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)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.280	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.300
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)
0-4	0.176	4-8	0.034

Total Area Contributing (ha) = 0.210

Total Pipe Volume (m^3) = 39.985

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	11.770	0.030	392.3	0.089	5.00	0.0	0.600	o	900	Pipe/Conduit	
1.001	18.520	0.050	370.4	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.002	10.300	0.030	343.3	0.036	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.003	21.915	0.060	365.3	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.004	12.500	2.850	4.4	0.085	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	50.00	5.12	169.370	0.089	0.0	0.0	0.0	1.58	1002.4	12.1
1.001	50.00	5.31	169.340	0.089	0.0	0.0	0.0	1.62	1031.9	12.1
1.002	50.00	5.42	169.290	0.125	0.0	0.0	0.0	1.69	1072.1	16.9
1.003	50.00	5.64	169.260	0.125	0.0	0.0	0.0	1.63	1039.2	16.9
1.004	50.00	5.68	169.150	0.210	0.0	0.0	0.0	4.85	85.6	28.4

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backd (mm
S3	172.680	3.310	Open Manhole	3000	1.000	169.370	900				
S3A	173.270	3.930	Open Manhole	3000	1.001	169.340	900	1.000	169.340	900	
S4	172.890	3.600	Open Manhole	3000	1.002	169.290	900	1.001	169.290	900	
S4A	172.480	3.220	Open Manhole	3000	1.003	169.260	900	1.002	169.260	900	
S5	171.170	2.020	Open Manhole	3000	1.004	169.150	150	1.003	169.200	900	
OUTFALL	167.600	1.300	Open Manhole	1200		OUTFALL		1.004	166.300	150	

No coordinates have been specified, layout information cannot be produced.

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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)
1.000	o	900	S3	172.680	169.370	2.410	Open Manhole	3000
1.001	o	900	S3A	173.270	169.340	3.030	Open Manhole	3000
1.002	o	900	S4	172.890	169.290	2.700	Open Manhole	3000
1.003	o	900	S4A	172.480	169.260	2.320	Open Manhole	3000
1.004	o	150	S5	171.170	169.150	1.870	Open Manhole	3000

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)
1.000	11.770	392.3	S3A	173.270	169.340	3.030	Open Manhole	3000
1.001	18.520	370.4	S4	172.890	169.290	2.700	Open Manhole	3000
1.002	10.300	343.3	S4A	172.480	169.260	2.320	Open Manhole	3000
1.003	21.915	365.3	S5	171.170	169.200	1.070	Open Manhole	3000
1.004	12.500	4.4	OUTFALL	167.600	166.300	1.150	Open Manhole	1200

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	OUTFALL	167.600	166.300	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	0
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	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.280		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S5, DS/PN: 1.004, Volume (m³): 26.3

Unit Reference	MD-SHE-0075-3500-2100-3500
Design Head (m)	2.100
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	169.150
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.100	3.5
Flush-Flo™	0.332	2.6
Kick-Flo®	0.674	2.1
Mean Flow over Head Range	-	2.7

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	2.1	1.200	2.7	3.000	4.1	7.000	6.1
0.200	2.5	1.400	2.9	3.500	4.4	7.500	6.3
0.300	2.6	1.600	3.1	4.000	4.7	8.000	6.5
0.400	2.6	1.800	3.3	4.500	5.0	8.500	6.7
0.500	2.5	2.000	3.4	5.000	5.2	9.000	6.9
0.600	2.3	2.200	3.6	5.500	5.5	9.500	7.1
0.800	2.2	2.400	3.7	6.000	5.7		
1.000	2.5	2.600	3.9	6.500	5.9		

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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	0
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)	19.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S3	120 Winter	1	+0%	100/60 Summer				169.542
1.001	S3A	120 Winter	1	+0%	100/60 Summer				169.542
1.002	S4	120 Winter	1	+0%	100/60 Summer				169.542
1.003	S4A	120 Winter	1	+0%	100/60 Summer				169.542
1.004	S5	120 Winter	1	+0%	1/15 Summer				169.542

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S3	-0.728	0.000	0.01			3.4	OK	
1.001	S3A	-0.698	0.000	0.00			2.5	OK	
1.002	S4	-0.648	0.000	0.01			2.8	OK	
1.003	S4A	-0.618	0.000	0.00			1.7	OK	
1.004	S5	0.242	0.000	0.03			2.6	SURCHARGED	

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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	0
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)	19.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S3	180 Winter	30	+0%	100/60 Summer				170.017
1.001	S3A	180 Winter	30	+0%	100/60 Summer				170.017
1.002	S4	180 Winter	30	+0%	100/60 Summer				170.017
1.003	S4A	180 Winter	30	+0%	100/60 Summer				170.017
1.004	S5	180 Winter	30	+0%	1/15 Summer				170.017

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S3	-0.253	0.000	0.01			6.0	OK	
1.001	S3A	-0.223	0.000	0.00			3.3	OK	
1.002	S4	-0.173	0.000	0.00			2.5	OK	
1.003	S4A	-0.143	0.000	0.00			1.7	OK	
1.004	S5	0.717	0.000	0.03			2.6	SURCHARGED	

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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	0
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)	19.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S3	240 Winter	100	+30%	100/60 Summer				171.156
1.001	S3A	240 Winter	100	+30%	100/60 Summer				171.156
1.002	S4	240 Winter	100	+30%	100/60 Summer				171.156
1.003	S4A	240 Winter	100	+30%	100/60 Summer				171.157
1.004	S5	240 Winter	100	+30%	1/15 Summer				171.157

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S3	0.886	0.000	0.02			8.1	SURCHARGED	
1.001	S3A	0.916	0.000	0.01			3.9	SURCHARGED	
1.002	S4	0.966	0.000	0.00			2.5	SURCHARGED	
1.003	S4A	0.997	0.000	0.00			2.7	SURCHARGED	
1.004	S5	1.857	0.000	0.04			3.4	FLOOD RISK	

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