

SURFACE WATER DRAINAGE CALCULATIONS

BIKE PARK WALES, BRECON

Project Reference

6655

Report Reference

6655-00-00-RP-C-050

Client

Ride Bike Wales.

Revision / Date

(-) 4th October 2019

 Consulting Civil & Structural Engineers Morganstown, Cardiff, CF15 8LW Tel: 02920 488588	SW Drainage Calcs Bike Park Wales	Job No	:	6655
		Job Ref	:	BPW
		Report By	:	RC
		Checked By	:	RG
		Revision	:	-
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ISSUE AND REVISION RECORD

Client: Ride Bike Wales
Project: The Expansion of Bike Park Wales
Project Ref: 6655
Report Title: Surface Water Calculations
Prepared By: Russell Clue (MEng)
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Rev	Date	Amendments	Prepared By	Authorised By
-	04.10.19	-	R Clue	R Green

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CALCULATIONS FOR THE SURFACE WATER DRAINAGE

These calculations cover the proposed surface water drainage for the developed site. The network assessed in the following calculations, is based on the drainage scheme shown on BHPL's drawings, reference: 6655-(60)P01; a copy of which have been appended to these calculations for reference. The analysis of the network has been undertaken using design software 'MicroDrainage' with the following design parameters:

M5-60 (mm) = 19.200; Ratio R = 0.280;

The proposed network has been designed in accordance with the SUDS manual and CIRIA document C753. The two networks considered in the following calculations have been designed with restricted flows and thus have attenuation facilities accommodating all storm durations for the 1 in 100 return period along with an allowance of 30% for climate change.

NETWORK 1:

The following network serves the car park facilities to the north of the site along with the access road between this car park and the south car park (served by a different surface water system). These impermeable areas have been identified on Figure 1 below. The water from the northern car park shall utilise the existing topography of the site to drain to constructed dry swales located between the rows of car parking bays. The dry swales shall act as a form of storage and treatment for the collected runoff water as well as dramatically slowing down the discharge. Flows from the dry swales are then directed towards a flow control chamber to the north east of the site. The associated on-site attenuation for this area and restricted flow results in **300m³**; see **Appendix A** for simulation results.

In addition, to this area described above and depicted in Figure 1; an allowance has been made for the area central to the site; highlighted in Figure 2 below. Due to the topography of the site, this will undoubtedly drain to the swale running adjacent to the access road described above and will consequently discharge to Network 1, with its restricted flow and attenuation facility. The required storage for this area has been calculated using Microdrainage's Source Control feature, specifically the greenfield runoff volume calculator; refer to **Appendix B**. The resulting additional storage for this area has been calculated as **200m³**.

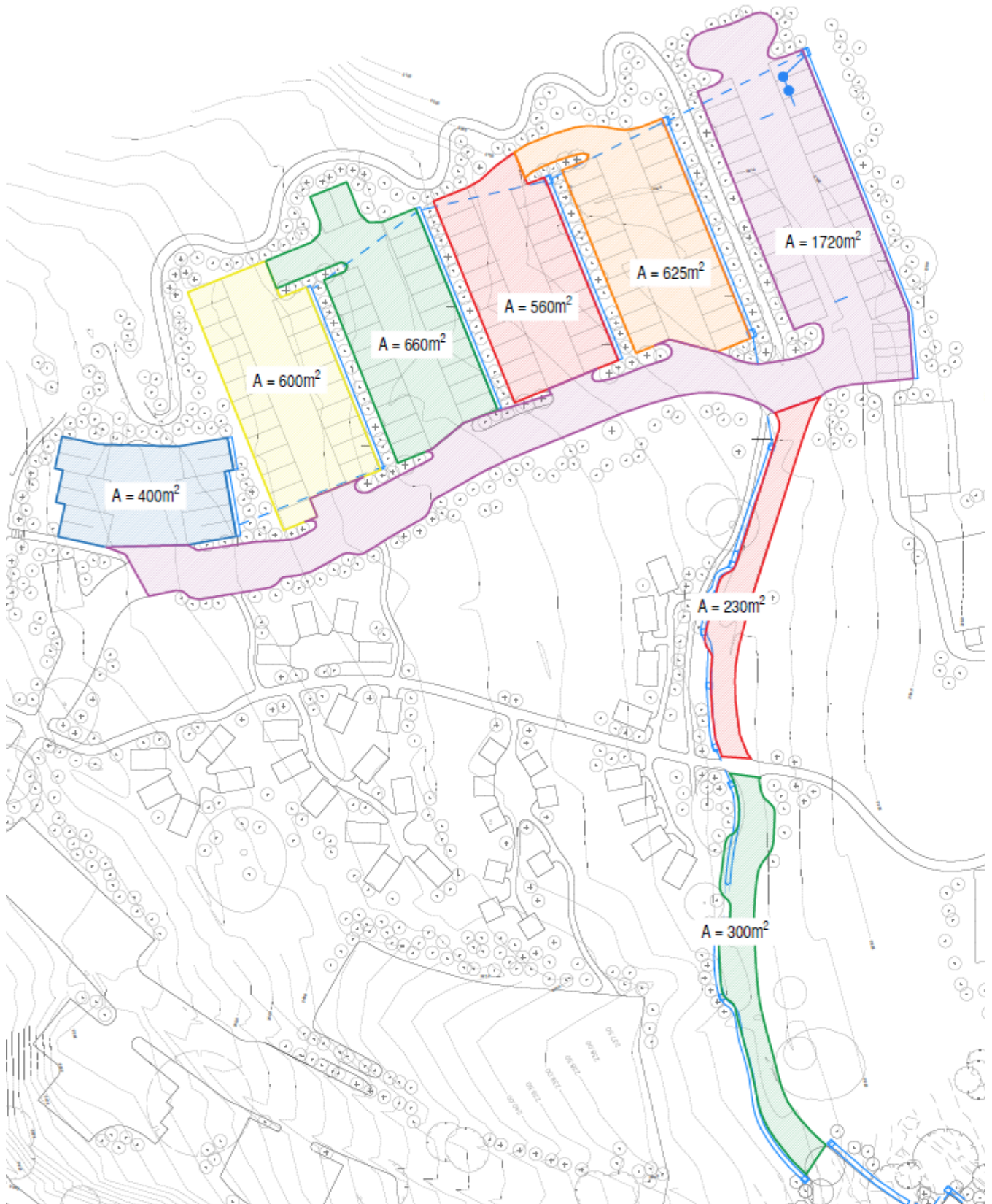


Figure 1. Drainage Areas Considered in the Network 1 Simulation

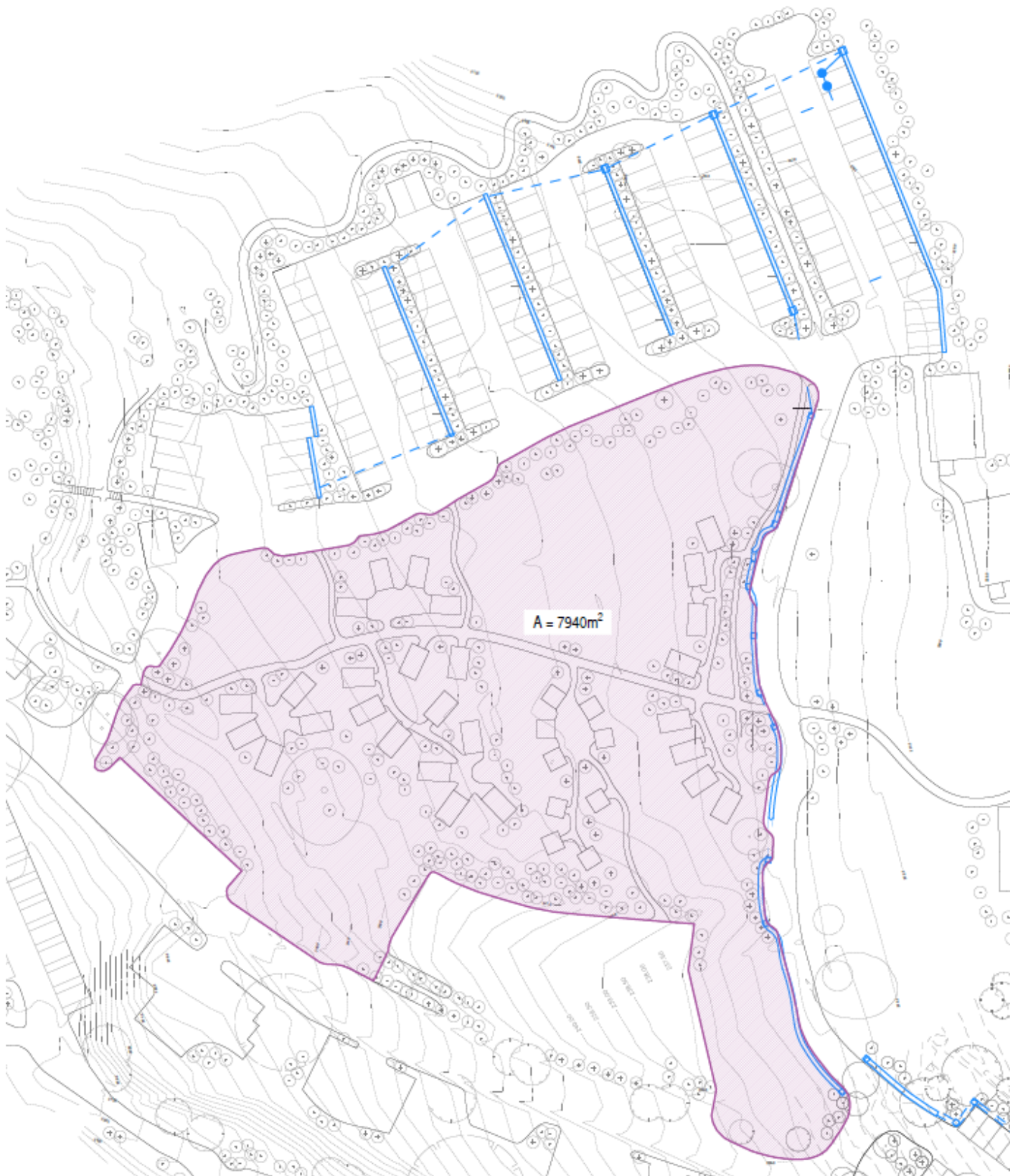


Figure 2. Extent of greenfield area allowed for within the Network 1 Storage

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NETWORK 2:

The following network serves the proposed accommodation to the east of the site and considers the roof areas only; see Figure 3 below, which highlights the extent of impermeable area. Surface water runoff from these roof areas shall be collected via rainwater pipes and discharged by below ground traditional gravity sewers in a northerly direction. Following this, a flow control chamber shall limit flows to a maximum discharge rate of **2.0 l/s**.



Figure 3. Drainage Areas Considered in the Network 2 Simulation

APPENDIX A

NETWORK 1 PARAMETERS AND SIMULATION RESULTS

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.200	Add Flow / Climate Change (%)	0
Ratio R	0.282	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.260	4-8	0.161	8-12	0.088

Total Area Contributing (ha) = 0.509

Total Pipe Volume (m³) = 160.685

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	15.000	1.000	15.0	0.040	10.00	0.0	0.600	\	-1	Pipe/Conduit	
S1.001	23.000	1.700	13.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	30.000	1.000	30.0	0.060	0.00	0.0	0.600	\	-1	Pipe/Conduit	
S1.003	20.000	2.000	10.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	30.000	1.000	30.0	0.066	10.00	0.0	0.600	\	-1	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	41.83	10.05	240.600	0.040	0.0	0.0	0.0	5.38	2775.0	4.5
S1.001	41.61	10.15	239.600	0.040	0.0	0.0	0.0	3.58	142.2	4.5
S1.002	41.36	10.29	237.900	0.100	0.0	0.0	0.0	3.80	1960.2	11.2
S1.003	41.20	10.37	236.900	0.100	0.0	0.0	0.0	4.16	165.5	11.2
S2.000	41.66	10.13	235.900	0.066	0.0	0.0	0.0	3.80	1960.2	7.4

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Micro Drainage		Network 2019.1

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
S1.004	20.000	2.000	10.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	30.000	1.000	30.0	0.056	10.00	0.0	0.600	\	-1	Pipe/Conduit	
S1.005	20.000	2.000	10.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.000	65.000	1.000	65.0	0.030	10.00	0.0	0.600	\	-1	Pipe/Conduit	
S4.001	45.000	2.000	22.5	0.023	0.00	0.0	0.600	\	-1	Pipe/Conduit	
S4.002	35.000	1.200	29.2	0.062	0.00	0.0	0.600	\	-1	Pipe/Conduit	
S1.006	25.000	3.300	7.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.000	50.000	2.500	20.0	0.172	10.00	0.0	0.600	\	-1	Pipe/Conduit	
S6.000	5.000	0.025	200.0	0.000	10.00	0.0	0.600	o	450	Pipe/Conduit	
S1.007	20.000	2.000	10.0	0.000	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)
S1.004	41.05	10.45	234.900	0.166	0.0	0.0	0.0	4.16	165.5	18.5
S3.000	41.66	10.13	233.900	0.056	0.0	0.0	0.0	3.80	1960.2	6.3
S1.005	40.90	10.53	232.900	0.222	0.0	0.0	0.0	4.16	165.5	24.6
S4.000	41.10	10.42	235.100	0.030	0.0	0.0	0.0	2.58	1329.6	3.3
S4.001	40.78	10.59	234.100	0.053	0.0	0.0	0.0	4.39	2264.5	5.9
S4.002	40.49	10.74	232.100	0.115	0.0	0.0	0.0	3.85	1988.1	12.6
S1.006	40.34	10.83	230.900	0.337	0.0	0.0	0.0	4.78	190.2	36.8
S5.000	41.56	10.18	230.100	0.172	0.0	0.0	0.0	4.66	2402.3	19.4
S6.000	41.80	10.06	227.625	0.000	0.0	0.0	0.0	1.43	228.1	0.0
S1.007	40.19	10.91	227.600	0.509	0.0	0.0	0.0	4.16	165.5	55.4

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)
S1.007	S	228.000	225.600	0.000	0	0

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S9, DS/PN: S1.007, Volume (m³): 31.1

Unit Reference	MD-SHE-0108-5000-0825-5000
Design Head (m)	0.825
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	227.600
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.825	5.0
Flush-Flo™	0.247	5.0
Kick-Flo®	0.548	4.1
Mean Flow over Head Range	-	4.3

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	3.7	1.200	5.9	3.000	9.1	7.000	13.7
0.200	5.0	1.400	6.4	3.500	9.8	7.500	14.2
0.300	5.0	1.600	6.8	4.000	10.5	8.000	14.6
0.400	4.8	1.800	7.2	4.500	11.1	8.500	15.0
0.500	4.5	2.000	7.6	5.000	11.7	9.000	15.4
0.600	4.3	2.200	7.9	5.500	12.2	9.500	15.9
0.800	4.9	2.400	8.2	6.000	12.7		
1.000	5.5	2.600	8.6	6.500	13.2		

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Storage Structures for Storm

Cellular Storage Manhole: S14, DS/PN: S6.000

Invert Level (m) 227.625 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	375.0	375.0	5.200	0.0	437.0
0.400	375.0	406.0	5.600	0.0	437.0
0.800	375.0	437.0	6.000	0.0	437.0
0.801	0.0	437.0	6.400	0.0	437.0
1.201	0.0	437.0	6.800	0.0	437.0
2.000	0.0	437.0	7.200	0.0	437.0
2.400	0.0	437.0	7.600	0.0	437.0
2.800	0.0	437.0	8.000	0.0	437.0
3.200	0.0	437.0	8.400	0.0	437.0
3.600	0.0	437.0	8.800	0.0	437.0
4.000	0.0	437.0	9.200	0.0	437.0
4.400	0.0	437.0	9.600	0.0	437.0
4.800	0.0	437.0	10.000	0.0	437.0

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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 * 10m ³ /ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	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	1
Number of Online Controls	1	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	0.280
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.200	Cv (Winter)	0.840

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

Profile(s)	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 (%)	30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	30 Winter	100	+30%					240.618
S1.001	S2	30 Winter	100	+30%					239.649
S1.002	S3	15 Winter	100	+30%					237.955
S1.003	S4	15 Winter	100	+30%					236.983
S2.000	S5	30 Winter	100	+30%					235.940
S1.004	S5	15 Winter	100	+30%					235.003
S3.000	S7	30 Winter	100	+30%					233.934
S1.005	S6	15 Winter	100	+30%					233.019
S4.000	S9	30 Winter	100	+30%					235.127
S4.001	S9	15 Winter	100	+30%					234.133
S4.002	S9	15 Winter	100	+30%					232.161
S1.006	S7	15 Winter	100	+30%					231.048
S5.000	S13	30 Winter	100	+30%					230.158
S6.000	S14	600 Winter	100	+30%	100/60 Winter				228.422
S1.007	S9	600 Winter	100	+30%	100/15 Winter				228.495

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	
S1.000	S1	-0.382	0.000	0.01		13.7	OK
S1.001	S2	-0.176	0.000	0.11		13.7	OK
S1.002	S3	-0.345	0.000	0.03		42.9	OK
S1.003	S4	-0.142	0.000	0.29		42.7	OK
S2.000	S5	-0.360	0.000	0.01		22.6	OK
S1.004	S5	-0.122	0.000	0.42		63.0	FLOOD RISK
S3.000	S7	-0.366	0.000	0.01		19.2	OK
S1.005	S6	-0.106	0.000	0.54		81.5	FLOOD RISK
S4.000	S9	-0.373	0.000	0.01		10.2	OK
S4.001	S9	-0.367	0.000	0.01		20.5	OK
S4.002	S9	-0.339	0.000	0.03		52.6	OK
S1.006	S7	-0.077	0.000	0.75		131.5	FLOOD RISK
S5.000	S13	-0.342	0.000	0.03		58.9	OK
S6.000	S14	0.347	0.000	0.29		37.1	SURCHARGED
S1.007	S9	0.670	0.000	0.03		5.0	SURCHARGED

APPENDIX B

GREENFIELD RUNOFF VOLUME RESULTS DISCHARGING TO NETWORK 1

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Micro Drainage Source Control 2019.1		

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	19.300
Ratio R	0.276
Areal Reduction Factor	1.00
Area (ha)	0.794
SAAR (mm)	1480
CWI	124.440
Urban	0.000
SPR	30.000

Results

Percentage Runoff (%)	34.73
Greenfield Runoff Volume (m³)	193.142

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APPENDIX C

NETWORK 2 PARAMETERS AND SIMULATION RESULTS

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.200	Add Flow / Climate Change (%)	0
Ratio R	0.280	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	4-8	0.054	8-12	0.009

Total Area Contributing (ha) = 0.063

Total Pipe Volume (m³) = 12.966

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	225.000	1.800	125.0	0.063	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	65.000	0.520	125.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	25.000	0.125	200.0	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	25.000	0.200	125.0	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	48.48	7.21	227.400	0.063	0.0	0.0	0.0	1.17	46.4	8.3
S1.001	45.98	8.14	225.600	0.063	0.0	0.0	0.0	1.17	46.4	8.3
S2.000	58.53	4.45	225.205	0.000	0.0	0.0	0.0	0.92	36.6	0.0
S1.002	44.84	8.60	225.080	0.063	0.0	0.0	0.0	0.90	15.9	8.3

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Micro Drainage	Network 2019.1	

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S3, DS/PN: S1.002, Volume (m³): 6.8

Unit Reference MD-SHE-0068-2000-0925-2000
Design Head (m) 0.925
Design Flow (l/s) 2.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 68
Invert Level (m) 225.080
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.925	2.0
Flush-Flo™	0.284	2.0
Kick-Flo®	0.580	1.6
Mean Flow over Head Range	-	1.8

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	1.7	1.200	2.3	3.000	3.4	7.000	5.1
0.200	2.0	1.400	2.4	3.500	3.7	7.500	5.3
0.300	2.0	1.600	2.6	4.000	3.9	8.000	5.4
0.400	2.0	1.800	2.7	4.500	4.1	8.500	5.6
0.500	1.8	2.000	2.8	5.000	4.4	9.000	5.7
0.600	1.6	2.200	3.0	5.500	4.6	9.500	5.9
0.800	1.9	2.400	3.1	6.000	4.7		
1.000	2.1	2.600	3.2	6.500	4.9		

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Micro Drainage	Network 2019.1	

Storage Structures for Storm

Cellular Storage Manhole: S3, DS/PN: S2.000

Invert Level (m) 225.205 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	25.0	25.0	5.200	0.0	41.0
0.400	25.0	33.0	5.600	0.0	41.0
0.800	25.0	41.0	6.000	0.0	41.0
0.801	0.0	41.0	6.400	0.0	41.0
1.600	0.0	41.0	6.800	0.0	41.0
2.000	0.0	41.0	7.200	0.0	41.0
2.400	0.0	41.0	7.600	0.0	41.0
2.800	0.0	41.0	8.000	0.0	41.0
3.200	0.0	41.0	8.400	0.0	41.0
3.600	0.0	41.0	8.800	0.0	41.0
4.000	0.0	41.0	9.200	0.0	41.0
4.400	0.0	41.0	9.600	0.0	41.0
4.800	0.0	41.0	10.000	0.0	41.0

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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 Coefficient 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 1
 Number of Online Controls 1 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 0.280
 Region England and Wales Cv (Summer) 0.750
 M5-60 (mm) 19.200 Cv (Winter) 0.840

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

Profile(s) 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 (%) 30

PN	US/MH		Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
	Name	Storm							
S1.000	S1	15 Winter	100	+30%					227.541
S1.001	S2	120 Winter	100	+30%	100/60 Winter				225.904
S2.000	S3	120 Winter	100	+30%	100/15 Winter				225.896
S1.002	S3	180 Winter	100	+30%	100/15 Winter				225.901

PN	US/MH		Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
	Name								
S1.000	S1		-0.084	0.000	0.53		24.4	OK	
S1.001	S2		0.079	0.000	0.26		11.7	SURCHARGED	
S2.000	S3		0.466	0.000	0.04		1.5	SURCHARGED	
S1.002	S3		0.671	0.000	0.13		2.0	SURCHARGED	

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