STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for 223-150 SW.SWS

Pipe Sizes 223-150 SW Manhole Sizes 223-150 SW

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	18.200	Add Flow / Climate Change (%)	10
Ratio R	0.353	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

Network Design Table for 223-150 SW.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	11.194	0.187	60.0	0.030	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	17.035	0.170	100.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
2.000	11.086	0.357	31.1	0.009	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.002	5.021	0.050	100.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.003	11.834	0.393	30.1	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
3.000	11.901	0.198	60.0	0.065	5.00	0.0	0.600	o	150	Pipe/Conduit	
3.001	8.747	0.087	100.0	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)
1.000	50.00	5.19	63.200	0.030	0.0	0.0	0.4	1.00	7.8	4.5
1.001	50.00	5.56	63.013	0.030	0.0	0.0	0.4	0.77	6.0	4.5
2.000	50.00	5.13	63.200	0.009	0.0	0.0	0.1	1.39	10.9	1.3
1.002	50.00	5.67	62.843	0.039	0.0	0.0	0.5	0.77	6.0	5.8
1.003	50.00	5.81	62.793	0.039	0.0	0.0	0.5	1.41	11.1	5.8
3.000	50.00	5.15	62.850	0.065	0.0	0.0	0.9	1.30	23.0	9.7
3.001	50.00	5.30	62.652	0.065	0.0	0.0	0.9	1.00	17.8	9.7

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Network Design Table for 223-150 SW.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
3.002	4.081	0.214	19.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	8.334	0.083	100.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	2.783	0.028	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.006	5.427	0.054	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.007	4.186	0.042	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.008	3.459	0.035	100.0	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)
3.002	50.00	5.33	62.564	0.065	0.0	0.0	0.9	2.32	41.0	9.7
1.004	50.00	5.94	62.350	0.104	0.0	0.0	1.4	1.00	17.7	15.5
1.005	50.00	5.99	62.267	0.104	0.0	0.0	1.4	1.00	17.8	15.5
1.006	50.00	6.08	62.239	0.104	0.0	0.0	1.4	1.00	17.8	15.5
1.007	50.00	6.15	62.185	0.104	0.0	0.0	1.4	1.00	17.8	15.5
1.008	50.00	6.21	62.143	0.104	0.0	0.0	1.4	1.00	17.8	15.5

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Manhole Schedules for 223-150 SW.SWS

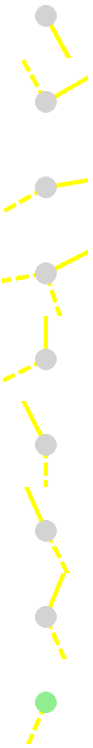
MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	63.850	0.650	Open Manhole	475	1.000	63.200	100				
2	63.850	0.837	Open Manhole	475	1.001	63.013	100	1.000	63.013	100	
11	63.850	0.650	Open Manhole	475	2.000	63.200	100				
3	63.820	0.977	Open Manhole	475	1.002	62.843	100	1.001	62.843	100	
								2.000	62.843	100	
4	64.206	1.413	Open Manhole	475	1.003	62.793	100	1.002	62.793	100	
12	63.600	0.750	Open Manhole	475	3.000	62.850	150				
13	63.850	1.198	Open Manhole	475	3.001	62.652	150	3.000	62.652	150	
14	63.796	1.232	Open Manhole	475	3.002	62.564	150	3.001	62.564	150	
5	64.038	1.688	Open Manhole	1200	1.004	62.350	150	1.003	62.400	100	
								3.002	62.350	150	
6	64.194	1.927	Open Manhole	1200	1.005	62.267	150	1.004	62.267	150	
7	64.095	1.856	Open Manhole	1200	1.006	62.239	150	1.005	62.239	150	
8	64.129	1.944	Open Manhole	1200	1.007	62.185	150	1.006	62.185	150	
9	64.096	1.953	Open Manhole	1200	1.008	62.143	150	1.007	62.143	150	
10	63.932	1.824	Open Manhole	2100		OUTFALL		1.008	62.108	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
1	385858.523	400280.161	385858.523	400280.161	Required	
2	385868.239	400285.721	385868.239	400285.721	Required	
11	385850.155	400295.116	385850.155	400295.116	Required	
3	385859.826	400300.534	385859.826	400300.534	Required	
4	385860.540	400305.504	385860.540	400305.504	Required	

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Manhole Schedules for 223-150 SW.SWS

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
12	385839.418	400322.128	385839.418	400322.128	Required	
13	385845.120	400311.681	385845.120	400311.681	Required	
14	385852.708	400316.033	385852.708	400316.033	Required	
5	385856.733	400316.709	385856.733	400316.709	Required	
6	385864.193	400320.425	385864.193	400320.425	Required	
7	385864.176	400323.208	385864.176	400323.208	Required	
8	385861.697	400328.035	385861.697	400328.035	Required	
9	385859.997	400331.861	385859.997	400331.861	Required	
10	385861.311	400335.061			No Entry	



Free Flowing Outfall Details for 223-150 SW.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.008	10	63.932	62.108	56.932	2100	0

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Simulation Criteria for 223-150 SW.SWS

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	10.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 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)	18.200	Storm Duration (mins)	30
Ratio R	0.353		

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Online Controls for 223-150 SW.SWS

Hydro-Brake® Optimum Manhole: 9, DS/PN: 1.008, Volume (m³): 2.3

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	98
Invert Level (m)	62.143
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0	Kick-Flo®	0.878	3.9
Flush-Flo™	0.431	4.9	Mean Flow over Head Range	-	4.3

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	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

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Storage Structures for 223-150 SW.SWS

Tank or Pond Manhole: 8, DS/PN: 1.007

Invert Level (m) 62.185

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	24.0	0.400	24.0	0.401	0.0

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-150 SW.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.353
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.300	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, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 45

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	2	+0%	30/15 Summer	100/15 Summer			63.263
1.001	2	15 Winter	2	+0%	30/15 Summer				63.102
2.000	11	15 Winter	2	+0%	30/15 Winter				63.226
1.002	3	15 Winter	2	+0%	2/15 Summer				62.967
1.003	4	15 Winter	2	+0%	30/15 Summer				62.851
3.000	12	15 Winter	2	+0%	30/15 Summer	100/15 Summer			62.929
3.001	13	15 Winter	2	+0%	30/15 Summer				62.748
3.002	14	15 Winter	2	+0%	30/15 Summer				62.630
1.004	5	15 Winter	2	+0%	2/15 Summer				62.575
1.005	6	15 Winter	2	+0%	2/15 Summer				62.475
1.006	7	30 Winter	2	+0%	2/15 Summer				62.413
1.007	8	30 Winter	2	+0%	2/15 Summer				62.403
1.008	9	30 Winter	2	+0%	2/15 Summer				62.395

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-150 SW.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.037	0.000	0.70		5.2	OK	8
1.001	2	-0.012	0.000	0.89		5.1	OK	
2.000	11	-0.074	0.000	0.15		1.6	OK	
1.002	3	0.024	0.000	1.25		6.6	SURCHARGED	
1.003	4	-0.042	0.000	0.63		6.6	OK	
3.000	12	-0.071	0.000	0.54		11.2	OK	12
3.001	13	-0.054	0.000	0.71		11.1	OK	
3.002	14	-0.085	0.000	0.39		11.2	OK	
1.004	5	0.075	0.000	1.11		17.1	SURCHARGED	
1.005	6	0.058	0.000	1.57		17.0	SURCHARGED	
1.006	7	0.024	0.000	0.94		13.7	SURCHARGED	
1.007	8	0.068	0.000	0.38		4.8	SURCHARGED	
1.008	9	0.102	0.000	0.40		4.6	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-150 SW.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.353
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.300	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, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 45

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%	30/15 Summer	100/15 Summer			63.692
1.001	2	15 Winter	30	+0%	30/15 Summer				63.524
2.000	11	15 Winter	30	+0%	30/15 Winter				63.303
1.002	3	15 Winter	30	+0%	2/15 Summer				63.288
1.003	4	15 Winter	30	+0%	30/15 Summer				63.159
3.000	12	15 Winter	30	+0%	30/15 Summer	100/15 Summer			63.165
3.001	13	15 Winter	30	+0%	30/15 Summer				63.045
3.002	14	60 Winter	30	+0%	30/15 Summer				62.979
1.004	5	60 Winter	30	+0%	2/15 Summer				62.975
1.005	6	60 Winter	30	+0%	2/15 Summer				62.962
1.006	7	60 Winter	30	+0%	2/15 Summer				62.956
1.007	8	60 Winter	30	+0%	2/15 Summer				62.947
1.008	9	60 Winter	30	+0%	2/15 Summer				62.940

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-150 SW.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.392	0.000	0.99		7.3	FLOOD RISK	8
1.001	2	0.411	0.000	1.19		6.9	SURCHARGED	
2.000	11	0.003	0.000	0.29		3.0	SURCHARGED	
1.002	3	0.345	0.000	1.65		8.7	SURCHARGED	
1.003	4	0.266	0.000	0.82		8.6	SURCHARGED	
3.000	12	0.165	0.000	0.87		18.1	SURCHARGED	12
3.001	13	0.243	0.000	1.11		17.4	SURCHARGED	
3.002	14	0.265	0.000	0.38		10.9	SURCHARGED	
1.004	5	0.475	0.000	1.10		17.0	SURCHARGED	
1.005	6	0.545	0.000	1.52		16.5	SURCHARGED	
1.006	7	0.567	0.000	1.09		16.0	SURCHARGED	
1.007	8	0.612	0.000	0.51		6.5	SURCHARGED	
1.008	9	0.647	0.000	0.42		4.9	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-150 SW.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.353
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.300	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, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 45

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	30 Winter	100	+45%	30/15 Summer	100/15 Summer			63.853
1.001	2	60 Winter	100	+45%	30/15 Summer				63.819
2.000	11	60 Winter	100	+45%	30/15 Winter				63.791
1.002	3	60 Winter	100	+45%	2/15 Summer				63.771
1.003	4	60 Winter	100	+45%	30/15 Summer				63.718
3.000	12	120 Winter	100	+45%	30/15 Summer	100/15 Summer			63.614
3.001	13	120 Winter	100	+45%	30/15 Summer				63.612
3.002	14	60 Winter	100	+45%	30/15 Summer				63.612
1.004	5	60 Winter	100	+45%	2/15 Summer				63.614
1.005	6	60 Winter	100	+45%	2/15 Summer				63.599
1.006	7	60 Winter	100	+45%	2/15 Summer				63.592
1.007	8	60 Winter	100	+45%	2/15 Summer				63.582
1.008	9	60 Winter	100	+45%	2/15 Summer				63.573

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-150 SW.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.553	3.366	1.04		7.6	FLOOD	8
1.001	2	0.706	0.000	1.16		6.7	FLOOD RISK	
2.000	11	0.491	0.000	0.25		2.6	FLOOD RISK	
1.002	3	0.828	0.000	1.60		8.5	FLOOD RISK	
1.003	4	0.825	0.000	0.78		8.1	SURCHARGED	
3.000	12	0.614	13.897	0.57		11.9	FLOOD	12
3.001	13	0.810	0.000	0.73		11.4	FLOOD RISK	
3.002	14	0.897	0.000	0.58		16.8	FLOOD RISK	
1.004	5	1.114	0.000	1.49		23.1	SURCHARGED	
1.005	6	1.182	0.000	2.00		21.7	SURCHARGED	
1.006	7	1.203	0.000	1.39		20.2	SURCHARGED	
1.007	8	1.247	0.000	0.69		8.8	SURCHARGED	
1.008	9	1.280	0.000	0.42		4.9	SURCHARGED	

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