STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for RHEDA 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	16.820	0.168	100.1	0.105	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	47.407	0.297	159.6	0.114	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	19.282	0.140	137.7	0.089	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	13.141	1.591	8.3	0.013	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	37.225	0.219	170.0	0.188	5.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	24.923	0.102	245.0	0.114	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	27.304	0.090	305.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.000	35.130	1.536	22.9	0.051	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	26.611	0.109	244.1	0.033	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.006	44.157	1.993	22.2	0.033	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.007	13.899	0.560	24.8	0.103	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.000	25.821	1.291	20.0	0.078	5.00	0.0	0.600	o	225	Pipe/Conduit	
4.001	31.605	1.181	26.8	0.072	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.002	35.620	0.291	122.4	0.068	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.003	66.651	1.132	58.9	0.079	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.004	6.504	0.027	240.9	0.025	0.00	0.0	0.600	o	300	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	0.00	5.18	143.800	0.105	0.0	0.0	0.0	1.57	111.1	0.0
1.001	0.00	5.81	143.632	0.219	0.0	0.0	0.0	1.24	87.8	0.0
1.002	0.00	6.05	143.335	0.308	0.0	0.0	0.0	1.34	94.6	0.0
1.003	0.00	6.09	143.195	0.321	0.0	0.0	0.0	5.50	389.0	0.0
2.000	0.00	5.62	142.000	0.188	0.0	0.0	0.0	1.00	39.8	0.0
2.001	0.00	6.04	141.706	0.302	0.0	0.0	0.0	1.00	70.7	0.0
1.004	0.00	6.54	141.529	0.623	0.0	0.0	0.0	1.03	114.0	0.0
3.000	0.00	5.28	143.200	0.051	0.0	0.0	0.0	2.11	37.4	0.0
1.005	0.00	6.92	141.439	0.707	0.0	0.0	0.0	1.16	127.6	0.0
1.006	0.00	7.11	141.330	0.740	0.0	0.0	0.0	3.86	426.8	0.0
1.007	0.00	7.17	139.337	0.843	0.0	0.0	0.0	3.65	403.1	0.0
4.000	0.00	5.15	142.897	0.078	0.0	0.0	0.0	2.94	116.9	0.0
4.001	0.00	5.35	141.606	0.150	0.0	0.0	0.0	2.54	101.0	0.0
4.002	0.00	5.77	140.350	0.218	0.0	0.0	0.0	1.42	100.4	0.0
4.003	0.00	6.31	140.059	0.297	0.0	0.0	0.0	2.05	145.1	0.0
4.004	0.00	6.42	138.927	0.322	0.0	0.0	0.0	1.01	71.3	0.0

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for RHEDA 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
4.005	14.398	0.048	300.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.008	8.049	0.028	287.5	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.009	33.224	0.083	400.3	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.010	46.191	1.033	44.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.011	47.078	0.471	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.012	90.000	2.725	33.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.013	90.000	3.150	28.6	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.014	38.740	1.114	34.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.015	55.223	0.325	169.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.016	55.223	0.325	169.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.017	56.264	0.331	170.0	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)
4.005	0.00	6.65	138.825	0.322	0.0	0.0	0.0	1.04	115.0	0.0
1.008	0.00	7.28	138.627	1.165	0.0	0.0	0.0	1.32	284.9	0.0
1.009	0.00	7.77	138.599	1.165	0.0	0.0	0.0	1.11	241.0	0.0
1.010	0.00	8.28	138.516	1.165	0.0	0.0	0.0	1.51	26.7	0.0
1.011	0.00	9.06	137.483	1.165	0.0	0.0	0.0	1.01	17.8	0.0
1.012	0.00	9.92	137.012	1.165	0.0	0.0	0.0	1.76	31.1	0.0
1.013	0.00	10.71	134.287	1.165	0.0	0.0	0.0	1.89	33.4	0.0
1.014	0.00	11.09	131.137	1.165	0.0	0.0	0.0	1.71	30.3	0.0
1.015	0.00	12.01	129.948	1.165	0.0	0.0	0.0	1.00	39.8	0.0
1.016	0.00	12.93	129.623	1.165	0.0	0.0	0.0	1.00	39.8	0.0
1.017	0.00	13.87	129.298	1.165	0.0	0.0	0.0	1.00	39.8	0.0

Free Flowing Outfall Details for RHEDA SW.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.017	UU MANHOLE	140.330	128.967	0.000	1200	0

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Simulation Criteria for RHEDA 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 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)	17.500	Storm Duration (mins)	30
Ratio R	0.246		

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Online Controls for RHEDA SW.SWS

Hydro-Brake® Optimum Manhole: HB, DS/PN: 1.010, Volume (m³): 11.9

Unit Reference	MD-SHE-0101-6000-1984-6000
Design Head (m)	1.984
Design Flow (l/s)	6.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	138.516
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.984	6.0
Flush-Flo™	0.440	5.2
Kick-Flo®	0.898	4.2
Mean Flow over Head Range	-	4.8

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	4.7	1.400	5.1	3.500	7.8	7.500	11.2
0.300	5.1	1.600	5.4	4.000	8.3	8.000	11.6
0.400	5.2	1.800	5.7	4.500	8.8	8.500	11.9
0.500	5.2	2.000	6.0	5.000	9.3	9.000	12.3
0.600	5.1	2.200	6.3	5.500	9.7	9.500	12.6
0.800	4.7	2.400	6.6	6.000	10.1		
1.000	4.4	2.600	6.8	6.500	10.5		

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Storage Structures for RHEDA SW.SWS

Infiltration Basin Manhole: HB, DS/PN: 1.010

Invert Level (m) 138.516 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01530 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01530

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	234.0	1.984	1210.0

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Summary of Critical Results by Maximum Level (Rank 1) for RHEDA 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 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	0.250
Region	England and Wales	Cv (Summer)	1.000
M5-60 (mm)	17.100	Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	100
Climate Change (%)	40

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Summer	100	+40%	100/15 Summer			
1.001	2	15 Summer	100	+40%	100/15 Summer			
1.002	3	30 Summer	100	+40%	100/15 Summer			
1.003	4	30 Summer	100	+40%	100/15 Summer			
2.000	5	30 Summer	100	+40%	100/15 Summer	100/15 Summer		
2.001	6	30 Summer	100	+40%	100/15 Summer			
1.004	7	30 Summer	100	+40%	100/15 Summer			
3.000	8	30 Summer	100	+40%	100/15 Summer			
1.005	9	30 Summer	100	+40%	100/15 Summer			
1.006	10	30 Summer	100	+40%	100/15 Summer			
1.007	11	30 Summer	100	+40%	100/15 Summer			
4.000	12	15 Summer	100	+40%				
4.001	13	30 Summer	100	+40%	100/15 Summer			
4.002	14	30 Summer	100	+40%	100/15 Summer			
4.003	15	30 Summer	100	+40%	100/15 Summer			
4.004	16	30 Summer	100	+40%	100/15 Summer			
4.005	17	360 Winter	100	+40%	100/15 Summer			

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Summary of Critical Results by Maximum Level (Rank 1) for RHEDA SW.SWS

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	1	144.967	0.867	0.000	0.65			61.8	SURCHARGED
1.001	2	144.907	0.975	0.000	1.45			119.3	SURCHARGED
1.002	3	144.365	0.730	0.000	2.00			164.3	SURCHARGED
1.003	4	143.862	0.367	0.000	0.52			162.9	SURCHARGED
2.000	5	143.910	1.685	13.208	2.44			91.8	FLOOD
2.001	6	143.698	1.692	0.000	1.94			122.2	SURCHARGED
1.004	7	143.452	1.548	0.000	2.71			270.1	SURCHARGED
3.000	8	143.557	0.207	0.000	0.80			28.7	SURCHARGED
1.005	9	142.849	1.035	0.000	2.75			305.4	SURCHARGED
1.006	10	142.041	0.336	0.000	0.81			315.3	SURCHARGED
1.007	11	140.748	1.036	0.000	1.20			352.8	SURCHARGED
4.000	12	143.003	-0.119	0.000	0.45			48.2	OK
4.001	13	142.579	0.748	0.000	0.85			80.6	SURCHARGED
4.002	14	141.855	1.205	0.000	1.11			102.8	FLOOD RISK
4.003	15	141.491	1.132	0.000	0.98			136.5	FLOOD RISK
4.004	16	140.409	1.182	0.000	2.85			144.6	FLOOD RISK
4.005	17	140.222	1.022	0.000	0.40			36.8	SURCHARGED

PN	US/MH Name	Level Exceeded
1.000	1	
1.001	2	
1.002	3	
1.003	4	
2.000	5	5
2.001	6	
1.004	7	
3.000	8	
1.005	9	
1.006	10	
1.007	11	
4.000	12	
4.001	13	
4.002	14	
4.003	15	
4.004	16	
4.005	17	

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Summary of Critical Results by Maximum Level (Rank 1) for RHEDA SW.SWS

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.008	18	360 Winter	100	+40%	100/15 Summer				140.220
1.009	19	360 Winter	100	+40%	100/15 Summer				140.218
1.010	HB	360 Winter	100	+40%	100/15 Summer				140.214
1.011	20	360 Winter	100	+40%					137.541
1.012	21	360 Winter	100	+40%					137.055
1.013	22	360 Winter	100	+40%					134.328
1.014	23	360 Winter	100	+40%					131.181
1.015	24	360 Winter	100	+40%					130.005
1.016	25	360 Winter	100	+40%					129.680
1.017	26	360 Winter	100	+40%					129.355

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.008	18	1.068	0.000	0.77			135.1	SURCHARGED	
1.009	19	1.094	0.000	0.66			134.6	SURCHARGED	
1.010	HB	1.548	0.000	0.22			5.6	FLOOD RISK	
1.011	20	-0.092	0.000	0.32			5.6	OK	
1.012	21	-0.107	0.000	0.18			5.6	OK	
1.013	22	-0.109	0.000	0.17			5.6	OK	
1.014	23	-0.106	0.000	0.19			5.6	OK	
1.015	24	-0.168	0.000	0.15			5.6	OK	
1.016	25	-0.168	0.000	0.15			5.6	OK	
1.017	26	-0.168	0.000	0.15			5.6	OK	

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