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IESISSTRUCTURES

Project Name: Euston One
Project Address: 17 -37 William Road, London NW1 3ER
Sub-catchment addressed by this Addendum: 35 – 37 William Road
Note Title: Flood Risk Assessment Addendum No.1
Date: 19th May 2021 (1st Issue)

1.0 Introduction

1.1 Iesis Structures provided a Flood Risk Assessment (FRA) in support of Planning Reference 2020/5473/P to the London Borough of Camden, in respect of a proposed redevelopment at 17 – 37 William Road, London NW1 3ER.

1.2 Following the submission of the original FRA, comments were received from the Lead Local Flood Authority (LLFA) and the Greater London Authority (GLA).

1.3 This FRA Addendum (FRAA) should be read in read in conjunction with the original submitted FRA. This Addendum provides additional information supporting the proposed surface water drainage strategy as requested by the LLFA/GLA, together with clarification on other items relating to flood risk.

2.0 Additional information requested by the LLFA and GLA

2.1 "*Missing document: Suds Proforma*": please refer to Appendix A for the completed Camden/GLA proforma.

2.2 "*Missing document: SuDS lifetime maintenance plan*": please refer to separate document SuDS Maintenance & Management Plan by Iesis Structures.

2.3 "*Evidence of capacity confirmation from Thames Water (or initial correspondence)":* Thames Water has confirmed there is sufficient sewerage capacity for the proposed foul and surface water flows from the development – refer to Pre-planning enquiry response from Thames Water in Appendix B.

2.4 "*Management of H&S risks related to SuDS design*": the scheme does not contain open SuDS features which could present risk from drowning. It is not considered that the SuDS elements within the design present any special H&S risk provided they are maintained adequately in accordance with the SuDS Maintenance & Management Plan.

2.5 "*Details of flow routes for exceedance events":* refer to Exceedance Flow Routes plan in Appendix C.

2.6 "*Viability of blue roof attenuation required*": the incorporation of a blue roof into the design has been considered. It is proposed to implement blue roof attenuation on the main high-level roof (15th floor, catchment area 403m^2) using a 108mm Aquamodul blue roof system by Axter. This will restrict the outflow from the roof to a maximum of 1.44 l/s and will provide approximately 38m.cu of attenuation storage (0.108m x 351m.sq attenuation area = 37.9m.cu). This will reduce the quantity of below ground storage by 50% compared to the strategy within the originally submitted FRA, from 38m^3 to 19m^3. For calculations pertaining to the blue roof system, revised Drainage Strategy Drawing and supporting Micro Drainage outputs refer to Appendices D, E & F.

2.7 "*The southern half of the site is located above a Secondary A Aquifer, as defined by the Environment Agency (EA), which corresponds to the Lynch Hill Gravel superficial deposits. There is therefore the potential for shallow groundwater beneath the site, which should be assessed, with appropriate mitigation measures provided if necessary":* While the north half of the site overlies an 'Unproductive' Aquifer, the south overlies a 'Low' Aquifer. The site is removed from all Source Protection Zones. Appendix C of the FRA contains both Groundwater maps referred to. An excerpt from LBC's SFRA Groundwater Vulnerability Map shows the site lying at the north edge of the area susceptible to flooding from this source – refer to Appendix G. The basement level will be constructed with suitable 'dual membrane' (eg by Newton or similar) and good quality concrete - that is inherently waterproof.

2.8 "*The Applicant should provide an assessment of sewer flood risk and provide appropriate mitigation measures against the potential for elevated groundwater beneath the site.":* the site is removed from the highlighted problem area identified in LBC's SFRA – refer to map ref "DG5 External Sewer Flooding" – in Appendix G. Consequently, the level of flood risk from sewers is considered to be low.

2.9 "*Inclusion of a range of SuDS including rainwater harvesting and green roofs;":* the scheme comprises green roof solutions on the lower level set back roofs (6th and 8th floors), of approximately 33m.sq and 43m.sq respectively. A rainwater harvesting system is proposed to serve the amenity space toilets, comprising tanks of total volume 3000 litres.

2.10 "*Confirmation that gravity discharge from the attenuation tank to the public sewer is feasible":* we confirm that gravity discharge to the sewer from the attenuation tank is feasible as shown on the Site Drainage Strategy drawing in Appendix D. The base of the tank will sit at level +25.025, which is 135mm above the existing boundary manhole invert level of +24.890 (reference "Ex.CMH"), which itself drains to the sewer in William Road by gravity.

2.11 "*The Applicant should aim to achieve a maximum indoor water consumption of 105 l/person/day, which can be achieved through incorporating additional measures such as a leak detection system and rainwater harvesting and/or water recycling. The proposed development does not currently meet the requirements of London Plan Policy SI 5.*" As per paragraph 2.9, a rainwater harvesting system is proposed to serve the amenity space toilets.

John Roberts
BSc (Hons)

Appendix A – SuDS Proforma

Camden

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LoDEG

1. Project & Site Details		
	Project / Site Name (including sub-catchment / stage / phase where appropriate)	Project Name: 17 - 37 William Road Sub-catchment: 35 - 37 William Road
	Address & post code	17-37 William Road, London NW1 3ER
	OS Grid ref. (Easting, Northing)	E 529083
		N 182537
	LPA reference (if applicable)	
	Brief description of proposed work	No. 35-37 redeveloped as 15-storey building plus basement to provide 168 student units with shared amenity spaces. Retention of No. 17-33 with affordable workspace at ground floor level together with ancillary
	Total site Area	658 m^2
	Total existing impervious area	658 m^2
	Total proposed impervious area	658 m^2
	Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	Partially: the site lies at the edge of a Critical Drainage Area with the SW half of the building outside of it.
	Existing drainage connection type and location	Combined drain, gravity, branch connection to combined sewer
	Designer Name	John Roberts
	Designer Position	Civil Engineer
	Designer Company	IESIS Structures

2. Proposed Discharge Arrangements			
	2a. Infiltration Feasibility		
	Superficial geology classification	Langley Silt Member (clay and silt)	
	Bedrock geology classification	London Clay Formation (clay, silt and sand)	
	Site infiltration rate	Not known m/s	
	Depth to groundwater level	Not known m below ground level	
	Is infiltration feasible?	No	
	2b. Drainage Hierarchy		
		Feasible (Y/N)	*Proposed (Y/N)*
	1 store rainwater for later use	Y	Y
	2 use infiltration techniques, such as porous surfaces in non-clay areas	N	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	Combined Sewer	
	Has the owner/regulator of the discharge location been consulted?	Yes	

Camden

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LoDEG

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 in 1	0.3	11	8	0.7
1 in 30	0.6	31	28	0.7
1 in 100	0.7	41	42	0.8
1 in 100 + CC			60	1
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Hydro-brake		

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	TBC		3
Infiltration systems	0		0
Green roofs	95	74	0.37
Blue roofs	403	351	38
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	41	41	5
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	ENTIRE SITE		19
Total	**539**	**466**	**65.37**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Paragraph 5.3 of FRA
Drainage hierarchy (2b)	Section 5 of FRA
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	FRAA
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	FRAA
Proposed SuDS measures & specifications (3b)	FRAA
4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Appendix D of FRA
Detailed drainage design drawings, including exceedance flow routes	FRAA
Detailed landscaping plans	There is no landscaping
Maintenance strategy	Refer to SMMP
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	FRA Section 5.0 and FRAA
b) biodiversity?	FRAA
c) amenity?	FRAA

Appendix B – Thames Water Utilities Correspondence

GTA Civils & Transport Ltd
Gloucester House
66A Church Walk
Burgess Hill
West Sussex
RH15 9AS

Wastewater pre-planning
Our ref DS6077617

24 November 2020

Pre-planning enquiry: Confirmation of sufficient capacity

Dear Mr Roberts,

Thank you for providing information on your development.

Site: 35 to 37 William Road, Euston, London, NW1 3ER.

Proposed site: Redevelopment of site for 168 student units (239 bed spaces) accommodation including shared amenity space for students, including a meeting room, cinema and gym.
Proposed foul water: To discharge via existing connection to 1270mmx838mm public combined water sewer in William Road.
Proposed surface water: Surface water discharge limited to 1l/s to connect via existing connection to 1270mmx838mm public combined water sewer in William Road.

We have completed the assessment of the foul water flows and surface water run-off based on the information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network.

Foul Water

If your proposals progress in line with the details you've provided, we're pleased to confirm that there will be sufficient sewerage capacity in the adjacent combined water sewer network to serve your development.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity.

Surface Water

When developing a site, policy 5.13 of the London Plan and Policy 3.4 of the Supplementary Planning Guidance (Sustainable Design And Construction) states that every attempt should be made to use flow attenuation and SuDS/Storage to reduce the surface water discharge from the site as much as possible.

In accordance with the Building Act 2000 Clause H3.3, positive connection of surface water to a public sewer will only be consented when it can be demonstrated that the hierarchy of disposal

methods have been examined and proven to be impracticable. Before we can consider your surface water needs, you'll need written approval from the lead local flood authority that you have followed the sequential approach to the disposal of surface water and considered all practical means.

The disposal hierarchy being:

1. store rainwater for later use.
2. use infiltration techniques where possible.
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.
8. discharge rainwater to the foul sewer

Where connection to the public sewerage network is still required to manage surface water flows we will accept these flows at a discharge rate in line with CIRIA's best practice guide on SuDS or that stated within the sites planning approval.

If the above surface water hierarchy has been followed and if the flows are restricted to a rate of 1l/s then Thames Water would not have any objections to the proposal.

What happens next?

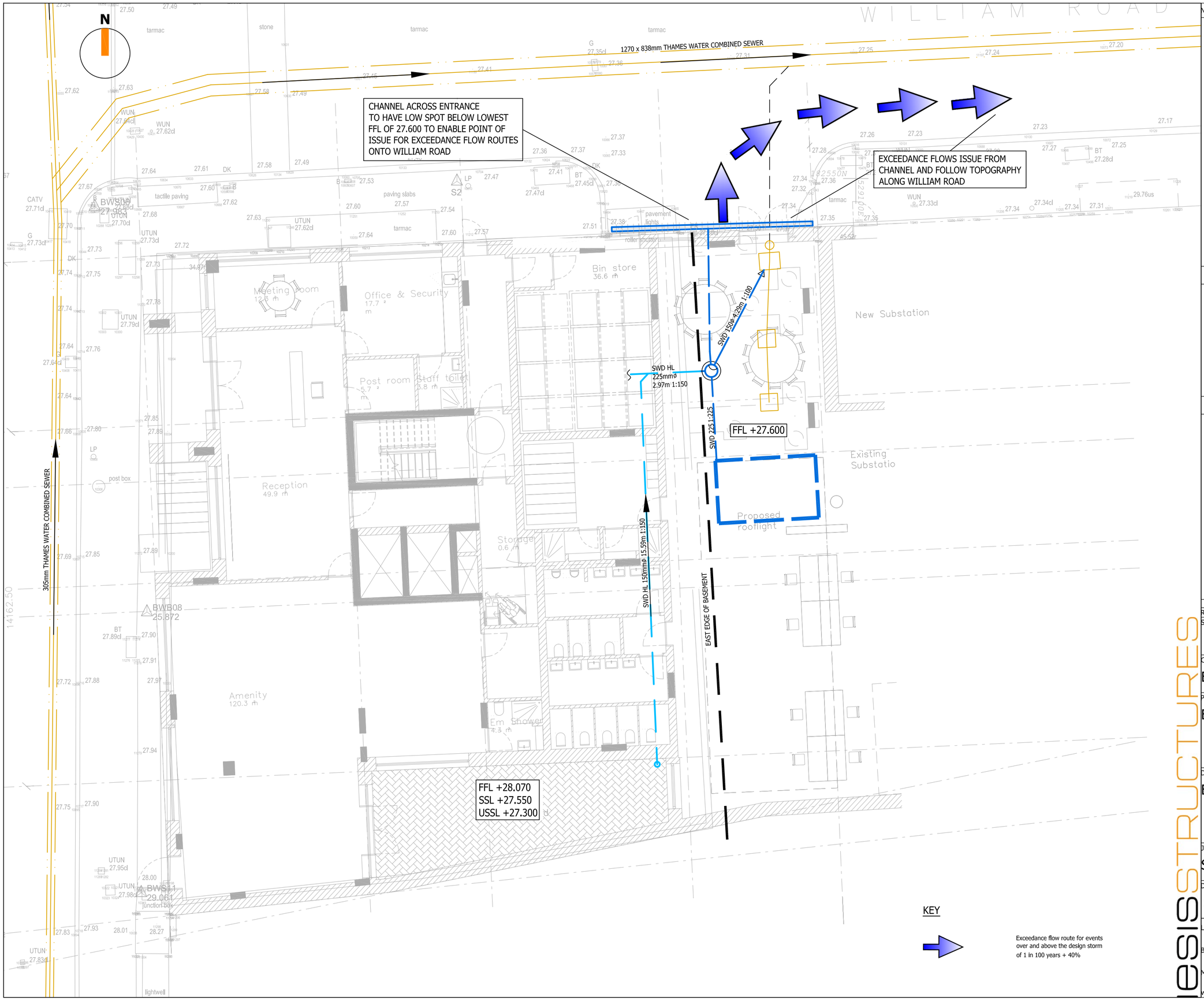
Please make sure you submit your connection application, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me on 020 3577 9223.

Yours sincerely

Alan Dovey
Development Engineer
Developer Services – Sewer Adoptions Team

Appendix C – Exceedance Flow Routes Plan



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS (mm) ALL LEVELS ARE IN METERS (m).
2. DO NOT SCALE FROM DRAWINGS, WORK TO FIGURED DIMENSIONS ONLY.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS, THE SPECIFICATION AND THE CONTRACT DOCUMENTS.
4. ALL WORK IS TO COMPLY WITH THE RELEVANT EUROCODES, CODES OF PRACTICE AND THE BUILDING REGULATIONS.
5. ANY DISCREPANCIES BETWEEN THE ARCHITECTS AND THE ENGINEERS DRAWINGS TO BE BROUGHT TO THE ATTENTION OF THE DESIGN TEAM.
6. ALL SETTING OUT TO BE VERIFIED WITH THE ARCHITECT PRIOR TO COMMENCEMENT OF SITE CONSTRUCTION.
7. WORKS TO ENSURE THE STRUCTURAL STABILITY OF ALL ELEMENTS IN THEIR TEMPORARY STATE DURING CONSTRUCTION TO BE THE RESPONSIBILITY OF THE CONTRACTOR.
8. ALL FOUNDATION WORKS ARE TO BE UNDERTAKEN IN ACCORDANCE WITH PARTY WALL AWARDS.
9. FOR FULL DESIGN NOTES REFER TO IESIS DRAWING: XXX-ISS-XX-XX-DR-S-7000.

KEY:

LEGEND:

REV	DATE	DRAWN/CHK	REVISION INFO
P01	18.05.21	JR/MR	INITIAL PRELIMINARY ISSUE

STATUS: PRELIMINARY

CLIENT: EUSTON ONE LIMITED

PROJECT: EUSTON ONE

DRAWING TITLE: EXCEEDANCE FLOW ROUTES

JOB NUMBER:	SCALE AT A1:	REV. STATUS:
SE1714	1:100	S3

DRAWING NUMBER: SE1714-ISS-XX-00-DR-C-3001 REVISION: P01

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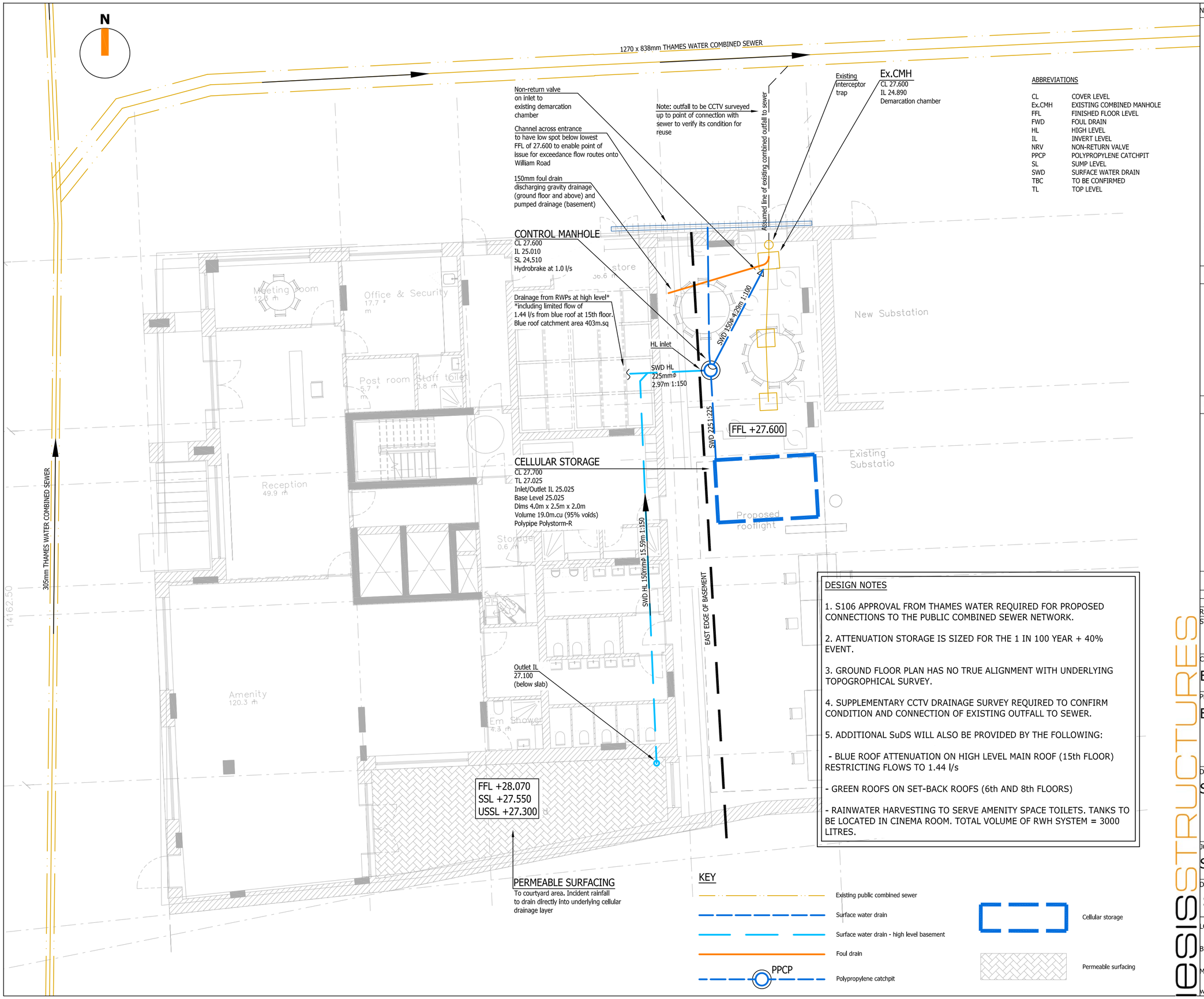
Appendix D – Revised Site Drainage Plan



ABBREVIATIONS

CL	COVER LEVEL
Ex.CMH	EXISTING COMBINED MANHOLE
FFL	FINISHED FLOOR LEVEL
FWD	FOUL DRAIN
HL	HIGH LEVEL
IL	INVERT LEVEL
NRV	NON-RETURN VALVE
PPCP	POLYPROPYLENE CATCHPIT
SL	SUMP LEVEL
SWD	SURFACE WATER DRAIN
TBC	TO BE CONFIRMED
TL	TOP LEVEL

DESIGN NOTES

1. S106 APPROVAL FROM THAMES WATER REQUIRED FOR PROPOSED CONNECTIONS TO THE PUBLIC COMBINED SEWER NETWORK.

2. ATTENUATION STORAGE IS SIZED FOR THE 1 IN 100 YEAR + 40% EVENT.

3. GROUND FLOOR PLAN HAS NO TRUE ALIGNMENT WITH UNDERLYING TOPOGROPHICAL SURVEY.

4. SUPPLEMENTARY CCTV DRAINAGE SURVEY REQUIRED TO CONFIRM CONDITION AND CONNECTION OF EXISTING OUTFALL TO SEWER.

5. ADDITIONAL SuDS WILL ALSO BE PROVIDED BY THE FOLLOWING:

- BLUE ROOF ATTENUATION ON HIGH LEVEL MAIN ROOF (15th FLOOR) RESTRICTING FLOWS TO 1.44 l/s

- GREEN ROOFS ON SET-BACK ROOFS (6th AND 8th FLOORS)

- RAINWATER HARVESTING TO SERVE AMENITY SPACE TOILETS. TANKS TO BE LOCATED IN CINEMA ROOM. TOTAL VOLUME OF RWH SYSTEM = 3000 LITRES.

KEY

- Existing public combined sewer
- Surface water drain
- Surface water drain - high level basement
- Foul drain
- PPCP — Polypropylene catchpit
- Cellular storage
- Permeable surfacing

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KEY:

LEGEND:

REV	DATE	DRAWN/CHK	REVISION INFO
P03	18.05.21	JR/MR	REVISED TO TAKE ACCOUNT OF ALL SUDS
P02	15.10.20	JR/MR	REVISED TO LATEST GA
P01	07.09.20	JR/MR	INITIAL PRELIMINARY ISSUE

STATUS:

PRELIMINARY

CLIENT:

EUSTON ONE LIMITED

PROJECT:

EUSTON ONE

DRAWING TITLE:

SITE DRAINAGE STRATEGY

JOB NUMBER:	SCALE AT A1:	REV. STATUS:
SE1714	1:100	S3

DRAWING NUMBER: SE1714-ISS-XX-00-DR-C-3000 REVISION: P03

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Appendix E – Blue Roof Attenuation & Outflow Calculation

AQUAMODUL™ ATTENUATION AND OUTFLOW CALCULATION

Project Name:	Axter - Euston One, 35-37, William Rd, NW1 3ER - Main Roof (15th Floor) - FEH Data
Date:	11/05/2021
Axter Project ID:	24063
Notes/description:	Central plant area (with screen), and hard landscaping (pavers on pedestals and ballast); with potential for free-standing/ballasted PV panels & plant to be installed, on top of the 'blue roof' system (recommended); and maintenance access only - TBC. Higher strength, 'blue roof' system utilised - 2no. 3780kg ASHP supports TBC with ABG, Axter, and structural and MEP engineers. Axter, warm roof, construction, with zero falls.

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)

Return period:	100 years	*As supplied by Client*
Allowance for Climate Change:	40 %	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 29097 82534	

Input Parameters – Roof Information

Total catchment area:	403 m^2	*As supplied by Client*
Attenuation area:	351 m^2	*As supplied by Client*
Maximum allowable runoff:	1.5 l/s	*As supplied by Client*

Output – Rainfall Calculation

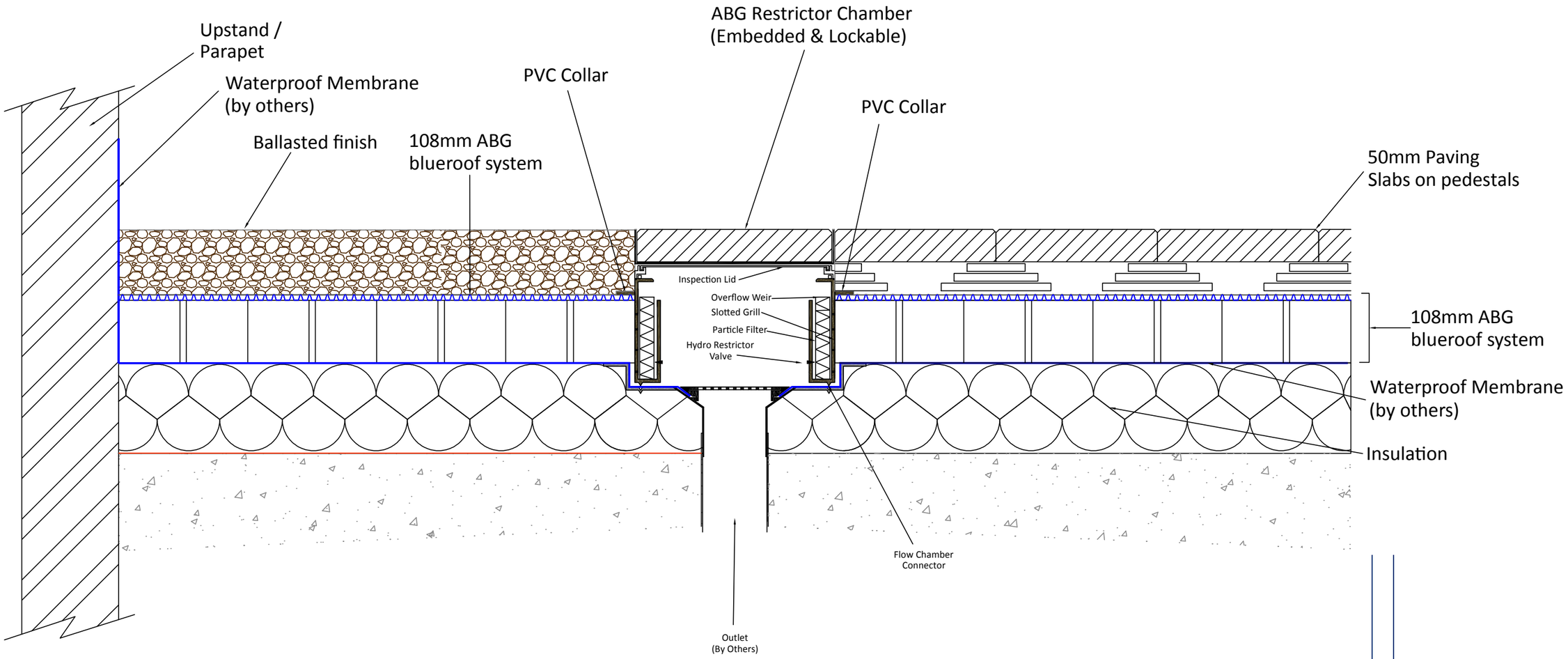
Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	6 hours and 40 minutes	1.07
30 mins	7 hours and 40 minutes	1.20
1 hour	8 hours and 30 minutes	1.30
2 hours	9 hours and 30 minutes	1.41
4 hours	9 hours and 40 minutes	1.44
6 hours	9 hours and 20 minutes	1.39
10 hours	7 hours and 50 minutes	1.22
24 hours	2 hours and 30 minutes	0.55
48 hours	0 hours and 0 minutes	0.10

Total attenuation required:	33.80 m^3
Half empty time:	3 hours and 50 minutes.

Output – Recommended Blue Roof System:

System Name:	ABG blueroof VF HD/VF HD+ 108mm
Description:	No. of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.
Total attenuation capacity:	34 m^3
Number of Blue Roof outlets:	3

Notes:
1. This document contains an estimate which has been prepared by Axter Ltd and its partners and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from Axter Ltd. The values given for the performance of the system relate to testing, modelling and analysis of our systems obtained from laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes to our systems without notice at any time.
3. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, Axter Ltd should be contacted to provide a revised estimate.
4. This estimate is specific to the characteristics of Axter Ltd products/systems and is not applicable to other competitor products. The substitution of the whole or any component of this design for a material supplied from another source renders this estimate invalid.
5. Final determination of the suitability of any information is the sole responsibility of the user. Axter Ltd will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.



Rev:	Comments:	By:	Date:

Project:
Blue Roof - Warm

Title:
Restrictor Chamber &
Ballasted / Paved Detail

Drawn by:	Date:	
RH	13/01/20	
Scale: NTS	Drawing Ref: BRST12	Rev: 1.03

abg creative geosynthetic engineering

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Appendix F – Revised Micro Drainage Output Sheets

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (ha)	0.066	Urban	0.750
SAAR (mm)	600	Region Number	Region 6

Results l/s

QBAR Rural	0.1
QBAR Urban	0.4
Q1 year	0.3
Q1 year	0.3
Q30 years	0.6
Q100 years	0.7

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	25.057	0.167	11.0	0.3	O K
30 min Summer	25.047	0.157	9.2	0.2	O K
60 min Summer	25.004	0.114	6.4	0.2	O K
120 min Summer	24.976	0.086	4.3	0.1	O K
180 min Summer	24.965	0.075	3.2	0.1	O K
240 min Summer	24.960	0.070	2.7	0.1	O K
360 min Summer	24.949	0.059	2.0	0.1	O K
480 min Summer	24.943	0.053	1.6	0.1	O K
600 min Summer	24.939	0.049	1.4	0.1	O K
720 min Summer	24.935	0.045	1.2	0.1	O K
960 min Summer	24.930	0.040	1.0	0.0	O K
1440 min Summer	24.925	0.035	0.7	0.0	O K
2160 min Summer	24.919	0.029	0.5	0.0	O K
2880 min Summer	24.916	0.026	0.4	0.0	O K
4320 min Summer	24.913	0.023	0.3	0.0	O K
5760 min Summer	24.910	0.020	0.2	0.0	O K
7200 min Summer	24.908	0.018	0.2	0.0	O K
8640 min Summer	24.906	0.016	0.2	0.0	O K
10080 min Summer	24.906	0.016	0.2	0.0	O K
15 min Winter	25.055	0.165	10.7	0.3	O K
30 min Winter	25.036	0.146	7.8	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	33.658	0.0	4.2	10
30 min Summer	21.713	0.0	5.4	17
60 min Summer	13.524	0.0	6.7	32
120 min Summer	8.242	0.0	8.2	62
180 min Summer	6.136	0.0	9.1	92
240 min Summer	4.971	0.0	9.8	122
360 min Summer	3.667	0.0	10.9	184
480 min Summer	2.950	0.0	11.7	242
600 min Summer	2.491	0.0	12.3	308
720 min Summer	2.170	0.0	12.9	358
960 min Summer	1.745	0.0	13.8	478
1440 min Summer	1.283	0.0	15.2	728
2160 min Summer	0.945	0.0	16.8	1100
2880 min Summer	0.760	0.0	18.1	1448
4320 min Summer	0.558	0.0	19.9	2196
5760 min Summer	0.449	0.0	21.3	2848
7200 min Summer	0.379	0.0	22.5	3648
8640 min Summer	0.330	0.0	23.5	4304
10080 min Summer	0.294	0.0	24.5	5016
15 min Winter	33.658	0.0	4.7	9
30 min Winter	21.713	0.0	6.0	18

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	24.985	0.095	5.1	0.1	O K
120 min Winter	24.965	0.075	3.2	0.1	O K
180 min Winter	24.955	0.065	2.4	0.1	O K
240 min Winter	24.948	0.058	1.9	0.1	O K
360 min Winter	24.940	0.050	1.5	0.1	O K
480 min Winter	24.935	0.045	1.1	0.1	O K
600 min Winter	24.931	0.041	1.0	0.0	O K
720 min Winter	24.928	0.038	0.9	0.0	O K
960 min Winter	24.924	0.034	0.7	0.0	O K
1440 min Winter	24.919	0.029	0.5	0.0	O K
2160 min Winter	24.915	0.025	0.4	0.0	O K
2880 min Winter	24.913	0.023	0.3	0.0	O K
4320 min Winter	24.908	0.018	0.2	0.0	O K
5760 min Winter	24.906	0.016	0.2	0.0	O K
7200 min Winter	24.905	0.015	0.2	0.0	O K
8640 min Winter	24.904	0.014	0.1	0.0	O K
10080 min Winter	24.903	0.013	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	13.524	0.0	7.5	32
120 min Winter	8.242	0.0	9.1	62
180 min Winter	6.136	0.0	10.2	94
240 min Winter	4.971	0.0	11.0	120
360 min Winter	3.667	0.0	12.2	178
480 min Winter	2.950	0.0	13.1	244
600 min Winter	2.491	0.0	13.8	300
720 min Winter	2.170	0.0	14.4	370
960 min Winter	1.745	0.0	15.5	474
1440 min Winter	1.283	0.0	17.1	730
2160 min Winter	0.945	0.0	18.9	1124
2880 min Winter	0.760	0.0	20.2	1448
4320 min Winter	0.558	0.0	22.3	2200
5760 min Winter	0.449	0.0	23.9	2896
7200 min Winter	0.379	0.0	25.2	3904
8640 min Winter	0.330	0.0	26.4	4528
10080 min Winter	0.294	0.0	27.4	5040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.440	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.066

Time (mins) From:	To:	Area (ha)
0	4	0.066

Model Details

Storage is Online Cover Level (m) 27.700

Pipe Structure

Diameter (m)	0.150	Length (m)	8.000
Slope (1:X)	60.000	Invert Level (m)	24.890

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	60.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	24.890
Roughness k (mm)	0.600		

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	25.394	0.504	30.8	0.6	O K
30 min Summer	25.264	0.374	25.7	0.5	O K
60 min Summer	25.114	0.224	18.1	0.4	O K
120 min Summer	25.067	0.177	12.6	0.3	O K
180 min Summer	25.048	0.158	9.5	0.2	O K
240 min Summer	25.031	0.141	7.6	0.2	O K
360 min Summer	24.992	0.102	5.7	0.1	O K
480 min Summer	24.977	0.087	4.5	0.1	O K
600 min Summer	24.970	0.080	3.8	0.1	O K
720 min Summer	24.965	0.075	3.2	0.1	O K
960 min Summer	24.957	0.067	2.5	0.1	O K
1440 min Summer	24.945	0.055	1.7	0.1	O K
2160 min Summer	24.937	0.047	1.3	0.1	O K
2880 min Summer	24.930	0.040	1.0	0.0	O K
4320 min Summer	24.925	0.035	0.7	0.0	O K
5760 min Summer	24.921	0.031	0.6	0.0	O K
7200 min Summer	24.918	0.028	0.5	0.0	O K
8640 min Summer	24.916	0.026	0.4	0.0	O K
10080 min Summer	24.915	0.025	0.4	0.0	O K
15 min Winter	25.393	0.503	30.7	0.6	O K
30 min Winter	25.193	0.303	22.4	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	96.475	0.0	11.9	10
30 min Summer	61.519	0.0	15.2	17
60 min Summer	37.397	0.0	18.5	32
120 min Summer	23.911	0.0	23.7	62
180 min Summer	17.925	0.0	26.6	92
240 min Summer	14.438	0.0	28.6	124
360 min Summer	10.463	0.0	31.1	182
480 min Summer	8.245	0.0	32.7	240
600 min Summer	6.828	0.0	33.8	304
720 min Summer	5.841	0.0	34.7	358
960 min Summer	4.553	0.0	36.1	482
1440 min Summer	3.198	0.0	38.0	732
2160 min Summer	2.251	0.0	40.1	1076
2880 min Summer	1.761	0.0	41.8	1452
4320 min Summer	1.260	0.0	44.9	2188
5760 min Summer	1.003	0.0	47.7	2928
7200 min Summer	0.846	0.0	50.3	3632
8640 min Summer	0.741	0.0	52.8	4160
10080 min Summer	0.665	0.0	55.3	5040
15 min Winter	96.475	0.0	13.4	10
30 min Winter	61.519	0.0	17.1	17

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	25.079	0.189	14.2	0.3	O K
120 min Winter	25.048	0.158	9.4	0.2	O K
180 min Winter	25.014	0.124	7.0	0.2	O K
240 min Winter	24.992	0.102	5.6	0.1	O K
360 min Winter	24.973	0.083	4.1	0.1	O K
480 min Winter	24.965	0.075	3.2	0.1	O K
600 min Winter	24.960	0.070	2.7	0.1	O K
720 min Winter	24.954	0.064	2.3	0.1	O K
960 min Winter	24.946	0.056	1.8	0.1	O K
1440 min Winter	24.937	0.047	1.3	0.1	O K
2160 min Winter	24.929	0.039	0.9	0.0	O K
2880 min Winter	24.924	0.034	0.7	0.0	O K
4320 min Winter	24.919	0.029	0.5	0.0	O K
5760 min Winter	24.916	0.026	0.4	0.0	O K
7200 min Winter	24.914	0.024	0.3	0.0	O K
8640 min Winter	24.912	0.022	0.3	0.0	O K
10080 min Winter	24.911	0.021	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	37.397	0.0	20.7	32
120 min Winter	23.911	0.0	26.5	64
180 min Winter	17.925	0.0	29.8	92
240 min Winter	14.438	0.0	32.0	124
360 min Winter	10.463	0.0	34.8	184
480 min Winter	8.245	0.0	36.6	242
600 min Winter	6.828	0.0	37.9	292
720 min Winter	5.841	0.0	38.9	366
960 min Winter	4.553	0.0	40.4	472
1440 min Winter	3.198	0.0	42.6	734
2160 min Winter	2.251	0.0	44.9	1068
2880 min Winter	1.761	0.0	46.9	1464
4320 min Winter	1.260	0.0	50.3	2268
5760 min Winter	1.003	0.0	53.4	2912
7200 min Winter	0.846	0.0	56.3	3464
8640 min Winter	0.741	0.0	59.2	4392
10080 min Winter	0.665	0.0	62.0	5184

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 529097 182534 TQ 29097 82534
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.066

Time (mins) From:	To:	Area (ha)
0	4	0.066

Model Details

Storage is Online Cover Level (m) 27.700

Pipe Structure

Diameter (m)	0.150	Length (m)	8.000
Slope (1:X)	60.000	Invert Level (m)	24.890

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	60.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	24.890
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	25.707	0.817	40.4	1.0	O K
30 min Summer	25.489	0.599	34.0	0.7	O K
60 min Summer	25.230	0.340	24.2	0.5	O K
120 min Summer	25.102	0.212	16.8	0.3	O K
180 min Summer	25.071	0.181	13.2	0.3	O K
240 min Summer	25.055	0.165	10.7	0.3	O K
360 min Summer	25.040	0.150	7.8	0.2	O K
480 min Summer	25.003	0.113	6.3	0.2	O K
600 min Summer	24.986	0.096	5.2	0.1	O K
720 min Summer	24.977	0.087	4.5	0.1	O K
960 min Summer	24.968	0.078	3.5	0.1	O K
1440 min Summer	24.956	0.066	2.4	0.1	O K
2160 min Summer	24.944	0.054	1.7	0.1	O K
2880 min Summer	24.938	0.048	1.3	0.1	O K
4320 min Summer	24.929	0.039	0.9	0.0	O K
5760 min Summer	24.925	0.035	0.7	0.0	O K
7200 min Summer	24.922	0.032	0.6	0.0	O K
8640 min Summer	24.919	0.029	0.5	0.0	O K
10080 min Summer	24.917	0.027	0.4	0.0	O K
15 min Winter	25.707	0.817	40.5	1.0	O K
30 min Winter	25.369	0.479	29.8	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	128.217	0.0	15.9	10
30 min Summer	82.443	0.0	20.4	17
60 min Summer	50.274	0.0	24.9	32
120 min Summer	32.329	0.0	32.0	62
180 min Summer	24.511	0.0	36.4	92
240 min Summer	19.927	0.0	39.5	122
360 min Summer	14.621	0.0	43.4	184
480 min Summer	11.594	0.0	45.9	242
600 min Summer	9.628	0.0	47.7	306
720 min Summer	8.245	0.0	49.0	366
960 min Summer	6.420	0.0	50.8	480
1440 min Summer	4.481	0.0	53.2	716
2160 min Summer	3.108	0.0	55.4	1092
2880 min Summer	2.397	0.0	56.9	1420
4320 min Summer	1.668	0.0	59.5	2124
5760 min Summer	1.296	0.0	61.6	2856
7200 min Summer	1.072	0.0	63.7	3592
8640 min Summer	0.923	0.0	65.8	4288
10080 min Summer	0.816	0.0	67.8	5080
15 min Winter	128.217	0.0	17.8	10
30 min Winter	82.443	0.0	22.9	17

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	25.130	0.240	19.1	0.4	O K
120 min Winter	25.067	0.177	12.5	0.3	O K
180 min Winter	25.048	0.158	9.5	0.2	O K
240 min Winter	25.035	0.145	7.7	0.2	O K
360 min Winter	24.994	0.104	5.7	0.1	O K
480 min Winter	24.978	0.088	4.5	0.1	O K
600 min Winter	24.970	0.080	3.8	0.1	O K
720 min Winter	24.965	0.075	3.2	0.1	O K
960 min Winter	24.958	0.068	2.5	0.1	O K
1440 min Winter	24.945	0.055	1.8	0.1	O K
2160 min Winter	24.937	0.047	1.3	0.1	O K
2880 min Winter	24.930	0.040	1.0	0.0	O K
4320 min Winter	24.924	0.034	0.7	0.0	O K
5760 min Winter	24.920	0.030	0.5	0.0	O K
7200 min Winter	24.917	0.027	0.4	0.0	O K
8640 min Winter	24.915	0.025	0.4	0.0	O K
10080 min Winter	24.914	0.024	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	50.274	0.0	27.9	32
120 min Winter	32.329	0.0	35.8	62
180 min Winter	24.511	0.0	40.8	94
240 min Winter	19.927	0.0	44.2	124
360 min Winter	14.621	0.0	48.6	182
480 min Winter	11.594	0.0	51.4	244
600 min Winter	9.628	0.0	53.4	298
720 min Winter	8.245	0.0	54.9	370
960 min Winter	6.420	0.0	56.9	476
1440 min Winter	4.481	0.0	59.6	722
2160 min Winter	3.108	0.0	62.0	1100
2880 min Winter	2.397	0.0	63.8	1432
4320 min Winter	1.668	0.0	66.6	2080
5760 min Winter	1.296	0.0	69.0	2896
7200 min Winter	1.072	0.0	71.3	3504
8640 min Winter	0.923	0.0	73.7	4304
10080 min Winter	0.816	0.0	76.0	5008

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 529097 182534 TQ 29097 82534
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.066

Time (mins) From:	To:	Area (ha)
0	4	0.066

Model Details

Storage is Online Cover Level (m) 27.700

Pipe Structure

Diameter (m)	0.150	Length (m)	8.000
Slope (1:X)	60.000	Invert Level (m)	24.890

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	60.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	24.890
Roughness k (mm)	0.600		

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
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

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
S1.000	5.000	0.050	100.0	0.040	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	4.290	0.120	35.8	0.026	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.004	8.000	0.080	100.0	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)
S1.000	50.00	5.08	25.110	0.040	0.0	0.0	0.0	1.00	17.8	5.4
S1.001	50.00	5.20	25.060	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.002	50.00	5.32	25.035	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.003	50.00	5.36	25.010	0.066	0.0	0.0	0.0	1.69	29.8	8.9
S1.004	50.00	5.49	24.890	0.066	0.0	0.0	0.0	1.00	17.8	8.9

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	150	S1	27.600	25.110	2.340	Open Manhole	1200
S1.001	o	150	S2	27.600	25.060	2.390	Open Manhole	1200
S1.002	o	150	S3	27.600	25.035	2.415	Open Manhole	1200
S1.003	o	150	S3	27.600	25.010	2.440	Open Manhole	1200
S1.004	o	150	S4	27.600	24.890	2.560	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	5.000	100.0	S2	27.600	25.060	2.390	Open Manhole	1200
S1.001	5.000	200.0	S3	27.600	25.035	2.415	Open Manhole	1200
S1.002	5.000	200.0	S3	27.600	25.010	2.440	Open Manhole	1200
S1.003	4.290	35.8	S4	27.600	24.890	2.560	Open Manhole	1200
S1.004	8.000	100.0	S	27.600	24.810	2.640	Open Manhole	0

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.040	0.040	0.040
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.026	0.026	0.026
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.066	0.066	0.066

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

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Orifice Manhole: S2, DS/PN: S1.001, Volume (m³): 2.9

Diameter (m) 0.085 Discharge Coefficient 0.600 Invert Level (m) 25.060

Non Return Valve Manhole: S3, DS/PN: S1.002, Volume (m³): 3.0

Hydro-Brake® Optimum Manhole: S3, DS/PN: S1.003, Volume (m³): 3.0

Unit Reference	MD-SHE-0042-1000-1500-1000
Design Head (m)	1.500
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	42
Invert Level (m)	25.010
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.0	Kick-Flo®	0.378	0.5
Flush-Flo™	0.186	0.7	Mean Flow over Head Range	-	0.7

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	0.6	1.200	0.9	3.000	1.4	7.000	2.0
0.200	0.7	1.400	1.0	3.500	1.5	7.500	2.1
0.300	0.6	1.600	1.0	4.000	1.6	8.000	2.1
0.400	0.6	1.800	1.1	4.500	1.6	8.500	2.2
0.500	0.6	2.000	1.1	5.000	1.7	9.000	2.3
0.600	0.7	2.200	1.2	5.500	1.8	9.500	2.3
0.800	0.8	2.400	1.2	6.000	1.9		
1.000	0.8	2.600	1.3	6.500	1.9		

Storage Structures for Storm

Cellular Storage Manhole: S2, DS/PN: S1.001

Invert Level (m) 25.060 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	351.0	50.0	1.300	0.0	86.8
0.100	351.0	52.8	1.400	0.0	89.6
0.200	0.0	55.7	1.500	0.0	92.4
0.300	0.0	58.5	1.600	0.0	95.3
0.400	0.0	61.3	1.700	0.0	98.1
0.500	0.0	64.1	1.800	0.0	100.9
0.600	0.0	67.0	1.900	0.0	103.7
0.700	0.0	69.8	2.000	0.0	106.6
0.800	0.0	72.6	2.100	0.0	109.4
0.900	0.0	75.5	2.200	0.0	112.2
1.000	0.0	78.3	2.300	0.0	115.1
1.100	0.0	81.1	2.400	0.0	117.9
1.200	0.0	83.9	2.500	0.0	120.7

Cellular Storage Manhole: S3, DS/PN: S1.003

Invert Level (m) 25.025 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	10.0	10.0	1.300	10.0	26.4
0.100	10.0	11.3	1.400	10.0	27.7
0.200	10.0	12.5	1.500	10.0	29.0
0.300	10.0	13.8	1.600	10.0	30.2
0.400	10.0	15.1	1.700	10.0	31.5
0.500	10.0	16.3	1.800	10.0	32.8
0.600	10.0	17.6	1.900	10.0	34.0
0.700	10.0	18.9	2.000	10.0	35.3
0.800	10.0	20.1	2.100	0.0	35.9
0.900	10.0	21.4	2.200	0.0	35.9
1.000	10.0	22.6	2.300	0.0	35.9
1.100	10.0	23.9	2.400	0.0	35.9
1.200	10.0	25.2	2.500	0.0	35.9

1 year Return Period Summary of Critical Results by Maximum Level (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 Storage Structures	2
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.440
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	21.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	0.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1
Climate Change (%)	0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	15 minute 1 year Winter I+0%	27.600	25.179	-0.081	0.000	0.43	
S1.001	S2	720 minute 1 year Winter I+0%	27.600	25.079	-0.131	0.000	0.02	
S1.002	S3	180 minute 1 year Winter I+0%	27.600	25.074	-0.111	0.000	0.01	
S1.003	S3	30 minute 1 year Winter I+0%	27.600	25.164	0.004	0.000	0.03	
S1.004	S4	30 minute 1 year Winter I+0%	27.600	24.910	-0.130	0.000	0.04	

PN	US/MH Name	Maximum Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1	0.073		6.0	OK
S1.001	S2	6.212	780	0.2	OK
S1.002	S3	0.051		0.1	OK
S1.003	S3	1.538	26	0.7	SURCHARGED
S1.004	S4	0.019		0.7	OK

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
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

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
S1.000	5.000	0.050	100.0	0.040	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	4.290	0.120	35.8	0.026	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.004	8.000	0.080	100.0	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)
S1.000	50.00	5.08	25.110	0.040	0.0	0.0	0.0	1.00	17.8	5.4
S1.001	50.00	5.20	25.060	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.002	50.00	5.32	25.035	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.003	50.00	5.36	25.010	0.066	0.0	0.0	0.0	1.69	29.8	8.9
S1.004	50.00	5.49	24.890	0.066	0.0	0.0	0.0	1.00	17.8	8.9

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	150	S1	27.600	25.110	2.340	Open Manhole	1200
S1.001	o	150	S2	27.600	25.060	2.390	Open Manhole	1200
S1.002	o	150	S3	27.600	25.035	2.415	Open Manhole	1200
S1.003	o	150	S3	27.600	25.010	2.440	Open Manhole	1200
S1.004	o	150	S4	27.600	24.890	2.560	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	5.000	100.0	S2	27.600	25.060	2.390	Open Manhole	1200
S1.001	5.000	200.0	S3	27.600	25.035	2.415	Open Manhole	1200
S1.002	5.000	200.0	S3	27.600	25.010	2.440	Open Manhole	1200
S1.003	4.290	35.8	S4	27.600	24.890	2.560	Open Manhole	1200
S1.004	8.000	100.0	S	27.600	24.810	2.640	Open Manhole	0

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.040	0.040	0.040
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.026	0.026	0.026
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.066	0.066	0.066

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

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Orifice Manhole: S2, DS/PN: S1.001, Volume (m³): 2.9

Diameter (m) 0.085 Discharge Coefficient 0.600 Invert Level (m) 25.060

Non Return Valve Manhole: S3, DS/PN: S1.002, Volume (m³): 3.0

Hydro-Brake® Optimum Manhole: S3, DS/PN: S1.003, Volume (m³): 3.0

Unit Reference	MD-SHE-0042-1000-1500-1000
Design Head (m)	1.500
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	42
Invert Level (m)	25.010
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.0	Kick-Flo®	0.378	0.5
Flush-Flo™	0.186	0.7	Mean Flow over Head Range	-	0.7

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	0.6	1.200	0.9	3.000	1.4	7.000	2.0
0.200	0.7	1.400	1.0	3.500	1.5	7.500	2.1
0.300	0.6	1.600	1.0	4.000	1.6	8.000	2.1
0.400	0.6	1.800	1.1	4.500	1.6	8.500	2.2
0.500	0.6	2.000	1.1	5.000	1.7	9.000	2.3
0.600	0.7	2.200	1.2	5.500	1.8	9.500	2.3
0.800	0.8	2.400	1.2	6.000	1.9		
1.000	0.8	2.600	1.3	6.500	1.9		

Storage Structures for Storm

Cellular Storage Manhole: S2, DS/PN: S1.001

Invert Level (m) 25.060 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	351.0	50.0	1.300	0.0	86.8
0.100	351.0	52.8	1.400	0.0	89.6
0.200	0.0	55.7	1.500	0.0	92.4
0.300	0.0	58.5	1.600	0.0	95.3
0.400	0.0	61.3	1.700	0.0	98.1
0.500	0.0	64.1	1.800	0.0	100.9
0.600	0.0	67.0	1.900	0.0	103.7
0.700	0.0	69.8	2.000	0.0	106.6
0.800	0.0	72.6	2.100	0.0	109.4
0.900	0.0	75.5	2.200	0.0	112.2
1.000	0.0	78.3	2.300	0.0	115.1
1.100	0.0	81.1	2.400	0.0	117.9
1.200	0.0	83.9	2.500	0.0	120.7

Cellular Storage Manhole: S3, DS/PN: S1.003

Invert Level (m) 25.025 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	10.0	10.0	1.300	10.0	26.4
0.100	10.0	11.3	1.400	10.0	27.7
0.200	10.0	12.5	1.500	10.0	29.0
0.300	10.0	13.8	1.600	10.0	30.2
0.400	10.0	15.1	1.700	10.0	31.5
0.500	10.0	16.3	1.800	10.0	32.8
0.600	10.0	17.6	1.900	10.0	34.0
0.700	10.0	18.9	2.000	10.0	35.3
0.800	10.0	20.1	2.100	0.0	35.9
0.900	10.0	21.4	2.200	0.0	35.9
1.000	10.0	22.6	2.300	0.0	35.9
1.100	10.0	23.9	2.400	0.0	35.9
1.200	10.0	25.2	2.500	0.0	35.9

30 year Return Period Summary of Critical Results by Maximum Level (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 Storage Structures	2
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 529097 182534 TQ 29097 82534
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	0.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	30
Climate Change (%)	0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	15 minute 30 year Winter I+0%	27.600	25.281	0.021	0.000	1.23
S1.001	S2	480 minute 30 year Winter I+0%	27.600	25.126	-0.084	0.000	0.04
S1.002	S3	480 minute 30 year Winter I+0%	27.600	25.123	-0.062	0.000	0.04
S1.003	S3	120 minute 30 year Winter I+0%	27.600	25.629	0.469	0.000	0.03
S1.004	S4	120 minute 30 year Winter I+0%	27.600	24.910	-0.130	0.000	0.04

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1		0.188		17.2	SURCHARGED
S1.001	S2		21.954	480	0.5	OK
S1.002	S3		0.127		0.4	OK
S1.003	S3		6.500	116	0.7	SURCHARGED

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

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.004	S4		0.019		0.7	OK

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
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

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
S1.000	5.000	0.050	100.0	0.040	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	4.290	0.120	35.8	0.026	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.004	8.000	0.080	100.0	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)
S1.000	50.00	5.08	25.110	0.040	0.0	0.0	0.0	1.00	17.8	5.4
S1.001	50.00	5.20	25.060	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.002	50.00	5.32	25.035	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.003	50.00	5.36	25.010	0.066	0.0	0.0	0.0	1.69	29.8	8.9
S1.004	50.00	5.49	24.890	0.066	0.0	0.0	0.0	1.00	17.8	8.9

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	150	S1	27.600	25.110	2.340	Open Manhole	1200
S1.001	o	150	S2	27.600	25.060	2.390	Open Manhole	1200
S1.002	o	150	S3	27.600	25.035	2.415	Open Manhole	1200
S1.003	o	150	S3	27.600	25.010	2.440	Open Manhole	1200
S1.004	o	150	S4	27.600	24.890	2.560	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	5.000	100.0	S2	27.600	25.060	2.390	Open Manhole	1200
S1.001	5.000	200.0	S3	27.600	25.035	2.415	Open Manhole	1200
S1.002	5.000	200.0	S3	27.600	25.010	2.440	Open Manhole	1200
S1.003	4.290	35.8	S4	27.600	24.890	2.560	Open Manhole	1200
S1.004	8.000	100.0	S	27.600	24.810	2.640	Open Manhole	0

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.040	0.040	0.040
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.026	0.026	0.026
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.066	0.066	0.066

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

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Orifice Manhole: S2, DS/PN: S1.001, Volume (m³): 2.9

Diameter (m) 0.085 Discharge Coefficient 0.600 Invert Level (m) 25.060

Non Return Valve Manhole: S3, DS/PN: S1.002, Volume (m³): 3.0

Hydro-Brake® Optimum Manhole: S3, DS/PN: S1.003, Volume (m³): 3.0

Unit Reference	MD-SHE-0042-1000-1500-1000
Design Head (m)	1.500
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	42
Invert Level (m)	25.010
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.0	Kick-Flo®	0.378	0.5
Flush-Flo™	0.186	0.7	Mean Flow over Head Range	-	0.7

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	0.6	1.200	0.9	3.000	1.4	7.000	2.0
0.200	0.7	1.400	1.0	3.500	1.5	7.500	2.1
0.300	0.6	1.600	1.0	4.000	1.6	8.000	2.1
0.400	0.6	1.800	1.1	4.500	1.6	8.500	2.2
0.500	0.6	2.000	1.1	5.000	1.7	9.000	2.3
0.600	0.7	2.200	1.2	5.500	1.8	9.500	2.3
0.800	0.8	2.400	1.2	6.000	1.9		
1.000	0.8	2.600	1.3	6.500	1.9		

Storage Structures for Storm

Cellular Storage Manhole: S2, DS/PN: S1.001

Invert Level (m) 25.060 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	351.0	50.0	1.300	0.0	86.8
0.100	351.0	52.8	1.400	0.0	89.6
0.200	0.0	55.7	1.500	0.0	92.4
0.300	0.0	58.5	1.600	0.0	95.3
0.400	0.0	61.3	1.700	0.0	98.1
0.500	0.0	64.1	1.800	0.0	100.9
0.600	0.0	67.0	1.900	0.0	103.7
0.700	0.0	69.8	2.000	0.0	106.6
0.800	0.0	72.6	2.100	0.0	109.4
0.900	0.0	75.5	2.200	0.0	112.2
1.000	0.0	78.3	2.300	0.0	115.1
1.100	0.0	81.1	2.400	0.0	117.9
1.200	0.0	83.9	2.500	0.0	120.7

Cellular Storage Manhole: S3, DS/PN: S1.003

Invert Level (m) 25.025 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	10.0	10.0	1.300	10.0	26.4
0.100	10.0	11.3	1.400	10.0	27.7
0.200	10.0	12.5	1.500	10.0	29.0
0.300	10.0	13.8	1.600	10.0	30.2
0.400	10.0	15.1	1.700	10.0	31.5
0.500	10.0	16.3	1.800	10.0	32.8
0.600	10.0	17.6	1.900	10.0	34.0
0.700	10.0	18.9	2.000	10.0	35.3
0.800	10.0	20.1	2.100	0.0	35.9
0.900	10.0	21.4	2.200	0.0	35.9
1.000	10.0	22.6	2.300	0.0	35.9
1.100	10.0	23.9	2.400	0.0	35.9
1.200	10.0	25.2	2.500	0.0	35.9

100 year Return Period Summary of Critical Results by Maximum Level (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 Storage Structures	2
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 529097 182534 TQ 29097 82534
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	0.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	15 minute 100 year Winter I+0%	27.600	25.342	0.082	0.000	1.63
S1.001	S2	720 minute 100 year Winter I+0%	27.600	25.158	-0.052	0.000	0.05
S1.002	S3	720 minute 100 year Winter I+0%	27.600	25.156	-0.029	0.000	0.05
S1.003	S3	180 minute 100 year Winter I+0%	27.600	25.920	0.760	0.000	0.04
S1.004	S4	180 minute 100 year Winter I+0%	27.600	24.912	-0.128	0.000	0.05

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1		0.257		22.8	SURCHARGED
S1.001	S2		32.725	696	0.5	OK
S1.002	S3		0.174		0.5	OK
S1.003	S3		9.591	150	0.8	SURCHARGED

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

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.004	S4		0.021		0.8	OK

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	150	S1	27.600	25.110	2.340	Open Manhole	1200
S1.001	o	150	S2	27.600	25.060	2.390	Open Manhole	1200
S1.002	o	150	S3	27.600	25.035	2.415	Open Manhole	1200
S1.003	o	150	S3	27.600	25.010	2.440	Open Manhole	1200
S1.004	o	150	S4	27.600	24.890	2.560	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	5.000	100.0	S2	27.600	25.060	2.390	Open Manhole	1200
S1.001	5.000	200.0	S3	27.600	25.035	2.415	Open Manhole	1200
S1.002	5.000	200.0	S3	27.600	25.010	2.440	Open Manhole	1200
S1.003	4.290	35.8	S4	27.600	24.890	2.560	Open Manhole	1200
S1.004	8.000	100.0	S	27.600	24.810	2.640	Open Manhole	0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
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

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
S1.000	5.000	0.050	100.0	0.040	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	4.290	0.120	35.8	0.026	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.004	8.000	0.080	100.0	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)
S1.000	50.00	5.08	25.110	0.040	0.0	0.0	0.0	1.00	17.8	5.4
S1.001	50.00	5.20	25.060	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.002	50.00	5.32	25.035	0.040	0.0	0.0	0.0	0.71	12.5	5.4
S1.003	50.00	5.36	25.010	0.066	0.0	0.0	0.0	1.69	29.8	8.9
S1.004	50.00	5.49	24.890	0.066	0.0	0.0	0.0	1.00	17.8	8.9

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.040	0.040	0.040
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.026	0.026	0.026
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.066	0.066	0.066

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

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 489288 181316 SU 89288 81316
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Orifice Manhole: S2, DS/PN: S1.001, Volume (m³): 2.9

Diameter (m) 0.085 Discharge Coefficient 0.600 Invert Level (m) 25.060

Non Return Valve Manhole: S3, DS/PN: S1.002, Volume (m³): 3.0

Hydro-Brake® Optimum Manhole: S3, DS/PN: S1.003, Volume (m³): 3.0

Unit Reference	MD-SHE-0042-1000-1500-1000
Design Head (m)	1.500
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	42
Invert Level (m)	25.010
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.0	Kick-Flo®	0.378	0.5
Flush-Flo™	0.186	0.7	Mean Flow over Head Range	-	0.7

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	0.6	1.200	0.9	3.000	1.4	7.000	2.0
0.200	0.7	1.400	1.0	3.500	1.5	7.500	2.1
0.300	0.6	1.600	1.0	4.000	1.6	8.000	2.1
0.400	0.6	1.800	1.1	4.500	1.6	8.500	2.2
0.500	0.6	2.000	1.1	5.000	1.7	9.000	2.3
0.600	0.7	2.200	1.2	5.500	1.8	9.500	2.3
0.800	0.8	2.400	1.2	6.000	1.9		
1.000	0.8	2.600	1.3	6.500	1.9		

Storage Structures for Storm

Cellular Storage Manhole: S2, DS/PN: S1.001

Invert Level (m) 25.060 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	351.0	50.0	1.300	0.0	86.8
0.100	351.0	52.8	1.400	0.0	89.6
0.200	0.0	55.7	1.500	0.0	92.4
0.300	0.0	58.5	1.600	0.0	95.3
0.400	0.0	61.3	1.700	0.0	98.1
0.500	0.0	64.1	1.800	0.0	100.9
0.600	0.0	67.0	1.900	0.0	103.7
0.700	0.0	69.8	2.000	0.0	106.6
0.800	0.0	72.6	2.100	0.0	109.4
0.900	0.0	75.5	2.200	0.0	112.2
1.000	0.0	78.3	2.300	0.0	115.1
1.100	0.0	81.1	2.400	0.0	117.9
1.200	0.0	83.9	2.500	0.0	120.7

Cellular Storage Manhole: S3, DS/PN: S1.003

Invert Level (m) 25.025 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	10.0	10.0	1.300	10.0	26.4
0.100	10.0	11.3	1.400	10.0	27.7
0.200	10.0	12.5	1.500	10.0	29.0
0.300	10.0	13.8	1.600	10.0	30.2
0.400	10.0	15.1	1.700	10.0	31.5
0.500	10.0	16.3	1.800	10.0	32.8
0.600	10.0	17.6	1.900	10.0	34.0
0.700	10.0	18.9	2.000	10.0	35.3
0.800	10.0	20.1	2.100	0.0	35.9
0.900	10.0	21.4	2.200	0.0	35.9
1.000	10.0	22.6	2.300	0.0	35.9
1.100	10.0	23.9	2.400	0.0	35.9
1.200	10.0	25.2	2.500	0.0	35.9

100 year Return Period Summary of Critical Results by Maximum Level (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 Storage Structures	2
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 529097 182534 TQ 29097 82534
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	0.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

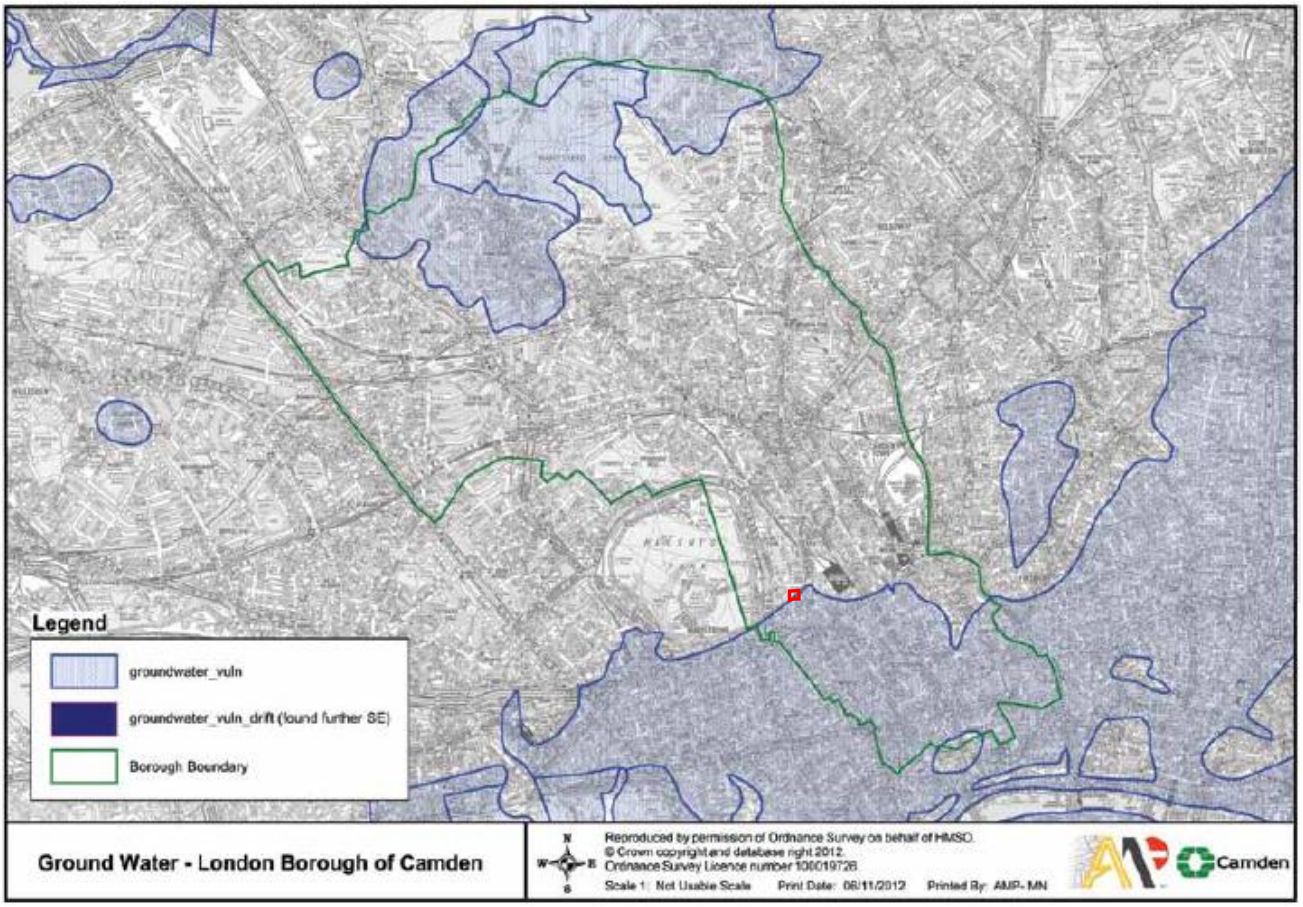
PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	720 minute 100 year Winter I+40%	27.600	25.518	0.258	0.000	0.19
S1.001	S2	720 minute 100 year Winter I+40%	27.600	25.518	0.308	0.000	0.15
S1.002	S3	720 minute 100 year Winter I+40%	27.600	25.517	0.332	0.000	0.16
S1.003	S3	180 minute 100 year Winter I+40%	27.600	26.394	1.234	0.000	0.04
S1.004	S4	180 minute 100 year Winter I+40%	27.600	24.914	-0.126	0.000	0.06

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1		0.456		2.7	SURCHARGED
S1.001	S2		45.040		1.5	SURCHARGED
S1.002	S3		0.606		1.6	SURCHARGED
S1.003	S3		14.632	180	1.0	SURCHARGED

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

PN	US/MH Name	Overflow (l/s)	Maximum Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.004	S4		0.024		1.0	OK

Appendix G – Additional Flood Risk Maps


Legend
groundwater_vuln
groundwater_vuln_drift (found further SE)
Borough Boundary
Ground Water - London Borough of Camden
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Scale 1: Not Usable Scale
Print Date: 08/11/2012
Printed By: AMP- MN
Camden

NORTH

0 1

KILOMETRES

NW3 1

NW3 5

NW6 2

NW6 3

NW6 4

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT

LEGEND

London Borough Camden Boundary

Exterior Sewer Flooding
No. of Properties affected

- 1
- 2
- 4
- 18

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: DG5 External Sewer Flooding

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
47070547	1:40,000

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URS

Drawing Number	Rev
FIGURE 5b	Rev 1

N:\Water\Current Projects\47070547 Camden SFRA Update (ghost)\0700 WIP\0705 GIS_Data\01-WIP\01_03-Project_Files\WORs