Member of the Surbana Jurong Group

Barnes Hospital

Flood Risk Assessment & Drainage Strategy

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LS Estates

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4427

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P01		Draft	N. Quinn	J. Gold	09/07/21
P02		Planning. Document no. updated from 4427-RP-CV-001	N.Quinn	J. Gold	22/07/21
P03		Combined with previous FRA (Appendix G)	G. Kim	G. Irvine	04/08/21
P04		Updated Proposed Drainage drawings (Appendix C)	G. Kim	G. Irvine	06/08/21
P05		AY Comments Addressed	J. Hodder	G. Irvine	19/08/21
P06		Reduced green roof, increased attenuation tank	G. Kim	J.Gold	23/09/21
P07		Green roof hatch adjusted	J.Hodder	J.Gold	15/10/21
P08		Red line boundary updated	J.Hodder	G.Irvine	18/11/21

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Date: 18/11/2021

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Date: 18/11/2021

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1.0 Introduction

1.1. General

Robert Bird Group (RBG) have been appointed by Star Land Realty UK Ltd to undertake a site-specific Flood Risk Assessment (FRA) to support a standalone planning application for the residential plot of the proposed Barnes Hospital Site. The entire site has already been granted Outline Planning Permission (OPP) under ref. 18/3642/OUT. This planning application seeks approval for the optimisation of the residential plot which forms part of the overall Barnes Hospital Site.

1.2. Planning Context

A Planning application was submitted to the Royal London Borough of Richmond upon Thames (LBRUT) on 26th October 2018 and validated on the 18th December 2018 for the following development:
''Outline planning permission for the demolition and comprehensive redevelopment (phased development) of land at Barnes Hospital to provide a mixed use development comprising a health centre (Use Class D1), A Special Educational Needs School (Use Class D1), up to 80 new build residential units (Class C3), the conversion of two of the retained BTMs for use for up 3no.residential units (Use Class C3), the conversion of one BTM for medical use (Use Class D1), car parking, landscaping and associated works. All matters reserved for the full details submitted in relation to access points at the site boundaries.''
Planning permission was granted by LBRUT on 14th September 2020. The proposals for this application seek to optimise this site for residential use, in line with adopted and emerging policy. This planning application has been prepared in relation only to the residential plot of the Barnes Hospital Site as approved under the Outline Planning Permission (ref. 18/3642/OUT).

1.3. FRA Scope

This report will support the "Flood Risk Assessment for the South West London and St George's Mental Health Trust" (Appendix G, BAH-FRA-2018) by Arup dated November 2018 which was approved by LBR as part of the OPP. It will look at any changes the proposals will have on the Flood Risk of the site and give an overview of the proposed drainage scheme for the area. The proposals have been carried out in accordance with the National Planning Policy Framework (NPPF) and the NPPF Technical Guide. This FRA will summarise the Flood Risk outlined in the previously approved FRA as well as examine any potential new risks which arise as part of the amended proposals and outline the Drainage Strategy. This can be used to assist LBRUT as the Local Lead Flood Authority (LLFA) when considering the flood risk of the proposed development as part of the planning application.

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2.0 Site and Surroundings

2.1. The Site

Barnes Hospital is located in Barnes, within the administrative boundary of the London Borough of Richmond on Thames and is 1.4km south of the River Thames. The site occupies an area of circa 0.8 ha (8,000 sqm) and is bound by South Worple Way to the north, South Worple Avenue to the east, residential dwellings fronting Grosvenor Avenue to the south; and Mortlake Cemetery to the west. The site is currently occupied by the existing hospital and associated facilities which provide community and in-patient mental health services. It is made up mostly of buildings and hard standing with a small amount of green space.

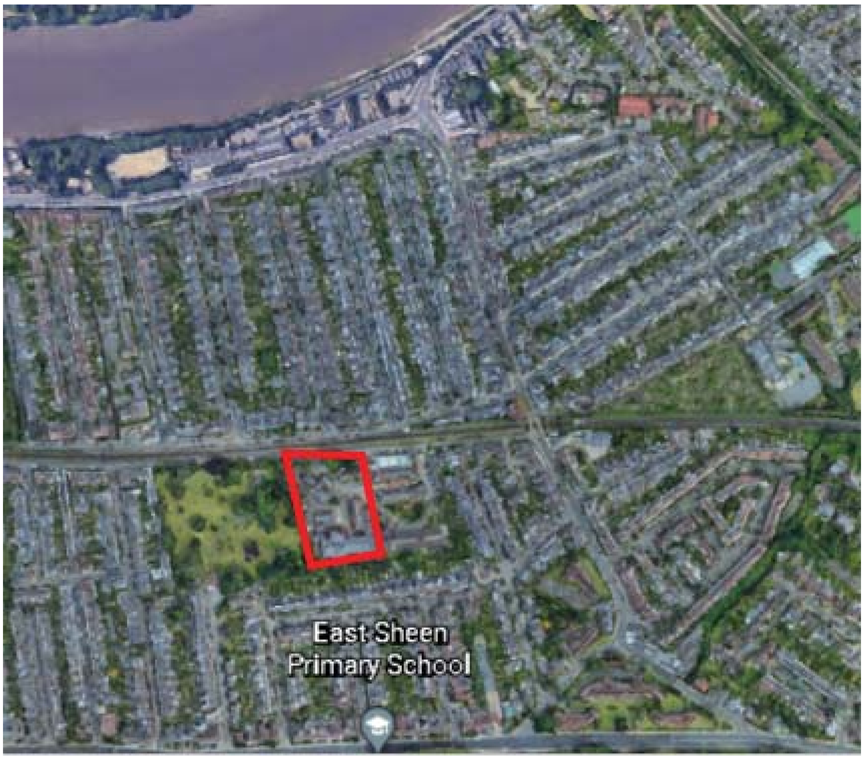

Figure 2-1 Site Area (extracted from Google Earth July 2021)

2.2. Proposed Development

The proposed development seeks to optimise the residential plot and will result in an increase in the height of Blocks B and C by an additional storey to match the height of the existing buildings on site in the area that has less impact to the neighbours. The internal cores and building envelopes have been rationalised to reflect the low rise nature of the buildings and improve communal access control. These changes result in an uplift of 29 additional residential units, bringing the total to 109. There is a total reduction of 968sqm of hardstanding. There will be no impact on the Flood Risk for this area when compared to the approved OPP development. A copy of the Ground Floor and Basement level architectural plans can be found in Appendix B.

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3.0 Site Flood Risk

The Flood Risk for the residential plot is covered within the entire sites previously approved FRA which was submitted as part of the OPP. This was written referring to the LBRUT Strategic Flood Risk Assessment (SFRA) carried out in June 2008 with updates in August 2010 and March 2016 and concluded that the site was not located in an area at risk of flooding. The current report has also reviewed information within the SFRA issued in March 2021. A summary of these flood risks for the site are outlined below:

	High	Medium	Low	
Tidal/ Fluvial			x	Barnes Hospital is located within Flood Zone 1
Surface Water			x	Barnes Hospital site may have a flooding depth of 0.00 – 0.15 m according to the 2018 SFRA Flood Maps. This is expected to be primarily due to the very flat topography of the site, rather than flow from off-site. This will be mitigated by the proposed surface water drainage network and SuDS so pluvial flooding is deemed as low.
Groundwater			x	Barnes Hospital site does have a potential for groundwater flooding of property situated below ground. Current proposals for the site include some subterranean car parking. It is expected that these elements would include sufficient waterproofing measures. The risk of flooding from groundwater is considered to be low.
Sewers			x	The LBRUT SFRA shows that there have been between 1 and 5 reported incidences of sewer flooding within the vicinity of the site, though does not give any further detail on the exact location of these incidents. This number is relatively low over a large area, hence sewer flood risk is considered to be low.
Artificial sources			x	The EA produce maps showing flood risk to the site due to the breach of a large reservoir shows flood risk as negligible.

Figure 3-1 Summary of Site Flood Risks

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4.0 Development Proposals

4.1. Existing Drainage

The existing foul network around the Barnes Hospital site shows an existing foul water drainage pipe in South Worple Way to the north of the site. It is assumed that the site currently draining to manhole TQ2175NW1702 at the start of this run. The manhole in South Worple Way is 3.80m deep (CL: 6.43m, IL: 2.63m.) There is another drainage route on South Worple Avenue to the southeast of the site, with an unknown depth.

Figure 4-1 Thames Water Asset Location Search

4.2. Proposed Drainage

The proposed drainage strategy drawing is included in Appendix C. The surface water network discharges to the 225 mm Thames Water existing sewer in South Worple Way, connecting at an invert level of 4.600 with a flow rate of 5 l/s. To the northwest of the site, a 0.9 m x 260 m^2 attenuation tank crate system is proposed. A hydrobrake control chamber will limit the flow to 5 l/s for the 1 in 30 year storm event. The LBRUT 2021 SFRA states that planning applications should utilise the 'upper end' climate change scenarios when implementing the climate change allowances for surface water and so the calculations have allowed for a 40% increase due to climate change. The flow rate of 5l/s has previously been agreed with the LLFA under the OPP for this site and confirmation has been received that the flow rate of 5l/s is acceptable if we can show that the exceedance flows from the 100-year storm events are managed. Correspondence with the LLFA is included in Appendix E. Thames Water have also confirmed in response to a pre-planning application in December 2018 that there is sufficient capacity. The existing flow for the site during a 1/30 year storm is 113l/s so the proposals offer a 96% betterment on the existing. Microdrainage calculations for the proposals are included in Appendix D.

Any additional volume unable to be contained within the storage during 100-year storm events, can be managed within the design of the site topography – these additional volumes of water can be directed to the soft landscaped areas of site via level design, which will be developed at the next stage. Levels will be designed to ensure that no overland flows are directed towards any of the buildings or site access routes. An exceedance flow drawing is included in Appendix C.

The foul water drainage from buildings will be collected in a series of new manholes and pipes. The network will connect to the TW sewer in South Worple Way. Refer to Appendix C for details.

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4.3. Sustainable Drainage Assessment

This SuDS selection assessment provides a high-level assessment of the different SuDS techniques and solutions which may or may not be appropriate for accommodating the surface runoff from the proposed development. The assessment addresses the quality, quantity and amenity impact on the future development proposals as well as the opportunity to combine various SuDS techniques to produce a recognised management/treatment train solution.

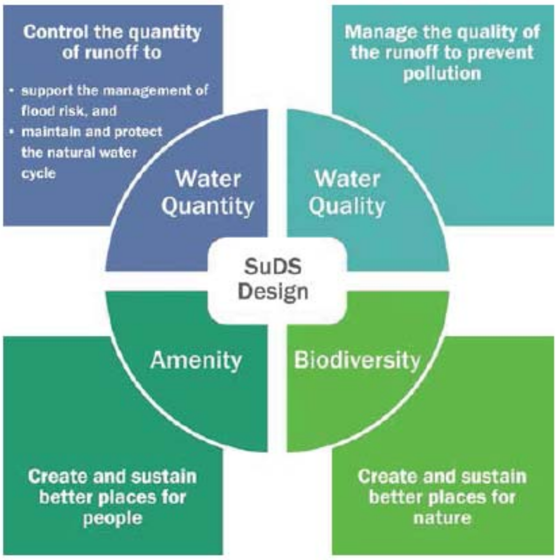

Figure 4-2: The Four Pillars of SuDS Design (extracted from CIRIA 753 The SuDS Manual)

This selection assessment is undertaken at a preliminary level and further details of the SuDS strategy are to be developed at further design stages.

4.4. SuDS Design Process

The three key aims of any SuDS network are as follows:

- Provision of attenuation for quantity of onsite surface water
- Pollution and particulate removal for quality of the onsite surface water
- Provision of spaces to enhance biodiversity, ecology and amenity spaces

Surface level SuDS can also provide resilience against extreme storm events and potential below ground blockages by intercepting surface water flows through landscape features, preventing reliance on gullies and drainage channels. These provide exceedance flow routes at ground level when the below ground network is at capacity.

4.5. SuDS Hierarchy

In line with Section 3.2 SCC SuDS Handbook surface water run-off is to be managed as close to source as possible in line with the following drainage hierarchy.

Table 4-1 Sustainable Drainage Hierarchy

	SuDS technique	Proposed	Comment
Most sustainable	Use infiltration techniques, such as porous surfaces in non-clay areas	✗	Infiltratrion can be explored at a later stage if the infiltration tests confirm it can be used.
	Discharge to a a surface water body;	✗	No surface water body in the area.
	Discharge to a surface water sewer, highway drain, or other surface water drainage system	✓	The site will discharge to the surface water sewer in South Warpole Way.

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	SuDS technique	Proposed	Comment
Least sustainable	Discharge rainwater to the combined sewer.	✗	Not required due to presence of surface water sewers.

4.6. SuDS Selection

The selection of SuDS measures has been based on the constraints and drainage hierarchy detailed above. As per the LBRUT 2021 SFRA a Statement on SuDS will be provided as part of this Drainage Strategy which will demonstrate how the proposed development will manage different sources of flood risk now and over the development's lifetime using SuDS.

A green roof will be used to provide a level of source treatment and increases the surface waters time of entry into the public drainage network. A total area of 860 m^2 has been modelled, using 100 mm depth, which corresponds to 30% of the total roof area across the three buildings. As the design develops, if further area at roof level becomes available it will be utilised as green roof.

To the east of the site, 250 m2 of permeable paving will be used on external pavement areas. It has been designed with 0.35 m depth of substrate. This will provide shallow storage and water quality treatment at the source of capture.

The attenuation tank in the northwest corner will also help store surface water on site. There is also potential for a drainage mat on the podium area.

Table 4-2 identifies the potential SuDS options for the development:

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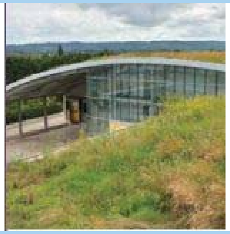
Table 4-2 SuDS Options for Development

SUDS group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
Source Control	Green/Brown roof		Multi-layered system that covers the roof of a building with vegetation cover/landscaping over a drainage layer. Designed to intercept and retain precipitation, reducing the volume of runoff and attenuating peak flows.	Mimics greenfield state of building footprint for high density developments, good removal of pollutants, ecological benefits, insulates buildings, sound absorption.	Additional weight, not appropriate for steep roofs, maintenance of roof vegetation.	✓ Used across all 3 buildings, totalling 860m^2.
	Rainwater harvesting		Uses rainwater from roofs to supply toilets, washing machines and irrigation systems. Harvested rainwater is stored onsite and is substituted for mains supply, reducing both site discharge and potable water consumption.	Can provide source control of storm water total volume, reduces demand on mains water.	Use is dependent on demand requirements, contributing surface area, and seasonal rainfall characteristics.	✗ Not currently included in strategy.
	Porous Paving/ Porous Asphalt		Surfacing that allows rainwater to infiltrate through the surface and into the underlying layers. The water is temporarily stored before infiltrating the ground or discharging to the sewerage system.	Provides source attenuation and low-level treatment of highway runoff. Reduction in runoff volume via potential infiltration.	Often requires increased construction depth and may not be applicable to heavy traffic loadings.	✓ This will be conisdered as part of the landscaping proposals in public realm areas.
	Rain Gardens and Bio-retention Areas		Planted features in which surface water can be stored or conveyed. They can be designed to allow infiltration, where appropriate. Rain gardens receive runoff from adjacent areas of paving	Incorporate into landscaping, good removal of pollutants, reduces runoff rates and volumes, low cost.	Requires considered use of water tolerant plant species.	✓ To be explored when landscape architect's design is developed.
Infiltration	Infiltration trench, Infiltration basins and soakaway		Surface water runoff can be discharged directly to ground for infiltration by soakaways, basins, or trenches. A prerequisite is that both groundwater and ground conditions are appropriate to receive the quality and quantity of water generated	Reduces the volume of runoff, effective at pollutant removal, contributes to groundwater recharge, simple and cost-effective, easy performance observation.	Requires appropriate pre-treatment, basins require a large flat area, offset from foundations.	✓ Option to be explored following infiltration test.

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SUDS group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
Conveyance	Filter Drains/ French drains		Shallow excavations filled with rubble or stone that create temporary subsurface storage for filtration of storm water runoff. Intercept water flow across a surface.	Hydraulic benefits achieved with filter trenches, trenches can be incorporated into site landscaping and fit well beside roads and car parks.	High clogging potential without effective pre-treatment, limited to small catchments, high cost of replacing filter material.	✓ This will be conisdered as part of the landscaping proposals.
	Vegetated Swales		Swales are linear planted drainage features in which surface water can be stored and conveyed. Swales can also enable local infiltration.	Drainge can be easily mintained and incorporated into landscaping, there is good removal of pollutants and discharge volumes. Generally low cost to implement.	Not suitable for steep areas, significant land take.	✗ Site size constraints mean these cannot be used.
	Rills and Canals		Formal linear drainage features in which surface water can be stored or conveyed. They can be incorporated with water features such as ponds or waterfalls where appropriate. Rills can be planted to further remove pollutants within the receiving water.	Reduce the need for underground pipework. Can provide some attenuation and amentiy benefits through the visual use of water through the landscape. Possible reduction in runoff volume via plant uptake and infiltration.	Potential trip/wheel hazard, disabled access issues.	✗ Not currently included in the landscape design.
Retention	Retention Pond		Provides both storm water attenuation and treatment. Runoff from each rain event is detained and treated in the pool. The retention time promotes pollutant removal through sedimentation.	Good removal of pollutants, can be used where groundwater is vulnerable, good community acceptability, high ecological, and amenity benefits.	No reduction in runoff volume, land take may limit use in high density sites.	✗ Size of site unsuitable.
Detention	Detention Pond		Surface storage basins that provide flow control through attenuation. Normally dry and in certain situations the land may also function as a recreational facility.	Cater for a wide range of rainfall events, can be used where groundwater is vulnerable, potential for dual land use, easy to maintain.	Land take, little reduction in runoff volume, detention depths constrained by levels.	✗ Size of site unsuitable.

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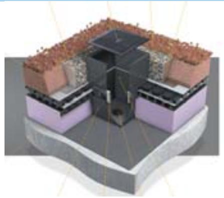
SUDS group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
	Blue Roofs		Blue roofs are used to attenuate water at roof level within either a cellular storage crate system above the roof itself.	The water is released slowly from the roof through the use of controls such as orifices or restricted outlets. Reduces the demand on provision of below ground attenuation, reduces the dischrage rate from the site.	Impose additional dead loading to the structure which may require a small increase in structural members. No water quality treatment if used without green/brown roofs	✗ Not currently included in strategy.
	Below ground Storage		Oversized pipes, tank systems and modular geocellular systems that can be used to create a below ground storage structure.	Modular and flexible, dual usage (infiltration/storage, high void ratios, can be installed beneath trafficked and soft landscaped areas.	No water quality treatment.	✓ Below ground storage tanks are suitable to limit the discharge rate

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5.0 SuDS Maintenance Plan

All SuDS features proposed within the surface water drainage strategy are to remain private and will be owned and maintained by the landowner. A summary of the anticipated maintenance and operations requirements for the strategy is proposed for the site to maintain the drainage networks:

Table 3 SuDS Maintenance Strategy

Suds component:	Geocellular boxes, oversized pipes and tanks	
Maintenance	**Action**	**Frequency**
Regular maintenance	- check inlets, outlets, control structures, catchpits and overflows	Monthly or annually or after a large storm
Occasional tasks	- jetting and suction where silt has settled	As required
Remedial work	- reinstate	As required

Suds component:	Permeable surfaces	
Maintenance	**Action**	**Frequency**
Regular maintenance	- swept clean with a stiff broom and hose with clean water	Monthly
	- mow grass edges to paving at 35-50mm and Remove weeds and leaves	As required
	- check outlets and control structures	Monthly depending on detail
Occasional tasks	- jetting to remove dirt, grime and moss.	As required
Remedial work	- small areas of damage can be repaired using the same blend as the surrounding surface.	As required

Suds component:	Green roof	
Maintenance	**Action**	**Frequency**
Regular maintenance	- Mow grasses	Monthly
Occasional tasks	- Removal of litter and debris to prevent clogging of inlet drains	Six monthly / annually or as required
	- Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Anually
	- Inspect underside of roof for evidence of leakage	Anually
Remedial Works	- If erosion channels are evident, these should be stabilised with additional soil substrate similar to the original material. Sources of erosion damage must be identified and controlled.	As required

Suds component:	Hydrobrake	
Maintenance	**Action**	**Frequency**
Regular maintenance	- Visual inspection regularly during first year of installation to determine site-specific rate of sediment accumulation	3 months
Occasional tasks	- Inspect Hydrobrake 6 month there after - Sump cleanout typically conducted once a year during any season but weather and cold temperatures should be considered	Six months/ or as required Annually

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6.0 Conclusion

The site is in Flood Zone 1 and is at low risk of river or sea flooding. There have been no changes to the proposals for this site development from the approval OPP that affect Flood Risk. Future climate change effects are not expected to significantly increase risk of flooding from sources except from rainfall which has been accounted for as per the LBRUT SFRA. The site is at low risk of flooding from other sources such as surface water, sewers, groundwater and artificial sources.

The proposed strategy for surface water drainage includes various SuDS measures including green roofs, permeable paving and an attenuation tank. There is also potential for a drainage mat to the west of the site. This network will connect to the existing Thames Water surface water sewers in South Worple Way. Discharge at this connection point is limited to 5 l/s which offers a 96% betterment compared to existing. This surface water flow rate has been agreed with the LLFA under the OPP and recent communications. Thames Water have also approved the pre-planning application confirming capacity.

Foul water from buildings will be collected in a series of new manholes and pipes and discharged to the existing manhole in South Worple Way.

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Appendix A

Topographical Survey

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COORDINATE TABLE

STATION	DESCRIPTION	EASTING	NORTHING	LEVEL
STN4	PK Nail	521236.053	175678.420	6.428
STN5	PK Nail	521200.201	175703.520	6.250
STNP1	PK Nail	521181.271	175693.646	6.064
STNP10	PK Nail	521216.175	175640.296	6.518
STNP1A	PK Nail	521192.273	175665.085	6.496
STNP2	PK Nail	521203.593	175730.668	6.185
STNP3	PK Nail	521164.767	175727.523	6.170
STNP4	PK Nail	521154.633	175684.354	6.260
STNP5	PK Nail	521137.616	175721.598	6.292
STNP5A	PK Nail	521136.322	175733.307	6.291
STNP6	PK Nail	521150.672	175663.478	6.155
STNP6A	PK Nail	521164.853	175666.188	6.330
STNP7	PK Nail	521155.613	175639.950	6.283
STNP8	PK Nail	521171.298	175633.632	6.291
STNP9	PK Nail	521196.318	175637.384	6.502

Rev	Notes	Drawn	Date

Notes: Grid Origin and Level Datum are referenced to XYZ Surveys drawing "2016/027" which has been inserted into this model for background reference.

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Title: TOPOGRAPHIC SURVEY

Client: BEADMANS

Project: BARNES HOSPITAL

Date Completed:	SEPTEMBER 2019	Post Code:	SW14 8SU
Surveyed:	PS	Scale:	1:200@A0
Drawn:	PS		
Checked:	ME		
Dwg No: 01		Job No: C2019/263	Rev: 0

Appendix B

Proposed Architectural Plans

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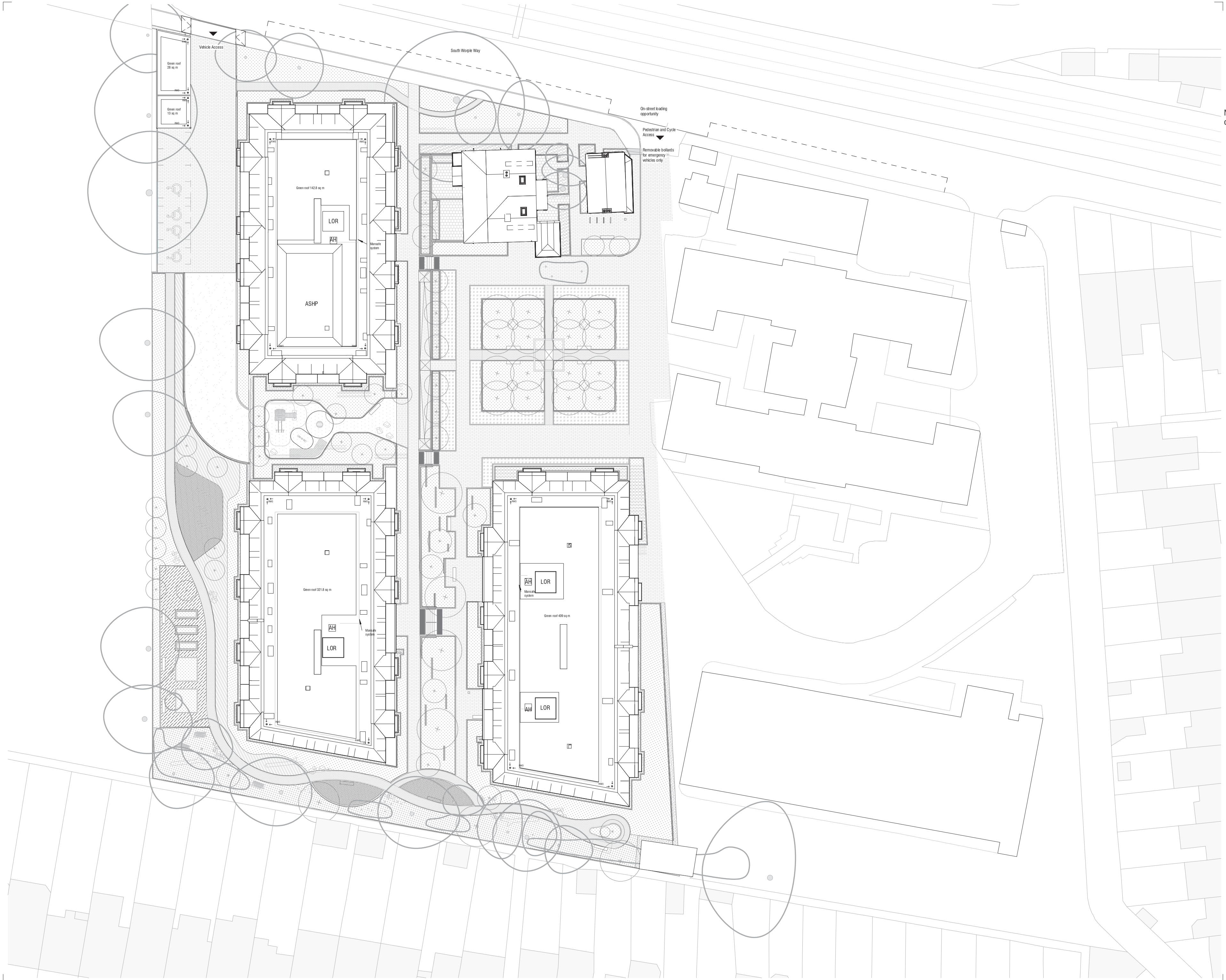

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Figured dimensions only are to be taken from this drawing. All dimensions are to be checked on site before any work is put in hand.

metres 5 10 15 20 25

SCALE BAR: 1:250

NOTE: Top level roof and dormers are subject to design devlopment and facade coordination

Revision	Description	Date	Drawn	Checked
9	For Planning Submission	12/11/2021	FS	OM
8	For Planning Submission	13/08/2021	FS	OM
7	For Planning Submission	12/08/2021	FS	OM
6	Update Desing Freeze	23/07/2021	FS	OM
5	Draft Planning Submission	09/07/2021	FS	OM
4	For Information	05/07/2021	FS	OM
3	For Information	23/06/2021	FS	OM
2	For Information	04/06/2021	FS	OM
1	For Information	15/04/2021	FS	OM

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Client's Name
Star Land Realty UK Ltd.

Job Title
Barnes Hospital Site

Drawing Title
Proposed Site Roof Plan

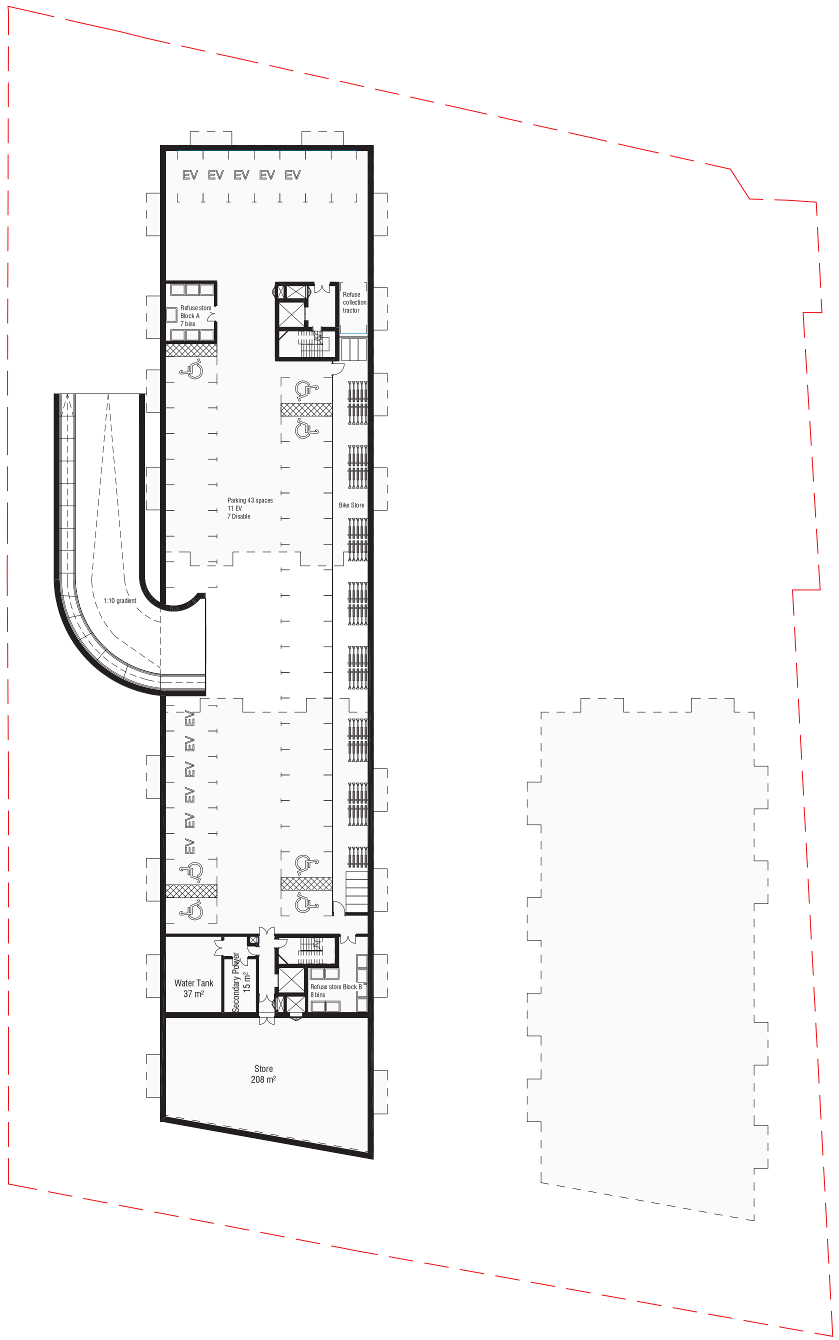
Scale
1 : 250 @A1

SBR Project No.
18387

SBR Project No. Originator Volume Level Type Role Number
18387-SBR- ZZ-00-DR-A-80103

Suitability Code Status
S4 - FOR STAGE APPROVAL

Rev
9



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metres 5 10 15 20 25

SCALE BAR: 1:250

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9	For Information	23/06/2021	FS	OM
8	For Information	04/06/2021	FS	OM
7	For information	12/05/2021	FS	OM
6	For Information	10/05/2021	FS	OM
5	For Information	25/03/2021	FS	OM
4	Pre-App 2 Issue	25/02/2021	FS	OM
3	Building position update	08/02/2021	FS	OM
2	For Information	28/01/2021	FS	OM
1	For Information	14/01/2021	FS	OM

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Client's Name
Star Land Realty UK Ltd.

Job Title
Barnes Hospital Site

Drawing Title
Basement Plan

Scale
1 : 250 @A1

SBR Project No.
18387

SBR Project No. Originator Volume Level Type Role Number
18387-SBR- ZZ-B1-DR-A-80102

Suitability Code Status
S4 - FOR STAGE APPROVAL

Rev
14

Appendix C

Drainage Drawings

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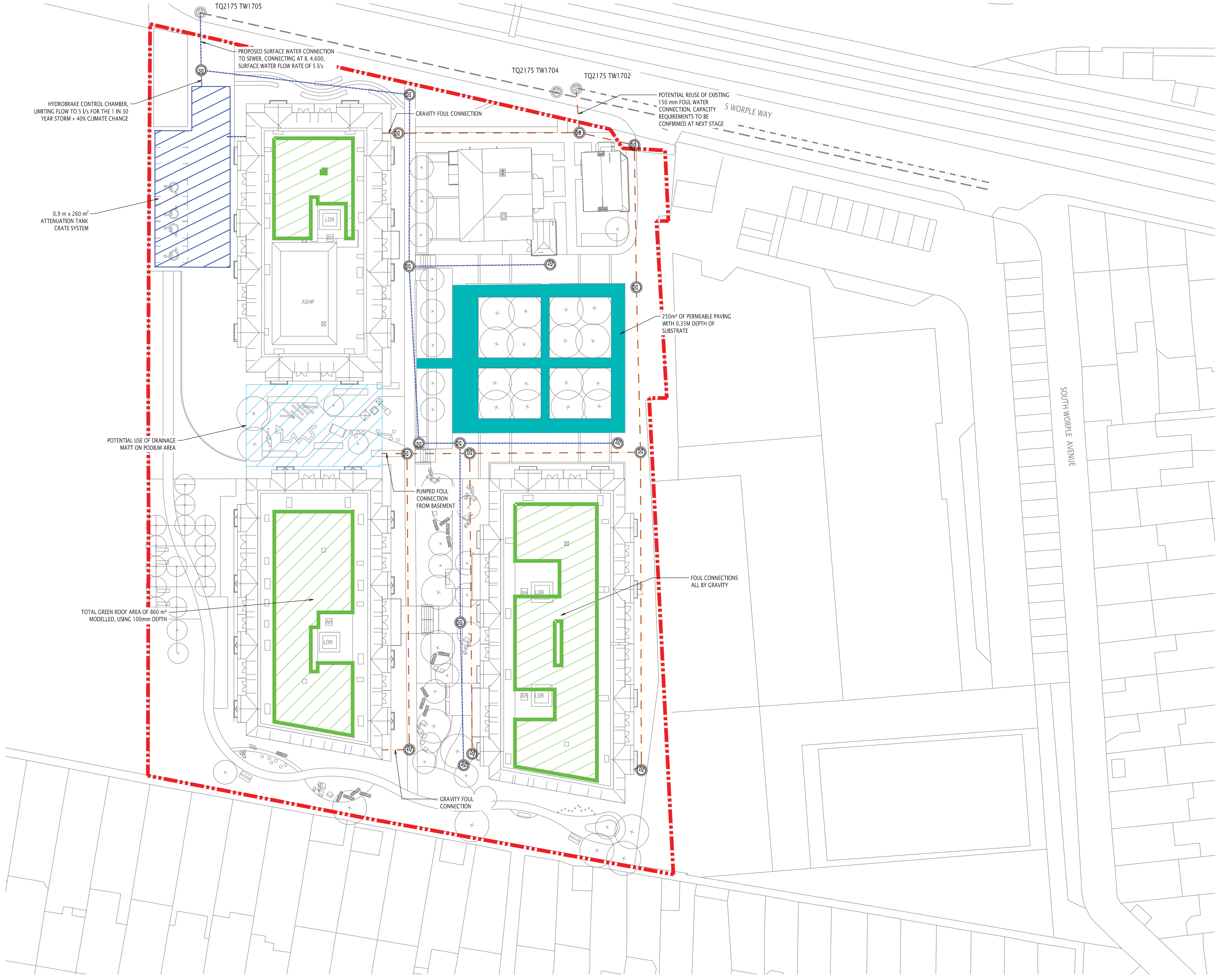

KEY TO HEALTH AND SAFETY SYMBOLS

- INDICATES A RESIDUAL RISK REQUIRING A COMPULSORY ACTION
- INDICATES A RESIDUAL RISK REQUIRING A PROHIBITIVE ACTION
- INDICATES A RESIDUAL RISK AS A WARNING
- INDICATES A RESIDUAL RISK FOR INFORMATION

LEGEND

- POTENTIAL GREEN ROOF AREAS
- ATTENUATION TANK
- DRAINAGE MATT
- PERMEABLE PAVING
- FOUL WATER PIPE
- SURFACE WATER PIPE
- EXISTING PUBLIC COMBINED SEWER
- EXISTING PUBLIC SURFACE WATER SEWER
- FOUL WATER MANHOLE
- SURFACE WATER MANHOLE
- EXISTING TW MANHOLE
- SITE BOUNDARY

Rev	Revision Description	By	App	Date
P05	RED LINE BOUNDARY UPDATED	JH	JG	18.11.21
P04	GREEN ROOF HATCH UPDATED	JH	JG	14.10.21
P03	AREAS UPDATED	GK	JG	23.09.21
P02	NETWORKS UPDATED	VS	JG	06.08.21
P01	FOR INFORMATION	VS	JG	09.07.21

Scale 1 2 3 4 5 6 7 8

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Client
LS ESTATES

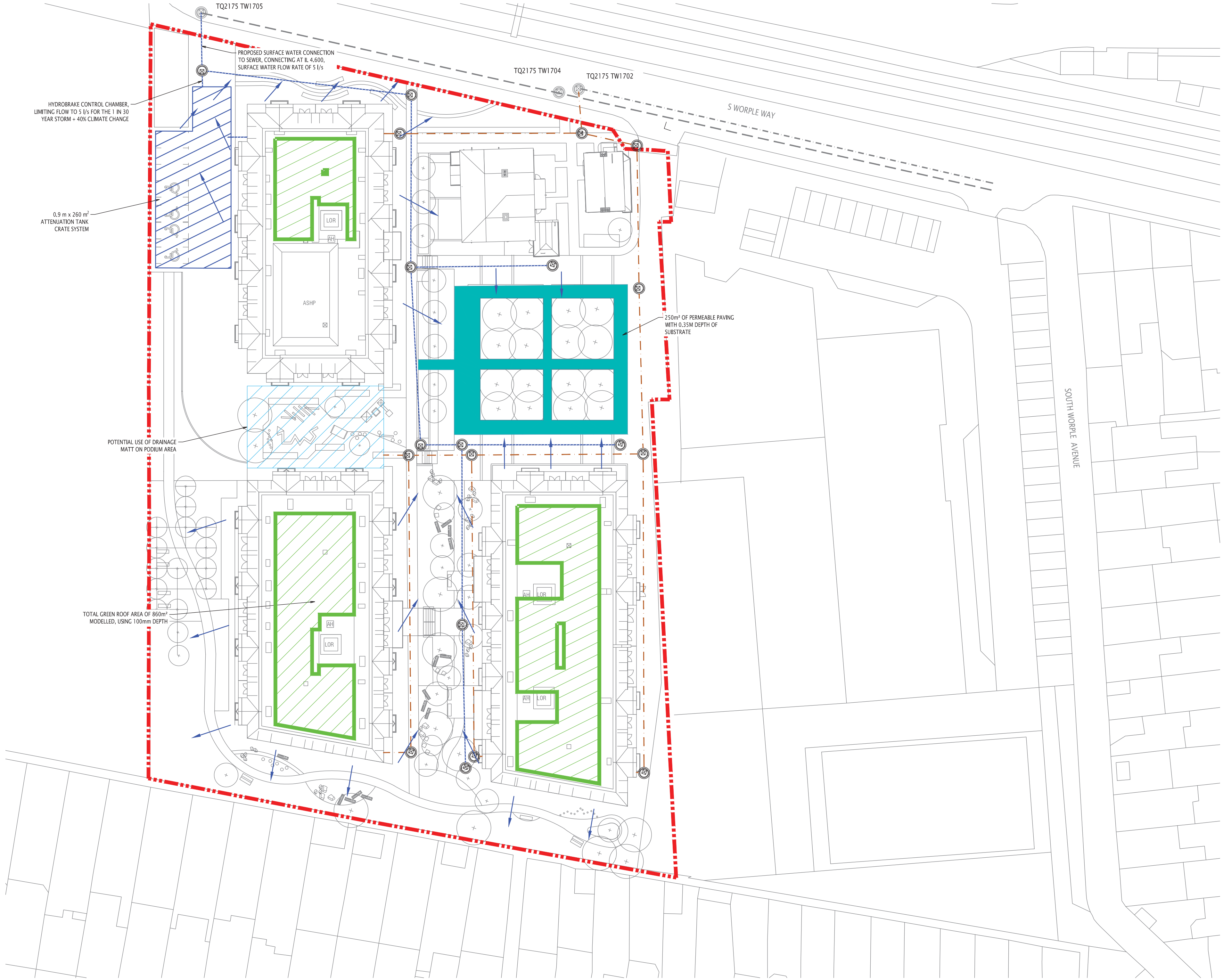
Project
BARNES HOSPITAL SITE

Title
DRAINAGE GENERAL ARRANGEMENT

Date JULY/2021	Drawn J.BELL
Scale at A1 1:250	Designer G.KIM
Suitability Code S2	Design Checker -
Job Number 4427	Approved L.RAPSON

FOR INFORMATION

Drawing Number 4427-RBG-XX-00-DR-CV-86001
Revision P05



KEY TO HEALTH AND SAFETY SYMBOLS

- INDICATES A RESIDUAL RISK REQUIRING A COMPULSORY ACTION
- INDICATES A RESIDUAL RISK REQUIRING A PROHIBITIVE ACTION
- INDICATES A RESIDUAL RISK AS A WARNING
- INDICATES A RESIDUAL RISK FOR INFORMATION

LEGEND

- BUILDINGS CONTAINING GREEN ROOF AREAS
- ATTENUATION TANK
- DRAINAGE MATT
- PERMEABLE PAVING
- FOUL WATER PIPE
- SURFACE WATER PIPE
- EXISTING PUBLIC COMBINED SEWER
- EXISTING PUBLIC SURFACE WATER SEWER
- FOUL WATER MANHOLE
- SURFACE WATER MANHOLE
- EXISTING TW MANHOLE
- SITE BOUNDARY
- OVERLAND EXCEEDANCE FLOW ROUTES

Rev	Revision Description	By	App	Date
P05	RED LINE BOUNDARY UPDATE	JH	JG	18.11.21
P04	GREEN ROOF HATCH UPDATED	JH	JG	14.10.21
P03	AREAS UPDATED	GK	JG	23.09.21
P02	NETWORKS UPDATED	VS	JG	06.08.21
P01	FOR INFORMATION	VS	JG	09.07.21

Scale	1	2	3	4	5	6	7	8

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Client
LS ESTATES

Project
BARNES HOSPITAL SITE

Title
OVERLAND FLOW DRAWING

Date: AUGUST/2021	Drawn: J.BELL
Scale at A1: 1:250	Designer: G.KIM
Suitability Code: S2	Design Checker: -
Job Number: 4427	Approved: L.RAPSON

FOR INFORMATION

Drawing Number: 4427-RBG-XX-00-DR-CV-86002
Revision: P05

Appendix D

Microdrainage Calculations

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 521203 175677 TQ 21203 75677
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	12.127	0.125	97.0	0.032	5.00	0.0	0.600	o	100	Pipe/Conduit	🔓
1.001	12.127	0.125	97.0	0.058	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
1.002	9.850	0.099	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
1.003	14.836	0.148	100.0	0.038	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
1.004	37.241	0.528	70.5	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.26	6.100	0.032	0.0	0.0	0.0	0.78	6.1	4.3
1.001	50.00	5.46	5.925	0.090	0.0	0.0	0.0	1.02	18.0	12.2
1.002	50.00	5.62	5.800	0.090	0.0	0.0	0.0	1.00	17.8	12.2
1.003	50.00	5.87	5.702	0.128	0.0	0.0	0.0	1.00	17.8	17.4
1.004	50.00	6.26	5.528	0.157	0.0	0.0	0.0	1.56	62.0	21.3

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
2.000	22.715	0.227	100.0	0.014	5.00	0.0	0.600	o	100	Pipe/Conduit	
2.001	10.149	0.798	12.7	0.090	0.00	0.0	0.600	o	150	Pipe/Conduit	
3.000	11.360	0.114	100.1	0.040	5.00	0.0	0.600	o	100	Pipe/Conduit	
3.001	11.360	0.114	99.6	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.002	6.786	0.041	165.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.003	40.876	0.243	168.2	0.090	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.004	48.393	0.589	82.2	0.071	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	11.707	0.065	180.1	0.036	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	16.261	0.260	62.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.007	6.588	0.040	164.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
2.000	50.00	5.49	6.100	0.014	0.0	0.0	0.0	0.77	6.0	1.9
2.001	50.00	5.55	5.873	0.104	0.0	0.0	0.0	2.84	50.2	14.1
3.000	50.00	5.25	6.100	0.040	0.0	0.0	0.0	0.77	6.0	5.4
3.001	50.00	5.39	5.862	0.090	0.0	0.0	0.0	1.31	52.1	12.2
3.002	50.00	5.50	5.748	0.090	0.0	0.0	0.0	1.01	40.3	12.2
3.003	50.00	6.18	5.707	0.180	0.0	0.0	0.0	1.01	40.0	24.4
3.004	50.00	6.74	5.464	0.251	0.0	0.0	0.0	1.44	57.4	34.0
1.005	50.00	6.91	4.800	0.548	0.0	0.0	0.0	1.17	82.6	74.2
1.006	50.00	7.12	4.860	0.548	0.0	0.0	0.0	1.27	22.5«	74.2
1.007	50.00	7.26	4.600	0.548	0.0	0.0	0.0	0.78	13.8«	74.2

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.007		6.430	4.560	0.000	0	0

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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 3
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 521203 175677 TQ 21203 75677
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: 4, DS/PN: 1.006, Volume (m³): 3.1

Unit Reference	MD-SHE-0103-5000-1200-5000
Design Head (m)	1.200
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	103
Invert Level (m)	4.860
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	5.0	Kick-Flo®	0.745	4.0
Flush-Flo™	0.354	5.0	Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.4	1.200	5.0	3.000	7.7	7.000	11.5
0.200	4.7	1.400	5.4	3.500	8.3	7.500	11.8
0.300	5.0	1.600	5.7	4.000	8.8	8.000	12.2
0.400	5.0	1.800	6.0	4.500	9.3	8.500	12.6
0.500	4.9	2.000	6.3	5.000	9.8	9.000	12.9
0.600	4.7	2.200	6.6	5.500	10.2	9.500	13.3
0.800	4.1	2.400	6.9	6.000	10.7		
1.000	4.6	2.600	7.2	6.500	11.1		

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Storage Structures for Storm

Porous Car Park Manhole: 1, DS/PN: 3.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	25.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	69.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	5.832	Cap Volume Depth (m)	0.350

Cellular Storage Manhole: 4, DS/PN: 1.006

Invert Level (m)	4.860	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	260.0	0.0	0.901	0.0	0.0
0.900	260.0	0.0			

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2 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 3
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 429007 433103 SE 29007 33103
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 40, 40

PN	**US/MH Name**	**Storm**	**Return Period**	**Climate Change**	**First (X) Surcharge**	**First (Y) Flood**	**First (Z) Overflow**	**Overflow Act.**
1.000	4	120 Winter	2	+0%	30/30 Summer	100/30 Summer		
1.001	2	120 Winter	2	+0%	30/30 Summer	100/30 Winter		
1.002	5	120 Winter	2	+0%	30/30 Summer	100/240 Winter		
1.003	1	120 Winter	2	+0%	30/30 Summer	100/240 Winter		
1.004	2	120 Winter	2	+0%	30/360 Winter	100/240 Winter		
2.000	5	120 Winter	2	+0%	30/30 Winter	100/240 Winter		
2.001	6	120 Winter	2	+0%	100/30 Summer	100/240 Winter		
3.000	1	120 Winter	2	+0%	100/120 Winter	100/240 Winter		
3.001	9	120 Winter	2	+0%	100/30 Summer	100/240 Winter		
3.002	2	120 Winter	2	+0%	100/30 Summer	100/240 Winter		
3.003	1	120 Winter	2	+0%	30/30 Summer	100/240 Winter		
3.004	10	120 Winter	2	+0%	30/30 Summer	100/240 Winter		

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2 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	4	6.130	-0.070	0.000	0.20			1.1	OK	5
1.001	2	5.973	-0.102	0.000	0.22			3.6	OK	4
1.002	5	5.848	-0.102	0.000	0.23			3.6	OK	3
1.003	1	5.759	-0.092	0.000	0.32			5.2	OK	3
1.004	2	5.577	-0.176	0.000	0.11			6.4	OK	2
2.000	5	6.135	-0.065	0.000	0.27			1.6	OK	3
2.001	6	5.907	-0.116	0.000	0.12			5.3	OK	3
3.000	1	6.120	-0.080	0.000	0.09			0.5	OK	3
3.001	9	5.897	-0.190	0.000	0.06			2.6	OK	3
3.002	2	5.792	-0.180	0.000	0.09			2.6	OK	3
3.003	1	5.770	-0.162	0.000	0.18			6.7	OK	3
3.004	10	5.528	-0.160	0.000	0.18			10.1	OK	3

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2 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.005	3	120 Winter	2	+0%	2/360 Winter	100/240 Winter			5.065
1.006	4	120 Winter	2	+0%	2/60 Winter				5.061
1.007	13	120 Winter	2	+0%					4.666

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.005	3	-0.034	0.000	0.35			22.2	OK	
1.006	4	0.051	0.000	0.23			4.7	SURCHARGED	
1.007	13	-0.084	0.000	0.41			4.7	OK	

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30 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0   Number of Offline Controls 0 Number of Time/Area Diagrams 3
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 429007 433103 SE 29007 33103
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	4	120 Winter	30	+40%	30/30 Summer	100/30 Summer		
1.001	2	120 Winter	30	+40%	30/30 Summer	100/30 Winter		
1.002	5	120 Winter	30	+40%	30/30 Summer	100/240 Winter		
1.003	1	120 Winter	30	+40%	30/30 Summer	100/240 Winter		
1.004	2	120 Winter	30	+40%	30/360 Winter	100/240 Winter		
2.000	5	120 Winter	30	+40%	30/30 Winter	100/240 Winter		
2.001	6	120 Winter	30	+40%	100/30 Summer	100/240 Winter		
3.000	1	120 Winter	30	+40%	100/120 Winter	100/240 Winter		
3.001	9	120 Winter	30	+40%	100/30 Summer	100/240 Winter		
3.002	2	120 Winter	30	+40%	100/30 Summer	100/240 Winter		
3.003	1	120 Winter	30	+40%	30/30 Summer	100/240 Winter		
3.004	10	120 Winter	30	+40%	30/30 Summer	100/240 Winter		

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30 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	4	6.156	-0.044	0.000	0.61			3.5	OK	5
1.001	2	6.020	-0.055	0.000	0.72			11.8	OK	4
1.002	5	5.918	-0.032	0.000	0.75			11.8	OK	3
1.003	1	5.864	0.012	0.000	1.06			17.4	SURCHARGED	3
1.004	2	5.670	-0.083	0.000	0.37			21.6	OK	2
2.000	5	6.170	-0.030	0.000	0.84			4.9	OK	3
2.001	6	5.939	-0.084	0.000	0.40			17.8	OK	3
3.000	1	6.135	-0.065	0.000	0.27			1.5	OK	3
3.001	9	5.930	-0.157	0.000	0.20			8.9	OK	3
3.002	2	5.844	-0.128	0.000	0.30			8.9	OK	3
3.003	1	5.831	-0.101	0.000	0.59			22.3	OK	3
3.004	10	5.673	-0.015	0.000	0.60			32.9	OK	3

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30 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.005	3	120 Winter	30	+40%	2/360 Winter	100/240 Winter			5.661
1.006	4	120 Winter	30	+40%	2/60 Winter				5.657
1.007	13	120 Winter	30	+40%					4.668

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.005	3	0.562	0.000	1.18			75.4	SURCHARGED	
1.006	4	0.647	0.000	0.24			5.0	SURCHARGED	
1.007	13	-0.082	0.000	0.43			5.0	OK	

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100 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 3
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 429007 433103 SE 29007 33103
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	4	360 Winter	100	+40%	30/30 Summer	100/30 Summer		
1.001	2	360 Winter	100	+40%	30/30 Summer	100/30 Winter		
1.002	5	240 Winter	100	+40%	30/30 Summer	100/240 Winter		
1.003	1	360 Winter	100	+40%	30/30 Summer	100/240 Winter		
1.004	2	240 Winter	100	+40%	30/360 Winter	100/240 Winter		
2.000	5	360 Winter	100	+40%	30/30 Winter	100/240 Winter		
2.001	6	360 Winter	100	+40%	100/30 Summer	100/240 Winter		
3.000	1	480 Winter	100	+40%	100/120 Winter	100/240 Winter		
3.001	9	360 Winter	100	+40%	100/30 Summer	100/240 Winter		
3.002	2	360 Winter	100	+40%	100/30 Summer	100/240 Winter		
3.003	1	240 Winter	100	+40%	30/30 Summer	100/240 Winter		
3.004	10	360 Winter	100	+40%	30/30 Summer	100/240 Winter		

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100 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	4	6.933	0.733	3.466	0.70			4.0	FLOOD	5
1.001	2	6.933	0.858	2.551	0.45			7.3	FLOOD	4
1.002	5	6.930	0.980	0.198	0.62			9.8	FLOOD	3
1.003	1	6.930	1.079	0.078	0.65			10.6	FLOOD	3
1.004	2	6.930	1.177	0.017	0.30			17.6	FLOOD	2
2.000	5	6.933	0.733	2.505	0.60			3.5	FLOOD	3
2.001	6	6.930	0.907	0.067	0.25			11.0	FLOOD	3
3.000	1	6.932	0.732	1.822	0.56			3.2	FLOOD	3
3.001	9	6.932	0.846	2.174	0.12			5.3	FLOOD	3
3.002	2	6.931	0.959	1.476	0.18			5.3	FLOOD	3
3.003	1	6.931	1.000	1.475	0.46			17.6	FLOOD	3
3.004	10	6.930	1.242	0.048	0.34			18.5	FLOOD	3

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100 year Return Period Summary of Critical Results by Maximum Flood Volume (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.005	3	240 Winter	100	+40%	2/360 Winter	100/240 Winter			6.927
1.006	4	120 Winter	100	+40%	2/60 Winter				6.407
1.007	13	120 Winter	100	+40%					4.673

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.005	3	1.827	0.002	0.93			59.3	FLOOD	
1.006	4	1.397	0.000	0.27			5.6	SURCHARGED	
1.007	13	-0.077	0.000	0.48			5.6	OK	

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Appendix E

LLFA correspondence

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Grace KIM

From: Bunker, Elizabeth <Elizabeth.Bunker@richmondandwandsworth.gov.uk>
Sent: 21 July 2021 14:59
To: James HODDER
Cc: Grace KIM; Creegan, Darragh
Subject: Re: Barnes Hospital Planning Enquiry

Official

Dear James,

As the greenfield runoff rate would be 6.2 l/s, the proposed rate of 5 l/s is absolutely fine.

As the attenuation capacity is not sufficient for the 1 in 100 year event, evidence should be provided for how exceedance flows during a 1 in 100 year event will be managed in a suitable manor e.g. route water away from any vulnerable property, and avoid creating hazards to access and egress routes.

Kind regards,
Lizzy

Lizzy Bunker
Flood Risk Consultant
Richmond and Wandsworth LLFA team
07508888378

From: James HODDER <James.Hodder@robertbird.com>
Sent: 21 July 2021 09:27
To: Bunker, Elizabeth <Elizabeth.Bunker@richmondandwandsworth.gov.uk>
Cc: Grace KIM <Grace.Kim@robertbird.com>; Creegan, Darragh <Darragh.Creegan@richmondandwandsworth.gov.uk>
Subject: RE: Barnes Hospital Planning Enquiry

Official

Good Morning Lizzy,

Thank you for your swift response to my colleague Grace below.

Please see my responses to your questions below in red:

1. We usually assess whether a site's drainage can handle the 1 in 100 year event +40% climate change - would the runoff rate still be 5l/s for this?
   We have made an effort to ensure that all surface water manholes/chambers are at external ground level, to remove the risk of flooding to the buildings in the 100 year storm event, in accordance with BS 752 as per the previously approved application.
2. If so, does the attenuation tank have enough capacity to store runoff discharging at 5 l/s for the 1 in 100 year event +40% Climate Change with the new site area included in the calculations?
   The attenuation tank is currently designed to allow for the 30 year + 40% CC to discharge at 5l/s and only provides storage for this. The attenuation tank, and green roof areas have been pushed to as much as we can fit on the site with the limitations we face on space and other consultants.

3. Is the greenfield runoff rate 5 l/s or greater for the 1 in 100 year event?
   The greenfield run off rate for the 100 year event has been calculated as 6.2 l/s.
4. If not, has the runoff rate of 5 l/s previously been agreed with the LLFA?
   The 5l/s run off rate is what was agreed by the previous consultant who completed the FRA for this site, of which the application gained approval with no conditions raised in relation to flood risk/drainage, I have attached the previous FRA/Drainage strategy document above.

Thank you for your time, another quick response confirming if you are happy with the above would be greatly appreciated to help us with the issue of this application, I look forward to hearing from you.

Many Thanks,

James Hodder
DESIGN ENGINEER

Level 1, 47-51 Great Suffolk Street
Southwark, London, SE1 0BS, United Kingdom
Phone: +44 20 7633 2880
Website: www.robertbird.com

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From: Grace KIM <Grace.Kim@robertbird.com>
Sent: 20 July 2021 17:33
To: James HODDER <James.Hodder@robertbird.com>
Subject: FW: Barnes Hospital Planning Enquiry

Hi James,

As I am on annual leave tomorrow please could you address the questions below.

Thanks,

Grace Kim
GRADUATE ENGINEER

Level 1, 47-51 Great Suffolk Street
Southwark, London, SE1 0BS, United Kingdom
Phone: +44 20 7633 2880
Website: www.robertbird.com

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From: Bunker, Elizabeth <Elizabeth.Bunker@richmondandwandsworth.gov.uk>
Sent: 20 July 2021 17:22
To: Grace KIM <Grace.Kim@robertbird.com>
Cc: Creegan, Darragh <Darragh.Creegan@richmondandwandsworth.gov.uk>
Subject: Re: Barnes Hospital Planning Enquiry

Official

Dear Grace,

Thanks for your email.

For some reason I can't access the documents from the original application from the planning portal so can't view the drainage details in full. I would have had a look for these details myself but it would be great if you could help me out. Here are my questions:

1. We usually assess whether a site's drainage can handle the 1 in 100 year event +40% climate change - would the runoff rate still be 5l/s for this?
2. If so, does the attenuation tank have enough capacity to store runoff discharging at 5 l/s for the 1 in 100 year event +40% Climate Change with the new site area included in the calculations?
3. Is the greenfield runoff rate 5 l/s or greater for the 1 in 100 year event?
4. If not, has the runoff rate of 5 l/s previously been agreed with the LLFA?

If only the 1 in 30 year +40% climate change has been considered previously, then this may need a second look and potentially another official consultation with the LLFA. Runoff rates are based on site area so you may need new calculations to provide enough evidence for approval.

Kind regards,
Lizzy

Lizzy Bunker
Flood Risk Consultant
Richmond and Wandsworth LLFA team
07508888378

From: Grace KIM <Grace.Kim@robertbird.com>
Sent: 20 July 2021 15:18
To: Bunker, Elizabeth <Elizabeth.Bunker@richmondandwandsworth.gov.uk>
Subject: Barnes Hospital Planning Enquiry

Hi Elizabeth,

I received your contact details after calling the Richmond Planning telephone number earlier today.

I would like to raise a query in regards to planning on the Barnes Hospital site, ref. 18/3642/OUT.
The site was granted Outline Planning Permission in 2018 with a proposed surface water discharge rate of 5 l/s.

Since then we have updated the proposal to provide residential developments only.
A short summary is included below:

The proposed development comprises three residential buildings, Block A, Block B and Block C, providing 106 residential apartments, with associated access at ground and levels. There is a single-storey basement underneath Blocks A & B containing plant, car parking, cycle stores plant and refuse. Block A is 3 storeys high while Blocks B and C are 4 storeys high.

I have also attached a pdf drawing of our proposed development.
The site area has been reduced from 1.4 hectares in the initial proposal to 0.8 hectares.

Please could you confirm that the 5 l/s SW discharge rate for the site is still valid for the 1 in 30 year storm event (+40% for climate change).

We are issuing our Stage 2 proposal this Thursday so please could I request a prompt response.

Thank you,

Grace Kim
GRADUATE ENGINEER

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Southwark, London, SE1 0BS, United Kingdom
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Appendix F

SuDS Proforma

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1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	Barnes Hospital
Address & post code	Barnes Hospital, South Worple Way, London, SW14 8SU
OS Grid ref. (Easting, Northing)	E 521180 N 175685
LPA reference (if applicable)	
Brief description of proposed work	Three residential buildings, providing 109 residential apartments, office space, nursery, and a gym. There is a single-storey basement underneath Blocks A & B containing plant, car parking, cycle stores and refuse.
Total site Area	8,060 m^2
Total existing impervious area	7000 m^2
Total proposed impervious area	5750 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	Flood Zone 1
Existing drainage connection type and location	Combined, to Thames Water sewer in South Warpole Way
Designer Name	James Hodder
Designer Position	Civil Engineer
Designer Company	Robert Bird Group

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	Made Ground and Kempton Park Gravels	
Bedrock geology classification	London Clay	
Site infiltration rate	0.0001	m/s
Depth to groundwater level	3	m below ground level
Is infiltration feasible?	Partial	

2b. Drainage Hierarchy

	Feasible (Y/N)	*Proposed (Y/N)*
1 store rainwater for later use	N	N
2 use infiltration techniques, such as porous surfaces in non-clay areas	Y	N
3 attenuate rainwater in ponds or open water features for gradual release	N	N
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
5 discharge rainwater direct to a watercourse	N	N
6 discharge rainwater to a surface water sewer/drain	N	N
7 discharge rainwater to the combined sewer.	Y	Y

2c. Proposed Discharge Details

Proposed discharge location	TWMH 1705
Has the owner/regulator of the discharge location been consulted?	Within previous FRA

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	Existing discharge rate (l/s)	Required storage for GF rate (m^3)	Proposed discharge rate (l/s)
Qbar	1.9			
1 in 1	1.6	41.7	276	4.9
1 in 30	4.4	67.31	276	5
1 in 100	6.2	88.9	276	5
1 in 100 + CC			276	6.4
Climate change allowance used	40%			

3b. Principal Method of Flow Control

Hydrobreak

3c. Proposed SuDS Measures

	Catchment area (m^2)	Plan area (m^2)	Storage vol. (m^3)
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	1420	1420	140
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	1500	250	90
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	2830		190
Total	**5750**	**1670**	**420**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	N/A
Drainage hierarchy (2b)	Section 4.5
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Section 4.2
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Appendix B
Proposed SuDS measures & specifications (3b)	Section 4.6

4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Appendix B
Detailed drainage design drawings, including exceedance flow routes	Appendix C
Detailed landscaping plans	N/A
Maintenance strategy	Section 5.0
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Section 4.6
b) biodiversity?	Section 4.6
c) amenity?	Section 4.6

Appendix G

Previous Flood Risk Assessment

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South West London and St George's Mental Health NHS Trust

Barnes Hospital

Flood Risk Assessment

BAH-FRA-2018

2nd Issue | 2 November 2018

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 226594

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London
W1T 4BQ
United Kingdom
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ARUP

Document Verification

ARUP

Job title		Barnes Hospital			**Job number** 226594
Document title		Flood Risk Assessment			**File reference** 04-05-03
Document ref		BAH-FRA-2018			
Revision	**Date**	**Filename**	Barnes Hospital FRA - Oct 2018.docx		
Draft 1	15 Oct 2018	**Description**	Draft for review		
			Prepared by	Checked by	Approved by
		Name	Richie Turner	Hamish Tozer	Stuart Jordan
		Signature			
Issue	26 Oct 2018	**Filename**	Barnes Hospital FRA - Oct 2018 - Issue.docx		
		Description	Final Issue		
			Prepared by	Checked by	Approved by
		Name	Richie Turner	Hamish Tozer	Stuart Jordan
		Signature			
2nd Issue	2 Nov 2018	**Filename**	Barnes Hospital FRA - Nov 2018 - Issue.docx		
		Description	2nd Issue		
			Prepared by	Checked by	Approved by
		Name	Richie Turner	Hamish Tozer	Stuart Jordan
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

Figures

Pictures

Appendices

Executive Summary

Arup has been commissioned by the South West London and St George's Mental Health Trust (SWLStG) to prepare a site-specific Flood Risk Assessment (FRA) to support a full planning application for the proposed Barnes Hospital development.

This FRA has been undertaken in accordance with the National Planning Policy Framework (NPPF) (July 2018), the London Plan (March 2016), the London Borough of Richmond upon Thames (LBRT) Local Plan (adopted July 2018) and the LBRT Strategic Flood Risk Assessment (March 2016). Refer to Appendix A for a summary of relevant legislation and planning policy documents.

The findings of this site-specific Flood Risk Assessment are as follows:

- The site is in Flood Zone 1 and at a low risk of river or sea flooding (<0.1% annual probability);
- Future climate change effects are not expected to significantly increase the risk of flooding from sources except rainfall;
- The site is at a low risk of flooding from other sources such as surface water, sewers, groundwater, and artificial sources;
- The groundwater level is a minimum of 2.7 m below ground level, and previous borehole logs show sandy gravel down to approximately 10 m below ground level. Therefore, infiltration is considered a feasible method of discharge of surface water, however this is subject to further ground investigation;
- Surface water runoff is proposed to be captured primarily by permeable paving, with a geo-cellular sub-base replacement layer providing attenuation. Disposal is intended to be by infiltration and discharge at a restricted rate into existing Thames Water surface water sewers within South Worple Way.

1 Introduction

This FRA assesses the flood risk to the SWLStG Barnes Hospital development site, considering changes to the current flood risk caused by the development and from climate change. It also considers a preliminary drainage strategy for the site, in accordance with Sustainable Drainage Systems (SUDS) objectives to restrict the rate of surface water discharge from the site into the existing drainage network.

2 Existing Site

2.1 Location

The Barnes Hospital site lies on South Worple Way at SW14 8SU in the London Borough of Richmond upon Thames (LBRT). The site is approximately 1.4 hectares and is located to the south of the River Thames, bounded by South Worple Way to the north, Old Mortlake Burial Ground to the west, Grosvenor Avenue residences to the south and South Worple Avenue (public footpath) to the east. National Rail tracks are located along the far side of South Worple Way.

The site is currently occupied by the existing hospital and associated facilities which provide community and in-patient mental health services. It is made up mostly of buildings and hard standing with a small amount of green space.

A topographical survey was undertaken by XYZ Land Chartered Surveyors dated February 2016. It shows that the site levels across the site are generally in the range of +5.8 to +6.5 mAOD.

Figure 1 below illustrates the location of the site.

2.2 Flood Zone

The Environment Agency (EA) produces flood maps for the UK, which show the areas at risk of fluvial and/or tidal flooding. These express the risk of flooding as an annual probability of occurrence.

The EA has provided a Product 1, which is a Flood Map for planning. This shows that the site is located in Flood Zone 1 (i.e. a very low risk of flooding from rivers or sea, with < 0.1 % annual probability). This Flood Map is included in Figure 2 and Appendix C.

Figure 1: Location of Barnes Hospital site

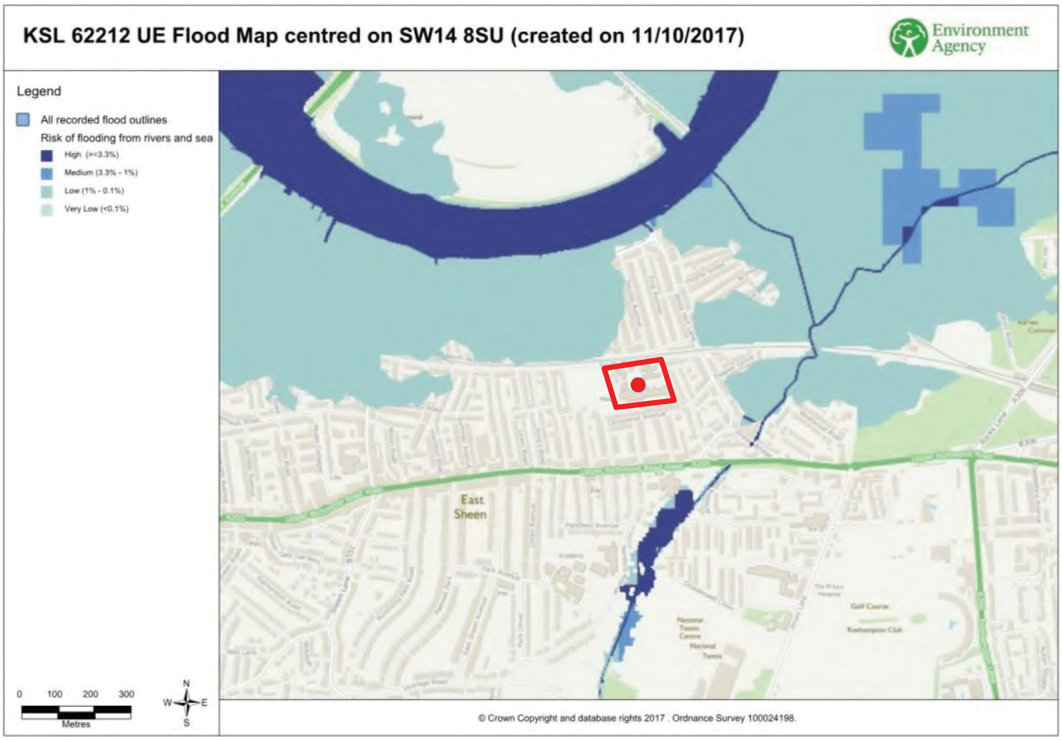

Figure 2: EA Product 1 showing risk of flooding from rivers and sea

3 Proposed Development

Outline planning permission for the demolition and comprehensive redevelopment (phased development) of land at Barnes Hospital to provide a mixed use development comprising a health centre (Use Class D1), a Special Educational Needs (SEN) School (Use Class D1), up to 80 new build residential units (Use class C3), the conversion of two of the retained BTMs for use for up 3no. residential units (Use Class C3), the conversion of one BTM for medical use (Use Class D1), car parking, landscaping and associated works. All matters reserved save for the full details submitted in relation to access points at the site boundaries.

The new buildings and roads will replace the majority of the existing arrangement on site. The extent of site considered by this report is indicated by the black and dashed red boundary in Figure 3, which shows an illustrated masterplan of the site.

Figure 3: Proposed ground floor plan for the development. (Source: Squire & Partners Architects)

4 Climate Change

4.1 Fluvial and Tidal Flooding

Since the proposed site is within Flood Zone 1, climate change is not expected to have a significant impact on the risk of fluvial or tidal flooding.

4.2 Surface Water Flooding

Rainfall intensity is anticipated to increase with climate change. The upper end allowance, as defined by the EA for a design life of 100 years (typical for residential development), is +40%. This has been taken into account when developing the surface water drainage strategy in Section 6.

4.3 Sewer Flooding

Climate change is not expected to have a significant impact on the risk of flooding from foul water drainage through existing foul water sewers, as foul water is primarily from internal sources.

4.4 Groundwater Flooding

Since the measured groundwater level is between 2.7-4.5m below proposed ground level, climate change is not expected to significantly increase the risk of flooding from groundwater.

5 Site Specific Flood Risk

A Level 1 Strategic Flood Risk Assessment (SFRA) has been carried out for the LBRT in June 2008 with updates in August 2010 and March 2016, which is applicable for this site. The SFRA has a strong emphasis on flooding from the river and sea.

Additionally, the LBRT Surface Water Management Plan 2011 (SWMP) assesses the surface water flood risk within the borough, using both historical information and undertaking pluvial modelling to determine the future flood risk for a range of rainfall events. These identify the areas of significant surface water and groundwater flooding risk and options to address this.

The National Planning Policy Framework (NPPF) (published in July 2018) and accompanying Planning Practice Guidance highlight the risk of flooding from the following sources:

- Fluvial (river) and tidal (sea);
- Pluvial (surface water);
- Groundwater;
- Drainage (surface water and foul);
- Reservoirs, canals, and other artificial sources.

5.1 Fluvial and Tidal Flooding

5.1.1 Environment Agency Fluvial Flood Maps

The Environment Agency (EA) produces flood maps for the UK, which show the areas at risk of fluvial and/or tidal flooding. These express the risk of flooding as an annual probability of occurrence.

The EA has provided a Product 1, which is a Flood Map for planning. This shows that the site is located in Flood Zone 1 (i.e. a very low risk of flooding from rivers or sea, with < 0.1 % annual probability). This Flood Map is included in Figure 4 and Appendix C.

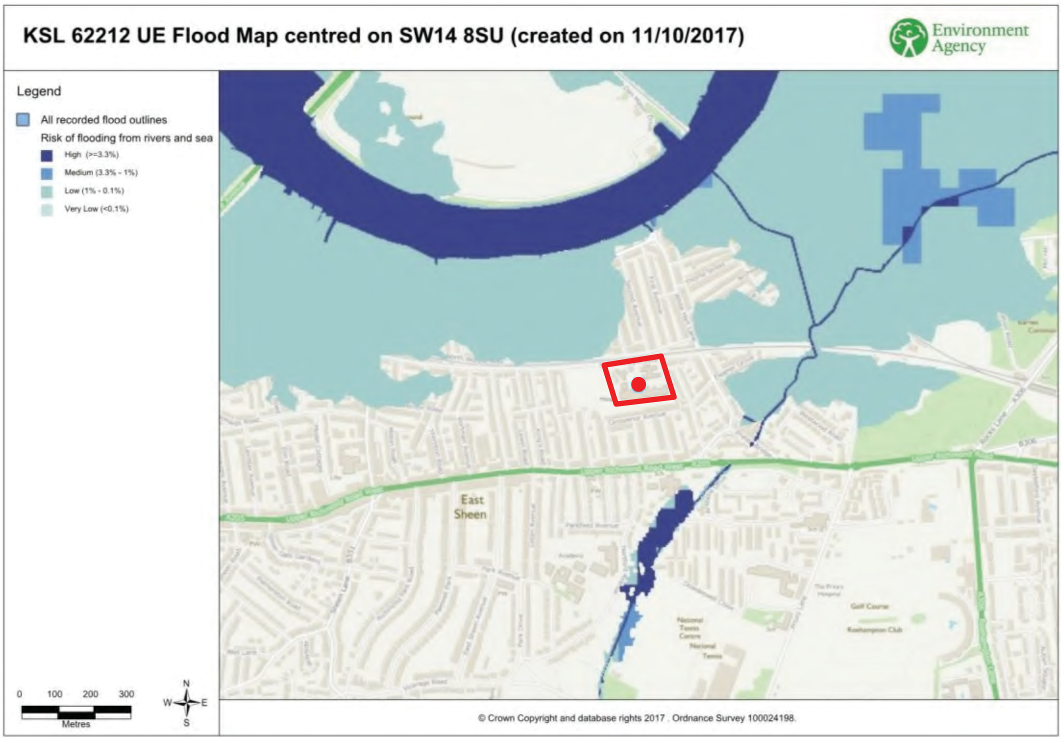

Figure 4: EA Product 1 showing risk of flooding from rivers and sea

5.1.2 Strategic Flood Risk Assessment

A Level 1 Strategic Flood Risk Assessment (SFRA) has been carried out for the LBRT in March 2016 in accordance with Planning Policy Statement 25: Development & Flood Risk. An extract of the SFRA maps show flood zones for planning is shown in Figure 5.

The SFRA shows the site is within Flood Zone 1, which is consistent with the EA flood maps.

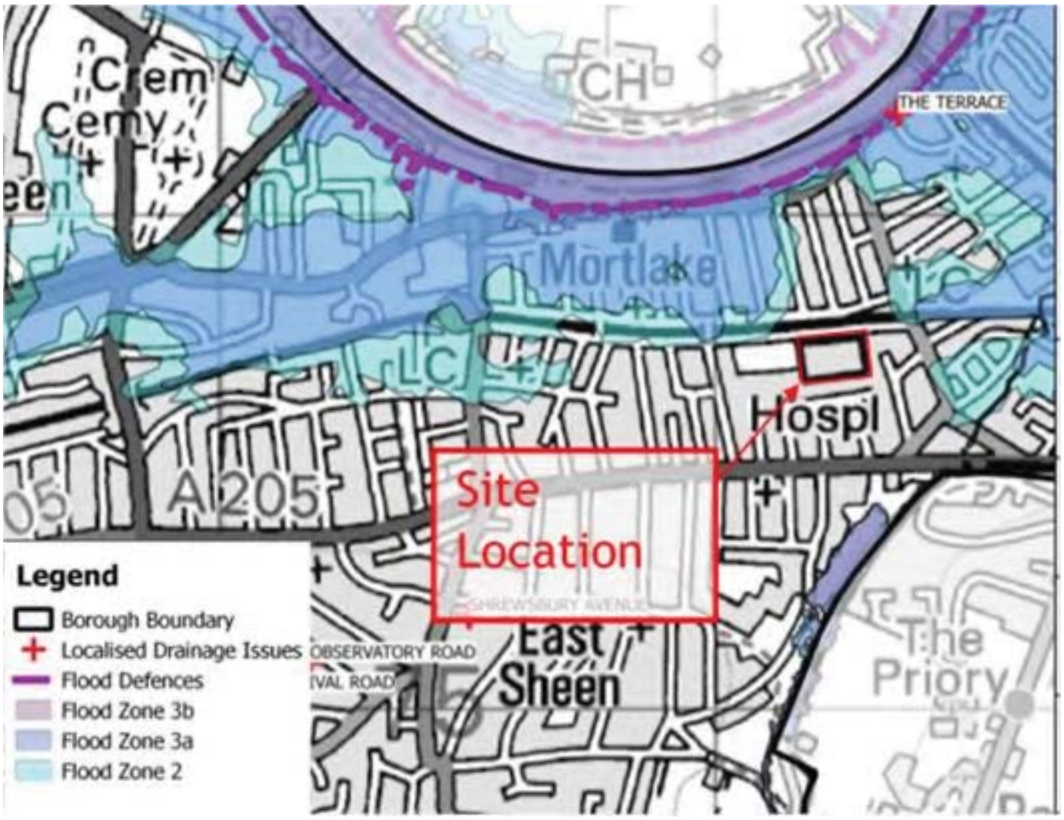

Figure 5: Extract from LBRT SFRA for Barnes

5.2 Pluvial (Surface Water) Flooding

The LBRT SFRA includes an assessment of the risk of flooding from surface water. This is driven by topography rather than existing drainage networks, and therefore is focussed on obstructions to overland flow.

Figure 6 is an extract from the SFRA, which shows that the Barnes Hospital site may have a flooding depth of 0.00 – 0.15 m. This is expected to be primarily due to the very flat topography of the site, rather than flow from off-site, and should be mitigated by a proposed surface water drainage network.

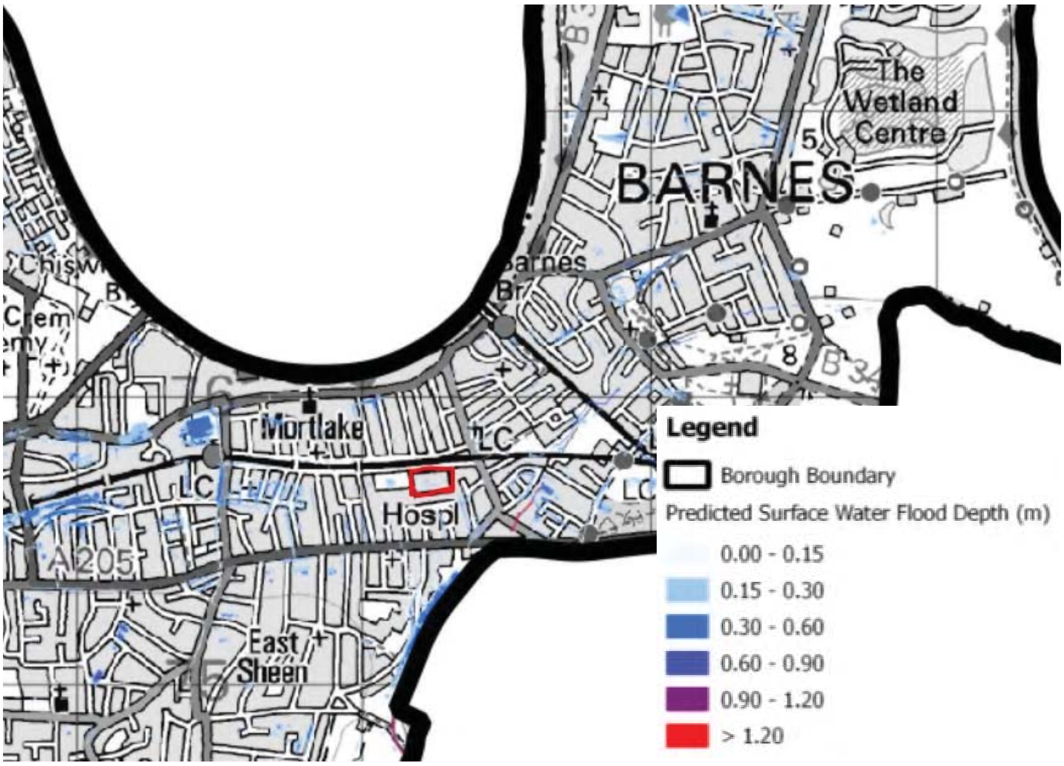

Figure 6: SFRA risk of flooding from surface water (for 1% chance of flooding in any one year) – approximate site boundary in red

5.3 Sewer Flooding

The LBRT SFRA shows that there have been between 1 and 5 reported incidences of sewer flooding within the vicinity of the site, though does not give any further detail on the exact location of these incidents, see Figure 7. This number is relatively low over a large area, hence sewer flood risk is considered to be low.

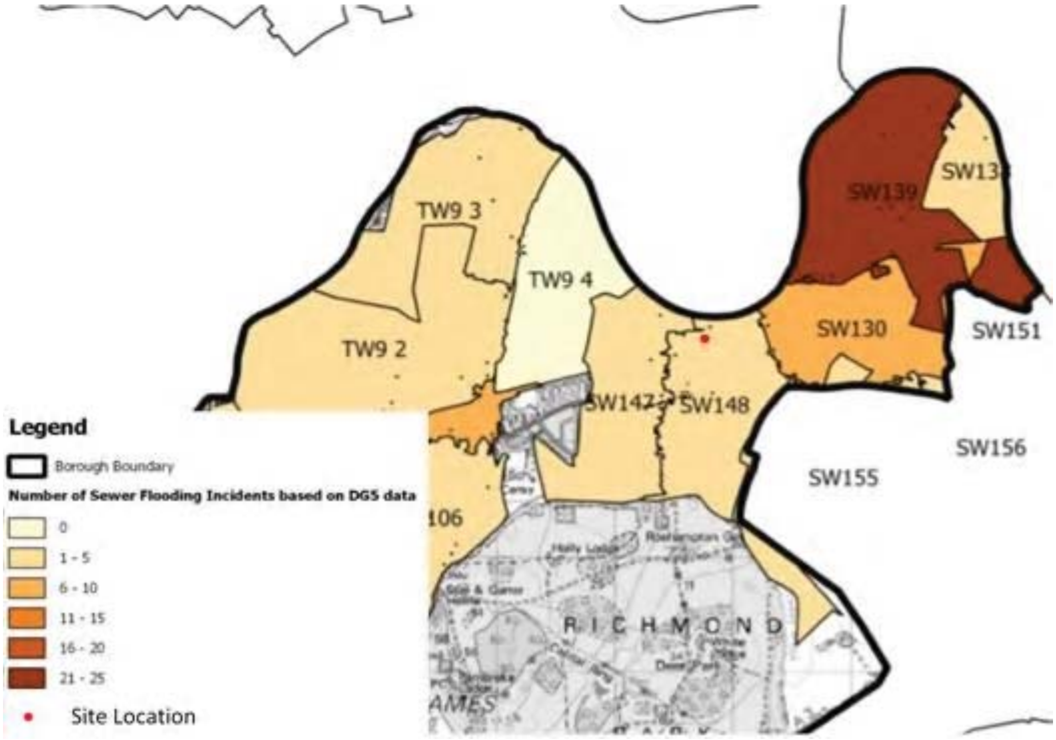

Figure 7: SFRA historic sewer flooding incidents

5.4 Groundwater Flooding

The LBRT SFRA includes the British Geological Survey (BGS) susceptibility to groundwater flooding assessment. An extract is included in Figure 8, which shows that the Barnes Hospital site does have a potential for groundwater flooding of property situated below ground.

Current proposals for the site include some subterranean car parking. It is expected that these elements would include sufficient waterproofing measures.

The risk of flooding from groundwater is considered to be low.

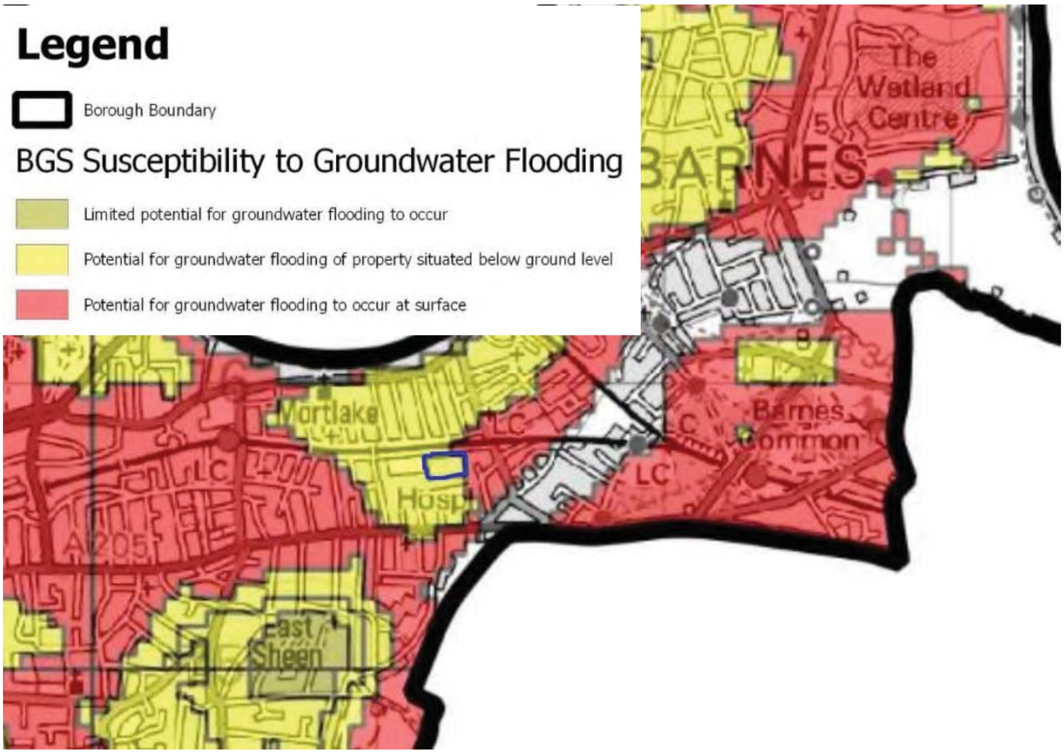

Figure 8: SFRA BGS susceptibility to groundwater flooding – approximate site boundary in blue

5.5 Artificial Sources of Flooding

The EA produce maps showing flood risk to the site due to the breach of a large reservoir. It can be seen in Figure 9, below, that the site has a negligible risk of being exposed to such flooding.

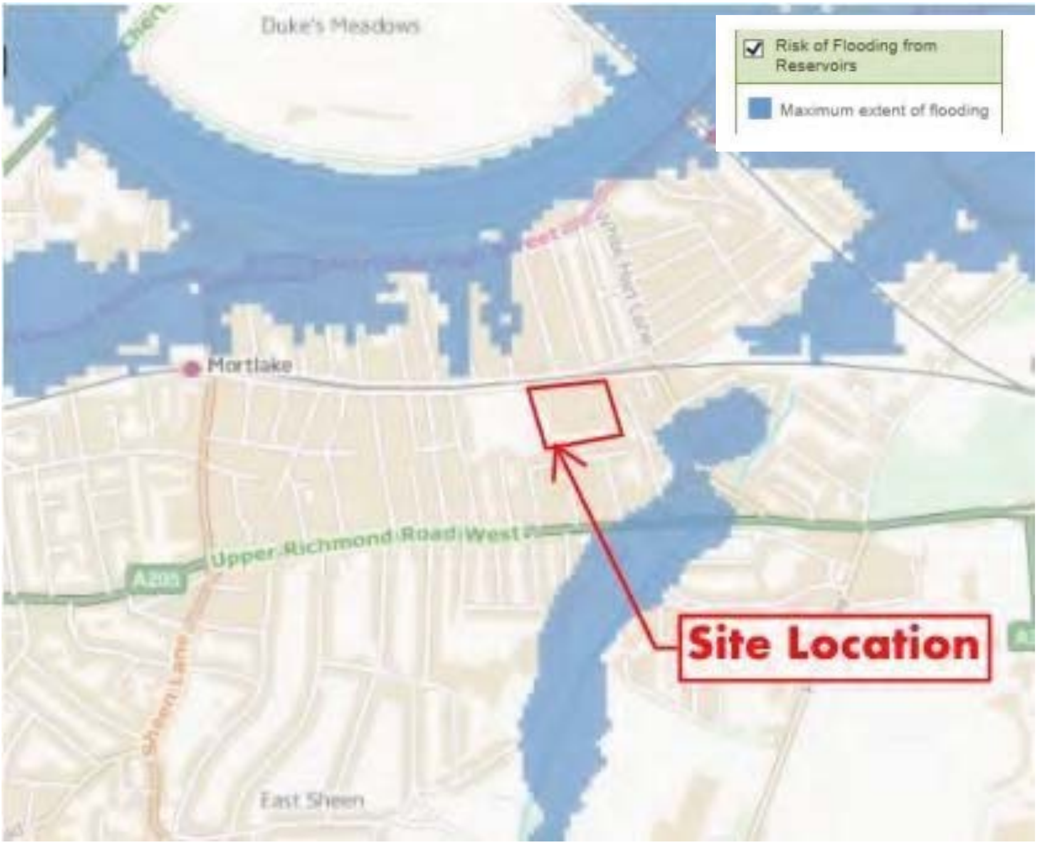

Figure 9: Extract of the EA Map showing risk of flooding from Artificial Water Sources

6 Surface Water Management

6.1 Preliminary Surface Water Drainage Study

Thames Water Utilities Limited (TWUL) have been identified as the local provider for surface water collection and operate services in South Worple Way, Lodge Avenue, Grosvenor Avenue and Buxton Road east of South Worple Avenue.

The Barnes Hospital site generally drains from south to north served by a private on-site network of sumps, downpipes, slot drains, manholes and pipes which discharge to an existing Ø225 mm TWUL sewer located in South Worple Way. The connection is located at the head of the TWUL network at a depth to invert ranging from 0.76-1.83 m, with one length running east before discharging into White Hart Lane, and one length falling to the west before discharging to a culvert beneath South Worple Way. From here, it is likely that this infrastructure feeds into a larger local network, leading to the Thames River, though this was not shown on the extents of the received utility records.

6.1.1 SUDS Assessment

The London Plan 2016 and the relevant Supplementary Planning Guidance (Sustainable Design and Construction 2014) advise developers to aim for ‘greenfield’ runoff rate from their development. This is defined as the runoff rate from a site in its natural state, prior to any development. For previously developed sites, runoff rates should not be more than three time the calculated greenfield rate.

The Flood and Water Management Act 2010 designate Lead Local Flood Authorities (for this site it is London Borough of Richmond and Thames) to establish requirements for design, building and operating Sustainable Urban Drainage Systems (SuDS) for approval of new developments. Developers will be required to utilise SuDS unless there are practical reasons for not doing so.

SuDS should be fully justified by adopting techniques in a hierarchical manner, maximising the use of those techniques higher up the hierarchy and those that deliver multi-functional benefits before considering others further down the hierarchy:

1. Store rainwater for later use;
2. Use infiltration techniques, such as porous surfaces in non-clay areas;
3. Attenuate rainwater in ponds or open water features for gradual release;
4. Attenuate rainwater by storing in tanks or sealed water feature for gradual release;
5. Discharge rainwater direct to a watercourse;
6. Discharge rainwater to a surface water sewer/drain;
7. Discharge rainwater to the combined sewer.

It is anticipated that the new development will require a new on-site surface water network to infiltrate and/or attenuate onsite before release to the TWUL network in South Worple Way at an appropriate rate to be agreed with TWUL.

Appropriate SuDS techniques for this site could include green/blue roofs, rainwater collection for greywater use, permeable pavements, filter drains/strips, swales, underground attenuation tanks and flow control devices. Space for these items should be incorporated into the development masterplan where practicable.

It is proposed that the site will discharge to the existing Ø225 mm TWUL network in South Worple Way. A new connection to the Ø225 mm sewer in Buxton Road may be a viable alternative.

The new network will be designed to adoptable standards and the extent of adoption will need to be discussed and agreed with TWUL.

The following works are recommended to progress the design:

- Further site visits and ground investigations of soil permeability and local hydrogeology to determine the viability of infiltration methods;
- Further site investigations to verify location, level and condition of connection to TWUL sewer;
- A review of a range of SuDS systems to assess the opportunities for inclusion in the development including surface water runoff prevention, runoff rate and volume reduction;
- Development of an integrated surface water drainage strategy for the development’s masterplan which incorporates a SuDS management train with consideration for key issues including: construction and utility phasing, adoption strategy, suitability of existing connection points to external networks, details of new connections required to external networks, the extent of off-site reinforcements required and location of proposed utility corridors and building discharge locations;
- Consultation with and payment to TWUL to complete a sewer impact study to assess the impact of the proposed development flows on their existing drainage network.

6.2 Proposed Surface Water Drainage

The proposed strategy for surface water drainage primarily collects run off from roads and buildings within a new surface water network, using a permeable paving strategy to collect run off and transfer it to an on-site attenuation tank for storage and infiltration, before discharging by a restricted outflow to a Thames Water manhole within South Worple Way.

6.2.1 Feasibility of Infiltration

Geology

Available published map data from the British Geological Survey, see Figure 10 below, indicates the following strata will be encountered at or near surface within the site boundary:

- Kempton Park Gravel Formation (comprising sand and gravel, locally with lenses of silt, clay or peat);
- London Clay Formation (comprising clay, silt and sand).

It is anticipated that artificial deposits (made ground and re-worked deposits) will be encountered as a result of historical developments.

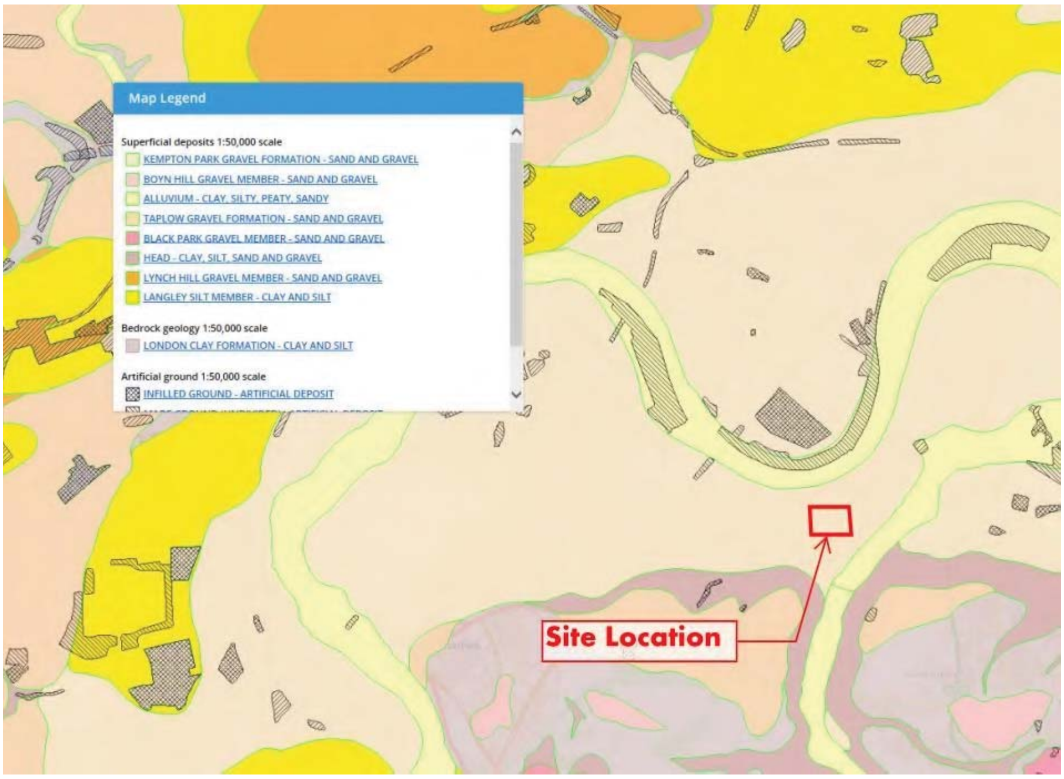

Figure 10: Superficial deposits and bedrock geology.

Borehole Records

A selection of historical borehole records, obtained from the BGS, were reviewed to confirm shallow ground conditions. Borehole record locations are shown on Figure 11 below and included the following:

- TQ27NW12
- TQ27NW11
- TQ27NW423

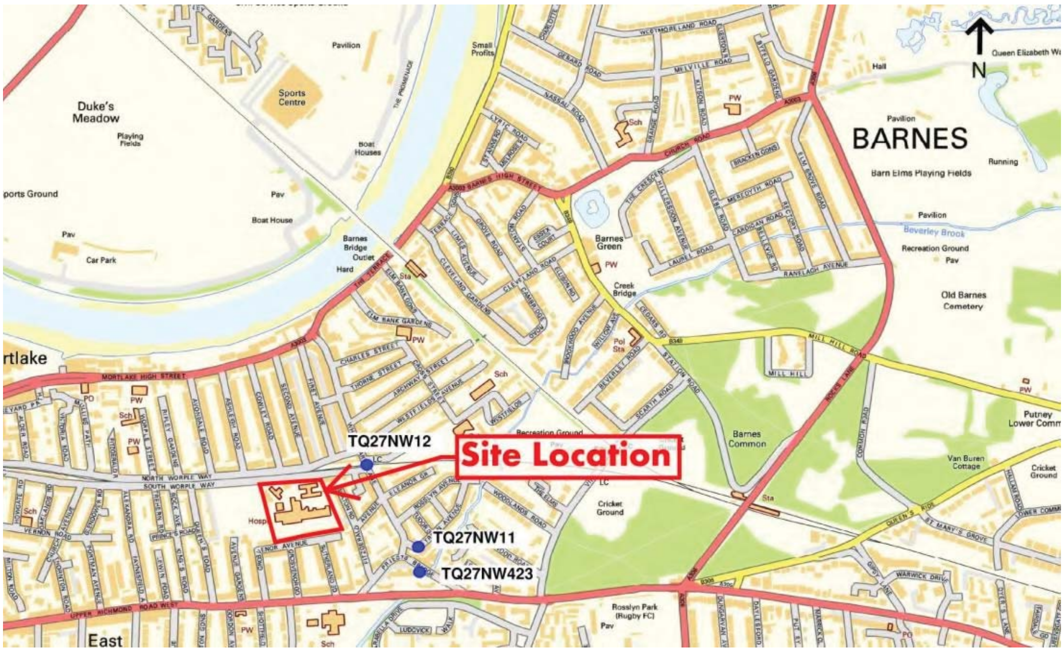

Figure 11: Borehole record locations

Borehole records generally confirm that there is a presence of sandy gravel to approximately 10 m below ground level followed by a clay formation to a depth of 45 m. This would indicate that infiltration methods could be viable for this site.

Records also indicated a groundwater level between 2.7 to 4.5 m below ground level. Ground water levels on site should be confirmed. There is a negligible risk of the site being exposed to groundwater flooding.

Allowing infiltration of surface water reduces the amount of water going into the existing network and also allows for the construction of a smaller attenuation tank on site. For the purposes of this FRA, two designs for the attenuation tank (one with and one without use of infiltration), have been made.

6.2.2 Greenfield Runoff Estimation

The greenfield runoff from the site was estimated using the online tool at uksuds.com; the results are included in Table 1 and Appendix D.

Table 1: Greenfield Runoff Rates

Design Storm	Greenfield Runoff Rate (l/s)
Qbar	2.19
1 in 1 year	1.86
1 in 30 years	5.04
1 in 100 years	6.98

6.2.3 Drainage Strategy

The site has a very flat topography, with a range of ground levels between 6.5 mAOD in the south-west corner of site and 6.0 mAOD just north of the centre of the site. The existing surface water drainage pipe in South Worple Way (north of site) is very shallow, at a depth of 0.76 m to invert (invert level (IL) of 5.28 mAOD) at its highest point, a manhole immediately adjacent to the proposed site egress.

The surface water drainage strategy is to store the runoff from a 1 in 30 year design storm (+40% allowance for climate change) below ground, and restrict the discharge into the existing TWUL network in South Worple Way to the estimated greenfield runoff rate for a 1 in 30 year design storm of approximately 5.0 l/s.

For the design of the surface water drainage, the buildings, healthcare / school car parking and access road to the residential underground car park are assumed to be 100% impermeable. These areas can be seen in the site plan (Appendix E). The strip of soft landscaping, approximately 8.0 m wide, along the west and south-western edges of the site is assumed to have no positive drainage (i.e. infiltrates naturally). The remainder of the site area is assumed 50% impermeable; a conservative estimate considering the site is predominantly soft landscaping intersected by footpaths. The total impermeable area is therefore approximately 0.95 ha.

A MicroDrainage Quick Storage Estimate was used to obtain an approximate volume of attenuation storage required for a 1 in 30 year rainfall event. Without infiltration this volume is 667 m^3, and with infiltration this is 601 m^3 (refer to Appendix B).

6.2.4 Proposed Solution

The proposed surface water drainage solution divides the attenuation and discharge into two separate areas: The healthcare / school area on the eastern side of the site and the residential area on the western side.

Eastern area

The volume of water to be attenuated in the eastern area of the site is 338 m^3 (refer Appendix B). The solution in the eastern area is to use permeable paving with geocellular sub-base replacement within the healthcare centre car park. The geocellular elements could be 600 mm deep and therefore would require a total surface area of approx. 560 m^2 to attenuate the area, with no infiltration. A potential layout for the geocellular area is in Figure 12. The remainder of the eastern area would be drained via channel drains and shallow pipes to discharge into the geocellular units.

Utilities required to/from the healthcare / school buildings could be routed around areas with geocellular storage, or utility corridors could be created through the geocellular system if necessary.

Western Area

To attenuate storm water on the western (residential) area of the site, geocellular blocks with a total depth of 900 mm could be installed under the soft landscaping between the residential blocks. These will have a cover of 150mm to allow for grass growth on the land above. The volume of water to be attenuated is approx. 330 m^3 without infiltration, therefore a total surface area of 366 m^2 would be required. A potential layout for the geocellular area is also shown in Figure 12. The remainder of the western area in hard landscaping could be drained via channel drains and shallow pipes to discharge into the geocellular units.

Utilities required to/from the residential blocks could be routed around areas with geocellular storage, or utility corridors could will be created through the geocellular system if necessary.

Figure 12: Proposed locations of geocellular surface water attenuation.

6.2.5 Proposed Connections

Two connections are proposed from the site, and shown in Figure 12 above. The eastern attenuation will connect to a new manhole on the existing drainage pipe in South Worple Way to the north-east of site, which would have an estimated IL of 5.20 mAOD. The permeable paving/geocell in the eastern area would have an IL of approximately 5.34 mAOD and so a 1% pipe grade for the short (approx. 12 m) distance between the attenuation tank and existing pipe is feasible for this connection.

The western area is to connect into the existing manhole TW1705 on South Worple Way. The pipe at this manhole is Ø225 mm with an IL of 4.60 mAOD. The base of the western geocellular tanks will be at approximately 5.10 mAOD, hence a 1% pipe grade over the approximately 66 m length would allow this connection.

6.3 Proposed Foul Water Drainage

6.3.1 Existing Network

The existing foul network around the Barnes Hospital site shows an existing foul water drainage pipe in South Worple Way to the north of the site. It is assumed that the site currently drains to manhole TQ2175NW1702 at the start of this run. The manhole in South Worple Way is 3.80m deep (CL: 6.43m, IL: 2.63m.) There is another drainage route on South Worple Avenue to the south east of the site, with an unknown depth. See Figure 13 below.

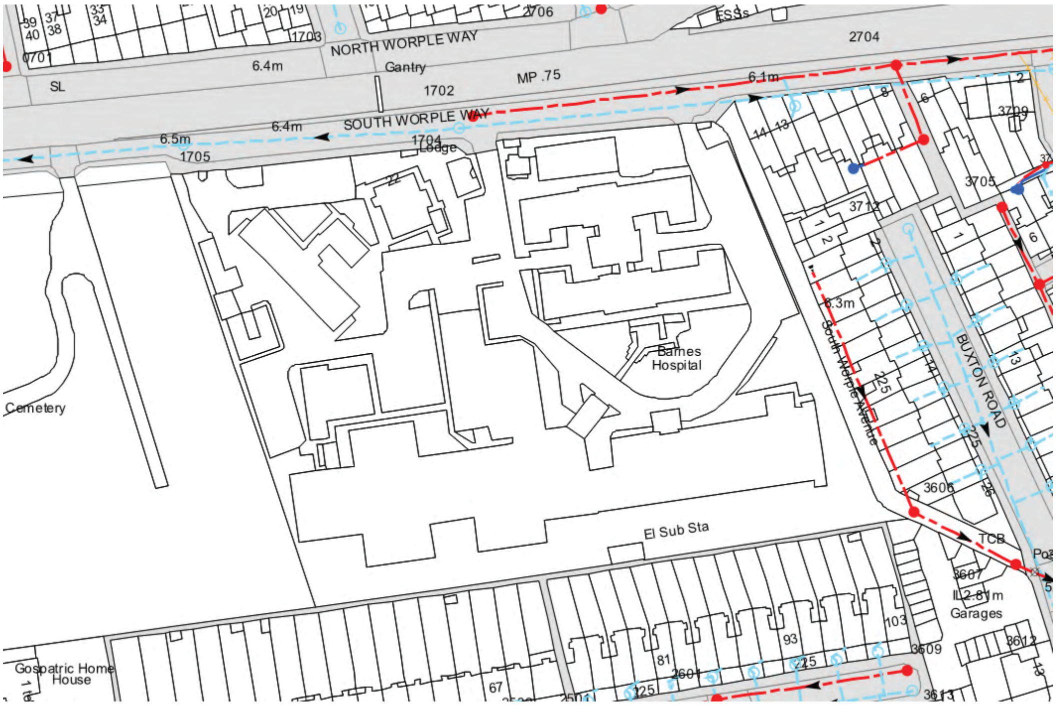

Figure 13: Existing drainage around Barnes hospital site (from Thames Water (TWUL) Asset Location Search (ALS))

6.3.2 Proposed Network

The proposed foul water drainage solution for the site is to gather the foul water from all buildings on site in manholes and pipes, and direct the flow north to the existing manhole TQ2175 NW1702 on South Worple Way. An indicative pipe network is shown in Figure 14. The pipe network will be designed to the standards set out in SfA 7th Edition.

6.3.3 Proposed Connections

One foul water connection is proposed from each building on the site. Foul water from the buildings will flow by gravity to these points and any foul water from the basements will be pumped up to these points. An indicative location for these can be seen on Figure 14.

There is one proposed connection to the existing manhole in South Worple Way. This will be routed into the existing connection in the manhole if possible, or this manhole could be rebuilt if required.

A survey of the existing network in this area should be carried out before finalising the design to establish the depth of the existing incoming pipe to manhole TQ2175 NW1702. A maximum allowable outflow to the existing network is to be agreed with TWUL before design completion.

Figure 14: Indicative FW network design

7 Conclusion

The findings of this site-specific Flood Risk Assessment are as follows:

- The site is in Flood Zone 1 and at a low risk of river or sea flooding (<0.1% annual probability);
- Future climate change effects are not expected to significantly increase the risk of flooding from sources except rainfall;
- The site is at a low risk of flooding from other sources such as surface water, sewers, groundwater, and artificial sources;
- The groundwater level is a minimum of 2.7 m below ground level, and previous borehole logs show sandy gravel down to approximately 10 m below ground level. Therefore, infiltration is considered a feasible method of discharge of surface water, however this is subject to further ground investigation;
- Surface water runoff is proposed to be captured by permeable paving and shallow drainage, directed to geo-cellular tanks under the sub-base; providing attenuation. Disposal is intended to be by infiltration and at a restricted rate of 5.0 l/s into existing Thames Water surface water sewers within South Worple Way;
- Foul water drainage from buildings will be collected in a series of new manholes and pipes and discharged to the existing manhole TQ2175NW1702 in South Worple Way.

Appendix A

Background Legislation and Guidance

A1 Legislation

A1.1 Floods Directive (2007/60/EC)

The aim of the Directive[1] is to provide a consistent approach across the European Union to reducing and managing the risks posed by flooding to human health, the environment, cultural heritage and economic activity. The Floods Directive is to be delivered in conjunction with the objectives of the Water Framework Directive (2000/60/EC) to deliver a better water environment through river basin management.

In the UK the Floods Directive is transposed into law via the Flood Risk Regulations (2009) by setting out the duties of local government in assessing flood risk to their area.

A1.2 Flood Risk Regulations (2009)

The Flood Risk Regulations[2] transpose the Floods Directive (2007/60/EC) into law in England and Wales.

The Regulations required the Lead Local Flood Authority (LLFA), in this case LBRT, to produce:

- a Preliminary Flood Risk Assessment (PFRA) by December 2011;
- flood hazard and flood risk maps by December 2013; and
- a Local Flood Risk Management Strategy by December 2015.

A1.3 The Flood and Water Management Act (2010)

The Flood and Water Management Act 2010 (FWMA)[3], which received Royal Assent on 8th April 2010, takes forward some of the proposals in three previous documents published by the UK Government:

- Future Water;
- Making Space for Water; and
- The Government's Response to the Sir Michael Pitt's Review of the summer 2007 Floods.

The Act gives the EA a strategic overview of the management of flood and coastal erosion risk in England. In accordance with the Government's Response to the Pitt Review, it also gives upper tier local authorities in England responsibility for

[1] European Parliament and Council, October 2007. Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.
[2] UK Parliament, November 2009. The Flood Risk Regulations 2009, 2009 No. 3042.
[3] UK Parliament, April 2010. The Flood and Water Management Act 2010, 2010 c. 29.

preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas.

A1.4 The Water Resources Act (1991) and Water Act (2003, 2014)

The Water Resources Act 1991[4] provides legislation for the control of the pollution of water resources. Under this Act, offences of polluting controlled waters occur if a person knowingly permits any poisonous, noxious or polluting matter or any solid waste matter to enter any controlled waters. The Water Resources Act also provides an all-embracing system for the licensing of the abstraction of water for use, which is administered by the EA. The Water Acts (2003[5], 2014[6]) modernise water legislation and amend the Water Resources Act 1991 to improve long-term water resource management.

A1.5 Land Drainage Acts (1991, 1994)

The water quality and flood risk management of controlled waters including rivers and aquifers is protected by legislation under the Land Drainage Acts (1991[7], 1994[8]).

A1.6 Land Drainage Byelaws (1981)

This law was made by the Thames Water Authority under Section 34 of Land Drainage Act 1976. The Thames Water Authority Land Drainage Byelaws 1981[9] are in force in the Thames Region of the EA. They are now enforced by the EA by virtue of the Water Resources Act and the Environment Act. These Byelaws have effect within the area of the Thames Regional Flood Defence Committee of the National Rivers Authority for the purposes of their functions relating to land drainage and flood risk management.

[4] UK Parliament, November 2009. Water Resources Act 1991, 1991 c. 57.
[5] UK Parliament, November 2003. Water Act 2003, 2014 c. 37.
[6] UK Parliament, May 2014. Water Act 2014, 2014 c. 21.
[7] UK Parliament, July 1991. Land Drainage Act 1991, 1991 c. 59.
[8] UK Parliament, July 1994. Land Drainage Act 1994, 1994 c. 25.
[9] Environment Agency, April 2014. Thames water authority: land drainage byelaws, Thames Region: Land Drainage Byelaws.

A2 National Policy and Guidance

A2.1 National Planning Policy Framework (July 2018)

The NPPF[10] includes policies on flood risk and minimising the impact of flooding under '14. Meeting the challenge of climate change, flooding and coastal management' (Paragraphs 155-165).

The NPPF states that:

- Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.
- Strategic policies should be informed by a Strategic Flood Risk Assessment (SFRA), and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as Lead Local Flood Authorities (LLFA) and internal drainage boards.
- All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk
- When determining any planning applications, Local Planning Authorities (LPAs) should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

  a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

  b) the development is appropriately flood resistant and resilient;

  c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

  d) any residual risk can be safely managed; and

  e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.
- Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

[10] Ministry of Housing, Communities and Local Government, July 2018. National Planning Policy Framework.

a) take account of advice from the LLFA;

b) have appropriate proposed minimum operational standards;

c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and

d) where possible, provide multifunctional benefits.

A2.2 National Planning Practice Guidance (November 2016)

The NPPG[11], comprising a web-based resource, has been issued to ensure the effective implementation of the NPPF and contains a section covering Flood Risk and Coastal Change. With regard to planning for flood risk, the Guidance assesses the suitability of the development type with respect to the flood risk zone in which it lies.

The NPPG also provides an overview of the expected effect of climate change and recommends contingency allowances for sensitivity ranges for peak rainfall intensities. Advice regarding allowance for climate change was updated in February 2016.

A2.3 Sewers for Adoption (2012)

An adopted drainage network needs to meet the criteria outlined in Sewers for Adoption[12]. A piped drainage system is required to not flood the ground in a 1 in 30 year flood, or surcharge for a 1 in 2 year event, using a design storm with the critical duration relevant to the site (i.e. the worst-case for a given return period). Private drainage systems also tend to use these criteria as a basis for design. Adoption of new sewers or abandonment of old sewers should take place in accordance with the Water Industry Act 1991, Sections 104 and 116 respectively.

A2.4 National Encroachment Policy for Tidal Rivers and Estuaries (2005)

The EA's National Encroachment Policy for Tidal Rivers and Estuaries has been approved by the Regional Flood Defence Committees of England and Wales. The EA is generally opposed to works on tidal rivers and estuaries that cause encroachment, but treat developments on a case by case basis.

[11] Department for Communities and Local Government, November 2016. Planning practice guidance.
[12] Water UK/WRc plc, August 2012. Sewers for Adoption (7th Edition): A design and construction guide for developers.

A3 Regional Policy and Guidance

A3.1 The London Plan: The Spatial Development Strategy for London Consolidated with Alterations Since 2011 (March 2016)

The document in its current state is The London Plan (2011) consolidated with Revised Early Minor Alteration to The London Plan (2013), Further Alterations to The London Plan (2015), Housing Standards Minor Alterations to The London Plan (March 2016) and Parking Standards Minor Alterations to The London Plan (March 2016)[13].

The London Plan is the overall strategic plan for London setting out an integrated economic, environmental, transport and social framework for the development of London; it recognises the need to address the increasing effects of climate change as predictions show there are more people likely to be living and working on the floodplain.

Relevant policies from the Plan are outlined below:

Policy 5.12: Flood risk management

The policy states:

- Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF on flood risk over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 and Catchment Flood Management Plans.
- Developments which are required to pass the Exceptions Test set out in the NPPF will need to address flood resilient design and emergency planning by demonstrating that:
    1. The development will remain safe and operational under flood conditions;
    2. A strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions;
    3. Key services including electricity, water etc. will continue to be provided under flood conditions; and
    4. Buildings are designed for quick recovery following a flood.
- Development adjacent to flood defences will be required to protect the integrity of existing flood defences and wherever possible should aim to be set back from the banks of watercourses and those defences to allow their management, maintenance and upgrading to be undertaken in a sustainable and cost effective way.

[13] Greater London Authority, March 2016. The London Plan: The Spatial Development Strategy for London consolidated with alterations since 2011.

Policy 5.13: Sustainable drainage

The policy states:

- Development should utilise Sustainable Urban Drainage Systems (SuDS) unless there are practical reasons for not doing so, and should aim to achieve Greenfield runoff rates and ensure that surface water runoff is managed as close to its source as possible in line with the following drainage hierarchy:
    1. Store rainwater for later use;
    2. Use infiltration techniques, such as porous surfaces in non-clay areas;
    3. Attenuate rainwater in ponds or open water features for gradual release;
    4. Attenuate rainwater by storing in tanks or sealed water features for gradual release;
    5. Discharge rainwater direct to a watercourse;
    6. Discharge rainwater to a surface water sewer/drain;
    7. Discharge rainwater to the combined sewer.
- Drainage should be designed and implemented in ways that deliver other policy objectives of this plan, including water use efficiency and quality, biodiversity, amenity and recreation.

Policy 7.13: Safety, security and resilience to emergency

The policy states that developments should maintain a safe, secure environment and minimise potential physical risks, including those arising from flooding and related hazards.

A3.2 The London Plan: Supplementary Planning Guidance - Sustainable Design and Construction (April 2014)

The Supplementary Planning Guidance (SPG)[14] sets out the Mayor's priorities with regard to flooding as follows:

- Through their Local Flood Risk Management Strategies boroughs should identify areas where there are particular surface water management issues and develop policies and actions to address these risks.
- Developers should maximise all opportunities to achieve greenfield runoff rates in their developments.
- When designing their schemes developers should follow the drainage hierarchy set out in London Plan policy 5.13.

[14] Greater London Authority, April 2016. Sustainable Design and Construction Supplementary Planning Guidance.

- Developers should design Sustainable Drainage Systems (SuDS) into their schemes that incorporate attenuation for surface water runoff as well as habitat, water quality and amenity benefits.
- Development in areas at risk from any form of flooding should include flood resistance and resilience measures in line with industry best practice.
- Developments are designed to be flexible and capable of being adapted to and mitigating the potential increase in flood risk as a result of climate change.
- Developments incorporate the recommendation of the TE2100 plan for the future tidal flood risk management in the Thames Estuary.
- Where development is permitted in a flood risk zone, appropriate residual risk management measures are to be incorporated into the design to ensure resilience and the safety of occupiers.

A3.3 Thames Estuary 2100 Plan (2012)

The Thames Estuary 2100 (TE2100) Strategy[15] has been prepared by the EA to consider flood risk management for the next 100 years. The plan that has been prepared looks at the work that is needed to maintain and improve the flood defences protecting London and the Thames Estuary, including the Thames Barrier.

A3.4 Thames Region Catchment Flood Management Plan (2008)

A Catchment Flood Management Plan (CFMP) is a high-level strategic plan prepared by the EA, which identifies long-term (50 to 100 year) policies for sustainable flood risk within a catchment.

The relevant key messages contained within the Thames Region CFMP[16] are that:

- Climate change will be the major cause of increased flood risk in the future. In urban areas and areas of narrow floodplain, flooding from heavy rainfall will be more regular and more severe. Surface water, sewer and fluvial flooding can occur within minutes of a severe rainfall event. Flooding can therefore occur at any time of the year, and there is very little time to provide flood warnings.
- It is increasingly necessary to recognise the value of flood plain in reducing the effects of flooding. Technical, environmental and economic constraints mean there are likely to be very few flood defence schemes in areas of narrow floodplain in the foreseeable future.
- Development and urban regeneration provide a crucial opportunity to manage flood risk. The location, layout and design of development can all reduce

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[15] Environment Agency, November 2012. TE2100 Plan: Managing flood risk through London and the Thames estuary.

[16] Environment Agency, December 2009. Thames Catchment Flood Management Plan: Summary Report December 2009.

flood risk. For example, the use of SuDS can help to control surface water (design).

A3.5 River Basin Management Plan, Thames River Basin District (2015)

River Basin Management Plans[17] are plans for protecting and improving the water environment and have been developed in consultation with organisations and individuals. They contain the main issues for the water environment and actions required. The River Basin Management Plans have been approved by the Secretary of State (SoS) for the Department of the Environment, Food and Rural Affairs (Defra) and the Welsh Minister.

[17] Department for Environment Food & Rural Affairs/Environment Agency, February 2016. River basin management plans: 2015, Thames river basin district RBMP: 2015.

A4 Local Guidance

A4.1 London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA)

The SFRA document was prepared in consultation with the Environment Agency and determines the level of flood risk across the borough. The SFRA is used to inform and support the Borough's flooding policies in its emerging Local Development Framework, (LDF) in accordance with the NPPF.

The SFRA states:

- *This residual risk (of flooding) is associated with a number of potential risk factors including (but not limited to):*
    - *a flooding event that exceeds that for which the local drainage system has been designed*
    - *the residual danger posed to property and life as a result of flood defence failure or exceedance*
    - *general uncertainties inherent in the prediction of flooding*
    - *reservoir failure*
- *For all sites greater than 1ha in area, a Flood Risk Assessment / Sustainable Drainage Strategy must be prepared. The potential impacts of the development to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff must be considered.*
- *Details of proposed sustainable drainage systems (SuDS) that will be implemented to ensure that runoff from the site (post redevelopment) does not exceed greenfield runoff rates. Any SuDS design must take due account of groundwater and geological conditions.*
- *The risk of other sources of flooding (e.g. urban drainage and/or groundwater) must be considered.*
- *There are four main approaches to designing for flood risk:*
    - *Flood Avoidance: Constructing a building and its surroundings (at site level) in such a way to avoid being flooded.*
    - *Flood Resistance: Constructing a building in such a way to prevent flood water entering the building and damaging its fabric.*
    - *Flood Resilience: Constructing a building in such a way that although flood water may enter the building its impact is reduced.*
    - *Flood Repairable: Constructing a building in such a way that although flood water enters a building, elements that are damaged by flood water can be easily repaired or replaced. This is also a form of flood resilience.*
- *A planning solution to flood risk management should be sought wherever possible, steering vulnerable development away from areas affected by flooding in accordance with the Sequential Test.*

- *Where other planning considerations must guide the allocation of sites following the application of the Sequential Test, specific recommendations have been provided to assist the Borough and the developer to meet the Exception Test. These should be applied as development control recommendations for all future development (refer Section 7.4).*
- *Flood Warning and Evacuation Plans should be in place for those areas at an identified risk of flooding. Developers should ensure that appropriate evacuation and flood response procedures are in place to manage the residual risk associated with an extreme flood event, and include how such plans will be implemented.*
- *When constructing new properties, permanent flood resistance measures are always preferable to temporary measures as they do not require intervention by the property occupants.*

A4.2 London Borough of Richmond upon Thames Local Plan (adopted 2018)

A4.2.1 Core Strategies

The core strategy document was adopted in 2009 and contains strategic policies to guide the future development of the Borough. It sets out the Strategic Planning Framework for the Borough for the next 15 years, taking account of the other plans and strategies and will serve as the delivery mechanism for the spatial elements of the Community Plan.

CP3 Climate Change – Adapting to the Effects.

- *Development will need to be designed to take account of the impacts of climate change over its lifetime, including:*
  - *Water conservation and drainage*
  - *Flood risk from the River Thames and its tributaries*
- *The Council's Strategic Flood Risk Assessment and advice from the Environment Agency can be used to identify the strategic flood risk, which will then need to be assessed at site level when development is proposed.*
- *Developers should undertake site specific flood risk assessments (FRAs) as set out in chapter 3 of PPS 25 Practice Guide and relevant CIRIA guidance. The FRA will need to demonstrate to the satisfaction of the Council that any flood risks to the development, or additional risk arising from the proposal will be successfully managed with the minimum environmental effect, and that necessary flood risk management measures are sufficiently funded to ensure that the site can be developed and occupied safely throughout its proposed lifetime.*
- *With respect to flooding specifically, community management measures will be taken forward through the Council's Emergency Planning measures, in conjunction with others such as Thames Water, TLS, the Environment Agency and the Emergency Services.*

A4.2.2 Development Management Plan

The DMP was adopted in 2011 and contains the detailed policies which will be used when new developments are considered. It takes forward the strategic objectives in the Core Strategy and is consistent with it and with National and Regional Policies.

Policy DM SD 6 – Flood Risk

- *Development will be guided to areas of lower risk by applying the Sequential Test asset out in paragraph 3.1.35.*
- *Developments and Flood Risk Assessments must consider all sources of flooding and the likely impacts of climate change.*
- *Where a Flood Risk Assessment is required and in addition to the Environment Agency's normal floodplain compensation requirement, attenuation areas to alleviate fluvial and/or surface water flooding must be considered where there is an opportunity.*
- *In areas at risk of flooding, all proposals on sites of 10 dwellings or 1000sqm of non-residential development or more are required to submit a Flood Warning and Evacuation Plan.*

Policy DM SD 7 – Sustainable Drainage

- *All development proposals are required to follow the drainage hierarchy when disposing of surface water and must utilise Sustainable Drainage Systems (SuDS) wherever practical. Any discharge should be reduced to greenfield run-off rates wherever feasible.*
- *When discharging surface water to a public sewer, developers will be required to provide evidence that capacity exists in the public sewerage network to serve their development.*

Policy DM SD 8 – Flood Defences

- *The effectiveness, stability and integrity of the flood defences, river banks and other formal and informal flood defence infrastructure within the borough will be retained and provision for maintenance and upgrading will be ensured.*
- *The removal of formal or informal flood defences is only acceptable if this is part of an agreed flood risk management strategy by the Environment Agency*
- *The Environment Agency must be consulted for any development that could affect a flood defence infrastructure.*

Policy DM SD 9 – Protecting Water Resources and Infrastructure

- *The borough’s water resources and supplies will be protected by resisting development proposals that would pose an unacceptable threat to surface water and groundwater quantity and quality. This includes pollution caused by water run-off from developments into nearby waterways.*
- *New developments should also consider the following:*

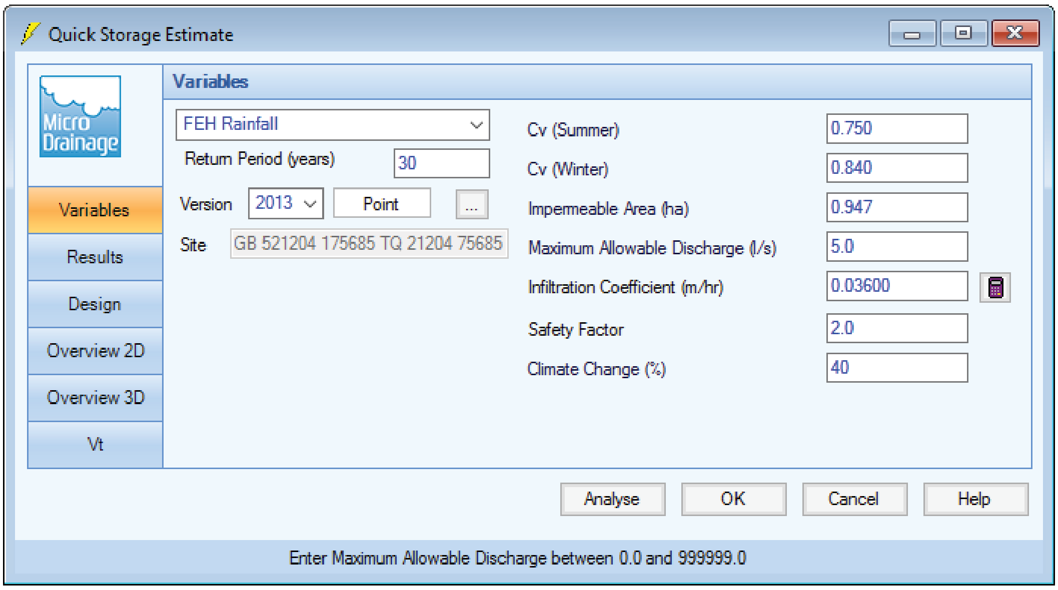
1. *utilising rainwater harvesting and greywater recycling for all non-potable uses to reduce the consumption of potable water wherever possible, and*
2. *designing of landscaping to minimise water demand.*

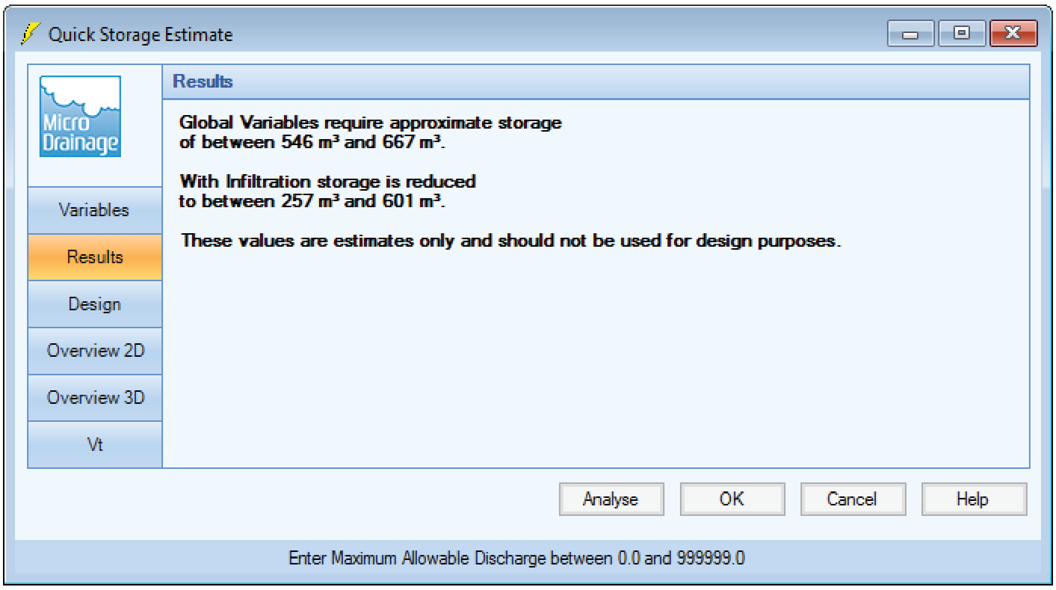
- *Where rivers have been classified by the Environment Agency as having 'poor' status (currently the River Crane, the Beverley Brook and the River Thames, upstream of Teddington), any development affecting such rivers is encouraged to improve the water quality in these areas.*

Appendix B

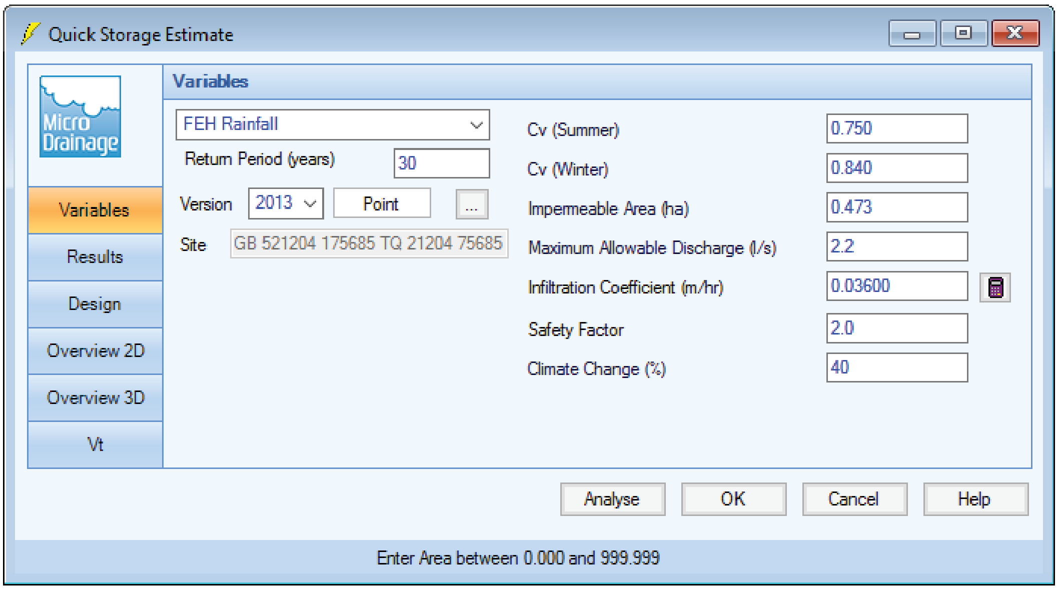
Micro Drainage Calculations

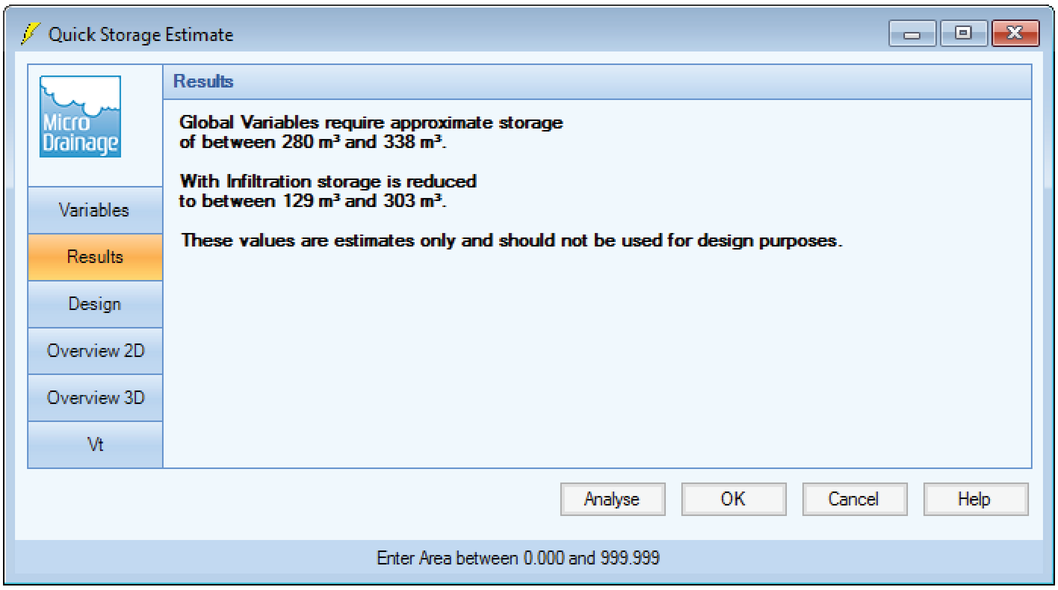
Whole Site


Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Variables
FEH Rainfall
Return Period (years) 30
Version 2013
Point
...
Site GB 521204 175685 TQ 21204 75685
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 0.947
Maximum Allowable Discharge (l/s) 5.0
Infiltration Coefficient (m/hr) 0.03600
Safety Factor 2.0
Climate Change (%) 40
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

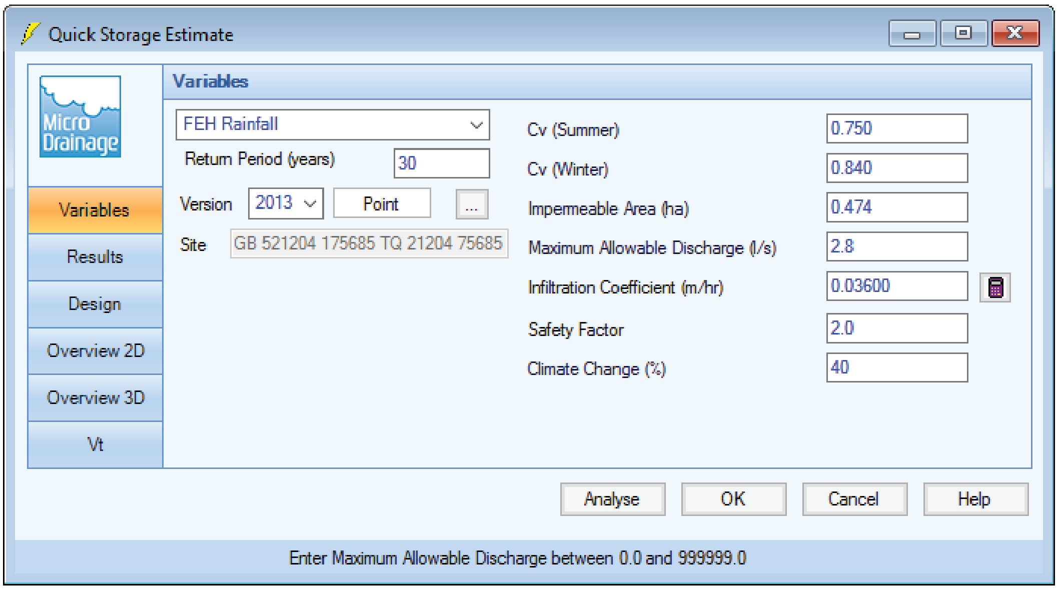

Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Results
Global Variables require approximate storage of between 546 m³ and 667 m³.
With Infiltration storage is reduced to between 257 m³ and 601 m³.
These values are estimates only and should not be used for design purposes.
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

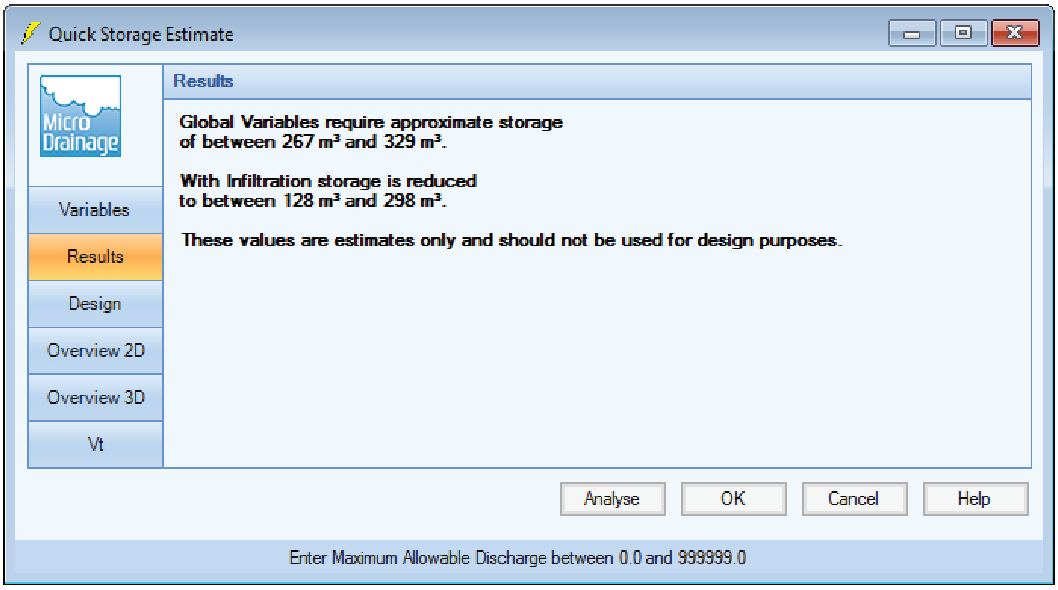
Eastern Site (Healthcare Centre and School)





Western Site (Residential)





Appendix C

Environment Agency Product 1

KSL 62212 UE Flood Map centred on SW14 8SU (created on 11/10/2017)

Environment Agency

Legend

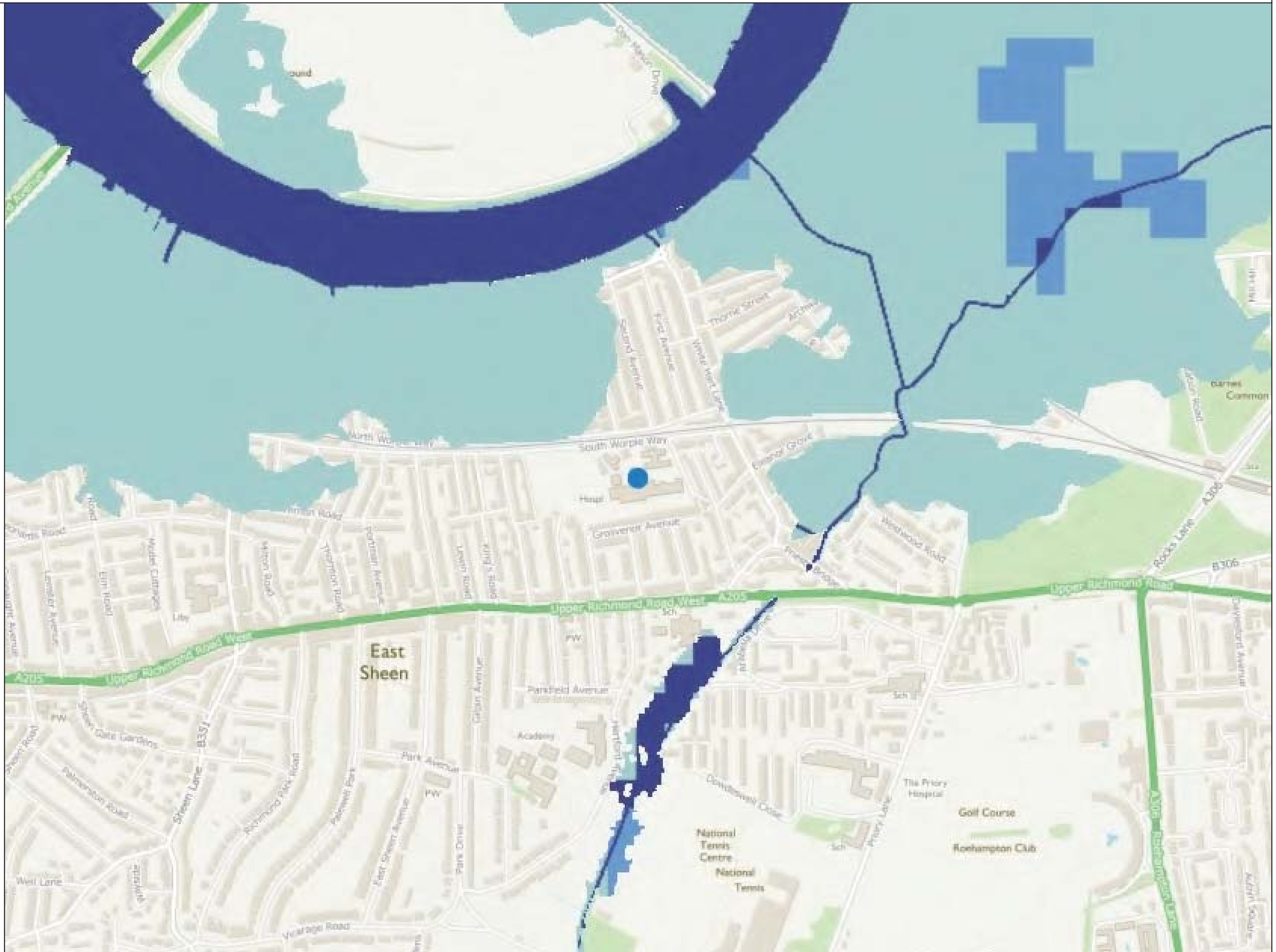
All recorded flood outlines

Risk of flooding from rivers and sea

- High (>=3.3%)
- Medium (3.3% - 1%)
- Low (1% - 0.1%)
- Very Low (<0.1%)

0 100 200 300
Metres

N W E S



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Appendix D

Greenfield Runoff Estimation

Greenfield runoff estimation for sites

www.uksuds.com | Greenfield runoff tool

HR Wallingford
Working with water

Calculated by:	Hamish Tozer
Site name:	Barnes Hospital
Site location:	SW14 8SU

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site coordinates

Latitude:	51.46725° N
Longitude:	0.25641° W
Reference:	6147910
Date:	2017-10-13T11:55:22

Methodology	IH124

Site characteristics

Total site area (ha)	1.45

Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	596	596
Hydrological region	6	6
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Notes:

(1) Is Q_{BAR} < 2.0 l/s/ha?

Normally limiting discharge rates which are less than 2.0 l/s/ha are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consents are usually set at 5.0l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	2.19	2.19
1 in 1 year (l/s)	1.86	1.86
1 in 30 years (l/s)	5.04	5.04
1 in 100 years (l/s)	6.98	6.98

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at http://uksuds.com/terms-and-conditions.htm. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for use of this data in the design or operational characteristics of any drainage scheme.

Appendix E

Proposed Drainage Plan

NOTES:
DO NOT SCALE FROM THIS DRAWING.
ALL DIMENSIONS TO BE CHECKED ON SITE.
ALL OMISSIONS AND DISCREPANCIES TO BE REPORTED TO THE ARCHITECT IMMEDIATELY.

Legend:

- Site Boundary
- Existing Surface Water (SW) pipe
- Existing Foul Water (FW) pipe
- New SW Pipe
- New FW Pipe
- SW Attenuation Tank
- SfA Type 2 Manhole
- SfA Type 3 Inspection Chamber
- Indicative basement outline

Barnes Hospital
Proposed Combined Drainage and Attenuation

Barnes Hospital
02 Nov 2018 | For Information | RCT
Rev P01
ARUP

ISO 9001 Quality Management
FS 538679

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