

APPENDIX B**INFORMATION FROM ENVIRONMENT AGENCY, 14-07-2015**

- PRODUCT 4 INFORMATION,
- HISTORICAL 1947 FLOODING EXTENT,
- SUPERFICIAL GEOLOGY,
- ABSTRACTIONS

Our ref: HNL/047809/JH

Your ref:

Date: 14 July 2015

Dear Janette Hunter

Enquiry regarding Redevelopment of THFC stadium

Thank you for your enquiry which was received on 16 June 2015 and subsequent payment received on 14 July 2015

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

Please find attached a product 4 data set as requested.

Please contact the our local sustainable places team to discuss the possible issues relating to source protection zones and vulnerability. Contact Jane Wilkin on 0203 263 8052.

Please find attached a WFD spreadsheet of the current WFD status. I have also attached a map of the WFD reference. This can be used at the attached website [Catchment Data Explorer](#) which holds all our WFD data which is freely available.

The geology beneath the site is CLAY, SILT AND SAND with drift deposits of SAND AND GRAVEL / CLAY AND SILT (see attached map). If you require information on the depths of the geology layers, please visit the British Geological Survey's borehole records at <http://www.bgs.ac.uk/data/boreholescans/home.html>

Please find attached a map and spreadsheet of abstractions and discharges within 1km of the location Grid Ref: 534107, 191404

Under the Water Act 2003, abstractions equal to or less than 20 cubic metres per day were deregulated as of 1 April 2005. We do not hold records of current abstractions which are below this threshold value. We only hold information on abstractions that were below the threshold before 1 April 2005.

We advise you to visit British Geological Survey's website <http://www.bgs.ac.uk/data/boreholescans/home.html> for details of all known boreholes and wells.

For details of deregulated surface water abstractions, we recommend you carry out your own survey of any watercourses within the area of interest.

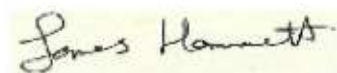
I have attached our Standard Notice which explains the permitted use of this information.

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

We would be really grateful if you could spare five minutes to help us improve our service. Please click on the link below and fill in our survey – we use every piece of feedback we receive:

<http://www.smartsurvey.co.uk/s/EnvironmentAgencyCustomerSurvey/>

Yours sincerely

A handwritten signature in black ink on a yellow rectangular background. The signature appears to read 'James Hammett'.

Customers and Engagement Officer

Direct dial 01707 632468

Direct fax 01707 632610

Direct email HNL enquiries@environment-agency.gov.uk

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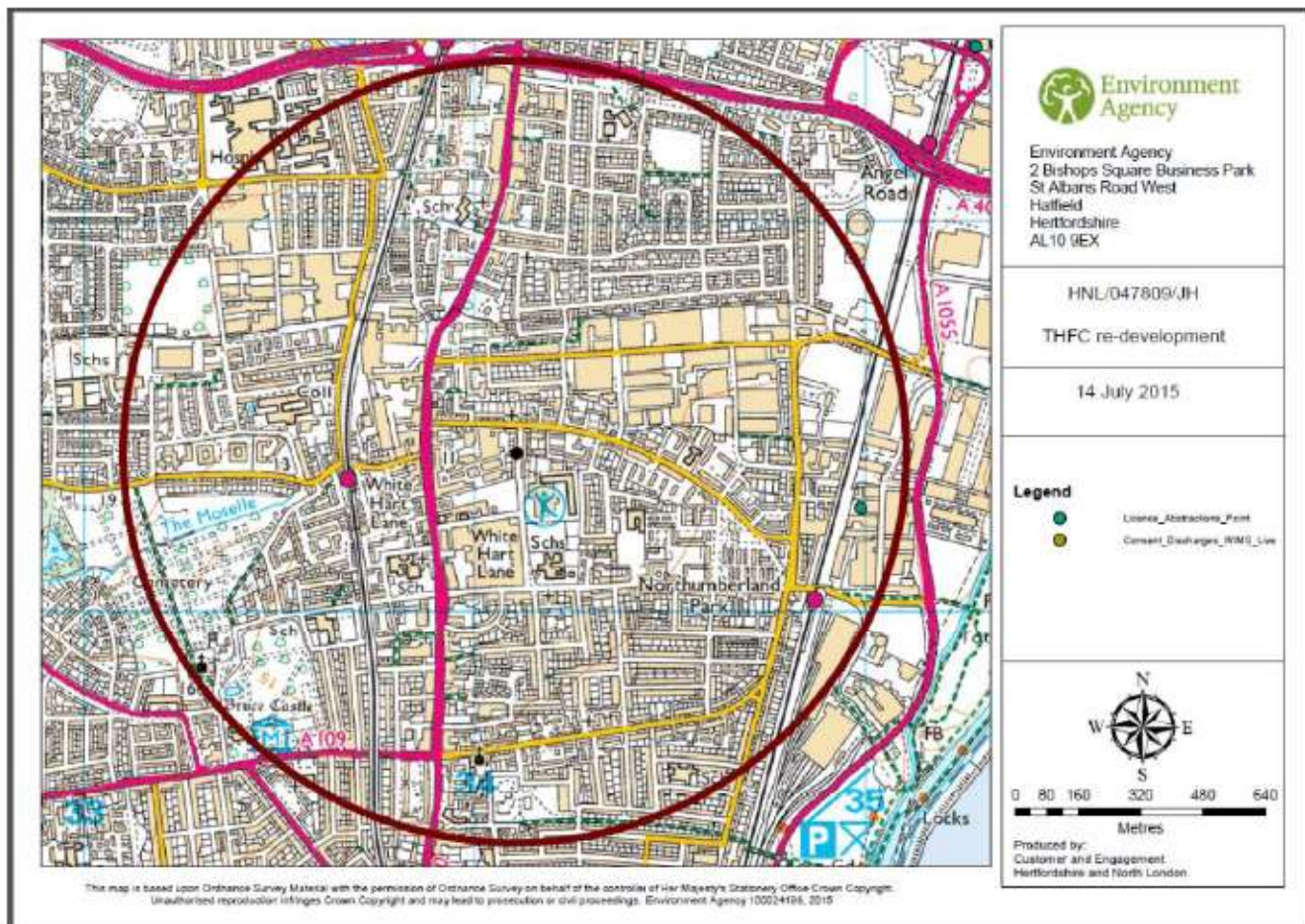
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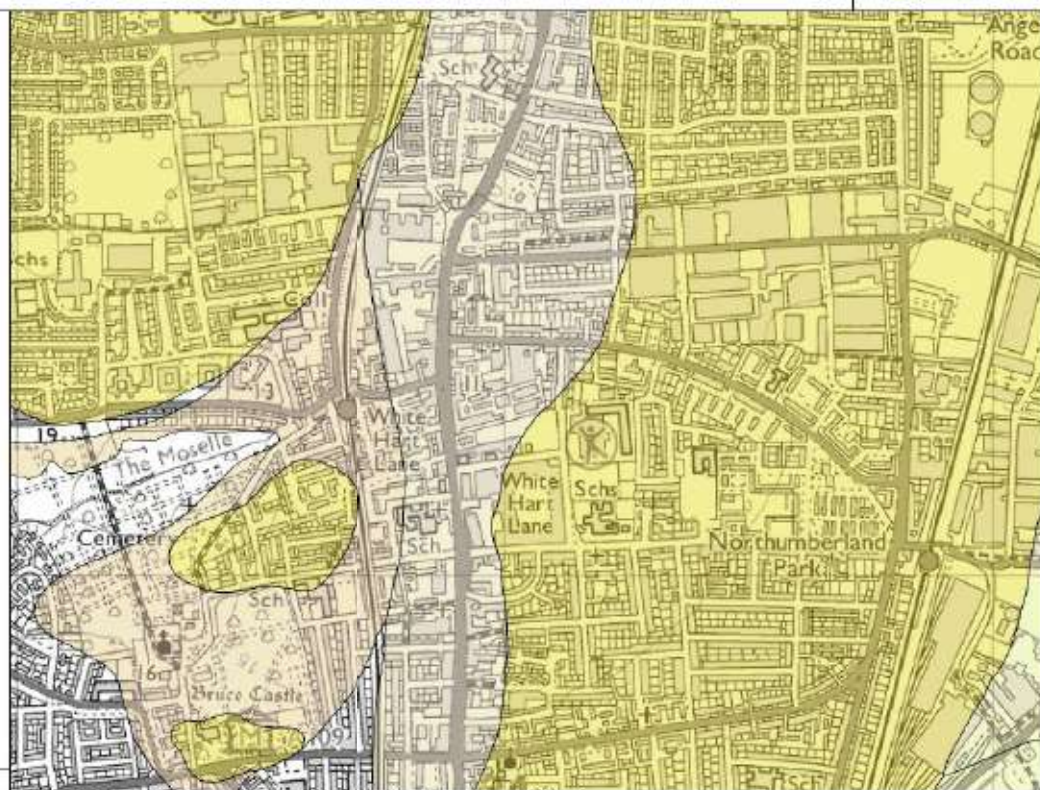
Abstraction

LIC_NO	AREA_CODE	EA_AREA	LEAP_CODE
TH/038/0009/007	AGY3N	NE AREA NON STRATEGIC	L15
EA_LEAP	ORIG_EFF_D	EXP_DATE	ISSUE_NO
NORTH LONDON LEAP	27/11/2009	31/03/2019	1
INCRE_NO	START_DATE	END_DATE	ORIG_APP
0	27/11/2009		NPS/WR/001704
VER_APP_NO	LH_NAME	ADDR_LINE1	ADDR_LINE2
NPS/WR/001704	Montagus Ltd	t/a Empire Laundry	42 Garman Road
TOWN	COUNTY	POSTCODE	PURP_CODE
Tottenham	GREATER LONDON	N17 0UL	I
SUB_CODE	USE_CODE	PURPOSE	SUBPURPOSE
LAU	270	Industrial, Commercial And Public Services	Laundry
USE	ABS_START	ABS_END	LANDS
Laundry Use	01/04	31/03	Empire Laundry, Tottenham
SOS_CODE	SOURCE	POINT_NAME	POINT_TYPE
SOSGW	THAMES GROUNDWATER	EMPIRE LAUNDRY BOREHOLE	SP
NGR	CART1EAST	CART1NORTH	AQUIFR_TYP
TQ3499191264	534991	191264	G8.3 GW - CHALK & LOWER LONDON TERTIARIES

Discharge

AG_APL_NUM	AG_VERSION	AG_ISSUED
CANM.0223	1	09/02/2001
AG_EFFECTV	AG_REVIEW	AG_REVOCED
09/02/2001	09/02/2005	01/06/2006
AG_COMMENT	DS_SNAME	DS_LNAME
discharge ceased	GAS WORKS	WILLOUGHBY LANE GAS WORKS
DS_ADD1	DS_ADD2	DS_ADD3
WILLOUGHBY LANE & TEESIDE ROAD	TOTTENHAM	LONDON
DS_ADD4	DS_NGR	EASTING
N17 0RY	TQ3480091850	534800
NORTHING	DS_TYPE	REGION
191850	Public Gas Supply	TH

Legend

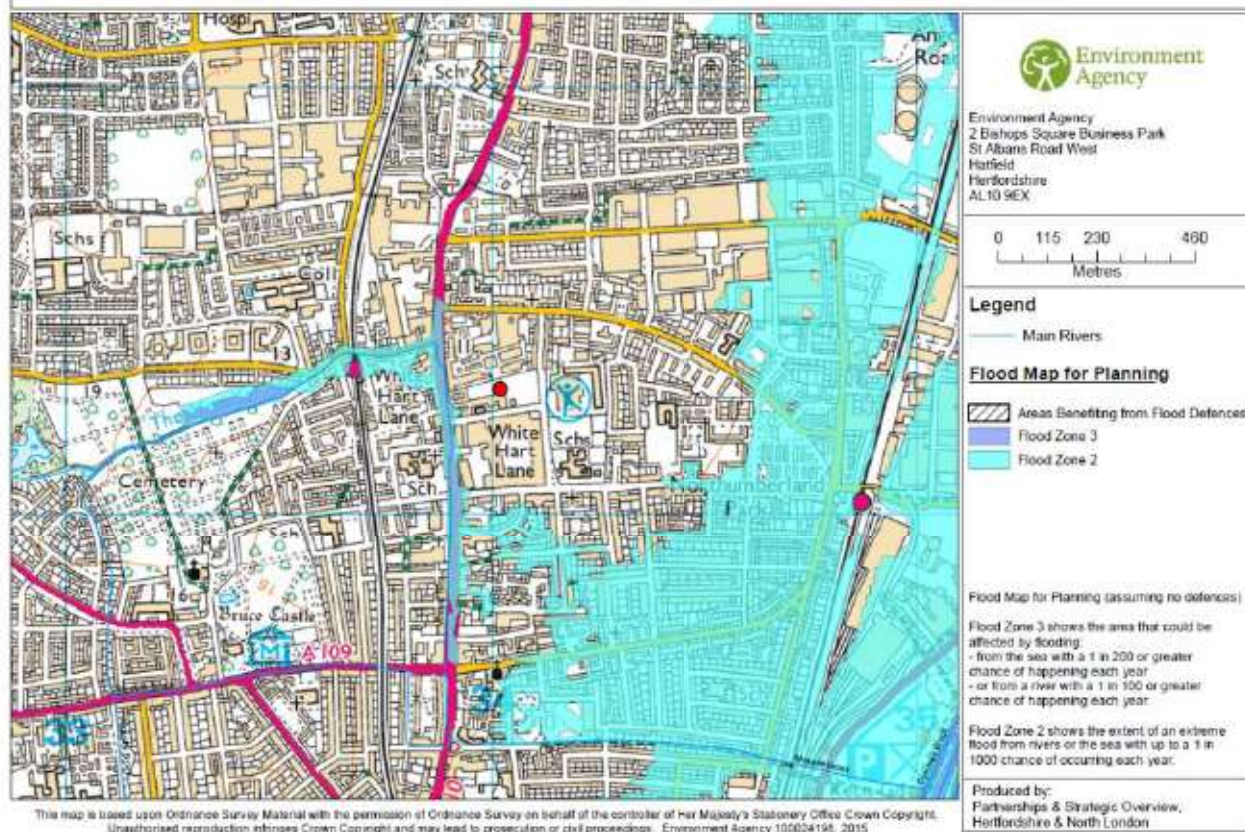


0 50 100 200 m

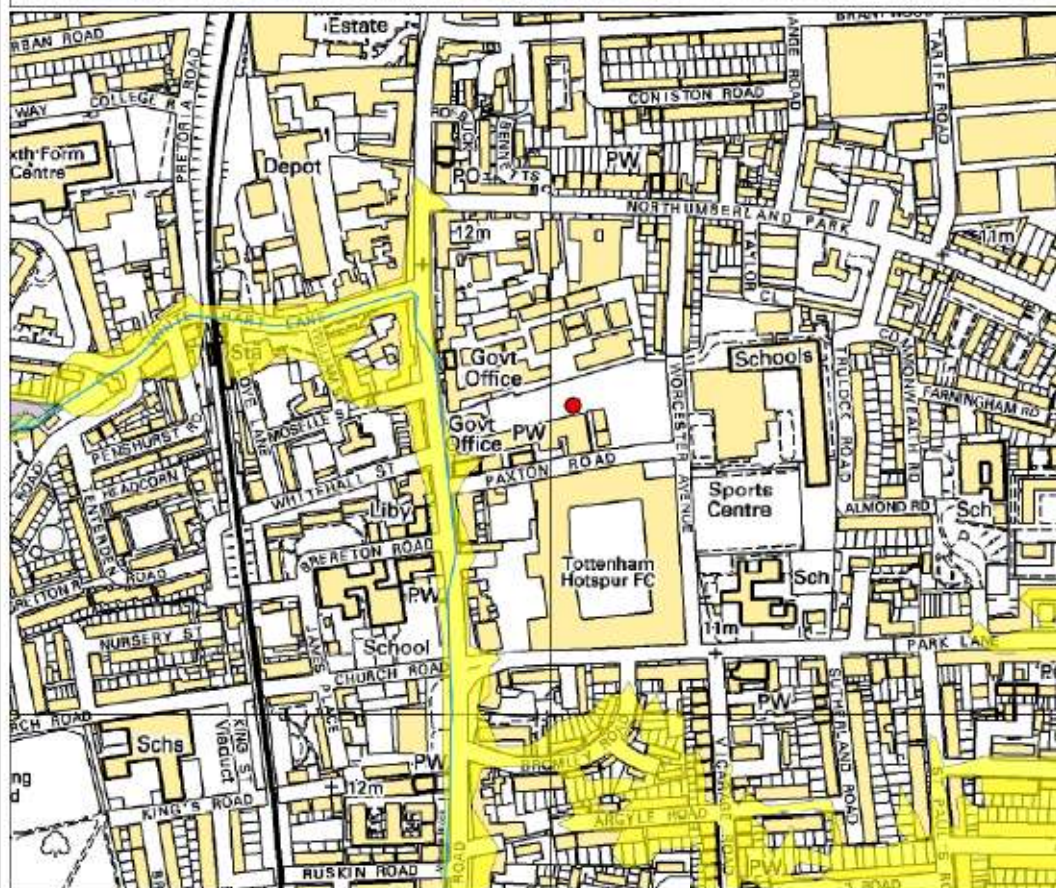


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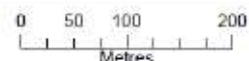
Flood Map for Planning centred on THFC 534021, 191293 - 14/07/2015 - HNL/047809JH



Detailed FRA centred on THFC 534021, 191293 - 14/07/2015 - HNL/047809JH



Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX



Legend

Main Rivers

Defended Flood Outlines

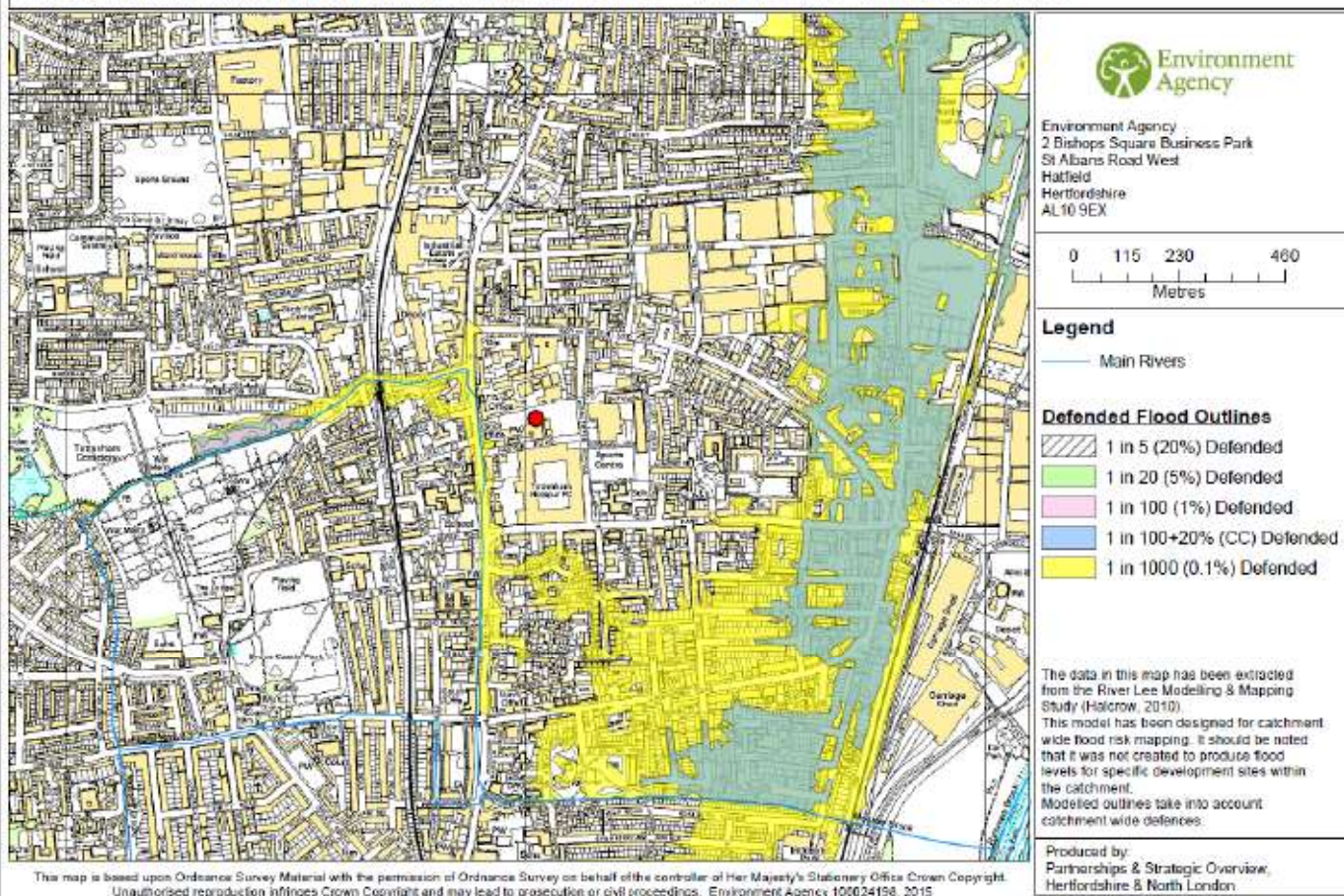
- 1 in 5 (20%) Defended
- 1 in 20 (5%) Defended
- 1 in 100 (1%) Defended
- 1 in 100+20% (CC) Defended
- 1 in 1000 (0.1%) Defended

The data in this map has been extracted from the River Lee Modelling & Mapping Study (Halcrow, 2010). This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

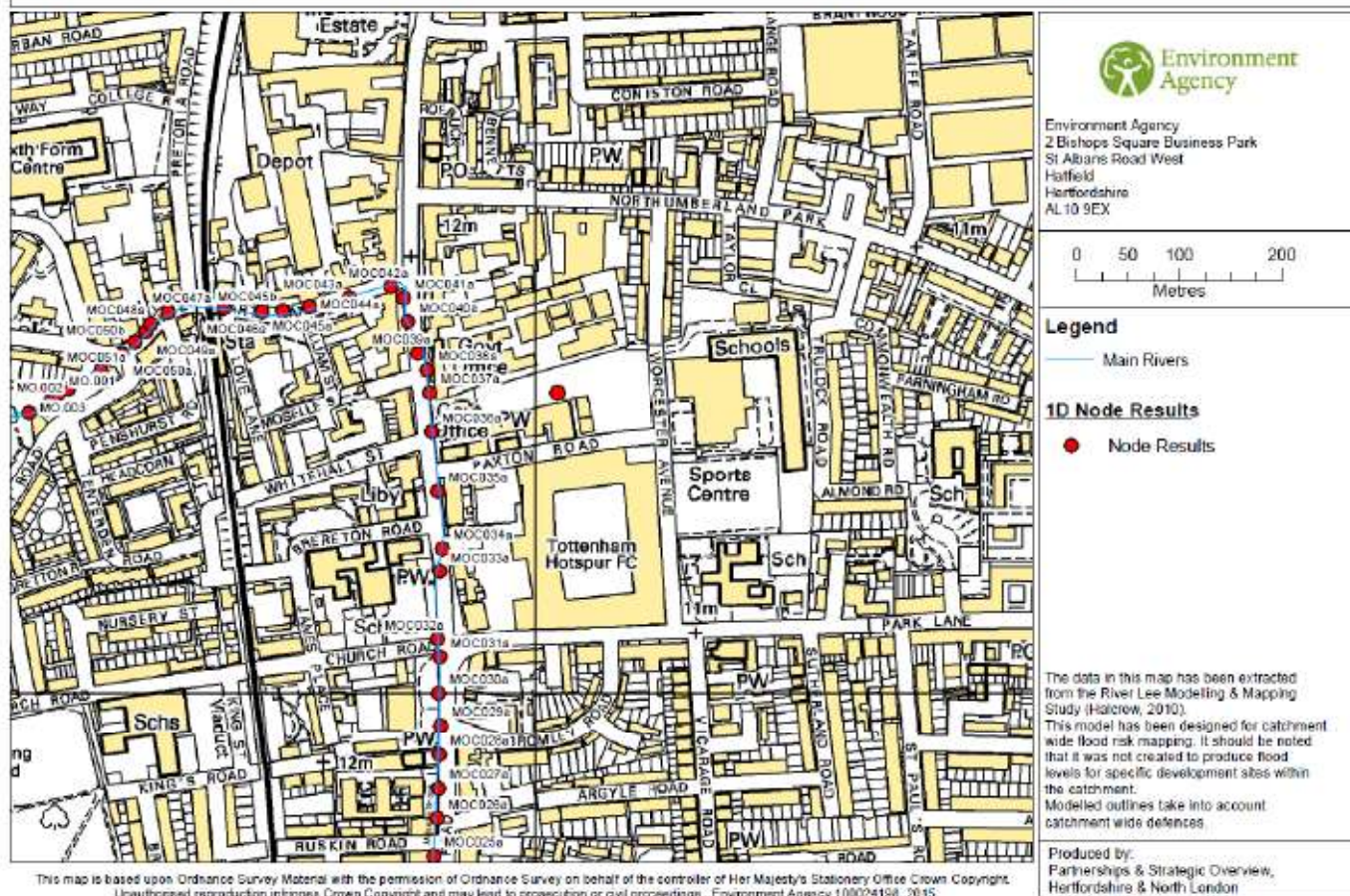
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Detailed FRA centred on THFC 534021, 191293 - 14/07/2015 - HNL/047809JH



Detailed FRA centred on THFC 534021, 191293 - 14/07/2015 - HNL/047809JH



Environment Agency ref: **HNL/047809JH**

The following information has been extracted from the River Lee Modelling & Mapping Study (Halcover, 2010)

Caution:

This model has been designed for catchment wide flood risk mapping

It should be noted that it was not created to produce flood levels for specific development sites within the catchment

Each sub-model has been given a 'Model Confidence Limit' score (1-4) to give an indication of the level of confidence in the hydraulic model

The confidence for this area is shown in the last column:

- 1 - Good Quality channel and floodplain survey and good calibration
- 2 - Old channel or floodplain survey or limited calibration
- 3 - Poor quality channel or floodplain survey
- 4 - No channel survey, model data assumed

All flood levels are given in metres Above Ordnance Datum (mAOD)

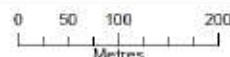
All flows are given in cubic metres per second (cumecs)

MODELLED FLOOD LEVEL

Node Label	Easting	Northing	Return Period										Confidence
			2 yr	5 yr	10 yr	20 yr	25 yr	50 yr	100 yr	100 yr + 20%	200 yr	1000 yr	
MO003	535504.58	161273.31	11.47	11.72	11.82	11.88	11.93	12.01	12.13	12.08	12.30	13.28	1
MO002	535525.56	161255.09	11.41	11.69	11.77	11.83	11.88	11.98	12.08	12.08	12.38	13.28	1
MO001	535533.19	161261.81	11.38	11.62	11.73	11.79	11.83	11.92	12.04	12.04	12.32	13.28	1
MO052a	535542.00	161266.80	11.34	11.68	11.68	11.74	11.78	11.85	11.97	12.5	12.28	13.24	3
MO051a	535574.71	161314.75	11.28	11.51	11.62	11.67	11.71	11.79	11.91	12.54	12.24	13.19	3
MO050a	535595.29	161331.98	11.23	11.48	11.68	11.81	11.86	11.73	11.98	12.5	12.21	13.14	3
MO050b	535608.40	161342.77	11.2	11.43	11.63	11.58	11.62	11.7	11.82	12.48	12.10	13.12	3
MO046a	535618.07	161352.56	11.2	11.43	11.63	11.58	11.62	11.7	11.82	12.48	12.10	13.12	3
MO048a	535625.44	161350.22	11.18	11.4	11.5	11.58	11.6	11.67	11.8	12.48	12.18	13.1	3
MO047a	535640.17	161371.8	11.08	11.31	11.4	11.48	11.49	11.57	11.7	12.38	12.14	13	3
MO046a	535655.24	161376.40	11.06	11.27	11.36	11.41	11.45	11.52	11.66	12.36	12.12	12.07	3
MO045a	535732.11	161372.57	10.97	11.18	11.27	11.31	11.35	11.43	11.58	12.3	12.09	12.9	3
MO046b	535752.48	161373.84	10.48	10.71	10.81	10.87	10.81	11.13	11.37	12.22	11.88	12.84	3
MO044a	535778.08	161377.43	10.43	10.67	10.78	10.83	10.87	11.1	11.35	12.16	11.04	12.77	3
MO043a	535817.46	161386.16	10.43	10.68	10.77	10.82	10.85	11.09	11.36	12.14	11.01	12.74	3
MO042a	535858.24	161386.84	10.42	10.68	10.78	10.82	10.86	11.09	11.34	12.12	11.89	12.71	3
MO041a	535870.86	161386.16	10.41	10.64	10.78	10.8	10.84	11.08	11.31	12.08	11.88	12.67	3
MO040a	535874.74	161382.80	10.30	10.62	10.72	10.78	10.82	11.04	11.26	12.01	11.70	12.59	3
MO039a	535884.44	161391.8	10.37	10.59	10.69	10.75	10.78	10.99	11.19	11.98	11.73	12.52	3
MO038a	535893.17	161315.26	10.37	10.68	10.68	10.78	10.78	10.88	11.17	11.93	11.72	12.5	3
MO037a	535895.08	161282.86	10.33	10.63	10.63	10.69	10.71	10.88	11.03	11.77	11.87	12.31	3
MO036a	535898.02	161255.1	10.28	10.47	10.55	10.6	10.68	10.77	10.91	11.04	11.46	12.10	3
MO035a	535903.84	161198.85	10.23	10.39	10.47	10.52	10.45	10.83	10.71	11.42	11.24	11.9	3
MO034a	535903.7	161140.54	10.22	10.38	10.47	10.51	10.44	10.61	10.88	11.42	11.24	11.9	3
MO033a	535905.78	161118.21	10.22	10.38	10.47	10.51	10.44	10.6	10.88	11.42	11.24	11.9	3
MO032a	535903.84	161052.19	9.97	10.18	10.25	10.3	10.34	10.41	10.51	11.28	11.11	11.74	3
MO031a	535905.78	161034.72	9.94	10.14	10.24	10.28	10.32	10.4	10.48	11.28	11.1	11.73	3
MO030a	535904.81	160998.6	9.94	10.14	10.24	10.29	10.32	10.4	10.48	11.27	11.1	11.72	3
MO029a	535905.78	160956.76	9.87	10.08	10.18	10.23	10.27	10.34	10.44	11.21	11.04	11.65	3
MO028a	535905.82	160937.47	9.88	10.07	10.17	10.22	10.26	10.34	10.43	11.2	11.03	11.64	3
MO027a	535904.85	160904.46	9.84	10.08	10.18	10.2	10.24	10.32	10.42	11.16	11	11.58	3
MO026a	535903.88	160876.33	9.83	10.04	10.14	10.19	10.23	10.31	10.41	11.13	10.97	11.56	3

MODELLED FLOWS

Node Label	Easting	Northing	Return Period										Confidence
			2 yr	5 yr	10 yr	20 yr	25 yr	50 yr	100 yr	100 yr + 20%	200 yr	1000 yr	
MO003	535504.58	161273.31	2.2	3.33	3.88	4.18	4.43	4.9	5.43	8.01	8.2	8.36	1
MO002	535525.56	161255.09	2.19	3.23	3.86	4.18	4.43	4.9	5.43	8.05	8.19	8.36	1
MO001	535533.19	161261.81	2.19	3.33	3.86	4.18	4.43	4.9	5.43	8.04	8.19	8.36	1
MO052a	535542.00	161266.80	2.19	3.33	3.88	4.18	4.43	4.9	5.43	8.04	8.19	8.36	3
MO051a	535574.71	161314.75	2.19	3.33	3.87	4.18	4.43	4.9	5.44	8.00	8.18	8.36	3
MO050a	535595.29	161331.98	2.19	3.33	3.87	4.19	4.43	4.9	5.44	8.07	8.17	8.36	3
MO050b	535608.40	161342.77	2.19	3.33	3.88	4.19	4.43	4.9	5.44	8.07	8.17	8.36	3
MO046a	535618.07	161352.56	2.38	3.6	4.19	4.53	4.1	5.3	5.89	6.71	6.66	7.45	3
MO048a	535625.44	161350.22	2.37	3.6	4.19	4.53	4.1	5.3	5.89	6.7	6.66	7.45	3
MO047a	535640.17	161371.8	2.36	3.6	4.2	4.54	4.1	5.31	5.89	6.63	6.84	7.45	3
MO046a	535655.24	161376.40	2.36	3.6	4.2	4.54	4.1	5.31	5.9	6.6	6.84	7.45	3
MO045a	535732.11	161372.57	2.35	3.61	4.21	4.54	4.1	5.31	5.9	6.54	6.63	7.42	3
MO046b	535752.48	161373.84	2.35	3.61	4.21	4.54	4.1	5.31	5.9	6.54	6.63	7.42	3
MO044a	535778.08	161377.43	2.38	3.61	4.21	4.55	4.1	5.3	5.9	6.51	6.62	7.42	3
MO043a	535817.46	161386.16	2.37	3.61	4.21	4.55	4.1	5.3	5.9	6.51	6.62	7.42	3
MO042a	535858.24	161386.84	2.34	3.6	4.21	4.56	4.1	5.3	5.9	6.51	6.62	7.42	3
MO041a	535870.86	161386.16	2.34	3.6	4.21	4.56	4.1	5.3	5.9	6.51	6.62	7.42	3
MO040a	535874.74	161382.80	2.34	3.6	4.22	4.56	4.1	5.29	5.9	6.51	6.62	7.42	3
MO039a	535884.44	161391.8	2.34	3.6	4.22	4.56	4.1	5.29	5.9	6.51	6.62	7.42	3
MO038a	535893.17	161315.26	2.34	3.6	4.22	4.56	4.1	5.29	5.9	6.51	6.62	7.42	3
MO037a	535895.08	161282.86	2.33	3.6	4.22	4.56	4.1	5.29	5.9	6.51	6.62	7.42	3
MO036a	535898.02	161255.1	2.33	3.6	4.22	4.56	4.1	5.29	5.9	6.51	6.62	7.42	3
MO035a	535903.84	161198.85	2.33	3.6	4.22	4.56	4.1	5.29	5.9	6.51	6.62	7.42	3
MO034a	535903.7	161140.54	2.32	3.59	4.22	4.56	4.1	5.29	5.9	6.5	6.62	7.39	3
MO033a	535905.78	161118.21	2.32	3.59	4.22	4.56	4.1	5.29	5.9	6.5	6.62	7.39	3
MO032a	535903.84	161052.19	2.31	3.58	4.22	4.56	4.1	5.27	5.9	6.45	6.58	7.13	3
MO031a	535905.78	161034.72	2.31	3.58	4.22	4.56	4.1	5.27	5.9	6.44	6.58	7.13	3
MO030a	535904.81	160998.6	2.31	3.58	4.22	4.56	4.73	5.26	5.9	6.44	6.58	7.13	3
MO029a	535905.78	160956.76	2.3	3.58	4.22	4.56	4.73	5.26	5.9	6.41	6.55	6.96	3
MO028a	535905.82	160937.47	2.3	3.58	4.22	4.56	4.73	5.25	5.9	6.41	6.55	6.96	3
MO027a	535904.85	160904.46	2.29	3.57	4.22	4.56	4.73	5.24	5.9	6.36	6.53	6.96	3
MO026a	535903.88	160876.33	2.29	3.57	4.22	4.56	4.73	5.24	5.9	6.38	6.51	6.96	3



Legend

 Main Rivers

2D Node Results: Heights

- 1 in 1000 (0.1%) Defended

The data in this map has been extracted from the River Lee Modelling & Mapping Study (Halcover, 2010). This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

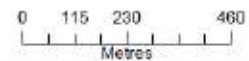
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Historic Flood Map centred on THFC 534021, 191293 - 14/07/2015 - HNL/047809JH



Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX



Legend

Main Rivers

Flood Event Outlines

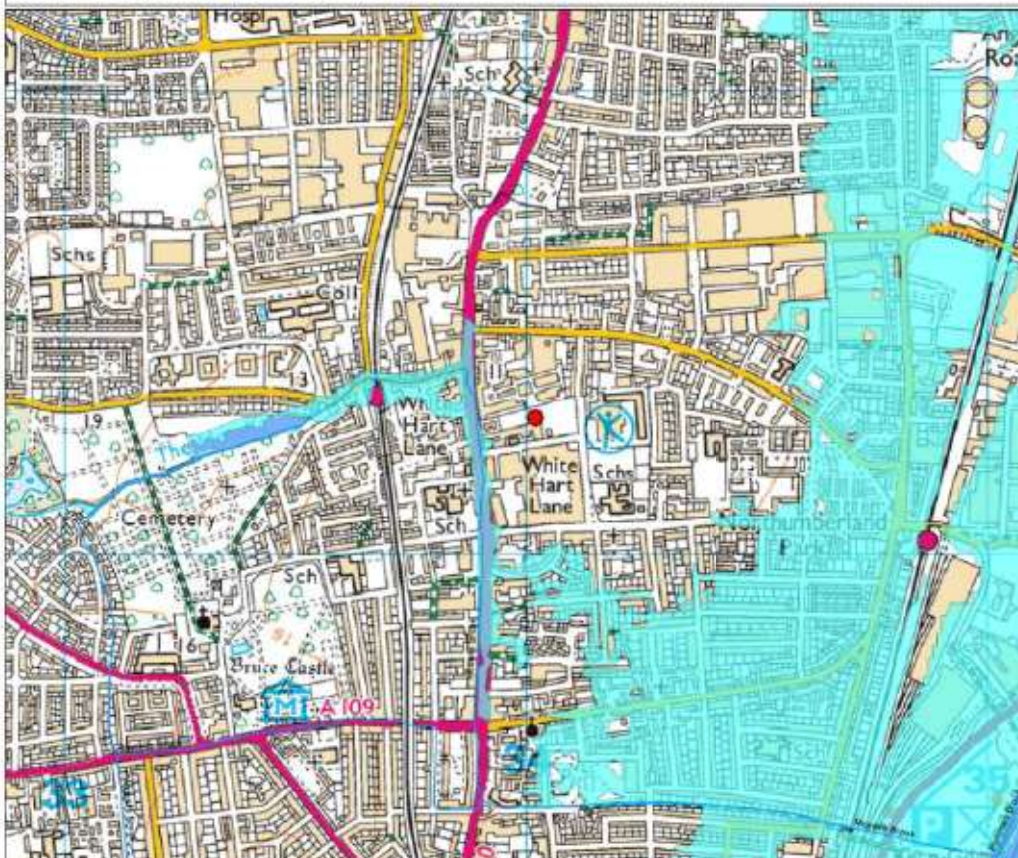
1947

The historic flood event outlines are based on a combination of anecdotal evidence, Environment Agency staff observations and survey.
Our historic flood event outlines do not provide a definitive record of flooding. It is possible that there will be an absence of data in places where we have not been able to record the extent of flooding.
It is also possible for errors occur in the digitisation of historic records of flooding.

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Flood Map for Planning centred on THFC 534021, 191293 - 14/07/2015 - HNL/047809JH



Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX



Legend

Main Rivers

Flood Map for Planning

- Areas Benefiting from Flood Defences
- Flood Zone 3
- Flood Zone 2

Flood Map for Planning (assuming no defences)

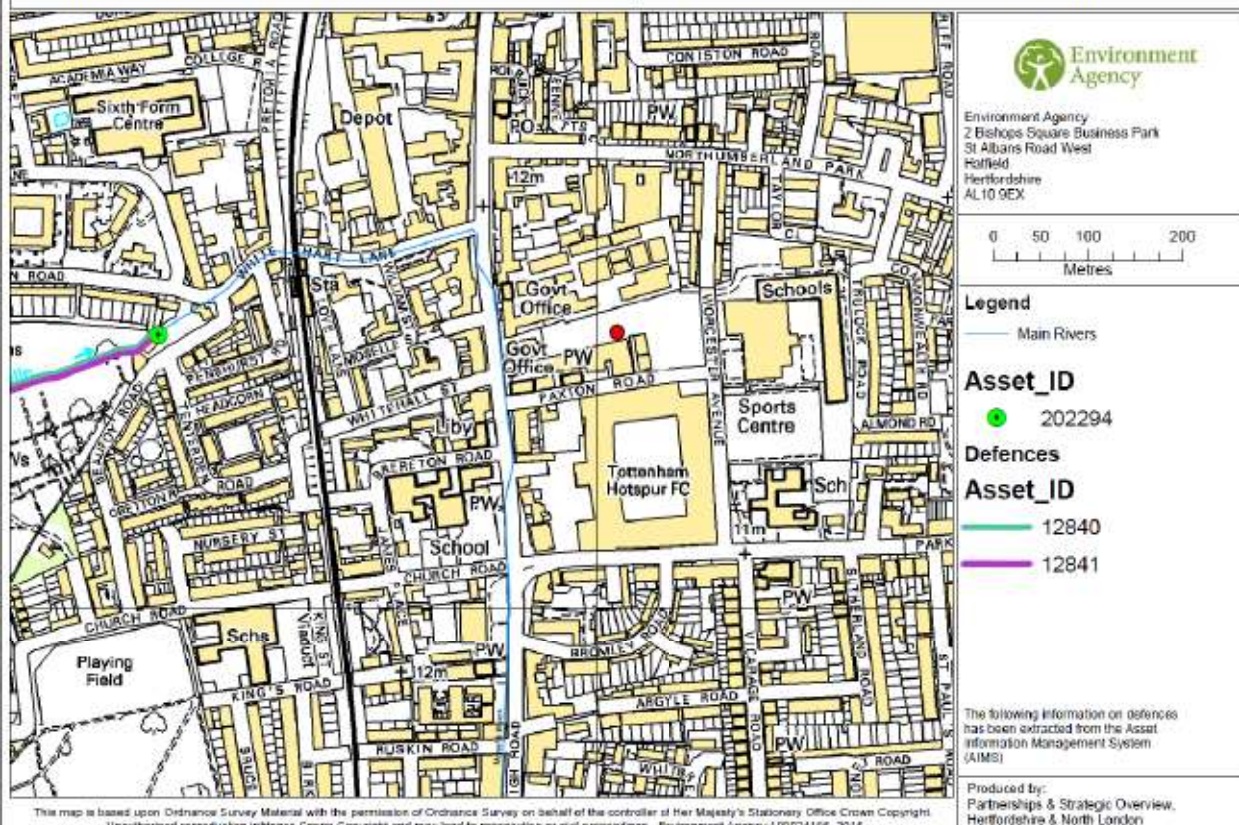
Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

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Structures & Defences centred on THFC 534021, 191293 - 14/07/2015 - HNL/047809JH

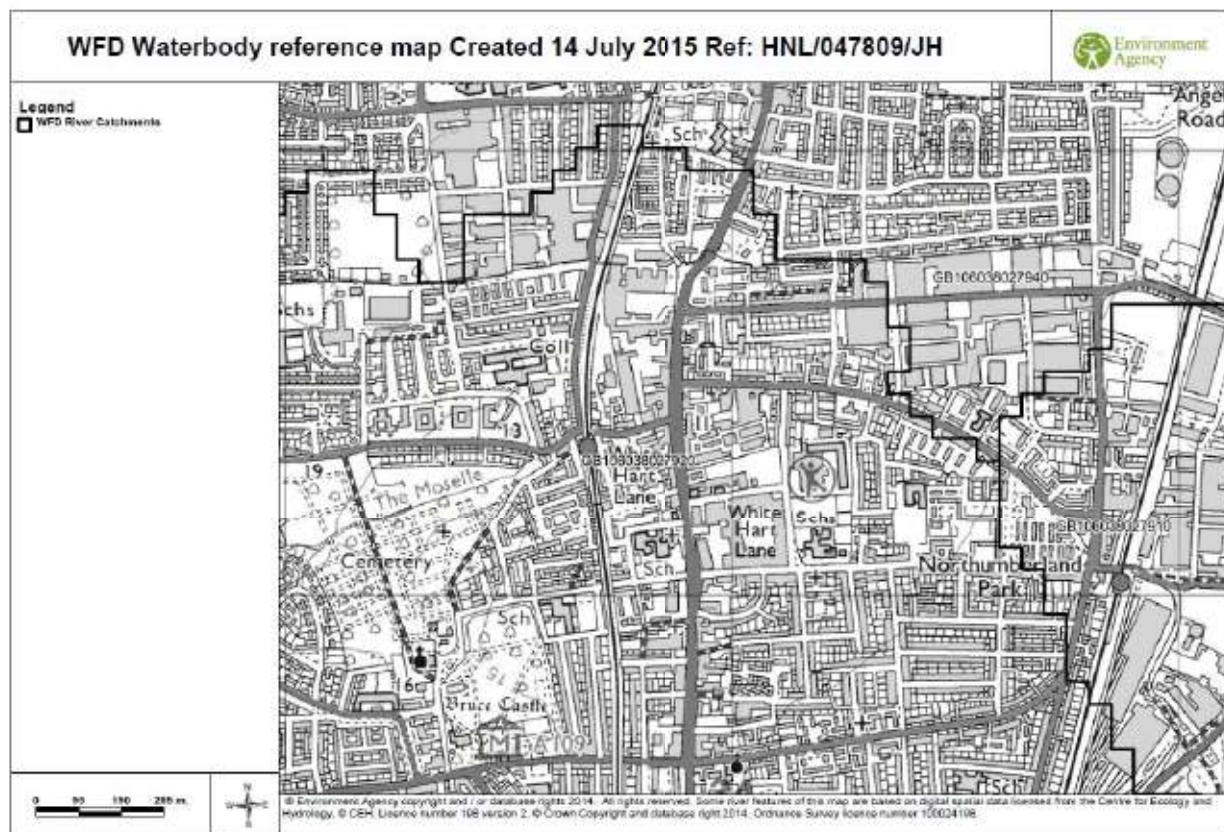


Environment Agency ref: **HNL/047809JH**

The following information on defences has been extracted from the Asset Information Management System (AIMS):

Map ID	Asset Reference	Asset Type	Asset Protection	Asset Comment	Asset Description	Asset Location	Actual DCL	Actual DCL	Design Set	NBR
12840	0023034M50111L04	high ground	Fluvial	Natural bank with concrete lined sections	Natural bank	Through Tottenham cemetery	15.82	14.87	00	TQ3303091090
12841	0023034M50111R04	high ground	Fluvial	Concrete lined channel	Lined channel	Through Tottenham Cemetery	15.72	14.82	5	TQ3303091070

Map ID	Asset Reference	Asset Type	Asset Protection	Asset Comment	Asset Description	Asset Location	NBR
202294	0023034M50111R01002	screen	Fluvial	MA - Weirgate Yard Screen. Castal walls planned, 3.5m wide steel screen inclined around 20 degrees off the vertical. Concrete wing walls are placed at 0 degrees to the flow. EA responsible for regular clearing (2-3 times/week). No corner to top of screen.	SCREEN	The Moseley's Beauty Oughton Fids	TQ3303401200



WB Details				
WB ID	WB Name	Catchment	Water Body Length	
GB106038027920	Moselle Brook	Lower Lee	2.86	
Ecological Status				
2009	2010	2011	2012	2013
Moderate	Moderate	Moderate	Moderate	Moderate
Ecology Results				
Fish Results	Inverts Results	Macrophytes Results	Phytobenthos (Diatoms) Results	
Not assessed 2009, Not assessed 2010, Not assessed 2011, Not assessed 2012, Not assessed 2013	Not assessed 2009, Not assessed 2010, Not assessed 2011, Not assessed 2012, Not assessed 2013	Not assessed 2009, Not assessed 2010, Not assessed 2011, Not assessed 2012, Not assessed 2013	Not assessed 2009, Not assessed 2010, Good 2011, Good 2012, Good 2013	
Physchem Results				
Phosphate Results	Ammonia Results	DO Results	pH Results	Temp Results
Poor 2009, Poor 2010, Not assessed 2011, Bad 2012, Poor 2013	High 2009, High 2010, Not assessed 2011, Bad 2012, Bad 2013	High 2009, High 2010, Not assessed 2011, Bad 2012, Bad 2013	High 2009, High 2010, Not assessed 2011, High 2012, High 2013	Good 2009, High 2010, Not assessed 2011, High 2012, High 2013

Chemical Classification	
Chemical Status (Annex 10)	Elements currently achieving less than good chemical status
DNRA2009, 2010, 2011, 2012, Not assessed 2013	2009, 2010, 2011, 2012, Not assessed 2013
Specific Pollutants	
Annex 8 Chem	A8 Failure
Yes2009, Yes2010, 2011, Yes2012, Not assessed 2013	Moderate2009, Moderate2010, 2011, Moderate2012, Not assessed 2013
Flow	
Flow impacted by abstraction - Yes / No	If investigated certainty of failure
No	
HMWB Designation	
HMWB?	Mitigation Measures Assessment
Yes	Moderate
Objective	
Objective set in 2009 RBMP	
GEP by 2027	

APPENDIX C

THAMES WATER ASSETS



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Based on the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office License Number: 100018345. This map is to be used for the purpose of showing the location of Thames Water pipes only. Any other uses of the map data or other copies are not permitted. The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. This information is valid for the date printed. 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 on site before any works are undertaken.

Four Sewer	Four Manhole
Surface Sewer	Surface Manhole
Combined Sewer	Combined Manhole
Abandoned Sewer	Abandoned Manhole
Pressure Main	Other Manhole
Private Asset (Colour denotes different type)	End Item
Proposed Asset	5104 Boundary
Colour denotes different type	

emma.bousied@urs.com



Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
	S	-	-	-
	S	-	-	-
	S	-	-	-
	S	-	-	-
0201	F	12.15	10.97	1.18
0202	S	12.11	11.31	0.8
0203	S	11.94	11.04	0.9
0204	F	11.84	10.76	1.08
0205	F	11.72	10.21	1.51
0206	F	11.66	10.19	1.47
0207	S	11.76	10.6	1.16
03YZ	F	-	-	-
03ZP	F	-	-	-
03ZQ	F	-	-	-
03ZS	F	-	-	-
03ZT	F	-	-	-
03ZV	S	-	-	-
03ZX	S	-	-	-
03ZY	S	-	-	-
0401	S	11.58	10.31	1.27
0402	F	11.69	10.1	1.59
0403	S	11.6	10.35	1.25
0404	F	11.74	9.91	1.83
04YV	F	-	-	-
04YX	F	-	-	-
1101	S	10.9	9.67	1.23
1102	F	10.9	9.3	1.6
1201	F	11.86	10.47	1.39
1202	S	11.84	10.38	1.46
1301	F	11.74	10.54	1.2
1302	S	11.76	10.85	0.91
1303	S	11.84	11.18	0.66
1304	S	11.82	10.98	0.84
13VX	S	-	-	-
13VY	S	-	-	-
13WP	S	-	-	-
13WQ	S	-	-	-
13WS	S	-	-	-
13WT	S	-	-	-
13WW	S	-	-	-
13WX	S	-	-	-
13WY	S	-	-	-
13WZ	S	-	-	-
13XR	S	-	-	-
13XS	S	-	-	-
13XT	F	-	-	-
13XW	F	-	-	-
13XX	F	-	-	-
13XZ	S	-	-	-
13YQ	S	-	-	-

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
1401	F	11.69	9.84	1.85
1402	S	11.6	10.4	1.2
1403	F	11.65	10.21	1.44
1404	S	11.46	10.68	0.78
1405	F	11.56	9.73	1.83
1406	F	11.58	9.67	1.91
1407	S	11.46	10.5	0.96
1416	F	-	-	-
1417	F	-	-	-
141A	F	-	-	1.8
141B	F	-	-	1.8
141C	F	-	-	2
141D	F	-	-	1
141E	F	-	-	-
141F	F	-	-	1
14VQ	S	-	-	-
14VS	F	-	-	-
14W	S	-	-	-
14WV	S	-	-	-
14VY	S	-	-	-
14VZ	S	-	-	-
14WP	F	-	-	-
14WQ	S	-	-	-
14WR	S	-	-	-
14WT	F	-	-	-
14WV	F	-	-	1
14WV	F	-	-	1.3
14WX	S	-	-	-
14WY	S	-	-	-
14WZ	S	-	-	-
14XR	S	-	-	-
14XS	S	-	-	-
14XV	F	-	-	-
14XX	F	-	-	-
14XZ	S	-	-	-
14YP	S	-	-	-
14YR	S	-	-	-
14YS	S	-	-	-
1514	F	-	-	-
151A	F	-	-	-
151B	F	-	-	-
151C	F	-	-	-
151D	F	-	-	-
151E	F	-	-	-
203B	S	11.18	10.32	0.86
2101	S	11.01	10.39	0.62
2102	S	11.02	10.31	0.71
2103	S	10.73	9.76	0.97
2104	F	10.54	9.52	1.02
2105	S	10.54	9.58	0.96

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
2106	S	10.44	9.48	0.96
2107	F	10.43	9.39	1.04
2201	S	11.28	10.3	0.96
2301	S	11.24	10.49	0.75
2303	S	11.24	10.17	1.07
2304	S	11.45	10.07	1.38
2305	F	11.46	9.45	2.01
2306	S	11.41	9.95	1.46
23XQ	F	-	-	-
2401	S	11.31	10.18	1.13
2402	F	10.41	9.53	0.88
2403	S	11.28	9.91	1.37
2405	F	-	9.68	-
2406	F	-	9.63	-
2407	S	-	10.2	-
2408	S	-	10.1	-
2409	S	11.02	9.91	1.11
2410	F	11.11	9.36	1.75
2411	F	-	9.59	-
2412	S	-	10.17	-
2413	S	11.09	9.99	1.1
2414	F	-	9.88	-
241A	F	-	-	0.5
241B	F	-	-	-
241C	F	-	-	0.5
241D	F	-	-	-
2506	F	-	9.78	-
251B	F	-	-	-
251C	F	-	-	-
3016	F	-	-	-
3017	F	-	-	-
3018	F	-	-	-
3019	F	-	-	-
301B	S	11.55	10.2	1.35
301K	F	-	-	1
301L	F	-	-	1
301M	F	-	-	1
3020	F	-	-	-
3021	F	-	-	-
3101	F	11.02	10.17	0.85
3102	S	11.02	10.34	0.68
3103	S	10.95	10.07	0.88
3104	F	11.02	9.61	1.41
3105	F	11.01	9.44	1.57
3106	S	10.98	9.95	1.03
321A	F	-	-	1
32V	F	-	-	-
32VW	F	-	-	-
32VX	F	-	-	-
32VY	F	-	-	-

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
32VZ	F	-	-	-
32WP	S	-	-	-
32WQ	S	-	-	-
32WR	S	-	-	-
32WX	F	-	-	-
32WY	F	-	-	-
32XP	F	-	-	-
32XR	S	-	-	-
32XS	S	-	-	-
32XT	S	-	-	-
32XW	S	-	-	-
32XX	F	-	-	-
32XZ	F	-	-	-
32YQ	S	-	-	-
32YS	S	-	-	-
33TR	F	-	-	-
33TS	S	-	-	-
33TT	F	-	-	-
33TW	S	-	-	-
33VP	S	-	-	-
33VQ	F	-	-	-
33VR	F	-	-	-
33VS	F	-	-	-
33VV	S	-	-	-
33VX	S	-	-	-
33VZ	F	-	-	-
33WP	S	-	-	-
33WQ	S	-	-	-
33WS	S	-	-	-
33WV	F	-	-	-
33WW	F	-	-	-
33WX	S	-	-	-
33WZ	F	-	-	-
33XP	F	-	-	-
33XV	F	-	-	-
33XX	F	-	-	-
33XZ	S	-	-	-
33YR	S	-	-	-
33YS	S	-	-	-
33YT	S	-	-	-
33YW	F	-	-	-
3402	S	10.89	9.82	1.07
3403	F	10.94	9.16	1.78
3404	S	10.86	9.75	1.11
3405	S	10.85	9.74	1.11
3406	S	11.04	9.92	1.12
3407	S	10.87	9.81	1.06
3408	S	11.08	9.84	1.24
3409	F	11.16	9.34	1.82
3410	S	10.74	9.8	0.94

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
3411	S	10.86	9.68	1.18
3412	S	10.89	9.57	1.32
3413	S	10.9	9.48	1.42
3414	S	10.75	9.45	1.3
3415	F	10.7	9.19	1.51
3416	F	10.86	9.04	1.82
341E	F	-	-	1
3436	F	-	-	-
34VR	F	-	-	-
34VS	F	-	-	-
34VT	F	-	-	-
34W	S	-	-	-
34VY	S	-	-	-
34WQ	F	-	-	-
34WR	F	-	-	-
351E	F	-	-	-
4010	F	-	-	-
401A	S	10.98	10.06	0.92
4204	F	11.22	9.3	1.92
441A	F	-	-	-
5004	S	12.04	10.8	1.24
503B	S	11.83	11.09	0.74
504A	S	11.81	11.01	0.8
505B	F	11.81	10.38	1.43
5105	S	12.05	10.82	1.23
5106	S	12.69	11.65	1.04
5107	F	12.03	10.47	1.56
5108	S	12.05	11.08	0.97
5201	S	13.08	11.05	2.03
5202	F	12.9	-	-
5216	Z	-	-	-
5217	S	-	-	-
521A	S	-	-	-
52TR	F	-	-	-
52TS	F	-	-	-
52TT	F	-	-	-
52TV	F	-	-	-
52TW	F	-	-	-
52WQ	F	-	-	-
52WR	F	-	-	-
52WS	F	-	-	-
52XS	F	-	-	-
5306	F	12.72	10.81	1.91
541A	F	16.4	13.7	2.7
541B	F	-	13.88	-
541C	F	15.9	15.35	0.55
551D	F	16.1	13.5	2.6
551F	F	16.44	15.54	0.9
551I	S	16.1	13.95	2.15
551J	S	15.6	14.5	1.1

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
551L	S	16.3	15.4	0.9
551N	S	16.3	15.4	0.9
6101	F	12	10.74	1.26
6102	S	12.15	10.18	1.97
6103	F	12.09	9.92	2.17
6104	S	12.16	10.26	1.9
6105	F	12.15	9.98	2.17
6106	S	12.12	10.38	1.74
6107	S	12.09	10.49	1.6
6108	F	12.1	10.1	2
6109	S	12.01	10.74	1.27
6110	F	12.25	9.78	2.47
6111	S	12.06	11.09	0.97
6112	S	12.03	10.98	1.05
6113	F	12.01	10.39	1.62
6114	S	12.25	10.07	2.18
6201	F	13.07	11.6	1.47
6202	S	13.55	11.95	1.6
6203	F	13.78	12.08	1.7
6204	S	13.79	11.79	2
6205	S	12.04	10.86	1.18
6206	S	11.98	10.96	1.02
6207	F	11.96	10.53	1.43
62TQ	F	-	-	-
62TS	F	-	-	-
62TT	F	-	-	-
62TV	F	-	-	-
62TW	F	-	-	-
62VY	F	-	-	-
62VZ	F	-	-	-
62WQ	F	-	-	-
62WR	F	-	-	-
62XP	F	-	-	-
62XQ	F	-	-	-
62XR	F	-	-	-
6301	F	12.21	10.56	1.65
6302	F	12.01	10.05	1.96
6303	F	12.36	11.04	1.32
6304	F	12.05	9.89	2.16
6305	F	12.11	9.68	2.43
6306	S	11.96	10.03	1.93
6308	F	12.81	11.15	1.66
6309	S	12.8	11.99	0.81
6310	S	12.69	11.83	0.86
6312	F	12.6	11.05	1.55
6313	F	12.28	10.97	1.31
6314	F	12.36	11.04	1.32
6315	S	12.74	9.51	3.23
631A	F	-	-	-
631B	F	-	-	-

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
6322	S	-	-	-
6323	F	-	-	-
63WV	F	-	-	-
63WW	F	-	-	-
63WX	F	-	-	-
63WY	S	-	-	-
6401	F	13.34	10.37	2.97
64YS	F	-	-	-
64YV	S	-	-	-
6506	S	13.43	11.37	2.06
6507	F	13.48	11.13	2.35
7101	F	13.21	10.22	2.99
7102	S	13.25	10.67	2.58
7103	F	13	8.9	4.1
7104	S	12.81	9.7	3.11
7105	F	12.78	8.84	3.94
7106	S	12.3	9.63	2.67
7107	F	12.29	8.76	3.53
7108	F	13.13	9.55	3.58
7109	F	13.01	9.58	3.43
7110	F	12.56	9.72	2.84
7111	S	12.68	10.01	2.67
7112	S	13.11	9.84	3.27
7113	S	12.99	9.84	3.15
7201	S	12.88	11.14	1.74
7202	S	12.86	11.97	0.89
7203	F	13.08	10.49	2.59
7204	S	13.11	10.87	2.24
7209	S	12.53	11.02	1.51
7210	S	12.98	12.2	0.78
7217	S	12.92	11.71	1.21
7218	S	12.72	11.2	1.52
7301	F	12.18	9.5	2.68
7302	S	12.16	10.33	1.83
7303	F	12.13	9.39	2.74
7304	S	12.02	9.53	2.49
7305	F	12.31	10.53	1.78
7306	S	12.12	11.23	0.89
7307	S	12.12	10.95	1.17
7308	S	11.88	9.47	2.41
7314	S	12.2	10.64	1.36
7315	S	12.5	10.8	1.7
731A	F	-	-	-
7401	F	-	-	-
741A	F	-	-	-
741B	F	-	-	1
7505	F	13.25	12.28	0.97
8101	S	12.35	9.58	2.77
8102	F	12.37	8.57	3.8
8103	F	12.23	8.47	3.76

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
8106	S	11.41	9.45	1.96
8207	S	12.22	11.26	0.96
8208	F	12.23	10.64	1.59
8209	S	12.23	10.63	1.6
8219	F	11.58	10.33	1.25
821A	F	-	-	1.5
8220	S	11.56	10.3	1.26
8221	F	11.91	10.1	1.81
8222	S	11.86	10.55	1.31
8223	F	11.86	10.06	1.8
8224	F	11.37	9.87	1.5
8225	S	11.41	10.38	1.03
8226	F	11.08	-	-
8227	S	11.06	9.33	1.73
8228	F	10.86	8.47	2.39
8229	S	10.85	10.05	0.8
8233	S	10.74	9.71	1.03
8301	S	11.56	9.53	2.03
8302	F	11.84	10.04	1.8
8303	S	11.77	9.4	2.37
8304	F	11.84	9.22	2.62
8305	F	11.42	9.08	2.34
8306	S	11.37	9.64	1.73
8307	S	11.3	9.5	1.8
8308	S	11.25	10.42	0.83
8309	F	11.43	8.76	2.67
8310	F	11.3	10.15	1.15
8311	F	11.36	10.09	1.27
8312	S	11.12	9.41	1.71
8313	F	11.03	8.57	2.46
8314	S	-	-	-
831A	F	-	-	0.7
831B	F	-	-	-
831C	F	-	-	-
831D	F	-	-	-
831E	F	-	-	0.3
8331	F	-	-	-
8332	S	-	-	-
8333	F	-	-	-
8401	F	11.46	10.09	1.37
8402	S	11.55	-	-
8403	F	11.52	9.2	2.32
8404	S	11.46	9.91	1.55
8405	S	11.42	9.88	1.54
8406	F	11.61	10.65	0.96
8407	F	11.8	10.93	0.87
8408	S	11.41	9.83	1.58
8409	F	11.52	9.02	2.5
8411	S	11.34	9.8	1.54
8412	S	11.35	9.75	1.6

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
8413	F	11.35	8.37	2.98
841A	F	-	-	-
841B	F	-	-	-
8434	F	-	-	-
8435	F	-	-	-
8436	F	-	-	-
8437	F	-	-	-
8438	F	-	-	-
8503	S	12.89	12.42	0.47
8504	S	13.12	12.16	0.96
8505	F	12.83	12.03	0.8
8506	F	12.81	11.83	0.98
8507	F	12.88	11.47	1.41
8508	S	12.79	12.05	0.74
8509	S	12.94	11.61	1.33
8512	S	11.64	10.08	1.56
8513	S	11.55	10.04	1.51
8514	F	11.61	9.38	2.23
8517	F	11.53	10.47	1.06
9001	F	10.55	8.11	2.44
9101	S	10.74	9.91	0.83
9102	F	10.77	8.25	2.52
9103	S	10.72	9.63	1.09
9104	F	10.93	8.68	2.25
9105	S	10.86	9.57	1.29
9106	S	10.65	9.37	1.28
91XS	S	-	-	-
91XT	S	-	-	-
91XW	S	-	-	-
91XY	F	-	-	-
91XZ	F	-	-	-
91YQ	F	-	-	-
9201	F	10.89	8.35	2.54
9202	S	11.46	9.9	1.56
9203	S	10.82	9.77	1.05
9204	S	11.36	9.88	1.48
9206	F	11.54	9.49	2.05
9401	S	11.53	10.22	1.31
9402	F	11.68	10.37	1.31
9403	S	11.54	10.23	1.31
9404	F	11.68	10.23	1.45
9405	S	11.59	10.26	1.33
9406	S	11.66	10.27	1.39
941A	F	-	-	-
9508	S	12.18	10.99	1.19
9509	F	12.18	10.69	1.49
9510	S	11.79	10.75	1.04
9511	F	11.77	10.45	1.32
951A	F	-	-	-

APPENDIX D
SITE LAYOUT DRAWING

ABOUT AECOM

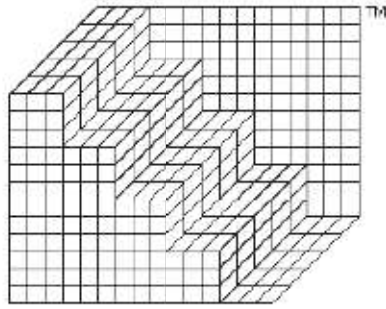
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**023971 Northumberland
Development Project**

Geotechnical Desk Study and
Preliminary Geoenvironmental Risk
Assessment

November 2008

Revision 00

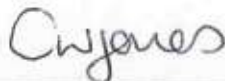
Revision	Description	Issued by	Date	Checked
00	First Issue	CWJ	Nov 2008	ASP

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Geotechnical Desk Study and Preliminary Geoenvironmental Risk Assessment 00-asp.doc

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author **Charlotte Woodhall-Jones**

signature



date **14 November 2008**

approved **Syd Pycroft**

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date **14 November 2008**

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1 Executive Summary

Buro Happold have been appointed by Tottenham Hotspur Football & Athletic Club to carry out a desk based assessment of ground related risks associated with the proposed Northumberland Development Project, in Tottenham North London.

Historically the site has been occupied since 1867 with; residential, offices, industrial uses, and some open space recorded. Current site uses include the existing football stadium (which has occupied the site since 1899) alongside vacant land, retail, commercial and residential properties. There are two industrial estates in the north comprising offices, studios, light industrial workshops and storage facilities.

Records of World War II bombing indicate that the site was subjected to bombing, with exploded ordnance noted within the site boundary.

A review of ground conditions has shown most of the site to be underlain by Made Ground (MG) onto Kempton Park Gravels (KPGR), which is underlain by the London Clay (LC), Woolwich and Reading Beds (WRB), Thanet Sands (TS) and Chalk at depth (approximately 60m below ground level). The Enfield Silt Formation (ESI) is noted between the MG and KPGR in some boreholes in the south east of the site.

The KPGR, WRB and TS are all Minor Aquifers, and the LC is a Non-Aquifer. The Chalk is classified as a Major Aquifer. The site lies within an Environment Agency (EA) Source Protection Zone II and there are several water abstractions within a kilometre, these are likely to be abstracting from the Chalk.

Based on; the nature and extent of potential contaminant sources, current and future end-use, site sensitivity, and the likely implementation of an appropriate health and safety regime, there is a Very Low to Moderate/Low risk to human health from soil contamination, a Moderate risk to human health and buildings from ground gas migration/accumulation, a Moderate/Low risk to groundwater, and a Very Low to Low risk to plants and below ground structures.

Information outlined in this report shows that the site is unlikely to meet the criteria for determination as "Contaminated Land" under Part IIA of the Environmental Protection Act 1990; subject to appropriate site investigation and assessment.

The following geoenvironmental issues require further clarification by ground investigation:

- Composition and extent of contamination within the MG; and near current and historical contamination sources.
- Location of any underground tanks and the extent of contamination associated with them;
- Nature of the ground gas regime associated with the MG, underground tanks, and former fuel station;

- Nature and extent of contamination in groundwater; and
- Likely waste classes for excavated material.

A foundations options appraisal has been undertaken, assessing the relative merits of different foundation options.

Shallow foundations i.e. pads/strips would need to be formed on the KPGR and could provide an allowable bearing capacity up to 400kPa. Their use is subject to confirmation of; engineering properties, levels and extent of the KPGR, groundwater levels, and excavation stability through the MG.

Piled foundations would provide a more suitable and flexible foundation option for larger column loads, obtaining their capacity from the LC and WRB. Their use is subject to confirmation of engineering properties, levels and extent of the LC and WRB. Rather than extend into the WRB, which have known geological hazards, higher pile capacities could be achieved through under-reams in the LC or by using larger diameter piles, however there is an associated risk of increased pile settlement. Given the geological hazards, variable ground conditions and difficulties of obtaining reliable design parameters for the WRB, consideration should be given to carrying out a preliminary pile test.

The study has also highlighted the following geotechnical issues for further clarification by ground investigation:

- High groundwater table;
- Variable and potentially unstable MG with potential for obstructions.
- Engineering properties, level, thickness and extent of KPGR, LC, and WRB.

It is recommended that a combined site specific ground investigation is undertaken, which should include:

- Trial pitting/window sampling of the MG to obtain systematic and targeted samples for laboratory analysis.
- Several boreholes into the LC formation at locations specific to the proposed structures, with a minimum of three 30m+ deep boreholes to penetrate and prove the WRB.
- Detailed logging of all soil and rock samples in accordance with current UK guidelines
- In situ testing to obtain geotechnical design parameters and in situ screening for contamination.
- Geotechnical and geoenvironmental laboratory testing of samples in accordance with current UK guidelines
- Monitoring of groundwater and ground gas levels during- and post-ground investigation.

2 Introduction

Buro Happold Limited was instructed by Tottenham Hotspur Football & Athletic Club to carry out a Desktop Study and Preliminary Risk Assessment of the proposed new Northumberland Development Project, in Tottenham, North London with regard to geotechnical issues and potential ground contamination. Refer to Figure 1 for a location map.

The entire development site including the stadium site is indicated by the red line boundary shown in Figure 2. At present the site is occupied by the existing football stadium, large areas of hardstanding used for car parking, light manufacturing industrial units, warehouses, vacant premises, a steel and metal works, car repair workshops, residential properties and other commercial properties. Paxton Road bisects the site running in an east-west direction.

2.1 Study Aims and Objectives

The assessment has taken the form of a desk based study covering geotechnical and ground contamination issues. The principal objectives of the work were to evaluate the site conditions, identify key risks with respect to ground conditions. The particular objectives of the work are as follows:

- Determine the historical and current use of the site and its surroundings;
- Determine the environmental setting including the likely geological, hydrogeological and hydrological conditions within the site and its surroundings;
- Carry out a Preliminary Contaminated Land Risk Assessment. This aspect of the work was carried out in general accordance with the provisions of the EA/DEFRA Model Procedures for the management of land contamination, 2004 (CLR11) (Ref. 1) and included:
 - identification of potential sources of contamination from past and present land use;
 - identification of potential contaminant migration pathways; and
 - assessment of any potential risks from contamination.
- Identify potential design and construction issues and restraints associated with the proposed development;
- Determine the need for, and scope of, intrusive ground investigation or further more detailed desk based studies necessary to provide information to clarify any identified or discovered potentially significant risks; and
- Consider the status of the site with respect to Part 2A of the Environmental Protection Act and any associated potential liabilities.

2.2 Information Sources

The principal sources of information for this desk study included:

- Landmark Envirocheck Report 23761205_1_1 (December 2007)
- Historical ground investigation reports
- Published geology and groundwater vulnerability maps
- British Geological Survey (BGS) archive borehole logs
- Bruce Castle Museum Archives
- Literature
- Online sources

A site walkover survey was undertaken by Buro Happold on 22 May 2008. The objectives of this walkover were to assess visual evidence of any contamination, to review on-site activities/processes and associated standards of housekeeping, to identify surrounding land uses regarding impact on the site, to assess the access available for future ground investigations and to identify any geotechnical issues currently on the site. The observations and conclusions drawn from the site walkover are solely based on those areas accessed by Buro Happold at the time of the walkover. Those areas not accessed by Buro Happold were private property.

This report is based upon information obtained from third-party sources together with observations from the site walkover survey. The third-party data have been accepted at face value and have not been independently verified. Buro Happold can therefore give no warranty, representation or assurance as to the accuracy or completeness of such information. The depth of research and extent of the information discovered has inevitably been limited by the time period available for the study.

3 The Site

3.1 Site Location and Description

The development site ("the site") is located in Tottenham, within the London Borough of Haringey, North London. The approximate Ordnance Survey National Grid Reference for the centre of the site is 534010, 191270. The location is shown in Figure 1.

The site boundary and detail is shown in Figure 2, is roughly rectangular in shape and covers an area of approximately 11.5ha. Paxton Road bisects the site running in an east-west direction from Worcester Avenue in the east to High Road in the west.

The area to the north of Paxton Road is generally flat, with levels typically between +12.0m OD and +12.6m OD, with the exception of the northwestern corner which lies at +11.5m OD. The area to the south of Paxton Road is also generally flat, with levels typically +11.7m OD with the exception of a low spot in the southeastern corner (+10.7m OD)

The site is currently bounded by the following:

- To the east: Worcester Avenue, residential housing, Northumberland Park Community Secondary School, Northumberland Park Sports Centre and St Paul's and All Hallows School.
- To the south: Park Lane, community centre, public house, café and car workshop.
- To the west: High Road, St Francis de Sales Church and Junior School, library, retail and residential properties.
- To the north: place of worship, residential and retail properties.

Selected photographs of the site and surrounding area taken on the site visit are presented in Appendix A.

3.2 Site History

The history of the site has been traced using Historical Ordnance Survey (OS) maps dating from 1867 to 2007. These maps were provided in the Envirocheck Report and are included in Appendix B. Based on this information, a summary of the history of the site and the immediate surrounding area (SA) is provided in Table 3-1. Key historical changes are shown in Figure 3.

Table 3-1 Summary of Historical Development

Map Reference	Location		Salient Features
	Site	SA	
1867 Middlesex (1:2500)	✓		Dwellings including residential and public house E and N fronting High Road and Northumberland Park respectively. Orchards & Open Space.
		✓	Brunswick Nursery and Brewery, a Chapel and Vicarage 100m to the NW. Further dwellings and schools from 15m to the N, S and W.
1876 Essex & 1876-81 Middlesex (1:10,560)		✓	Stoke Newington & Edmonton Railway line to the 200m W, Tottenham and Edmonton Gas works 1000m NW, Brick Clay Mill 200m W, India Rubber Mills 900m S, Great Eastern Railway 700m E and a brick field 700m NW.
1896 London (1:2500), Middlesex & London (1:10,560) & 1897-98 Essex (1:10,560)	✓		Orchards cleared, Tottenham Nursery built to the S, Paxton Road constructed from High Road to the E.
	✓		Orchards cleared, dwellings to the SE.
		✓	Tramway along High Road running N to S, Brick Clay Mill demolished, Tottenham and Edmonton Gas works expanded, Longwater Pumping station 1000m E. Orchards replaced with nurseries and dwellings to E, brick field 700m NW.
1913 Middlesex	✓		Football Stadium to the SE, Tottenham Nursery demolished, Paxton Road extended E and S to Park Lane, residential dwellings E fronting Paxton Road. Further dwellings and Crown Lane N of Paxton Road.
1920 Middlesex, Essex and London (1:10,560)		✓	Gravel pit in brick field & kiln 700m NW, possible pit 700m W, refuse destructor 1000m N. Lockwood Reservoir 1200m SE & Infirmary 900m NW. No longer India Rubber Mills 900m S, Engineering Works 100m NE.

Map Reference	Location		Salient Features
	Site	SA	
1935 Middlesex (1:2500)	✓		Large increase in residential & industrial development. Industrial units including (inc.) a mechanical engineering manufactory & brewery. Residential dwellings fronting new Worcester Avenue & allotment gardens, stadium extended E to Paxton Road, N & S stands built.
	✓		Industrial units including Precision Machinery manufactory.
		✓	Sports ground to E replaced nurseries. Further industrial premises inc. furniture manufactory 100m NW and residential dwellings mainly from 50m to N, S and E.
1938 Middlesex (1:10,560)		✓	Gravel pit & brick field 700m NW replaced by further industrial buildings inc. a weatherproof manufactory & distillery. Growth of industrial buildings from 1000m NE inc. clothing factory & electric platinum works.
1946 Essex (1:10,560)		✓	Possible pit 700m W and large buildings 100m NE, later shown as Works.
1955-56 Ordnance Survey Plan (OSP) (1:1250), 1956 OSP (1:2500) & 1952 OSP(1:10,560)	✓		Increase in industrial premises inc. engineering works, bottling stores, paper works, shoe factory, garages and piano works. Wingate Trading Estate established, Worcester Avenue extended south to Paxton Road, Albion Works noted as 'ruin' (possibly linked to WWII bomb damage).
	✓		Increase in industrial premises inc. engineering works N.
		✓	High Road Tram removed, some terrace dwellings surrounding site demolished (possibly linked to WWII bomb damage), TA centre and fire centre 50m SW, day nursery & welfare centre 170m E, a goods and coal depot 130m NW. Pit shown 700m W.
1964-71 (1:1250), 1969 (1:2500) &	✓		Growth of Wingate Trading Estate, 'ruin' demolished, building occupying allotment gardens, depot and surgery N of Paxton Road.

Map Reference	Location		Salient Features
	Site	SA	
1962-68 OSP (1:10,560)		✓	Works 100m NW and NE, large increase in industrial buildings (depots and works) 900m E, tower blocks 100m W and 130m E. Sports centre 50m SW replaced TA centre.
1970-77 OSP(1:1250), 1975-77 OSP (1:10,000) & 1974 Survey of Unpublished Survey Information	✓		Milk depot, works, warehouses, electrical substation, engineering works and surgery. Garages removed.
	✓		Engineering Works to the N extended, residential dwellings demolished fronting Park Lane, electrical substation, bank and works.
		✓	Two schools built 15m E, school 60m W extended, church 15m SE demolished, playground 100m W, carriage sheds 800m SE as part of Great Eastern Railway.
1977- 84 & 1981- 86 (1:1250) Additional SIMS, 1975-85 (1:1250) OSP & 1983-88 OSP (1:10,000)	✓		Government offices, Kingdom Hall and extension of works replaced Crown Road and dwellings N of Paxton Road.
1990-95 OSP (1:10000), 1991-92 & 1991 Large- Scale National Grid Date (1:1250)	✓		Works fronting Northumberland Park extended.
		✓	Sports Centre 30m E of boundary, church rebuilt 15m SE.
	✓		SW Works demolished now open space possibly for car parking.
	✓		Works fronting Northumberland Park subdivided into smaller buildings, Gibson House Business Centre established.
1999 & 2007 10K Raster Mapping (1:10,000)		✓	Tottenham and Edmonton Gas Works 1000m NW decreased in size, Industrial Estates 150m NW & 600m NE.
	✓		Buildings demolished between the football stadium and Paxton Road.

3.3 Current Site Use

The site and surrounding areas were visited by a representative of Buro Happold Ground Engineering on 22nd May 2008 as part of this study. Selected photographs taken during the site visit have been included as Appendix A and Figure 4 shows a current site use plan.

The majority of the site to the south of Paxton Road is occupied by the existing Tottenham Hotspur Football Stadium and hardstanding currently used for car parking. Vacant, retail and residential properties as well as other commercial properties front onto High Road.

Immediately to the north, fronting Paxton Road, are sheet metal works, offices, a place of worship and a large area of hardstanding currently used for additional car parking for the stadium. A former fuel station at 776 High Road, which is currently a shop, is understood by the Client to have foam filled underground tanks associated with its previous use, see Appendix C for location. The petroleum section of the London Fire and Emergency Planning Authority does not hold records on whether these tanks were foam filled or not however does hold plans from September 2006 (Appendix C) showing the location of the tanks and indicating previous tanks were to be excavated and removed. Further retail, residential, vacant and other commercial premises front onto the High Road.

Wingate Trading Estate to the north consists of offices, studios, light industrial workshops and storage space. Properties within the Gibson Business Centre consist of a dyers, church and solicitors. Access from High Road to these areas of the site is restricted because of low head room. To the far north of the site, it is mainly occupied by industrial and office premises including car repair workshops and storage warehouses. There is also a place of worship, some residential and retail properties. Mature trees were noted in the north of the site.

3.4 Evidence of Contamination

During the site visit, a new diesel tank (Appendix A) was noted in the football stadium car park, opposite the west stand main entrance. There was no evidence of leakage was observed. A second tank (Appendix A) to the north of Gibson Business Centre was identified but the content is unknown. Oil tanks (Appendix A) were noted in the car repair workshops and gas cylinders identified behind the church in Gibson Business Centre. An electrical sub-station to the north of Paxton Road was identified; however, due to access restrictions, the locations of the two sub-stations noted by the Envirocheck Report (Appendix B) were unable to be verified. The locations of these sub-stations and tanks are shown in Figure 5.

General housekeeping within the Sheet Metal Works north of Paxton Road and car repair workshops fronting Northumberland Park was poor.

3.5 Regulatory data

Information related to various regulatory controls is presented in Appendix D. The potential for any hazardous materials associated with these activities to impact upon the ground conditions on site are summarised in Table 3-2 below.

Table 3-2 Summary of Regulatory Data

Issue	Location [On/ off site]	Information	Potential to impact site
Landfill sites	One 810m SE	Landfill 1955-1962. Inert and Industrial Waste	No
Licensed waste management	Two 112-166m NW, Four within 501-1000m	Redcorn Ltd, (i) Metal Recycling Sites (Vehicle Dismantlers) issued 10th January 2005, expiry Unknown (112m NW), and (ii) Metal Recycling Sites (Vehicle Dismantlers) Issued 22nd May 1996, expiry unknown (166m NW)	No
Registered waste transfer sites	Three between 816-988m	Lead/ Acid Batteries, inert gases, General Non-Putrescible Mineral Oils, Difficult General Waste and 'Putrescible' waste specifically for recycling. License Operational as far as known. Construction and demolition wastes (license lapsed), household waste and waste mineral oil, (license superseded).	No
Registered waste treatment or disposal sites	One 186m NW One 981m NE	Redcorn Ltd (186m NE), authorised waste: engines, gearboxes, axle assemblies and scrap motor vehicles (operational, dated 22nd May 1996).	No
Registered contaminated land	None	-	No

Issue	Location [On/ off site]	Information	Potential to impact site
LAAPC [Local Authority Air Pollution Control]	Two within the site, One 0-250m, three 251-500m and nine up to 1000m	Onsite: North of Paxton Road, Autohouse, respraying of road vehicles 3rd November 2000 (authorised) and Oakstead Hotspur Petrol Filling Station 17th April 2001 (authorised). Offsite: Respraying of road vehicles, Petrol Filling Station, Wood Coating, Chemical treatment and manufacture of timber and wood-based products, Aluminium and aluminium alloy processes and general waste incineration processes etc.	Yes No
Pollution incidents	Two 120-222m, four within 251- 500m, ten within 501-1000m.	White Hart Lane (120m N), Category 3-Minor Incident, Unknown Sewage 18th April 1995. Pymmes Park (222m NW), Category 3-Minor Incident, Unknown Oils, 10th March 1992.	No
Prosecutions relating to authorised processes/ controlled waters	None	-	No
Discharge consents	None	-	No
Enforcement Notices	Two between 480m -599m	Air pollution control enforcement notice for 20-27 Commercial Road, Edmonton (480m NW) 11th July 1996 and Unit 16-17 Landmark Commercial Estate, Shaftsbury Road (599m NW) 22nd April 1996.	No

Issue	Location [On/ off site]	Information	Potential to impact site
Fuel stations	One on site, one 479m N, three between 558-725m	On site: Hotspur Service Station, north of Paxton Road, Closed. Offsite: Edmonton Service Station, (479m N), Open. Wilsons Service Station (558m SE) Obsolete, Tcs Grove (658m SE) Open, Tcs High Cross (725m SW).	Yes No
Hazardous substance	One 965m NE	Transco, Liquefied extremely flammable gas (including LPG) and natural gas (liquefied or not), Planning Hazardous Substance Consent 16th November 1992, withdrawn. Notification of Installations Handling Hazardous Substances and Control of Major Accident Hazard Sites both active.	No
Registered Radioactive Substances	Eight 920m NW	North Middlesex Hospital (920m NW) (31st March 1991 -1st December 2003) including disposal of radioactive waste (four registrations), and keeping and use of radioactive materials (one registration).	No

Issue	Location [On/ off site]	Information	Potential to impact site
Trade Directory Entries	34 on site, 66 (0-250m), 75 (251-500m), 197 (501-1000m)	Onsite: Manufacturers (2), Sheet Metal Work, Soft Furnishings Manufacturers, Mot Testing Centres, Petrol Filling Stations, T-shirts, Footwear Manufacturers, Footwear Manufacturers & Wholesale, Car Body Repairs, Cash Registers & Check-Out Equipment, Clothing & Fabrics Manufacturers (10), Garage Services (3), Lithographic Plate Makers, Cabinet Makers, Telecommunications Equipment & Systems, Clothing Accessory Manufacturers, Car Breakers & Dismantlers, Pest & Vermin Control (2), Dyers, Textile Manufacturing, Scientific Apparatus & Instruments Manufacturers. Offsite: (0-250m) Packaging & Wrapping Equipment & Supplies, Floorcoverings- Manufacturers & Wholesalers, Furniture Repairing & Restoring, Clothing Accessory Manufacturers, Refrigeration Equipment Commercial, Garage Services, Dry Cleaners, Waste Disposal Services, Mot Testing Centres, Car Body Repairs etc (refer to Appendix D for further Trade Directory Entries).	Yes No

3.6 Unexploded Ordnance (UXO)

According to online sources including BBC internet archives (www.bbc.co.uk/ww2peopleswar), the Tottenham area was extensively bombed during World War II. Amongst those buildings which were damaged were the St Francis de Sales School, immediately to the west of the site and residential housing approximately 500m to the southeast.

Inspection of the 1935 Middlesex 1:2500 and 1955-56 Ordnance Survey Plan maps indicate that during this period, some significant areas of demolition occurred within and near the development site. The main clearance areas were to the north and south of Church Lane, 40m southwest of the site. In these areas, high density terrace housing and a convent was replaced post-war by much lower density developments including a TA Centre. Small sections of terrace housing had been demolished from 40m west of the site. These demolitions could have been as a result of bomb damage during World War II.

According to the bomb record map obtained from Bruce Castle Museum, reproduced in Figure 6, only exploded incendiary bombs were recorded falling on the Tottenham Hotspur stadium site including one in the football pitch. Within the remaining development site, two exploded anti-aircraft shells, one unexploded incendiary bomb, one unexploded and two exploded high explosive bombs were recorded.

There is a potential that UXO may be present at the site. This conclusion is based on:

- records that Tottenham was bombed extensively during WWII;
- evidence of possible bomb damage from historical maps; and
- the fact that re-development post-WWII will have reduced any risk.

As a minimum it is recommended that an appropriately good standard of health and safety is implemented during any intrusive investigation and/or earthworks including toolbox talks. Provision should be made for encountering UXO or any suspect items, which should include these being reported to the authorities for appropriate identification and disposal if required. It is standard good practice to be vigilant for the presence of unidentified objects on any site and especially within an urban environment.

3.7 Underground Structures

Since the site has been extensively developed in the past, there is a risk of encountering historic foundations from previous developments. On the site visit, it was noted that within the area of hardstanding north of Paxton Road, several buildings had been razed but the foundations have remained as shown in Appendix A. There was also evidence of foundations and ground floor slab for a new building, north of Gibson Business Centre Appendix A. However, building has currently ceased.

According to 'Football Grounds of Britain' (ref.2), the foundations from the old nursery greenhouse foundations were removed in 1953 when 3500 tons of subsoil was removed from the pitch.

Historic maps indicate that the proposed stadium site has been occupied in the past by terrace housing. These may have had basements or coal cellars which were probably backfilled by rubble. This possibility has been highlighted in SOILTECHNICS ground investigation report 2005 (ref. 3). As such, there is a risk that cellar walls and floors are encountered during intrusive ground investigation, or during future construction activities.

The risk of subsurface obstructions across the whole site will need to be considered for any proposed foundation works. It might be feasible to obtain a better understanding of these risks by; obtaining any available structural records of the existing buildings, and, if necessary, investigating any identified subsurface obstruction during the ground investigation.

The Envirocheck report (Appendix B) has identified two tanks and two potential tanks and a former petrol station within the proposed stadium site. SOILTECHNICS ground investigation report 2005 notes that underground tanks and fuel lines still remain under the former petrol station, believed to be foam filled. The

location of these tanks is shown in Appendix C on a plan produced by London Fire & Emergency Planning Authority.

The development site is not affected by the London Underground or any buried Ministry of Defence (MOD) assets (ref 4). Given the location of the site in London, it is also not affected by the Post Office Rail Tunnels, Cross Rail, the Chelsea-Hackney Line and the London Ring Main including the proposed extension from New River to Stoke Newington and Copper Mills.

There is the possibility that old Victorian sewers are beneath the development site. Further desk study investigation by the design team may assist in assessing the risk of encountering any sewers; however, it is likely that a residual risk will need to be carried forward.

3.8 Site Utilities

Service plans have been requested from the relevant utility companies in order to obtain information on the expected position and extent of buried and over-ground cables, pipes, wires etc, which may present constraints on future site development works. Refer to Buro Happold drawing number C0300 Existing Combined Utilities by Infrastructure 29.

It should be noted that the service plans issued by the various utility companies will only record the public mains locations and do not generally include private supply routes. As such, the information available for most development sites is usually restricted to the periphery (unless public roads or rights of way cross the site) and therefore, the absence of service routes beneath the footprint of the proposed development site on such drawings is not confirmation that the site is clear of services. Any private service routes connecting the mains to any existing buildings thus need to be identified and located. It is therefore normally recommended that a full utilities survey is undertaken prior to the commencement of site works.

4 Environmental Setting

4.1 Geology and Ground Conditions

According to the geological map for North London, (ref. 5) and the Envirocheck Geology Report (Appendix E), the sequence of strata beneath the site is summarised as the Kempton Park Gravel Formation underlain by London Clay, the Woolwich and Reading Beds and Thanet Sands. The Thanet Sands are underlain by the Upper Chalk. The southeast corner of the site is also recorded to be underlain by the Enfield Silt Formation (Brickearth) which overlies the Kempton Park Gravels.

Borehole logs have been obtained from historical ground investigations and British Geological Survey (BGS) (Appendix E) which are consistent with the geological description. Taking into account the geological map for North London (2006), the BGS borehole records and previous ground investigations, the expected geology underlying the site is summarised in Table 4-1 below.

Table 4-1 Summary of Anticipated Geology

Name	Lithological Description	Thickness (m)	Top of Layer	
			Depth (m BGL)	Elevation (m OD)
Made Ground (MG)	Concrete/ Tarmac covered MADE GROUND typically clayey SAND and GRAVEL occasionally sandy CLAY with GRAVEL. Gravels typically of brick, flint, clinker, ash, chalk, glass, slag and china with rare occurrence of organic material i.e. wood. Pipes and historical foundations encountered in some exploratory holes.	0.50 – 3.80 (average 1.9)	0	+10.40 to +13.91
Enfield Silt Formation (ESI) (partial cover in south only)	Firm to stiff silty CLAY with rare/occasional sand and fine to medium GRAVEL. Occasional organic matter noted.	0.55 – 1.25 (average 0.7)	0.50 to 0.95 (average 0.7)	+10.25 to +10.55

Name	Lithological Description	Thickness (m)	Top of Layer	
			Depth (m BGL)	Elevation (m OD)
Kempton Park Gravel Formation (KPGR)	Medium dense to dense SAND and GRAVEL with some pockets/lenses of firm clay, rare organic matter. Gravels of flint and quartz.	2.20 – 5.70 (average 3.9)	1.05 to 3.80 (average 2.1)	+8.38* to +11.25*
Weathered London Clay (WLC)	Weathered brown CLAY~	0.15	5.25	+6.25
London Clay (LC)	Stiff to very stiff grey blue closely fissured silty CLAY with fine sand partings. Occasional pyrite and claystone.	14.10 – 18.35 (average 16.2)	4.10 to 7.40 (average 6)	+5.09* to +6.95
Blackheath Beds (BHB)	Fine sandy CLAY with rare fine to medium gravel where encountered#	0.20	23.60	-12.10
Woolwich and Reading Beds (WRB)	Generally very stiff grey-blue slightly red-green friable/fissured slightly silty CLAY. Note limestone (1m thick) and sandstone (1.8m thick) bands at variable depths.	7.50 (where proven)	20.80 to 24.00 (average 22.3)	-12.30 to - 8.72*
Thanet Sands (TS)	Very silty fine SAND where encountered.	Not proven (~30m)	29.3	-18.90
Chalk		Not proven	Not proven ~ 60	Not proven ~ 47

Only encountered, Soil Mechanics South Stand (ref 6) borehole 1, ~ Only encountered, Soil Mechanics South Stand (ref7) borehole 2, * OD levels have been interpreted from the most recent topographic survey

4.2 Ground Instability and Geo-Hazards

Details on potential ground stability and geo-hazards are included in the Envirocheck report and summarised in Table 4-2 below.

Table 4-2 Summary of Geo-hazards

Hazard Type	Hazard Applicable to this Site?		Hazard Potential for site recorded in Envirocheck Report
	No	Yes	
Collapsible Ground Stability		✓	'Moderate'
Compressible Ground Stability	✓		'No hazard'
Ground Dissolution Stability	✓		'No hazard'
Landslide Ground Stability		✓	'Very Low'
Running Sand Ground Stability		✓	'Low'
Shrinking or Swelling Clay Ground Stability		✓	'Moderate'

4.2.1 Engineering in the Woolwich and Reading Beds

The WRBs are part of the Lambeth Group. Engineering in the Lambeth Group is subject to hazards associated with uncertainties stemming from its geological history. Some of these uncertainties are the:

- highly variable stratigraphic conditions;
- permeability contrast between adjacent sand layers;
- difficulty of interpreting piezometric profiles;
- difficulty of obtaining good undisturbed samples for geotechnical testing.

A full discussion of the engineering hazards associated with the Lambeth Group is given by Hight et al, Engineering in the Lambeth Group, CIRIA Report C533, London, 2004 (ref. 18).

4.3 Hydrology

The nearest surface water feature is the River Moselle located 357m to the west of the site boundary. The river at this point flows in a north easterly direction and is only visible for approximately 500m through Tottenham Cemetery, flowing in a natural open gully which is partially concrete lined in places. On exit from the cemetery, at the junction between White Hart Lane and Beaufoy Road, the River Moselle becomes culverted [Haringey's Hidden Streams Revealed by Pinchey and Dell] (ref 8). Both Haringey's Hidden Streams Revealed (see Figure 7) and British History Online (ref. 9) record that the River Moselle then flows to the junction with White Hart

Lane and High Road, before turning south along High Road to Scotland Green where it continues eastwards towards Tottenham Marshes. Based on the available information (Figure 7), the River runs along the western edge of High Road, adjacent to the western boundary of the site, but the possibility that the course of the river crossed the site before this map was published cannot be excluded.

Further water courses, the nearest approximately 800m towards the east of the site, were either infilled or culverted between 1876 and 1946. If these water courses were culverted, the route is unknown and there is a small risk that culverted rivers pass under the site. Two areas of potentially infilled land, previously identified as surface water features, have also been reported on the eastern site boundary.

The western boundary of the site lies within a zone 2 fluvial floodplain where the annual probability of flooding of a river is between 1 in 100 and 1 in 1000. This is a medium to low risk zone as defined by the Environment Agency (EA) and as such a flood risk assessment in accordance with PPS25 (ref 10) is required prior to development at the site.

4.4 Hydrogeology

The National Rivers Authority groundwater vulnerability map for Thames Estuary (ref 11) and the Envirocheck Report (see Appendix D) both indicate that with the exception of the southeast corner, there is a 'Minor Aquifer (variably permeable)' with soils of high leaching potential (HU- High Class/Urban) underlying the site.

According to the National Rivers Authority groundwater vulnerability map, the KPGR Formation, the WRBs and the TS Formation are all Minor Aquifers as defined in Table 4-3 Minor Aquifers are important for local supplies and supplying base flow to rivers but do not tend to be used for abstracting large quantities of water. The Chalk is designated by the EA as a Major Aquifer that is of very high importance to the regional water supply. The Environment Agency should therefore be consulted, and any applicable licences obtained, if any activities that are likely to pose a risk of creating a contamination pathway into the Major Aquifer are to be carried out; this includes approvals for borehole drilling methodology and installation details etc.

High leaching potential soils have little ability to attenuate diffuse source pollutants and may allow the rapid transfer of non-absorbed diffuse source pollutants and liquid discharges into underlying strata or groundwater. It should be noted that in urban areas, the classification is based on fewer observations than elsewhere. A worst-case vulnerability classification of H (High Class) has therefore assumed for these areas.

The southeast corner of the site, according to the National Rivers Authority groundwater vulnerability map, is underlain with a 'Non Aquifer (Negligibly Permeable)'. This is because of the presence of the Enfield Silt Formation. The LC formation is also defined as a 'Non Aquifer' which may act as an aquiclude, protecting the underlying Minor Aquifers (WRB and TS) and the Major Chalk aquifer from downward migration of contaminants.

The majority of the site, excluding the northwest corner, is within a Groundwater Source Protection Zone (SPZ) II (Outer Protection Zone). This is described by the Environment Agency as *'either 25% of the source area or a*

400 day travel time whichever is greater. A Zone 1 SPZ as described in the report as *'travel time of 50 days of less to the groundwater source'* is located 216m southeast of the site. The Park Wells abstraction borehole reference Th271 is 898m southeast of the site. The aquifer this borehole abstracts from is unknown but is likely to be the Chalk.

The Envirocheck Report recorded no groundwater abstractions within the site boundary. The closest operator has had three abstraction licenses for *'Rubber: General Cooling (Existing Licenses Only) (High Loss)'* at 881 High Road, approximately 285m northeast of the site. Between 501m and 1000m of the site, six licenses have been issued and a further twenty seven up to 2000m have been recorded in the Envirocheck report, see Appendix D.

Within the site boundary, three different ground investigation reports have been obtained with groundwater level data as summarised in Section 6.1, below. The data are summarised in Table 4-3, providing an indication of ground water levels in the different geological strata. These groundwater levels are subject to seasonal variation.

Since there are large variations in recorded groundwater levels and the pitch level is likely to coincide with the water table, it is therefore recommend that monitoring of groundwater levels in the various strata is included as part of the ground investigation programme. To obtain maximum benefit from this monitoring it should be initiated as soon as is practically possible, and should ideally include a complete seasonal cycle of observations.

Table 4-3 Observed ground water levels (refer to Figure 8 for borehole location map)

Name	Ground Water Levels		Aquifer Type	Comments
	Minimum mOD	Maximum mOD		
MG	-	-	Not Classified	Water struck at +8.9m OD ¹ . Water found in borehole at +12.41m OD.
ESI (south east only)	-	-	Non Aquifer	-

Name	Ground Water Levels		Aquifer Type	Comments
	Minimum mOD	Maximum mOD		
KPGR	+8.5	+9.4 ¹	Minor Aquifer	Levels taken from piezometers. Water struck during drilling between +7.22m OD ¹ and +8.75m OD ¹ . Maximum rise 0.58m. Water found in borehole from +5.9m OD to +8.5m OD.
LC	-5.27	+5.1	Non Aquifer	Levels from pneumatic piezometers. Seepage recorded in BH2 (south stand) at +2.5m OD and -8.5m OD. Water encountered in boreholes after 15 hours (at the beginning of the shift) at borehole elevations between -10.07m OD and +1.3m OD.
WRB	-17.1	-14.9	Minor Aquifer	Levels from pneumatic piezometer. Water struck in boreholes between -10.91m OD ¹ and -8.82m OD ¹ with maximum rise of 0.9m (into London Clay) after 15 minutes. Water encountered in boreholes at elevations between -12.5m and -10.6m OD.
TS	-	-	Minor Aquifer	Water struck at -19.6m OD, rose by 2.9m to -16.7m OD after 20 minutes.
UC	-	-	Major Aquifer	-

Note: ¹.Where historical reports reported no ground levels; levels have been interpreted from the most recent topographic survey and noted.

4.5 Radon

Less than 1% of homes are affected by radon in the area of the proposed development. In accordance with Building Research Establishment (BRE) Digest BR211 Radon: Guidance on Protective Measures for New Dwellings, no radon protection measures are required for new dwellings or extensions in the site.

5 Proposed Development

The Northumberland Development Project comprises three distinct areas; North, Central and South.

The northern part of the development is occupied by a supermarket including offices and plant room. The supermarket will be suspended over a ground floor level car park, and the total structure will be approximately three-storeys high.

The central part of the site is occupied by the new stadium for Tottenham Hotspur Football Club.

The southern part of the site is occupied by residential dwellings, and the club store and offices. The residential dwellings comprise three blocks, up to a maximum of 12 storeys in height, with the first two-storeys comprising car parking. There is a movement joint between the residential development and the club store and offices, with the club store occupying the first two-storeys, and the offices filling the remaining space up over variable levels up to a total of six-storeys.

To achieve the proposed developments within a tight urban setting may require adoption of phased construction processes.

6 Previous Investigations

6.1 Onsite

The following site investigation and ground investigation reports, listed in Table 6-1, have been obtained and reviewed as part of this study for areas within the site boundary. Locations of all holes have been summarised in Figure 8.

Table 6-1 Summary of previous ground investigations located within the site

Company/ Date Published		Report	Investigation Detail
October 2005	SOILTECHNICS	Proposed Residential Redevelopment On land Off Paxton Road, Tottenham – Ground Investigation Report (ref 3) and Report on the Classification of waste soils for off site disposal (ref 12).	Eight cable-tool percussion boreholes (up to 25m bgl) and three exploratory boreholes (up to 4m bgl) using driven tube sampling equipment. Gas and groundwater monitoring standpipe piezometers installed in three boreholes and in three exploratory boreholes.
December 1993	Soil Mechanics	Site Investigation for Tottenham Hotspur Football Club South Stand (ref. 6).	Three cable-tool percussion boreholes up to 30m bgl. Three trial pits up to 3.4m bgl. Standpipe and pneumatic piezometers installed in two boreholes. Window sampling at the base of two trial pits.
January 1993	Soil Mechanics	Site Investigation for North Stand Roof Towers, Tottenham (ref 7).	Two cable-tool percussion boreholes up to 30m bgl. Two trial pits up to 2.6m bgl. Standpipe piezometers installed in both boreholes.

6.2 SOILTECHNICS Report – Key Findings

SOILTECHNICS undertook a geotechnical and geoenvironmental investigation in August 2005 for a site immediately north of Paxton Road.

Access for the ground investigation was restricted to the car park, former petrol station and the car repair workshop which has since been demolished. Services surrounding the entrance to the car park and the former petrol station forecourt also restricted the site investigation.

Key findings of the investigation have been summarised below:

- The Enfield Silt Formation was not recorded in boreholes BH5 to BH8 as expected; Made Ground comprising concrete, ash and brick fill was noted instead.
- Groundwater was encountered in the Kempton Park Gravels between 3.17 and 3.47m below ground level. Using the current topographical survey, these are equivalent to levels of +8.7 to +9.4m OD
- Groundwater was also encountered within the made ground at depths as shallow as 2.6m below ground level. Using the current topographical survey, this is approximately equivalent to +9.8m OD.
- Risk of encountering former cellar walls or floors during intrusive ground works, and risk of unstable excavations.
- Near surface deposits are Design Sulfate Class DS-1 and Aggressive Chemical Environment for Concrete (ACEC) AC-1.
- Tanks noted beneath the former petrol station; location and size was unknown, but it was understood that these tanks and their fuel lines were foam filled.
- A slight hydrocarbon odour from the Kempton Park Gravels noted at 2.6m depth in DTS102.
- Laboratory data shows elevated concentrations of arsenic (up to 32mg/kg), lead (up to 1100mg/kg), benzo(a)pyrene (up to 10mg/kg) and PAH (up to 120mg/kg) in the near surface soils, and elevated concentrations of benzo(a)pyrene (18mg/kg) in the groundwater.
- Gas monitoring of the Made Ground and gravels recorded a maximum concentration of carbon dioxide of 12%v/v and methane of 24.5%, with low flow rate (0 l/hr).

6.3 Soil Mechanics South Stand Report

Soil Mechanics undertook a geotechnical investigation in October 1998 for the south stand at Tottenham Hotspurs Football Ground.

Key findings of the investigation have been summarised below:

- The Enfield Silt Formation was not recorded in boreholes BH1 and BH3 as expected based on the geological map.
- Limestone and sandstone bands were encountered within the Woolwich and Reading Beds
- Standard penetration tests were carried out and gave the following ranges for strata
 - o Enfield Silt Formation N 21
 - o Kempton Park Gravels N 12-33
 - o London Clay N 5-35
 - o Woolwich and Reading Beds N 32-52
- Groundwater was encountered in the Kempton Park Gravels between 1.9m and 2.85m below ground level (+8.5m OD and +8.65m OD).
- Piezometers in the London Clay and Woolwich and Reading Beds recorded ground water levels at +5.1m OD and -17.1m OD respectively, with seepages noted in the London Clay.
- pH values between 7.1 and 8.9 and water soluble sulphate up to 2.04 g/l was recorded in the London Clay.
- pH value of 9.8 and water soluble sulphate of less than 0.01 g/l was recorded in the Woolwich and Reading Beds.

6.4 Soil Mechanics North Stand Roof Towers Report

Soil Mechanics undertook a geotechnical investigation in November 1992 for the north stand at Tottenham Hotspurs Football Ground.

Key findings of the investigation have been summarised below:

- The Enfield Silt Formation was not recorded in borehole BH102 as expected based on the geological map.
- Claystone and pyrite were recorded in the London Clay, which was also noted to contain lenses and pockets of very fine grained sand.
- Standard penetration tests were carried out and gave the following ranges for strata
 - o Kempton Park Gravels N 14-44
 - o London Clay N 14-55
 - o Woolwich and Reading Beds N 31-56

- Piezometers in the London Clay and Woolwich and Reading beds recorded ground water levels at -5.27m OD and -14.9m OD respectively.
- pH value of 10.5 and water soluble sulphate of 1.32g/l was recorded in the Made Ground
- pH value of 8.7 and water soluble sulphate of 0.42g/l was recorded in the Enfield Silt Formation.
- pH values between 7.5 and 7.8 and water soluble sulphate of up to 0.98 g/l was recorded in the London Clay.

7 Preliminary Contamination Risk Assessment

7.1 General Approach

In the UK, the assessment of risk from contamination follows the source-pathway-receptor approach. If one of these three elements is absent it is considered that there is no risk of harm. If, however, there is considered to be a linkage between any given source and any given target/receptor then a risk-based approach is used to assess the significance or impact of any such linkage.

Risks are defined as the probability of an event occurring combined with the severity of the consequence of that event occurring. Particularly, to assess the risk to site end-users posed by any given source, the sensitivity of each receptor is considered. For example, the concentration of contamination acceptable at a site to be developed as a residential property with a garden used to grow vegetables and accessible to young children is set lower than that for a commercial site where soil is exposed in minor areas of landscaping and the only long-term users of the site are adults. Similarly, a site overlying a major aquifer supplying potable water to a large population will be considered more stringently than a site overlying an impermeable geology with only minor seepages of groundwater.

7.2 Source-Pathway-Receptor risk assessment

The potential contaminant sources relevant to this site are listed in Table 7-1. The potential receptors and the plausible exposure pathways that could link them to the identified sources are described in Section 7.2.2. The risk assessment is presented in Appendix F and the results summarised in Section 10.1.

7.2.1 Contamination sources

Identified potential contamination sources from former uses of the site and neighbouring area have been summarised on Figure 9. The 'Contaminants of Concern' in this risk assessment are based primarily on information from the review of historical information, the results of the walkover survey and reference to DEFRA R&D Publication CLR 8 'Priority contaminants for the assessment of land' (ref. 13) and relevant Industry Profile reports published by the Department of Environment. Table 7-1, below summarises the principal potential sources of contamination.

Table 7-1 Principal Sources of Contamination

Potential Source	Location	Likely Age	Potential contaminants of concern/Comments
Made Ground (demolition debris, in filled cellars, former & current industrial land uses inc. steelworks, car workshops & engineering works etc)	Site wide	Approx 140 years	Heavy metals, other inorganic contaminants, asbestos, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), carbon dioxide, methane, semi-volatile and volatile organic compounds (SVOC & VOC), PCB oils.
Former Fuel Station	On site	Approx 35-45 years	PAHs, MTBE, heavy metals, VOCs, SVOC, hydrocarbons (TPH, BTEX), methane and carbon dioxide gases.
Tanks (including Diesel, Unknown Storage)	On site	Approx 50 years	Heavy metals, other inorganic contaminants, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), carbon dioxide, methane, semi-volatile and volatile organic compounds (SVOC & VOC), PCB oils and solvents.
Electrical Substations	On site	Approx 35-45 years	PCBs and Mineral Oils

Other activities in the vicinity of the site, located at distances over 100m, were not subject to formal risk assessment in this desk study. These sources are regarded as unlikely to affect the soils and groundwater on the site due to their relatively small size, nature of activities and distance from the site.

7.2.2 Receptors and pathways

People (site users, construction and maintenance workers and casual visitors), controlled waters, local environment (e.g. animal and plant life) and buildings could be at risk from contamination if present.

At present and in the final development, site users will have some contact with soil (in the areas of soft landscape) and no direct contact with groundwater. Future construction and maintenance workers may come into contact with contaminated soil and groundwater *via* dermal contact, accidental soil ingestion and inhalation of dust. Residents of the properties adjacent to the site may be at risk from soil contamination *via* migration of contaminated dusts during construction.

Contamination of controlled waters can occur *via* migration of free product (e.g. petroleum hydrocarbons) or leaching.

The site is currently occupied by a mixture of buildings and hardstanding with little soft landscaping. The final development is likely to be of a similar nature. In any areas of soft landscaping, any plants grown on site may be at risk from, for example, heavy metal contamination *via* root uptake etc.

Any harmful gases and vapours generated in the Made Ground or around the former fuel station could accumulate in the buildings on site and also migrate onto adjacent sites and accumulate in neighbouring buildings. Any such accumulation could present risk to site users, workers (asphyxiation, fire and explosion) and buildings (fire, explosion).

High concentrations of sulphate or sulphur compounds that may potentially be converted into sulphate can have adverse effect on building materials.

7.3 Results of contamination risk assessment

The details of the Preliminary Risk Assessment are presented in Appendix F and the results/ conclusions discussed in Section 10.1. The present conceptual site model is shown in Figure 9

8 Waste Management

8.1 Site Waste Management Plans

A site waste management plan will be required prior to the re-development of this site in accordance with Site Waste Management Plans Regulations 2008 (ref 14). A pre-demolition site survey will be required prior to the demolition of the site to determine the quantities of material that can be re-used, recycled etc.

8.2 Environmental Permitting

Where soils are regarded as "waste" (excavated contaminated soil) their re-use onsite may take place under an "exemption" from Environmental Permitting (ref 15) as long this is carried out without:

- endangering human health or the environment;
- risk to air, soil, plants or animals;
- causing nuisance through noise and odours; and
- adversely affecting the countryside or sites of special scientific interest.

In order to determine whether site won material may qualify for an exemption, risk assessment and waste classification is required. Such classification will require sampling and particular chemical analysis.

Considering the nature of the current and historical activities on site, and soil data from previous investigation most of the surplus Made Ground is likely to be classified as Non-Hazardous. However, allowance should be made for a proportion of soil arisings to be classified as Hazardous. Such material is likely to be present as a result of the activities of the former petrol station, car/mechanical works and steel works onsite along with the potential for asbestos containing material and fibres to be present in Made Ground (e.g. as a result of earlier demolition/ construction etc). The re-use of Hazardous waste on site will not be allowed under an exemption. Natural soil is likely to be classified as Inert Waste. This will however require confirmation through further ground investigation

It must be noted that exemptions also place restrictions on the volumes of soils to be re-used and the period they may remain stockpiled on-site. If surplus groundwater is generated during construction work a trade effluent consent to discharge from the relevant statutory undertaker will be required.

8.3 Waste management Policy

A number of elements of UK policy and guidance with respect to waste are currently at a draft or interim stage, including a proposed Code of Practice (CoP) (ref 16). The Environment Agency proposes to update published guidance (ref 17) following issue of any final CoP. It is therefore recommended that early liaison with the

Environment Agency waste officer is carried out to discuss the potential and requirements for re-use of potentially contaminated soils onsite.

9 Geotechnical Assessment

9.1 Design and Construction Issues

A conceptual ground model illustrating the anticipated geological profile, as well as geoenvironmental and geotechnical aspects of the proposed development is shown in Figure 9. The following sections discuss design and construction issues for the proposed development.

9.1.1 Buried Obstructions

With reference to Section 3.7, the key buried obstructions that might be encountered during construction include:

- Historic foundations
- Historic cellars/ basements
- Underground tanks of unknown content including those beneath the former petrol station believed to be foam filled
- Buried abandoned utilities, including Victorian sewers
- Geological obstructions i.e. claystone in the London Clay and limestone in the Woolwich and Reading Beds
- The River Moselle (refer to Section 4.3)

The presence of these buried structures and services will have an impact on the design and construction of the foundations for the new buildings. Further consultation with the relevant authorities and third-parties should be considered to further assess the risk of buried obstructions that might have an adverse effect on foundation design and construction.

9.1.2 Concrete Classification

The London Clay is a principal sulphate and sulphide bearing stratum (ref. 15), supported by the presence of pyrite noted in previous ground investigations and high water soluble sulphate values (Section 4.1 and Section 6).

Taking this into account, it is likely that for concrete in contact with the London Clay an elevated design sulphate and ACEC class will be necessary.

9.1.3 Groundwater Levels

There was a large variation in groundwater levels previously recorded on site, as summarised in Section 4.4. An average groundwater level of +8.83m OD (1.85m below ground level) can be taken as a typical value.

However, the groundwater level across the site is uncertain and will be subject to seasonal variation. Due to the lack of groundwater monitoring, the direction of groundwater flow is also unknown. We therefore recommend that monitoring of groundwater levels in the various strata is included as part of the ground investigation programme. To obtain maximum benefit from this monitoring it should be initiated as soon as is practically possible, and should ideally include a complete seasonal cycle of observations.

Given the high water table, there is a low likelihood that soakaway drainage will be possible on site.

9.1.4 Excavations

Due to the anticipated high groundwater levels and the nature of the ground conditions, open excavations may require temporary dewatering and excavation supports depending on their depth and location. For permanent works, options such as a secant wall or a drained under slab for the pitch may need to be considered. There is a potential risk of heave of the excavation floor if excavations are required into the London Clay.

Any large unsupported excavations close to surrounding existing buildings and structures are liable to induce ground movement, possibly undermining existing foundations. Further consultation with the relevant parties/neighbours is recommended to establish available working spaces, agreed construction methodologies, and any monitoring requirements.

9.1.5 Retaining Walls

If retaining walls are required, there are various options available depending on the depth, size and location. Due to the anticipated high groundwater levels and nature of the ground conditions, any temporary excavations may require vertical supports and permanent excavations may require secant or sheet pile walls to provide water cut-off. Driving of sheet piles in the dense gravels (Kempton Park Gravels) may be difficult, and obstructions may be encountered in the made ground. Pre-boring may be required to aid installation.

9.1.6 Trees

During the walkover, several mature trees were identified. Based on the location of these trees and the geological map (ref 5), there is a low risk of heave. However, given the size of these trees, these may be subject to tree preservation orders.

9.2 Foundation Options

The following table (Table 9-1) outlines the advantages and disadvantages for shallow and piled foundation options, as well as outlining other methods and considerations for the proposed foundations for buildings within the Northumberland Development Project.

Table 9-1 Summary of Foundation Options

Foundation Option inc. detail	Advantages and Disadvantages	Information required
Shallow Foundations: Pad, Strips, and Raft The MG and ESI are not considered to be suitable formations for shallow foundations given their variability. If adopted, shallow foundations would need to be formed with the KPGR. A typical column load of 3,500kN would require pads of about 3m x 3m, or strip foundations of about 1.2m width	Advantages • Could obtain allowable bearing capacities of 250kPa to 400kPa using conventional construction methods. • Reduces creation of contamination pathways into underlying aquifers Disadvantages • Depth to gravel between 1.0m and 3.8m with potential for ground instability. • Relies on presence of KPGR across site. • Foundation width may result in some load distributed onto the underlying LC resulting in increased settlement. • Possible perched groundwater in the MG and ESI • Differential settlement.	Engineering properties of the KPGR. Confirmation of level to top, thickness and extent of the KPGR. Stiffness of top of LC. Groundwater level Excavation stability Allowable total and differential settlements
Piled Foundations: Driven Cast in situ (DCIS), Continuous Flight Auger (CFA), Rotary Bored DCIS obtains capacity from KPGR through end bearing. CFA and Rotary obtain most capacity from shaft friction in the	Advantages • Suitable and flexible for large column loads (except DCIS). • The use of under-reams or large diameter piles would achieve a higher capacity for shorter piles. Disadvantages • Thickness of the London Clay.	Thickness of the London Clay Engineering properties of the London Clay and Lambeth Group Groundwater level Confirmation of obstructions in the Made

Foundation Option inc. detail	Advantages and Disadvantages	Information required
LC and WRB. A typical column load of 3,500kN could be supported by 600mm dia piles 20m long arranged in groups of three.	- Degree of vertical and lateral variation of the WRB, and difficulty and obtaining reliable design parameters. - Increased pile settlement at a given load for under-reams and large diameter piles; can be minimised through base grouting. - Control of groundwater into bore (rotary only) - Can be influenced by obstructions in the Made Ground	Ground
Other options/considerations		Information required
Incorporation of a basement level to reduce levels to the top of the Kempton Park Gravels. Would result in increased excavation of potentially contaminated soils.		Assessment of waste classification of soils.
Use of vibrated concrete columns (VCCs) or vibrated stone columns (VSCs) to locally improve bearing capacity. VSCs subject to confirmation of ground gases. Both are influenced by the presence of significant obstructions in the Made Ground.		Assessment of ground gases.

9.2.1 Preliminary Pile Test

If a piled foundation solution is progressed, given the difficulties of obtaining reliable design parameters in the Lambeth Group, the potential cost- and design-benefits of installing a full-scale instrumented preliminary test pile should be considered. This will enable a more reliable assessment of the design and performance of the piles, which should result in a more economic pile design as well as managing the risks associated with constructing piles in the Lambeth Group. Ground investigation at the test location will be required to inform the test design. Sufficient programme time should be allowed ahead of the main piling works to obtain maximum benefit from the test through careful design, planning and analysis.

10 Conclusions

10.1 Geoenvironmental

A Preliminary Risk Assessment with has been carried out. Source-pathway-receptor linkages have been identified, considered and the results of the risk assessment are summarised below.

10.1.1 Risk to human health

Human health risks from soil contamination are assessed as being Very Low to Moderate/Low, reflecting the following:

- The likelihood of substantial contamination being present due to the historic uses of the site and the presence of underground tanks;
- The close proximity of residential properties, community premises and schools;
- The low likelihood of site users' accidental contact with contaminated soil and groundwater due to the majority of the site being covered with hard standing at the present and in the future; and
- The likely implementation of good construction practice and appropriate health and safety procedures by construction workers;

Human health risks from the presence of ground gas are assessed as Moderate reflecting; the highly elevated concentrations of methane and carbon dioxide and low flow rates previously recorded, the limited data available, and the proposed end use.

These potential risks can be mitigated by appropriate investigation, the adoption of appropriate remedial measures and the implementation of the recommended health and safety regime.

10.1.2 Risks to controlled waters

The risk to the Kempton Park Gravels is assessed as Low to Moderate/Low reflecting; the nature and extent of potential contaminant sources, the sensitivity of the aquifer (SPZ II and Minor Aquifer), the relatively shallow groundwater level, but also the relatively large distance (> 250m) to the nearest abstraction point and the extent of hardstanding covering the site at present and in the future.

The risk to the Woolwich and Reading Beds (WRB) and Chalk is assessed as Low reflecting; the nature and extent of potential contaminant sources, the sensitivity of the Aquifers (SPZ II, WRB - Minor Aquifer and Chalk - Major Aquifer), the significant thickness (approximately 15m) of low permeability London Clay overlying the WRB, the relatively large distance (> 250m) to the nearest abstraction point and the extent of hardstanding covering the site at present and in the future.

The risks to controlled waters are capable of mitigation by appropriate investigation and the adoption of appropriate remedial measures.

10.1.3 Risks to plant life and buildings/ structures

The potential risks to plants and below ground structures on the redeveloped site from soil contamination is assessed as Very Low to Low reflecting; the nature and extent of the potential contaminant sources, and likely use of appropriate investigation and mitigation measures.

10.1.4 Statutory designation

In our opinion, based upon the information obtained from this Phase 1 study, together with the result of the related risk assessment, the site is unlikely to meet the criteria for determination as "Contaminated Land" under Part IIA of the Environmental Protection Act 1990 subject to appropriate site investigation and assessment.

10.1.5 Summary of issues with respect to contamination

Based on; the anticipated ground conditions, the nature of the proposed development, and the above risk assessment, issues that need to be resolved with respect to contamination sources include the following:

- The nature and extent of contamination within the Made Ground;
- The nature and extent of contamination associated with current and historical site uses; steel works, car repair workshops and engineering works etc;
- The nature and extent of contamination in the vicinity of the former fuel station and electrical substations;
- The location of any underground tanks and the extent of contamination associated with them;
- The nature of the ground gas regime in the Made Ground, underground tanks and former fuel station;
- The nature and extent of contamination in groundwater beneath the site; and
- The likely waste classes for excavated material.

10.2 Geotechnical

The available geotechnical and geological information has been reviewed and the major constraints/ issues associated with the development are summarised in the section below.

10.2.1 Summary of geotechnical issues

From the Desk Study, the main issues/ constraints associated with the development are summarised below:

- A relatively high water table; any basements or excavations which are required will need to take account of this.

- The Made Ground is variable and may have problems with instability and/ or obstructions during excavation.
- Any large unsupported excavations close to surrounding existing buildings and structures are liable to induce ground movement, possibly undermining existing foundations.
- There is a potential risk of heave of the excavation floor if excavations are required into the London Clay.
- Open excavations may require temporary/permanent support and localised water cut-offs or dewatering depending on their size and location.
- If retaining walls are required, there are various retaining options available depending on the depth, size and location. Given the anticipated ground conditions and groundwater levels, any temporary excavations may require vertical supports and permanent excavations may require secant/ sheet pile walls to provide water cut-off.
- Driving of sheet piles in the dense gravels (KPGR) may be difficult, and obstructions may be encountered in the Made Ground. Pre-boring may be required to aid installation.
- There are likely to be obstructions beneath the site which have been summarised in Section 9.1.1. The presence of any of these obstructions will need to be taken into account during design and construction of the foundations. It is recommended that further consultation with the relevant authorities and third-parties is considered to further assess the risk of buried obstructions that might have an adverse effect on foundation design and construction. This should be carried out by the design team. Further consultation by the design team with the relevant parties/ neighbours is recommended to establish available working spaces, agreed construction methodologies and any monitoring requirements.
- The relative merits of different foundation options have been reviewed in this report. Shallow foundations could be adopted for allowable bearing capacities up to 400kPa based on foundations formed within the KPGR. These foundations may be experience differential settlement, and their use is subject to confirmation of the engineering properties, depth, thickness and extent of the KPGR.
- For larger structural loads, piled foundations could be adopted obtaining capacity from the LC and WRB. Higher pile capacities will require either under-reams in the LC, which may increase settlement at a given load, or deeper piles into the WRB which may cause problems during construction. Given the geological hazards, variable ground conditions and difficulties of obtaining reliable design parameters for the WRB, consideration should be given to carrying out a preliminary pile test.
- The risk of heave associated with tree removal is considered to be low; however these trees may be subject to tree preservation orders.

- The risk posed by UXO at the site is considered to be low to moderate. An appropriate good standard of health and safety will need to be implemented during any intrusive investigation and/or earthworks, and any suspect items be reported to the authorities for appropriate identification and disposal if required. It is standard good practice to be vigilant for the presence of unidentified objects on any site and especially within an urban environment.

11 Recommendations

11.1 Ground Investigation

An intrusive ground investigation will be required to verify and improve the ground model and provide design information to permit geotechnical design and geoenvironmental assessment. A preliminary scope of ground investigation is summarised below.

11.1.1 Geoenvironmental

Taking into consideration the size and the current ownership issues of the proposed development site, it is recommended that further ground investigations are undertaken in phases. This will allow a more thorough spread of samples (both systematic and targeted) to be undertaken across the site to enable a better assessment of the potential risks related to ground conditions.

A ground investigation to satisfy these objectives should comprise the following elements:

- A series of trial pits and window samples to allow:
 - targeted sampling of contaminant hotspots (substations, tanks and former fuel station etc); and
 - systematic sampling of Made Ground and natural material to highlight any un-identified areas of contamination.
- Installation of shallow boreholes to investigate the shallow groundwater and ground gas regimes in the Made Ground and Kempton Park Gravels;
- Installation of deep boreholes to investigate groundwater in the deeper aquifers; and
- A Generic Quantitative Risk Assessment in general accordance with the provisions of the EA/DEFRA Model Procedures for the management of land contamination, 2004 (CLR11) (ref.1).

11.1.2 Geotechnical

From a geotechnical design point of view, the objective of the ground investigation is to:

- Determine the surface level and spatial variability (vertically and horizontally) of the London Clay and underlying Woolwich and Reading Beds;
- Determine the nature and distribution of the superficial deposits;
- Determine the position of the groundwater level and variation with season;
- Develop a geotechnical ground model to include properties and parameters for geotechnical design.

To meet these objectives, the ground investigation should include:

- Several boreholes into the London Clay formation at locations specific to the proposed structures. The boreholes should be progressed using drilling methods appropriate to the ground conditions and obtain undisturbed samples at regular intervals;
- A minimum of three 30m+ deep boreholes to penetrate and prove the Woolwich and Reading Beds. Boreholes should be progressed using drilling methods appropriate to the ground conditions and obtain undisturbed samples at regular intervals;
- Detailed logging of all soil and rock samples obtained from the borehole in accordance with current UK guidelines;
- In situ testing comprising Standard Penetration Tests at regular intervals. Depending upon design progression, there may be a requirement for in situ parameters obtained using pressuremeter tests;
- Geotechnical laboratory testing of samples obtained in accordance with current UK guidelines to provide appropriate geotechnical parameters for subsequent design of foundations and earthworks classification;
- Monitoring of groundwater levels during- and post-ground investigation using piezometers in the superfcials, London Clay, and Woolwich and Reading Beds. Both the London Clay and Woolwich and Reading Beds may require installation of vibrating wire piezometers to ensure a sufficiently rapid response to changing groundwater levels.

We would also recommend undertaking soakaway tests and in situ CBR tests at appropriate locations to the proposed infrastructure to assess the feasibility of soakaway drainage systems and to address pavement design requirements.

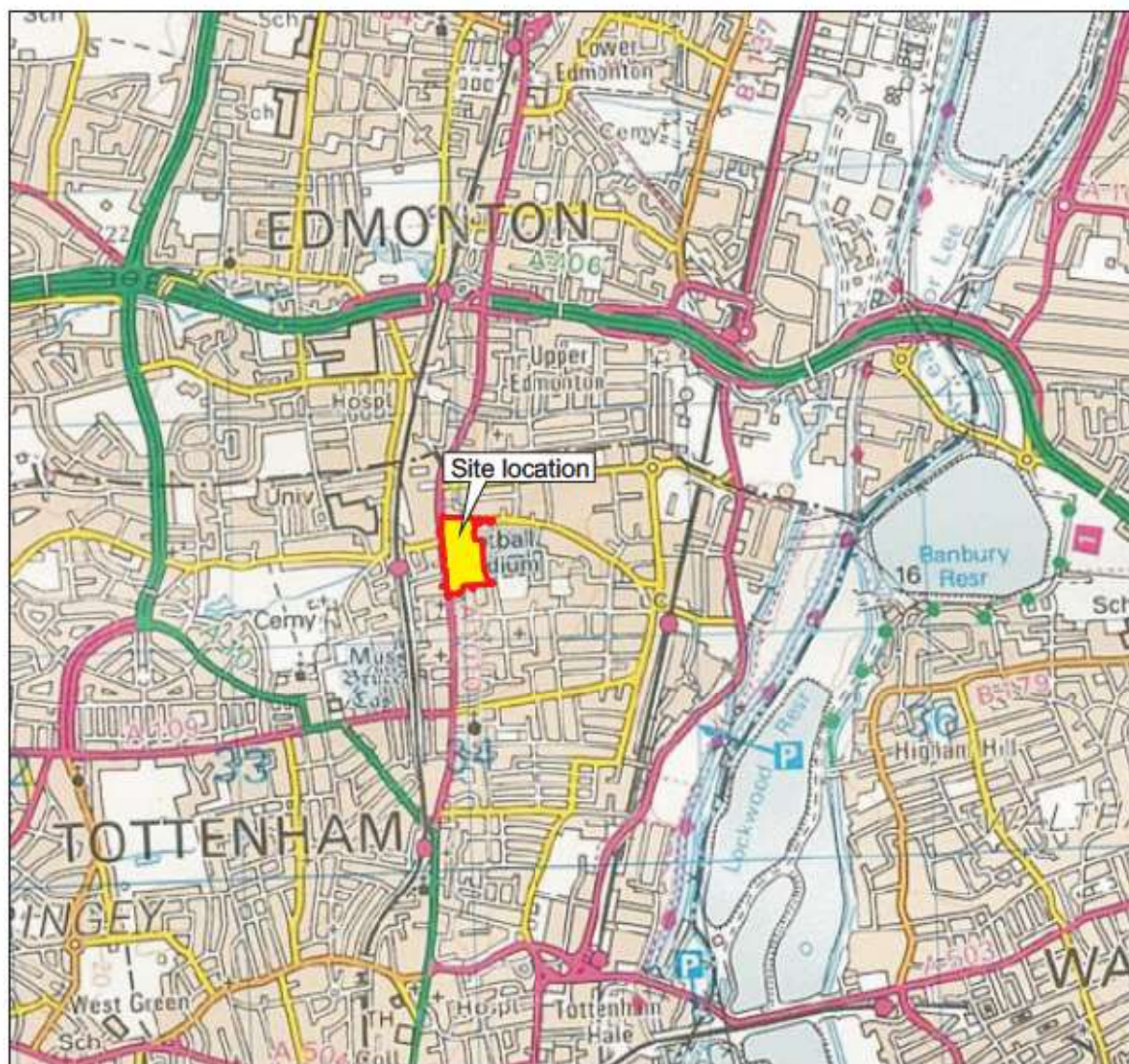
11.2 Access and restrictions for Ground Investigation

Access for Ground Investigation (GI) in and around the development will be restricted by the high volume of pedestrian and vehicular traffic associated with the stadium during the football season and those areas of the site which are currently privately owned. All exploratory hole positions will need to be confirmed with the Client before site works commence, and a schedule of works agreed so that access to each location is agreed.

Plant access in certain areas of the site may be restricted as several masonry arches fronting High Road have low head-room. Head room restrictions may also limit plant access into the football stadium from Park Lane.

12 References

1. Environment Agency. 2004. Model Procedures for the Management of Land Contamination – Contaminated Land Report 11 (CLR 11)
2. Inglis Simon. 1996. Football Grounds of Britain. Collins Willow. Third edition.
3. SOILTECHNICS. 2005. Ground Investigation Report for Proposed Residential Redevelopment on land off Paxton Road Tottenham.
4. Email from David H Magee, Senior Estate Surveyor at the MOD to Clare Jones, Buro Happold (22nd May 2008) entitled Buried MOD Assets.
5. Geological Survey of Great Britain (England and Wales). 2006. Sheet 256 North London 1:50,000.
6. Soil Mechanics. 1993. Site Investigation for Tottenham Hotspur Football Club South Stand. Report 7518/63.
7. Soil Mechanics. 1993. Site Investigation for North Stand Roof Towers. Report 7508/62.
8. Pinching, Albert and Dell, David. 2005. Haringey's Hidden Streams Revealed. Hornsey Historical Society. First Edition.
9. British History Online. www.british-history.ac.uk. Last viewed July 2008. Extract from Baker et al. A History of the County of Middlesex: Volume 5. 1976.
10. Planning policy Statement 25: Development and Flood Risk. 2006.
11. National Rivers Authority. 1995. Sheet 40 Groundwater vulnerability of the Thames Estuary 1:100,000.
12. SOILTECHNICS. 2005. Report on the Classification of Waste Soils for Off Site Disposal for Proposed Residential Redevelopment on land off Paxton Road Tottenham London.
13. Environment Agency. 2002. Potential Contaminants for the Assessment of Land – Contaminated Land Report 8 (CLR8).
14. Defra. 2008. Non statutory guidance for site waste management plans.
15. Environmental Permitting (England and Wales) Regulations 2007/3538.
16. CL:AIRE. 2008. The definition of waste: Development Industry Code of Practice. Draft for consultation.
17. Environment Agency. 2006. The Definition of Waste. Developing greenfield and brownfield sites.
18. CIRIA. 2004. Report C583, Engineering in the Lambeth Group.
19. BRE. 2005. Special Digest 1 Concrete in aggressive ground.



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Project: Northumberland Development Project

SITE LOCATION PLAN

Scale: NTS

Drawn: NG

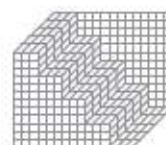
Chk: ASP

Date: Nov 2008

Job No: 023971

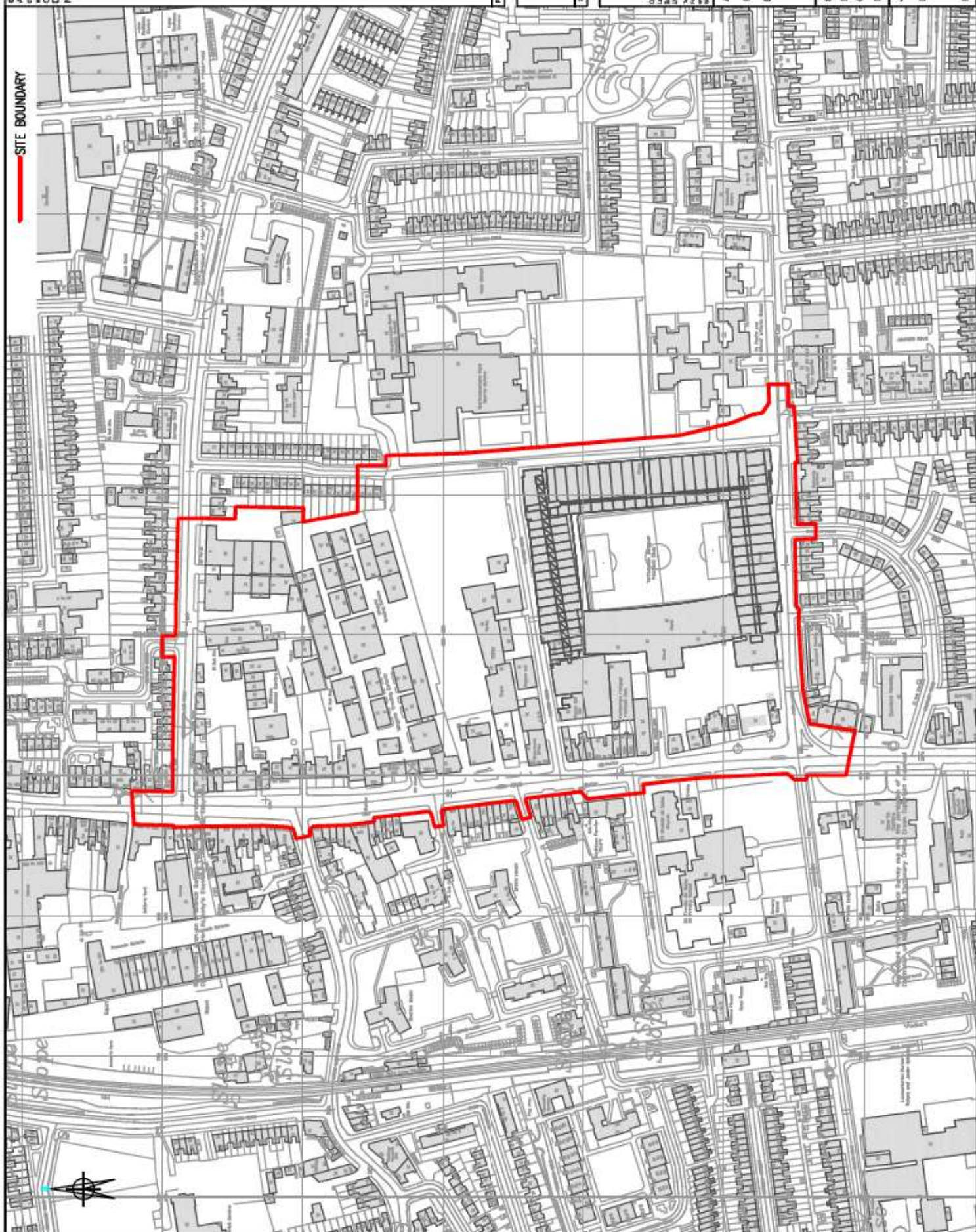
Drawing No: FIGURE 1

Rev: 00



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— SITE BOUNDARY



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Rev Description Date
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Architect: MAKE & KSS
Project: Northumberland Development
Project: Project
Drg Title: SITE BOUNDARY PLAN

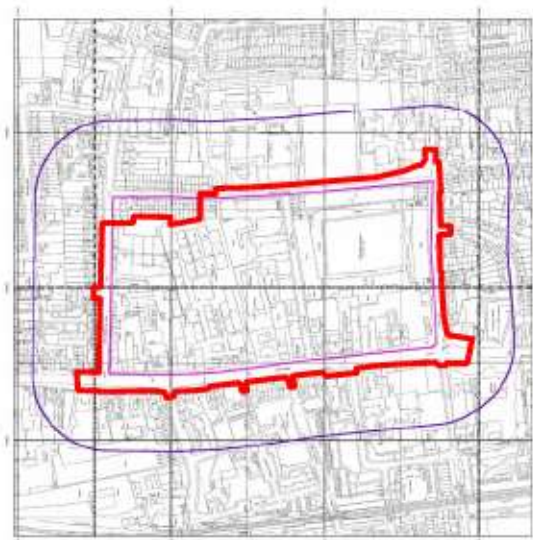
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Drawn by: NG
Checked by: CNJ
Date: NOV 2008

Job No: 023971
Drg No: FIGURE 2
Rev: 00

SITE BOUNDARY



1913



1991



1896



1955-56



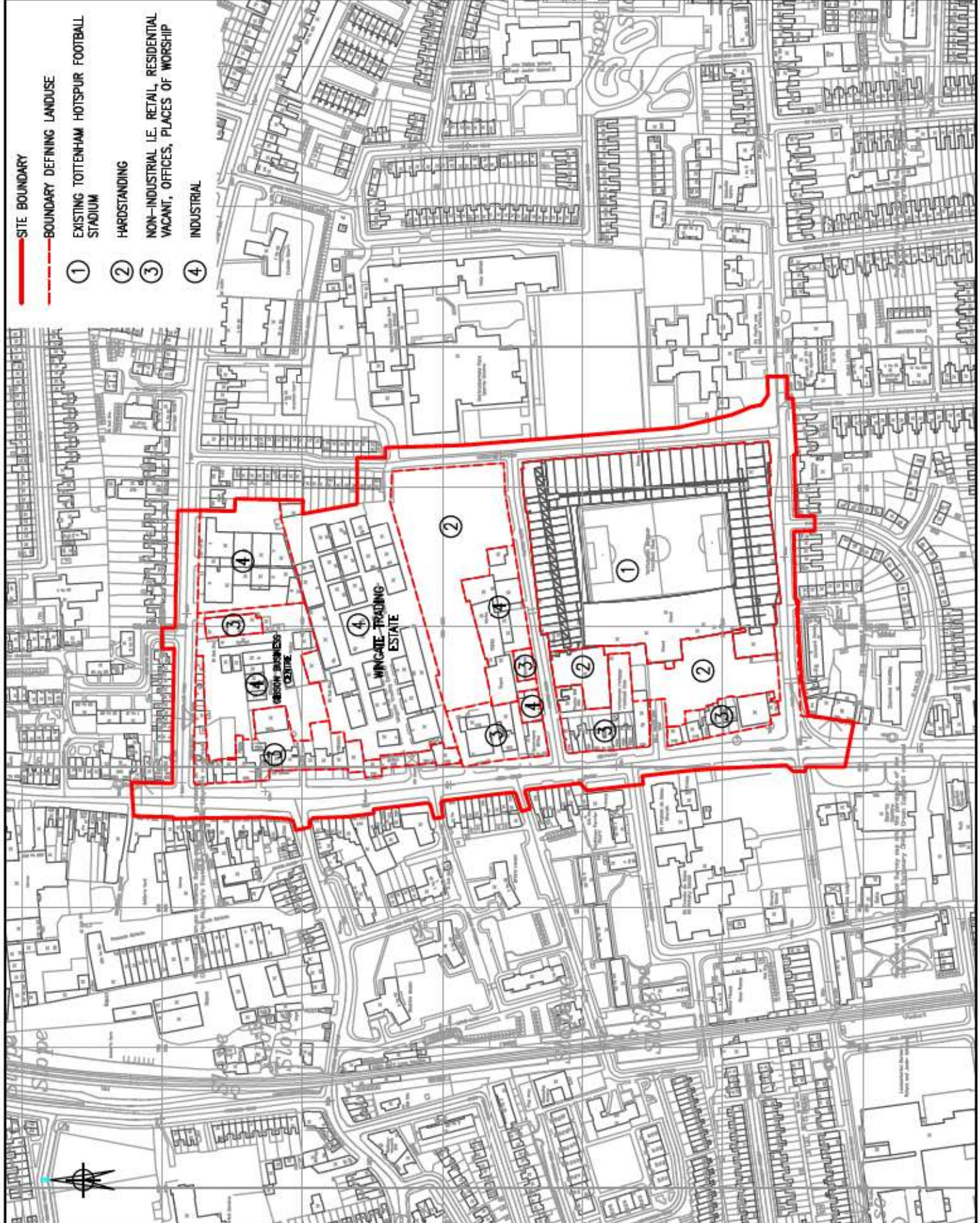
1867



1935

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Notes
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Architect: MAKE & KSS
Project: Northumberland Development
Project: Project
Project Title: CURRENT LANDUSE

Scale: A3 12500
Drawn by: NG
Checked by: CNU
Date: NOV 2008

Job No. 023971
Drg No. FIGURE 4
Rev 00



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REF: MIDDLESEX XII OS MAP (1:2500), 1935-7

Rev Description Date

Doc One

INFORMATION

Status of sheet

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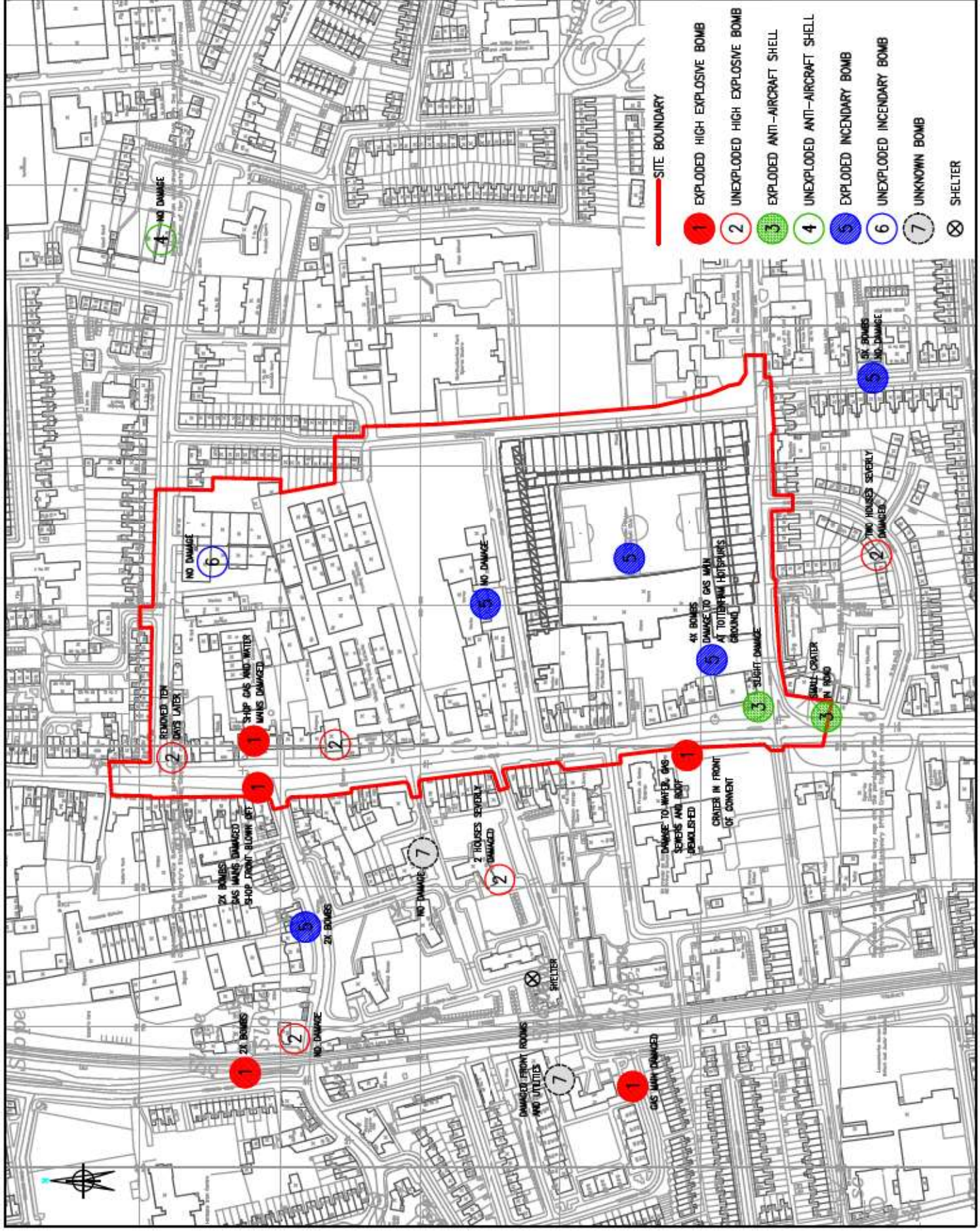
Architect **MAKE & KSS**
Northumberland Development Project

Dwg Title **WORLD WAR II BOMBS RECORDED ON SITE & IN THE IMMEDIATE AREA**

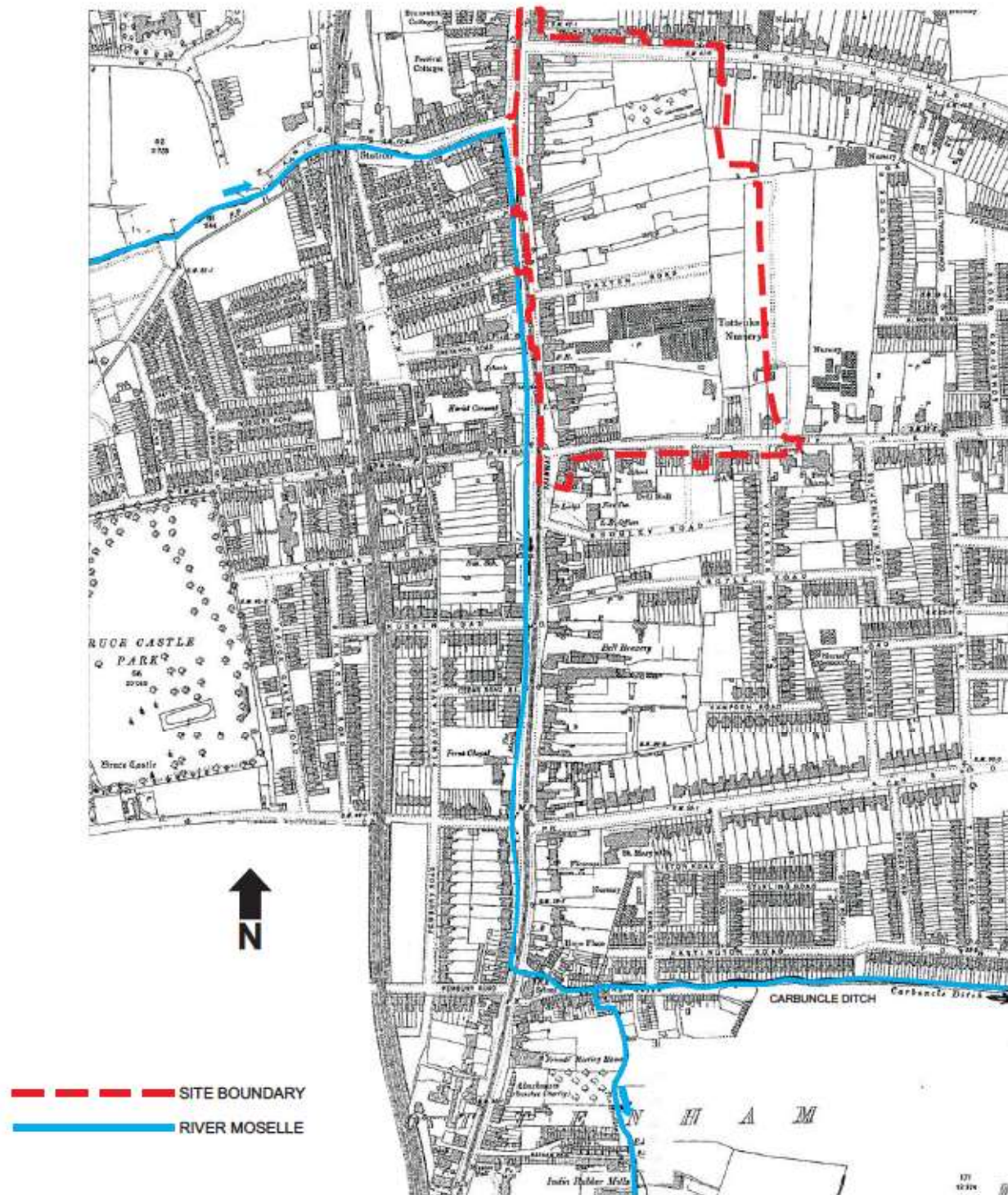
Scale 1:2500
Drawn by NG
Checked by CNU
Date NOV 2008

Job No. **023971**
Dwg No. **FIGURE 6**

Rev **00**



- SITE BOUNDARY**
- 1** EXPLODED HIGH EXPLOSIVE BOMB
 - 2** UNEXPLODED HIGH EXPLOSIVE BOMB
 - 3** EXPLODED ANTI-AIRCRAFT SHELL
 - 4** UNEXPLODED ANTI-AIRCRAFT SHELL
 - 5** EXPLODED INCENDIARY BOMB
 - 6** UNEXPLODED INCENDIARY BOMB
 - 7** UNKNOWN BOMB
 - ⊗** SHELTER



REF. HARINGEY'S HIDDEN STREAMS REVEALED
 COMPILED BY ALBERT PINCHING AND DAVID DELL
 BY HORNSEY HISTORICAL SOCIETY ISBN 0905794354
 PUBLISHED 2005

Project: Northumberland Development Project

ROUTE OF RIVER MOSELLE

Scale: NTS

Drawn: NG

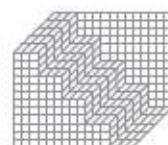
Chk: CWJ

Date: NOV 2008

Job No: 023971

Drawing No: FIGURE 7

Rev: 00

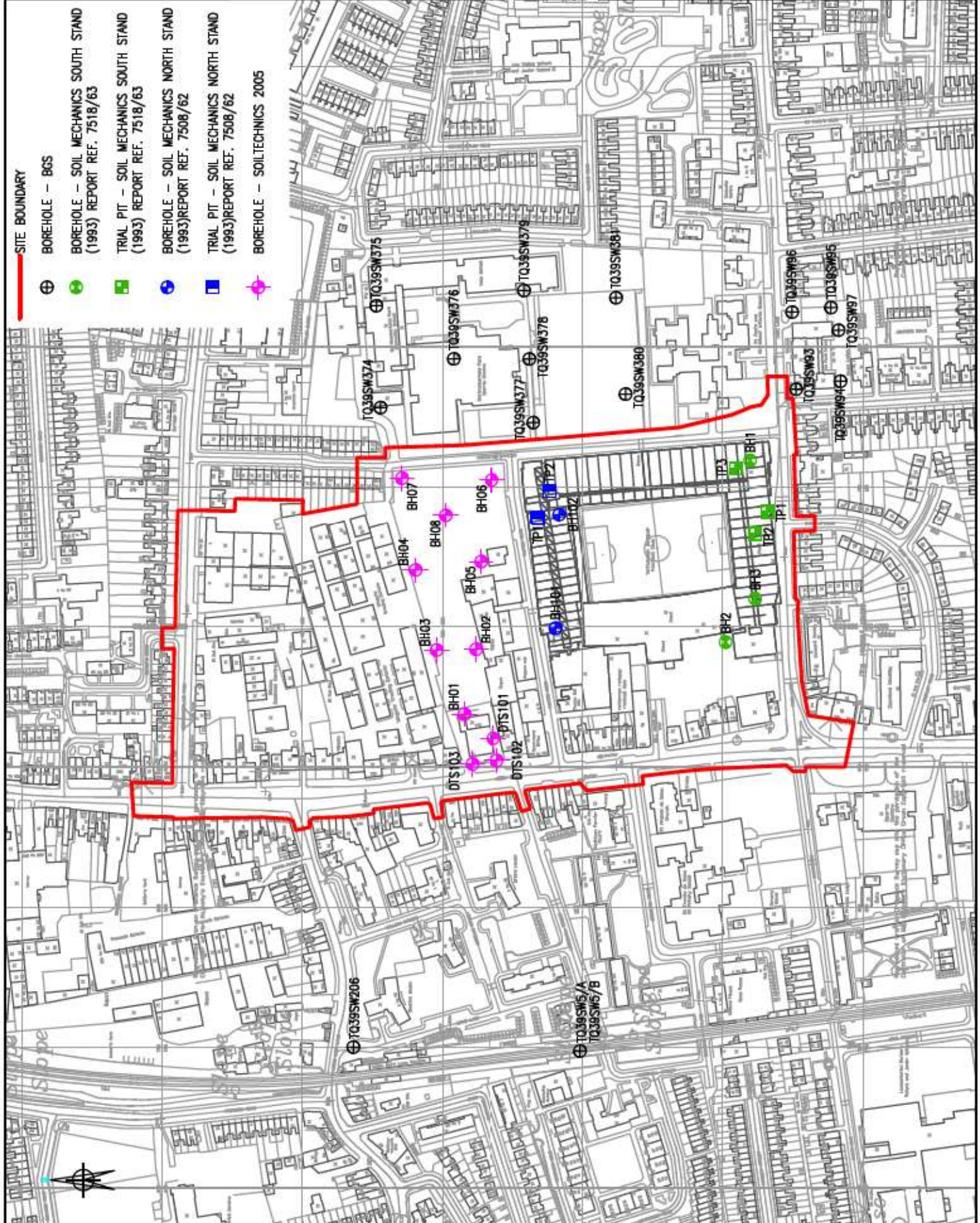


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Notes

POSITION OF ALL BOREHOLES APPROXIMATE



- SITE BOUNDARY
- ⊕ BOREHOLE — BGS
- ⊕ BOREHOLE — SOIL MECHANICS SOUTH STAND (1993) REPORT REF. 7518/63
- ⊕ TRIAL PIT — SOIL MECHANICS SOUTH STAND (1993) REPORT REF. 7518/63
- ⊕ BOREHOLE — SOIL MECHANICS NORTH STAND (1993) REPORT REF. 7508/62
- ⊕ TRIAL PIT — SOIL MECHANICS NORTH STAND (1993) REPORT REF. 7508/62
- ⊕ BOREHOLE — SOIL TECHNIQS 2005

INFORMATION

Buro Happold Consulting Engineers	
Architect: MAKE & KSS Project: Northumberland Development Project: AVAILABLE GROUND Investigation: BOREHOLES	Scale: A3 12500 Drawn by: NG Checked by: CNU Date: NOV 2008
Job No. 023971 Drg No. FIGURE 8	Rev 00

GROUND EXPLORATIONS LTD.

BOREHOLE NO. 2

TQ39SW 375

Contract Name Northumberland Park Report No. 5286/APB/IAD

Client C.J. Pell, Frischmann and Partners, Site Address

3423
9135

Address 4 Manchester Square,

Northumberland Park Primary School,

London W1M 6EB

Worcester Avenue,

Haringey, London, N.17.

Standing Water Level 5'0"

Method of Boring Shell and auger

Water Struck 4'6"

Diameter 6 inches

Ground Level 35.35

Start 20.4.71. Finish 20.4.71.

Remarks

JARS		CORES		BULK	
8101	2'6"	8107	16'6"	8102	5'0"
8103	7'0"	8109	22'0"	8104	10'0"
8105	12'6"	8110	25'0"	8106	14'0"
8108	20'0"				
8123	water				
Description				Thickness	Depth
Topsoil				2'6"	2'6"
Gravel with clay				2'6"	5'0"
Gravel and sand with some clay				2'0"	7'0"
Compact gravel and sand				7'6"	14'6"
Stiff blue clay				10'6"	25'0"
TOTALS				25'0"	25'0"

- Notes
1. Descriptions are in accordance with B.S. Code of Practice C.P. 2001
Clients are requested to compare with samples submitted.
 2. Core samples are nominally 4 ins. diameter and 18 ins. long.
Depths shown to top of sample.

PR030





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[TQ39SW BJ 375.]

GROUND EXPLORATIONS LTD.

BOREHOLE NO. 3

TQ39SW 376

Contract Name Northumberland Park Report No. 5286/APE/IAB 3420
 Client C.J.Pell, Frischmann and Partners, Site Address 9131
 Address 4 Manchester Square, Northumberland Park Primary School,
 London W1M 6EB Worcester Avenue,
 Haringey, London, N.17.

Standing Water Level 5'0" Method of Boring Shell and auger
 Water Struck 4'6" Diameter 6 inches
 Ground Level 35.51 Start 21.4.71. Finish 23.4.71.
 Remarks

JARS		CORES		BULK	
8111 3'0"	8130 45'0"	8117 18'0"		8113 9'0"	
8112 6'0"	8132 water	8119 23'6"		8115 14'0"	
8114 12'0"		8121 27'6"			
8124 15'0"		8125 32'6"			
8116 16'0"		8127 37'6"			
8118 21'0"		8129 42'6"			
8120 25'0"		8131 48'6"			
8122 30'0"					
8126 35'0"					
8128 40'0"					
Description				Thickness	Depth
Topsoil				2'6"	2'6"
Firm brown sandy clay				1'0"	3'6"
Sand and gravel				11'6"	15'0"
Stiff brown clay with stones				0'6"	15'6"
Stiff to very stiff blue silty clay gradually getting sandy				34'6"	50'0"
TOTALS				50'0"	50'0"

- Notes 1. Descriptions are in accordance with B.S. Code of Practice C.P. 2001
 Clients are requested to compare with samples submitted.
 2. Core samples are nominally 4 ins. diameter and 18 ins. long.
 Depths shown are to top of sample.





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[TQ39SW BJ 376.]

GROUND EXPLORATIONS LTD.

BOREHOLE NO. 4

TQ39SW 377

Contract Name Northumberland Park

Report No. 5286/ APE/IAB

3415

Client C.J.Pell, Frischmann and Partners,

Site Address

9126

Address 4 Manchester Square,

Northumberland Park Primary School,

London W1M 6EB

Worcester Avenue,

Haringey, London, N.17.

Standing Water Level 4'6"

Method of Boring Shell and auger

Water Struck 5'0"

Diameter 6 inches

Ground Level 35.21

Start 22.4.71. Finish 22.4.71.

Remarks

JARS			CORES		BULK	
6924 2'6"			6931 16'6"		6926 6'0"	
6925 5'6"			6932 21'6"		6928 11'0"	
6927 10'6"						
6929 14'6"						
6930 15'6"						
6933 23'0"						
6934 water						
Description					Thickness	Depth
Topsoil					1'6"	1'6"
Hardcore					3'6"	5'0"
Compact sand and gravel					9'0"	14'0"
Stiff brown clay					1'0"	15'0"
Stiff blue clay					8'0"	23'0"
TOTALS					23'0"	23'0"

- Notes
1. Descriptions are in accordance with B.S. Code of Practice C.P. 2001
Clients are requested to compare with samples submitted.
 2. Core samples are nominally 4 ins. diameter and 18 ins. long.
Depths shown are to top of sample.



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[TQ39SW BJ 377.]

GROUND EXPLORATIONS LTD.

BOREHOLE NO. 5

TQ39SW378

Contract Name Northumberland Park

Report No. 5286/APB/IAB

3419

Client C.J.Pell, Frischmann and Partners,

Site Address

9126

Address 4 Manchester Square,

Northumberland Park Primary School,

London W1M 6EB

Worcester Avenue,

Haringey, London, N.17.

Standing Water Level 4'0"

Method of Boring Shell and auger

Water Struck 5'0"

Diameter 6 inches

Ground Level 35.33

Start 19.4.71. Finish 19.4.71.

Remarks

JARS		CORES		BULK	
5288	2'6"	5296	17'6"	5289	4'0"
5290	7'6"			5291	9'0"
5292	12'6"			5293	14'0"
5294	15'6"				
5295	16'6"				
5297	20'0"				
5298	water				
Description				Thickness	Depth
Topsoil				1'6"	1'6"
Compact sand and gravel				13'6"	15'0"
Stiff brown clay				1'0"	16'0"
Stiff blue clay				4'0"	20'0"
TOTALS				20'0"	20'0"

- Notes 1. Descriptions are in accordance with B.S. Code of Practice C.P. 2001
Clients are requested to compare with samples submitted.
2. Core samples are nominally 4 ins. diameter and 18 ins. long.
Depths shown are to top of sample





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[TQ39SW BJ 378.]

GROUND EXPLORATIONS LTD.

BOREHOLE NO. 6

TQ 39SW 379

Contract Name Northumberland Park

Report No. 5286/APH/IAB

Client C.J. Pell, Frischmann and Partners,

Site Address

3423

9126

Address 4 Manchester Square,

Northumberland Park Primary School,

London W1N 6EB

Worcester Avenue,

Haringey, London, N.17.

Standing Water Level 5'6"

Method of Boring Shell and auger

Water Struck 5'6"

Diameter 6 inches

Ground Level 34.81

Start 16.4.71. Finish 16.4.71.

Remarks

JARS			CORES			BULK		
5273	2'6"		5280	13'6"		5275	4'0"	
5274	3'0"		5283	18'6"		5277	9'0"	
5276	8'0"		5285	23'6"				
5278	13'0"							
5279	13'6"							
5281	16'6"							
5282	18'6"							
5284	23'6"							
5286	25'0"							
5287	water							
Description						Thickness	Depth	
Topsoil						2'0"	2'0"	
Firm brown clay						0'6"	2'6"	
Sand and gravel						10'0"	12'6"	
Stiff brown clay						1'0"	13'6"	
Stiff blue clay						2'6"	16'0"	
Claystone						1'0"	17'0"	
Stiff blue clay						8'0"	25'0"	
TOTALS						25'0"	25'0"	

Notes 1. Descriptions are in accordance with B.S. Code of Practice C.P. 2001.

Clients are requested to compare with samples submitted.

2. Core samples are nominally 4 ins. diameter and 18 ins. long.

Depths shown are to top of sample.



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