STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for TUDOR.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	35
Ratio R	0.327	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

Network Design Table for TUDOR.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
1.000	17.949	0.179	100.0	0.010	5.00	0.0	0.600	o	150	Pipe/Conduit
1.001	12.052	0.366	33.0	0.004	0.00	0.0	0.600	o	150	Pipe/Conduit
2.000	12.309	0.123	100.1	0.010	5.00	0.0	0.600	o	150	Pipe/Conduit
2.001	17.209	0.172	100.1	0.005	0.00	0.0	0.600	o	150	Pipe/Conduit
1.002	8.170	0.044	185.7	0.011	0.00	0.0	0.600	o	150	Pipe/Conduit
1.003	18.249	0.147	124.1	0.019	0.00	0.0	0.600	o	150	Pipe/Conduit
3.000	9.936	0.054	184.0	0.009	5.00	0.0	0.600	o	150	Pipe/Conduit
3.001	9.965	0.054	184.5	0.000	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	5.30	68.000	0.010	0.0	0.0	0.5	1.00	17.8	1.8
1.001	50.00	5.41	67.821	0.014	0.0	0.0	0.7	1.76	31.1	2.6
2.000	50.00	5.20	67.750	0.010	0.0	0.0	0.5	1.00	17.8	1.8
2.001	50.00	5.49	67.627	0.015	0.0	0.0	0.7	1.00	17.8	2.7
1.002	50.00	5.68	67.455	0.040	0.0	0.0	1.9	0.73	13.0	7.3
1.003	50.00	6.01	67.411	0.059	0.0	0.0	2.8	0.90	15.9	10.8
3.000	50.00	5.22	67.420	0.009	0.0	0.0	0.4	0.74	13.0	1.6
3.001	50.00	5.45	67.366	0.009	0.0	0.0	0.4	0.74	13.0	1.6

©1982-2017 XP Solutions

Network Design Table for TUDOR.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
4.000	3.665	0.020	183.3	0.019	5.00	0.0	0.600	o	150	Pipe/Conduit
3.002	8.852	0.048	184.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit
1.004	25.386	0.137	185.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
5.000	11.399	0.062	183.9	0.013	5.00	0.0	0.600	o	150	Pipe/Conduit
1.005	11.862	0.064	185.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
6.000	25.477	0.138	184.6	0.026	5.00	0.0	0.600	o	150	Pipe/Conduit
1.006	5.150	0.028	183.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
1.007	4.087	0.054	75.7	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)
4.000	50.00	5.08	67.332	0.019	0.0	0.0	0.9	0.74	13.1	3.5
3.002	50.00	5.65	67.312	0.028	0.0	0.0	1.3	0.74	13.0	5.1
1.004	50.00	6.45	67.189	0.087	0.0	0.0	4.1	0.96	38.1	15.9
5.000	50.00	5.26	67.189	0.013	0.0	0.0	0.6	0.74	13.0	2.4
1.005	50.00	6.66	67.052	0.100	0.0	0.0	4.7	0.96	38.1	18.3
6.000	50.00	5.58	67.201	0.026	0.0	0.0	1.2	0.74	13.0	4.8
1.006	50.00	6.75	66.988	0.126	0.0	0.0	6.0	0.96	38.2	23.0
1.007	50.00	6.80	66.960	0.126	0.0	0.0	6.0	1.50	59.8	23.0

©1982-2017 XP Solutions

Manhole Schedules for TUDOR.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	68.600	0.600	Open Manhole	1200	1.000	68.000	150				
2	68.450	0.629	Open Manhole	1200	1.001	67.821	150	1.000	67.821	150	
10	68.450	0.700	Open Manhole	1200	2.000	67.750	150				
11	68.300	0.673	Open Manhole	1200	2.001	67.627	150	2.000	67.627	150	
3	68.300	0.845	Open Manhole	1200	1.002	67.455	150	1.001	67.455	150	
								2.001	67.455	150	
4	68.300	0.889	Open Manhole	1200	1.003	67.411	150	1.002	67.411	150	
12	68.300	0.880	Open Manhole	1200	3.000	67.420	150				
13	68.300	0.934	Open Manhole	1200	3.001	67.366	150	3.000	67.366	150	
15	68.300	0.968	Open Manhole	1200	4.000	67.332	150				
14	68.300	0.988	Open Manhole	1200	3.002	67.312	150	3.001	67.312	150	
								4.000	67.312	150	
5	68.300	1.111	Open Manhole	1200	1.004	67.189	225	1.003	67.264	150	
								3.002	67.264	150	
16	68.150	0.961	Open Manhole	1200	5.000	67.189	150				
6	68.150	1.098	Open Manhole	1200	1.005	67.052	225	1.004	67.052	225	
								5.000	67.127	150	
17	68.150	0.949	Open Manhole	1200	6.000	67.201	150				
7	68.100	1.112	Open Manhole	1200	1.006	66.988	225	1.005	66.988	225	
								6.000	67.063	150	
8	68.240	1.280	Open Manhole	1200	1.007	66.960	225	1.006	66.960	225	
9	67.878	0.972	Open Manhole	0		OUTFALL		1.007	66.906	225	

©1982-2017 XP Solutions

PIPELINE SCHEDULES for TUDOR.SWS

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	150	1	68.600	68.000	0.450	Open Manhole	1200
1.001	o	150	2	68.450	67.821	0.479	Open Manhole	1200
2.000	o	150	10	68.450	67.750	0.550	Open Manhole	1200
2.001	o	150	11	68.300	67.627	0.523	Open Manhole	1200
1.002	o	150	3	68.300	67.455	0.695	Open Manhole	1200
1.003	o	150	4	68.300	67.411	0.739	Open Manhole	1200
3.000	o	150	12	68.300	67.420	0.730	Open Manhole	1200
3.001	o	150	13	68.300	67.366	0.784	Open Manhole	1200
4.000	o	150	15	68.300	67.332	0.818	Open Manhole	1200
3.002	o	150	14	68.300	67.312	0.838	Open Manhole	1200
1.004	o	225	5	68.300	67.189	0.886	Open Manhole	1200
5.000	o	150	16	68.150	67.189	0.811	Open Manhole	1200

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	17.949	100.0	2	68.450	67.821	0.479	Open Manhole	1200
1.001	12.052	33.0	3	68.300	67.455	0.695	Open Manhole	1200
2.000	12.309	100.1	11	68.300	67.627	0.523	Open Manhole	1200
2.001	17.209	100.1	3	68.300	67.455	0.695	Open Manhole	1200
1.002	8.170	185.7	4	68.300	67.411	0.739	Open Manhole	1200
1.003	18.249	124.1	5	68.300	67.264	0.886	Open Manhole	1200
3.000	9.936	184.0	13	68.300	67.366	0.784	Open Manhole	1200
3.001	9.965	184.5	14	68.300	67.312	0.838	Open Manhole	1200
4.000	3.665	183.3	14	68.300	67.312	0.838	Open Manhole	1200
3.002	8.852	184.4	5	68.300	67.264	0.886	Open Manhole	1200
1.004	25.386	185.3	6	68.150	67.052	0.873	Open Manhole	1200
5.000	11.399	183.9	6	68.150	67.127	0.873	Open Manhole	1200

©1982-2017 XP Solutions

PIPELINE SCHEDULES for TUDOR.SWS

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)
1.005	o	225	6	68.150	67.052	0.873	Open Manhole	1200
6.000	o	150	17	68.150	67.201	0.799	Open Manhole	1200
1.006	o	225	7	68.100	66.988	0.887	Open Manhole	1200
1.007	o	225	8	68.240	66.960	1.055	Open Manhole	1200

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)
1.005	11.862	185.3	7	68.100	66.988	0.887	Open Manhole	1200
6.000	25.477	184.6	7	68.100	67.063	0.887	Open Manhole	1200
1.006	5.150	183.9	8	68.240	66.960	1.055	Open Manhole	1200
1.007	4.087	75.7	9	67.878	66.906	0.747	Open Manhole	0

Free Flowing Outfall Details for TUDOR.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.007	9	67.878	66.906	0.000	0	0

Simulation Criteria for TUDOR.SWS

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	35.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	120
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	2

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		

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.327
Return Period (years)	100	Profile Type	Winter
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

©1982-2017 XP Solutions

Synthetic Rainfall Details

Storm Duration (mins) 60

©1982-2017 XP Solutions

Online Controls for TUDOR.SWS

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.006, Volume (m³): 2.1

Unit Reference	MD-SHE-0105-5000-1000-5000
Design Head (m)	1.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	105
Invert Level (m)	66.988
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0	Kick-Flo®	0.637	4.1
Flush-Flo™	0.296	5.0	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	3.6	1.200	5.4	3.000	8.4	7.000	12.5
0.200	4.8	1.400	5.8	3.500	9.0	7.500	12.9
0.300	5.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	4.9	1.800	6.6	4.500	10.1	8.500	13.7
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.1
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.5
0.800	4.5	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.1		

©1982-2017 XP Solutions

Storage Structures for TUDOR.SWS

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

Invert Level (m) 67.052

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5.8	1.000	44.8

©1982-2017 XP Solutions

Summary of Results for 60 minute 100 year Winter (TUDOR.SWS)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	68.041	-0.109	0.000	0.17		2.8	OK
1.001	2	68.036	0.065	0.000	0.14		3.9	SURCHARGED
2.000	10	68.038	0.138	0.000	0.16		2.6	SURCHARGED
2.001	11	68.036	0.259	0.000	0.20		3.4	FLOOD RISK
1.002	3	68.033	0.429	0.000	0.66		7.4	FLOOD RISK
1.003	4	68.028	0.467	0.000	0.77		11.5	FLOOD RISK
3.000	12	68.023	0.453	0.000	0.14		1.7	FLOOD RISK
3.001	13	68.022	0.506	0.000	0.11		1.3	FLOOD RISK
4.000	15	68.022	0.540	0.000	0.41		4.1	FLOOD RISK
3.002	14	68.021	0.559	0.000	0.37		4.2	FLOOD RISK
1.004	5	68.017	0.603	0.000	0.42		14.9	FLOOD RISK
5.000	16	68.010	0.671	0.000	0.22		2.6	FLOOD RISK
1.005	6	68.008	0.731	0.000	0.15		4.8	FLOOD RISK
6.000	17	68.010	0.659	0.000	0.48		5.9	FLOOD RISK
1.006	7	67.994	0.781	0.000	0.18		5.0	FLOOD RISK
1.007	8	67.018	-0.167	0.000	0.15		5.0	OK

©1982-2017 XP Solutions