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)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.360	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	75	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)	Time (mins)	Area (ha)
0-4	0.087	4-8	0.055	8-12	0.024	12-16	0.012

Total Area Contributing (ha) = 0.178

Total Pipe Volume (m³) = 11.910

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
1.000	19.000	0.190	100.0	0.007	7.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	44.000	0.176	250.0	0.025	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	17.501	0.070	250.0	0.004	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	20.500	0.082	250.0	0.029	7.00	0.0	0.600	o	300	Pipe/Conduit	
2.001	7.000	0.028	250.0	0.004	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.002	15.000	0.060	250.0	0.005	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.64	7.32	31.420	0.007	0.0	0.0	0.0	1.00	17.8	1.0
1.001	48.34	8.06	31.080	0.032	0.0	0.0	0.0	0.99	70.0	4.2
1.002	47.49	8.35	30.904	0.036	0.0	0.0	0.0	0.99	70.0	4.6
2.000	50.54	7.35	31.446	0.029	0.0	0.0	0.0	0.99	70.0	4.0
2.001	50.16	7.46	31.364	0.033	0.0	0.0	0.0	0.99	70.0	4.5
2.002	49.37	7.72	31.336	0.038	0.0	0.0	0.0	0.99	70.0	5.1

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
2.003	24.800	0.099	250.5	0.011	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.004	9.499	0.038	250.0	0.014	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.000	2.500	0.251	10.0	0.078	14.00	0.0	0.600	o	450	Pipe/Conduit	
2.005	4.500	0.305	14.8	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.003	3.998	0.016	249.9	0.001	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.004	2.786	0.151	18.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
2.003	48.11	8.13	31.276	0.049	0.0	0.0	0.0	0.99	69.9	6.4
2.004	47.65	8.29	31.177	0.063	0.0	0.0	0.0	0.99	70.0	8.1
3.000	36.08	14.01	31.240	0.078	0.0	0.0	0.0	6.47	1029.1	7.6
2.005	36.06	14.02	30.989	0.141	0.0	0.0	0.0	5.31	845.1	13.8
1.003	35.99	14.07	30.684	0.178	0.0	0.0	0.0	1.28	203.8	17.3
1.004	35.96	14.09	30.668	0.178	0.0	0.0	0.0	2.36	41.6	17.3

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)
1.004	C1	32.300	30.517	0.000	1200	0

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	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

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Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.360		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S1, DS/PN: 1.004, Volume (m³): 6.5

Unit Reference	MD-SHE-0111-6000-1300-6000
Design Head (m)	1.300
Design Flow (l/s)	6.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	111
Invert Level (m)	30.668
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.300	6.0
Flush-Flo™	0.383	6.0
Kick-Flo®	0.804	4.8
Mean Flow over Head Range	-	5.2

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	3.8	1.200	5.8	3.000	8.9	7.000	13.3
0.200	5.6	1.400	6.2	3.500	9.6	7.500	13.7
0.300	5.9	1.600	6.6	4.000	10.2	8.000	14.2
0.400	6.0	1.800	7.0	4.500	10.8	8.500	14.6
0.500	5.9	2.000	7.3	5.000	11.3	9.000	15.0
0.600	5.8	2.200	7.7	5.500	11.8	9.500	15.4
0.800	4.8	2.400	8.0	6.000	12.3		
1.000	5.3	2.600	8.3	6.500	12.8		

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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 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 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 0.359
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.000 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 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 (%) 40

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
1.000	S5	120 minute 30 year Winter I+40%	32.470	31.595	0.025	0.000
1.001	S4	120 minute 30 year Winter I+40%	32.546	31.592	0.212	0.000
1.002	S3	120 minute 30 year Winter I+40%	32.444	31.592	0.388	0.000
2.000	S11	120 minute 30 year Winter I+40%	32.496	31.561	-0.185	0.000
2.001	S10	120 minute 30 year Winter I+40%	32.470	31.560	-0.104	0.000
2.002	S9	120 minute 30 year Winter I+40%	32.538	31.560	-0.076	0.000
2.003	S8	120 minute 30 year Winter I+40%	32.482	31.565	-0.011	0.000
2.004	S7	120 minute 30 year Winter I+40%	32.479	31.572	0.095	0.000
3.000	Perm. Paving U/S	120 minute 30 year Winter I+40%	32.531	31.551	-0.139	0.000
2.005	S6	120 minute 30 year Winter I+40%	32.517	31.572	0.133	0.000
1.003	S2	120 minute 30 year Winter I+40%	32.484	31.592	0.458	0.000
1.004	S1	120 minute 30 year Winter I+40%	32.453	31.602	0.784	0.000

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Pipe Flow (l/s)	Status
1.000	S5	0.06		0.048	1.0	SURCHARGED
1.001	S4	0.06		0.469	4.1	SURCHARGED
1.002	S3	0.08		3.261	4.6	SURCHARGED
2.000	S11	0.07		0.031	4.0	OK
2.001	S10	0.09		0.760	4.4	OK
2.002	S9	0.08		0.358	4.9	OK
2.003	S8	0.09		0.981	5.8	OK
2.004	S7	0.13		1.800	6.9	SURCHARGED
3.000	Perm. Paving U/S	0.05		22.658	12.8	OK*
2.005	S6	0.04		1.883	12.6	SURCHARGED
1.003	S2	0.09		3.236	10.2	SURCHARGED
1.004	S1	0.25		3.566	6.0	SURCHARGED

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