STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for 223-151 S.W NETWORK REV C.SWS

Pipe Sizes 223-151 S.W NETWORK REV B Manhole Sizes 223-151 S.W NETWORK REV B

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	18.100	Add Flow / Climate Change (%)	10
Ratio R	0.354	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

Time Area Diagram for 223-151 S.W NETWORK REV C.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.101	4-8	0.028

Total Area Contributing (ha) = 0.129

Total Pipe Volume (m³) = 2.539

Network Design Table for 223-151 S.W NETWORK REV C.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	31.434	0.524	60.0	0.027	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	17.325	0.173	100.0	0.015	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	11.577	0.207	56.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	31.842	0.531	60.0	0.027	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	16.908	0.323	52.3	0.015	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	5.40	61.550	0.027	0.0	0.0	0.4	1.30	23.0	4.0
1.001	50.00	5.69	61.026	0.042	0.0	0.0	0.6	1.00	17.8	6.3
1.002	50.00	5.83	60.853	0.042	0.0	0.0	0.6	1.35	23.8	6.3
2.000	50.00	5.41	61.550	0.027	0.0	0.0	0.4	1.30	23.0	4.0
2.001	50.00	5.61	61.019	0.042	0.0	0.0	0.6	1.39	24.6	6.3

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Network Design Table for 223-151 S.W NETWORK REV C.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	3.394	0.034	99.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	6.268	0.175	35.8	0.045	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	6.330	0.063	100.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.006	4.743	0.047	100.0	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)
1.003	50.00	5.89	60.646	0.084	0.0	0.0	1.1	1.01	17.8	12.5
1.004	50.00	5.95	60.612	0.129	0.0	0.0	1.7	1.69	29.8	19.2
1.005	50.00	6.03	60.362	0.129	0.0	0.0	1.7	1.30	51.9	19.2
1.006	50.00	6.09	60.299	0.129	0.0	0.0	1.7	1.31	52.0	19.2

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Manhole Schedules for 223-151 S.W NETWORK REV C.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	62.150	0.600	Open Manhole	1200	1.000	61.550	150				
2	62.000	0.974	Open Manhole	1200	1.001	61.026	150	1.000	61.026	150	
3	61.950	1.097	Open Manhole	1200	1.002	60.853	150	1.001	60.853	150	
9	62.150	0.600	Open Manhole	1200	2.000	61.550	150				
10	61.950	0.931	Open Manhole	1200	2.001	61.019	150	2.000	61.019	150	
4	61.900	1.254	Open Manhole	1200	1.003	60.646	150	1.002	60.646	150	
								2.001	60.696	150	50
5	62.550	1.938	Open Manhole	1200	1.004	60.612	150	1.003	60.612	150	
6	62.968	2.606	Open Manhole	1200	1.005	60.362	225	1.004	60.437	150	
7	62.228	1.929	Open Manhole	1200	1.006	60.299	225	1.005	60.299	225	
8	61.598	1.346	Open Manhole	1200		OUTFALL		1.006	60.252	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
1	385932.881	400161.933	385932.881	400161.933	Required	
2	385950.876	400136.159	385950.876	400136.159	Required	
3	385960.794	400121.954	385960.794	400121.954	Required	
9	385942.402	400168.498	385942.402	400168.498	Required	
10	385960.630	400142.390	385960.630	400142.390	Required	
4	385970.320	400128.534	385970.320	400128.534	Required	
5	385972.272	400125.758	385972.272	400125.758	Required	
6	385973.749	400119.667	385973.749	400119.667	Required	
7	385968.636	400115.936	385968.636	400115.936	Required	

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Manhole Schedules for 223-151 S.W NETWORK REV C.SWS

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
8	385967.950	400111.243			No Entry	

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Network Classifications for 223-151 S.W NETWORK REV C.SWS

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	1	150	0.450	0.840	Unclassified	1200	0	0.450	Unclassified
1.001	2	150	0.824	1.034	Unclassified	1200	0	0.824	Unclassified
1.002	3	150	0.947	2.097	Unclassified	1200	0	0.947	Unclassified
2.000	9	150	0.450	2.035	Unclassified	1200	0	0.450	Unclassified
2.001	10	150	0.781	2.823	Unclassified	1200	0	0.781	Unclassified
1.003	4	150	1.104	2.648	Unclassified	1200	0	1.104	Unclassified
1.004	5	150	1.788	2.594	Unclassified	1200	0	1.788	Unclassified
1.005	6	225	1.704	2.381	Unclassified	1200	0	2.381	Unclassified
1.006	7	225	1.121	1.704	Unclassified	1200	0	1.704	Unclassified

Free Flowing Outfall Details for 223-151 S.W NETWORK REV C.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006	8	61.598	60.252	59.768	1200	0

Simulation Criteria for 223-151 S.W NETWORK REV C.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 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)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.100	Storm Duration (mins)	30
Ratio R	0.354		

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Online Controls for 223-151 S.W NETWORK REV C.SWS

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.006, Volume (m³): 2.4

Unit Reference	MD-SHE-0100-5000-1350-5000
Design Head (m)	1.350
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	100
Invert Level (m)	60.299
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.350	5.0
Flush-Flo™	0.400	5.0
Kick-Flo®	0.829	4.0
Mean Flow over Head Range	-	4.4

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	3.3	1.200	4.7	3.000	7.3	7.000	10.9
0.200	4.6	1.400	5.1	3.500	7.8	7.500	11.2
0.300	4.9	1.600	5.4	4.000	8.3	8.000	11.6
0.400	5.0	1.800	5.7	4.500	8.8	8.500	11.9
0.500	5.0	2.000	6.0	5.000	9.2	9.000	12.2
0.600	4.8	2.200	6.3	5.500	9.7	9.500	12.6
0.800	4.2	2.400	6.5	6.000	10.1		
1.000	4.4	2.600	6.8	6.500	10.5		

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Storage Structures for 223-151 S.W NETWORK REV C.SWS

Tank or Pond Manhole: 6, DS/PN: 1.005

Invert Level (m) 60.362

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	105.0	0.400	105.0	0.401	0.0

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-151 S.W NETWORK REV C.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 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	0.354
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.200	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	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, 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	1	+0%	100/15 Summer				61.591
1.001	2	15 Winter	1	+0%	30/15 Summer				61.084
1.002	3	15 Winter	1	+0%	30/15 Summer				60.903
2.000	9	15 Winter	1	+0%	100/15 Summer				61.591
2.001	10	15 Winter	1	+0%	100/15 Summer				61.068
1.003	4	15 Winter	1	+0%	30/15 Summer				60.758
1.004	5	15 Winter	1	+0%	30/15 Summer				60.698
1.005	6	60 Winter	1	+0%	100/15 Summer				60.432
1.006	7	60 Winter	1	+0%	30/30 Summer				60.426

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	-0.109	0.000	0.16		3.5	OK	
1.001	2	-0.092	0.000	0.32		5.2	OK	
1.002	3	-0.100	0.000	0.24		5.2	OK	
2.000	9	-0.109	0.000	0.16		3.5	OK	

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 223-151 S.W NETWORK REV C.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
2.001	10	-0.101	0.000	0.23		5.3	OK	
1.003	4	-0.038	0.000	0.90		10.4	OK	
1.004	5	-0.064	0.000	0.61		15.2	OK	
1.005	6	-0.155	0.000	0.11		3.9	OK	
1.006	7	-0.098	0.000	0.13		3.9	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-151 S.W NETWORK REV C.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 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	0.354
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.200	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	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, 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%	100/15 Summer				61.616
1.001	2	15 Winter	30	+0%	30/15 Summer				61.207
1.002	3	15 Winter	30	+0%	30/15 Summer				61.117
2.000	9	15 Winter	30	+0%	100/15 Summer				61.616
2.001	10	15 Winter	30	+0%	100/15 Summer				61.151
1.003	4	15 Winter	30	+0%	30/15 Summer				61.060
1.004	5	15 Winter	30	+0%	30/15 Summer				60.930
1.005	6	60 Winter	30	+0%	100/15 Summer				60.568
1.006	7	120 Winter	30	+0%	30/30 Summer				60.596

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	-0.084	0.000	0.39		8.6	OK	
1.001	2	0.031	0.000	0.76		12.5	SURCHARGED	
1.002	3	0.114	0.000	0.61		13.2	SURCHARGED	
2.000	9	-0.084	0.000	0.39		8.6	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 223-151 S.W NETWORK REV C.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
2.001	10	-0.018	0.000	0.57		13.1	OK	
1.003	4	0.264	0.000	2.14		24.7	SURCHARGED	
1.004	5	0.169	0.000	1.40		35.0	SURCHARGED	
1.005	6	-0.019	0.000	0.17		6.0	OK	
1.006	7	0.072	0.000	0.16		4.8	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-151 S.W NETWORK REV C.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 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	0.354
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.200	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	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, 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	100	+45%	100/15 Summer				62.022
1.001	2	15 Winter	100	+45%	30/15 Summer				61.884
1.002	3	15 Winter	100	+45%	30/15 Summer				61.708
2.000	9	15 Winter	100	+45%	100/15 Summer				61.946
2.001	10	15 Winter	100	+45%	100/15 Summer				61.785
1.003	4	15 Winter	100	+45%	30/15 Summer				61.590
1.004	5	120 Winter	100	+45%	30/15 Summer				61.554
1.005	6	120 Winter	100	+45%	100/15 Summer				61.542
1.006	7	120 Winter	100	+45%	30/30 Summer				61.538

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	0.322	0.000	0.63		13.9	FLOOD RISK	
1.001	2	0.708	0.000	0.98		16.2	FLOOD RISK	
1.002	3	0.705	0.000	0.81		17.4	FLOOD RISK	
2.000	9	0.246	0.000	0.64		14.1	FLOOD RISK	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 223-151 S.W NETWORK REV C.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
2.001	10	0.616	0.000	0.77		17.5	FLOOD RISK	
1.003	4	0.794	0.000	3.11		35.9	SURCHARGED	
1.004	5	0.792	0.000	1.05		26.3	SURCHARGED	
1.005	6	0.955	0.000	0.22		7.9	SURCHARGED	
1.006	7	1.014	0.000	0.16		5.0	SURCHARGED	

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