STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 517559 283921 TL 17559 83921
Data Type	Point
Maximum Rainfall (mm/hr)	100
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
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	0.056	4-8	0.038

Total Area Contributing (ha) = 0.094

Total Pipe Volume (m³) = 1.562

Network Design Table for Surface Network 1

« - 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	11.438	0.046	250.0	0.012	5.00	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	100.00	5.30	10.994	0.012	0.0	0.0	0.0	0.63	11.2	3.4

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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
2.000	9.774	0.039	250.6	0.015	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	21.186	0.085	249.7	0.034	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	28.245	0.113	250.0	0.033	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	17.736	0.165	107.7	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)
2.000	100.00	5.26	10.987	0.015	0.0	0.0	0.0	0.63	11.1	4.1
1.001	100.00	5.86	10.948	0.061	0.0	0.0	0.0	0.63	11.2«	16.6
1.002	100.00	6.61	10.863	0.094	0.0	0.0	0.0	0.63	11.2«	25.5
1.003	100.00	6.91	10.750	0.094	0.0	0.0	0.0	0.97	17.1«	25.5

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Manhole Schedules for Surface Network 1

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)
S4	11.568	0.574	Open Manhole	1350	1.000	10.994	150				
S5	11.737	0.750	Open Manhole	1350	2.000	10.987	150				
S3	11.691	0.743	Open Manhole	1350	1.001	10.948	150	1.000	10.948	150	
								2.000	10.948	150	
S2	11.592	0.729	Open Manhole	1350	1.002	10.863	150	1.001	10.863	150	
S1	11.453	0.703	Open Manhole	1350	1.003	10.750	150	1.002	10.750	150	
9652	11.330	0.745	Open Manhole	1350		OUTFALL		1.003	10.585	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S4	516879.978	283594.539	516879.978	283594.539	Required	
S5	516895.074	283594.639	516895.074	283594.639	Required	
S3	516888.646	283602.002	516888.646	283602.002	Required	
S2	516890.479	283623.108	516890.479	283623.108	Required	
S1	516911.868	283641.555	516911.868	283641.555	Required	
9652	516908.803	283659.024			No Entry	



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PIPELINE SCHEDULES for Surface Network 1

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	S4	11.568	10.994	0.424	Open Manhole	1350
2.000	o	150	S5	11.737	10.987	0.600	Open Manhole	1350
1.001	o	150	S3	11.691	10.948	0.593	Open Manhole	1350
1.002	o	150	S2	11.592	10.863	0.579	Open Manhole	1350
1.003	o	150	S1	11.453	10.750	0.553	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)
1.000	11.438	250.0	S3	11.691	10.948	0.593	Open Manhole	1350
2.000	9.774	250.6	S3	11.691	10.948	0.593	Open Manhole	1350
1.001	21.186	249.7	S2	11.592	10.863	0.579	Open Manhole	1350
1.002	28.245	250.0	S1	11.453	10.750	0.553	Open Manhole	1350
1.003	17.736	107.7	9652	11.330	10.585	0.595	Open Manhole	1350

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)
1.003	9652	11.330	10.585	0.000	1350	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 Storage Structures	3
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 FEH
Return Period (years) 100

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Synthetic Rainfall Details

FEH Rainfall Version	2013
Site Location	GB 517559 283921 TL 17559 83921
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S1, DS/PN: 1.003, Volume (m³): 1.5

Unit Reference	MD-SHE-0073-2000-0600-2000
Design Head (m)	0.600
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	73
Invert Level (m)	10.750
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	2.0
Flush-Flo™	0.177	2.0
Kick-Flo®	0.397	1.7
Mean Flow over Head Range	-	1.7

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	1.9	1.200	2.7	3.000	4.2	7.000	6.3
0.200	2.0	1.400	2.9	3.500	4.5	7.500	6.5
0.300	1.9	1.600	3.1	4.000	4.8	8.000	6.7
0.400	1.7	1.800	3.3	4.500	5.1	8.500	6.9
0.500	1.8	2.000	3.5	5.000	5.3	9.000	7.1
0.600	2.0	2.200	3.6	5.500	5.6	9.500	7.3
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

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Storage Structures for Surface Network 1

Complex Manhole: S3, DS/PN: 1.001

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	13.9	Slope (1:X)	250.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	10.948	Membrane Depth (mm)	0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	15.0
Max Percolation (l/s)	41.7	Slope (1:X)	250.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	10.948	Membrane Depth (mm)	0

Porous Car Park Manhole: S2, DS/PN: 1.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	9.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	50.0	Slope (1:X)	250.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	10.863	Membrane Depth (mm)	0

Porous Car Park Manhole: S1, DS/PN: 1.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	8.5
Membrane Percolation (mm/hr)	1000	Length (m)	28.0
Max Percolation (l/s)	66.1	Slope (1:X)	250.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	10.750	Membrane Depth (mm)	0

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2 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 Storage Structures	3
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	FEH
FEH Rainfall Version	2013
Site Location	GB 517559 283921 TL 17559 83921
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	150.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 35, 40

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	S4	15 Summer	2	+0%	30/15 Summer				11.046
2.000	S5	15 Summer	2	+0%	30/15 Summer				11.046
1.001	S3	30 Summer	2	+0%	30/15 Summer				11.020
1.002	S2	120 Summer	2	+0%	30/15 Summer				10.945
1.003	S1	180 Summer	2	+0%	2/120 Summer				10.912

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S4	-0.098	0.000	0.26			2.6	OK	
2.000	S5	-0.091	0.000	0.32			3.2	OK	
1.001	S3	-0.078	0.000	0.47		15	4.9	OK	
1.002	S2	-0.068	0.000	0.57		36	6.1	OK	
1.003	S1	0.012	0.000	0.12		81	2.0	SURCHARGED	

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30 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 Storage Structures	3
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	FEH
FEH Rainfall Version	2013
Site Location	GB 517559 283921 TL 17559 83921
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	150.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 35, 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.	Water Level (m)
1.000	S4	30 Summer	30	+35%	30/15 Summer				11.191
2.000	S5	30 Summer	30	+35%	30/15 Summer				11.193
1.001	S3	30 Summer	30	+35%	30/15 Summer				11.179
1.002	S2	240 Winter	30	+35%	30/15 Summer				11.146
1.003	S1	240 Winter	30	+35%	2/120 Summer				11.136

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S4	0.047	0.000	0.72			7.2	SURCHARGED	
2.000	S5	0.056	0.000	0.91			9.1	SURCHARGED	

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

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
1.001	S3	0.081	0.000	1.12		25	11.7	SURCHARGED	
1.002	S2	0.133	0.000	0.63		236	6.8	SURCHARGED	
1.003	S1	0.236	0.000	0.12			2.0	SURCHARGED	

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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 Storage Structures	3
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	FEH
FEH Rainfall Version	2013
Site Location	GB 517559 283921 TL 17559 83921
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	150.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 35, 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.	Water Level (m)
1.000	S4	240 Winter	100	+40%	30/15 Summer				11.307
2.000	S5	240 Winter	100	+40%	30/15 Summer				11.307
1.001	S3	240 Winter	100	+40%	30/15 Summer				11.306
1.002	S2	240 Winter	100	+40%	30/15 Summer				11.299
1.003	S1	360 Winter	100	+40%	2/120 Summer				11.287

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S4	0.164	0.000	0.22			2.2	SURCHARGED	
2.000	S5	0.170	0.000	0.28			2.8	SURCHARGED	

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

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
1.001	S3	0.208	0.000	0.67			7.1	SURCHARGED	
1.002	S2	0.285	0.000	0.71			7.6	SURCHARGED	
1.003	S1	0.387	0.000	0.12			2.0	SURCHARGED	

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