Manhire Associates
CONSULTING ENGINEERS

159 – 161 Iverson Road,

Geo-Environmental Report

Formation Homes (London) Ltd

DATE OF ISSUE: 19/09/2014

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1.0 Synopsis

An investigation has been carried out at 159 - 161 Iverson Road in West Hampstead on the instructions of Formation Homes (London) Ltd.

The purpose of the investigation was to determine the ground conditions and to provide advice on geotechnical matters for the proposed mixed use redevelopment of the site.

One boreholes and four windowless sampler holes were completed to determine the ground conditions, supported by a programme of in situ and laboratory testing.

The ground conditions revealed by the investigation comprised Made Ground overlying London Clay. It is expected that piled foundations will be required for the proposed works; whilst contamination results found an excess of one contaminant which will require a cover system to be utilised within the garden and landscaped areas.

2.0 Site Description

The site comprises the existing Iverson Tyres site. This consists of a single storey building at the rear of the site with adjacent portacabon, with rough hardstanding at the front. There is a small overgrown area to the rear north east of the main building, although no access to this area was possible during our works. The general layout of the site is shown at Figure 1 of Appendix D.

The site is located within a mixed retail and residential environment.

Small areas of isolated light staining was noted on the surfacing.

3.0 Development Proposals

It is proposed to demolish all building on site and build a 19 unit multi storey blocks covering the majority of the site, although an area of landscaping is to be provided to the east of the main building as shown at Figure 2. Loading are not yet know but are expected to be moderate and too be carried on pile foundations.

4.0 Geology

Published records of the British Geological Survey indicate the site to lie on London Clay.

5.0 Field Work

The extent of the field work was specified by the Client and comprised one light percussive borehole to 20m depth. This was supplemented by four windowless sampler holes to 3m depth to give a more detailed assessment of near surface soils.

Representative soil samples were recovered from the borehole pits for subsequent laboratory examination and testing; whilst Standard Penetration Tests (SPT) were carried out as appropriate. Details of the strata encountered are provided on the Borehole Record at Appendix A; together with particulars of the samples recovered, groundwater observations and SPT results. The profile of SPT with depth is also presented at Figure 3 of Appendix D.

6.0 Laboratory Testing

The following laboratory tests were conducted on samples recovered during the field work:-

- Natural moisture content: to assess the in situ condition of the soil.
- Liquid and Plastic Limits: to classify cohesive soil into behavioural groups
- Unconsolidated undrained triaxial compression: to determine the shear strength of cohesive material and thus to assess its load bearing capacity.
- Soluble sulphate concentration and pH value: for the specification of buried concrete.

- Contamination: chemical analyses to detect the presence of common contaminants:-
- Metals and semi - metals:
- Arsenic
- Cadmium
- Chromium
- Lead
- Mercury
- Selenium
- Copper
- Nickel
- Zinc

Organic compounds
Total monohydric phenols
Total petroleum hydrocarbons - TPH
Speciated polyaromatic hydrocarbons - PAH
Others
Asbestos

Results of these tests are presented at Appendix B. The variation of shear strength with depth is also shown at Figure 4 of Appendix D.

7.0 Ground Conditions

7.1 Stratigraphy

The stratigraphy of the site as revealed by the boreholes is described in detail at Appendix A and in general terms hereafter.

7.1.1 Made Ground

Made Ground was encountered in all exploratory holes and to a maximum of 2m depth in the percussive borehole.

Beneath the hardstanding it generally comprised a brick rubble with some ashy pockets overlying a brown and occasional grey green sandy clay with various man made detritus.

7.1.2 London Clay

London Clay was proved in all boreholes beneath the Made Ground and was proved to the limit of investigation. It was principally found to be a fissured dark grey clay which is consistent with the un-weathered portion of the London Clay. A layer of brown clay with grey mottling and orange brown sandy silt pockets was encountered initially and represents the upper weathered portion.

Triaxial testing will show it being in a firm to stiff condition, which confirmed the visual assessment.

7.2 Ground Water

No groundwater was only during boring, however the speed of drilling and the low permeability of the London Clay may have masked any inflows.

Details of all groundwater observations are provided on the Borehole Records at Appendix A.

8.0 Discussion

8.1 General

The site has already carried development and it is therefore probable that pockets of Made Ground may exist locally; perhaps deeper, of different character or associated with underground construction; even though not detected during this investigation.

The thickness of the Made Ground and the expected column loads are such that piled foundations are expected to be utilised.

8.2 Piled Foundations

Either driven or bored piles would be suitable in the ground conditions found at this site. However, compared with bored piling, construction of driven piles generates greater noise and vibration which is unlikely to be acceptable in this environment. In particular, high levels of ground - borne vibrations could damage nearby structures. Consideration of the various advantages and disadvantages of the different pile types suggests CFA piles to be preferred. They avoid many of the installation difficulties that would otherwise be experienced; particularly the need for casing and control of water. Parameters for their preliminary design are provided in Tables 1 and 2.

Table 1: Design parameters for bored piles - Shaft friction

Stratum	Depth, m	Ultimate unit shaft friction
All material	0.0 - 2.0	Ignore
London Clay	2.0 - 20.0	Increases linearly from 20 to 75 kPa

Table 1 has been derived in conjunction with an adhesion factor of 0.6 in the London Clay.

Table 2: Design parameters for bored piles - End bearing capacity

Stratum	Depth, m	Ultimate unit end bearing capacity
London Clay	10.0 - 20.0	Increases linearly from 655 to 1080 kPa

A factor of safety must be applied to derive the allowable working load from the ultimate values obtained from Tables 1 and 2. An overall value of 2.5 is commonly employed in compression.

Working pile load tests could be carried out to verify the chosen FoS on a development of this scale. This could result in a lower factor of safety than 2.5 which could result in significant cost savings. The actual factor of safety will be dependent upon the knowledge and experience of the chosen pilling contractor and agreement with relevant parties, but is generally in the order of 2.25.

Tables 1 and 2 predict that a CFA pile of 4500 mm diameter, bored to 18m depth, will have an allowable load capacity of some 460 kN required under an overall factor of safety of 2.5.

Table 3 provides preliminary load capacity for bored piles in compression under a factor of safety (FoS) of 2.5 for various pile diameters.

Table 3: Pile diameters and capacities for bored piles (FoS of 2.5)

Depth below g.l.	Cohesion	Ultimate Unit Capacity		Pile dia. 0.30				Pile dia. 0.45				Pile dia. 0.60			
				Ultimate Load Capacity			Allowable	Ultimate Load Capacity			Allowable	Ultimate Load Capacity			Allowable
		Shaft Friction	End Bearing	Shaft Friction	End Bearing	Total	Load Capacity	Shaft Friction	End Bearing	Total	Load Capacity	Shaft Friction	End Bearing	Total	Load Capacity
m	kPa	kPa	kPa	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
2.0	35	21	315	0	22	22	9	0	50	50	20	0	89	89	36
2.5	37	22	336	10	24	34	14	15	53	69	28	20	95	116	46
3.0	40	24	358	21	25	46	19	32	57	89	35	42	101	143	57
3.5	42	25	379	33	27	59	24	49	60	109	44	65	107	172	69
4.0	44	27	400	45	28	73	29	67	64	131	52	90	113	203	81
4.5	47	28	421	58	30	88	35	87	67	154	61	116	119	235	94
5.0	49	30	443	71	31	103	41	107	70	177	71	143	125	268	107
5.5	52	31	464	86	33	118	47	128	74	202	81	171	131	302	121
6.0	54	32	485	101	34	135	54	151	77	228	91	201	137	338	135
6.5	56	34	506	116	36	152	61	174	81	255	102	232	143	375	150
7.0	59	35	528	132	37	170	68	199	84	282	113	265	149	414	166
7.5	61	37	549	149	39	188	75	224	87	311	124	298	155	454	181
8.0	63	38	570	167	40	207	83	250	91	341	136	334	161	495	198
8.5	66	39	591	185	42	227	91	278	94	372	149	370	167	537	215
9.0	68	41	613	204	43	247	99	306	97	403	161	408	173	581	232
9.5	70	42	634	224	45	268	107	335	101	436	174	447	179	626	251
10.0	73	44	655	244	46	290	116	366	104	470	188	488	185	673	269
10.5	75	45	676	265	48	313	125	397	108	505	202	529	191	721	288
11.0	78	47	698	286	49	336	134	429	111	540	216	573	197	770	308
11.5	80	48	719	309	51	359	144	463	114	577	231	617	203	820	328
12.0	82	49	740	331	52	384	153	497	118	615	246	663	209	872	349
12.5	85	51	761	355	54	409	164	533	121	654	261	710	215	925	370
13.0	87	52	783	379	55	435	174	569	124	693	277	759	221	980	392
13.5	89	54	804	404	57	461	184	606	128	734	294	808	227	1036	414
14.0	92	55	825	430	58	488	195	645	131	776	310	860	233	1093	437
14.5	94	56	846	456	60	516	206	684	135	819	327	912	239	1151	461
15.0	96	58	868	483	61	544	218	724	138	862	345	966	245	1211	484
15.5	99	59	889	511	63	573	229	766	141	907	363	1021	251	1272	509
16.0	101	61	910	539	64	603	241	808	145	953	381	1078	257	1335	534
16.5	103	62	931	568	66	634	253	852	148	1000	400	1135	263	1399	559
17.0	106	64	953	597	67	665	266	896	151	1047	419	1195	269	1464	586
17.5	108	65	974	628	69	696	279	941	155	1096	438	1255	275	1530	612
18.0	111	66	995	658	70	729	292	988	158	1146	458	1317	281	1598	639
18.5	113	68	1016	690	72	762	305	1035	162	1197	479	1380	287	1667	667
19.0	115	69	1038	722	73	796	318	1083	165	1249	500	1445	293	1738	695
19.5	118	71	1059	755	75	830	332	1133	168	1301	521	1511	299	1810	724
20.0	120	72	1080	789	76	865	346	1183	172	1355	542	1578	305	1883	753

Single piles could stress soil below depth of investigation; prove ground conditions throughout zone of stress before using. Pile groups should be considered separately.

The actual load capacity achieved in practice depends upon the precise installation procedures. Advice should therefore be sought from specialist contractors to verify the load capacity and settlement characteristics of their particular piles in the ground conditions revealed by this investigation. In any event, it is recommended that the chosen pile configuration be confirmed by preliminary load tests conducted before installation of the contract piles in order to take advantage of minimum FoS and thus minimum cost.

8.3 Ground Floor Slabs

The previously mentioned thickness and variability of the Made Ground is such that suspended ground floor construction should be adopted.

8.4 Excavations

8.4.1 Stability

Made Ground is inherently variable in both composition and compaction and should thus be regarded as unstable. It is recommended that all excavations should be supported at all times. This is especially important for the safety of personnel when required to work in or close to excavations.

It should be ensured that support is always provided to adjacent structures and that temporary works are sufficient to resist the additional lateral earth pressure from the structures without significant deformation.

It is expected that shallow excavations should remain sensibly dry.

8.5 Contamination

Contaminant testing was undertaken on selected soil samples and the results compared with the limited number of CLEA[1] Soil Guideline Values (SGVs) for residential land use that have been published to date. Where not available from that source, reference has also been made to the LQM CIEH Generic Assessment Criteria[2]. Appropriate trigger levels are given within the results at Appendix B. All results for metals and semi metals are below the relevant trigger concentrations.

There is no trigger presently available for lead, but the results are at worst less than half the previous trigger of 450mg/kg and are thus not expected to prejudice the development. In addition the results are below the value of 276mg/kg provided in the AtRiskSoil database produced by Atkins.

The results of the TPH analysis found levels to be below detection limits or at very low concentrations and are thus not expected to prejudice the development.

Elevated level of PAH's have been found for the vigorous carcinogen Benzo (a) pyrene [B(a)P] which was found to be above the trigger concentration of 0.83mg/kg in all samples.

Based on the above it is considered that where in areas of hardstanding or below building footprints, contaminants can remain in situ as the pathway in a source - pathway - receptor model will be blocked.

Due to the elevated levels of PAH it is recommended where in areas of soft landscaping or gardens; a cover system is provided as an appropriate remedial option. This should be constructed in accordance the BRE Cover Systems for Land Regeneration [3].

Based on the recorded concentrations of B(a)P at the site, covered by imported clean material and assuming a mixing zone thickness of 600mm, a cover thickness of 527mm should be utilised with a minimum of 176mm of the overall cover comprising a topsoil layer. A geotextile barrier should be utilised at the base of the cover layer to discourage excavation below that level. It should be ensured that a maximum concentration of 0.6mg/kg of B(a)P should be present within the imported materials.

Validation testing of the soil to be imported should be undertaken at a rate of one sample per garden area or equivalent to ensure suitable imported material is used. In addition the thickness of the imported material should be verified.

No asbestos was detected.

8.6 Buried Concrete

Laboratory tests yielded a maximum soluble sulphate concentration of 0.92g/l which give a Design Sulphate Class[4] of DS-2.

The soil was found to be slightly alkaline and the groundwater conditions are considered mobile. The aggressive chemical environment for concrete, ACEC, is therefore classed as AC-2.

References

[1] The Contaminated Land Exposure Assessment Model
Department for Environment, Food and Rural Affairs
The Environment Agency
R & D Publications SGV 1 *et al.*, March 2002

[2] The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition)
Nathanail, C.P., McCaffrey, C. *et al*
Land Quality Management Ltd., 2009

[3] Cover Systems for Land Regeneration
Thickness of cover systems for contaminated land
BRE Press BR465 2008

[4] Concrete in aggressive ground
BRE Special Digest 1
Building Research Establishment, 2005

PROCEDURAL NOTES for GROUND INVESTIGATIONS

General

This report is based upon data obtained from field descriptions of the strata and examination of the samples by an engineer, together with the results of in situ and laboratory tests as appropriate. Responsibility cannot be accepted for variations in ground conditions between and around any of the exploratory points that is not revealed by the data. Whilst the report may offer an opinion on the ground conditions between exploratory points and below the depth of investigation, this is for guidance only and no liability is accepted for its accuracy.

Drilling procedure

Boring by light cable percussion drilling allows the ground conditions to be reasonably well established. However, a certain amount of disturbance is inevitable and some mixing of soils can occur.

Sampling procedure

"Undisturbed" samples of predominantly cohesive soils are taken with a 100mm diameter open tube sampler, generally in accordance with BS 5930: 1999.

Where appropriate, or where an undisturbed sample is unsuccessful, disturbed samples are recovered and sealed into polythene bags.

Groundwater samples are taken when water is encountered in sufficient quantity.

Standard penetration tests

The test is conducted generally in accordance with BS 1377: Part 9: 1990. The sampler tube is subject to a seating drive of 150mm into the soil at the base of the borehole. Results are given on the Borehole Records as the number of blows required to drive the sampler tube a further 300mm and this is known as the “N” value. Where the driving resistance is such that full penetration is not achieved, the test is generally terminated after 50 blows and the actual distance penetrated is recorded.

Groundwater

Groundwater observations necessarily reflect the conditions encountered at the time of the exploratory work. Long term monitoring of standpipes is usually required to establish an equilibrium water level since the normal rate of boring is too fast to permit steady state conditions to be achieved.

Groundwater levels are subject to variations caused by changes in drainage conditions and seasonal climatic changes.

Water may necessarily be added to advance the bore whilst casing may be required to maintain an open hole. These can both mask subsequent groundwater observations and are therefore noted on the individual Borehole Record.

APPENDIX A

BOREHOLE RECORDS

SYMBOLS and ABBREVIATIONS

Samples

Undisturbed

U	Standard open drive "undisturbed" 102mm dia. in boreholes 38mm dia. in trial pits, window sampler and hand auger
T	Thin wall open drive
P	Piston
CBR	CBR mould
L	Windowless sampler liner

Disturbed

D	Small
B	Bulk
W	Water
C	Contaminants: plastic tub
J	Contaminants: brown glass jar

In situ tests

SPT	Standard Penetration Test, open shoe
CPT	solid cone

N value is number of blows for 300mm penetration.
Blow count also given as seating drive followed by four increments of 75mm.

V ( ) Vane test (c_u kPa)

P ( ) Hand penetrometer (c_u kg/cm^2)

M ( ) Mexe probe (CBR %)

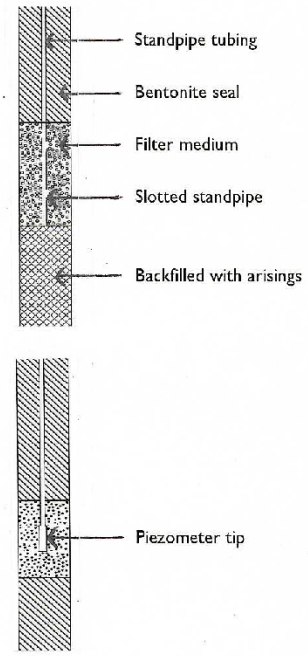
Water records

$\blacktriangledown_2$ Standing level

$\triangledown_2$ Depth encountered

suffix identifies separate strikes

Standpipes



MANHIRE ASSOCIATES
GEO-ENVIRONMENTAL LIMITED

Site	Borehole Number
159-161 IVERSON ROAD, LONDON, NW6 2RB	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 2.50m		Formation Homes (London) Ltd	13079
	Location See site plan	**Dates** 05/09/2014	**Engineer**	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30) 0.30	CONCRETE		
0.50	D1					(0.60) 0.90	MADE GROUND: Brick rubble with some gravel sandy clay and ashy pockets		
1.00-1.45	SPT N=6			1,1/1,1,2,2			MADE GROUND: Brown silty clay with some gravel and brick fragments		
1.50	D2					(1.10) 2.00			
2.00-2.45	SPT N=5			1,1/1,1,1,2			Firm to stiff brown silty CLAY with some orange brown sandy silt pockets and grey laminations		
2.50	D3								
3.00-3.45	U1			28 blows					
3.50	D4								
4.00-4.45	SPT N=11			2,2/2,3,3,3					
4.50	D5								
5.00-5.45	SPT N=12			2,2/3,3,3,3					
6.00	D6					(8.45)			
6.50-6.95	SPT N=14			2,3/3,3,4,4					
7.00	D7								
8.00-8.45	U2			58 blows					
8.50	D8								
9.50-9.95	SPT N=15			3,3/3,4,4,4					

Remarks
Borehole dry
Backfilled with arisings
Chiselling from 0.00m to 0.30m for 0.50 hours.

Scale (approx)	Logged By
1:50	ljs

Figure No. 13079 BH1

MANHIRE ASSOCIATES
GEO-ENVIRONMENTAL LIMITED

Site	Borehole Number
159-161 IVERSON ROAD, LONDON, NW6 2RB	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 2.50m		Formation Homes (London)	13079
	Location	**Dates**	**Engineer**	**Sheet**
	See site plan	05/09/2014		2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(8.45)	Firm to stiff brown silty CLAY with some orange brown sandy silt pockts and grey laminations		
						10.45			
10.50	D9						Stiff fissured dark grey silty CLAY with some sandy silt laminations		
11.00-11.45	U3			64 blows					
11.50	D10								
12.50-12.95	SPT N=18			3,4/4,4,5,5					
13.50	D11								
14.00-14.45	U4			66 blows					
14.50	D12								
						(9.55)			
15.50-15.95	SPT N=21			4,4/4,5,6,6					
16.50	D13								
17.00-17.45	U5			69 blows					
17.50	D14								
18.50-18.95	SPT N=23			4,5/5,6,6,6					
19.50	D15								
20.00-20.45	SPT N=26			5,5/6,6,7,7		20.00			

Remarks

Scale (approx)	Logged By
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Figure No.
13079 BH2

MANHIRE ASSOCIATES
GEO-ENVIRONMENTAL LIMITED

Site	Number
159-161 IVERSON ROAD, LONDON, NW6 2RB	WS1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Formation Homes (London)	13079
	Location See site plan	**Dates** 04/09/2014	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00	L1		30% recovery		(0.15) 0.15	CONCRETE		
					(0.35) 0.50	MADE GROUND: Granite cobble stones over brick and clinker		
					(0.70) 1.20	MADE GROUND: Brick rubble with some ashy pockets		
1.00-2.00 1.00-1.45	L2 SPT N=5		90% recovery 2/1,1,2,1					
					(0.60) 1.80	MADE GROUND: Brown silty clay with some brick and concrete fragments		
2.00-3.00 2.00-2.45	L3 SPT N=6		90% recovery 3/2,1,1,2		(1.20) 3.00	Firm to stiff brown silty CLAY with some orange brown sandy silt pockets and grey laminations		
3.00-3.45	SPT N=13		4/3,3,3,4			Complete at 3.00m		

Remarks
Borehole dry

Scale (approx)	Logged By
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Figure No.
13079 WS1

MANHIRE ASSOCIATES
GEO-ENVIRONMENTAL LIMITED

Site	Number
159-161 IVERSON ROAD, LONDON, NW6 2RB	WS2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Formation Homes (London)	13079
	Location See site plan	**Dates** 04/09/2014	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00	L1		80% recovery		(0.07) 0.07	CONCRETE slab		
					(0.73)	MADE GROUND: Brick rubble with some ashy and clayey pockets		
					0.80	MADE GROUND: Brown and grey green silty clay with some brick and concrete fragments		
1.00-2.00 1.00-1.45	L2 SPT N=5		90% recovery 1/1,1,2,1		(0.90)			
					1.70	Firm to stiff brown silty CLAY with some orange brown sandy silt pockets and grey laminations		
2.00-3.00 2.00-2.45	L3 SPT N=6		90% recovery 2/1,2,1,2		(1.30)			
3.00-3.45	SPT N=13		Water strike(1) at 3.00m. 4/3,3,3,4		3.00	Complete at 3.00m		▽1

Remarks
Borehole dry

Scale (approx)	Logged By
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Figure No.
13079 WS2

MANHIRE ASSOCIATES
GEO-ENVIRONMENTAL LIMITED

Site	Number
159-161 IVERSON ROAD, LONDON, NW6 2RB	WS3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Formation Homes (London)	13079
	Location See site plan	**Dates** 04/09/2014	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00	L1		90% recovery		(0.15) 0.15	CONCRETE slab		
						MADE GROUND: Brown silty clay with some brick, concrete fragments and gravel		
1.00-2.00 1.00-1.45	L2 SPT N=5		70% recovery 2/1,1,1,2		(1.55) 1.70			
						Firm to stiff brown silty CLAY with some orange brown sandy silt pockets and grey laminations		
2.00-3.00 2.00-2.45	L3 SPT N=9		100% recovery 2/2,2,3,2		(1.30) 3.00			▽1
3.00-3.45	SPT N=12		Water strike(1) at 3.00m. 4/2,3,3,4			Complete at 3.00m		

Remarks
Borehole dry

Scale (approx)	Logged By
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Figure No.
13079 WS3

MANHIRE ASSOCIATES
GEO-ENVIRONMENTAL LIMITED

Site	Number
159-161 IVERSON ROAD, LONDON, NW6 2RB	WS4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Formation Homes (London)	13079
	Location See site plan	**Dates** 04/09/2014	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-1.00	L1		70% recovery		(0.12) 0.12	CONCRETE		
					(0.68)	MADE GROUND: Brick rubble with some ashy pockets		
					0.80			
1.00-2.00 1.00-1.45	L2 SPT N=5		100% recovery 1/1,1,1,2		(0.50)	MADE GROUND: Brown silty clay with some brick and concrete fragments		
					1.30			
2.00-3.00 2.00-2.45	L3 SPT N=9		100% recovery 2/2,2,3,2		(1.70)	Firm to stiff brown silty CLAY with some orange brown sandy silt pockets and grey laminations		
					3.00			▽1
3.00-3.45	SPT N=12		Water strike(1) at 3.00m. 4/3,3,3,3			Complete at 3.00m		

Remarks
Borehole dry

Scale (approx)	Logged By
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Figure No.
13079 WS4

APPENDIX B

LABORATORY TEST RESULTS

SUMMARY OF GEOTECHNICAL TESTS

				CLASSIFICATION							TRIAXIAL COMPRESSION - TOTAL STRESS							CHEMICAL		
Location	Sample No	Depth	Description	Natural Moisture Content	Liquid Limit	Plastic Limit	Plast. Index	Passing 425µm	Mod. Plast. Index	Class	Type	Moisture Content	Bulk Density	Radial Stress	Deviator Stress	Cohesion		Sulphate (SO4)		pH
																cu, kPa assuming Øu = 0	cu, kPa Øu, deg	Water	Soil (Sol)	
		m		%	%	%	%	%	%			%	Mg/m³	kPa	kPa			g/l	g/l	
BH1	U1	3.00	Frim brown and orange brown mottled silty CLAY with some sandy pockets	30	76	28	48	100		CV	UU 102	30	2.01	60	108	54			0.76	7.2
	U2	8.00	Frim brown and orange brown mottled silty CLAY with some sandy pockets								UU 102	29	1.98	160	126	63			0.92	7.2
	U3	11.00	Stiff fissured dark grey silty CLAY with some sandy silt laminations								UU 102	29	2.00	220	144	72			0.42	7.1
	U4	14.00	Stiff fissured dark grey silty CLAY with some sandy silt laminations								UU 102	30	1.98	28	171	86				
	U5	17.00	Stiff fissured dark grey silty CLAY with some sandy silt laminations								UU 102	28	2.02	340	200	100				

Note: Soil Classification based upon unmodified Plasticity Index

Manhire Associates
CONSULTING ENGINEERS

CONTAMINANTS IN SOIL

Location	Sample	Depth	Arsenic	Cadmium	Chromium	Lead	Mercury	Nickel	Copper	Zinc	Selenium	Boron	PAH	Phenols	Organic	TPH by GCMS							pH
		m					inorganic					water sol.	screen	tot. monohydric	content, %	C8 - C10	C10 - C12	C12 - C16	C16 - C21	C21 - C35	Total C8 - C35		value
WS1		1.30	12.6	<0.5	11	53	<0.5	17	54	78	0.6	<0.5		<1		<5	<5	<5	<5	<5	<5		
WS2		0.50	18.2	<0.5	17	28	<0.5	20	57	50	0.7	<0.5		<1		<5	<5	<5	<5	<5	<5		
		1.20	18.8	<0.5	26	48	<0.5	48	61	92	1.2	<0.5		<1		<5	<5	<5	<5	<5	<5		
WS3		0.70	19.6	<0.5	18	22	<0.5	58	19	101	1.1	<0.5		<1		<5	<5	<5	14	28	42		
WS4		1.00	22.1	<0.5	17	86	0.5	82	84	104	1.2	<0.5		<1		<5	<5	<5	<5	18	18		
GAC[1]	residential			3	627				2330	3750		291		210									
	commercial			348	8840				71700	665000		192000		1100000									
CLEA[2]	residential		32				170	130			350												
	commercial		640				3600	1800			13000												

Notes
1. LQM/CIEH GAC given at 1% soil organic matter
2. CLEA SGVs given at 6% soil organic matter

All units are mg/kg dry weight of soil unless otherwise stated, except for pH which is dimensionless

Exceptions denoted thus: Residential XX

CONTAMINANTS IN SOIL

Speciated Polyaromatic Hydrocarbons by GCMS

Location	WS1	WS2	WS2	WS3	WS4							LQM/CIEH GAC[3]		
Sample														
Depth, m	1.30	0.50	1.20	0.70	1.00							residential	allotments	commercial
Determinand	Concentration, mg/kg													
PAH														
Naphthalene	<0.5	<0.5	<0.5	<0.5	<0.5							1.5	4.1	200
Acenaphthylene	<0.5	<0.5	<0.5	<0.5	<0.5							170	28	84000
Acenaphthene	<0.5	<0.5	<0.5	<0.5	<0.5							210	34	85000
Fluorene	<0.5	<0.5	<0.5	<0.5	<0.5							160	27	64000
Phenanthrene	2.6	2.9	<0.5	<0.5	<0.5							92	16	22000
Anthracene	1.1	0.8	<0.5	<0.5	<0.5							2300	380	530000
Fluoranthene	5.2	7.2	<0.5	1.8	<0.5							260	52	23000
Pyrene	8.1	6.1	1.8	1.1	0.9							560	110	54000
Benzo(a)anthracene	1.6	1.8	1.6	1.2	1.1							3.1	2.5	90
Chrysene	1.4	5.2	2.1	0.6	0.8							6.0	2.6	140
Benzo(b)fluoranthene	1.5	4.2	4.2	1.2	2.2							5.6	3.5	100
Benzo(k)fluoranthene	1.5	3.1	2.2	1.8	0.9							8.5	6.8	140
Benzo(a)pyrene	2.5	2.2	1.9	2.4	2.5							0.83	0.6	14
Indeno(123-cd)pyrene	0.9	2.1	0.9	1.8	0.6							3.2	1.8	60
Dibenzo(ah)anthracene	<0.5	0.6	<0.5	<0.5	<0.5							0.76	0.76	13
Benzo(ghi)perylene	<0.5	0.6	<0.5	<0.5	<0.5							44	70	650
Total PAH	**26.4**	**36.8**	**14.7**	**11.9**	**9.0**									

Notes
1. Total PAH = Sum of EPA16 identified components
2. The results are expressed as mg/kg dry weight soil after correction for moisture content
3. GAC given at 1% soil organic matter

Exceptions denoted thus: Residential XX
Commercial XX

CONTAMINANTS IN SOIL

Location	Sample	Depth	Asbestos identification		
		m	Description of matrix	Overall percentage of asbestos identified (approx.)	Type of asbestos identified
WS1		1.30	sandy loam		none detected
WS2		0.50	loam		none detected
WS2		1.20	sandy loam		none detected
WS3		0.70	sandy loam		none detected
WS4		1.00	sandy loam		none detected

APPENDIX C

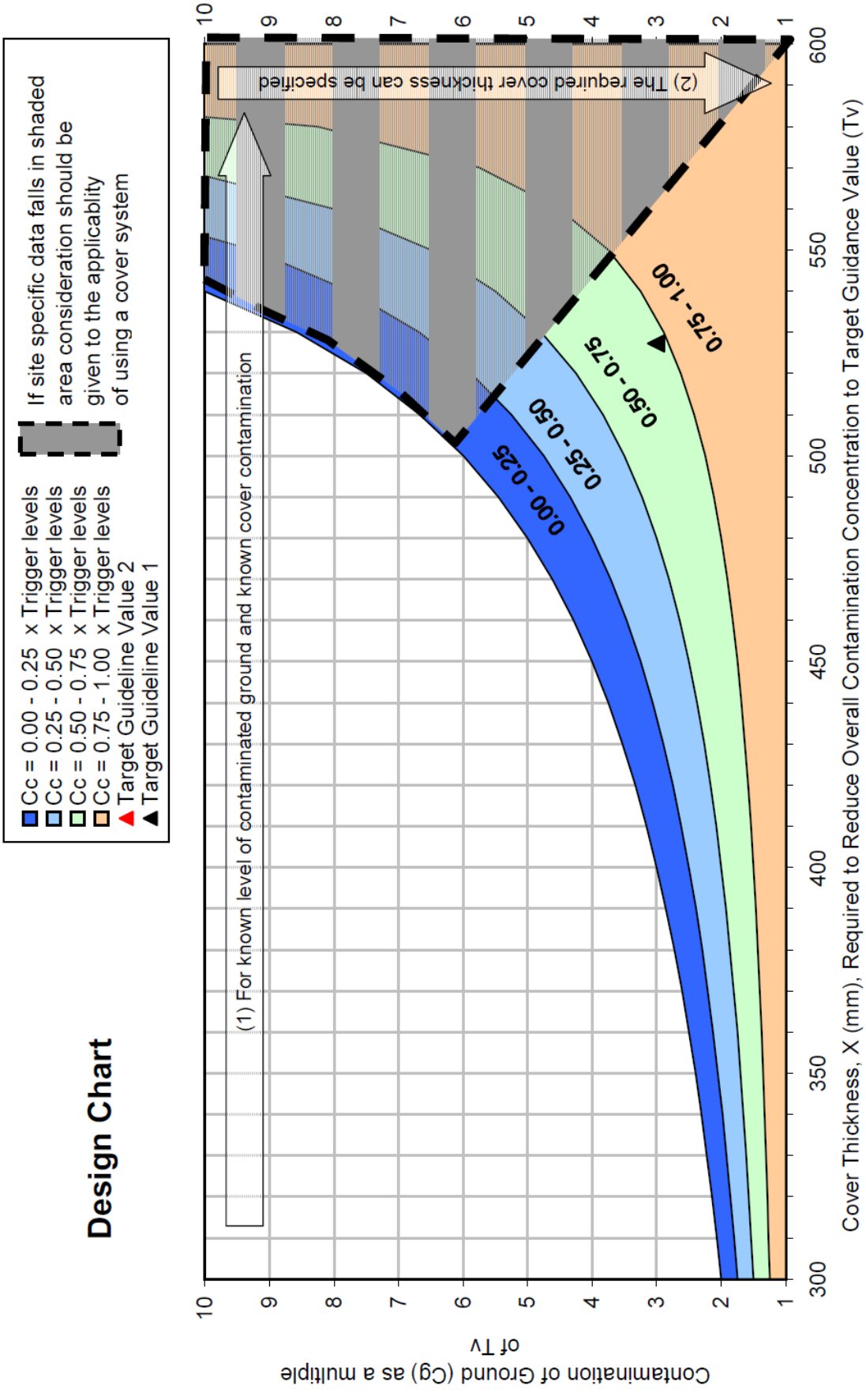
COVER SYSTEM

Calculations based on mixed zone (M)	600	mm

Contaminant	Site Data				Expressed as a Factor of Target Guideline Value				Cover Thickness Required for Compliance to Specified Target Guideline Value	
	Contamination of Ground (Cg)	Contamination of Cover (Cc)	Target Guideline Value 1	Target Guideline Value 2	Soil / Target Guideline Value 1	Cover / Target Guideline Value 1	Soil / Target Guideline Value 2	Cover / Target Guideline Value 2	Target Guideline Value 1	Target Guideline Value 2
	Units		Units		Fraction				(mm)	
Arsenic										
Cadmium (Soil pH8)										
Chromium										
Chromium (VI)										
Mercury										
Selenium										
Copper										
Nickel										
Zinc										
Lead										
Boron (Water sol)										
Sulphate (total)										
Phenols										
Sulphide										
Cyanide										
Solvent Extractable Matter										
Benzo (a) pyrene	2.5	0.6	0.83		3.0	0.7	No TV	No TV	527	No TV

Summary		
	Target Guideline Value 1	Target Guideline Value 2
Number of contaminants	17	17
Number of contaminants **with no** thickness calculation	16	17
Breakdown - Number for which no TV specfied	16	17
Breakdown - Number for which no soil specified	16	16
Breakdown - Number for which no cover specified	16	16
Breakdown - Number for which cover > TV	0	0
Number of contaminants **with** thickness calculation	1	0
Breakdown - Number for which no cover required	0	0
Breakdown - Number for which cover required	1	0

Overall thickness of cover required	**527**	**0**


Design Chart
Cc = 0.00 - 0.25 x Trigger levels
Cc = 0.25 - 0.50 x Trigger levels
Cc = 0.50 - 0.75 x Trigger levels
Cc = 0.75 - 1.00 x Trigger levels
Target Guideline Value 2
Target Guideline Value 1
If site specific data falls in shaded area consideration should be given to the applicablity of using a cover system
(1) For known level of contaminated ground and known cover contamination
(2) The required cover thickness can be specified
0.00 - 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
Contamination of Ground (Cg) as a multiple of Tv
Cover Thickness, X (mm), Required to Reduce Overall Contamination Concentration to Target Guidance Value (Tv)
10
9
8
7
6
5
4
3
2
1
300
350
400
450
500
550
600

APPENDIX D

FIGURES

159 - 161 Iverson Road

Borehole location plan

Scale unknown

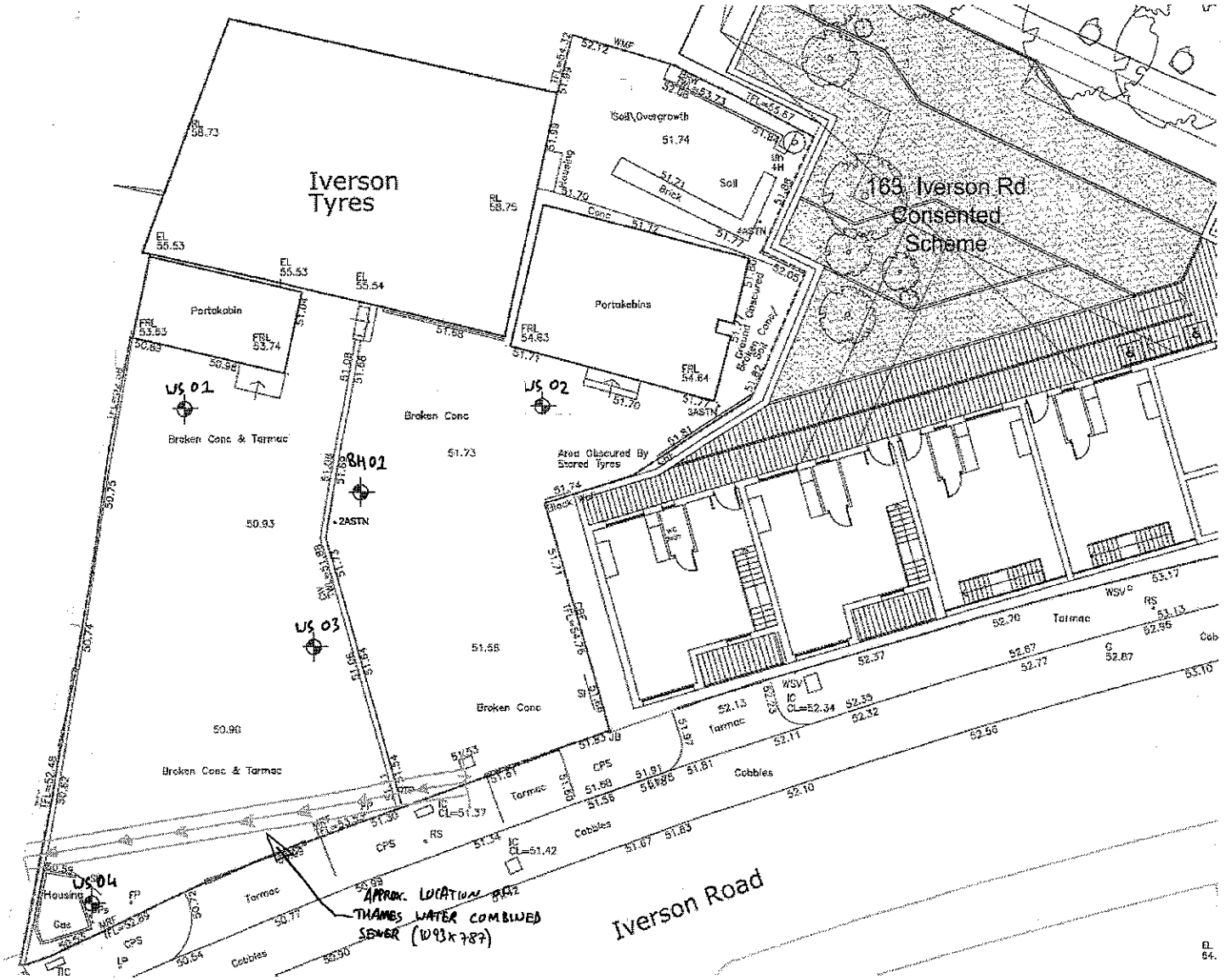
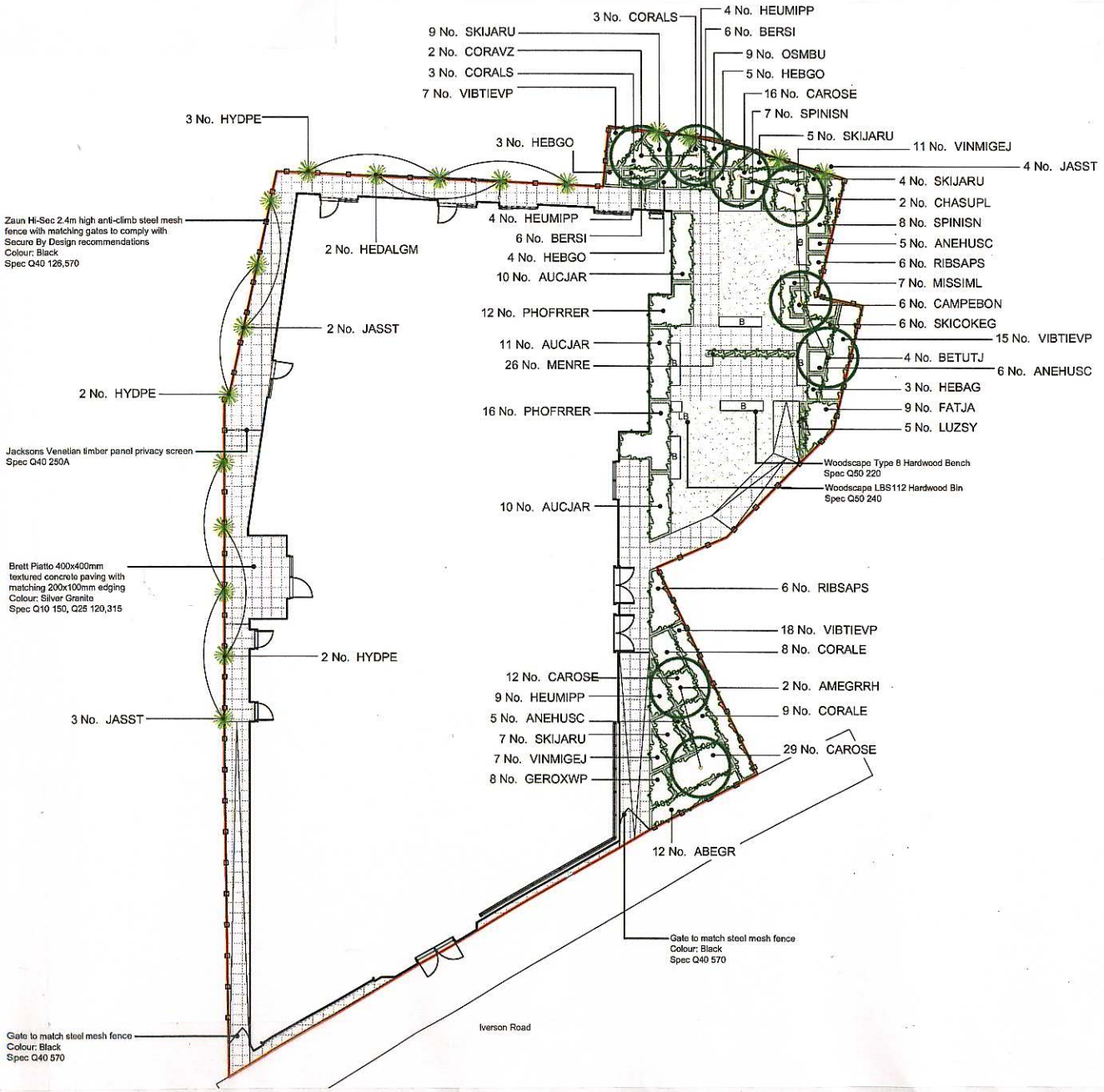


Figure 1



159 - 161 Iverson Road, NW6

Proposed plan including landscaping

Scale unknown

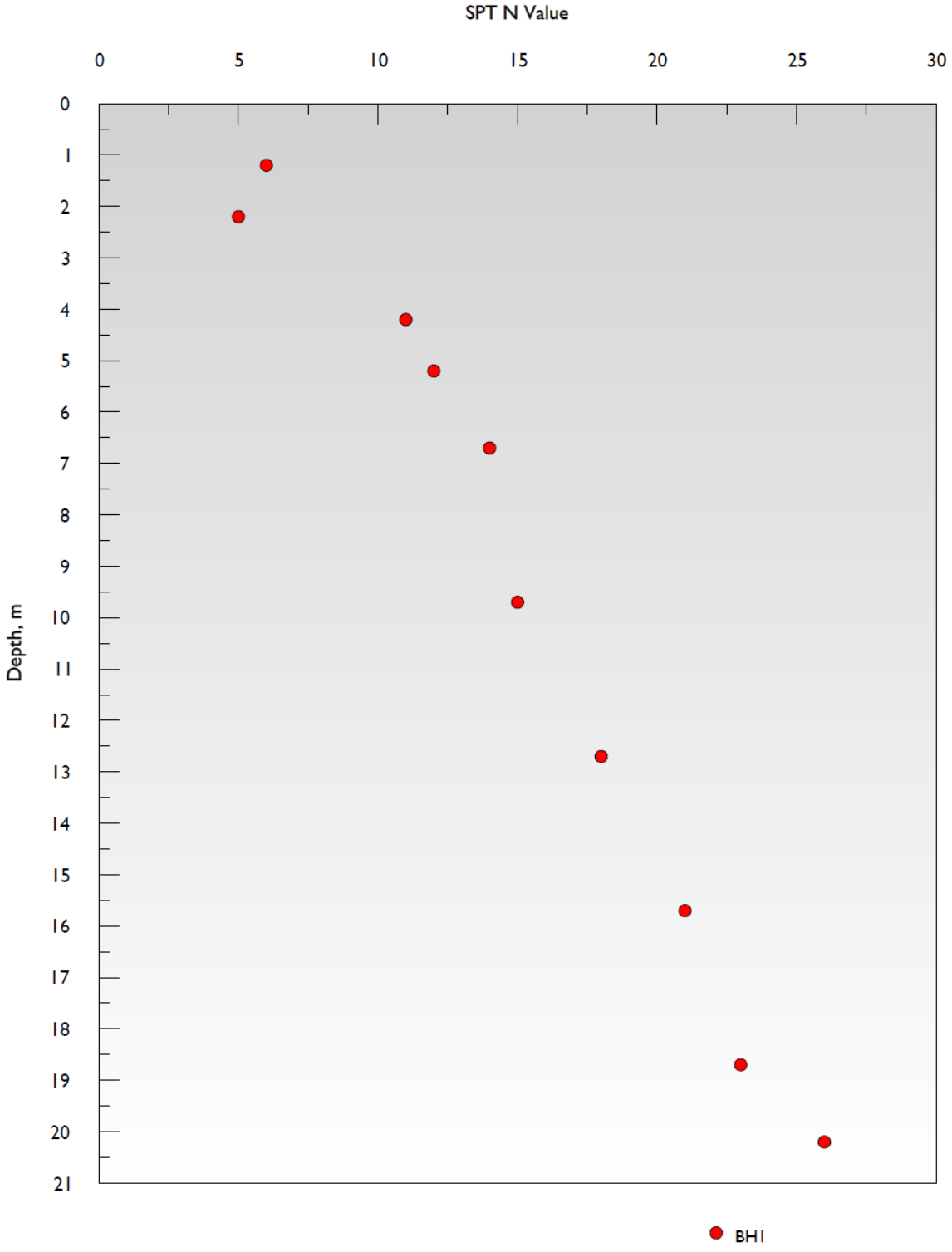
LEGEND:

- Proposed trees
- Proposed shrub planting beds
- Specimen / accent / climbing plants
- Grass (turf)
- Zaun Hi-Sec anti-climb fence
- Jacksons Venetian timber panel privacy screen
- Brett Piatto Paving
- Bench - Woodscape Type 8
- Site boundary
  Development area

Notes:
Drawing to read in conjunction with Lloyd Bore landscape specification 3256_SP_001.
All specifications and materials subject to client approval.

Figure 2

SPT PROFILE
159 - 161 IVERSON ROAD, NW6 2RB



SHEAR STRENGTH PROFILE
159 - 161 IVERSON ROAD, NW6 2RB