



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

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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	0.075	4-8	0.018

Total Area Contributing (ha) = 0.093

Total Pipe Volume (m³) = 13.413

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	0.089	225.8	0.022	5.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	1.800	0.090	20.0	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)
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	45.71	5.39	122.079	0.022	0.0	0.0	0.0	0.87	34.4	2.7
3.001	45.67	5.40	121.990	0.022	0.0	0.0	0.0	2.94	116.9	2.7



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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	0.093	0.0	0.0	0.0	1.12	19.9	11.4

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



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

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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	750	1.000	122.690	150				
S2	124.040	1.460	Open Manhole	750	2.000	122.580	150				
S3	124.040	1.500	Open Manhole	750	1.001	122.540	150	1.000	122.540	150	
								2.000	122.540	150	
S4	124.040	2.100	Open Manhole	750	1.002	121.940	-22	1.001	121.940	150	
S5	124.040	1.961	Open Manhole	1800	3.000	122.079	225				
S6	123.900	1.910	Open Manhole	1800	3.001	121.990	225	3.000	121.990	225	
S7	123.900	2.000	Open Manhole	2400	1.003	121.900	150	1.002	121.900	-22	
								3.001	121.900	225	
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	750
2.000	o	150	S2	124.040	122.580	1.310	Open Manhole	750
1.001	o	150	S3	124.040	122.540	1.350	Open Manhole	750
1.002	[]	-22	S4	124.040	121.940	1.600	Open Manhole	750
3.000	o	225	S5	124.040	122.079	1.736	Open Manhole	1800
3.001	o	225	S6	123.900	121.990	1.685	Open Manhole	1800
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	750
2.000	5.100	127.5	S3	124.040	122.540	1.350	Open Manhole	750
1.001	19.800	33.0	S4	124.040	121.940	1.950	Open Manhole	750
1.002	16.800	420.0	S7	123.900	121.900	1.500	Open Manhole	2400
3.000	20.100	225.8	S6	123.900	121.990	1.685	Open Manhole	1800
3.001	1.800	20.0	S7	123.900	121.900	1.775	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	0.022	0.022	0.022
3.001	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.093	0.093	0.093



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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	750	0	1.200	Unclassified
2.000	S2	150	1.310	1.350	Unclassified	750	0	1.310	Unclassified
1.001	S3	150	1.350	1.950	Unclassified	750	0	1.350	Unclassified
1.002	S4	-22	1.500	1.600	Unclassified	750	0	1.600	Unclassified
3.000	S5	225	1.685	1.736	Unclassified	1800	0	1.736	Unclassified
3.001	S6	225	1.685	1.775	Unclassified	1800	0	1.685	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-0076-3500-2000-3500
Design Head (m)	2.000
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	121.900
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	3.5	Kick-Flo®	0.679	2.1
Flush-Flo™	0.331	2.7	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)	Depth (m)	Flow (l/s)
0.100	2.1	0.800	2.3	2.000	3.5	4.000	4.8	7.000	6.3
0.200	2.5	1.000	2.5	2.200	3.7	4.500	5.1	7.500	6.5
0.300	2.7	1.200	2.8	2.400	3.8	5.000	5.4	8.000	6.7
0.400	2.6	1.400	3.0	2.600	4.0	5.500	5.6	8.500	6.9
0.500	2.6	1.600	3.2	3.000	4.2	6.000	5.8	9.000	7.1
0.600	2.4	1.800	3.3	3.500	4.5	6.500	6.1	9.500	7.3

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	1750	0	Yes	0	Yes
3.001	S6	123.900	Yes	No	1760	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	0.596	0.062	0.000	0.658
2.000	S2	0.645	0.090	0.000	0.735
1.001	S3	0.663	0.350	0.000	1.013
1.002	S4	0.928	11.970	0.000	12.898
3.000	S5	4.990	0.799	0.000	5.789
3.001	S6	4.860	0.072	0.000	4.932
1.003	S7	9.048	0.071	0.000	9.118
Total		21.730	13.413	0.000	35.143

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	0.596	0.049	0.000	0.645
2.000	S2	0.645	0.077	0.000	0.722
1.001	S3	0.663	0.337	0.000	0.999
1.002	S4	0.928	10.848	0.000	11.776
3.000	S5	4.990	0.728	0.000	5.718
3.001	S6	4.860	-0.012	0.000	4.848
1.003	S7	9.048	0.049	0.000	9.097
Total		21.730	12.075	0.000	33.805



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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%	100/30 Summer				122.708	-0.132	0.000	0.04
2.000	S2	15 Winter	1	+0%	100/15 Winter				122.623	-0.107	0.000	0.18
1.001	S3	15 Winter	1	+0%	100/15 Winter				122.578	-0.112	0.000	0.14
1.002	S4	60 Winter	1	+0%	100/15 Summer				122.094	-0.346	0.000	0.01
3.000	S5	15 Winter	1	+0%	30/30 Summer				122.124	-0.180	0.000	0.09
3.001	S6	60 Winter	1	+0%	30/15 Summer				122.094	-0.121	0.000	0.03
1.003	S7	60 Winter	1	+0%	1/15 Summer				122.094	0.044	0.000	0.18

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		4.7	OK	
3.000	S5		2.7	OK	
3.001	S6		1.1	OK	
1.003	S7		2.5	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 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%	100/30 Summer				122.720	-0.120	0.000	0.09
2.000	S2	15 Winter	30	+0%	100/15 Winter				122.650	-0.080	0.000	0.43
1.001	S3	15 Winter	30	+0%	100/15 Winter				122.603	-0.087	0.000	0.37
1.002	S4	60 Winter	30	+0%	100/15 Summer				122.420	-0.020	0.000	0.02
3.000	S5	60 Winter	30	+0%	30/30 Summer				122.421	0.117	0.000	0.09
3.001	S6	60 Winter	30	+0%	30/15 Summer				122.420	0.205	0.000	0.03
1.003	S7	60 Winter	30	+0%	1/15 Summer				122.420	0.370	0.000	0.19

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1		2.1	OK	
2.000	S2		5.4	OK	
1.001	S3		10.7	OK	
1.002	S4		11.4	OK	
3.000	S5		2.8	SURCHARGED	
3.001	S6		1.3	SURCHARGED	
1.003	S7		2.7	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	120 Winter	100	+40%	100/30 Summer				123.906	1.066	0.000	0.06
2.000	S2	120 Winter	100	+40%	100/15 Winter				123.907	1.177	0.000	0.28
1.001	S3	120 Winter	100	+40%	100/15 Winter				123.905	1.215	0.000	0.23
1.002	S4	120 Winter	100	+40%	100/15 Summer				123.899	1.459	0.000	0.02
3.000	S5	120 Winter	100	+40%	30/30 Summer				123.901	1.597	0.000	0.09
3.001	S6	120 Winter	100	+40%	30/15 Summer				123.899	1.684	0.000	0.04
1.003	S7	120 Winter	100	+40%	1/15 Summer				123.899	1.849	0.000	0.25

		Pipe			
PN	US/MH Name	Overflow (l/s)	Flow (l/s)	Status	Level Exceeded
1.000	S1		1.4	SURCHARGED	
2.000	S2		3.5	SURCHARGED	
1.001	S3		6.7	SURCHARGED	
1.002	S4		12.6	SURCHARGED	
3.000	S5		2.7	SURCHARGED	
3.001	S6		1.6	SURCHARGED	
1.003	S7		3.5	SURCHARGED	