Contents

Flood Risk Assessment

UCLH NHS Foundations Trust

April 2015

1.0 Introduction

1.1 Preamble

Environmental Planning & Assessment Limited (EPAL) has been commissioned by Clarke Nicholls Marcel (CNM) Ltd to undertake a Flood Risk Assessment (FRA) of proposals of the University College London Hospital (UCLH) NHS Trust for the redevelopment of land on the corner of Capper and Huntingdon Street (the 'development') for hospital uses. The site is located in the London Borough of Camden.

The development site (the "site") comprises an approximately rectangular plot of land. The site occupies an area of approximately 0.14 hectares (ha) and is centred approximately at National Grid reference 528510,182060. The site is bounded to the north by Capper Street, to the east by Huntley Street, to the south by Gordon's Mansions and to the west by Shropshire Place.

1.2 Requirements for a Flood Risk Assessment

1.2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF)[1] deals with flood risk and water resources. At paragraph 17 one of the 12 core land-use planning principles that underpin both plan-making and decision-taking relates to support for transition to a low carbon future in a changing climate, taking full account of flood risk.

At paragraphs 94, the NPPF states that local authorities should, *"adopt proactive strategies to mitigate and adapt to climate change, taking full account of flood risk, coastal change and water supply and demand considerations"*. This point is reiterated at paragraphs 99 and 100. The latter states that*, "inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere"*.

Paragraph 100 re-establishes broadly the sequential test and exception tests as set out in now deleted PPS25. The application of the tests is set out at paragraphs 101-104 of the NPPF.

[1] Department for Communities and Local Government (2012) *National Planning Policy Framework*, March 2012

Paragraph 101 reiterates the aim of the sequential test being to steer new development to areas with the lowest probability of flooding. The NPPF restates that the Strategic Flood Risk Assessment (SFRA) continues to provide the basis for applying this test. Paragraph 102 sets out the requirements for the application of the Exception Test. Paragraph 102 states in this regard that development should provide: (1) wider sustainability benefits to the community that outweigh the flood risk, informed by the SFRA; and (2) a site-specific FRA demonstrates that the development will be "*safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall".*

The NPPF requires that a FRA should be submitted with a planning application to determine the risk of flooding at a development site or the likely impact on neighbouring sites. As such a FRA is an essential element in the overall assessment of the economic viability of the development as well as its acceptability in planning terms. The detail and complexity of a FRA will depend on the scale of the development and potential significance of flood risk.

Further guidance on flood risk and FRA is provided in the National Planning Practice Guidance of 6th March 2014, which essentially restates previous withdrawn technical guidance *inter alia* on FRA, design floods, flood risk zonation and land use vulnerability classifications. The NPPG[2] refers to the Environment Agency Standing Advice on flood risk and strategic flood risk assessment, and to the technical guidance produced by the Agency.

1.2.2 Environment Agency Guidance

The Environment Agency has produced Standing Advice and Guidance Notes on development and Flood Risk Assessments which aim to simplify the requirements for a FRA according to the nature of the development and the site location in relation to the flood plain zones. The approach is summarised in the Agency's flood matrix which is summarised in Table 1 and is based on the size of site and the location within the flood plain.

The requirements for a FRA will therefore depend on the site area and the defined flood zone. The site area is of less than 1 ha and the Site is within Flood Zone 1. Flood risk assessment is therefore not obligatory for the Development, although in this case the

[2] Department for Communities and Local Government (2014) Planning Practice Guidance ID 7 Flood Risk and Coastal Change, 6th March 2014, http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

requirements of the FRA have been based on those set out in Guidance Note 1. The NPPF, the North London Strategic Flood Risk Assessment (SFRA) [3] and the EA's Guidance Note 1 have therefore been used as guidelines for the content.

Table 1: Environment Agency Requirements for a FRA by Flood Zone

Development Category	Flood Zone		
	1	2	3
Operational development less than 1 hectare	No consultation - see standard comment Check EA advisory comments.	FRA based on Guidance Note 3. Confirm Sequential Test (and where required Exception Test) have been applied.	FRA based on Guidance Note 3. Confirm Sequential Test (and where required Exception Test) have been applied.
Operational development of 1 hectare or greater	Consult EA with FRA using Guidance Note 1.	FRA based on Guidance Note 3. Confirm Sequential Test (and where required Exception Test) have been applied.	FRA based on Guidance Note 3. Confirm Sequential Test (and where required Exception Test) have been applied.

Guidance divides land use into five categories: essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water compatible development. Table 2 summarises the land uses appropriate to different flood risk zones. There are no constraints arising from flood risk in relation to land located in flood risk zone 1.

Table 2: Appropriate Land Use by Flood Risk Zone

Flood Risk	Zone			
	1	2	3a	3b
	Low	Medium	High	Functional flood plain
Fluvial Probability	< 0.1% (1000 year)	- 0.1% (100 to 1000 year)	> 1.0% (100 year)	> 1.0% (100 year)
Tidal Probability	< 0.1% (1000 year)	0.5 to 0.1% (200 to 1000 year)	> 0.5% (200 year)	> 0.5% (200 year)
Land Use				
Essential Infrastructure	Appropriate	Appropriate	Exception test	Exception test
Highly Vulnerable	Appropriate	Exception test	Not permitted	Not permitted
More Vulnerable	Appropriate	Appropriate	Exception test	Not permitted
Less Vulnerable	Appropriate	Appropriate	Appropriate	Not permitted
Water Compatible	Appropriate	Appropriate	Appropriate	If it has to be there

[3] Mouchel (2008) North London Strategic Flood Risk Assessment, Produced for North London Waste Plan 139pp plus appendices

1.3 The Report Content and Structure

The Report is structured as follows:

- Section 2 provides a brief description of the site and proposed development;
- Section 3 gives a review of the local hydrology and flooding history;
- Section 4 sets out the assessment of the implications of the development in relation to sources of potential flood risk outlined in Section 3;
- Section 5 provides a summary of the assessment and its conclusions.

2.0 Overview of the Site and Proposed Development

2.1 The Site

The site comprises 0.14ha of previously developed land that has been historically fully developed and is occupied by 2 buildings and associated hard-standing.

- The northern building comprises the former Royal Ear Hospital (2,409 sq m GEA), which is currently vacant.
- The southern building is the former University College London (UCL) Student Union (1,705 sq m GEA). This is currently used as a base for UCLH Transport and Finance departments, which are to be relocated in 2015.

Neighbouring buildings include:

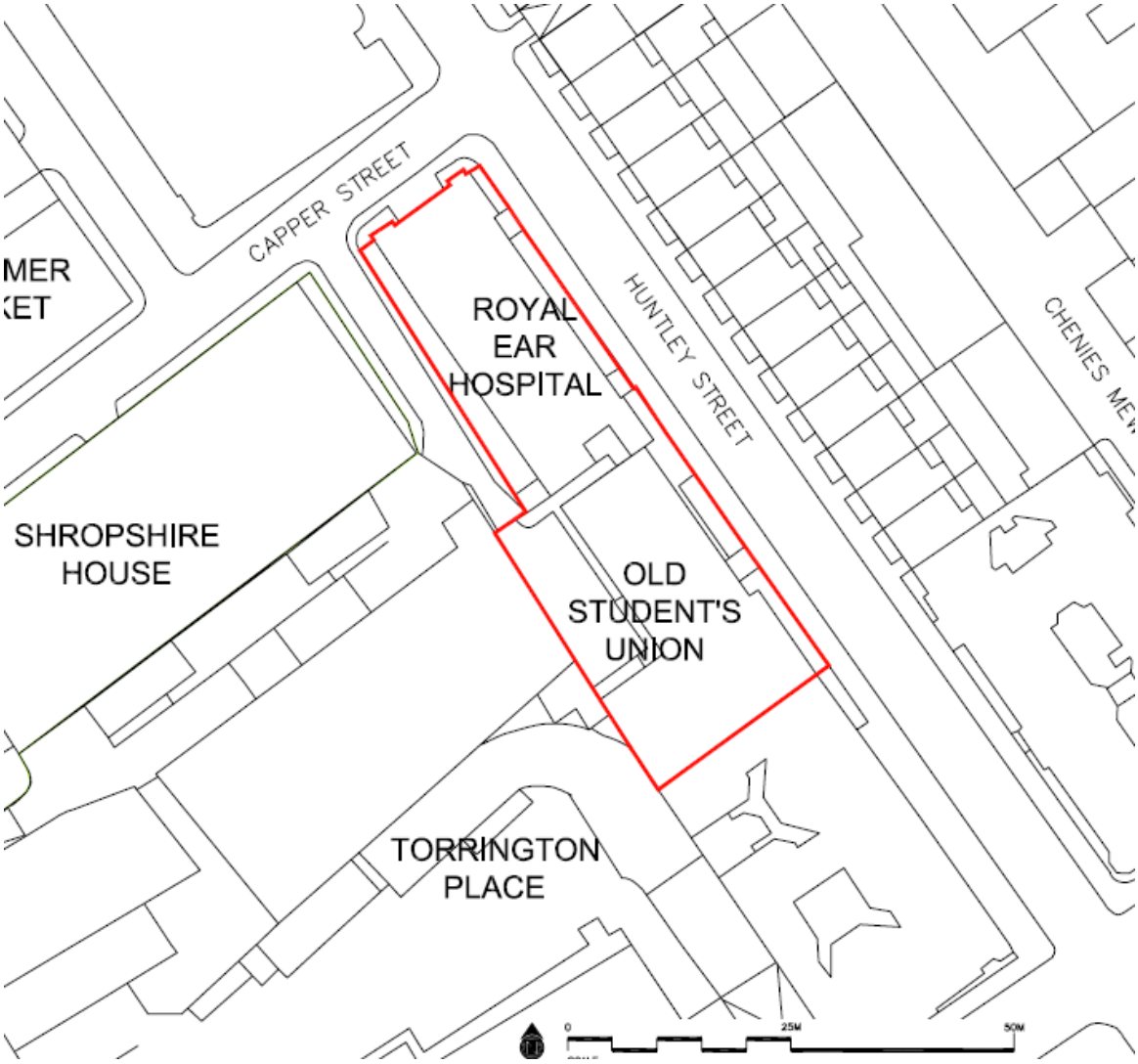
- To the north the MacMillan Cancer Centre (Class D1 hospital use);
- To the south Gordon's Mansions (Class C3 residential use);
- To the east Huntley Street townhouses (Class C3 residential and Class B1 offices) – Grade II listed; and
- To the west Shropshire House (Class B1 offices) with 179a Tottenham Court Road (Class D2 gym use).

2.2 The Proposed Development

The development is described in detail in the Design and Access Statement. The formal application description is:

"Application for demolition of the former University College London (UCL) Student Union and Royal Ear Hospital buildings, and redevelopment for a building of 6 storeys in height including ground and 3 storey basement comprising approximately 12,013 sq m GEA for use a specialist head and neck facility (Class D1) with 2 x pedestrian accesses from Huntley Street and Shropshire Place respectively and servicing/delivery bay accessed from Shropshire Place".

Figure 1: Site Plan (not to Scale)



3.0 Review of Hydrology and Flooding of the Site

3.1 Introduction

The potential causes of flooding that have been considered in relation to the Site include:

- tidal and/or fluvial flooding is a low risk;
- surface water flooding related to pluvial sources, and/or the surcharging of the surface and foul water drainage systems in the vicinity of the Site;
- groundwater flooding, which could conceivably occur in the event that groundwater levels were to rise towards the surface;
- flooding related to sources such as reservoirs, canals and other similar constructed water bodies.

The main sources of information on the different sources of flood risk to the Site include:

- The British Hydrological Society database[4];
- The North London Strategic Flood Risk Assessment (SFRA)[5] and Camden Surface Water Management Plan (SWMP)[6].

3.2 Topography, Geology and Hydrology of the Site

The site's topography appears to be rather flat, with a level of between 27.2m and 27.4m AOD. There are no obvious gradients across the site. There is a very slight upward gradient northwards along Tottenham Court Road, whilst on Huntley Street the very slight gradient is in the opposite direction.

Geologically the superficial strata at the Site comprise Made Ground (thickness of 2.75-3.5m) and terrace gravel (1-3m). Underlying the terrace gravel is a thick layer of London Clay (14-29m thick), followed by the Lambeth Group (14-15m) and then Thanet Sand. The site is not within a Source Protection Zone for any major public water supply abstractions. The site overlies a Drift Secondary 'A' aquifer associated with the Lynch Hill gravels underlying the site but is remote from any abstraction wells.

[4] http://www.dundee.ac.uk/geography/cbhe/

[5] Mouchel (2008) North London Strategic Flood Risk Assessment, Produced for North London Waste Plan 139pp plus appendices

[6] Halcrow (2011) Surface Water Management Plan for London Borough of Camden, 83pp plus appendices

The Thanet Sands and Chalk at depth from a Principal Aquifer but again the site is remote from active abstractions. Groundwater monitoring has noted the presence of groundwater within the River Terrace Deposits (where recorded) and within silt/sand bands in the London Clay, as well as in the Lambeth Group and Thanet Sands at depth. The perched water table of the River Terrace Gravels is present at depths of 3.7-5.0m below ground level (c.22.5-23.7m AOD), with –where present – groundwater in the London Clay at 6-11m below ground levels (6-11.4m AOD). The Principal aquifer, beneath the London clay, in the Thanet Sands is at levels of 33-48m below ground level (-6mAOD to -22mAOD).

The nearest surface water body is the tidal River Thames approximately 2km to the south of the site. The Grand Union canal is located approximately 1.5km to the north of the site. The subterranean River Fleet, which runs as a surface water sewer, is located about 1km to the east of the site; the 'lost' River Tyburn is about 1km west of the site.

3.3 Tidal and Fluvial Flood Risk

Figure 2 shows an extract of the EA's flood zone map for the area. This shows that the site is identified as being within Zone 1 in relation to tidal and fluvial flood risk. Zone 1 is defined as the land subject to an annual event probability (AEP) of flooding of in excess of 0.1% per annum (>1:1,000 year risk), and indicates **very low risks** of such flooding.

Figure 2: EA Flood Risk Map (Source: Environment Agency)

The British Hydrological Society (BHS) database (Chronology of British Hydrological Events –see footnote 4) includes no records of historical flooding of this part of Camden from tidal or fluvial sources related to the Thames or its tributaries, including underground rivers.

3.4 Surface Water and Sewer Flood Risk

The site has a gradient from north to south, and this also applies to the surrounding land (see Section 3.2). The site is at similar elevations to the surrounding land, and it is thus at low risk of flooding from extensive concentration of runoff generated from the adjoining buildings and impermeable surfaces surrounding the Site. It would be expected that the gradients would tend to direct surface water runoff away from the site, and towards the main drains in the roadways. The risk of ground saturation causing excess overland flow is considered to be extremely low.

The site and the area surrounding it are not identified as a critical drainage area (CDA) in the SWMP[7]. The Environment Agency on-line mapping for the risk of flooding from surface water flooding shows the Site to lie within an area with "very low" risk of flooding from surface water, albeit that the north eastern corner is better classified as having a 'low risk' of surface water flooding. Figure 3 shows the EA surface water flood mapping for the Site.

A "very low" risk of flooding means that the probability of flooding from surface water is assessed to be less than 0.1% in any given year; a low risk means that in any given year, an area has a chance of flooding of between 0.1% and 1%. A medium risk indicates surface flooding events of between 1 in 100 and 1 in 30 annual probability. A high risk means that each year, this area has a chance of flooding of greater than 1 in 30 (3.3%).

Camden suffered widespread surface water flooding in August 2002 due to a high intensity rainfall event. This event did not affect the site and generally occurred north of Euston Road[8].

Thames Water Utilities was consulted with regard to the locations of their assets and flood risk (see Appendix A). The Site is currently served by combined sewers in Capper Street (1143 X 787mm) and Huntley Street (1168 X 787mm). The blockage or poor maintenance of drains could lead to risks of overland flow generation, although should such contingencies arise it is envisaged that such blockages would be cleared rapidly.

[7] Halcrow (2011) Surface Water Management Plan for London Borough of Camden, 83pp plus appendices

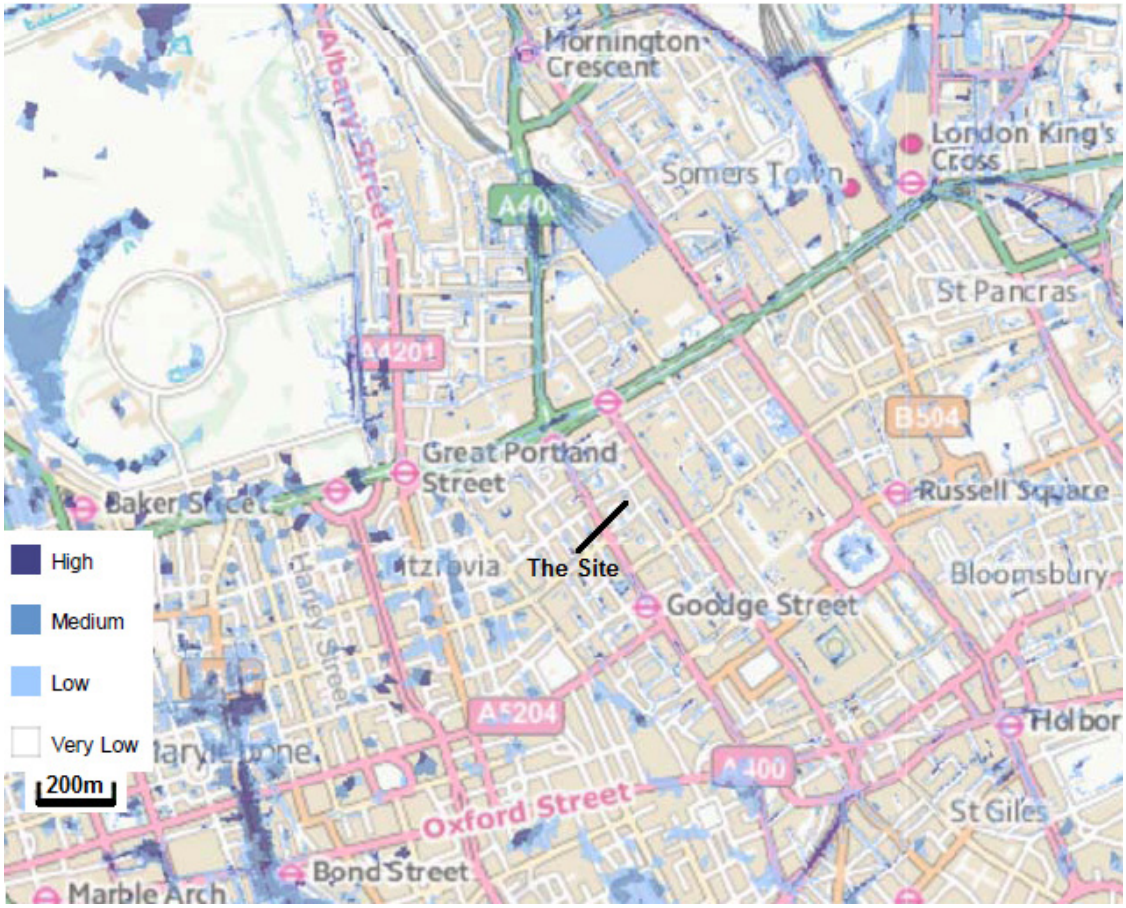
[8] LB Camden (2003) *Floods in Camden* Report of the Floods Scrutiny Panel, June 2003, 66pp

There are no records of sewer or surface water flooding recorded by Thames Water in relation to the site (see Appendix A).

The mapping of sewer flooding in the SFRA (Map 13) indicates very low rates of flooding from this source in the WC1 post code area.

Taking into consideration all sources of data, the Site is considered to be at **low risk** of flooding from surface water or overloaded sewers.

Figure 3: EA Surface Water Flood Risk Mapping for Site



The development proposes 3 levels of basements, which would in the main lie below the levels of the public sewers. In the event of surcharging of the public sewers localised flooding of the basements could plausibly result. The building should incorporate protection measures against this potential flood mechanism by either:

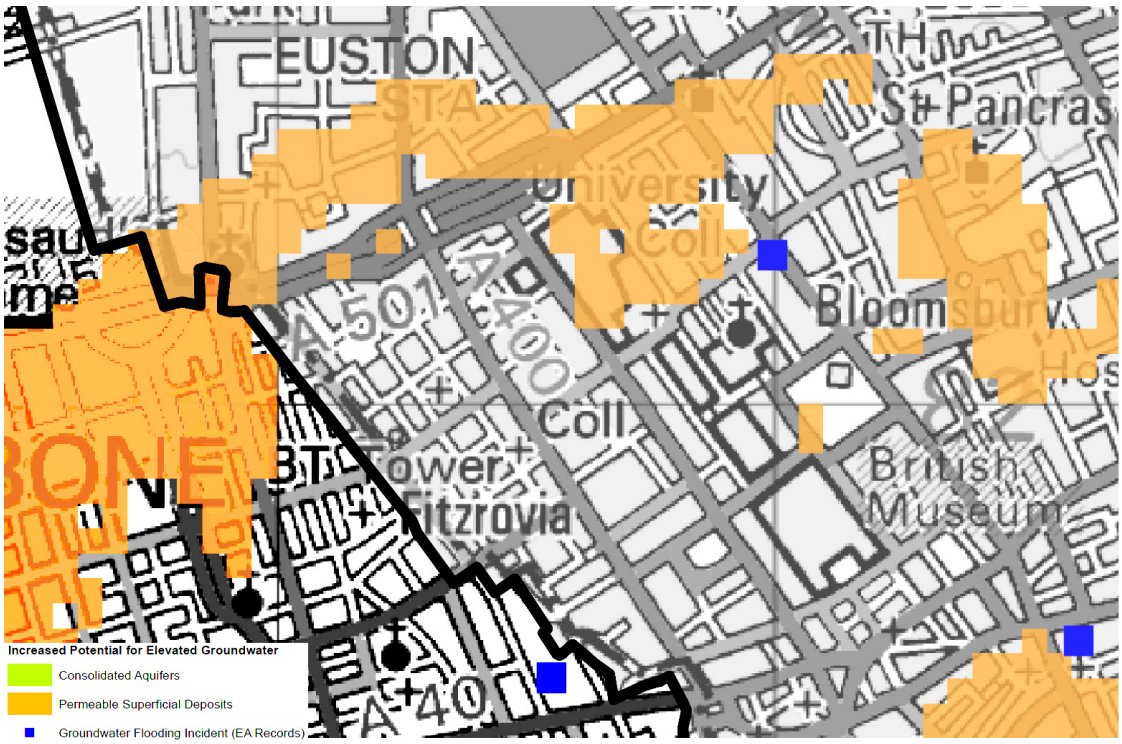
- pumping above the flood level, or

- the incorporation of anti-flood valves into the drainage network.

3.5 Groundwater Flood Risk

The SFRA[9] indicates areas that have been subject to groundwater flooding. The mapping provided in Map 20 of the SFRA indicates that instances of groundwater flooding have not been recorded in LB Camden. Figure 4 shows an extract from the Increased Potential for Elevated Groundwater (iPEG) map for the southern part of Camden and neighbouring Westminster. The iPEG map shows the areas wherein there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface. This indicates that the Site is just outside of the area of permeable deposits where this is likely. The closest location where a groundwater flooding incident has been identified by the Environment Agency is about 400m west of the site.

Figure 4: Increased Potential for Elevated Groundwater Map (Source: Westminster PFRA Figure 5.3)



[9] Mouchel (2008) North London Strategic Flood Risk Assessment, Produced for North London Waste Plan 139pp plus appendices

The geological mapping supports the contention that, with no areas nearby with increased risk of flooding from groundwater, the risk of groundwater flooding at the Site is low.

In conclusion, the Site is in an area of **low risk** in respect of groundwater flooding. There is a negligible potential for the Development proposed to cause an adverse impact on groundwater flood risk to surrounding sites.

3.6 Flooding from Artificial Water Bodies

The site is not within an area identified by the Environment Agency as being at risk of flooding from reservoirs. The nearest area identified as at risk is just north of St Pancras Station, where the risk related to the Highgate Pond No. 3 owned by the Corporation of London. This area is about 700m north east of the site. The Hampstead Heath ponds consist of two chains of earth banked reservoirs and ponds located on Hampstead Heath. In conclusion, the Site is in an area of **low risk** in respect of flooding from artificial water bodies.

4.0 Impact of Development and Mitigation

4.1 Tidal and Fluvial Flooding

The site is located at elevations of between 27.2-27.4mAOD, which is more than 20m above the level of the 1:1,000 tidal and fluvial flood level. Thus there will be **no** potential for the development proposed to transfer flood risk to other sites or to be affected by tidal flooding. With regard to fluvial flooding there are no proximate sources (including subterranean rivers) of such flood risk. There is no requirement to mitigate the impact of the development in respect of these **negligible** types of flood risk.

4.2 Surface Water and Sewer Flooding

Pluvial flooding refers to the flooding that occurs during intense rainfall events of generally short duration that is not fully accommodated by soaking into the ground and/or overcomes the capacity of surface water drainage systems to accept the flow of surface water. This can result in local flooding of the land surface, with ponding and flows of water, typically along roads, depending on the local topography and distribution of buildings and open space. In the area around the site the surface water drainage discharges to combined sewers, which take both surface water and foul sewage - see plan in Appendix A. For this reason it can be difficult to distinguish pluvial and surface water flooding events in a strict manner from sewer flooding, since the latter is often related to the excessive surface water inflows to the sewers during intense storms.

The existing site is entirely hard-surfaced and thus its redevelopment will not increase run-off volumes or flows from the land area involved; appendix B provides estimates of run-off for the 30 minute and 1 hour storm events and greenfield run-off. The effect on sewer inflows to the combined sewers will be **negligible**. There will be no transfer of surface water or sewer flood risk to other sites.

The clinical and healthcare requirements of the development on this site of restricted area preclude the incorporation of surface water attenuation measures, which due to the depth of the basements would be likely to require pumping; such a pumping requirement would tend to reduce the appropriateness of tanks or similar measures.

The building should incorporate protection measures against potential flooding caused by sewers backing up by either:

- pumping above the flood level, or

- the incorporation of anti-flood valves into the drainage network.

4.3 Groundwater Flood Risk

The hydrogeological information on the site (see Section 3.5) indicates that there is a discontinuous perched water table over parts of the Site in the Terrace Gravel. The main aquifer is at considerable depth and is at a level substantially below the proposed 3 level basement.

The 3 levels of the basement will be constructed through the made ground and into the terrace gravels and London Clay. The presence of perched water can be expected at a higher level. The depth of excavation is likely to be less than 14m to the underside of the 3-level basement, placing it below the boundary of the potential water level for the perched aquifer (see Section 3.5). This groundwater body would be minor feature with limited primary mechanisms of lateral flow through the relevant strata. It is expected that the regime would be dominated by secondary flow mechanisms, involving discharge via sewers and other infrastructure conduits as preferential pathways. As a result the likely impact of the structure as an impediment to groundwater flow would be of a small magnitude, and the effect on groundwater flow regime would be of **negligible** significance. The effect in relation to the transfer of groundwater flood risk to adjacent land is anticipated to be **negligible**.

The basement structure will be protected from groundwater ingress by the provision of a cavity drain system. This will collect any water seepage or penetration through the concrete walls and dispose of this in a positive manner.

4.4 Flooding from Artificial Water Bodies

The site is in an area of **low risk** in respect of flooding from artificial water bodies. There is no potential to increase risks of flooding from these sources elsewhere. No mitigation measures are necessary.

5.0 Summary and Conclusions

The site is located in Zone 1 (low) in relation to tidal and fluvial flood risk. The Site is not identified as having flooded during significant historic flooding events in the London area. The site, being of **low flood** risk, is suitable for all forms of development with reference to tidal and fluvial flood risk considerations.

The site is considered to be at **low risk** of flooding from surface water or overloaded sewers. The effect on sewer inflows to the combined sewers will be negligible and there will no increase in flood risks. There will be no transfer of surface water or sewer flood risk to other sites.

The site is in an area of **low risk** in respect of groundwater flooding. There is a negligible potential for the Development proposed to cause an adverse impact on groundwater flood risk to surrounding sites.

The site is in an area of **low risk** in respect of flooding from artificial water bodies. There is no potential to increase risks of flooding from these sources elsewhere.

Appendix A: Thames Water Information

Flood Risk Assessment

UCLH Phase 5

April 2015

Asset Location Search

John Towner
Environmental Planning & Assessment Ltd
22Old Kennels Lane
WINCHESTER
SO22 4JP

Search address supplied

Royal Ear Hospital
21
Capper Street
London
WC1E 2QG

Your reference N/A

Our reference ALS/ALS Standard/2015_2955272

Search date 26 January 2015

You are now able to order your Asset Location Search requests online by visiting
www.thameswater-propertysearches.co.uk

searchcode

Asset Location Search

Search address supplied: Royal Ear Hospital, 21, Capper Street, London, WC1E 2QG

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

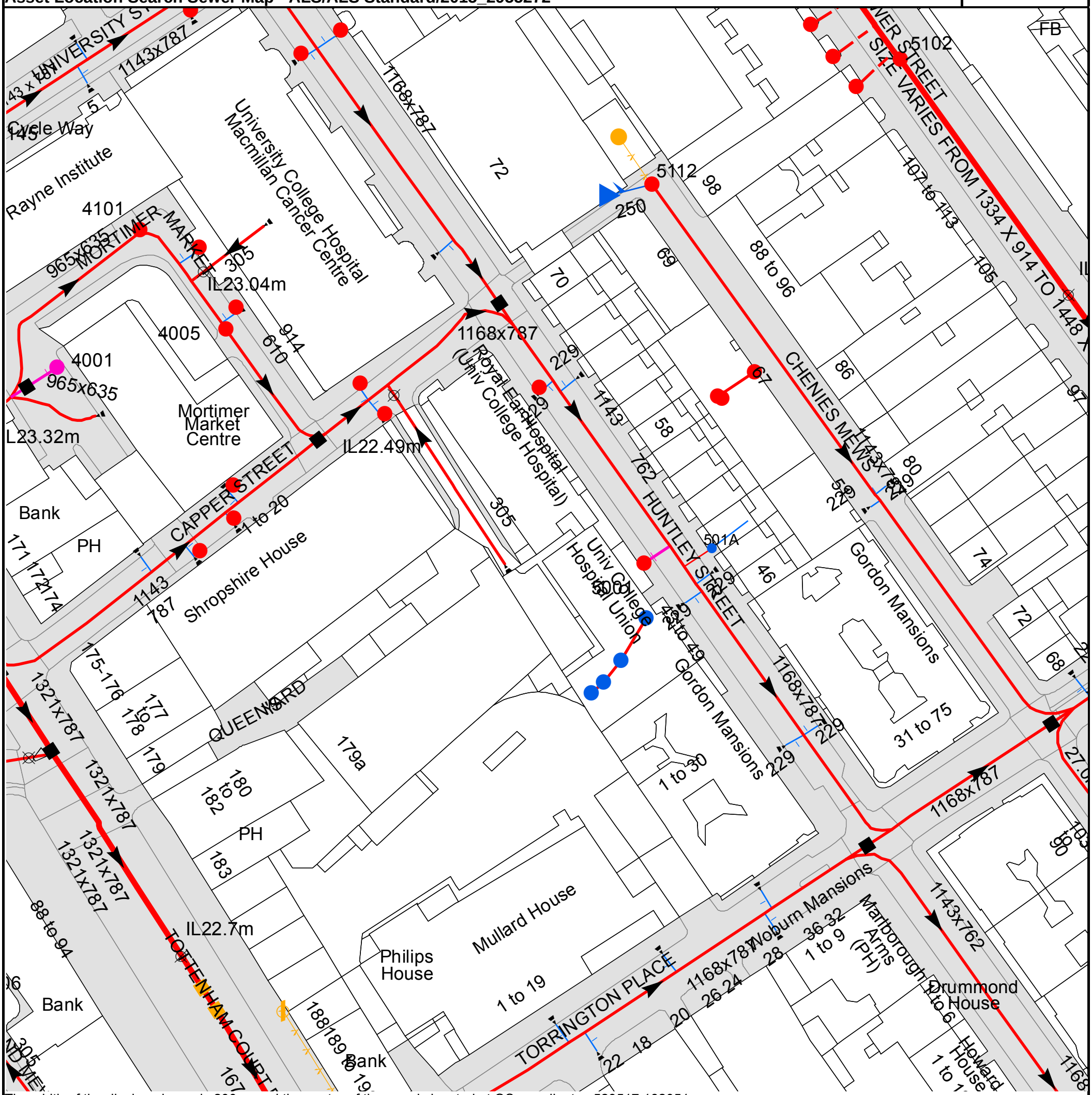
Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2015_2955272



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 529517,182051

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
5112	24.55	23.1
5116	n/a	n/a
5102	27.22	19.69
5115	n/a	n/a
41EA	n/a	n/a
41DJ	n/a	n/a
5114	n/a	n/a
50EJ	n/a	n/a
50FA	n/a	n/a
50FB	n/a	n/a
50FC	n/a	n/a
5001	n/a	n/a
40DJ	n/a	n/a
501A	n/a	n/a
40DG	n/a	n/a
40DF	n/a	n/a
40EE	n/a	n/a
50BH	n/a	n/a
50CC	n/a	n/a
50DD	n/a	n/a
40ED	n/a	n/a
50DE	n/a	n/a
4001	n/a	n/a
4005	27.38	22.77
40EA	n/a	n/a
41DC	n/a	n/a
4101	27.16	22.29
41DH	n/a	n/a

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16"

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

Flood Risk Assessment

UCLH Phase 5

April 2015

Appendix B: Surface Water Run-off Assessment

Estimates of the surface water runoff have been used to determine a peak flow based on the time of concentration (Tc) and a rainfall intensity (I) derived from rainfall data provided in the Flood Estimation Handbook (FEH)[10]. The time of concentration is equivalent to the critical storm duration. The length and slope of the Site suggest that the critical duration would be between 30 minutes and 1 hour.

Rainfall intensities for various return period storms and durations are given in Tables 3 and 4, based on point rainfall data provided by FEH at the nearest 1km grid point to the Site.

Based on these rainfall intensities, the Rational Method has been used to calculate runoff volumes in conjunction with the Site area, routing coefficient (assumed as 1), runoff coefficient based on the percentage run-off[11]. The Site was assumed to be 100% hard-surfaced, giving a percentage run-off of 80%, with an area of 0.14ha. Based on the above rainfall intensities, the following storm volumes, given in Tables 3 and 4, have been estimated.

Table 2: FEH Rainfall Intensities (mm) at TQ 2669 8214 and Site Peak Flows and Volumes using Rational Method for 30 minute storm

Return Period (years)	Storm Duration (30 minute)		
	Rainfall (mm)	Peak Flow (l/s)	Volume (m^3)
2	10.2	8.3	11.4
5	15.1	12.3	17.0
10	19.7	15.9	22.1
20	25.3	20.5	28.3
30	29.2	23.6	32.7
50	34.9	28.3	39.2
100	44.5	36.0	49.9
200	56.8	46.0	63.7

[10] Institute of Hydrology (1999) *Flood Estimation Handbook Volume 3*, Centre for Ecology and Hydrology, Wallingford, FEH CD-ROM, September 2009 Version 3.

[11] Rational Method provides peak flows (Q) on the basis of Q = 2.78 x Cv x Cr x I x AREA, where Cr = routing coefficient taken as 1.0; Cv = runoff coefficient and taken as PR/100; I= rainfall intensity (mm/hr); PR = FEH percentage runoff. The volume (Vol) of runoff is given by: Vol = R_{tot} x Cv x AREA, where R_{tot} = Rainfall storm total (mm)

The results indicate that the 100 year 30 minute storm would give rise to a peak flow rate for surface water run-off from the existing Site of 36 l/s and a volume of 49.9m^3. The longer but less intense 100 year 1 hour storm would give rise to a lower peak flow of 21 l/s and a volume of 59m^3. These differences reflect the greater intensity of the 30 minute event, which would give higher peak storm flows but the shorter duration gives rise to a lower total storm volume than the 1 hour event.

Table 4: FEH Rainfall Intensities (mm) at TQ 2669 8214 and Site Peak Flows and Volumes using Rational Method for 1 hour minute storm

Return Period (years)	Storm Duration (1 hour)		
	Rainfall (mm)	Peak Flow (l/s)	Volume (m^3)
2	13.0	5.3	14.6
5	19.0	7.7	21.3
10	24.3	9.8	27.3
20	30.8	12.5	34.6
30	35.4	14.3	39.7
50	42.0	17.0	47.1
100	52.9	21.4	59.3
200	66.6	27.0	74.7

Current CIRIA guidance on SUDS[12] (CIRIA C609B) recommends the use of IH124 procedure[13] for the estimation of runoff from Greenfield sites of less than 200 ha and the Flood Estimation Handbook (FEH)[10] methods for areas larger than 200 ha. For catchment areas of less than 50ha CIRIA C609B[20] recommends an approach of using a standardised 50 ha (0.5km) area in the calculations, and then multiplying the runoff rate derived by the ratio of the site area over the standardised 50ha area. Whilst CIRIA C609B recommends the use of IH124, the Site area at 0.14ha is substantially smaller than the areas for which IH124 procedure was developed (1.1 km^2), and the size of the small gauged catchments used to derive data for the development of the empirical equation used.

The IH124 procedure derived an equation for the mean annual flood (QBAR). From this quantity flood estimates for events of lesser frequencies can be further derived from the regional growth factor curves given in Table 1 of Flood Studies Report (FSR)

[12] Wilson, S, Bray R and Cooper P (2004) C609B Sustainable drainage systems – hydraulic structural and water quality advice, 320pp

[13] Marshall, D C W and Bayliss, A C (1994) *Flood Estimation for Small Catchments* Report IH124, Institute of Hydrology, Wallingford, 73pp

Supplementary Report 14[14]. The IH124 equation for the mean annual flood for a rural (Greenfield) catchment is given by:

$$QBAR_{rural}\ (m^3/s) = 0.00108\ AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$$

The catchment descriptors used are SAAR of 639mm (from the FEH CD for the relevant catchment) and SOIL of 0.45. A standardised catchment area of 50ha was used and the run-off rate adjusted as noted above for the site area of 0.14ha. The resulting value of $QBAR_{rural}$ estimated adjusted to the Site area of 0.14ha is 0.55l/s, giving a value of 3.95 l/s/ha for the annual event. Based on the regional growth curve for FSR region 6 of 3.19 for the 100 year return period event, the Greenfield run-off rate is estimated as 1.76l/s or 12.59 l/s/ha. This gives rise to a greenfield run-off volume of about $3.1m^3$ for the 30 minute storm.

[14] Institute of Hydrology (1983) *Review of Regional Growth Curves*, Flood Studies Supplementary Report 14. Institute of Hydrology, Wallingford

Flood Risk Assessment

UCLH Phase 5

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