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)	10	PIMP (%)	100
M5-60 (mm)	21.000	Add Flow / Climate Change (%)	40
Ratio R	0.440	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	300	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.900
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)	300

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.226	4-8	0.053

Total Area Contributing (ha) = 0.279

Total Pipe Volume (m³) = 8.446

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
1.000	39.700	0.397	100.0	0.027	4.00	0.0	0.600	o	150	Pipe/Conduit
1.001	13.180	0.962	13.7	0.007	0.00	0.0	0.600	o	150	Pipe/Conduit
2.000	27.264	0.891	30.6	0.042	4.00	0.0	0.600	o	150	Pipe/Conduit
3.000	11.148	0.112	99.5	0.024	4.00	0.0	0.600	o	150	Pipe/Conduit
3.001	8.663	0.087	100.0	0.008	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)
1.000	118.61	4.66	52.660	0.027	0.0	0.0	3.5	1.00	17.8	12.1
1.001	117.78	4.74	52.263	0.034	0.0	0.0	4.3	2.74	48.4	15.2
2.000	123.03	4.25	52.550	0.042	0.0	0.0	5.6	1.83	32.3	19.6
3.000	123.75	4.18	50.580	0.024	0.0	0.0	3.2	1.01	17.8	11.3
3.001	122.14	4.33	50.468	0.032	0.0	0.0	4.2	1.00	17.8	14.8

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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
1.002	14.589	0.060	241.9	0.021	0.00	0.0	0.600	o	300	Pipe/Conduit
4.000	26.530	1.153	23.0	0.042	4.00	0.0	0.600	o	150	Pipe/Conduit
1.003	14.185	0.176	80.6	0.016	0.00	0.0	0.600	o	375	Pipe/Conduit
5.000	33.060	0.333	99.3	0.027	4.00	0.0	0.600	o	150	Pipe/Conduit
5.001	14.000	0.697	20.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit
1.004	18.650	0.062	300.0	0.046	0.00	0.0	0.600	o	375	Pipe/Conduit
6.000	2.700	0.027	100.0	0.019	4.00	0.0	0.600	o	150	Pipe/Conduit
1.005	7.600	1.767	4.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
1.006	9.350	2.174	4.3	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)
1.002	115.38	4.98	50.231	0.129	0.0	0.0	16.1	1.01	71.1	56.4
4.000	123.47	4.21	52.710	0.042	0.0	0.0	5.6	2.11	37.3	19.7
1.003	114.26	5.10	50.096	0.187	0.0	0.0	23.1	2.02	223.1	81.0
5.000	119.78	4.55	52.830	0.027	0.0	0.0	3.5	1.01	17.8	12.3
5.001	118.70	4.65	52.497	0.027	0.0	0.0	3.5	2.26	39.9	12.3
1.004	111.51	5.40	49.920	0.260	0.0	0.0	31.4	1.04	115.0	109.9
6.000	125.37	4.04	50.400	0.019	0.0	0.0	2.6	1.00	17.8	9.0
1.005	111.33	5.42	49.858	0.279	0.0	0.0	33.6	6.35	252.6	117.8
1.006	111.11	5.44	48.091	0.279	0.0	0.0	33.6	6.35	252.6	117.8

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)
1.006		51.540	45.917	47.000	225	0

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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	40.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	60
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	1

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		

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Storm Duration (mins)	30
Ratio R	0.439		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S4, DS/PN: 1.005, Volume (m³): 4.6

Unit Reference	MD-SCU-0207-4890-1350-4890
Design Head (m)	1.350
Design Flow (l/s)	48.9
Flush-Flo™	Calculated
Objective	Linear discharge profile
Application	Surface
Sump Available	Yes
Diameter (mm)	207
Invert Level (m)	49.858
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.350	48.9
Flush-Flo™	0.242	24.8
Kick-Flo®	0.309	24.2
Mean Flow over Head Range	-	32.6

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	7.8	1.200	46.2	3.000	72.0	7.000	108.8
0.200	21.9	1.400	49.8	3.500	77.6	7.500	112.5
0.300	24.3	1.600	53.1	4.000	82.8	8.000	116.1
0.400	27.3	1.800	56.2	4.500	87.7	8.500	119.6
0.500	30.4	2.000	59.1	5.000	92.3	9.000	123.0
0.600	33.1	2.200	61.9	5.500	96.7	9.500	126.3
0.800	38.0	2.400	64.6	6.000	100.9		
1.000	42.3	2.600	67.2	6.500	104.9		

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Storage Structures for Storm

Cellular Storage Manhole: S4, DS/PN: 1.005

Invert Level (m) 49.870 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	45.0	0.0	1.201	0.0	0.0
1.200	45.0	0.0			

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Summary of Results for 30 minute 100 year Winter (Storm)

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

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
1.000	sic1	52.766	-0.044	0.000	0.83			14.3	OK
1.001	SIC2	52.330	-0.083	0.000	0.41			18.0	OK
2.000	SIC5	52.646	-0.054	0.000	0.73			22.5	OK
3.000	SAC6	51.253	0.523	0.000	0.72			11.5	FLOOD RISK
3.001	SIC7	51.239	0.621	0.000	0.90			14.0	FLOOD RISK
1.002	S1	51.222	0.691	0.000	0.99			58.7	SURCHARGED
4.000	SIC8	52.797	-0.063	0.000	0.63			22.5	OK
1.003	S2	51.202	0.731	0.000	0.52			86.2	SURCHARGED
5.000	SIC9	52.936	-0.044	0.000	0.84			14.3	OK
5.001	SIC10	52.562	-0.085	0.000	0.39			14.4	OK
1.004	S3	51.186	0.891	0.000	1.27			121.0	SURCHARGED
6.000	SIC11	51.165	0.615	0.000	0.89			9.6	FLOOD RISK
1.005	S4	51.160	1.077	0.000	0.26		21	47.9	SURCHARGED
1.006	EX FW	48.164	-0.152	0.000	0.23			47.9	OK

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