GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITHOUT GARDENS

RSK GROUP PLC

Table 5

Human Health Generic Assessment Criteria by Pathway for Residential Scenario Without Gardens

Compound	Notes	GrAC (mg/l)	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Total Petroleum Hydrocarbons														
Aliphatic hydrocarbons EC_5-EC_6		1.00E+01	2.23E+05	2.98E+01	2.98E+01	3.04E+02	2.23E+05	5.47E+01	5.47E+01	5.58E+02	2.23E+05	1.13E+02	1.13E+02	1.15E+03
Aliphatic hydrocarbons >EC_6-EC_8		5.40E+00	2.23E+05	7.27E+01	7.27E+01	1.44E+02	2.23E+05	1.62E+02	1.62E+02	3.22E+02	2.23E+05	3.72E+02	3.71E+02	7.36E+02
Aliphatic hydrocarbons >EC_8-EC_{10}		2.30E-01	4.45E+03	1.89E+01	1.88E+01	7.77E+01	4.45E+03	4.60E+01	4.59E+01	1.90E+02	4.45E+03	1.09E+02	1.09E+02	4.51E+02
Aliphatic hydrocarbons >EC_{10}-EC_{12}		3.00E-02	4.45E+03	9.34E+01	9.29E+01	4.75E+01	4.45E+03	2.32E+02	2.29E+02	1.18E+02	4.45E+03	5.57E+02	5.38E+02	2.83E+02
Aliphatic hydrocarbons >EC_{12}-EC_{16}		8.00E-04	4.45E+03	7.82E+02	7.45E+02	2.37E+01	4.45E+03	1.95E+03	1.69E+03	5.91E+01	4.45E+03	4.68E+03	3.04E+03	1.42E+02
Aliphatic hydrocarbons >EC_{16}-EC_{35}	(c)	-	4.53E+04	-	-	8.48E+00	6.41E+04	-	-	2.12E+01	7.66E+04	-	-	5.09E+01
Aliphatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	4.53E+04	-	-	8.48E+00	6.41E+04	-	-	2.12E+01	7.66E+04	-	-	5.09E+01
Aromatic hydrocarbons >EC_5-EC_7		-	1.98E+04	2.66E+02	2.63E+02	1.22E+03	1.98E+04	4.95E+02	4.83E+02	2.26E+03	1.98E+04	1.03E+03	9.78E+02	4.71E+03
Aromatic hydrocarbons >EC_7-EC_8		-	1.98E+04	6.26E+02	6.07E+02	8.69E+02	1.98E+04	1.38E+03	1.29E+03	1.92E+03	1.98E+04	3.14E+03	2.71E+03	4.36E+03
Aromatic hydrocarbons >EC_8-EC_9 (styrene)		7.40E+00	5.34E+03	2.65E+02	2.61E+02	6.20E+02	5.34E+03	6.47E+02	6.27E+02	1.52E+03	5.34E+03	1.54E+03	1.41E+03	3.61E+03
Aromatic hydrocarbons >EC_9-EC_{10}		7.40E+00	1.78E+03	3.33E+01	3.32E+01	6.13E+02	1.78E+03	8.16E+01	8.07E+01	1.50E+03	1.78E+03	1.94E+02	1.89E+02	3.58E+03
Aromatic hydrocarbons >EC_{10}-EC_{12}		2.50E+01	1.78E+03	1.82E+02	1.77E+02	3.64E+02	1.78E+03	4.48E+02	4.17E+02	8.99E+02	1.78E+03	1.07E+03	8.66E+02	2.15E+03
Aromatic hydrocarbons >EC_{12}-EC_{16}		5.80E+00	1.78E+03	2.00E+03	1.25E+03	1.69E+02	1.78E+03	4.96E+03	1.59E+03	4.19E+02	1.78E+03	1.18E+04	1.71E+03	1.00E+03
Aromatic hydrocarbons >EC_{16}-EC_{21}	(c)	-	1.29E+03	-	-	5.37E+01	1.31E+03	-	-	1.34E+02	1.32E+03	-	-	3.21E+02
Aromatic hydrocarbons >EC_{21}-EC_{35}	(c)	-	1.33E+03	-	-	4.83E+00	1.33E+03	-	-	1.21E+01	1.33E+03	-	-	2.90E+01
Aromatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	1.33E+03	-	-	4.83E+00	1.33E+03	-	-	1.21E+01	1.33E+03	-	-	2.90E+01

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

NR - the compound is not volatile and therefore a soil saturation limit not calculated within CLEA

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The CLEA model output is colour coded depending upon whether the soil saturation limit has been exceeded.

Calculated SAC exceeds soil saturation limit and may significantly effect the interpretation of any exceedances since the contribution of the indoor and outdoor vapour pathway to total exposure is >10%. This shading has also been used for the RBCA output where the theoretical solubility limit has been exceeded. The SAC has been set as the model calculated SAC with the saturation limits shown in brackets.

Calculated SAC exceeds soil saturation limit but will not effect the SAC significantly since the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.

Calculated SAC does not exceed the soil saturation limit.

For consistency where the theoretical solubility limit within RBCA has been exceeded in production of the GrAC, these cellls have also been hatched red.

The SAC for organic compounds are dependant upon soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58. 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3

(a) GAC taken as former Soil Guideline Value owing to uncertainty regarding toxicological approach to be adopted by the Environment Agency.

(b) GAC taken from the Environment Agency SGV reports published 2009.

(c) SAC for selenium, aliphatic and aromatic hydrocarbons >EC16 do not include inhalation pathway owing to absence of toxicity data. SAC for arsenic is only based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report.

(d) SAC for elemental mercury, chromium VI and nickel are based on the inhalation pathway only owing to an absence of toxicity for elemental mercury, in accordance with the SGV report for nickel and LQM report for chromium VI.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITHOUT GARDENS

RSK GROUP PLC

Table 6
Human Health Generic Assessment Criteria for Residential Without Gardens

Compound	GrAC for Groundwater (mg/l)	SAC for Soil SOM 1% (mg/kg)	SAC for Soil SOM 2.5% (mg/kg)	SAC for Soil SOM 6% (mg/kg)
Metals				
Arsenic	-	35	35	35
Cadmium	-	85	85	85
Chromium (III) - oxide	-	3,000	3,000	3,000
Chromium (VI) - hexavalent	-	4.3	4.3	4.3
Copper	-	6,200	6,200	6,200
Lead	-	450	450	450
Elemental Mercury (Hg0)	0.0094	0.17	0.42	1.0
Inorganic Mercury (Hg2+)	-	240	240	240
Methyl Mercury (Hg4+)	20	8.4	11	14
Nickel	-	130	130	130
Selenium	-	600	600	600
Zinc	-	41,000	41,000	41,000
Cyanide	-	110	110	110
Volatile Organic Compounds				
Benzene	7	0.27	0.49	1.0
Toluene	1,900	610	1,289	2,700
Ethylbenzene	260	170	381	840
Xylene - m	84	55	130	300
Xylene - o	100	60	139	320
Xylene - p	87	53	125	290
Total xylene	84	55	130	300
Methyl tertiary butyl ether (MTBE)	2,200	160	199.55	270
Trichloroethene	1.8	0.11	0.2	0.51
Tetrachloroethene	3.6	1.0	2.3	5.3
1,1,1-Trichloroethane	26	6.3	12.9	28
1,1,1,2-Tetrachloroethane	14	1.1	2.5	5.8
1,1,2,2-Tetrachloroethane	14	2.7	5.58	12
Carbon tetrachloride	0.055	0.02	0.040	0.09
1,2-Dichloroethane	0.30	0.006	0.0093	0.02
Vinyl chloride	0.019	0.0005	0.0007	0.001
1,2,4-Trimethylbenzene	0.075	0.4	0.99	2.3
1,3,5-Trimethylbenzene	0.047	0.5	1.10	2.6
Semi-Volatile Organic Compounds				
Acenaphthene	3.2	2,000 (57)	3,100 (141)	3,900 (340)
Acenaphthylene	4.2	2,000 (86)	3,000 (212)	3,900 (510)
Anthracene	0.021	20,000 (1.2)	22,000	23,000
Benzo(a)anthracene	0.004	3.7	5.2	6.2
Benzo(b)fluoranthene	0.002	7.0	7.3	7.4
Benzo(g,h,i)perylene	0.0003	47	47	48
Benzo(k)fluoranthene	0.0008	10	10	10
Chrysene	0.002	8.8	9.7	10
Dibenzo(a,h)anthracene	0.0006	0.87	0.91	0.93
Fluoranthene	0.23	970	993	1,000
Fluorene	1.9	1,900 (31)	2,500 (77)	2,900 (180)
Indeno(1,2,3-cd)pyrene	0.0002	4.2	4.4	4.4
Phenanthrene	0.53	840 (36)	930	970
Pyrene	0.13	2,300	2,400	2,400
Benzo(a)pyrene	0.004	1.0	1.0	1.0
Naphthalene	19	1.6	3.9	9.2
Phenol	-	310	420	520
Total Petroleum Hydrocarbons				
Aliphatic hydrocarbons EC_5-EC_6	10	30	55	110
Aliphatic hydrocarbons >EC_6-EC_8	5.4	73	160	370
Aliphatic hydrocarbons >EC_8-EC_{10}	0.23	19	46	110
Aliphatic hydrocarbons >EC_{10}-EC_{12}	0.03	93 (48)	230 (118)	540 (280)
Aliphatic hydrocarbons >EC_{12}-EC_{16}	0.0008	746 (24)	1,700 (59)	3,000 (140)
Aliphatic hydrocarbons >EC_{16}-EC_{35}	-	45,000	64,000 (21)	77,000
Aliphatic hydrocarbons >EC_{35}-EC_{44}	-	45,000	64,000 (21)	77,000
Aromatic hydrocarbons >EC_8-EC_9 (styrene)	7.4	260	627	1,400
Aromatic hydrocarbons >EC_9-EC_{10}	7.4	33	81	190
Aromatic hydrocarbons >EC_{10}-EC_{12}	25	180	417	870
Aromatic hydrocarbons >EC_{12}-EC_{16}	5.8	1,300 (170)	1,600 (419)	1,700
Aromatic hydrocarbons >EC_{16}-EC_{21}	-	1,300	1,300	1,300
Aromatic hydrocarbons >EC_{21}-EC_{35}	-	1,300	1,300	1,300
Aromatic hydrocarbons >EC_{35}-EC_{44}	-	1,300	1,300	1,300

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The SAC for organic compounds are dependent on Soil Organic Matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58. 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.

[shaded cell] The SAC has been set as the model calculated SAC with the saturation limit shown in brackets.
For consistency where the GrAC exceeds the solubility limit, GrSV has been set at the solubility limit. These are highly conservative since concentrations of the chemical are very unlikely to be at sufficient concentration to result in an exceedance of the health criteria value at the point of exposure (i.e. indoor air) provided free-phase product is absent.

REFERENCES

1) Environment Agency, 31 March 2009, May 2009 and September 2009. Science Report SC050021 / benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxinlike PCBs SGVs. Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs. Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs.

2) Environment Agency, January 2009. Science Report SC050021/SR2 Human Health Toxicological Assessment of Contaminants in Soil.

3) Environment Agency, January 2009. Science Report SC050021/SR3 Updated Technical Background to the CLEA Model.

4) Environment Agency, January 2009. Science Report SC050021/SR4 CLEA Software (Version 1.04) Handbook.

5) Environment Agency. 2008. Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values.

6) Land Quality Management (LQM) and Chartered Institute of Environmental Health (CIEH) 2009. The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment. 2nd Edition.

7) The Soil Generic Assessment Criteria for Human Health Risk Assessment, Report ref. ISBN 978-1-905046-20-1, December 2009, published by CL:AIRE

8) Changes made to the CLEA framework documents after the 3 month evaluation period in 2008, released January 2009 by the Environment Agency.

APPENDIX F

HASWASTE Assessment

(This appendix contains 2 pages, including this)

As cmpds (AsS), Cd (CdO), CrVI cmpds ($FeCrO_4$), Cu (Cu_2O), Inorg Hg cmpds (HgO), Pb cmpds ($PbSO_4$), Ni ($NiCO_3$), Se cmpds (SeS) and Zn as ZnO. Also Ba ($BaCO_3$), Be cmpds ($BeSO_4$), Co (CoO), Mn (MnO_2) and Mo (MoO_3).

HASWASTE. Envirolab's Contaminated Land Soil Hazardous Waste Assessment Tool.
Envirolab, Units 7&8 Sandpits Business Park, Mottram Road, Hyde, Cheshire SK14 3AR.
Dr Iain Haslock. BSc, PhD, CChem, MRSC.

Site Code and Name

TP/WS/BH		WS1	WS3	WS5	WS9	WS11									
Depth (m)		0.40	0.50	0.20	0.50	0.40									
Envirolab reference															
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Arsenic		23	9	8	20	18									
Chromium		1	1	1	1	1									
Copper		84	29	19	64	32									
Lead		446	194	109	347	254									
Nickel		36	17	15	38	39									
Zinc		216	45	54	182	98									
Cadmium		0.5	0.5	0.5	0.5	0.5									
Mercury		1.2	0.6	0.5	1.1	1.5									
Selenium		1.0	1.0	1.0	2.0	2.0									
Barium															
Beryllium															
Cobalt															
Manganese															
Molybdenum															
Total USEPA 16 PAHs															
Naphthalene		0.04	0.01	0.01	0.05	0.26									
Acenaphthylene		0.03	0.01	0.01	0.03	0.06									
Acenaphthene		0.05	0.01	0.02	0.08	0.86									
Fluorene		0.01	0.01	0.01	0.03	0.32									
Phenanthrene		0.35	0.08	0.27	1.34	5.16									
Anthracene		0.12	0.02	0.08	0.36	1.07									
Fluoranthene		0.72	0.17	0.51	1.70	7.72									
Pyrene		0.61	0.14	0.57	1.42	6.31									
Benzo(a)anthracene		0.38	0.04	0.25	0.73	3.54									
Chrysene		0.95	0.15	0.55	1.48	5.49									
Benzo(b)fluoranthene		0.32	0.02	0.24	0.69	2.10									
Benzo(k)fluoranthene		0.29	0.04	0.22	0.55	2.05									
Benzo(a)pyrene		0.59	0.16	0.42	1.18	3.56									
Indeno(123cd)pyrene		0.17	0.05	0.01	0.40	0.93									
Dibenzo(ah)anthracene		0.01	0.01	0.01	0.10	0.26									
Benzo(ghi)perylene		0.64	0.13	0.28	0.80	2.99									
Benzo(j)fluoranthene															
Benzene															
Toluene															
Ethylbenzene															
Xylenes															
Trimethylbenzenes															
Chlorobenzene															
1,2-Dichlorobenzene															
1,3-Dichlorobenzene															
1,4-Dichlorobenzene															
1,2,4-Trichlorobenzene															
2-Chlorotoluene															
4-Chlorotoluene															
Oil in Waste Carcinogenic H7															
Total TPH	≥1,000mg/kg	10	30	10	31	14									
Petrol or (C6-C10)	≥1,000mg/kg														
Diesel or (C10-C25)	≥10,000mg/kg														
Lube Oil or (C25+)	≥1,000mg/kg														
8 IARC H7 Carcinogenic PAHs marker test (applicable to LRO only)	≥1%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Kerosene															
Kerosene															
Creosote															
Creosote															
pH Corrosive H8 (Irritant H4)															
pH (soil)	≤2 H8 ≥11.5	8.4	8.7	10.8	8.4	8.5									
pH (leachate)	≤2 H8 ≥11.5														
Alkali Reserve (gNaOH/100g)															
H4 Alkali Reserve test	≥13	8.4	8.7	10.8	8.4	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H8 Alkali Reserve test	≥14.5	8.4	8.7	10.8	8.4	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Produces Toxic Gases H12															
Total Sulphide	≥1,400mg/kg														
Free Cyanide	≥1,200mg/kg														
PCBs Total															
Phenols Total															
Phenol															
Cresols															
Xylenols															
1-Naphthol															
Resourcinol															
Asbestos Screen (enter Y or N)	H7≥0.1%; H5≥3%; H6≥25%	N	N	N	N	N									

Hazard Codes	Thresholds	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Irritant H4	≥10%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Irritant H4	≥20%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Harmful H5	≥25%	0.083	0.038	0.022	0.069	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic H6 (Harmful H5)	≥0.1%H5<7%; H6≥7%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic H6 (Harmful H5)	≥3%H5<25%; H6≥25%	0.003	0.001	0.001	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carcinogenic H7	≥0.1%	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carcinogenic H7	≥1%	0.007	0.003	0.003	0.008	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Corrosive H8 (Irritant H4)	≥5%H4<10%; H8≥10%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic for Reproduction H10	≥0.5%	0.065	0.028	0.016	0.051	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Toxic for Reproduction H10	≥5%	0.065	0.028	0.016	0.051	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mutagenic H11	≥0.1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mutagenic H11	≥1%	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ecotoxic H14	≥1.0	0.367	0.134	0.098	0.304	0.215	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Consider other individual contaminants on a case by case basis.

Table 3.2 of Annex VI of the CLP Regulation.

APPENDIX G

Haycock Associates Report 'Assessment of the RSK Preliminary Site Investigation Report for Fitzroy Farm'

(This appendix contains 20 pages, including this)

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haycock
create restore protect

Assessment of the RSK Preliminary Site Investigation Report for Fitzroy Farm

Client: Fitzroy Park Residents Association

Authors: Roger Lamb (B.Sc C.Eng MICE) and
Dr N.E. Haycock

Date: 2nd July 2010

Version: Issued to client 17th June 2010
Amended 2nd July 2010

rivers soils hydrology landscapes

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Table of Contents

Introduction

The RSK Group Plc were commissioned by Daniel Levy to carry out a ground investigation (GI) as part of plans to re-build Fitzroy Farm. The GI information will form part of the proposed Planning Application for the redevelopment, which includes plans for the construction of a large basement.

Any development in this area is a concern to the Fitzroy Park Residents Association due to the potential interference with the local groundwater and surface water regimes. An additional concern is the potential for contamination of local water bodies such as the Ladies Bathing Pond (City of London). Water arriving at the Ladies Bathing Pond, drains into the Bird Sanctuary Pond and onwards through the Highgate chain of ponds. Therefore any modification of the ground and surface water dynamics of the area could potentially have a detrimental affect on the water levels and water quality of all of the ponds downstream of the site.

This report, commissioned by the Fitzroy Park Residents Association, provides an assessment of the GI Report, entitled "Geotechnical, Hydrogeological and Geoenvironmental Site Investigation Report", prepared by RSK Group Plc (RSK) in May 2010. The purpose of this assessment is to review the document in relation to the development on the local hydrology and also to review the construction method and the impact this has on the hydrology and ground stability. During this review, telephone discussions with RSK were held to fully understand the factual information and the proposals contained within the above report.

The foundation and retaining wall details put forward by the structural engineers Haskins Robinson Walters (HRW), shown in Appendix A (Drawing Nos. 858/SK01, SK02, SK11, 20 and SK21) have also been reviewed. Further to telephone discussions with HRW regarding the above, the Construction Management Plan (CMP) prepared by 'Construction Management Associates' was requested and reviewed as this document explains the drivers behind many of the design decisions regarding the foundations and the retaining structures.

This assessment will:

- Outline the location and extent of the proposed development
- Describe the main hydrogeological and geotechnical features of the local landscape and and how they interact within the context of the Hampstead Heath chain of ponds
- Critically review the above documents in relation to understanding the solid and drift geology and to cross check core evidence supplied and to confirm the classification of the geology.
- Review the impact of the basement construction on the hydrology and the entire chain of ponds and note any potential changes in surface and groundwater flows.
- Assess the appropriateness of the piling method proposed in relation to stability and ground water and third party land.

Proposed Development

The proposals are to construct a large detached property with a basement to replace the existing house. Plan and sections of the proposal, prepared by HRW are shown on Drawing Nos. 858/GA/SK20 and SK21 presented in Appendix A.

The ground levels around the existing building are at 83.7m AOD. It is understood that steel sheet piled walls will be used to facilitate the basement construction (these will remain in the ground permanently although they are only required during the construction of the basement structure[1]). Steel screw piles will be used to support the basement, ground floor slabs and perimeter walls. Due to the risks of shrinkage and swelling of the clay below the foundations it is proposed to design the

1 : The sheet piles have been designed to take both temporary and permanent loads in order to reduce material deliveries, note from HRW, 2nd July 2010 and discussed with Roger Lamb on 2nd July 2010.

floor slabs as suspended slabs (with a compressible void former below). It is assumed that the perimeter walls will be supported by suspended ground beams spanning between each screw pile.

The basement and ground floor slabs are proposed to be constructed in 300mm and 275mm reinforced concrete, respectively, the basement slab will provide lateral support for the sheet piles. The proposed level of the basement slab will be 3.4m below ground level (80.1m AOD)[2].

The reasons for choosing the above design solution are due to a number of drivers:

- the shrinkable nature of the underlying clay
- the desire to reduce construction traffic into the site (screw piles are displacement piles not requiring any concrete and according to the CMP it is believed that this solution would result in less construction traffic.

The area, depth and volume of the existing and proposed building foundations as well as the proposed basement are shown below in table 1.

Structure	Area (m^2)	Approximate Depth (m)	Approximate Volume (m^3)
Existing Ground Floor Slab	284	4	1136
Proposed Ground Floor Slab	728.1	4	2912.4
Proposed Basement Floor Area	197	3.5	689.5

Table 1: Existing and proposed building foundation characteristics [3]

Site Description and History

Site Description

The site is located on the edge of Hampstead Heath, within an area of drainage which supports a chain of ponds (the Highgate Ponds), which lie topographically down-gradient of the site.

The site is located at National Grid reference TQ 277 871. The site is located between Millfield Lane to the south-west and Fitzroy Park to the north-east. The site lies on a south westerly facing slope which descends towards Millfield Lane and the ponds beyond. The levels fall from an elevation of approximately 84mAOD at the site's north-eastern boundary to approximately 81mAOD at the site's south-western boundary

The current property on site comprises a large, two-storey, brick-built house of 1930s construction, founded on shallow spread foundations. A small single-storey brick-built outbuilding located to the immediate east of the main property, and a single-storey building formerly utilised as an office is located adjacent to the sites south-eastern boundary. A small outbuilding is also present within the area of informal gardens in the north-west of the site (see the drawings in Appendix A).

A residential property (The Little House) adjoins the site's south-eastern boundary and the North London Bowling pavilion adjoins the north-eastern boundary.

Trees are present on within the vicinity of the current (and proposed) property, these include mature oak, ash, pine and laurel.

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[2] Amended figure from 80.2m to 80.10m based on update from HRW, 2nd July 2010.

[3] HRW amendments to table 1 are: Existing foundations 1.4m deep, new average 0.5m, actual house area 525m2, terraces all above existing ground level. Figures issued 2nd July 2010.

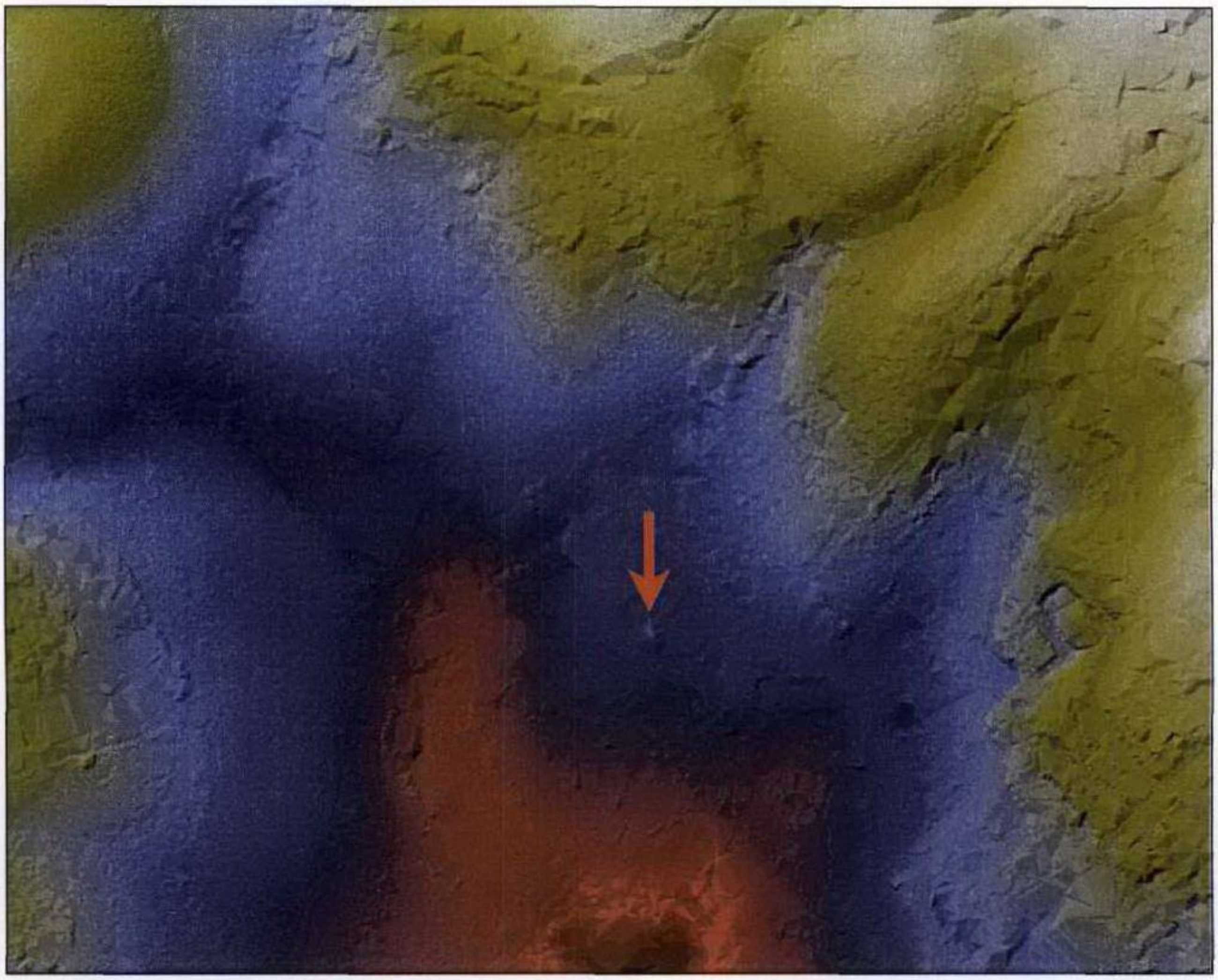

Figure 1: Topographic Map of the site (red arrow) and surroundings landscape land levels (red low elevation, yellow higher elevations).

Ground levels adjacent to the current property are level at approximately 84mAOD, stepping down to a level of approximately 82.6mAOD in the garden area in front of the property.

A retaining wall is present along most of the length of the site's north-eastern boundary with the North London Bowling Club. This comprises a timber fence adjacent to the bowling club car park and a brick wall adjacent to the current property, with the bowling club pavilion immediately beyond.

In the north-east of the site, the retaining wall comprises mortared concrete blocks and a mass concrete wall adjacent to the bowling green. Site levels step down approximately 3m from the adjacent bowling green in the northern corner of the site.

There is a brick-built retaining wall with weep-holes located along the site's south western boundary between the two gated entrances on Millfield Lane. Ground levels step down 1m from the site to the adjacent Millfield Lane. The area of the site comprising the informal gardens and tennis court is retained by wooden fence panelling, stepping down between 1.2m and 1.8m to the adjacent Millfield Lane.

The site's north-western boundary is also retained by a wooden fence, ground levels stepping down approximately 1.8m at its south western end adjacent to the surface watercourse.

The site lies within the catchment of the stream formerly known as the Highgate Brook, forming one of the tributaries of the River Fleet, which drains to the River Thames near Blackfriars. The Fleet rises on Hampstead Heath by two heads, separated by Parliament Hill. The eastern source lies near to the subject site, and is fed via a series of springs in the grounds of Kenwood House, whence the stream flows southwards, via the Highgate Ponds.

The ponds are formed in the channel of the Highgate Brook, which flows over impermeable London Clay. Flow in the stream is likely to be derived from direct surface runoff, and by drainage of groundwater from springs as noted above.

A surface watercourse is present immediately adjacent to the site's north-western boundary. This watercourse is orientated north-east to south-west, and flows in a south-westerly direction, discharging into the northern end of the Ladies Bathing Pond (figure 2a-c). Fitzroy Farm is situated on the inter-fluve between Ladies Bathing Pond and Bird Santuary with no mapped surface flow routes through the proposed development foundation. As in previous reports, we have assumed that the surface flow routes will be represented as potential shallow sub-surface flow routes in the made ground geology.

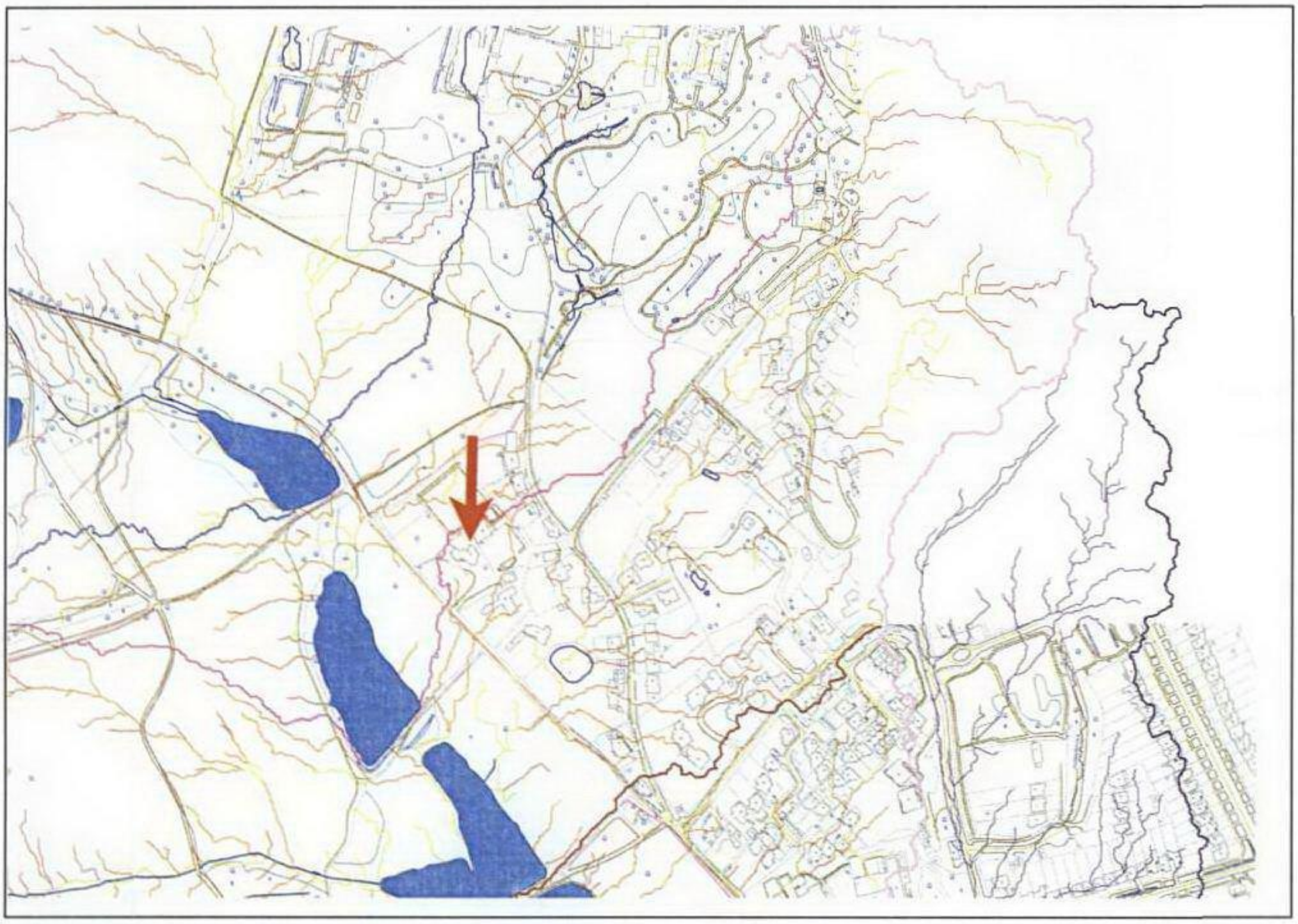

Figure 2a: Map of the site (red arrow) and surroundings drainage landscape based on surface flow routes mapped using 1m resolution LiDAR ground model sourced from the City of London.

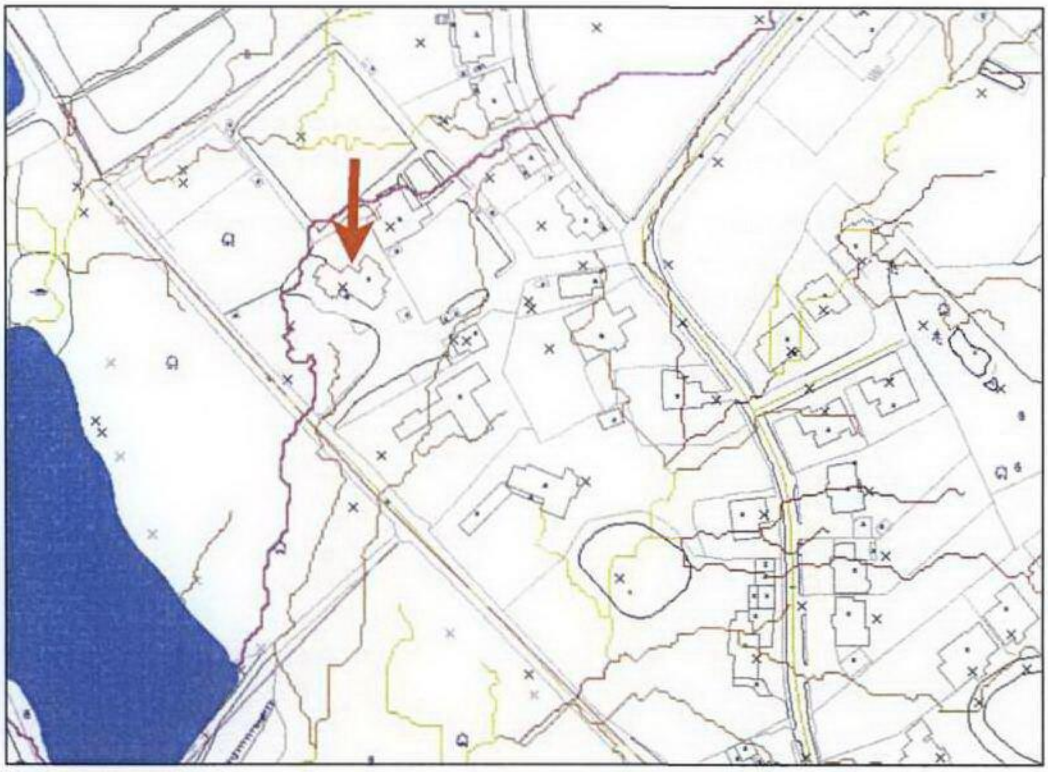

Figure 2b: Map of the site (red arrow) and surroundings drainage landscape based on surface flow routes mapped using 1m resolution LiDAR ground model sourced from the City of London.

Figure 2c: Map of the site (red arrow) and surroundings drainage landscape based on surface flow routes mapped using 1m resolution LiDAR ground model sourced from the City of London.

History

Appendix A of the RSK Ground Investigation Report was obtained so as to check and understand the historical development of the site. From mid-Victorian times, the site lay within the wider Fitzroy Park Farm, which extended to the north and east of the present site boundary. A large courtyard surrounded by buildings occupied the centre of the site and the north-eastern half of the site was covered by mixed woodland.

No significant changes occurred at the site until the early-1930s, when the farm buildings were demolished and the current detached residential property was constructed. By the early-1950s, a small ornamental pond was present within the gardens fronting onto the house (see below). This was still present in 1991 but no evidence of this was found by RSK during the ground investigation (April 2010).

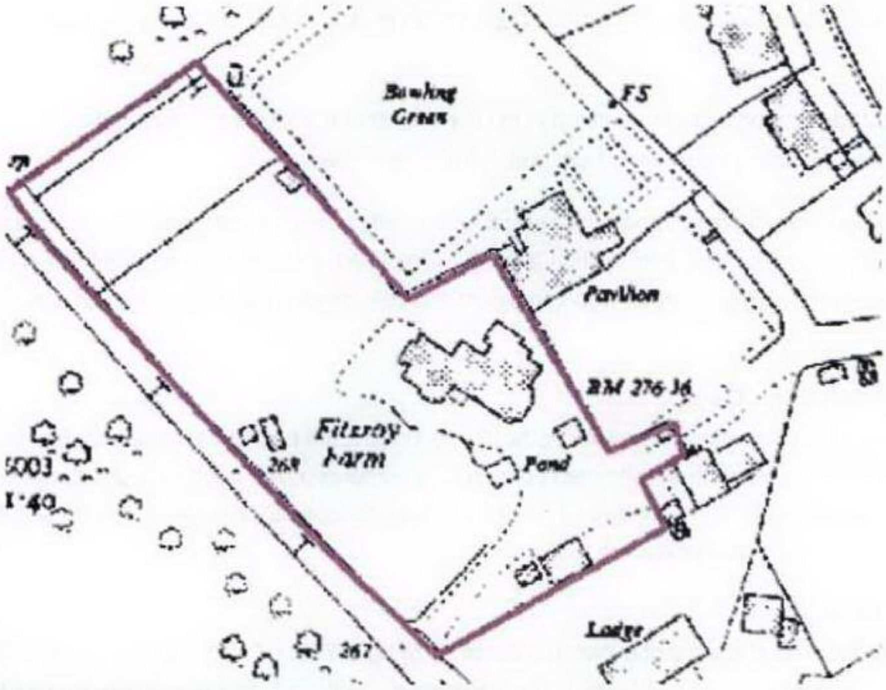

Figure 3: Snapshot of the 1953 Historical Map

The source of this pond is unknown and needs to be determined since it may have been fed by local springs. If this was the case these flows need to be understood and flow routes to the downstream ponds maintained.

Geology and Ground Conditions

The published 1:50,000 scale geological map (Sheet No. 256 'North London') and 1:10,560 scale geological map (TQ28NE) of the area indicate that the immediate site area is underlain by the London Clay Formation. The boundary between London Clay and the Claygate Beds is shown to the north-west of the site. Drift deposits are not present in this area, however Alluvium associated with the adjacent watercourse extends into the site from the north-western boundary. It does not however extend into any of the proposed building areas.

According to the BGS Report "London and Thames Valley", the London Clay consists of dark bluish to brownish grey clay containing variable amounts of fine grained sand and silt. The top of the London Clay Formation is a layer known as the Claygate Beds. This layer forms the transition between the clay rich London Clay and the sand rich Bagshot Sands Formation. The Claygate Beds are described as well laminated orange sands inter-bedded with pale grey to lilac clays.

The general colour description of the clay encountered in the ground investigation (BH1 to BH3 and WS1 to WS12) generally describe the upper layer as "brown mottled grey-green" and below this the clay is described as "dark brownish grey". These descriptions confirm that the geology encountered is London Clay and not Claygate Beds.

The Alluvium was encountered in the ground investigation as a soft, becoming firm, black and grey mottled black organic silt, greeny-grey slightly sandy slightly gravelly silt, and localised brown sandy slightly gravelly clay, with root traces / plant fragments and occasional fine flint gravel. This zone extends over the area indicated on Drawing No. 858/GA/SK20 presented in Appendix A.

The ground conditions across most of the site, except for the north-western area adjacent to the existing watercourse can be summarised as follows:

Topsoil/Made Ground

Topsoil generally comprised dark-brown slightly sandy slightly gravelly clay with roots and was encountered to depths of up to 0.3m. Made Ground was encountered to depths of up to 1.7m thick, although in general the Made Ground was 0.3m to 0.9m thick.

The thickest area of Made Ground was encountered in the north-west of the site, in the area of the tennis court and adjacent sloped informal gardens, and ranged between 1.0m and 1.7m in thickness.

In general, the Made Ground comprised brown, locally friable, very silty / clayey slightly gravelly sand or sandy slightly gravelly reworked clay with roots. The gravel fraction generally comprised flint, with fragments of brick and concrete and occasional fragments of clay tile, glass, slate, wood, charcoal and coal/clinker-type material and occasional cobbles of brick and concrete.

Weathered London Clay (Firm Clay)

The Weathered London Clay was encountered at depths from 0.1m to 3.8m bgl, and extended to depths of 5.8m to 6.7m bgl (77.39 - 75.94mAOD). In general, the weathered London Clay comprised firm, becoming stiff, fissured brown mottled grey-green, and locally orangey-brown, silty clay. The clay was also occasionally slightly sandy (fine sand) and widely spaced thin laminae of fine sand was present.

London Clay (Stiff Clay)

London Clay was encountered at depths of between 5.8m to 6.7m bgl (77.39 - 75.94mAOD), and extended to the base of the boreholes (maximum depth proved of 20m bgl). The upper zone comprised stiff fissured dark-brownish grey silty clay, locally slightly sandy (fine sand), with occasional thin laminae of fine sand and rare shell fragments. This horizon extended to depths of between 13.0m and 13.45m.

Below this, the London Clay comprised stiff fissured dark-brownish grey clay, which was only locally silty. Thin laminae of fine sand were not present at this depth.

Alluvium

Alluvium was encountered in WS10, WS11 and WS12, adjacent to the site's north-western boundary. The alluvium comprised soft, becoming firm, black and grey mottled black organic silt, greeny-grey slightly sandy slightly gravelly silt, and localised brown sandy slightly gravelly clay, with root traces / plant fragments and occasional fine flint gravel.

Groundwater

The groundwater monitoring carried out by RSK, indicates slow rates of water seepage within the weathered London Clay. Perched water appears to be locally present in the Made Ground across the site, overlying the low permeability weathered London Clay. This perched water may potentially be a source of water with regard to site hydrology.

The surface watercourse to the immediate north-west of the site is underlain by an alluvial tract which contains water-bearing alluvium and is likely to be a significant source of recharge for the Highgate Ladies Bathing Pond, however, no redevelopment works are planned for this area of the site.

Ground Investigation

The ground investigation carried out by RSK is summarised in the table 2, below.

Investigation Type	Number	Designation
Boreholes - by light cable percussive methods Standpipe/Piezometer installations	3 Boreholes (10m, 15m and 20m depth)	BH1 to BH3
Boreholes– by drive-in sampler	12 Window Sample Boreholes (up to 5m depth)	WS1 to WS12
Standpipe/piezometer Installations	9	BH1 to BH3, WS2, WS3, WS7, WS10, WS11, WS12
Inspection Pits - excavated by hand	5 (up to 1.2m depth)	TP1 to TP5
Water level monitoring in piezometer/monitoring well installations	During April and May 2010	BH1 to BH3, WS2, WS3, WS7, WS10 to WS12

Table 2: Summary of ground investigation completed by RSK

The position of the exploratory holes are shown in SK20, presented in Appendix A.

Geotechnical Testing

The geotechnical testing carried out is summarised in table 3, below.

Strata	Tests undertaken	No of Tests
London Clay Formation	pH and sulphate	7
	Plasticity Index	13
	Natural Moisture Content	33
	Triaxial Compression	14
	Particle Size Distribution and Hydrometer Analysis	2
	Compaction Testing	2

Table 3: Summary of geotechnical investigation

The extent of the soil testing appears to be reasonable but consolidation testing to define coefficient of consolidation (Cv) and coefficient of compressibility (Mv) values should be done if settlement/heave needs to be more accurately estimated.

Contamination Testing

The contamination testing carried out is summarised in the table 4, below.

Strata	Tests undertaken	No of Tests
Made Ground	Metals Suite: As, Cd, Cr, Pb, Hg, Se, B, Cu, Ni, Zn, pH	5
	Total Petroleum Hydrocarbons	5
	Speciated Polyaromatic Hydrocarbons	5
	Asbestos Screen	5

Table 4: Summary of contamiation testing

The extent of the soil testing appears to be reasonable but chemical testing of water samples and also a sample of the water from the Ladies Bathing Pond should be taken to provide benchmark data to compare the site water samples against.

Hydrology, Hydrogeology and Groundwater Monitoring

Hydrology

The site lies within the catchment of the stream formerly known as the Highgate Brook, forming one of the tributaries of the River Fleet, which drains to the River Thames near Blackfriars. The Fleet rises on Hampstead Heath by two heads, separated by Parliament Hill. The eastern, or Highgate, source lies near to the subject site, and is fed via a series of springs in the grounds of Kenwood House, whence the stream flows southwards, via the Highgate Ponds. It is understood that this series of ponds was excavated in the 17th and 18th centuries for water supply purposes. The ponds currently serve a variety of leisure and recreational purposes, and are the subject of a number of conservation and management measures under the Corporation of London's Hampstead Heath Management Plan.

The ponds are formed in the channel of the Highgate Brook, which flows over impermeable London Clay. Flow in the stream is likely to be derived from direct surface run-off, and by drainage of groundwater from springs. A surface watercourse is present immediately adjacent to the site's north-western boundary and flows in a south-westerly direction, discharging into the northern end of the Ladies Bathing Pond.

A second surface watercourse, located approximately 80m to the south-east of the site, is also present. This watercourse is also orientated north-east to south west, and discharges into the Wildfowl Reserve Pond, which lies to the south-east of (downstream from) the Ladies Bathing Pond.

Hydogeology

The London Clay Formation is classified by the Environment Agency as a Non-aquifer owing to its inability to store and transmit significant quantities of groundwater. Typical values for the coefficient of permeability for the London Clay Formation range from 3×10^{-9} m/s for clay with sand partings and silty clay to 3×10^{-11} m/s for intact clay, indicating the very low permeability.

No in-situ permeability testing has been carried out, however the particle size distribution testing carried out on samples of Weathered London Clay indicate that the clay comprises 4 – 5% sand, 42 – 48% silt and 48 – 51% clay. It is therefore likely that the London Clay has a permeability of at least 1×10^{-9} m/s in zones where there are no sand lenses present.

Groundwater Monitoring

The groundwater monitoring installations comprised standpipe piezometers in the boreholes and and these where set a specific depths with a sealed response zones in zones where more sandy clay was present or sand horizons were encountered. Within the Window Sample Boreholes standpipes were installed with the response zone extending from the base of the Made Ground to the base of the borehole (5m depth).

Observations made during the initial site works and subsequent groundwater monitoring suggest that groundwater is present on the site:

- Perched water is locally present within the Made Ground overlying the weathered London Clay
- Groundwater is present within the weathered London Clay within the sandy zones and sand lenses
- Groundwater was encountered within the Alluvium
- Groundwater was encountered in the London Clay Formation (water levels were found to lie at 80.2mAOD and 78.2mAOD in BH1 and BH3, respectively)

RSK have recommended that groundwater monitoring is continued and that rainfall records are obtained for the monitoring period. This would be a worthwhile exercise.