STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for NETWORK 1.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.300	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	0	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	1000

Designed with Level Soffits

Time Area Diagram for NETWORK 1.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	4-8	0.203	8-12	0.232

Total Area Contributing (ha) = 0.435

Total Pipe Volume (m³) = 29.494

Network Design Table for NETWORK 1.SWS

- Indicates pipe length does not match coordinates

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	15.735	0.319	49.3	0.106	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	18.740	0.113	166.0	0.080	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	21.570	0.551	39.1	0.014	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	21.448	0.053	404.7	0.095	5.00	0.0	0.600	o	450	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	0.00	5.14	223.390	0.106	0.0	0.0	0.0	1.87	74.2	0.0
1.001	0.00	5.45	223.071	0.186	0.0	0.0	0.0	1.01	40.2	0.0
1.002	0.00	5.62	222.958	0.200	0.0	0.0	0.0	2.10	83.4	0.0
2.000	0.00	5.36	220.644	0.095	0.0	0.0	0.0	1.00	159.7	0.0

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Network Design Table for NETWORK 1.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	23.090	0.061	378.5	0.047	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.004	13.461#	0.033	407.9	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.005	10.684	0.026	410.9	0.028	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.006	5.606	0.056	100.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.007	42.774	0.428	99.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.008	8.397	0.084	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.009	11.588	0.116	99.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.010	11.268	0.805	14.0	0.015	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.011	17.053	0.034	501.6	0.050	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.012	90.000	0.918	98.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.013	90.000	0.900	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.014	36.256	0.363	99.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.015	14.984	0.150	99.9	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	0.00	5.99	220.591	0.342	0.0	0.0	0.0	1.04	165.2	0.0
1.004	0.00	6.22	220.530	0.342	0.0	0.0	0.0	1.00	159.1	0.0
1.005	0.00	6.39	219.709	0.370	0.0	0.0	0.0	1.00	158.5	0.0
1.006	0.00	6.49	219.633	0.370	0.0	0.0	0.0	1.00	17.7	0.0
1.007	0.00	7.20	219.577	0.370	0.0	0.0	0.0	1.01	17.8	0.0
1.008	0.00	7.34	219.149	0.370	0.0	0.0	0.0	1.01	17.8	0.0
1.009	0.00	7.53	219.065	0.370	0.0	0.0	0.0	1.01	17.8	0.0
1.010	0.00	7.60	218.949	0.385	0.0	0.0	0.0	2.71	47.8	0.0
1.011	0.00	7.80	217.384	0.435	0.0	0.0	0.0	1.39	885.7	0.0
1.012	0.00	9.28	217.300	0.435	0.0	0.0	0.0	1.01	17.9	0.0
1.013	0.00	10.77	216.382	0.435	0.0	0.0	0.0	1.00	17.8	0.0
1.014	0.00	11.37	215.482	0.435	0.0	0.0	0.0	1.01	17.8	0.0
1.015	0.00	11.62	215.119	0.435	0.0	0.0	0.0	1.01	17.8	0.0

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Manhole Schedules for NETWORK 1.SWS

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)	Backdrop (mm)
1	225.701	2.311	Open Manhole	1200	1.000	223.390	225				
2	225.256	2.185	Open Manhole	1200	1.001	223.071	225	1.000	223.071	225	
3	224.776	1.818	Open Manhole	1200	1.002	222.958	225	1.001	222.958	225	
4	222.294	1.650	Open Manhole	1350	2.000	220.644	450				
5	223.912	3.321	Open Manhole	1500	1.003	220.591	450	1.002	222.407	225	1591
								2.000	220.591	450	
6	224.908	4.378	Open Manhole	1350	1.004	220.530	450	1.003	220.530	450	
J2	224.416	4.707	Open Manhole	1350	1.005	219.709	450	1.004	220.497	450	788
7	224.888	5.255	Open Manhole	2100	1.006	219.633	150	1.005	219.683	450	350
8	225.028	5.451	Open Manhole	1200	1.007	219.577	150	1.006	219.577	150	
9	222.804	3.655	Open Manhole	1200	1.008	219.149	150	1.007	219.149	150	
10	222.133	3.068	Open Manhole	1200	1.009	219.065	150	1.008	219.065	150	
11	221.216	2.267	Open Manhole	1200	1.010	218.949	150	1.009	218.949	150	
12	220.299	2.915	Open Manhole	1800	1.011	217.384	900	1.010	218.144	150	10
13	219.370	2.070	Open Manhole	2400	1.012	217.300	150	1.011	217.350	900	800
14	218.090	1.708	Open Manhole	1200	1.013	216.382	150	1.012	216.382	150	
15	216.990	1.508	Open Manhole	1200	1.014	215.482	150	1.013	215.482	150	
16	216.440	1.321	Open Manhole	1200	1.015	215.119	150	1.014	215.119	150	
17	216.110	1.141	Open Manhole	1500		OUTFALL		1.015	214.969	150	

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PIPELINE SCHEDULES for NETWORK 1.SWS

Upstream Manhole

- Indicates pipe length does not match coordinates

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	225	1	225.701	223.390	2.086	Open Manhole	1200
1.001	o	225	2	225.256	223.071	1.960	Open Manhole	1200
1.002	o	225	3	224.776	222.958	1.593	Open Manhole	1200
2.000	o	450	4	222.294	220.644	1.200	Open Manhole	1350
1.003	o	450	5	223.912	220.591	2.871	Open Manhole	1500
1.004	o	450	6	224.908	220.530	3.928	Open Manhole	1350
1.005	o	450	J2	224.416	219.709	4.257	Open Manhole	1350
1.006	o	150	7	224.888	219.633	5.105	Open Manhole	2100
1.007	o	150	8	225.028	219.577	5.301	Open Manhole	1200
1.008	o	150	9	222.804	219.149	3.505	Open Manhole	1200
1.009	o	150	10	222.133	219.065	2.918	Open Manhole	1200
1.010	o	150	11	221.216	218.949	2.117	Open Manhole	1200
1.011	o	900	12	220.299	217.384	2.015	Open Manhole	1800
1.012	o	150	13	219.370	217.300	1.920	Open Manhole	2400
1.013	o	150	14	218.090	216.382	1.558	Open Manhole	1200
1.014	o	150	15	216.990	215.482	1.358	Open Manhole	1200
1.015	o	150	16	216.440	215.119	1.171	Open Manhole	1200

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	15.735	49.3	2	225.256	223.071	1.960	Open Manhole	1200
1.001	18.740	166.0	3	224.776	222.958	1.593	Open Manhole	1200
1.002	21.570	39.1	5	223.912	222.407	1.280	Open Manhole	1500
2.000	21.448	404.7	5	223.912	220.591	2.871	Open Manhole	1500
1.003	23.090	378.5	6	224.908	220.530	3.928	Open Manhole	1350
1.004	13.461#	407.9	J2	224.416	220.497	3.469	Open Manhole	1350
1.005	10.684	410.9	7	224.888	219.683	4.755	Open Manhole	2100
1.006	5.606	100.1	8	225.028	219.577	5.301	Open Manhole	1200
1.007	42.774	99.9	9	222.804	219.149	3.505	Open Manhole	1200
1.008	8.397	100.0	10	222.133	219.065	2.918	Open Manhole	1200
1.009	11.588	99.9	11	221.216	218.949	2.117	Open Manhole	1200
1.010	11.268	14.0	12	220.299	218.144	2.005	Open Manhole	1800
1.011	17.053	501.6	13	219.370	217.350	1.120	Open Manhole	2400
1.012	90.000	98.0	14	218.090	216.382	1.558	Open Manhole	1200
1.013	90.000	100.0	15	216.990	215.482	1.358	Open Manhole	1200
1.014	36.256	99.9	16	216.440	215.119	1.171	Open Manhole	1200
1.015	14.984	99.9	17	216.110	214.969	0.991	Open Manhole	1500

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Setting Out Information - True Coordinates (NETWORK 1.SWS)

- Indicates pipe length does not match coordinates

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Layout (North)
1.000	1	1200		491124.720	401131.708	
1.001	2	1200		491119.833	401116.751	
1.002	3	1200		491107.277	401102.839	
2.000	4	1350		491120.065	401076.000	
1.003	5	1500		491099.675	401082.653	
1.004	6	1350		491077.725 #	401089.820 #	
1.005	J2	1350		491069.796	401078.249	
1.006	7	2100		491073.112	401088.405	
1.007	8	1200		491074.851	401093.734	
1.008	9	1200		491115.514	401080.461	
1.009	10	1200		491122.851	401076.378	
1.010	11	1200		491129.237	401066.709	
1.011	12	1800		491129.122	401055.442	
1.012	13	2400		491125.577	401038.762	
1.013	14	1200		491205.139	400996.692	

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Setting Out Information - True Coordinates (NETWORK 1.SWS)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Layout (North)
1.014	15	1200		491284.701	400954.622	
1.015	16	1200		491316.752	400937.674	

- Indicates pipe length does not match coordinates

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
1.015	17	1500		491321.603	400923.497	

Free Flowing Outfall Details for NETWORK 1.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.015	17	216.110	214.969	0.000	1500	0

Simulation Criteria for NETWORK 1.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	1
Number of Online Controls	2	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)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.300		

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Online Controls for NETWORK 1.SWS

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.006, Volume (m³): 19.6

Unit Reference	MD-SHE-0079-4200-2550-4200
Design Head (m)	2.550
Design Flow (l/s)	4.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	79
Invert Level (m)	219.633
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.550	4.2
Flush-Flo™	0.342	2.9
Kick-Flo®	0.706	2.3
Mean Flow over Head Range	-	3.1

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	2.3	1.200	3.0	3.000	4.5	7.000	6.7
0.200	2.8	1.400	3.2	3.500	4.9	7.500	7.0
0.300	2.9	1.600	3.4	4.000	5.2	8.000	7.2
0.400	2.9	1.800	3.6	4.500	5.5	8.500	7.4
0.500	2.8	2.000	3.8	5.000	5.8	9.000	7.6
0.600	2.7	2.200	3.9	5.500	6.0	9.500	7.8
0.800	2.5	2.400	4.1	6.000	6.3		
1.000	2.7	2.600	4.2	6.500	6.5		

Hydro-Brake® Optimum Manhole: 13, DS/PN: 1.012, Volume (m³): 18.9

Unit Reference	MD-SHE-0092-5000-2000-5000
Design Head (m)	2.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	92
Invert Level (m)	217.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

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Hydro-Brake® Optimum Manhole: 13, DS/PN: 1.012, Volume (m³): 18.9

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	5.0
Flush-Flo™	0.398	4.1
Kick-Flo®	0.816	3.3
Mean Flow over Head Range	-	3.9

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	2.9	1.200	3.9	3.000	6.0	7.000	9.0
0.200	3.8	1.400	4.2	3.500	6.5	7.500	9.3
0.300	4.1	1.600	4.5	4.000	6.9	8.000	9.6
0.400	4.1	1.800	4.8	4.500	7.3	8.500	9.9
0.500	4.1	2.000	5.0	5.000	7.7	9.000	10.2
0.600	4.0	2.200	5.2	5.500	8.0	9.500	10.4
0.800	3.4	2.400	5.4	6.000	8.4		
1.000	3.6	2.600	5.6	6.500	8.7		

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Storage Structures for NETWORK 1.SWS

Tank or Pond Manhole: J2, DS/PN: 1.005

Invert Level (m) 219.709

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	162.0	1.200	162.0	1.201	0.0

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 1.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	1
Number of Online Controls	2	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 0.300
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	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	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)	100
Climate Change (%)	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	1	15 Winter	100	+30%	100/15 Summer				224.286
1.001	2	15 Winter	100	+30%	100/15 Summer				224.096
1.002	3	15 Winter	100	+30%	100/15 Summer				223.442
2.000	4	480 Winter	100	+30%	100/30 Winter				221.970
1.003	5	480 Winter	100	+30%	100/15 Summer				221.971
1.004	6	480 Winter	100	+30%	100/15 Summer				221.969
1.005	J2	480 Winter	100	+30%	100/15 Summer				221.968
1.006	7	480 Winter	100	+30%	100/15 Summer				221.967
1.007	8	480 Winter	100	+30%					219.626
1.008	9	180 Winter	100	+30%	100/120 Winter				219.362
1.009	10	180 Winter	100	+30%	100/120 Winter				219.353
1.010	11	180 Winter	100	+30%	100/120 Winter				219.342
1.011	12	180 Winter	100	+30%	100/30 Summer				219.329
1.012	13	180 Winter	100	+30%	100/15 Summer				219.329
1.013	14	180 Winter	100	+30%					216.437
1.014	15	180 Winter	100	+30%					215.537
1.015	16	180 Winter	100	+30%					215.176

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 1.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	0.671	0.000	0.76		49.8	SURCHARGED	
1.001	2	0.800	0.000	2.37		85.7	SURCHARGED	
1.002	3	0.259	0.000	1.21		91.6	SURCHARGED	
2.000	4	0.876	0.000	0.05		6.9	SURCHARGED	
1.003	5	0.930	0.000	0.18		24.8	SURCHARGED	
1.004	6	0.989	0.000	0.24		24.8	SURCHARGED	
1.005	J2	1.809	0.000	0.09		8.5	SURCHARGED	
1.006	7	2.184	0.000	0.27		4.0	SURCHARGED	
1.007	8	-0.101	0.000	0.23		4.0	OK	
1.008	9	0.063	0.000	0.22		3.4	SURCHARGED	
1.009	10	0.138	0.000	0.23		3.6	SURCHARGED	
1.010	11	0.243	0.000	0.11		4.9	SURCHARGED	
1.011	12	1.045	0.000	0.02		10.9	SURCHARGED	
1.012	13	1.879	0.000	0.28		5.0	FLOOD RISK	
1.013	14	-0.095	0.000	0.29		5.0	OK	
1.014	15	-0.095	0.000	0.29		5.0	OK	
1.015	16	-0.093	0.000	0.31		5.0	OK	

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