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	0.286	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	0.222	4-8	0.170

Total Area Contributing (ha) = 0.392

Total Pipe Volume (m³) = 9.523

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
1.000	18.889	1.052	18.0	0.077	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	7.936	0.399	19.9	0.043	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	33.553	2.842	11.8	0.031	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	26.116	1.276	20.5	0.165	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	12.633	0.050	252.7	0.076	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	43.50	5.13	233.970	0.077	0.0	0.0	0.0	2.39	42.2	9.1
2.000	43.74	5.06	233.317	0.043	0.0	0.0	0.0	2.27	40.1	5.1
1.001	43.02	5.28	232.843	0.151	0.0	0.0	0.0	3.83	152.3	17.6
1.002	42.62	5.40	229.926	0.316	0.0	0.0	0.0	3.49	246.8	36.5
1.003	41.96	5.62	228.650	0.392	0.0	0.0	0.0	0.98	69.6	44.5

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
1.004	12.612	0.050	252.2	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.005	74.687	0.634	117.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

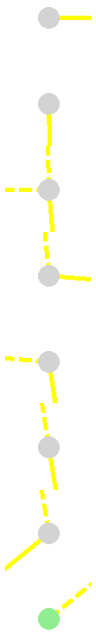
Network Results Table

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)
1.004	41.47	5.78	226.400	0.392	0.0	0.0	0.0	1.28	202.9	44.5
1.005	38.68	6.82	226.300	0.392	0.0	0.0	0.0	1.20	47.9	44.5

Manhole Schedules for SURFACE 001.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	235.320	1.350	Open Manhole	1200	1.000	233.970	150				
2	234.667	1.350	Open Manhole	1500	2.000	233.317	150				
3	234.269	1.426	Open Manhole	1500	1.001	232.843	225	1.000	232.918	150	
								2.000	232.918	150	
4	232.686	2.760	Open Manhole	1500	1.002	229.926	300	1.001	230.001	225	
5	231.309	2.659	Open Manhole	1500	1.003	228.650	300	1.002	228.650	300	
Tank	230.900	4.500	Open Manhole	1350	1.004	226.400	450	1.003	228.600	300	2050
6	230.900	4.600	Open Manhole	2100	1.005	226.300	225	1.004	226.350	450	275
EXSWMH3	228.016	2.350	Open Manhole	1200		OUTFALL		1.005	225.666	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
1	409253.893	415996.921	409253.893	415996.921	Required	
2	409272.631	416004.891	409272.631	416004.891	Required	
3	409272.782	415996.979	409272.782	415996.979	Required	
4	409275.713	415963.567	409275.713	415963.567	Required	
5	409301.742	415961.433	409301.742	415961.433	Required	
Tank	409303.716	415948.955	409303.716	415948.955	Required	
6	409305.750	415936.508	409305.750	415936.508	Required	
EXSWMH3	409248.006	415889.138			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)
1.005	EXSWMH3	228.016	225.666	225.741	1200	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	0.286		

Online Controls for SURFACE 001.SWS

Hydro-Brake® Optimum Manhole: 6, DS/PN: 1.005, Volume (m³): 17.7

Unit Reference	MD-SHE-0075-3500-2100-3500
Design Head (m)	2.100
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	226.300
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.100	3.5
Flush-Flo™	0.332	2.6
Kick-Flo®	0.674	2.1
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)
0.100	2.1	1.200	2.7	3.000	4.1	7.000	6.1
0.200	2.5	1.400	2.9	3.500	4.4	7.500	6.3
0.300	2.6	1.600	3.1	4.000	4.7	8.000	6.5
0.400	2.6	1.800	3.3	4.500	5.0	8.500	6.7
0.500	2.5	2.000	3.4	5.000	5.2	9.000	6.9
0.600	2.3	2.200	3.6	5.500	5.5	9.500	7.1
0.800	2.2	2.400	3.7	6.000	5.7		
1.000	2.5	2.600	3.9	6.500	5.9		

Storage Structures for SURFACE 001.SWS

Tank or Pond Manhole: Tank, DS/PN: 1.004

Invert Level (m) 226.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	2.500	100.0	2.600	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 0.288
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%	100/15 Winter				234.019
2.000	2	15 Winter	1	+0%					233.355
1.001	3	15 Winter	1	+0%					232.895
1.002	4	15 Winter	1	+0%	100/15 Summer				230.005
1.003	5	15 Winter	1	+0%	30/15 Summer				228.843
1.004	Tank	360 Winter	1	+0%	30/15 Winter				226.778
1.005	6	360 Winter	1	+0%	1/15 Summer				226.780

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.101	0.000	0.23			9.1	OK	
2.000	2	-0.112	0.000	0.15			5.1	OK	
1.001	3	-0.173	0.000	0.12			17.2	OK	
1.002	4	-0.221	0.000	0.15			33.6	OK	
1.003	5	-0.107	0.000	0.73			41.5	OK	

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)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	Tank	-0.072	0.000	0.03			4.4	OK	
1.005	6	0.255	0.000	0.06			2.6	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 0.288
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%	100/15 Winter				234.051
2.000	2	15 Winter	30	+0%					233.379
1.001	3	15 Winter	30	+0%					232.929
1.002	4	15 Winter	30	+0%	100/15 Summer				230.064
1.003	5	15 Winter	30	+0%	30/15 Summer				229.112
1.004	Tank	360 Winter	30	+0%	30/15 Winter				227.575
1.005	6	360 Winter	30	+0%	1/15 Summer				227.657

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.069	0.000	0.56			22.3	OK	
2.000	2	-0.088	0.000	0.36			12.4	OK	
1.001	3	-0.139	0.000	0.31			44.0	OK	
1.002	4	-0.162	0.000	0.43			94.8	OK	
1.003	5	0.162	0.000	2.07			117.6	SURCHARGED	

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)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	Tank	0.725	0.000	0.08			11.5	SURCHARGED	
1.005	6	1.132	0.000	0.06			2.8	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	0.288
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%	100/15 Winter				234.139
2.000	2	15 Winter	100	+40%					233.406
1.001	3	15 Winter	100	+40%					232.963
1.002	4	15 Winter	100	+40%	100/15 Summer				230.346
1.003	5	15 Winter	100	+40%	30/15 Summer				229.591
1.004	Tank	600 Winter	100	+40%	30/15 Winter				228.858
1.005	6	600 Winter	100	+40%	1/15 Summer				228.864

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.019	0.000	1.00			39.7	SURCHARGED	
2.000	2	-0.061	0.000	0.65			22.5	OK	
1.001	3	-0.105	0.000	0.55			78.7	OK	
1.002	4	0.120	0.000	0.75			166.4	SURCHARGED	
1.003	5	0.641	0.000	3.64			206.7	SURCHARGED	

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)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.004	Tank	2.008	0.000	0.12			17.9	SURCHARGED	
1.005	6	2.339	0.000	0.08			3.8	SURCHARGED	