STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

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)	1.500
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 Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.068	4-8	0.022

Total Area Contributing (ha) = 0.090

Total Pipe Volume (m³) = 1.929

Network Design Table for Storm

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	11.100	0.110	100.9	0.018	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	8.710	0.090	96.8	0.004	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	11.052	0.110	100.5	0.018	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	9.807	0.100	98.1	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	11.510	0.120	95.9	0.010	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	5.18	71.940	0.018	0.0	0.0	0.0	1.00	17.7	2.4
1.001	50.00	5.33	71.830	0.022	0.0	0.0	0.0	1.02	18.1	3.0
2.000	50.00	5.18	71.950	0.018	0.0	0.0	0.0	1.00	17.7	2.4
2.001	50.00	5.34	71.840	0.028	0.0	0.0	0.0	1.01	17.9	3.8
1.002	50.00	5.53	71.740	0.060	0.0	0.0	0.0	1.03	18.1	8.1

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Network Design Table for Storm

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
3.000	19.890	0.135	147.3	0.010	5.00	0.0	0.600	o	150	Pipe/Conduit	
3.001	24.560	0.165	148.8	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	9.875	0.100	98.8	0.005	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	2.645	0.025	105.8	0.005	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)
3.000	50.00	5.40	71.920	0.010	0.0	0.0	0.0	0.83	14.6	1.4
3.001	50.00	5.90	71.785	0.020	0.0	0.0	0.0	0.82	14.5	2.7
1.003	50.00	6.06	71.620	0.085	0.0	0.0	0.0	1.01	17.9	11.5
1.004	50.00	6.11	71.520	0.090	0.0	0.0	0.0	0.98	17.3	12.2

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Manhole Schedules for Storm

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	72.850	0.910	Open Manhole	1200	1.000	71.940	150				
2	72.800	0.970	Open Manhole	1200	1.001	71.830	150	1.000	71.830	150	
3	72.850	0.900	Open Manhole	1200	2.000	71.950	150				
3	72.800	0.960	Open Manhole	1200	2.001	71.840	150	2.000	71.840	150	
3	72.880	1.140	Open Manhole	1200	1.002	71.740	150	1.001	71.740	150	
								2.001	71.740	150	
6	72.750	0.830	Open Manhole	1200	3.000	71.920	150				
6	72.850	1.065	Open Manhole	1200	3.001	71.785	150	3.000	71.785	150	
4	73.000	1.380	Open Manhole	1200	1.003	71.620	150	1.002	71.620	150	
								3.001	71.620	150	
8	73.100	1.580	Open Manhole	1200	1.004	71.520	150	1.003	71.520	150	
	71.800	0.305	Open Manhole	0		OUTFALL		1.004	71.495	150	

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PIPELINE SCHEDULES for Storm

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	150	1	72.850	71.940	0.760	Open Manhole	1200
1.001	o	150	2	72.800	71.830	0.820	Open Manhole	1200
2.000	o	150	3	72.850	71.950	0.750	Open Manhole	1200
2.001	o	150	3	72.800	71.840	0.810	Open Manhole	1200
1.002	o	150	3	72.880	71.740	0.990	Open Manhole	1200
3.000	o	150	6	72.750	71.920	0.680	Open Manhole	1200
3.001	o	150	6	72.850	71.785	0.915	Open Manhole	1200
1.003	o	150	4	73.000	71.620	1.230	Open Manhole	1200
1.004	o	150	8	73.100	71.520	1.430	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	11.100	100.9	2	72.800	71.830	0.820	Open Manhole	1200
1.001	8.710	96.8	3	72.880	71.740	0.990	Open Manhole	1200
2.000	11.052	100.5	3	72.800	71.840	0.810	Open Manhole	1200
2.001	9.807	98.1	3	72.880	71.740	0.990	Open Manhole	1200
1.002	11.510	95.9	4	73.000	71.620	1.230	Open Manhole	1200
3.000	19.890	147.3	6	72.850	71.785	0.915	Open Manhole	1200
3.001	24.560	148.8	4	73.000	71.620	1.230	Open Manhole	1200
1.003	9.875	98.8	8	73.100	71.520	1.430	Open Manhole	1200
1.004	2.645	105.8		71.800	71.495	0.155	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		71.800	71.495	0.000	0	0

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Simulation Criteria for Storm

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	7
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

Orifice Manhole: 8, DS/PN: 1.004, Volume (m³): 1.9

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 71.520

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Storage Structures for Storm

Porous Car Park Manhole: 1, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	8.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	22.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	72.395	Cap Volume Depth (m)	0.375

Porous Car Park Manhole: 2, DS/PN: 1.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	8.0
Max Percolation (l/s)	11.1	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	72.345	Cap Volume Depth (m)	0.375

Porous Car Park Manhole: 3, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	8.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	22.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	72.395	Cap Volume Depth (m)	0.375

Porous Car Park Manhole: 3, DS/PN: 2.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	3.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	8.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	72.345	Cap Volume Depth (m)	0.375

Porous Car Park Manhole: 3, DS/PN: 1.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	14.0
Max Percolation (l/s)	19.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	72.425	Cap Volume Depth (m)	0.375

Porous Car Park Manhole: 6, DS/PN: 3.001

Infiltration Coefficient Base (m/hr)	0.00000	Max Percolation (l/s)	21.7
Membrane Percolation (mm/hr)	1000	Safety Factor	2.0

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Porous Car Park Manhole: 6, DS/PN: 3.001

Porosity	0.30	Slope (1:X)	0.0
Invert Level (m)	72.395	Depression Storage (mm)	5
Width (m)	6.0	Evaporation (mm/day)	3
Length (m)	13.0	Cap Volume Depth (m)	0.375

Porous Car Park Manhole: 4, DS/PN: 1.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	13.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	72.545	Cap Volume Depth (m)	0.375

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 7
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 0.400
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 OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
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	120 Winter	1	+0%	30/15 Summer				72.081
1.001	2	120 Winter	1	+0%	1/30 Winter				72.080
2.000	3	120 Winter	1	+0%	30/15 Summer				72.082
2.001	3	120 Winter	1	+0%	1/30 Winter				72.081
1.002	3	120 Winter	1	+0%	1/15 Summer				72.079
3.000	6	120 Winter	1	+0%	1/120 Winter				72.078
3.001	6	120 Winter	1	+0%	1/15 Winter				72.078
1.003	4	120 Winter	1	+0%	1/15 Summer				72.076
1.004	8	120 Winter	1	+0%	1/15 Summer				72.071

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	-0.009	0.000	0.05		0.8	OK	
1.001	2	0.100	0.000	0.05		0.8	SURCHARGED	
2.000	3	-0.018	0.000	0.05		0.8	OK	
2.001	3	0.091	0.000	0.07		1.2	SURCHARGED	

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.002	3	0.189	0.000	0.12		2.0	SURCHARGED	
3.000	6	0.008	0.000	0.03		0.5	SURCHARGED	
3.001	6	0.143	0.000	0.05		0.7	SURCHARGED	
1.003	4	0.306	0.000	0.08		1.3	SURCHARGED	
1.004	8	0.401	0.000	0.13		1.4	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 7
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 0.400
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 OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
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	120 Winter	30	+0%	30/15 Summer				72.460
1.001	2	120 Winter	30	+0%	1/30 Winter				72.459
2.000	3	120 Winter	30	+0%	30/15 Summer				72.461
2.001	3	120 Winter	30	+0%	1/30 Winter				72.460
1.002	3	120 Winter	30	+0%	1/15 Summer				72.458
3.000	6	120 Winter	30	+0%	1/120 Winter				72.457
3.001	6	120 Winter	30	+0%	1/15 Winter				72.455
1.003	4	120 Winter	30	+0%	1/15 Summer				72.453
1.004	8	120 Winter	30	+0%	1/15 Summer				72.447

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	0.370	0.000	0.10		1.6	SURCHARGED	
1.001	2	0.479	0.000	0.06		0.9	SURCHARGED	
2.000	3	0.361	0.000	0.10		1.6	SURCHARGED	
2.001	3	0.470	0.000	0.08		1.3	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.002	3	0.568	0.000	0.12		1.9	SURCHARGED	
3.000	6	0.387	0.000	0.07		1.0	FLOOD RISK	
3.001	6	0.520	0.000	0.10		1.3	SURCHARGED	
1.003	4	0.683	0.000	0.12		1.9	SURCHARGED	
1.004	8	0.777	0.000	0.17		1.8	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 7
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 0.400
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 OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
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	120 Winter	100	+40%	30/15 Summer				72.625
1.001	2	120 Winter	100	+40%	1/30 Winter				72.623
2.000	3	120 Winter	100	+40%	30/15 Summer				72.626
2.001	3	120 Winter	100	+40%	1/30 Winter				72.624
1.002	3	120 Winter	100	+40%	1/15 Summer				72.622
3.000	6	120 Winter	100	+40%	1/120 Winter				72.621
3.001	6	120 Winter	100	+40%	1/15 Winter				72.620
1.003	4	120 Winter	100	+40%	1/15 Summer				72.617
1.004	8	120 Winter	100	+40%	1/15 Summer				72.611

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	0.535	0.000	0.13		2.1	FLOOD RISK	
1.001	2	0.643	0.000	0.05		0.8	FLOOD RISK	
2.000	3	0.526	0.000	0.12		2.0	FLOOD RISK	
2.001	3	0.634	0.000	0.07		1.2	FLOOD RISK	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.002	3	0.732	0.000	0.12		2.0	FLOOD RISK	
3.000	6	0.551	0.000	0.13		1.8	FLOOD RISK	
3.001	6	0.685	0.000	0.10		1.4	FLOOD RISK	
1.003	4	0.847	0.000	0.12		2.0	SURCHARGED	
1.004	8	0.941	0.000	0.18		1.9	SURCHARGED	

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