STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for STORM-NET1-A.SWS

Pipe Sizes STORM-NET1 Manhole Sizes STORM-NET1

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for STORM-NET1-A.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.730	4-8	0.844	8-12	0.030

Total Area Contributing (ha) = 1.604

Total Pipe Volume (m³) = 308.119

Network Design Table for STORM-NET1-A.SWS

« - Indicates pipe capacity < flow

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	37.400	0.094	397.9	0.182	5.00	0.0	0.600	o	900	Pipe/Conduit	
1.001	30.022	0.106	283.2	0.128	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.002	53.713	0.341	157.5	0.062	0.00	0.0	0.600	o	900	Pipe/Conduit	
2.000	13.109	0.946	13.9	0.000	5.00	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	50.00	5.40	58.831	0.182	0.0	0.0	0.0	1.56	995.4	24.6
1.001	50.00	5.67	58.737	0.310	0.0	0.0	0.0	1.86	1181.2	42.0
1.002	50.00	6.03	58.620	0.372	0.0	0.0	0.0	2.49	1586.7	50.4
2.000	50.00	5.06	59.900	0.000	0.0	0.0	0.0	3.53	140.5	0.0

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Network Design Table for STORM-NET1-A.SWS

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	19.617	0.049	400.3	0.142	0.00	0.0	0.600	o	900	Pipe/Conduit	
3.000	14.532	0.185	78.6	0.088	5.00	0.0	0.600	o	900	Pipe/Conduit	
3.001	22.183	0.405	54.8	0.017	0.00	0.0	0.600	o	900	Pipe/Conduit	
3.002	9.618	0.155	62.1	0.089	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.004	57.229	0.143	400.2	0.102	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.005	59.017	0.150	393.4	0.146	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.006	26.754	0.064	418.0	0.168	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.007	35.401	0.089	397.8	0.092	0.00	0.0	0.600	o	900	Pipe/Conduit	
4.000	25.523	0.410	62.3	0.063	5.00	0.0	0.600	o	900	Pipe/Conduit	
4.001	34.429	0.557	61.8	0.027	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.008	48.847	0.122	400.4	0.298	0.00	0.0	0.600	o	900	Pipe/Conduit	
5.000	36.000	1.714	21.0	0.000	5.00	0.0	0.600	o	375	Pipe/Conduit	
1.009	26.804	0.741	36.2	0.000	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)
1.003	50.00	6.24	58.279	0.514	0.0	0.0	0.0	1.56	992.3	69.6
3.000	50.00	5.07	58.975	0.088	0.0	0.0	0.0	3.54	2250.3	11.9
3.001	50.00	5.16	58.790	0.105	0.0	0.0	0.0	4.24	2696.5	14.2
3.002	50.00	5.20	58.385	0.194	0.0	0.0	0.0	3.98	2532.9	26.3
1.004	50.00	6.85	58.230	0.810	0.0	0.0	0.0	1.56	992.5	109.7
1.005	50.00	7.47	58.087	0.956	0.0	0.0	0.0	1.57	1001.0	129.5
1.006	50.00	7.77	57.937	1.124	0.0	0.0	0.0	1.53	970.9	152.2
1.007	50.00	8.14	57.873	1.216	0.0	0.0	0.0	1.56	995.5	164.7
4.000	50.00	5.11	58.750	0.063	0.0	0.0	0.0	3.98	2528.9	8.5
4.001	50.00	5.25	58.340	0.090	0.0	0.0	0.0	3.99	2537.9	12.2
1.008	50.00	8.66	57.783	1.604	0.0	0.0	0.0	1.56	992.2	217.2
5.000	50.00	5.15	59.900	0.000	0.0	0.0	0.0	3.97	438.3	0.0
1.009	50.00	8.83	57.661	1.604	0.0	0.0	0.0	2.62	185.4«	217.2

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Manhole Schedules for STORM-NET1-A.SWS

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)
1	62.086	3.255	Open Manhole	1800	1.000	58.831	900				
2	61.068	2.331	Open Manhole	2400	1.001	58.737	900	1.000	58.737	900	
3	60.734	2.114	Open Manhole	2400	1.002	58.620	900	1.001	58.631	900	11
12	61.500	1.600	Open Manhole	2400	2.000	59.900	225				
4	60.785	2.506	Open Manhole	3000	1.003	58.279	900	1.002	58.279	900	
								2.000	58.954	225	
14	62.332	3.357	Open Manhole	2400	3.000	58.975	900				
15	62.019	3.229	Open Manhole	2400	3.001	58.790	900	3.000	58.790	900	
16	61.461	3.076	Open Manhole	2400	3.002	58.385	900	3.001	58.385	900	
5	61.150	2.920	Open Manhole	2400	1.004	58.230	900	1.003	58.230	900	
								3.002	58.230	900	
6	60.964	2.877	Open Manhole	2400	1.005	58.087	900	1.004	58.087	900	
7	60.599	2.662	Open Manhole	2400	1.006	57.937	900	1.005	57.937	900	
8	60.819	2.946	Open Manhole	2400	1.007	57.873	900	1.006	57.873	900	
18	63.613	4.863	Open Manhole	2400	4.000	58.750	900				
19	62.818	4.478	Open Manhole	2400	4.001	58.340	900	4.000	58.340	900	
9	61.750	3.967	Open Manhole	2400	1.008	57.783	900	1.007	57.784	900	1
								4.001	57.783	900	
22	60.740	0.840	Open Manhole	1200	5.000	59.900	375				
10	61.259	3.598	Open Manhole	2400	1.009	57.661	300	1.008	57.661	900	
								5.000	58.186	375	600
11	61.288	4.368	Open Manhole	1800		OUTFALL		1.009	56.920	300	

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PIPELINE SCHEDULES for STORM-NET1-A.SWS

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	1	62.086	58.831	2.355	Open Manhole	1800
1.001	o	900	2	61.068	58.737	1.431	Open Manhole	2400
1.002	o	900	3	60.734	58.620	1.214	Open Manhole	2400
2.000	o	225	12	61.500	59.900	1.375	Open Manhole	2400
1.003	o	900	4	60.785	58.279	1.606	Open Manhole	3000
3.000	o	900	14	62.332	58.975	2.457	Open Manhole	2400
3.001	o	900	15	62.019	58.790	2.329	Open Manhole	2400
3.002	o	900	16	61.461	58.385	2.176	Open Manhole	2400
1.004	o	900	5	61.150	58.230	2.020	Open Manhole	2400
1.005	o	900	6	60.964	58.087	1.977	Open Manhole	2400
1.006	o	900	7	60.599	57.937	1.762	Open Manhole	2400
1.007	o	900	8	60.819	57.873	2.046	Open Manhole	2400
4.000	o	900	18	63.613	58.750	3.963	Open Manhole	2400
4.001	o	900	19	62.818	58.340	3.578	Open Manhole	2400
1.008	o	900	9	61.750	57.783	3.067	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	37.400	397.9	2	61.068	58.737	1.431	Open Manhole	2400
1.001	30.022	283.2	3	60.734	58.631	1.203	Open Manhole	2400
1.002	53.713	157.5	4	60.785	58.279	1.606	Open Manhole	3000
2.000	13.109	13.9	4	60.785	58.954	1.606	Open Manhole	3000
1.003	19.617	400.3	5	61.150	58.230	2.020	Open Manhole	2400
3.000	14.532	78.6	15	62.019	58.790	2.329	Open Manhole	2400
3.001	22.183	54.8	16	61.461	58.385	2.176	Open Manhole	2400
3.002	9.618	62.1	5	61.150	58.230	2.020	Open Manhole	2400
1.004	57.229	400.2	6	60.964	58.087	1.977	Open Manhole	2400
1.005	59.017	393.4	7	60.599	57.937	1.762	Open Manhole	2400
1.006	26.754	418.0	8	60.819	57.873	2.046	Open Manhole	2400
1.007	35.401	397.8	9	61.750	57.784	3.066	Open Manhole	2400
4.000	25.523	62.3	19	62.818	58.340	3.578	Open Manhole	2400
4.001	34.429	61.8	9	61.750	57.783	3.067	Open Manhole	2400
1.008	48.847	400.4	10	61.259	57.661	2.698	Open Manhole	2400

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PIPELINE SCHEDULES for STORM-NET1-A.SWS

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)
5.000	o	375	22	60.740	59.900	0.465	Open Manhole	1200
1.009	o	300	10	61.259	57.661	3.298	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)
5.000	36.000	21.0	10	61.259	58.186	2.698	Open Manhole	2400
1.009	26.804	36.2	11	61.288	56.920	4.068	Open Manhole	1800

Free Flowing Outfall Details for STORM-NET1-A.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009	11	61.288	56.920	0.000	1800	0

Simulation Criteria for STORM-NET1-A.SWS

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	2
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)	20.000	Storm Duration (mins)	30
Ratio R	0.400		

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Online Controls for STORM-NET1-A.SWS

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.009, Volume (m³): 49.6

Unit Reference	MD-SHE-0234-3580-2500-3580
Design Head (m)	2.500
Design Flow (l/s)	35.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	234
Invert Level (m)	57.661
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.500	35.8
Flush-Flo™	0.724	35.8
Kick-Flo®	1.541	28.4
Mean Flow over Head Range	-	31.1

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	7.7	1.200	33.9	3.000	39.0	7.000	58.8
0.200	23.6	1.400	31.4	3.500	42.0	7.500	60.8
0.300	31.5	1.600	28.9	4.000	44.8	8.000	62.7
0.400	33.7	1.800	30.5	4.500	47.5	8.500	64.6
0.500	34.9	2.000	32.1	5.000	49.9	9.000	66.4
0.600	35.6	2.200	33.6	5.500	52.3	9.500	68.2
0.800	35.7	2.400	35.1	6.000	54.5		
1.000	35.1	2.600	36.4	6.500	56.7		

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Storage Structures for STORM-NET1-A.SWS

Cellular Storage Manhole: 12, DS/PN: 2.000

Invert Level (m) 59.900 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	232.0	0.0	0.401	0.0	0.0
0.400	232.0	0.0			

Cellular Storage Manhole: 22, DS/PN: 5.000

Invert Level (m) 59.500 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	340.0	0.0	0.401	0.0	0.0
0.400	340.0	0.0			

Manhole Headloss for STORM-NET1-A.SWS

PN	US/MH Name	US/MH Headloss
1.000	1	0.500
1.001	2	0.500
1.002	3	0.500
2.000	12	0.500
1.003	4	0.500
3.000	14	0.500
3.001	15	0.500
3.002	16	0.500
1.004	5	0.500
1.005	6	0.500
1.006	7	0.500
1.007	8	0.500
4.000	18	0.500
4.001	19	0.500
1.008	9	0.500
5.000	22	0.500
1.009	10	0.500

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM-NET1-A.SWS

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 2
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 0.385
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) 100
Climate Change (%) 40

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	1	60 Winter	100	+40%	100/30 Summer				60.463
1.001	2	60 Winter	100	+40%	100/30 Summer				60.460
1.002	3	60 Winter	100	+40%	100/15 Winter				60.457
2.000	12	180 Winter	100	+40%	100/60 Winter				60.221
1.003	4	60 Winter	100	+40%	100/15 Summer				60.413
3.000	14	60 Winter	100	+40%	100/30 Summer				60.417
3.001	15	60 Winter	100	+40%	100/30 Summer				60.416
3.002	16	60 Winter	100	+40%	100/15 Summer				60.414
1.004	5	60 Winter	100	+40%	100/15 Summer				60.413
1.005	6	60 Winter	100	+40%	100/15 Summer				60.409
1.006	7	60 Winter	100	+40%	100/15 Summer				60.403
1.007	8	60 Winter	100	+40%	100/15 Summer				60.396
4.000	18	60 Winter	100	+40%	100/30 Summer				60.388
4.001	19	60 Winter	100	+40%	100/15 Summer				60.389
1.008	9	60 Winter	100	+40%	100/15 Summer				60.389
5.000	22	180 Winter	100	+40%					59.900
1.009	10	60 Winter	100	+40%	100/15 Summer				60.375

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM-NET1-A.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.732	0.000	0.06		48.9	SURCHARGED	
1.001	2	0.823	0.000	0.08		73.1	SURCHARGED	
1.002	3	0.937	0.000	0.06		75.2	FLOOD RISK	
2.000	12	0.096	0.000	0.22		26.2	SURCHARGED	
1.003	4	1.234	0.000	0.11		69.3	SURCHARGED	
3.000	14	0.542	0.000	0.03		24.9	SURCHARGED	
3.001	15	0.726	0.000	0.02		25.4	SURCHARGED	
3.002	16	1.129	0.000	0.03		30.1	SURCHARGED	
1.004	5	1.283	0.000	0.12		101.2	SURCHARGED	
1.005	6	1.422	0.000	0.09		78.6	SURCHARGED	
1.006	7	1.566	0.000	0.11		78.2	FLOOD RISK	
1.007	8	1.623	0.000	0.12		89.4	SURCHARGED	
4.000	18	0.738	0.000	0.01		16.0	SURCHARGED	
4.001	19	1.149	0.000	0.01		13.7	SURCHARGED	
1.008	9	1.706	0.000	0.17		137.3	SURCHARGED	
5.000	22	-0.375	0.000	0.00		0.1	OK	
1.009	10	2.414	0.000	0.22		37.2	SURCHARGED	

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