STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for 19-157-PDS-EXPORT.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	19.800	Add Flow / Climate Change (%)	0
Ratio R	0.271	Minimum Backdrop Height (m)	1.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	3.000
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

Network Design Table for 19-157-PDS-EXPORT.SWS

- Indicates pipe length does not match coordinates
« - 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)	Section Type	Auto Design
1.000	15.113	0.421	35.9	0.201	6.00	0.0	0.600	o	1200	Pipe/Conduit	
2.000	9.880	0.050	197.6	0.000	6.00	0.0	0.600	o	900	Pipe/Conduit	
2.001	19.999	0.556	36.0	0.000	0.00	0.0	0.600	o	1350	Pipe/Conduit	
1.001	15.175	0.529	28.7	0.000	0.00	0.0	0.600	o	1350	Pipe/Conduit	
1.002	24.365	2.366	10.3	0.013	0.00	0.0	0.600	o	150	Pipe/Conduit	
3.000	16.034	0.484	33.1	0.031	6.00	0.0	0.600	o	150	Pipe/Conduit	
3.001	10.402	1.040	10.0	0.029	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	41.33	6.04	207.715	0.201	0.0	0.0	0.0	6.25	7072.8	22.5
2.000	41.23	6.07	208.200	0.000	0.0	0.0	0.0	2.23	1415.8	0.0
2.001	41.10	6.12	207.700	0.000	0.0	0.0	0.0	6.72	9611.8	0.0
1.001	41.00	6.16	207.144	0.201	0.0	0.0	0.0	7.52	10765.3	22.5
1.002	40.66	6.29	206.615	0.214	0.0	0.0	0.0	3.16	55.8	23.6
3.000	41.02	6.15	205.773	0.031	0.0	0.0	0.0	1.76	31.0	3.4
3.001	40.87	6.21	205.289	0.060	0.0	0.0	0.0	3.20	56.6	6.6

Network Design Table for 19-157-PDS-EXPORT.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	7.371	0.680	10.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	13.019	1.267	10.3	0.113	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.000	21.000#	0.021	1000.0	0.000	6.00	0.0	0.030	o	1950	Pipe/Conduit	
5.000	18.000	0.018	1000.0	0.051	6.00	0.0	0.030	o	1950	Pipe/Conduit	
4.001	8.776	0.009	975.1	0.021	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.005	2.476	0.112	22.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.006	6.275	0.476	13.2	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.007	33.057	0.395	83.7	0.013	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.008	30.590	3.059	10.0	0.019	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.009	13.275	1.230	10.8	0.029	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)
1.003	40.55	6.33	204.249	0.274	0.0	0.0	0.0	3.08	54.4	30.1
1.004	40.37	6.39	203.569	0.387	0.0	0.0	0.0	3.16	55.9	42.3
4.000	40.94	6.18	201.182	0.000	0.0	0.0	0.0	1.94	5805.4	0.0
5.000	41.01	6.15	201.179	0.051	0.0	0.0	0.0	1.94	5805.4	5.7
4.001	40.54	6.33	201.161	0.072	0.0	0.0	0.0	1.00	633.0	7.9
1.005	40.32	6.41	201.102	0.459	0.0	0.0	0.0	2.15	38.0«	50.1
1.006	40.22	6.45	200.990	0.459	0.0	0.0	0.0	2.79	49.3«	50.1
1.007	38.96	6.95	200.514	0.472	0.0	0.0	0.0	1.10	19.4«	50.1
1.008	38.58	7.11	200.119	0.491	0.0	0.0	0.0	3.20	56.6	51.3
1.009	38.41	7.18	195.480	0.520	0.0	0.0	0.0	3.08	54.5	54.1

Free Flowing Outfall Details for 19-157-PDS-EXPORT.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009	16	195.100	194.250	0.000	1200	0

Simulation Criteria for 19-157-PDS-EXPORT.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	0
Number of Online Controls	2	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	0.324		

Online Controls for 19-157-PDS-EXPORT.SWS

Hydro-Brake® Optimum Manhole: EXGS5, DS/PN: 1.002, Volume (m³): 33.3

Unit Reference	MD-SHE-0084-4200-2000-4200
Design Head (m)	2.000
Design Flow (l/s)	4.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	84
Invert Level (m)	206.615
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	4.2
Flush-Flo™	0.363	3.3
Kick-Flo®	0.745	2.7
Mean Flow over Head Range	-	3.3

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	2.5	1.200	3.3	3.000	5.1	7.000	7.6
0.200	3.1	1.400	3.6	3.500	5.4	7.500	7.8
0.300	3.3	1.600	3.8	4.000	5.8	8.000	8.0
0.400	3.3	1.800	4.0	4.500	6.1	8.500	8.3
0.500	3.3	2.000	4.2	5.000	6.4	9.000	8.5
0.600	3.1	2.200	4.4	5.500	6.7	9.500	8.7
0.800	2.8	2.400	4.6	6.000	7.0		
1.000	3.0	2.600	4.7	6.500	7.3		

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.005, Volume (m³): 15.6

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)	201.102
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.005, Volume (m³): 15.6

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

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 19-157-PDS-EXPORT.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	0
Number of Online Controls	2	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	0.271
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.800	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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160
Return Period(s) (years)	1, 30
Climate Change (%)	0, 0

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	EXGS1	15 Winter	1	+0%					207.764
2.000	EXGS2	120 Winter	1	+0%					208.200
2.001	EXGS3	120 Winter	1	+0%					207.700
1.001	EXGS4	120 Winter	1	+0%					207.436
1.002	EXGS5	120 Winter	1	+0%	1/15 Summer				207.436
3.000	6	15 Winter	1	+0%					205.807
3.001	7	15 Winter	1	+0%					205.325
1.003	8	15 Winter	1	+0%					204.295
1.004	9	15 Winter	1	+0%	30/15 Summer				203.637
4.000	12	480 Winter	1	+0%					201.772
5.000	18	480 Winter	1	+0%					201.772
4.001	17	480 Winter	1	+0%	30/60 Summer				201.772
1.005	10	480 Winter	1	+0%	1/15 Summer				201.772
1.006	11	960 Winter	1	+0%					201.024
1.007	13	15 Winter	1	+0%					200.573
1.008	14	15 Winter	1	+0%					200.157
1.009	15	15 Winter	1	+0%					195.528

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 19-157-PDS-EXPORT.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	EXGS1	-1.151	0.000	0.01		22.5	OK	
2.000	EXGS2	-0.900	0.000	0.00		0.0	OK	
2.001	EXGS3	-1.350	0.000	0.00		0.0	OK	
1.001	EXGS4	-1.058	0.000	0.00		9.2	OK	
1.002	EXGS5	0.671	0.000	0.06		3.3	SURCHARGED	
3.000	6	-0.116	0.000	0.12		3.5	OK	
3.001	7	-0.114	0.000	0.13		6.4	OK	
1.003	8	-0.104	0.000	0.21		9.7	OK	
1.004	9	-0.082	0.000	0.42		21.2	OK	
4.000	12	-1.360	0.000	0.00		0.7	OK	
5.000	18	-1.357	0.000	0.00		0.9	OK	
4.001	17	-0.289	0.000	0.01		3.6	OK	
1.005	10	0.520	0.000	0.23		4.9	SURCHARGED	
1.006	11	-0.116	0.000	0.12		4.9	OK	
1.007	13	-0.091	0.000	0.33		6.1	OK	
1.008	14	-0.112	0.000	0.15		8.0	OK	
1.009	15	-0.102	0.000	0.22		11.0	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 19-157-PDS-EXPORT.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	0
Number of Online Controls	2	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	0.271
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.800	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, 180, 240, 360, 480, 600, 720, 960, 1440, 2160
Return Period(s) (years)	1, 30
Climate Change (%)	0, 0

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	EXGS1	180 Winter	30	+0%					208.029
2.000	EXGS2	120 Winter	30	+0%					208.200
2.001	EXGS3	180 Winter	30	+0%					208.029
1.001	EXGS4	180 Winter	30	+0%					208.029
1.002	EXGS5	180 Winter	30	+0%	1/15 Summer				208.029
3.000	6	15 Winter	30	+0%					205.828
3.001	7	15 Winter	30	+0%					205.350
1.003	8	15 Winter	30	+0%					204.318
1.004	9	15 Winter	30	+0%	30/15 Summer				203.915
4.000	12	480 Winter	30	+0%					202.530
5.000	18	480 Winter	30	+0%					202.530
4.001	17	480 Winter	30	+0%	30/60 Summer				202.530
1.005	10	480 Winter	30	+0%	1/15 Summer				202.550
1.006	11	480 Winter	30	+0%					201.024
1.007	13	15 Winter	30	+0%					200.587
1.008	14	15 Summer	30	+0%					200.172
1.009	15	15 Winter	30	+0%					195.554

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 19-157-PDS-EXPORT.SWS

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	EXGS1	-0.886	0.000	0.01		17.7	OK	
2.000	EXGS2	-0.900	0.000	0.00		0.0	OK	
2.001	EXGS3	-1.021	0.000	0.00		0.3	OK	
1.001	EXGS4	-0.465	0.000	0.00		9.8	OK	
1.002	EXGS5	1.264	0.000	0.07		3.6	SURCHARGED	
3.000	6	-0.095	0.000	0.30		8.5	OK	
3.001	7	-0.089	0.000	0.34		17.4	OK	
1.003	8	-0.081	0.000	0.43		20.2	OK	
1.004	9	0.196	0.000	1.06		54.0	SURCHARGED	
4.000	12	-0.602	0.000	0.00		0.7	OK	
5.000	18	-0.599	0.000	0.00		2.0	OK	
4.001	17	0.469	0.000	0.01		5.4	SURCHARGED	
1.005	10	1.298	0.000	0.23		4.9	SURCHARGED	
1.006	11	-0.116	0.000	0.12		4.9	OK	
1.007	13	-0.077	0.000	0.48		9.0	OK	
1.008	14	-0.097	0.000	0.27		14.9	OK	
1.009	15	-0.076	0.000	0.48		24.1	OK	