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	Foul Sewage (l/s/ha)	0.000	Min Design Depth for Optimisation (m)	1.200
M5-60 (mm)	20.500	Volumetric Runoff Coeff.	0.750	Min Vel for Auto Design only (m/s)	1.00
Ratio R	0.422	Add Flow / Climate Change (%)	30	Min Slope for Optimisation (1:X)	500
Maximum Rainfall (mm/hr)	50	Minimum Backdrop Height (m)	0.200		
Maximum Time of Concentration (mins)	30	Maximum Backdrop Height (m)	1.500		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.209	4-8	0.533	8-12	0.177

Total Area Contributing (ha) = 0.919

Total Pipe Volume (m³) = 58.049

Network Design Table for Storm

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)

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)

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)
1.000	66.121	0.512	129.1	0.140	5.00	0.0	1.500	o	225
1.001	14.980	0.116	129.1	0.000	0.00	5.0	1.500	o	225
1.002	44.521	0.345	129.1	0.000	0.00	0.0	1.500	o	225
2.000	41.374	0.997	41.5	0.046	5.00	0.0	1.500	o	225
1.003	36.129	0.280	129.0	0.000	0.00	0.0	1.500	o	300
3.000	32.648	0.428	76.3	0.066	5.00	0.0	1.500	o	225
1.004	22.486	0.119	189.0	0.000	0.00	0.0	1.500	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	6.09	24.400	0.140	0.0	0.0	5.7	1.01	40.1	24.6
1.001	50.00	6.34	23.888	0.140	5.0	0.0	7.2	1.01	40.1	31.1
1.002	50.00	7.07	23.772	0.140	5.0	0.0	7.2	1.01	40.1	31.1
2.000	50.00	5.39	23.700	0.046	0.0	0.0	1.9	1.78	71.0	8.1
1.003	50.00	7.57	22.628	0.186	5.0	0.0	9.1	1.22	86.3	39.2
3.000	50.00	5.41	23.750	0.066	0.0	0.0	2.7	1.32	52.3	11.6
1.004	50.00	7.94	22.348	0.252	5.0	0.0	11.7	1.01	71.2	50.9

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)
4.000	40.999	0.930	44.1	0.040	5.00	0.0	1.500	o	225
1.005	45.727	0.241	189.7	0.000	0.00	0.0	1.500	o	375
1.006	30.000	0.289	103.8	0.000	0.00	0.0	1.500	o	300
5.000	35.897	0.300	119.7	0.160	5.00	0.0	1.500	o	300
6.000	32.290	0.533	60.6	0.040	5.00	0.0	1.500	o	225
6.001	20.796	0.362	57.5	0.020	0.00	0.0	1.500	o	225

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.000	50.00	5.39	23.600	0.040	0.0	0.0	1.6	1.73	68.8	7.0
1.005	50.00	8.59	22.154	0.292	5.0	0.0	13.4	1.16	128.4	57.9
1.006	50.00	8.96	21.913	0.292	5.0	0.0	13.4	1.36	96.2	57.9
5.000	50.00	5.47	23.275	0.160	0.0	0.0	6.5	1.27	89.6	28.2
6.000	50.00	5.36	24.400	0.040	0.0	0.0	1.6	1.48	58.7	7.0
6.001	50.00	5.59	23.867	0.060	0.0	0.0	2.4	1.52	60.3	10.6

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)
7.000	37.745	0.495	76.3	0.066	5.00	0.0	1.500	o	225
6.002	38.915	0.498	78.1	0.000	0.00	0.0	1.500	o	225
8.000	34.853	0.749	46.5	0.030	5.00	0.0	1.500	o	150
6.003	23.395	0.181	129.1	0.000	0.00	0.0	1.500	o	225
9.000	37.314	0.489	76.3	0.051	5.00	0.0	1.500	o	225
6.004	44.340	0.343	129.1	0.000	0.00	0.0	1.500	o	225

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
7.000	50.00	5.48	24.000	0.066	0.0	0.0	2.7	1.32	52.3	11.6
6.002	50.00	6.09	23.505	0.126	0.0	0.0	5.1	1.30	51.7	22.2
8.000	50.00	5.45	24.350	0.030	0.0	0.0	1.2	1.29	22.7	5.3
6.003	50.00	6.48	23.007	0.156	0.0	0.0	6.3	1.01	40.1	27.5
9.000	50.00	5.47	23.900	0.051	0.0	0.0	2.1	1.31	52.3	9.0
6.004	50.00	7.21	22.826	0.207	0.0	0.0	8.4	1.01	40.1	36.4

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)
1.007	80.674	0.393	205.2	0.000	0.00	0.0	1.500	o	375
10.000	8.383	0.113	74.2	0.000	5.00	0.0	1.500	o	375
1.008	28.065	0.137	205.2	0.000	0.00	0.0	1.500	o	375
1.009	5.000	0.024	205.2	0.000	0.00	0.0	1.500	o	375
11.000	7.000	0.092	76.0	0.260	5.00	5.0	1.500	o	225
1.010	29.863	0.110	272.7	0.000	0.00	0.0	1.500	o	525

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.007	50.00	10.16	21.549	0.659	5.0	0.0	28.3	1.12	123.5	122.5
10.000	50.00	5.08	22.100	0.000	0.0	0.0	0.0	1.86	205.7	0.0
1.008	50.00	10.58	21.156	0.659	5.0	0.0	28.3	1.12	123.5	122.5
1.009	50.00	10.66	21.019	0.659	5.0	0.0	28.3	1.12	123.5	122.5
11.000	50.00	5.09	23.200	0.260	5.0	0.0	12.1	1.32	52.4	52.3
1.010	49.85	11.07	20.845	0.919	10.0	0.0	40.2	1.20	260.7	174.3

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)
1.011	20.544	0.075	272.7	0.000	0.00	0.0	1.500	o	525

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.011	49.15	11.36	20.735	0.919	10.0	0.0	40.2	1.20	260.7	174.3

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)
SW 1	25.500	1.100	Open Manhole	1050	1.000	24.400	225				
SW2	25.500	1.612	Open Manhole	1050	1.001	23.888	225	1.000	23.888	225	
SW3	25.300	1.528	Open Manhole	1050	1.002	23.772	225	1.001	23.772	225	
SW4	25.000	1.300	Open Manhole	1050	2.000	23.700	225				
SW5	24.880	2.252	Open Manhole	1200	1.003	22.628	300	1.002	23.427	225	724
								2.000	22.703	225	
SW6	25.100	1.350	Open Manhole	1050	3.000	23.750	225				
SW7 (Dummy)	24.880	2.532	Open Manhole	1200	1.004	22.348	300	1.003	22.348	300	
								3.000	23.322	225	899
SW8	24.900	1.300	Open Manhole	1050	4.000	23.600	225				
SW9 (Dummy)	24.500	2.346	Open Manhole	1350	1.005	22.154	375	1.004	22.229	300	
								4.000	22.670	225	366
SW10	24.400	2.487	Open Manhole	1350	1.006	21.913	300	1.005	21.913	375	
SW11	24.700	1.425	Open Manhole	1050	5.000	23.275	300				
SW12	25.400	1.000	Open Manhole	1050	6.000	24.400	225				
SW13	25.400	1.533	Open Manhole	1050	6.001	23.867	225	6.000	23.867	225	
SW14	25.350	1.350	Open Manhole	1050	7.000	24.000	225				
SW15	25.350	1.845	Open Manhole	1200	6.002	23.505	225	6.001	23.505	225	
								7.000	23.505	225	
SW16	25.350	1.000	Open Manhole	1050	8.000	24.350	150				

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)
SW17	25.350	2.343	Open Manhole	1200	6.003	23.007	225	6.002	23.007	225	
								8.000	23.601	150	519
SW18	25.000	1.100	Open Manhole	1050	9.000	23.900	225				
SW19	25.000	2.174	Open Manhole	1200	6.004	22.826	225	6.003	22.826	225	
								9.000	23.411	225	585
SW20	24.400	2.851	Open Manhole	1350	1.007	21.549	375	1.006	21.624	300	
								5.000	22.975	300	1351
								6.004	22.482	225	783
Attenuation outlet	23.650	1.550	Open Manhole	1350	10.000	22.100	375				
SW21	23.750	2.594	Open Manhole	1350	1.008	21.156	375	1.007	21.156	375	
								10.000	21.987	375	831
SW22	23.750	2.731	Open Manhole	1350	1.009	21.019	375	1.008	21.019	375	
Porous Car Park	23.750	0.550	Open Manhole	1050	11.000	23.200	225				
SW23	23.750	2.905	Open Manhole	1500	1.010	20.845	525	1.009	20.995	375	
								11.000	23.108	225	1963
SW24	23.750	3.015	Open Manhole	1500	1.011	20.735	525	1.010	20.735	525	
Outfall	23.750	3.090	Open Manhole	1800		OUTFALL		1.011	20.660	525	

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	225	SW 1	25.500	24.400	0.875	Open Manhole	1050
1.001	o	225	SW2	25.500	23.888	1.387	Open Manhole	1050
1.002	o	225	SW3	25.300	23.772	1.303	Open Manhole	1050
2.000	o	225	SW4	25.000	23.700	1.075	Open Manhole	1050
1.003	o	300	SW5	24.880	22.628	1.952	Open Manhole	1200
3.000	o	225	SW6	25.100	23.750	1.125	Open Manhole	1050

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	66.121	129.1	SW2	25.500	23.888	1.387	Open Manhole	1050
1.001	14.980	129.1	SW3	25.300	23.772	1.303	Open Manhole	1050
1.002	44.521	129.1	SW5	24.880	23.427	1.228	Open Manhole	1200
2.000	41.374	41.5	SW5	24.880	22.703	1.952	Open Manhole	1200
1.003	36.129	129.0	SW7 (Dummy)	24.880	22.348	2.232	Open Manhole	1200
3.000	32.648	76.3	SW7 (Dummy)	24.880	23.322	1.333	Open Manhole	1200

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)
1.004	o	300	SW7 (Dummy)	24.880	22.348	2.232	Open Manhole	1200
4.000	o	225	SW8	24.900	23.600	1.075	Open Manhole	1050
1.005	o	375	SW9 (Dummy)	24.500	22.154	1.971	Open Manhole	1350
1.006	o	300	SW10	24.400	21.913	2.187	Open Manhole	1350
5.000	o	300	SW11	24.700	23.275	1.125	Open Manhole	1050

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)
1.004	22.486	189.0	SW9 (Dummy)	24.500	22.229	1.971	Open Manhole	1350
4.000	40.999	44.1	SW9 (Dummy)	24.500	22.670	1.605	Open Manhole	1350
1.005	45.727	189.7	SW10	24.400	21.913	2.112	Open Manhole	1350
1.006	30.000	103.8	SW20	24.400	21.624	2.476	Open Manhole	1350
5.000	35.897	119.7	SW20	24.400	22.975	1.125	Open Manhole	1350

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)
6.000	o	225	SW12	25.400	24.400	0.775	Open Manhole	1050
6.001	o	225	SW13	25.400	23.867	1.308	Open Manhole	1050
7.000	o	225	SW14	25.350	24.000	1.125	Open Manhole	1050
6.002	o	225	SW15	25.350	23.505	1.620	Open Manhole	1200
8.000	o	150	SW16	25.350	24.350	0.850	Open Manhole	1050

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)
6.000	32.290	60.6	SW13	25.400	23.867	1.308	Open Manhole	1050
6.001	20.796	57.5	SW15	25.350	23.505	1.620	Open Manhole	1200
7.000	37.745	76.3	SW15	25.350	23.505	1.620	Open Manhole	1200
6.002	38.915	78.1	SW17	25.350	23.007	2.118	Open Manhole	1200
8.000	34.853	46.5	SW17	25.350	23.601	1.599	Open Manhole	1200

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)
6.003	o	225	SW17	25.350	23.007	2.118	Open Manhole	1200
9.000	o	225	SW18	25.000	23.900	0.875	Open Manhole	1050
6.004	o	225	SW19	25.000	22.826	1.949	Open Manhole	1200
1.007	o	375	SW20	24.400	21.549	2.476	Open Manhole	1350

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)
6.003	23.395	129.1	SW19	25.000	22.826	1.949	Open Manhole	1200
9.000	37.314	76.3	SW19	25.000	23.411	1.364	Open Manhole	1200
6.004	44.340	129.1	SW20	24.400	22.482	1.693	Open Manhole	1350
1.007	80.674	205.2	SW21	23.750	21.156	2.219	Open Manhole	1350

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)
10.000	o	375	Attenuation outlet	23.650	22.100	1.175	Open Manhole	1350
1.008	o	375	SW21	23.750	21.156	2.219	Open Manhole	1350
1.009	o	375	SW22	23.750	21.019	2.356	Open Manhole	1350
11.000	o	225	Porous Car Park	23.750	23.200	0.325	Open Manhole	1050
1.010	o	525	SW23	23.750	20.845	2.380	Open Manhole	1500
1.011	o	525	SW24	23.750	20.735	2.490	Open Manhole	1500

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)
10.000	8.383	74.2	SW21	23.750	21.987	1.388	Open Manhole	1350
1.008	28.065	205.2	SW22	23.750	21.019	2.356	Open Manhole	1350
1.009	5.000	205.2	SW23	23.750	20.995	2.380	Open Manhole	1500
11.000	7.000	76.0	SW23	23.750	23.108	0.417	Open Manhole	1500
1.010	29.863	272.7	SW24	23.750	20.735	2.490	Open Manhole	1500
1.011	20.544	272.7	Outfall	23.750	20.660	2.565	Open Manhole	1800

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.140	0.140	0.140
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.046	0.046	0.046
1.003	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.066	0.066	0.066
1.004	-	-	100	0.000	0.000	0.000
4.000	-	-	100	0.040	0.040	0.040
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
5.000	-	-	100	0.160	0.160	0.160
6.000	-	-	100	0.040	0.040	0.040
6.001	-	-	100	0.020	0.020	0.020
7.000	-	-	100	0.066	0.066	0.066
6.002	-	-	100	0.000	0.000	0.000
8.000	-	-	100	0.030	0.030	0.030
6.003	-	-	100	0.000	0.000	0.000
9.000	-	-	100	0.051	0.051	0.051
6.004	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
10.000	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
11.000	-	-	100	0.260	0.260	0.260
1.010	-	-	100	0.000	0.000	0.000
1.011	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.919	0.919	0.919

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)
1.011	Outfall	23.750	20.660	20.000	1800	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	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	30.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	20.500	Cv (Summer)	0.750
Return Period (years)	100	Ratio R	0.422	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Storm

ACO Q-Brake Manhole: SW22, DS/PN: 1.009, Volume (m³): 6.9

Design Head (m) 3.000 Design Flow (l/s) 5.0 Diameter (mm) 65 Invert Level (m) 21.019

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)	Depth (m)	Flow (l/s)
0.100	1.5	0.600	2.5	1.600	3.7	2.600	4.7	5.000	6.5	7.500	7.9
0.200	2.1	0.800	2.6	1.800	3.9	3.000	5.0	5.500	6.8	8.000	8.2
0.300	2.5	1.000	2.9	2.000	4.1	3.500	5.4	6.000	7.1	8.500	8.5
0.400	2.5	1.200	3.2	2.200	4.3	4.000	5.8	6.500	7.4	9.000	8.7
0.500	2.5	1.400	3.4	2.400	4.5	4.500	6.2	7.000	7.7	9.500	8.9