STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.377	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
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

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.018	4-8	0.008

Total Area Contributing (ha) = 0.026

Total Pipe Volume (m³) = 1.006

Network Design Table for Surface Network 1

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	8.316	0.104	80.0	0.013	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	10.883	0.136	80.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	8.675	0.108	80.0	0.014	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	8.141	0.102	80.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	16.292	0.165	98.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	2.450	0.245	10.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	2.165	0.257	8.4	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	5.12	32.955	0.013	0.0	0.0	0.0	1.12	19.9	1.7
1.001	50.00	5.28	32.851	0.013	0.0	0.0	0.0	1.12	19.9	1.7
2.000	50.00	5.13	32.950	0.014	0.0	0.0	0.0	1.12	19.9	1.9
2.001	50.00	5.25	32.817	0.014	0.0	0.0	0.0	1.12	19.9	1.9
1.002	50.00	5.55	32.715	0.026	0.0	0.0	0.0	1.01	17.9	3.6
1.003	50.00	5.57	32.550	0.026	0.0	0.0	0.0	3.20	56.6	3.6
1.004	50.00	5.58	31.277	0.026	0.0	0.0	0.0	3.49	61.7	3.6

©1982-2020 Innovyze

Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.007	0.007	0.007
	User	-	100	0.006	0.006	0.013
1.001	-	-	100	0.000	0.000	0.000
2.000	User	-	100	0.007	0.007	0.007
	User	-	100	0.007	0.007	0.014
2.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.026	0.026	0.026

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004	COM01	33.550	31.020	0.000	1200	0

Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	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)	18.000	Storm Duration (mins)	30
Ratio R	0.377		

©1982-2020 Innovyze

Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S4, DS/PN: 1.004, Volume (m³): 4.0

Unit Reference	MD-SHE-0093-5000-1900-5000
Design Head (m)	1.900
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	31.277
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)	1.900	5.0	Kick-Flo®	0.830	3.4
Flush-Flo™	0.406	4.3	Mean Flow over Head Range	-	4.0

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	3.6	2.000	5.1	4.000	7.1	7.000	9.2
0.200	3.9	1.000	3.7	2.200	5.4	4.500	7.5	7.500	9.5
0.300	4.2	1.200	4.0	2.400	5.6	5.000	7.9	8.000	9.8
0.400	4.3	1.400	4.3	2.600	5.8	5.500	8.2	8.500	10.1
0.500	4.2	1.600	4.6	3.000	6.2	6.000	8.6	9.000	10.4
0.600	4.1	1.800	4.9	3.500	6.7	6.500	8.9	9.500	10.7

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	RE1	0.023	0.147	0.000	0.170
1.001	S1	0.205	0.192	0.000	0.397
2.000	RE2	0.021	0.153	0.000	0.175
2.001	S8	0.202	0.144	0.000	0.346
1.002	S2	0.223	0.288	0.000	0.510
1.003	S3	0.274	0.043	0.000	0.318
1.004	S4	3.943	0.038	0.000	3.981
Total		4.891	1.006	0.000	5.897

©1982-2020 Innovyze

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	RE1	0.023	0.140	0.000	0.163
1.001	S1	0.205	0.182	0.000	0.387
2.000	RE2	0.021	0.146	0.000	0.167
2.001	S8	0.202	0.133	0.000	0.335
1.002	S2	0.223	0.277	0.000	0.500
1.003	S3	0.274	0.025	0.000	0.299
1.004	S4	3.943	0.014	0.000	3.957
Total		4.891	0.917	0.000	5.808

©1982-2020 Innovyze

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 18.000 Cv (Summer) 1.000
Region England and Wales Ratio R 0.377 Cv (Winter) 1.000

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, 240, 360, 480, 960, 1440
Return Period(s) (years) 100
Climate Change (%) 45

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
1.000	RE1	30 Summer	100	+45%	100/15 Summer				33.253	0.148	0.000
1.001	S1	30 Summer	100	+45%	100/15 Summer				33.246	0.245	0.000
2.000	RE2	30 Summer	100	+45%	100/15 Summer				33.253	0.153	0.000
2.001	S8	30 Summer	100	+45%	100/15 Summer				33.245	0.278	0.000
1.002	S2	30 Summer	100	+45%	100/15 Summer				33.237	0.372	0.000
1.003	S3	30 Summer	100	+45%	100/15 Summer				33.217	0.517	0.000
1.004	S4	30 Summer	100	+45%	100/15 Summer				33.211	1.784	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	RE1	0.48			8.4	FLOOD RISK	
1.001	S1	0.47			8.4	SURCHARGED	
2.000	RE2	0.51			9.0	FLOOD RISK	
2.001	S8	0.52			9.0	FLOOD RISK	
1.002	S2	0.98			16.3	FLOOD RISK	
1.003	S3	0.51			15.8	SURCHARGED	
1.004	S4	0.16			5.0	FLOOD RISK	

©1982-2020 Innovyze