



Date 14/03/2020
File (2020-08-31).MDX

Designed by MM
Checked by

Innovyze

Network 2018.1.1

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)	1	PIMP (%)	100
M5-60 (mm)	20.100	Add Flow / Climate Change (%)	0
Ratio R	0.294	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)	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)
0-4	0.060	4-8	0.011

Total Area Contributing (ha) = 0.071

Total Pipe Volume (m³) = 12.930

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	3.500	0.150	23.3	0.007	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	5.100	0.040	127.5	0.018	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	19.800	0.600	33.0	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	16.800	0.040	420.0	0.036	0.00	0.0	0.600	[]	-22	Pipe/Conduit	
3.000	20.100	0.726	27.7	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
3.001	1.800	0.064	28.1	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)
1.000	46.98	5.03	122.690	0.007	0.0	0.0	0.0	2.09	37.0	0.9
2.000	46.73	5.10	122.580	0.018	0.0	0.0	0.0	0.89	15.7	2.3
1.001	46.07	5.28	122.540	0.035	0.0	0.0	0.0	1.76	31.1	4.4
1.002	45.36	5.49	121.940	0.071	0.0	0.0	0.0	1.35	960.5	8.7
3.000	46.45	5.17	122.690	0.000	0.0	0.0	0.0	1.92	33.9	0.0
3.001	46.39	5.19	121.964	0.000	0.0	0.0	0.0	1.91	33.7	0.0



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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
1.003	4.000	0.050	80.0	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)
1.003	45.16	5.55	121.900	0.071	0.0	0.0	0.0	1.12	19.9	8.7

Conduit Sections for Storm

NOTE: Diameters less than 66 refer to section numbers of hydraulic conduits. These conduits are marked by the symbols:- [] box culvert, \ / open channel, oo dual pipe, ooo triple pipe, O egg.

Section numbers < 0 are taken from user conduit table

Section Number	Conduit Type	Major Dimn. (mm)	Minor Dimn. (mm)	Side Slope (Deg)	Corner Splay (mm)	4*Hyd Radius (m)	XSect Area (m ²)
-22	[]	1425	500	90.0		0.740	0.713



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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	124.040	1.350	Open Manhole	600	1.000	122.690	150				
S2	124.040	1.460	Open Manhole	600	2.000	122.580	150				
S3	124.040	1.500	Open Manhole	600	1.001	122.540	150	1.000	122.540	150	
								2.000	122.540	150	
S4	124.040	2.100	Open Manhole	600	1.002	121.940	-22	1.001	121.940	150	
S5	124.040	1.350	Open Manhole	1200	3.000	122.690	150				
S6	123.900	1.936	Open Manhole	1200	3.001	121.964	150	3.000	121.964	150	
S7	123.900	2.000	Open Manhole	2400	1.003	121.900	150	1.002	121.900	-22	
								3.001	121.900	150	
C1	124.300	2.450	Open Manhole	0		OUTFALL		1.003	121.850	150	



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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	150	S1	124.040	122.690	1.200	Open Manhole	600
2.000	o	150	S2	124.040	122.580	1.310	Open Manhole	600
1.001	o	150	S3	124.040	122.540	1.350	Open Manhole	600
1.002	[]	-22	S4	124.040	121.940	1.600	Open Manhole	600
3.000	o	150	S5	124.040	122.690	1.200	Open Manhole	1200
3.001	o	150	S6	123.900	121.964	1.786	Open Manhole	1200
1.003	o	150	S7	123.900	121.900	1.850	Open Manhole	2400

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	3.500	23.3	S3	124.040	122.540	1.350	Open Manhole	600
2.000	5.100	127.5	S3	124.040	122.540	1.350	Open Manhole	600
1.001	19.800	33.0	S4	124.040	121.940	1.950	Open Manhole	600
1.002	16.800	420.0	S7	123.900	121.900	1.500	Open Manhole	2400
3.000	20.100	27.7	S6	123.900	121.964	1.786	Open Manhole	1200
3.001	1.800	28.1	S7	123.900	121.900	1.850	Open Manhole	2400
1.003	4.000	80.0	C1	124.300	121.850	2.300	Open Manhole	0



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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.007	0.007	0.007
2.000	-	-	100	0.018	0.018	0.018
1.001	-	-	100	0.010	0.010	0.010
1.002	-	-	100	0.036	0.036	0.036
3.000	-	-	100	0.000	0.000	0.000
3.001	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.071	0.071	0.071



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Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	S1	150	1.200	1.350	Unclassified	600	0	1.200	Unclassified
2.000	S2	150	1.310	1.350	Unclassified	600	0	1.310	Unclassified
1.001	S3	150	1.350	1.950	Unclassified	600	0	1.350	Unclassified
1.002	S4	-22	1.500	1.600	Unclassified	600	0	1.600	Unclassified
3.000	S5	150	1.200	1.786	Unclassified	1200	0	1.200	Unclassified
3.001	S6	150	1.786	1.850	Unclassified	1200	0	1.786	Unclassified
1.003	S7	150	1.850	2.300	Unclassified	2400	0	1.850	Unclassified

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)
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1.003	C1	124.300	121.850	122.000	0	0
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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	20.100	Cv (Summer)	0.750
Return Period (years)	1	Ratio R	0.294	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer Storm	Duration (mins)	30



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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S7, DS/PN: 1.003, Volume (m³): 19.9

Unit Reference	MD-SHE-0111-6700-1700-6700
Design Head (m)	1.700
Design Flow (l/s)	6.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	111
Invert Level (m)	121.900
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	6.7	Kick-Flo®	0.989	5.2
Flush-Flo™	0.486	6.5	Mean Flow over Head Range	-	5.8

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)	Depth (m)	Flow (l/s)
0.100	3.8	0.800	6.1	2.000	7.2	4.000	10.0	7.000	13.1
0.200	5.7	1.000	5.2	2.200	7.5	4.500	10.6	7.500	13.5
0.300	6.3	1.200	5.7	2.400	7.9	5.000	11.1	8.000	13.9
0.400	6.5	1.400	6.1	2.600	8.2	5.500	11.6	8.500	14.3
0.500	6.5	1.600	6.5	3.000	8.7	6.000	12.1	9.000	14.7
0.600	6.5	1.800	6.9	3.500	9.4	6.500	12.6	9.500	15.1

Manhole Headloss for Storm

PN	US/MH	US/MH
Name	Headloss	
1.000	S1	0.500
2.000	S2	0.500
1.001	S3	0.500
1.002	S4	0.500
3.000	S5	0.500
3.001	S6	0.500
1.003	S7	0.500



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CASDeF Controller for Storm

PN	US/MH Name	Level Exceeded	Not Modify Control	Modify Pipe Size	Max Pipe Diameter	No. Pipe Failures	Add Storage	No. Storage Failures	Use CASDeF
1.000	S1	124.040	Yes	No	1200	0	Yes	0	Yes
2.000	S2	124.040	Yes	No	1310	0	Yes	0	Yes
1.001	S3	124.040	Yes	No	1350	0	Yes	0	Yes
1.002	S4	124.040	Yes	No	1850	0	Yes	0	Yes
3.000	S5	124.040	Yes	No	1200	0	Yes	0	Yes
3.001	S6	123.900	Yes	No	1786	0	Yes	0	Yes
1.003	S7	123.900	Yes	No	1850	0	Yes	0	Yes

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	S1	0.382	0.062	0.000	0.444
2.000	S2	0.413	0.090	0.000	0.503
1.001	S3	0.424	0.350	0.000	0.774
1.002	S4	0.594	11.970	0.000	12.564
3.000	S5	1.527	0.355	0.000	1.882
3.001	S6	2.190	0.032	0.000	2.221
1.003	S7	9.048	0.071	0.000	9.118
Total		14.577	12.930	0.000	27.506

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	S1	0.382	0.051	0.000	0.433
2.000	S2	0.413	0.080	0.000	0.492
1.001	S3	0.424	0.339	0.000	0.763
1.002	S4	0.594	10.901	0.000	11.495
3.000	S5	1.527	0.334	0.000	1.861
3.001	S6	2.190	0.000	0.000	2.190
1.003	S7	9.048	0.049	0.000	9.097
Total		14.577	11.755	0.000	26.331



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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 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 Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.200 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.319 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	S1	15 Winter	1	+0%					122.708	-0.132	0.000	0.04
2.000	S2	15 Winter	1	+0%					122.623	-0.107	0.000	0.18
1.001	S3	15 Winter	1	+0%	100/60 Winter				122.578	-0.112	0.000	0.14
1.002	S4	30 Winter	1	+0%	100/30 Summer				122.019	-0.421	0.000	0.01
3.000	S5	60 Winter	1	+0%					122.690	-0.150	0.000	0.00
3.001	S6	30 Winter	1	+0%	30/15 Summer				122.018	-0.096	0.000	0.01
1.003	S7	30 Winter	1	+0%	30/15 Summer				122.018	-0.032	0.000	0.32

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1		0.9	OK	
2.000	S2		2.2	OK	
1.001	S3		4.1	OK	
1.002	S4		6.6	OK	
3.000	S5		0.0	OK	
3.001	S6		0.1	OK	
1.003	S7		4.5	OK	



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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 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 Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.200 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.319 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	S1	15 Winter	30	+0%					122.720	-0.120	0.000	0.09
2.000	S2	15 Winter	30	+0%					122.650	-0.080	0.000	0.44
1.001	S3	15 Winter	30	+0%	100/60 Winter				122.603	-0.087	0.000	0.37
1.002	S4	30 Winter	30	+0%	100/30 Summer				122.191	-0.249	0.000	0.03
3.000	S5	60 Winter	30	+0%					122.690	-0.150	0.000	0.00
3.001	S6	30 Winter	30	+0%	30/15 Summer				122.191	0.077	0.000	0.02
1.003	S7	30 Winter	30	+0%	30/15 Summer				122.191	0.141	0.000	0.45

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1		2.1	OK	
2.000	S2		5.5	OK	
1.001	S3		10.7	OK	
1.002	S4		17.0	OK	
3.000	S5		0.0	OK	
3.001	S6		0.3	SURCHARGED	
1.003	S7		6.2	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 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 Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.200 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.319 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	S1	15 Winter	100	+40%					122.730	-0.110	0.000	0.16
2.000	S2	60 Winter	100	+40%					122.716	-0.014	0.000	0.44
1.001	S3	60 Winter	100	+40%	100/60 Winter				122.712	0.022	0.000	0.37
1.002	S4	60 Winter	100	+40%	100/30 Summer				122.697	0.257	0.000	0.04
3.000	S5	60 Winter	100	+40%					122.691	-0.149	0.000	0.00
3.001	S6	60 Winter	100	+40%	30/15 Summer				122.696	0.582	0.000	0.04
1.003	S7	60 Winter	100	+40%	30/15 Summer				122.696	0.646	0.000	0.47

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1		3.8	OK	
2.000	S2		5.5	OK	
1.001	S3		10.8	SURCHARGED	
1.002	S4		21.3	SURCHARGED	
3.000	S5		0.0	OK	
3.001	S6		0.6	SURCHARGED	
1.003	S7		6.5	SURCHARGED	