STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SURFACE 001.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.350	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for SURFACE 001.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.512	4-8	0.138

Total Area Contributing (ha) = 0.650

Total Pipe Volume (m³) = 25.035

Network Design Table for SURFACE 001.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	13.105	1.196	11.0	0.034	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	11.240	0.996	11.3	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	13.529	1.212	11.2	0.017	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	71.435	6.681	10.7	0.150	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	45.641	2.475	18.4	0.040	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)
1.000	48.43	5.05	68.160	0.034	0.0	0.0	0.0	3.98	158.1	4.5
1.001	48.24	5.10	66.964	0.050	0.0	0.0	0.0	3.92	155.8	6.5
1.002	48.01	5.16	65.968	0.067	0.0	0.0	0.0	3.94	156.6	8.7
1.003	46.89	5.46	64.756	0.217	0.0	0.0	0.0	4.02	160.0	27.6
1.004	46.13	5.66	58.000	0.257	0.0	0.0	0.0	3.68	260.0	32.1

Network Design Table for SURFACE 001.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
1.005	11.900	0.255	46.7	0.235	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.006	7.289	0.090	81.0	0.012	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.007	6.041	0.070	86.3	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.008	12.799	0.153	83.7	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.009	32.498	1.271	25.6	0.071	0.00	0.0	0.600	o	450	Pipe/Conduit	
2.000	6.873	0.014	490.9	0.000	5.00	0.0	0.600	o	600	Pipe/Conduit	
1.010	12.458	0.025	500.0	0.054	0.00	0.0	0.600	o	600	Pipe/Conduit	
3.000	9.281	0.737	12.6	0.021	5.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	7.701	0.665	11.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.011	5.920	0.067	88.4	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)
1.005	45.90	5.73	55.375	0.492	0.0	0.0	0.0	2.98	474.3	61.2
1.006	45.71	5.78	55.120	0.504	0.0	0.0	0.0	2.26	359.5	62.4
1.007	45.55	5.83	55.030	0.504	0.0	0.0	0.0	2.19	348.2	62.4
1.008	45.22	5.92	54.960	0.504	0.0	0.0	0.0	2.22	353.7	62.4
1.009	44.77	6.06	54.807	0.575	0.0	0.0	0.0	4.03	641.5	69.7
2.000	48.23	5.10	53.400	0.000	0.0	0.0	0.0	1.09	308.8	0.0
1.010	44.14	6.25	53.386	0.629	0.0	0.0	0.0	1.08	306.0	75.2
3.000	48.48	5.04	55.138	0.021	0.0	0.0	0.0	3.71	147.4	2.8
3.001	48.35	5.07	54.401	0.021	0.0	0.0	0.0	3.87	153.7	2.8
1.011	43.84	6.34	53.311	0.650	0.0	0.0	0.0	1.07	18.9«	77.2

Manhole Schedules for SURFACE 001.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	69.585	1.425	Open Manhole	1350	1.000	68.160	225				
2	68.389	1.425	Open Manhole	1200	1.001	66.964	225	1.000	66.964	225	
3	67.393	1.425	Open Manhole	1200	1.002	65.968	225	1.001	65.968	225	
4	66.181	1.425	Open Manhole	1350	1.003	64.756	225	1.002	64.756	225	
5	60.469	2.469	Open Manhole	1200	1.004	58.000	300	1.003	58.075	225	
7	57.025	1.650	Open Manhole	1500	1.005	55.375	450	1.004	55.525	300	
8	56.770	1.650	Open Manhole	1500	1.006	55.120	450	1.005	55.120	450	
9	56.680	1.650	Open Manhole	1500	1.007	55.030	450	1.006	55.030	450	
10	56.610	1.650	Open Manhole	1500	1.008	54.960	450	1.007	54.960	450	
11	56.457	1.650	Open Manhole	1500	1.009	54.807	450	1.008	54.807	450	
12	57.000	3.600	Open Manhole	1200	2.000	53.400	600				
13	57.117	3.731	Open Manhole	1800	1.010	53.386	600	1.009	53.536	450	
								2.000	53.386	600	
14	56.563	1.425	Open Manhole	1200	3.000	55.138	225				
15	57.334	2.933	Open Manhole	1200	3.001	54.401	225	3.000	54.401	225	
16	57.280	3.969	Open Manhole	2100	1.011	53.311	150	1.010	53.361	600	500
								3.001	53.736	225	500
17	57.250	4.006	Open Manhole	0		OUTFALL		1.011	53.244	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
1	421446.717	421129.486	421446.717	421129.486	Required	
2	421459.663	421127.457	421459.663	421127.457	Required	
3	421468.713	421120.790	421468.713	421120.790	Required	
4	421473.318	421108.069	421473.318	421108.069	Required	
5	421466.845	421036.928	421466.845	421036.928	Required	
7	421512.280	421032.600	421512.280	421032.600	Required	

Manhole Schedules for SURFACE 001.SWS

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
8	421522.254	421039.090	421522.254	421039.090	Required	
9	421527.232	421044.414	421527.232	421044.414	Required	
10	421529.861	421049.852	421529.861	421049.852	Required	
11	421531.143	421062.586	421531.143	421062.586	Required	
12	421534.042	421090.732	421534.042	421090.732	Required	
13	421528.645	421094.989	421528.645	421094.989	Required	
14	421542.640	421112.470	421542.640	421112.470	Required	
15	421533.591	421114.531	421533.591	421114.531	Required	
16	421531.744	421107.055	421531.744	421107.055	Required	
17	421537.472	421105.560			No Entry	

Free Flowing Outfall Details for SURFACE 001.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.011	17	57.250	53.244	0.000	0	0

Simulation Criteria for SURFACE 001.SWS

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
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	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)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.350		

Online Controls for SURFACE 001.SWS

Hydro-Brake® Optimum Manhole: 16, DS/PN: 1.011, Volume (m³): 17.0

Unit Reference	MD-SHE-0077-4500-3200-4500
Design Head (m)	3.200
Design Flow (l/s)	4.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	77
Invert Level (m)	53.311
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	3.200	4.5
Flush-Flo™	0.343	2.8
Kick-Flo®	0.692	2.2
Mean Flow over Head Range	-	3.3

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	2.2	1.200	2.9	3.000	4.4	7.000	6.5
0.200	2.6	1.400	3.1	3.500	4.7	7.500	6.7
0.300	2.7	1.600	3.3	4.000	5.0	8.000	6.9
0.400	2.7	1.800	3.4	4.500	5.3	8.500	7.1
0.500	2.7	2.000	3.6	5.000	5.5	9.000	7.3
0.600	2.5	2.200	3.8	5.500	5.8	9.500	7.5
0.800	2.4	2.400	3.9	6.000	6.0		
1.000	2.6	2.600	4.1	6.500	6.3		

Storage Structures for SURFACE 001.SWS

Tank or Pond Manhole: 12, DS/PN: 2.000

Invert Level (m) 53.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	125.0	1.400	125.0	2.800	125.0	4.200	0.0
0.200	125.0	1.600	125.0	3.000	125.0	4.400	0.0
0.400	125.0	1.800	125.0	3.200	0.0	4.600	0.0
0.600	125.0	2.000	125.0	3.400	0.0	4.800	0.0
0.800	125.0	2.200	125.0	3.600	0.0	5.000	0.0
1.000	125.0	2.400	125.0	3.800	0.0		
1.200	125.0	2.600	125.0	4.000	0.0		

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SURFACE 001.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
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 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 0.350
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
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 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	15 Winter	1	+0%					68.186
1.001	2	15 Winter	1	+0%					66.995
1.002	3	15 Winter	1	+0%					66.003
1.003	4	15 Winter	1	+0%					64.815
1.004	5	15 Winter	1	+0%					58.068
1.005	7	15 Winter	1	+0%	100/15 Summer				55.507
1.006	8	15 Winter	1	+0%	100/15 Summer				55.296
1.007	9	15 Winter	1	+0%	100/15 Summer				55.205
1.008	10	15 Winter	1	+0%	100/15 Summer				55.111
1.009	11	15 Winter	1	+0%	100/60 Winter				54.907
2.000	12	240 Winter	1	+0%	30/15 Winter				53.921
1.010	13	240 Winter	1	+0%	30/15 Summer				53.927
3.000	14	15 Winter	1	+0%	100/60 Winter				55.161
3.001	15	15 Winter	1	+0%	30/120 Winter				54.424
1.011	16	240 Winter	1	+0%	1/15 Summer				53.939

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SURFACE 001.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	-0.199	0.000	0.03		4.3	OK	
1.001	2	-0.194	0.000	0.05		6.0	OK	
1.002	3	-0.190	0.000	0.06		7.8	OK	
1.003	4	-0.166	0.000	0.15		23.8	OK	
1.004	5	-0.232	0.000	0.12		28.1	OK	
1.005	7	-0.318	0.000	0.19		53.0	OK	
1.006	8	-0.274	0.000	0.32		54.6	OK	
1.007	9	-0.275	0.000	0.32		54.6	OK	
1.008	10	-0.299	0.000	0.25		54.3	OK	
1.009	11	-0.350	0.000	0.11		61.3	OK	
2.000	12	-0.079	0.000	0.03		5.8	OK	
1.010	13	-0.059	0.000	0.04		6.3	OK	
3.000	14	-0.202	0.000	0.02		2.7	OK	
3.001	15	-0.202	0.000	0.02		2.6	OK	
1.011	16	0.478	0.000	0.17		2.7	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SURFACE 001.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
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	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	0.350
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
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	OFF
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 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	15 Winter	30	+0%					68.201
1.001	2	15 Winter	30	+0%					67.016
1.002	3	15 Winter	30	+0%					66.028
1.003	4	15 Winter	30	+0%					64.863
1.004	5	15 Winter	30	+0%					58.122
1.005	7	15 Winter	30	+0%	100/15 Summer				55.618
1.006	8	15 Winter	30	+0%	100/15 Summer				55.475
1.007	9	15 Winter	30	+0%	100/15 Summer				55.385
1.008	10	15 Winter	30	+0%	100/15 Summer				55.252
1.009	11	15 Winter	30	+0%	100/60 Winter				54.987
2.000	12	480 Winter	30	+0%	30/15 Winter				54.897
1.010	13	480 Winter	30	+0%	30/15 Summer				54.933
3.000	14	15 Winter	30	+0%	100/60 Winter				55.172
3.001	15	480 Winter	30	+0%	30/120 Winter				54.935
1.011	16	480 Winter	30	+0%	1/15 Summer				54.946

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SURFACE 001.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	-0.184	0.000	0.08		10.5	OK	
1.001	2	-0.173	0.000	0.12		15.7	OK	
1.002	3	-0.165	0.000	0.16		21.2	OK	
1.003	4	-0.118	0.000	0.45		70.6	OK	
1.004	5	-0.178	0.000	0.34		83.6	OK	
1.005	7	-0.207	0.000	0.57		161.1	OK	
1.006	8	-0.095	0.000	0.97		163.9	OK	
1.007	9	-0.095	0.000	0.96		162.5	OK	
1.008	10	-0.158	0.000	0.75		164.4	OK	
1.009	11	-0.270	0.000	0.33		185.7	OK	
2.000	12	0.897	0.000	0.09		17.9	SURCHARGED	
1.010	13	0.947	0.000	0.07		11.9	SURCHARGED	
3.000	14	-0.191	0.000	0.05		6.5	OK	
3.001	15	0.309	0.000	0.02		1.8	SURCHARGED	
1.011	16	1.485	0.000	0.21		3.3	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SURFACE 001.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
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 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 0.350
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
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 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	15 Winter	100	+40%					68.216
1.001	2	15 Winter	100	+40%					67.035
1.002	3	15 Winter	100	+40%					66.050
1.003	4	15 Winter	100	+40%					64.913
1.004	5	15 Winter	100	+40%					58.173
1.005	7	720 Winter	100	+40%	100/15 Summer				56.408
1.006	8	720 Winter	100	+40%	100/15 Summer				56.412
1.007	9	720 Winter	100	+40%	100/15 Summer				56.428
1.008	10	720 Winter	100	+40%	100/15 Summer				56.438
1.009	11	720 Winter	100	+40%	100/60 Winter				56.441
2.000	12	720 Winter	100	+40%	30/15 Winter				56.381
1.010	13	720 Winter	100	+40%	30/15 Summer				56.455
3.000	14	720 Winter	100	+40%	100/60 Winter				56.436
3.001	15	720 Winter	100	+40%	30/120 Winter				56.450
1.011	16	600 Winter	100	+40%	1/15 Summer				56.497

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for SURFACE 001.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	-0.169	0.000	0.14		19.1	OK	
1.001	2	-0.154	0.000	0.22		28.5	OK	
1.002	3	-0.143	0.000	0.28		38.5	OK	
1.003	4	-0.068	0.000	0.82		127.9	OK	
1.004	5	-0.127	0.000	0.62		151.5	OK	
1.005	7	0.583	0.000	0.09		25.2	SURCHARGED	
1.006	8	0.842	0.000	0.18		30.6	SURCHARGED	
1.007	9	0.948	0.000	0.17		29.1	FLOOD RISK	
1.008	10	1.028	0.000	0.12		27.3	FLOOD RISK	
1.009	11	1.184	0.000	0.06		33.4	FLOOD RISK	
2.000	12	2.381	0.000	0.13		25.7	SURCHARGED	
1.010	13	2.469	0.000	0.17		27.7	SURCHARGED	
3.000	14	1.073	0.000	0.04		5.0	FLOOD RISK	
3.001	15	1.824	0.000	0.05		5.3	SURCHARGED	
1.011	16	3.036	0.000	0.28		4.4	SURCHARGED	