPTION	CHK	APP
Aventus DESIGN Aventus Design Ltd Unit 5 - Leaches Farm Business Centre Bicester Road Kingswood Aylesbury Bucks HP18 0RF Tel: 01296 770066 Email: mail@aventusdesign.co.uk Web: www.aventusdesign.co.uk				
Client: Hill				
Site: 107 Conwy Close Tilehurst, Reading, Berks. RG30 4BZ				
Title: Site Survey - Sheet 2 of 3				
Drawing no. H894 - 401				
Issue: A	Scale: 1:200 @ A1	Checked: -	Date: -	
	Drawn: C.U.	Date: Aug 17	Approved: -	Date: -

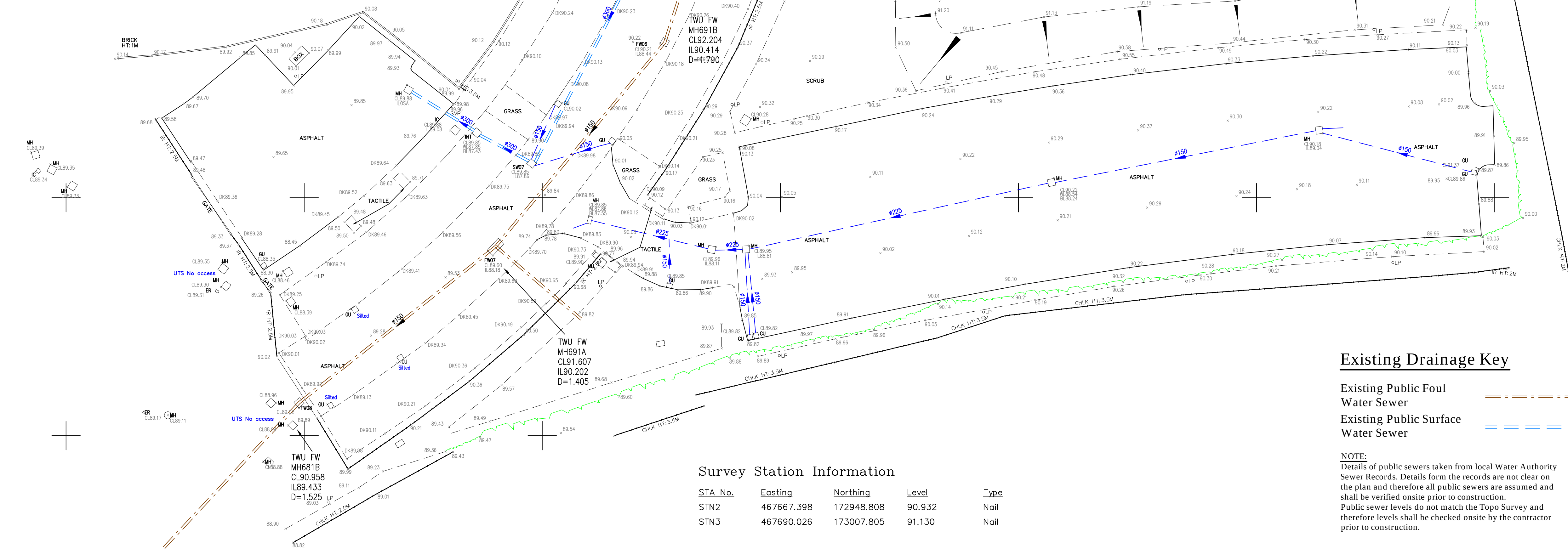
50mm
100mm
150mm
200mm
250mm
ORIGINAL SIZE - A1



Topographical Abbreviations

A/R Assumed Route
BH Borehole
BOL Ballard
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BW Barbed Wire Fence
BWK Brickwork
CATV Cable TV Cover
CB Close Boarded Fence
CCTV Closed Circuit TV
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EJB Electricity Junction Box
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FH Fire Hydrant
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FW Foul Water
GU Gully
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H Height
IC Inspection Cover
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KO Kerb Outlet
LB Litter Bin
LC Lamp Column
LP Lamp Post
MH Manhole

MKR Marker
MT Mercury Telecom Cover
OHC Overhead Cable
OHP Overhead Pipe
OSBM Ordnance Survey Bench Mark
PB Post Box
PGM Permanent Ground Marker
PR Post & Rail Fence
PW Post & Wire Fence
PWM Post & Wire Mesh Fence
RE Roding Eye
RG Road Gully
RN Road Name
RS Road Sign
RW Retaining Wall
RWP Rain Water Pipe
SAP Sapling
SC Stop Cock
SPR Spread
STA Traverse Station
SV Stop Valve
SVP Soil Vent Pipe
SW Storm Water
TB Telephone Box
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UTL Unable To Lift
UTT Unable To Trace
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Existing Public Surface Water Sewer

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Drawing Status PRELIMINARY ISSUE



REV.	DATE	DESCRIPTION	CHK	APP
------	------	-------------	-----	-----

Aventus Design Ltd
Unit 5 - Leaches Farm
Business Centre
Bicester Road
Kingswood
Aylesbury
Bucks HP18 0RF
Tel: 01296 770066
Email: mail@aventusdesign.co.uk
Web: www.aventusdesign.co.uk

Client: Hill

Site:
107 Conwy Close
Tilehurst, Reading,
Berks. RG30 4BZ

Title:
Site Survey - Sheet 3 of 3

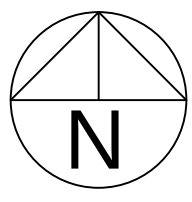
Drawing no.
H894 - 402

Issue:	Scale:	1:200 @ A1	Checked:	-	Date:	-
A	Drn:	C.U.	Date:	Aug 17	Approv:	-

50mm
100mm
150mm
200mm
250mm
ORIGINAL SIZE - A1

APPENDIX C

SCHEMATIC DRAINAGE LAYOUT



NOTE:
Details of public sewers taken from local Water Authority Sewer Records. Details from the records are not clear on the plan and therefore all public sewers are assumed and shall be verified onsite prior to construction.
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Issue:	Scale: 1:250 @ A1	Checked: -	Date: -
-	Drn: S.U.	Date: Aug '17	Approv: - Date: -

APPENDIX D

MICRO DRAINAGE CALCULATIONS

Aventus Design Limited		Page 1
Unit 7, Leaches Farm Bus. Ce...	Conwy Close	
Bicester Road	Reading	
Kingswood, Aylesbury, Bucks ...	Berks	
Date June 17	Designed by S.U.	
File H894-SW-NET01.MDX	Checked by	
Elstree Computing Ltd	Network 2015.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	30
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.400	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	5	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.255	4-8	0.290

Total Area Contributing (ha) = 0.545

Total Pipe Volume (m³) = 34.777

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	10.000	0.100	100.0	0.100	3.00	0.0	0.600	o	300
1.001	21.000	0.050	420.0	0.045	0.00	0.0	0.600	o	600
1.002	61.000	0.125	488.0	0.300	0.00	0.0	0.600	o	600
1.003	23.000	0.050	460.0	0.100	0.00	0.0	0.600	o	600
1.004	7.000	0.050	140.0	0.000	0.00	0.0	0.600	o	300
1.005	55.000	0.220	250.0	0.000	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	5.00	3.11	88.375	0.100	0.0	0.0	0.4	1.57	111.1	1.8
1.001	5.00	3.40	88.275	0.145	0.0	0.0	0.6	1.18	334.2	2.6
1.002	5.00	4.33	88.225	0.445	0.0	0.0	1.8	1.10	309.8	7.8
1.003	5.00	4.67	88.100	0.545	0.0	0.0	2.2	1.13	319.2	9.6
1.004	5.00	4.76	88.050	0.545	0.0	0.0	2.2	1.33	93.8	9.6
1.005	5.00	5.68	88.000	0.545	0.0	0.0	2.2	0.99	70.0	9.6

Aventus Design Limited		Page 2
Unit 7, Leaches Farm Bus. Ce...	Conwy Close	
Bicester Road	Reading	
Kingswood, Aylesbury, Bucks ...	Berks	
Date June 17	Designed by S.U.	
File H894-SW-NET01.MDX	Checked by	
Elstree Computing Ltd	Network 2015.1	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall C. Level Name (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
------------------------	------------------------------	-----------------	------------------------	-------------	-----------

1.005	88.930	87.780	0.000	1200	0
-------	--------	--------	-------	------	---

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	30.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	720
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	6

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0		

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	360
Ratio R	0.400		

Aventus Design Limited		Page 3
Unit 7, Leaches Farm Bus. Ce... Bicester Road Kingswood, Aylesbury, Bucks ...	Conwy Close Reading Berks	
Date June 17 File H894-SW-NET01.MDX	Designed by S.U. Checked by	
Elstree Computing Ltd	Network 2015.1	

Online Controls for Storm

Hydro-Brake Optimum® Manhole: 5, DS/PN: 1.004, Volume (m³): 10.1

Unit Reference	MD-SHE-0092-5000-2000-5000
Design Head (m)	2.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	92
Invert Level (m)	88.050
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	5.0
Flush-Flo™	0.398	4.1
Kick-Flo®	0.816	3.3
Mean Flow over Head Range	-	3.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	3.9	3.000	6.0	7.000	9.0
0.200	3.8	1.400	4.2	3.500	6.5	7.500	9.3
0.300	4.1	1.600	4.5	4.000	6.9	8.000	9.6
0.400	4.1	1.800	4.8	4.500	7.3	8.500	9.9
0.500	4.1	2.000	5.0	5.000	7.7	9.000	10.2
0.600	4.0	2.200	5.2	5.500	8.0	9.500	10.4
0.800	3.4	2.400	5.4	6.000	8.4		
1.000	3.6	2.600	5.6	6.500	8.7		

Aventus Design Limited		Page 4
Unit 7, Leaches Farm Bus. Ce...	Conwy Close	
Bicester Road	Reading	
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File H894-SW-NET01.MDX	Checked by	
Elstree Computing Ltd	Network 2015.1	

Storage Structures for Storm

Cellular Storage Manhole: 1, DS/PN: 1.000

Invert Level (m) 88.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	66.0	0.0	1.300	0.0	0.0
1.200	66.0	0.0			

Cellular Storage Manhole: 5, DS/PN: 1.004

Invert Level (m) 88.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	100.0	0.0	1.700	0.0	0.0
1.600	100.0	0.0			

Aventus Design Limited		Page 5
Unit 7, Leaches Farm Bus. Ce...	Conwy Close	
Bicester Road	Reading	
Kingswood, Aylesbury, Bucks ...	Berks	
Date June 17	Designed by S.U.	
File H894-SW-NET01.MDX	Checked by	
Elstree Computing Ltd	Network 2015.1	

Summary of Results for 360 minute 100 year Winter (Storm)

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
 Analysis Timestep Fine Inertia Status OFF
 DTS Status ON

		Water Surcharged Flooded				Pipe	
	US/MH	Level	Depth	Volume	Flow / Overflow	Flow	
PN	Name	(m)	(m)	(m³)	Cap.	(l/s)	(l/s) Status
1.000	1	90.003	1.328	0.000	0.06	4.7	SURCHARGED
1.001	2	90.002	1.127	0.000	0.02	6.3	SURCHARGED
1.002	3	90.002	1.177	0.000	0.07	18.8	SURCHARGED
1.003	4	90.002	1.302	0.000	0.11	26.0	SURCHARGED
1.004	5	90.001	1.651	0.000	0.08	4.9	SURCHARGED
1.005	6	88.054	-0.246	0.000	0.07	4.9	OK

APPENDIX E

SITE INVESTIGATION REPORT

REPORT N^o 70012984/CC/GIR001

CONWY CLOSE, TILEHURST

GROUND INVESTIGATION REPORT

Reading Borough Council

CONFIDENTIAL

JUNE 2017

CONWY CLOSE, TILEHURST

GROUND INVESTIGATION REPORT

Reading Borough Council

Project No: 70012984
Date: June 2017

WSP

WSP UK Ltd
Mountbatten House, Basing View,
Basing View, Hampshire, RG21 4HJ

Tel: +44 (0) 1256 318 800
Fax: +44 (0) 1256 318 700
www.wsp-pb.com



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1

EXECUTIVE SUMMARY

WSP was instructed by Reading Borough Council (RBC) to undertake a Ground Investigation for a proposed redevelopment of the former Medway Comprehensive School for residential houses and flats at Conwy Close, Tilehurst, Reading, RG30 4BZ.

This report fulfils the requirement for a Ground Investigation Report (GIR) of BS EN 1997-1:2004 +A2:2013 *Eurocode 7: Geotechnical Design* (Eurocode 7) and generally follows the format of Highways England document HD 22/08 *Managing Geotechnical Risk*.

It is understood that Reading Borough Council propose to construct two and three storey houses and flats across the site with associated parking and landscaped areas. The site is located adjacent the existing Thames Valley and Avenue schools to the west, and bordered to the north and east by residential dwellings and to the south by open space and school playing fields.

An intrusive ground investigation was undertaken between the dates 26 and 28 April 2017 and comprised two dynamic sampled / rotary cored boreholes to depths of 15.55 metres below ground level (m bgl), with standard penetration tests undertaken at regular intervals to develop a strength profile. Eight machine – excavated trial pits were excavated to depths of 2.00 to 4.60 m bgl in which infiltration / soakaway tests were undertaken (TP101, TP103, and TP108) and two California Bearing Ratio tests (CBR) were also undertaken (TP103 and TP106). Soil and groundwater samples were recovered for laboratory analysis.

The encountered ground conditions were found to comprise Made Ground with a thickness of between 0.15 and 1.70 m. Below this, Superficial Deposits of the Winter Hill Gravels comprising gravels and sand were encountered with a recorded thickness ranging from 1.70 to 3.35 m. London Clay was encountered beneath the Superficial Deposits and extends to a depth of 13.70 m bgl, after which the Lambeth Group is present to an unproven depth.

Groundwater strikes were reported during drilling of BH102 at a depth of 2.00 m with a rise to 1.90 m after 20 minutes. Slight seepages were observed in all Trial Pits except Trial Pit TP108 at depths between 2.50 to 3.50 m bgl. Subsequent groundwater monitoring was recorded at levels between 1.52 and 1.85 m bgl. This is deemed to be the groundwater as it is recorded within the Winter Hill Gravels which are a River Terrace Deposit and are classified as a Secondary A aquifer.

2 INTRODUCTION

2.1 SCOPE AND AIMS OF THE REPORT

WSP was instructed by Reading Borough Council (RBC) to undertake an intrusive ground investigation to support designs for a proposed residential development located at Conwy Close, Tilehurst, Reading, RG30 4BZ.

The aims of this report are to:

- Characterise the ground in terms of the soil composition and groundwater regime which could be used to inform design; and
- Identify possible geotechnical and contaminative constraints in relation to the ground conditions encountered.

This assessment was undertaken in accordance with the scope agreed between WSP and Reading Borough Council.

This report has been prepared in general accordance with the requirements for a Ground Investigation Report (GIR) to BS EN 1997-1:2004+A2:2013 Eurocode 7: Geotechnical Design [Ref.1] and generally follows the format of Highway Agency's 'Management of Geotechnical Risk' [Ref.2].

A ground contamination assessment has been prepared as part of this report.

2.2 DESCRIPTION OF THE PROJECT

Reading Borough Council wishes to re-develop the land at Conwy Close of which the former secondary school Meadway Comprehensive School used to occupy. The proposal comprises the construction of two and three storey houses and flats, new road construction and associated landscaped areas. An intrusive ground investigation is required in order to assess the ground conditions to inform the foundation design, pavement and road design, screen for land contaminants, and to comment on the potential hydrogeological issues.

The development of the site is approximately 1.1 hectares (ha) and is currently unoccupied. The site is located at National Grid Reference 467687 173011 and is adjacent the Avenue School and Thames Valley School. Conwy Close, The Avenue and Thames Valley School are to the west of the site, the Meadway road is to the north with residential dwellings beyond, with residential dwellings to the east and green open space / school playing fields to the south.

A site location plan (**Figure A**), an existing site layout plan (**Figure B**), and an exploratory hole location plan (**Figure C**) are presented in **Appendix A**. Site drawings provided by the Client are also included in **Appendix A** and included a proposed site layout and a topographic survey.

2.3 GEOTECHNICAL CATEGORY OF PROJECT

This scheme has been classified as a Geotechnical Category 2 scheme, as described within Eurocode 7 [Ref.1]. Geotechnical Category 2 projects include conventional structures and foundation forms, such as those likely to be proposed for this development, with no exceptional risk, difficult ground conditions or difficult loading conditions.

2.4 CONFIDENTIALITY STATEMENT AND LIMITATIONS

This report has been prepared for Reading Borough Council in accordance with our proposal dated 26/05/2016 and the terms and conditions as set out therein. It has further been prepared based on the site conditions encountered at the time of the intrusive site investigations as presented. The scope of WSP investigation and assessment is limited to that defined in our original proposals as confirmed or amended (where relevant and appropriate) within this report. Consequently this report should not be used in a different context without the express written consent of WSP.

Where relevant, any interpretation within this report refers to the condition of the site at the time of the investigation and is based on WSP understanding of any development proposals as described. Possible future changes in the condition of the site which may occur, or alterations in any proposed development layout / design will require further assessment.

It is further noted that whilst site conditions have been recorded at the investigation locations, variations may occur in the actual conditions present in other, un-investigated areas of the site. New or amended legislation may necessitate re-assessment of the site conditions and the associated risks and liabilities.

This report is addressed to and may be relied upon by Reading Borough Council. It may not be relied upon or transferred to any other parties without the express written authorisation of WSP. The report should be read and used in full. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

Third party information used in the production of this report has been taken in good faith as being accurate. WSP cannot and will not accept any liability for errors and / or omissions in data provided by others and WSP cannot warrant the work of others.

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3

EXISTING INFORMATION

3.1

TOPOGRAPHICAL MAPS

A topographical survey of the site was undertaken by 3D Engineering Surveys Limited in June 2014. The topographical survey drawing is provided in **Appendix A**.

The survey shows that ground level is fairly consistent across the site, dipping from approximately 92.08 metres Above Ordnance Datum (m AOD) in the northern area of the site to 90.28 m AOD in the southern area of the site.

Historical mapping for the local area has been sourced and the change in land use over time is summarised below:

- Open fields in a semi-rural setting until the mid-20th century;
- Surrounding area developed for residential by 1960;
- Site was part of Meadway Comprehensive School which opened in 1972 and extended to the west – the northern third of the site was occupied by buildings, the current central carpark was hardstanding sports courts, and southern third was playing fields;
- Meadway Comprehensive closed in 2001 and was demolished to make way for Thames Valley and The Avenue Schools which occupy land to the immediate west and were opened in 2013 and 2015 respectively.

3.2

GEOLOGICAL MAPS AND HYDROLOGICAL MAPS

The British Geological Survey (BGS) scale 1:50,000 series, solid and drift geology map of Reading Sheet 268 (2000) [Ref. 3], together with information available on the BGS on-line Geology of Britain Viewer, indicate that the site is covered by superficial deposits comprised of Winter Hill Gravel Deposits. The bedrock is recorded as being London Clay, overlying the Lambeth Group.

The Environment Agency's online tool 'what's in my backyard' [Ref. 4] indicates the following:

Table 3.1: Strata Aquifer Designation

GEOLOGICAL UNIT / STRATUM	DESCRIPTION	AQUIFER DESIGNATION
Winter Hill Gravel Deposits	Sand and gravel superficial deposits	Secondary A Aquifer
London Clay Formation	Predominantly clay with silt, locally sand, bedrock.	Unproductive Stratum
Lambeth Group	Clay, silt and sand bedrock	Secondary A Aquifer

3.3 ARCHAEOLOGICAL AND HISTORICAL INVESTIGATIONS

There are no known archaeological investigations that have been undertaken at the location of the proposed building. The website MAGIC [Ref.5] indicates that there are no archaeological findings within 1km to the site.

3.4 EXISTING GROUND INVESTIGATIONS

There are no known recent ground investigations undertaken at the site prior to this one. WSP did carry out a Phase 1 Land Contamination and Ground Condition Assessment in February 2016.

3.5 CONSULTATION WITH STATUTORY BODIES AND AGENCIES

No consultation was undertaken with statutory bodies or agencies prior to the ground investigation.

Information relating to the presence of underground services was obtained by WSP in July 2016. This information is included as **Appendix B** in the form of a utilities assessment report.

3.6 FLOOD RECORDS

Data obtained from the Environment Agency (EA) website [Ref.4] indicates that the site is within an area of low risk of flooding from surface water.

3.7 SURFACE WATER

The nearest surface water feature is an unnamed lake which is located approximately 750 m south west of the development site and is in the grounds Calcot Park Golf Course. No further information is available about this lake.

4 FIELD AND LABORATORY DATA

4.1 WALKOVER SURVEY

A site walkover survey was undertaken by a WSP engineer on the 28 November 2015 as part of the Phase 1 Desk Study. The following assessments were observed during the site walkover:

- An irregularly shaped parcel of land located on Conwy Close, Reading;
- Residential setting, bounded by Conwy Close to the west with The Avenue and Thames Valley schools beyond, residential dwellings to the north and east and green open space/school playing fields to the south;
- The northern third of the site comprises roughly vegetated scrubland and a gravel car park:
 - A mound of unknown material was observed to the southern end of the vegetated area;
 - Some demolition rubble was noted at the edge of the vegetated area adjacent to the mound;
- The central third was laid out for car parking with a temporary surface with grassed perimeters;
 - Some fly tipping was present around the perimeter;
- The southern portion of the site is occupied by a construction compound for extension works to the schools to the south-west. This area was not accessed during the walkover.

4.2 GROUND INVESTIGATION

4.2.1 DESCRIPTION OF FIELDWORK

WSP designed the joint geotechnical and geoenvironmental ground investigation. The objective of the geotechnical investigation was to obtain information on the ground and groundwater conditions and obtain Eurocode 7 compliant samples in order to derive information for use in design of the proposed residential properties. The objective of the geo-environmental investigation was primarily to assess and to determine if there are any potential contamination constraints which would need consideration in the building design.

The fieldwork was undertaken between 26 and 28 April 2017. The investigatory exploratory holes were undertaken by CC Ground Investigation (CCGI). WSP monitored the investigation on a part time basis to check technical compliance with the ground investigation specification.

To minimise the of contact with existing below ground services/utilities, in advance of any intrusive works each exploratory hole location was scanned and cleared using a CAT and Generator. Inspection pits were hand dug to a depth of 1.2mbgl prior to drilling works.

Table 4.1 provides a summary of the exploratory holes completed as part of the ground investigation, along with the rationale for utilising the selected techniques. An exploratory hole location plan is provided in **Appendix A**.

Table 4.1: Exploratory Hole Rationale

ELEMENT OF INVESTIGATION	DETAILS	RATIONALE
Rotary cored / dynamic sampling boreholes	BH101 – BH102	- To allow inspection of soils and to allow the retrieval of samples for geotechnical and contaminant laboratory testing. - To derive the ground model. - To assign material properties and to aid the derivation of geotechnical parameters for design purposes.
Trail Pits	TP101 – TP108	- To allow the inspection of soils and to retrieve samples for geotechnical and contaminant laboratory testing. - To derive the ground model. - To undertake infiltration/soakaway tests for potential drainage design. - To undertake CBR tests for potential road and pavement design.
In-situ testing	Standard Penetration Tests (SPTs) were undertaken at 1.0m intervals to 5.0m, and at 1.5m intervals thereafter alternating with UT100 sampling in cohesive soils.	In order to assign material properties and to aid the derivation of geotechnical parameters for design purposes.
Installation of groundwater and gas monitoring wells	Each borehole was installed with a shallow response zone standpipe with gas tap.	- To provide information to characterise the groundwater conditions and quality including standing groundwater conditions and variations over a period of time post installation. - To undertake ground gas monitoring to determine potential constraints to the development from soil gas generation.
Geotechnical laboratory testing	Selected soil samples were sent by CCGI to their chosen laboratory, a UKAS accredited laboratory, for geotechnical testing	To obtain material properties and to aid the derivation of geotechnical parameters for use in design.
Chemical Laboratory Testing	Selected soil and water samples were sent by CCGI to their chosen laboratory, a UKAS and MCERTS accredited laboratory, for chemical testing	To determine the level of contamination present at the site. This information is used to inform the building design as mitigation may be required.

The boreholes were positioned primarily within the vicinity of the proposed building footprints and to depths likely to be appropriate for the proposed two / three storey building and likely foundation requirements, assumed to be strip foundations with the potential for piled foundations if required. All boreholes were commenced with a Commacchio MC305 drill rig utilising dynamic sampling through shallow ground and using rotary core boring until target termination depths of 15 metres below ground level (m bgl).

Trial pitting was undertaken within the footprint of proposed buildings and the proposed main hall roads of the development. These were excavated using a JCB 3CX excavator to depths of

between 2.0 m bgl and 4.6 m bgl. Soakage testing was undertaken in Trial pits TP101, TP103, and TP108 and the results of the tests are discussed in **Section 4.3**. California Bearing Ratio tests (CBR) were undertaken in TP103 and TP106 and the results of the tests are discussed in **Section 4.4**.

Soil samples were collected for laboratory testing by CCGI. All samples were taken with due regard to industry good practice and procedures to minimise the potential for cross-contamination. Samples were collected into labelled containers provided by the laboratory and chain of custody documentation was completed. The samples were suitably preserved and submitted to CCGI's laboratory of choice, a UKAS and MCERTS accredited laboratory, for analysis.

4.2.2 GROUND INVESTIGATION REPORT

The investigation results are presented in the Factual Report prepared by CCGI which is included as **Appendix C**.

4.2.3 RESULTS OF IN SITU TESTS

Standard Penetration Tests (SPTs) were carried out in the exploratory boreholes BH101 and BH102. The results are shown on the borehole logs in the Factual Report and plots are included in **Section 6** of this report.

4.3 DRAINAGE STUDIES

Soil infiltration tests were undertaken in general accordance with BRE 365 [Ref.9] in trial pits TP101, TP103, and TP108 to inform the proposed drainage strategy being developed for the site. At the test locations, the trial pits encountered primarily granular material immediately below ground level. Despite the inherent high permeability of granular materials the tests did not successfully drain within a six hour period. Only one of the tests (TP101) successfully drained enough to gain a derived infiltration rate of $8.27\text{E}^{-6} \text{ ms}^{-1}$. This indicates that the groundwater infiltration rate is low. This is likely to do with the compacted sand that was found in the majority of locations. Further details of the tests can be found in the factual report.

4.4 CALIFORNIA BEARING RATIO TESTS

California Bearing Ratio tests (CBR) were undertaken in trial pits TP103 and TP106 to inform strength of the natural soils for design of roads and pavements being developed for the site. The tests were undertaken at depths between 0.55 and 0.75 m bgl and the material encountered was described as being a clayey sand and a slightly gravelly sand. The CBR values ranged from 1.7 % (TP103) to 13 % (TP106). The difference in values may be attributed to more >20mm particles being encountered in TP106.

4.5 LABORATORY INVESTIGATION

4.5.1 DESCRIPTION OF TESTS

The laboratory testing programme instructed by WSP was based on the soil types encountered and the relevant proposed design. Selected soil samples were submitted to a UKAS accredited laboratory for geotechnical and chemical testing in order to inform the strength and composition of the ground. The geotechnical laboratory testing regime included the following:

- Soil classification tests comprising Natural Moisture Content, Atterberg Limits and Particle Size Distribution (wet sieve and pipette);
- Unconsolidated undrained triaxial tests; and
- Chemical testing to determine acid and water soluble sulphate contents, pH and total sulphur.

4.5.2 TEST RESULTS

A full set of laboratory test results are included in **Appendix C** within the Factual Report prepared by CCGI.

5 GROUND SUMMARY

5.1 GENERAL

The ground conditions encountered in the 2017 ground investigation are generally consistent with the geological sequence detailed in the BGS geological maps. Exploratory hole logs for the 2017 investigation and an can be found in the factual report submitted by CCGI in **Appendix C**.

5.2 MADE GROUND

Made Ground was encountered within all exploratory holes with the exception of TP103 with a thickness ranging from 0.15 m to 1.70 m. The matrix of the Made Ground varied across the Site but generally comprised sandy gravel. The Made Ground included thin layers of tarmacadam at surface in four of the locations. The Made Ground included in varying proportions across the site, fragments of brick, concrete, plastic, felt, metal, timber, clay pipe, glass, and ceramic. A geotextile membrane was observed between 0.15 m and 0.50 m in four locations across the site.

5.3 WINTER HILL GRAVEL DEPOSITS / RIVER TERRACE DEPOSITS

Winter Hill Gravel Deposits were encountered in all exploratory hole locations beneath the Made Ground except TP103 where it was encountered from surface. The Winter Hill Gravel Deposits were encountered to a maximum depth of 4.60 m bgl however the base was not proven in this location and the maximum proven depth was 4.00 m bgl. The stratum thickness ranged between 1.70 m to 3.35 m. The Winter Hill Gravel Deposits were typically recorded as medium dense to very dense, orangish brown, sandy gravel / gravelly sand, the gravel is recorded as angular to rounded fine to coarse of flint, locally with low cobble content of flint.

5.4 LONDON CLAY

London Clay was encountered beneath the Winter Hill Gravels in four exploratory hole locations. London Clay was proven to a maximum depth of 13.70 m bgl, with a stratum thickness range of 9.7 m to 10.2 m. London Clay was typically recorded as stiff and very stiff, grey silty clay with thinly laminated very closely spaced fissures, with rare lenses of silty sand and rare shell fragments.

5.5 LAMBETH GROUP

Lambeth Group was encountered beneath the London Clay in two exploratory hole locations and it is believed to be the Upper Mottled Beds, although this cannot be proved without deeper boreholes confirming the exact location in the deposit. The Lambeth Group was encountered to a maximum depth of 15.55 m bgl, however its thickness was not proven due to borehole termination depths. The Lambeth Group descriptions are very stiff very closely fissured light grey mottled reddish brown clay. Locally with occasional sub-angular cobbles sized mudstone lithorelicts.

5.6 GROUNDWATER MONITORING

During the 2017 ground investigation groundwater was encountered during advancement of the borehole BH102 at 2.00 m rising to 1.90 m bgl. Seepages were recorded in all trial pits except TP108 between 2.50 m to 3.50. The two boreholes are installed with standpipe piezometers and one round of monitoring was undertaken. A summary of groundwater levels recorded during the monitoring period is presented below in **Table 5.1**.

Table 5.1: Groundwater Level Monitoring in Summary (depth to water m AOD)

BOREHOLE	RESPONSE ZONE	VISIT 1 (08/05/2017)
BH101	90.42 – 87.42	89.57
BH102	89.12 – 87.12	89.10

5.7

SUMMARY

The two tables below summarises the stratum thickness by exploratory holes and the levels each stratum was encountered.

Table 5.2: Summary of Stratum Depths

EXPLORATORY HOLE	MADE GROUND	WINTER HILL GRAVELS	LONDON CLAY	LAMBETH GROUP
BH101	0.75 m	4.00 m	13.70	Not proven
BH102	0.90 m	3.30 m	13.50 m	Not proven
TP101	0.90 m	Not proven	-	-
TP102	1.70 m	Not proven	-	-
TP103	-	Not proven	-	-
TP104	0.40 m	Not proven	-	-
TP105	0.70 m	3.80 m	Not proven	-
TP106	0.15 m	3.50 m	Not proven	-
TP107	0.95 m	Not proven	-	-
TP108	0.15 m	Not proven	-	-

Table 5.3: Summary of stratum levels and thickness

STRATUM	TOP OF STRATUM (M AOD)	BASE OF STRATUM (M AOD)	THICKNESS RANGE (M)
Made Ground	91.82 – 90.48	90.93 – 89.72	0.15 – 1.70 m
Winter Hill Gravels	91.53 – 89.60	87.42 – 87.21	1.70 – 3.35 m
London Clay	87.42 – 87.21	77.72 – 77.12	9.70 - 10.20 m
Lambeth Group	77.72 – 77.12	Not proven	Not proven

6

GROUND CONDITIONS AND MATERIAL PROPERTIES

6.1 INTRODUCTION

The following section summarises the results of the insitu tests and laboratory testing for individual soil types encountered across the site, and where appropriate presents preliminary design parameters.

This report is generally intended to meet the EC7 requirements for a Ground Investigation Report (GIR) to BS EN 1997-1:2004+A2:2013 Eurocode 7: Geotechnical Design [Ref.1] and generally follows the format of Highways Agency's 'Management of Geotechnical Risk' [Ref.2]. Test data is presented and interpreted using published correlations to produce derived values. Mean and lower quartile trend lines are presented where applicable to guide the user. The selection of suitable characteristic and design values will depend on the particular location, considered structure and the design calculation being undertaken.

6.2 MADE GROUND

6.2.1 DESCRIPTION

Made Ground was encountered across the whole site, excluding one location (TP103) and is variable in nature, however is predominantly a sandy gravel with varying quantities of manmade material inclusions.

6.2.2 STRENGTH

No tests to determine the strength of the Made Ground, and as it was all found to be granular no field examination of the strength was possible either. Due to the inherent variability of the Made Ground it is suggested that it is stripped during development.

6.3 WINTER HILL GRAVELS

6.3.1 DESCRIPTION

The surface of the Winter Hill Gravels lies between 0.0 and 1.70 m below ground surface and varies in thickness between 1.70 and 3.35 m. This unit generally comprises a sandy gravel or a gravelly sand. The gravel was comprised of angular to rounded fine to coarse flint.

6.3.2 MATERIAL PROPERTIES

Results of particle size distribution (PSD) analyses for the Winter Hill Gravels are presented on **Figure 6.1** below, which indicates the gravel sized fraction is between 6 and 63 %. The sand sized fraction is between 29 and 88 %. The samples were tested were found to contain up to 14 % fines fraction (<63 µm). It should be noted that part of the fines fraction can be lost in the samples recovered when using any flush; hence the measured particle size distribution may not be representative of the in situ conditions.

Figure 6.2 shows that the moisture content value varies between 4 and 14 % with the majority of results falling between 9 and 14 %.

Figure 6.1: Particle Size Distribution Analyses

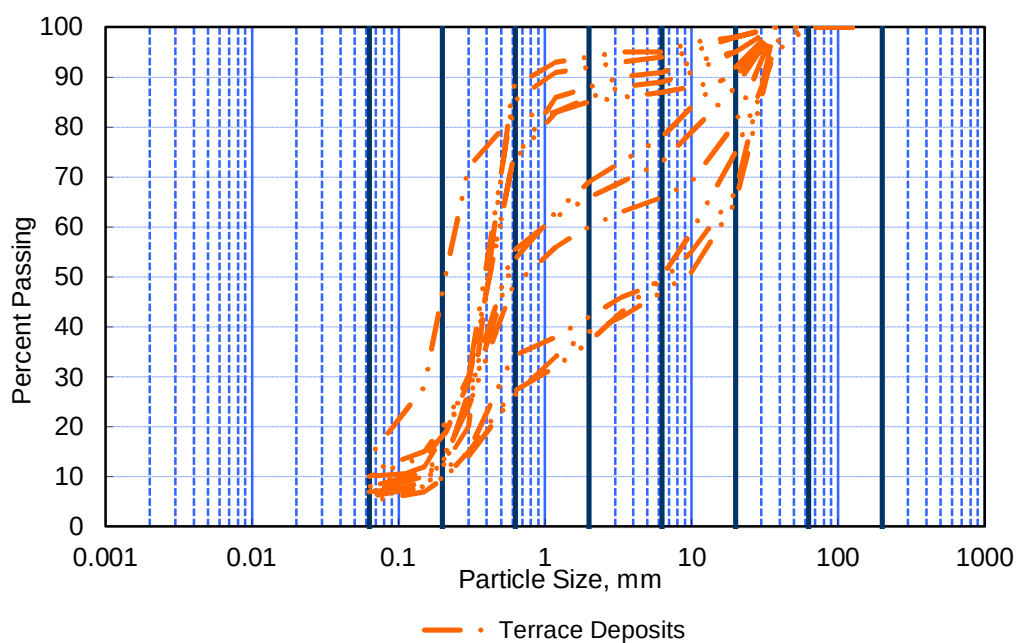
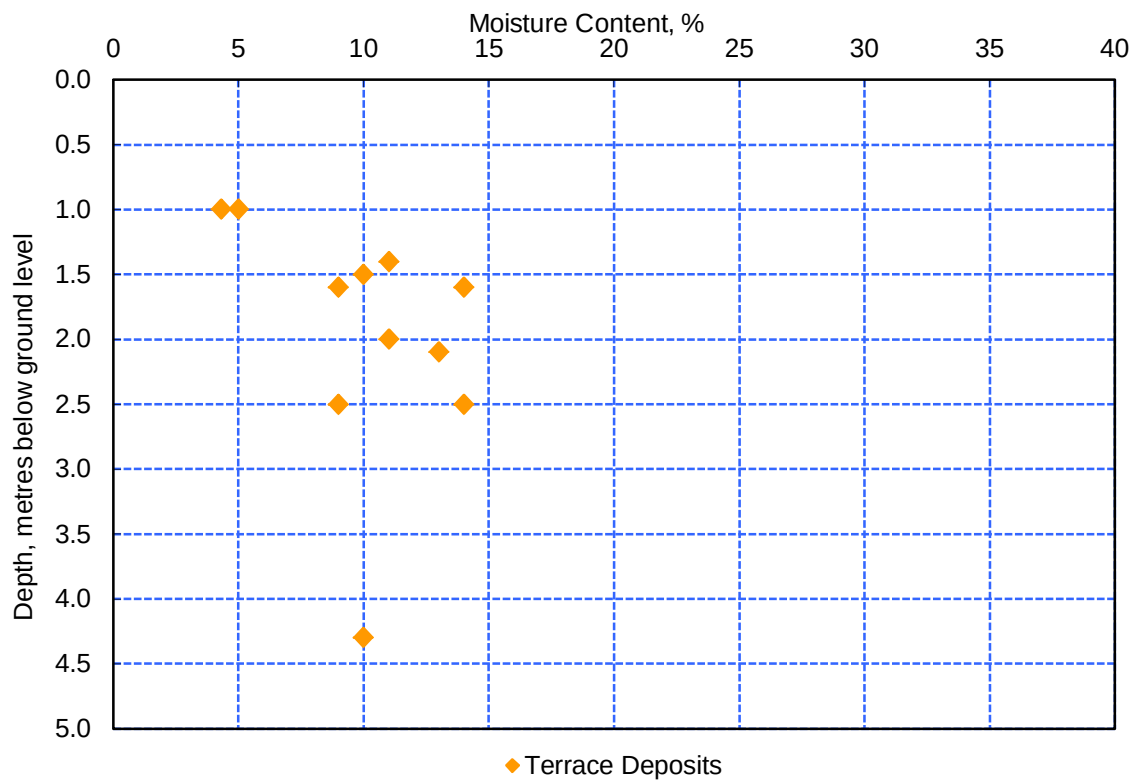


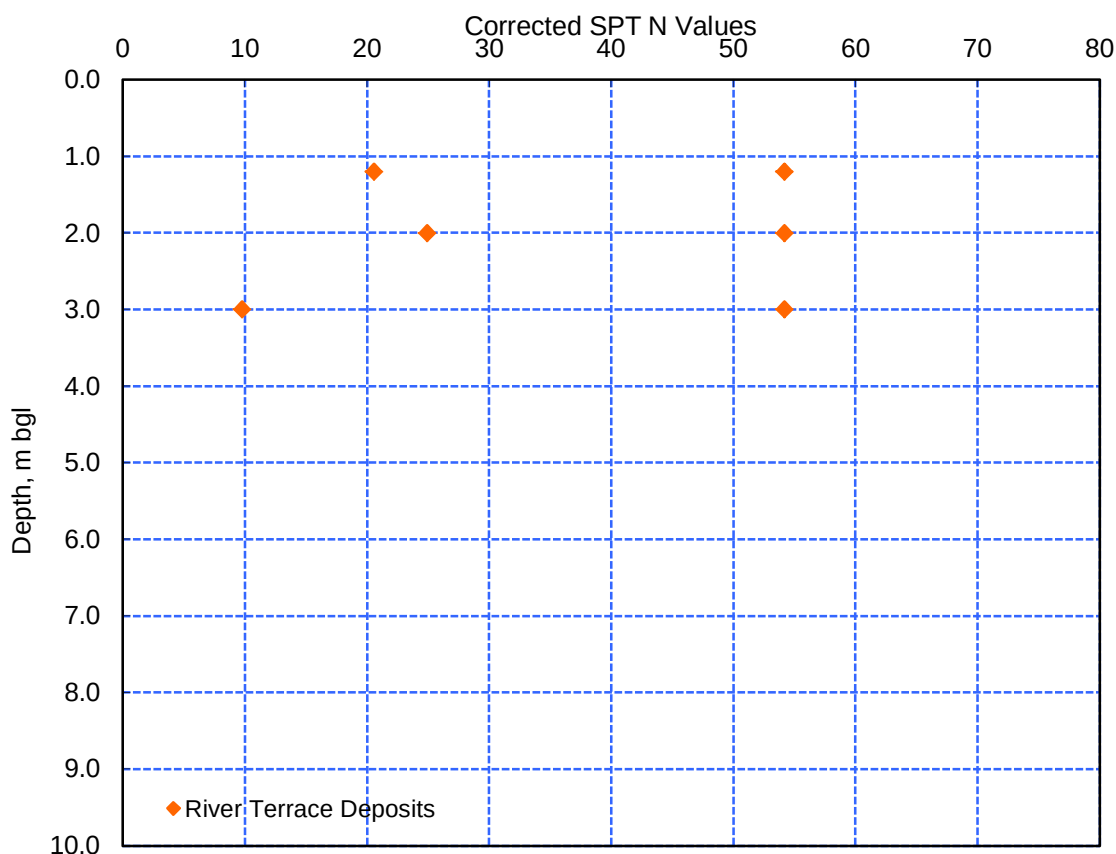
Figure 6.2: Moisture Content of Winter Hill Gravels



6.3.3 STRENGTH / DENSITY

Standard penetration tests were undertaken six times in the Winter Hill Gravels. The recorded SPT blow counts have been corrected to N_{60} values based on hammer efficiency certificates and ranged from 12 to >50 blows. **Figure 6.3** presents a plot of recorded blow counts against depth below ground level and it is noted that the density of the gravels in BH101 is much greater than that of the gravels in BH102. The mean SPT N_{60} value is calculated to be 42. Too few tests were undertaken within this stratum to establish a trend line.

Figure 6.3: Standard Penetration Test (SPT) results for Winter Hill Gravels



6.3.4 CHARACTERISTIC VALUES

Peak and critical state values of effective angle of friction of 36 and 34 degrees respectively, are considered appropriate for use in design analysis. These values have been selected from consideration of the particle angularity, material grading, and values of penetration resistance using the correlations in BS 8004:2015 Code of Practice for Foundations [Ref 16]. Bulk unit weight of the Winter Hill Gravels may be taken to be 20 kN/m³.

6.4 LONDON CLAY FORMATION

6.4.1 DESCRIPTION

London Clay was encountered in both boreholes and its surface was located between 3.30 m and 4.00 m below ground level and was proven to have a thickness of 9.70 to 10.20 m. London Clay

is generally described to be stiff and very stiff, grey silty clay with thinly laminated very closely spaced fissures. The base of the London Clay was encountered at 13.50 to 137.70 m bgl in both boreholes.

6.4.2 CLASSIFICATION

The bulk density of the London Clay, measured on samples submitted for triaxial testing, ranges from 1.99 Mg/m^3 to 2.13 Mg/m^3 , averaged at 2.08 Mg/m^3 . **Figure 6.4** plots bulk unit weight (kN/m^3) against depth and this shows a slight increase in density with depth. A constant bulk density of 2.08 Mg/m^3 equating to a unit weight of 20.4 kN/m^3 could be used for design.

Figure 6.4: Bulk Density vs Depth for London Clay

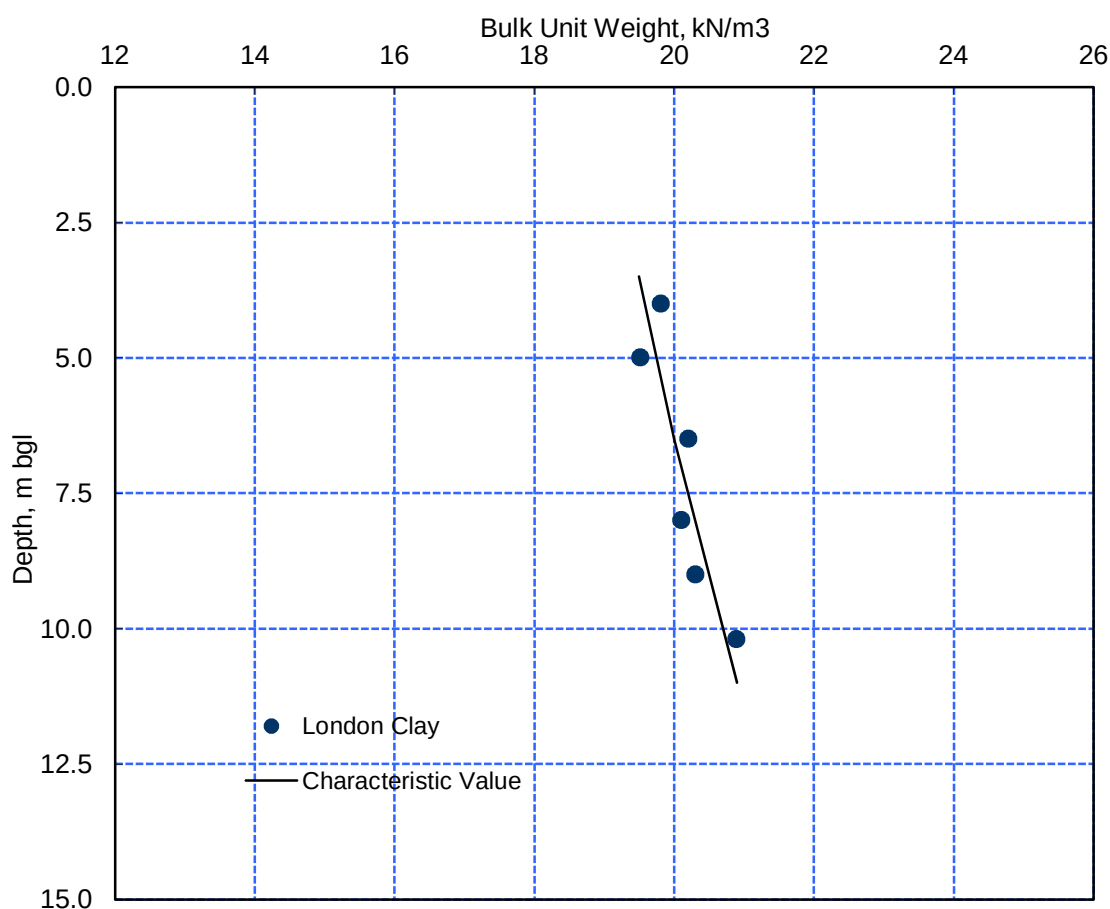


Figure 6.5 shows that the moisture content varies between 20 and 30 % with the majority of results falling between 22 and 27 %, generally reducing with depth.

Figure 6.6 shows Plasticity Index against Liquid Limit plotted on an A-line. The plot shows the plasticity index ranges from between 23 and 39 % and shows that the formation is a clay of intermediate to high plasticity.

Figure 6.5: Moisture Content vs Depth for London Clay

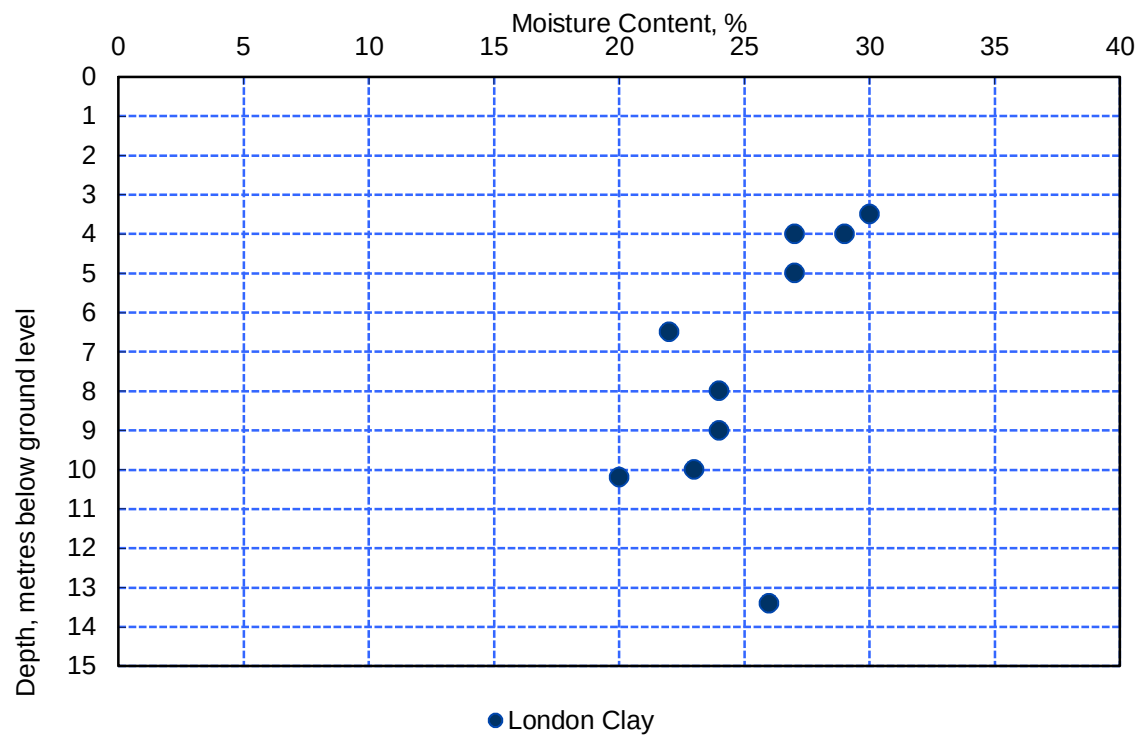
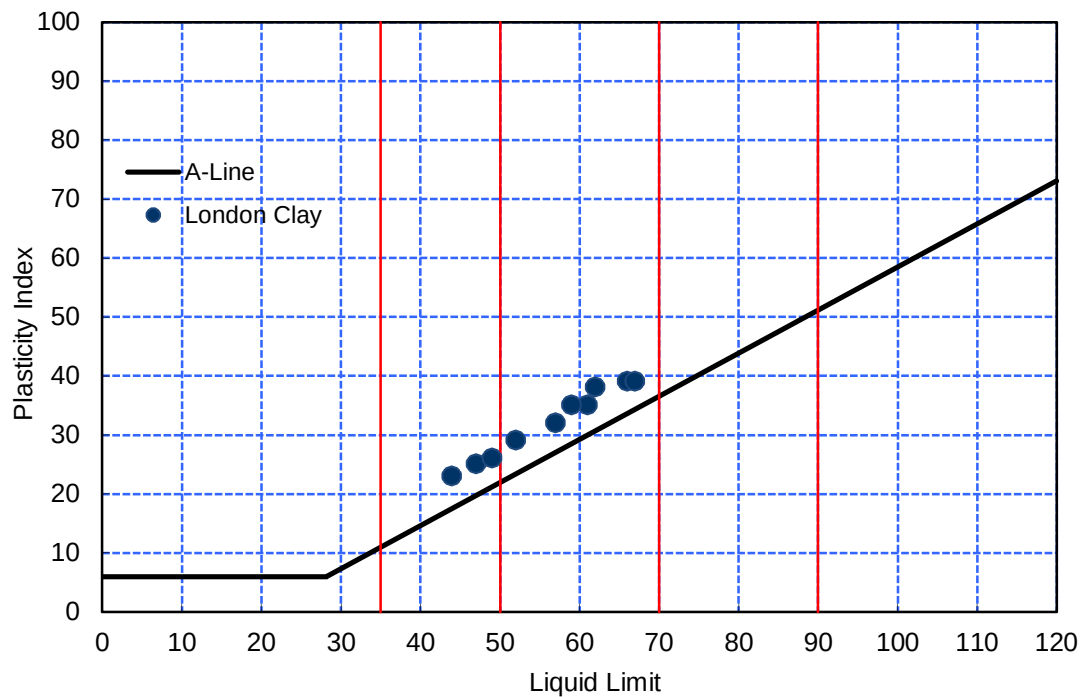


Figure 6.6: A-line plot of Atterberg limits for London Clay



6.4.3 STRENGTH

The SPT blow counts (N_{60}) for the London Clay are plotted against depth below ground level in **Figure 6.7**. They show a strong tendency to increase with depth, from around 13 at the surface of the London Clay (4.00 mbgl) to greater than 50 before the base of the London Clay.

The undrained shear strength (c_u) of the London Clay has been measured by unconsolidated undrained triaxial testing of 100mm samples, which provide results ranging from 58 kPa to 169 kPa. This information is supplemented with derived values using correlations with SPT N_{60} [Ref.10] where $f_1 = c_u/N_{60}$. For a mean plasticity index of 32 %, f_1 is estimated to be 4.5 kN/m^2 which when substituted into the above equation results in an undrained shear strength ranging from 59 kPa to 225 kPa, based on maximum SPT N value of 50. The derived and measured undrained shear strengths are plotted against depth as **Figure 6.8**.

Figure 6.7: Standard Penetration Test (SPT) results for London Clay

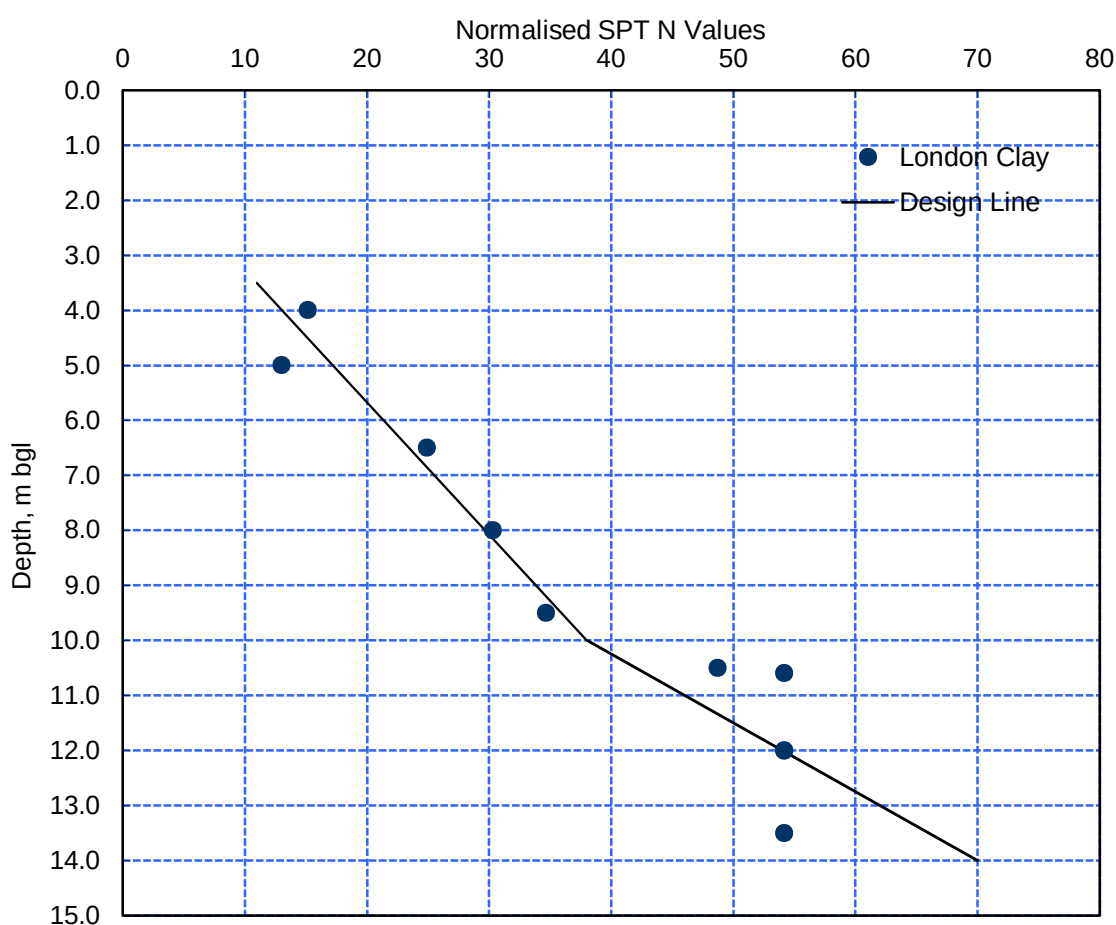
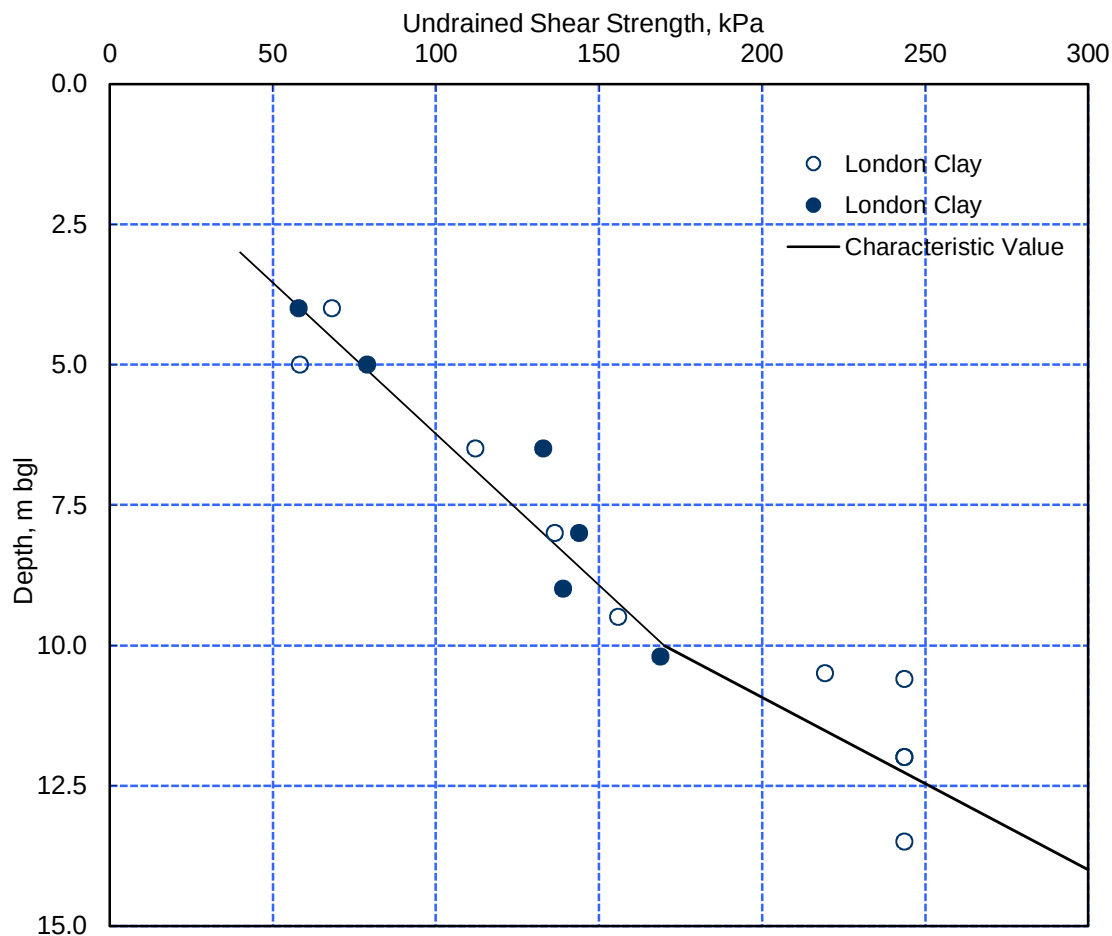


Figure 6.8: Undrained Shear Strength vs Depth for London Clay



Note: 1. Open symbols denote values of undrained shear strength determined using the empirical correlation with SPT N values (Stroud, 1989), with a factor N_c of 4.5 and SPT N values normalised for hammer efficiency.
 2. Closed symbols denote values of undrained shear strength determined by laboratory triaxial testing of 100 mm diameter specimens

The angle of internal friction (Φ') has been derived from plasticity index using Figure 6 of BS 6031:2009 Code of Practice for Earthworks [Ref.11]. The mean plasticity index of the London Clay is 32 % which correlates to a lower bound angle of internal friction of 19° .

A summary of the in situ field testing and laboratory geotechnical testing undertaken in the London Clay is provided in **Table 6.1**. It is noted that maximum, minimum and mean values for undrained shear strength are not provided as depth should be considered by the designer and the trend lines shown on **Figure 6.8** should be reviewed.

Table 6.1: Summary of test results in London Clay

	ATTERBERG LIMITS (%)			MOISTURE CONTENT (%)	SPT BLOW COUNT (N_{60})
	LL	PL	PI		
No. of tests	10	10	10	10	10
Maximum	67	28	39	30	50 ¹
Minimum	44	21	23	20	13
Mean	56	24	32	25	37

¹ Blow count (SPT N_{60}) limited to 50.

6.5 LAMBETH GROUP FORMATION

6.5.1 DESCRIPTION

The Lambeth Group, specifically the Mottled Beds, was encountered below the London Clay formation. The surface of the Lambeth Group coincides with the base of the London Clay at 77.72 mAOD, generally 13-14m below ground level. The Lambeth Group is found to be highly variable and comprises layers of sand, silt and clay. If foundation solutions are intended to penetrate or found in this stratum the borehole logs should be inspected closely by the Designer. The Lambeth Group was only penetrated a maximum of 2.0 m in the two boreholes and was found to comprise a very stiff very closely fissured grey mottled reddish brown clay.

The bulk density of the Lambeth Group, measured on cohesive samples submitted for triaxial testing, ranges from 2.12 Mg/m³ to 2.19 Mg/m³, averaged at 2.16 Mg/m³. A unit weight of 21.2 kN/m³ could be used for design.

The moisture content values vary between 17 and 23 % with the majority of the results falling between 17 and 18 %, however not enough testing points are available to determine a trend.

The plasticity index is plotted on an A-Line against liquid limit it shows that plasticity index values fall between 26 and 28 %, and the formation sits above the line and is classified as a clay of high plasticity.

6.5.2 STRENGTH

A total of three SPTs were undertaken within the Lambeth Group and the recorded SPT blow counts (N_{60}) between 49 and greater than 50. These have been corrected for hammer efficiency. This suggests that the stratum is a very stiff clay, however caution should be made as tests may have missed weak layers within the group.

The undrained shear strength (c_u) of the Lambeth Group has been measured two times by unconsolidated undrained triaxial testing. The results were 110 kPa, and 188 kPa, which is lower than the recorded SPT blow counts. Undrained shear strength has not been derived from SPT

blow count due to blow counts being capped at 50. It is likely that any such derivation would result in overestimated shear strength of this material when compared with the results of triaxial testing.

It is suggested to the Designer that consistent undrained shear strength of 200kPa is considered for this material where clay or silt is present. This is based on recommendations within the London District Surveyors Associations guidance note for the design of straight shafted bored piles [Ref.12].

In terms of the angle of internal friction (Φ'), the borehole log descriptions indicate that this material is predominantly cohesive with very little granular material. For the cohesive layers the angle of friction is based on plasticity index using Figure 6 of BS 6031:2009. The mean plasticity index of the Lambeth Group is 37 % which correlates to a lower bound angle of internal friction of 18°.

A summary of the in situ field testing and laboratory geotechnical testing undertaken in the Lambeth Group is provided in **Table 6.2**. It is noted that maximum, minimum and mean values for undrained shear strength are not provided due to the capped SPT blow counts being likely to skew the results.

Table 6.2: Summary of test results in Lambeth Group

	ATTERBERG LIMITS (%)			MOISTURE CONTENT (%)	SPT BLOW COUNT (N_{60})
	LL	PL	PI		
No. of tests	3	3	3	3	3
Maximum	67	28	39	23	50 ¹
Minimum	62	26	36	17	50 ¹
Mean	64	27	37	19	50 ¹

¹ Blow count (SPT N_{60}) limited to 50.

6.6 SOIL AND GROUNDWATER CHEMISTRY (SULPHATES)

In accordance with the assessment methodology outlined in British Research Establishment (BRE) Special Digest 1: Concrete in Aggressive Ground (2005) [Ref.13], chemical testing was undertaken on soil samples which were obtained during the ground investigation. The results of this testing have been utilised to determine the Design Sulphate Class of the strata present and the Aggressive Chemical Environment for Concrete (ACEC). This is summarised in the table below.

Table 6.3: Sulphate test results

STRATA	HOLE NO.	DEPTH (M)	pH	WATER SOLUBLE SULPHATE (MG/L)
Winter Hill Gravels	BH101	1.50-2.00	8.9	<10
	BH102	1.00	7.5	130
	TP101	1.00-1.20	8.1	20
	TP102	1.50	7.3	1100
	TP103	1.70-1.90	7.3	29
	TP104	1.60-1.80	7.2	38
	TP105	1.70-1.90	7.4	44
	TP106	1.20-1.40	7.6	95
	TP107	1.00-1.20	7.3	88
London Clay Formation	BH101	4.00	7.9	<10
	BH101	5.45-5.00	7.4	120
	BH101	8.45-8.55	7.3	140
	BH101	13.40	7.4	230
	BH102	3.50	6.8	25
	BH102	4.30	6.7	190
	BH102	6.95-7.05	7.3	130
	BH102	9.45-9.55	7.7	200

STRATA	HOLE NO.	DEPTH (M)	pH	WATER SOLUBLE SULPHATE (MG/L)
Lambeth Group	BH101	14.90	8.0	41
	BH102	14.20	9.1	91
	BH102	15.45-15.55	8.8	71

It is evident from the results that the London Clay will be the most aggressive environment for any buried concrete, however the highest water soluble sulphate of 1,100 mg/l was recovered from the Winter Hill Gravels. Taking an average of the highest 20 % test results in the Winter Hill Gravels provides a characteristic water soluble sulphate of 615 mg/l and a total potential sulphate characteristic of 0.10 %, with a characteristic pH value of 7.25. These values correspond to a Design Sulphate Class of DS-2 and ACEC class of AC-2 for the Winter Hill Gravels.

Taking an average of the highest 20 % test results in the London Clay provides a characteristic water soluble sulphate of 215 mg/l and a total potential sulphate characteristic of 2.67 %, with a characteristic pH value of 6.75. The London Clay is noted to be pyritic and therefore has a high total potential sulphate characteristic. These values correspond to a Design Sulphate Class of DS-5 and ACEC class of AC-4s for the London Clay.

It is anticipated that the foundations for the site are likely to be strip foundations and therefore the more conservative design classes of the Winter Hill Gravels should be used. However, the concrete design class should be revisited if shallow foundations are constructed in excavations within the London Clay.

6.7 GEOTECHNICAL RECOMMENDATIONS

The following sub-sections use the findings of the ground investigation and laboratory testing to provide some general guidance on likely ground engineering solutions for the proposed development.

6.7.1 FOUNDATION SOLUTIONS

It is expected that the bearing resistance of the superficial deposits of the Winter Hill Gravels would be sufficient to accommodate the anticipated column loads. It is therefore likely that a traditional strip foundation solution would be suitable.

6.7.2 PRESUMED BEARING VALUE

In accordance with the guidance given in the NHBC (2016) [Ref 15], it is recommended that shallow spread footings are formed in undisturbed natural soils 0.3 m below the top of the natural stratum or a minimum of 0.9 m below existing or the proposed final ground level, whichever is the greatest. On this basis, presumed bearing values not exceeding 100 kPa for footing on the Winter Hill Gravels may be used to make preliminary determination of the required dimensions of the spread foundations. Once the detailed design foundation loads are known, the dimensions of the foundations should be verified for the various design limit states in accordance with the requirements BS EN 1997-1: 2004+A1:2013. Guidance on minimum foundation width is given in BS 8103:2011 Part1: Structural Design of Low-Rise Buildings [Ref 17] and NHBC (2016).

6.7.3 SETTLEMENT

For footings on the Winter Hill Gravels, it is estimated that foundation settlements will be less than 10 mm for footings up to about 1.0 m in width. It is expected that this settlement will comprise short term elastic settlement.

Once the detailed foundation loads and dimensions are known, the total and the potential differential foundation settlements (short and long term), both beneath and between individual foundations should be checked and verified for the various design limit states in accordance with the requirements of BS EN 1997-1: 2004+A1:2013.

6.7.4 DISTURBED GROUND

Given that disturbed ground or otherwise unsuitable soils may be present at the formation level; it is recommended that all bearing surfaces be inspected by a qualified geotechnical engineer prior to constructing the foundations. Any soft or loose soil encountered at foundation level should be removed and replaced with well compacted granular fill or foundation concrete. The bearing surface should be rolled to re-compact any soils disturbed during excavation.

6.7.5 EXCAVATIONS

The stability of any foundation trenches will need to be inspected and monitored as the near surface deposits may be unstable, especially in the presence of groundwater. Where ground is unstable or there is a need to leave steep sided excavations open for longer periods, there may be a need for excavations to be supported.

Groundwater may be encountered in excavations greater than 1m in depth and an appropriate method of groundwater management, such as draining to a sump and pumping, may be required.

6.7.6 PRELIMINARY PAVEMENT DESIGN

CBR values of the near surface soils as determined by in-situ CBR tests are presented in the factual report (CCGI, 2017) and are typically in the range of 1.7 to 13 %. It is noted that CBR values determined from in-situ tests may not be representative of the long term equilibrium conditions present below the completed pavement.

Based on Table 5.1 of IAN 73/06 Rev 1 (2009) [Ref.14], and in combination with the in-situ CBR values, it is recommended that a conservative design value of 4 % be used for the Winter Hill Gravels. A geotextile should be placed to ensure separation of the granular fill from the underlying formation.

7

GEOTECHNICAL RISK REGISTER

7.1

GENERAL

The geotechnical risks associated with this project have been identified and relevant health and safety issues have also been considered. The register highlights the risks and consequences of those risks.

7.2

BASIS OF THE ASSESSMENT OF RISKS

The geotechnical risk register identifies geotechnical hazards/ risks associated with the construction phase and the risks have been assessed in accordance with the general methods described in HD22/02 'Managing Geotechnical Risk' [Ref.2]. A simple rating of probability (1-5) has been included within the assessment: a rating of 1 represents a negligible chance of the risk being realised, whereas 5 would indicate a very high chance. Table 8 summarises the risk rating criteria. The risk register is presented as **Table 7.1** to **Table 7.4**.

Table 7.1: Risk Rating Criteria

RISK RATING (R) = PROBABILITY (P) X IMPACT (I)						
Probability (P)		IMPACT (I)				
				Reputation	H & S	Environment
Very Likely	5	Very High	5	Threat to business survival and credibility	Fatality	Significant incident with irreversible effects and threat to public health or natural resource
Likely	4	High	4	Threat to future work and clients	Life Threatening	Major incident leading to prosecution
Probable	3	Medium	3	Serious	Serious injury	Incident requiring management input
Unlikely	2	Low	2	Significant	Minor injury	Minor incident
Negligible	1	Very Low	1	Very Low	Negligible	Negligible

Table 7.2: Risk Rating Values

IMPACT						
PROBABILITY		5	4	3	2	1
	5	25	20	15	10	5
	4	20	16	12	8	4
	3	15	12	9	6	3
	2	10	8	6	4	2
	1	5	4	3	2	1

Table 7.3: Risk Rating Categories

RISK RATING	1 to 4	Low Risk	Trivial, but no action required.
	5 to 10	Medium Risk	Tolerable, but must consider more costs effective solutions or improvements at no additional cost.
	12 to 16	High Risk	Substantial and work must not start until risk has been reduced.
	20 +	Critical Risk	Intolerable and work must not start on the project until risk has been reduced. If risk cannot be reduced, project should not proceed.

Table 7.4: Geotechnical Risk Register

REF No.	TOPIC / SUBTOPIC	CONSEQUENCE / EFFECT C – COST P – PROGRAMME R – REPUTATION Q - QUALITY	RISK ASSESSMENT ISSUE	CONSEQUENCE	PRE-CONTROL MEASURES			CONTROL MEASURES	POST CONTROL MEASURES		
					LIKELIHOOD	CONSEQUENCES	RISK SCORE		LIKELIHOOD	CONSEQUENCES	RISK SCORE
1 – Unexpected conditions encountered during construction											
1.1	Unexpected adverse ground conditions (e.g. suitable founding strata deeper than anticipated, soft ground more extensive than expected etc.)	C, P, R, Q	Need to adjust the design if problem identified. If not recognised, possibility of underperformance of structure (e.g. increased settlements)	Cost and delays during redesign. Possible increase in excavation depths, pile lengths, soil reinforcement etc. Poor performance of structure and maintenance costs if not corrected.	3	5	15	Reduce likelihood with appropriate ground investigation, interpretation and design. Reduce consequences by identifying any remaining gaps in data and adopting conservative solutions. Make provision for over-excavation and replacement of soft materials where appropriate.	2	3	6
1.2	High groundwater conditions encountered on site.	C, P, Q, R	Possibility of underperformance of structures if not taken into account during design.	Cost and delays during reassessment of design. Poor performance of structure with possible maintenance or remediation costs if not corrected.	3	5	15	Reduce likelihood by making sure that all available ground water data is assessed during detailed and temporary works design. Allow appropriate length of time for ground water monitoring period. Reduce consequences by identifying potential gaps in data coverage and adopt conservative groundwater regime. Make provision for emergency dewatering during construction.	2	2	4
1.3	Variability of superficial/surface deposits.	C, P, R	The superficial/surface deposits are inherently variable and unpredictable. Possible design or construction changes.	Cost and delays with design is reassessed. Possible increase in excavation depths, pile lengths etc.	4	4	16	Reduce likelihood by assessing all ground investigation data during detailed design. Reduce consequences by identifying potential problems early and incorporating the over-	2	1	2

REF No.	TOPIC / SUBTOPIC	CONSEQUENCE / EFFECT C – COST	RISK ASSESSMENT ISSUE	CONSEQUENCE	PRE-CONTROL MEASURES			CONTROL MEASURES	POST CONTROL MEASURES		
								excavation and replacement or compaction of materials where appropriate.			
2 – Environmental Risks											
2.1	Materials excavated and allocated for use in earthworks are different than expected.	C, P, R	More material processing or more import/export of material required.	Additional cost and delay to programme. Potential increase in vehicle movements.	4	3	12	Reduce likelihood by using results of contamination and geotechnical testing and planning earthworks accordingly. Reduce consequences by making provision for possible additional import/export of materials or additional material processing.	3	2	6
2.2	Unidentified contamination encountered on site	C, P, R	Need to impose additional control measures to continue sites work. Health and safety impact if encountered but not identified. More material processing or import/export of material required.	Delays and additional costs while contaminant is identified. Possible health issues for site staff if not identified.	4	3	12	Reduce likelihood by referring to geoenvironmental conditions section to identify possible locations of contamination. Reduce consequences by making provision for possible remediation. Site health and safety plans to make provision for detection of contamination and additional control measures if encountered.	3	2	6
2.3	Asbestos encountered in Made Ground	C, P, R	Need to impose additional control measures to continue site works safely. Health and safety impact if not discovered. Excavated material not suitable for reuse on site without treatment.	Delays and additional costs while asbestos is identified and health and safety control measure are defined and implemented. Possible health issues for site staff if not identified.	1	3	3	Reduce consequences by referring to ground investigation data to establish locations of Made Ground. All site staff to be given asbestos awareness training to aid early identification.	1	2	2
3 – Underground Obstructions Encountered During Construction											
3.1	Unidentified utilities	C, P, R	Health and safety hazards associated with striking live services. Cost of repairs.	Delays to programme and possible additional costs for re-routing or avoiding utilities.	3	4	12	Reduce likelihood by obtaining latest utilities plans and results of utilities survey. Use non-intrusive	2	4	12

REF No.	TOPIC / SUBTOPIC	CONSEQUENCE / EFFECT C – COST	RISK ASSESSMENT ISSUE	CONSEQUENCE	PRE-CONTROL MEASURES			CONTROL MEASURES	POST CONTROL MEASURES		
			Need to determine type of utilities and to make contact with statutory undertakers. Establish whether services are live or decommissioned. Need to re-route utilities or alter the works to avoid the obstruction.					service detection methods prior to breaking ground. Vigilance during construction for signs of backfilled excavations or trenches.			
4 – Geotechnical Design Risks											
4.1	Earthworks quantities different from those calculated.	C, P, R	Need to import or export additional material.	Additional cost and delay to programme whilst further fill sources or additional material removed.	4	3	12	To reduce likelihood, use 3D modelling techniques to confirm earthworks requirement.	2	3	6
4.2	Instability of temporary excavations.	C, P, R, Q	Possible instability of temporary works during construction of foundations	Delay and cost of additional temporary works. Safety of site staff.	3	5	15	Ground investigation data to be used to inform temporary works design.	2	5	10
4.3	Geotechnical design recommendations are not taken through to construction.	C, P, R, Q	Need to adjust the design if problems identified during construction. If not recognised, possibility of underperformance of structure (e.g. increased settlements)	Delays to programme and possible additional costs for re-design or remediation works.	2	4	8	Appoint a suitably qualified Geotechnical Engineer to attend site during construction and to validate the works.	1	4	4
4.4	Moisture susceptibility of ground and materials.	C, P, R, Q	Possible instability of excavations, softening of ground. Underperformance of ground and materials.	Delays to programme and worsening of material properties.	3	3	9	The construction should be planned in such a way to minimise the impacts of weather.	1	3	3

8

GEOENVIRONMENTAL CONDITIONS

8.1 INTRODUCTION

This section of the report discusses the measured concentrations of potential contaminants and assesses the geoenvironmental conditions on the Site with respect to any hazards posed by the existing conditions to the proposed development and the environment. This section does not constitute a Generic Quantitative Risk Assessment (GQRA) in accordance with CLR11. The factual description of the data below is provided to inform design and construction and is not intended to support discharge of any planning conditions.

8.2 CONTAMINATION

Chemical testing has been carried out on 24 samples of soil during the recent investigation for a range of general contaminants, together with carbon banding of petroleum hydrocarbons (TPH - Criteria Working Group), speciated determination of polycyclic hydrocarbons (PAH), selected volatile organic compounds (BTEX), and asbestos.

Samples were taken from the Made Ground and the Winter Hill Gravels. The results of the analysis of the general contaminants, TPH, PAH, BTEX, VOCs and asbestos of soil samples carried out are presented in the factual report of the ground investigation (CCGI, 2017) in **Appendix C**.

Chemical testing was also carried out on two samples of groundwater during the recent investigation for a range of general contaminants and the results are also presented in the factual report in **Appendix C**.

8.2.1 IDENTIFIED AREAS OF CONTAMINATION

Soil sample laboratory results have not been screened against generic assessment criteria (GAC) for the purpose of this investigation. Any samples with elevated concentrations that may need to be dealt with before or during development are highlighted.

- BH102 – Elevated Benzo(a)pyrene and elevated TPH Aliphatic and Aromatic C21-C35. Both samples were recovered from the Made Ground and would be expected to be stripped off during development;
- TP102 – detected asbestos fibres of chrysotile. Asbestos quantification results returned a result of <0.0001 %. The sample was recovered from within the Made Ground in the area of the demolition rubble from the previous school;
- BH101 – Groundwater results taken identified slightly elevated levels of total phenols and elevated levels of TPH Aliphatic C21 - C35; and
- BH102 – Groundwater results taken identified elevated levels of ammoniacal nitrogen and TPH CWG Aliphatic C16 – C35.

Prior to the start of the ground investigation, the caretaker for the adjacent Thames Valley School identified that people of the travelling community had been living on the site prior to the GIR. Numerous items appeared to have been fly tipped on site including pieces of a car and oil drums.

8.3 GROUND GAS

One round of gas monitoring was undertaken on 8 May 2017 in high atmospheric conditions. BH101 identified very small concentrations of methane (CH₄) (0.10 %), slightly elevated concentrations of carbon dioxide (CO₂) (2.80 %) and 6 parts per million (ppm) of carbon monoxide (CO). Soil gas from BH102 identified similar levels of CH₄, low levels of CO₂ (0.10 %), and 8 ppm of CO. A copy of the ground gas monitoring can be found in the factual report in **Appendix C**.

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Appendix A

SITE MAPS AND PLANS







4577

Conwy Close, Reading

09.05.16

SCHEDULE OF DWELLINGS

DWELLING TYPES		Type	No. of units	Car parking spaces req.	Area - GIA (sqm.)	Essential GIA (sqm.) Space Standards
1 bed flat - 1b2p		1F	9	13.5	50	50
2 bed flat - 2b4p		2F	26	39.0	61	70
2 bed house - 2b4p		2Ha	6	9.0	84	83
2 bed house - 2b4p		2Hb	9	13.5	93	83
3 bed house - 3b6p		3Hb	6	12.0	118	108
4 bed house - 4b7p		4H	2	4.0	128	121
Total flats			35			
Total houses			23			
Total units			58			

CARPARKING SPACES

Total carparking spaces req.	91.0
Total visitor carparking spaces req.	8.8
	99.8

Percentage check	1 beds	16
	2 beds	71
	3 beds	10
	4 beds	3
		100

WORK IN PROGRESS, NUMBERS AND LAYOUT SUBJECT TO CHANGE

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No dimensions are to be scaled from this drawing. All dimensions are to be checked on site. Area measurements for indicative purposes only.

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Sources Ordnance Survey

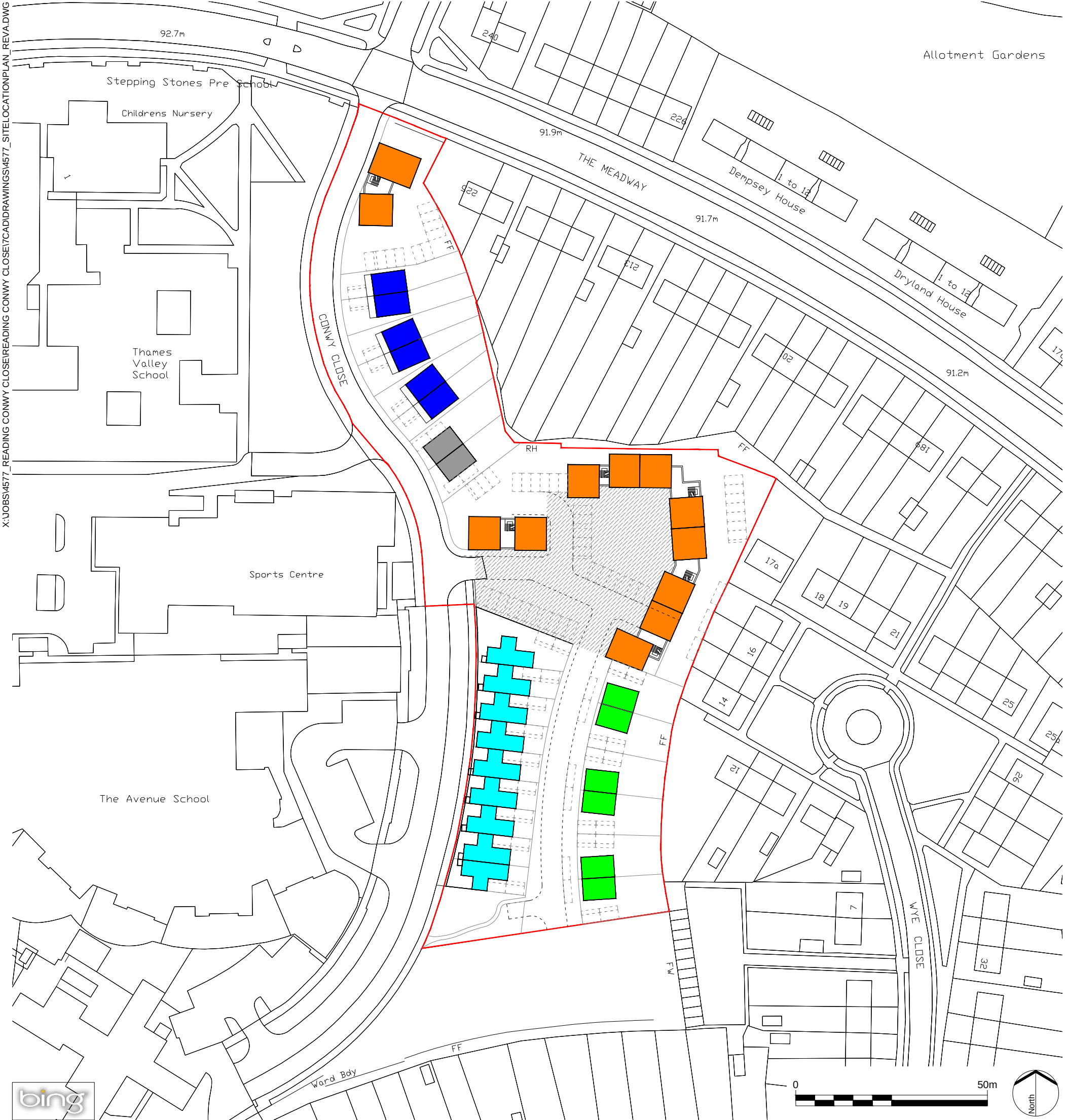
B	Revisions following client meeting	09.05.16
A	Revisions to courtyard house layout	08.03.16
REV.	DESCRIPTION	APP. DATE
ISSUED BY	Oxford	T: 01865 887 050
DATE	01 DEC 2015	DRAWN CH
SCALE@A3	1:1,000	CHECKED
STATUS	Sketch	APPROVED

PROJECT TITLE
CONWY CLOSE, READING

DRAWING TITLE
DWELLING TYPES

WORK IN PROGRESS, NUMBERS AND LAYOUT SUBJECT TO CHANGE

DWG. NO4577_SK_003



1 BED FLAT (1F)	1 BED HOUSE (1H)	3 BED HOUSE (3Ha)	4 BED HOUSE (4H)
2 BED FLAT (2F)	2 BED HOUSE (2Ha)	3 BED HOUSE (3Hb)	
2 BED HOUSE (2Hb)	3 BED HOUSE (3Hc)		