

Dudleys Structural and Civil Engineers		Page 1
Suite 3 Tithe House 35 Town Street Horsforth Leeds West Yorkshire LS18 5LJ		
Date 03/02/2017 10:43 File 170202 SW.MDX	Designed by VB Checked by AW	
Micro Drainage	Network 2015.1	

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)	5	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.900	Minimum Backdrop Height (m)	0.600
Ratio R	0.288	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	100	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	200
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.507	4-8	0.070

Total Area Contributing (ha) = 0.577

Total Pipe Volume (m³) = 359.514

Network Design Table for Storm

« - 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)	Auto Design
1.000	34.111	2.437	14.0	0.145	4.00	0.0	0.600	o	225	
2.000	5.000	0.050	100.0	0.000	4.00	0.0	0.600	o	450	
2.001	28.501	0.190	150.0	0.100	0.00	0.0	0.600	[]	22	
2.002	3.000	0.020	150.0	0.000	0.00	0.0	0.600	[]	22	
1.001	30.889	1.544	20.0	0.163	0.00	0.0	0.600	o	225	
1.002	19.966	0.133	150.1	0.000	0.00	0.0	0.600	[]	17	
1.003	11.561	0.077	150.1	0.000	0.00	0.0	0.600	[]	17	
3.000	7.146	0.071	100.6	0.000	4.00	0.0	0.600	o	450	
1.004	21.740	0.145	149.9	0.058	0.00	0.0	0.600	[]	17	
4.000	12.884	0.086	149.8	0.059	4.00	0.0	0.600	[]	17	
1.005	17.281	0.115	150.3	0.052	0.00	0.0	0.600	[]	17	
1.006	1.399	0.021	66.6	0.000	0.00	0.0	0.600	o	750	
1.007	2.247	0.022	102.1	0.000	0.00	0.0	0.600	o	150	

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	81.47	4.16	192.800	0.145	0.0	0.0	0.0	3.52	139.8	32.0
2.000	82.29	4.04	190.600	0.000	0.0	0.0	0.0	2.03	323.4	0.0
2.001	81.55	4.15	189.020	0.100	0.0	0.0	0.0	4.34	18471.3	22.1
2.002	81.47	4.16	188.830	0.100	0.0	0.0	0.0	4.34	18471.6	22.1
1.001	80.32	4.34	188.810	0.408	0.0	0.0	0.0	2.94	116.9	88.7
1.002	79.75	4.43	185.290	0.408	0.0	0.0	0.0	3.78	9986.5	88.7
1.003	79.43	4.48	185.157	0.408	0.0	0.0	0.0	3.78	9985.8	88.7
3.000	82.17	4.06	186.700	0.000	0.0	0.0	0.0	2.03	322.3	0.0
1.004	78.84	4.57	185.080	0.466	0.0	0.0	0.0	3.79	9992.9	99.5
4.000	82.18	4.06	185.021	0.059	0.0	0.0	0.0	3.79	9996.8	13.1
1.005	78.37	4.65	184.935	0.577	0.0	0.0	0.0	3.78	9981.6	122.5
1.006	78.33	4.65	184.820	0.577	0.0	0.0	0.0	3.43	1516.1	122.5
1.007	78.10	4.69	184.799	0.577	0.0	0.0	0.0	0.99	17.6«	122.5

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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coefficient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m ³ /ha Storage	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	2	Number of Storage Structures	2	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.900	Cv (Summer)	0.750
Return Period (years)	5	Ratio R	0.288	Cv (winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: SW1.1, DS/PN: 1.001, Volume (m³): 22.8

Unit Reference	MD-SHE-0094-5000-1800-5000	Diameter (mm)	94
Design Head (m)	1.800	Invert Level (m)	188.810
Design Flow (l/s)	5.0	Minimum Outlet Pipe Diameter (mm)	150
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	5.0	Kick-Flo®	0.838	3.5
Flush-Flo™	0.411	4.4	Mean Flow over Head Range	-	4.1

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)	Depth (m)	Flow (l/s)
0.100	3.0	0.800	3.7	2.000	5.2	4.000	7.3	7.000	9.5
0.200	4.0	1.000	3.8	2.200	5.5	4.500	7.7	7.500	9.8
0.300	4.3	1.200	4.1	2.400	5.7	5.000	8.1	8.000	10.1
0.400	4.4	1.400	4.4	2.600	5.9	5.500	8.4	8.500	10.4
0.500	4.4	1.600	4.7	3.000	6.3	6.000	8.8	9.000	10.7
0.600	4.3	1.800	5.0	3.500	6.8	6.500	9.1	9.500	11.0

Hydro-Brake Optimum® Manhole: SW1.7 FC, DS/PN: 1.007, Volume (m³): 12.0

Unit Reference	MD-SHE-0092-5000-2000-5000	Diameter (mm)	92
Design Head (m)	2.000	Invert Level (m)	184.799
Design Flow (l/s)	5.0	Minimum Outlet Pipe Diameter (mm)	150
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	5.0	Kick-Flo®	0.816	3.3
Flush-Flo™	0.398	4.1	Mean Flow over Head Range	-	3.9

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)	Depth (m)	Flow (l/s)
0.100	2.9	0.800	3.4	2.000	5.0	4.000	6.9	7.000	9.0
0.200	3.8	1.000	3.6	2.200	5.2	4.500	7.3	7.500	9.3
0.300	4.1	1.200	3.9	2.400	5.4	5.000	7.7	8.000	9.6
0.400	4.1	1.400	4.2	2.600	5.6	5.500	8.0	8.500	9.9
0.500	4.1	1.600	4.5	3.000	6.0	6.000	8.4	9.000	10.2
0.600	4.0	1.800	4.8	3.500	6.5	6.500	8.7	9.500	10.4

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
1.000	SW1.0	0.500
2.000	PRVT ATT 1	0.500
2.001	SW2.1	1.200
2.002	SW2.2	0.500
1.001	SW1.1	0.500
1.002	SW1.2	0.500
1.003	SW1.3	0.500
3.000	PRVT ATT 2	0.500
1.004	SW1.4	0.500
4.000	SW4.0	0.500
1.005	SW1.5	1.200
1.006	SW1.6	0.500
1.007	SW1.7 FC	0.900

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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 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
 Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
 Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 2 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.200 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.250 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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	SW1.0	15 winter	1	+0%					192.856	-0.169	0.000	0.14
2.000	PRVT ATT 1	360 winter	1	+0%	100/180 winter				190.600	-0.450	0.000	0.00
2.001	SW2.1	180 winter	1	+0%	100/60 winter				189.445	-1.375	0.000	0.00
2.002	SW2.2	180 winter	1	+0%	100/60 Summer				189.445	-1.185	0.000	0.00
1.001	SW1.1	180 winter	1	+0%	1/15 Summer				189.449	0.414	0.000	0.04
1.002	SW1.2	960 winter	1	+0%	100/1440 winter				185.478	-1.312	0.000	0.00
1.003	SW1.3	960 winter	1	+0%	100/960 winter				185.479	-1.178	0.000	0.00
3.000	PRVT ATT 2	360 winter	1	+0%					186.700	-0.450	0.000	0.00
1.004	SW1.4	960 winter	1	+0%	100/720 winter				185.479	-1.101	0.000	0.00
4.000	SW4.0	960 winter	1	+0%	100/600 winter				185.478	-1.043	0.000	0.00
1.005	SW1.5	960 winter	1	+0%	100/480 winter				185.479	-0.956	0.000	0.00
1.006	SW1.6	960 winter	1	+0%	30/120 winter				185.478	-0.092	0.000	0.01
1.007	SW1.7 FC	960 winter	1	+0%	1/15 Summer				185.479	0.530	0.000	0.41

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW1.0		18.7	OK	
2.000	PRVT ATT 1		0.0	OK	
2.001	SW2.1		3.3	OK	
2.002	SW2.2		7.5	OK	
1.001	SW1.1		4.4	SURCHARGED	
1.002	SW1.2		4.4	OK	
1.003	SW1.3		4.2	OK	
3.000	PRVT ATT 2		0.0	OK	
1.004	SW1.4		4.9	OK	
4.000	SW4.0		0.9	OK	
1.005	SW1.5		6.6	OK	
1.006	SW1.6		5.6	OK	
1.007	SW1.7 FC		4.1	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 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
 Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
 Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 2 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.200 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.250 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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m ³)	Flow / Cap.
1.000	SW1.0	15 winter	30	+0%					192.891	-0.134	0.000	0.35
2.000	PRVT ATT 1	360 winter	30	+0%	100/180 winter				190.600	-0.450	0.000	0.00
2.001	SW2.1	360 winter	30	+0%	100/60 winter				190.449	-0.371	0.000	0.00
2.002	SW2.2	360 winter	30	+0%	100/60 Summer				190.449	-0.181	0.000	0.00
1.001	SW1.1	360 winter	30	+0%	1/15 Summer				190.450	-1.415	0.000	0.04
1.002	SW1.2	2880 winter	30	+0%	100/1440 winter				186.041	-0.749	0.000	0.00
1.003	SW1.3	2880 winter	30	+0%	100/960 winter				186.041	-0.616	0.000	0.00
3.000	PRVT ATT 2	360 winter	30	+0%					186.700	-0.450	0.000	0.00
1.004	SW1.4	2880 winter	30	+0%	100/720 winter				186.041	-0.539	0.000	0.00
4.000	SW4.0	2880 winter	30	+0%	100/600 winter				186.041	-0.480	0.000	0.00
1.005	SW1.5	2880 winter	30	+0%	100/480 winter				186.041	-0.394	0.000	0.00
1.006	SW1.6	2880 winter	30	+0%	30/120 winter				186.041	0.471	0.000	0.02
1.007	SW1.7 FC	2880 winter	30	+0%	1/15 Summer				186.043	1.094	0.000	0.41

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW1.0		45.7	OK	
2.000	PRVT ATT 1		0.0	OK	
2.001	SW2.1		4.3	OK	
2.002	SW2.2		7.1	OK	
1.001	SW1.1		4.8	SURCHARGED	
1.002	SW1.2		4.4	OK	
1.003	SW1.3		4.2	OK	
3.000	PRVT ATT 2		0.0	OK	
1.004	SW1.4		5.0	OK	
4.000	SW4.0		0.8	OK	
1.005	SW1.5		7.7	OK	
1.006	SW1.6		5.9	SURCHARGED	
1.007	SW1.7 FC		4.1	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 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
 Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
 Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 2 Number of Storage Structures 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.200 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.250 Cv (winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
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Profile(s) Summer and winter
 Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	SW1.0	15 winter	100	+30%					192.924	-0.101	0.000	0.58
2.000	PRVT ATT 1	360 winter	100	+30%	100/180 winter				191.155	0.105	0.000	0.06
2.001	SW2.1	480 winter	100	+30%	100/60 winter				191.162	0.342	0.000	0.00
2.002	SW2.2	480 winter	100	+30%	100/60 Summer				191.163	0.533	0.000	0.00
1.001	SW1.1	480 winter	100	+30%	1/15 Summer				191.163	2.128	0.000	0.05
1.002	SW1.2	2160 winter	100	+30%	100/1440 winter				186.836	0.046	0.000	0.00
1.003	SW1.3	2160 winter	100	+30%	100/960 winter				186.837	0.180	0.000	0.00
3.000	PRVT ATT 2	2160 winter	100	+30%					186.808	-0.342	0.000	0.01
1.004	SW1.4	2160 winter	100	+30%	100/720 winter				186.836	0.256	0.000	0.00
4.000	SW4.0	2160 winter	100	+30%	100/600 winter				186.837	0.316	0.000	0.00
1.005	SW1.5	2160 winter	100	+30%	100/480 winter				186.837	0.402	0.000	0.00
1.006	SW1.6	2160 winter	100	+30%	30/120 winter				186.839	1.269	0.000	0.03
1.007	SW1.7 FC	2160 winter	100	+30%	1/15 Summer				186.843	1.894	0.000	0.50

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW1.0		76.8	OK	
2.000	PRVT ATT 1		10.2	SURCHARGED	
2.001	SW2.1		8.7	SURCHARGED	
2.002	SW2.2		7.6	SURCHARGED	
1.001	SW1.1		5.7	SURCHARGED	
1.002	SW1.2		5.4	SURCHARGED	
1.003	SW1.3		16.4	SURCHARGED	
3.000	PRVT ATT 2		1.1	OK	
1.004	SW1.4		14.0	SURCHARGED	
4.000	SW4.0		1.6	SURCHARGED	
1.005	SW1.5		13.7	SURCHARGED	
1.006	SW1.6		10.9	SURCHARGED	
1.007	SW1.7 FC		5.0	SURCHARGED	