


Topping Engineers Ltd		Page 1
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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)	100	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.350	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 Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.339	4-8	0.275

Total Area Contributing (ha) = 0.614


Total Pipe Volume (m³) = 29.654

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)	Section Type	Auto Design
1.000	147.600	0.738	200.0	0.214	5.00	0.0	0.600	o	375	Pipe/Conduit	
1.001	29.300	0.293	100.0	0.100	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.002	13.400	0.134	100.0	0.000	0.00	0.0	0.600	o	375	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	6.93	146.600	0.214	0.0	0.0	0.0	1.28	141.1	29.0
1.001	50.00	7.20	146.283	0.314	0.0	0.0	0.0	1.81	200.1	42.5
1.002	50.00	7.32	145.990	0.314	0.0	0.0	0.0	1.81	200.1	42.5


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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)	Section Type	Auto Design
2.000	23.800	1.190	20.0	0.026	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	4.600	0.019	242.1	0.044	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.000	57.200	0.572	100.0	0.230	5.00	0.0	0.600	o	300	Pipe/Conduit	
3.001	23.500	0.235	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.002	5.500	0.055	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	1.500	0.008	187.5	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.005	2.700	0.027	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	17.800	0.371	48.0	0.000	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)
2.000	50.00	5.18	147.000	0.026	0.0	0.0	0.0	2.26	40.0	3.5
1.003	50.00	7.38	145.856	0.384	0.0	0.0	0.0	1.16	128.1	52.0
3.000	50.00	5.61	146.700	0.230	0.0	0.0	0.0	1.57	111.1	31.1
3.001	50.00	5.86	146.128	0.230	0.0	0.0	0.0	1.57	111.1	31.1
3.002	50.00	5.91	145.893	0.230	0.0	0.0	0.0	1.57	111.1	31.1
1.004	50.00	7.40	145.400	0.614	0.0	0.0	0.0	1.32	145.8	83.1
1.005	50.00	7.43	145.392	0.614	0.0	0.0	0.0	1.57	111.1	83.1
1.006	50.00	7.56	145.365	0.614	0.0	0.0	0.0	2.28	160.8	83.1

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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)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	147.600	1.000	Open Manhole	1350	1.000	146.600	375				
2	147.760	1.898	Open Manhole	1350	1.001	146.283	375	1.000	145.862	375	
3	147.520	1.530	Open Manhole	1350	1.002	145.990	375	1.001	145.990	375	
4	147.950	0.950	Open Manhole	1200	2.000	147.000	150				
5	147.600	1.790	Open Manhole	1350	1.003	145.856	375	1.002	145.856	375	
								2.000	145.810	150	
6	147.500	0.800	Open Manhole	1200	3.000	146.700	300				
7	147.400	1.272	Open Manhole	1200	3.001	146.128	300	3.000	146.128	300	
8	147.550	1.657	Open Manhole	1200	3.002	145.893	300	3.001	145.893	300	
9	147.800	2.400	Open Manhole	1350	1.004	145.400	375	1.003	145.837	375	437
								3.002	145.838	300	363
10	147.650	2.258	Open Manhole	1350	1.005	145.392	300	1.004	145.392	375	
11	147.600	2.235	Open Manhole	1200	1.006	145.365	300	1.005	145.365	300	
	146.020	1.026	Open Manhole	0		OUTFALL		1.006	144.994	300	

No coordinates have been specified, layout information cannot be produced.


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	375	1	147.600	146.600	0.625	Open Manhole	1350
1.001	o	375	2	147.760	146.283	1.102	Open Manhole	1350
1.002	o	375	3	147.520	145.990	1.155	Open Manhole	1350
2.000	o	150	4	147.950	147.000	0.800	Open Manhole	1200
1.003	o	375	5	147.600	145.856	1.369	Open Manhole	1350
3.000	o	300	6	147.500	146.700	0.500	Open Manhole	1200
3.001	o	300	7	147.400	146.128	0.972	Open Manhole	1200
3.002	o	300	8	147.550	145.893	1.357	Open Manhole	1200
1.004	o	375	9	147.800	145.400	2.025	Open Manhole	1350
1.005	o	300	10	147.650	145.392	1.958	Open Manhole	1350
1.006	o	300	11	147.600	145.365	1.935	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	147.600	200.0	2	147.760	145.862	1.523	Open Manhole	1350
1.001	29.300	100.0	3	147.520	145.990	1.155	Open Manhole	1350
1.002	13.400	100.0	5	147.600	145.856	1.369	Open Manhole	1350
2.000	23.800	20.0	5	147.600	145.810	1.640	Open Manhole	1350
1.003	4.600	242.1	9	147.800	145.837	1.588	Open Manhole	1350
3.000	57.200	100.0	7	147.400	146.128	0.972	Open Manhole	1200
3.001	23.500	100.0	8	147.550	145.893	1.357	Open Manhole	1200
3.002	5.500	100.0	9	147.800	145.838	1.662	Open Manhole	1350
1.004	1.500	187.5	10	147.650	145.392	1.883	Open Manhole	1350
1.005	2.700	100.0	11	147.600	145.365	1.935	Open Manhole	1200
1.006	17.800	48.0		146.020	144.994	0.726	Open Manhole	0

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Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	1	375	0.625	1.523	Unclassified	1350	0	0.625	Unclassified
1.001	2	375	1.102	1.155	Unclassified	1350	0	1.102	Unclassified
1.002	3	375	1.155	1.369	Unclassified	1350	0	1.155	Unclassified
2.000	4	150	0.800	1.640	Unclassified	1200	0	0.800	Unclassified
1.003	5	375	1.369	1.588	Unclassified	1350	0	1.369	Unclassified
3.000	6	300	0.500	0.972	Unclassified	1200	0	0.500	Unclassified
3.001	7	300	0.972	1.357	Unclassified	1200	0	0.972	Unclassified
3.002	8	300	1.357	1.662	Unclassified	1200	0	1.357	Unclassified
1.004	9	375	1.883	2.025	Unclassified	1350	0	2.025	Unclassified
1.005	10	300	1.935	1.958	Unclassified	1350	0	1.958	Unclassified
1.006	11	300	0.726	1.935	Unclassified	1200	0	1.935	Unclassified

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)
1.006		146.020	144.994	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	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 Online Controls	1	Number of Storage Structures	1
		Number of Time/Area Diagrams	0
		Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.350		

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Online Controls for Storm


Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.005, Volume (m³): 3.2

Unit Reference	MD-SHE-0271-4190-1165-4190
Design Head (m)	1.165
Design Flow (l/s)	41.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	271
Invert Level (m)	145.392
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.165	41.9	Kick-Flo®	0.868	36.4
Flush-Flo™	0.440	41.9	Mean Flow over Head Range	-	34.7

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	8.6	1.200	42.5	3.000	66.1	7.000	99.8
0.200	27.9	1.400	45.8	3.500	71.3	7.500	103.3
0.300	40.8	1.600	48.8	4.000	76.0	8.000	106.6
0.400	41.8	1.800	51.6	4.500	80.5	8.500	109.8
0.500	41.8	2.000	54.3	5.000	84.7	9.000	112.9
0.600	41.2	2.200	56.9	5.500	88.8	9.500	115.9
0.800	38.5	2.400	59.3	6.000	92.6		
1.000	38.9	2.600	61.7	6.500	96.3		

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Storage Structures for Storm


Cellular Storage Manhole: 9, DS/PN: 1.004

Invert Level (m) 145.400 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	126.0	126.0	1.300	0.0	186.0
1.200	126.0	186.0			

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
1.000	1	0.500
1.001	2	0.500
1.002	3	0.500
2.000	4	0.500
1.003	5	0.500
3.000	6	0.500
3.001	7	0.500
3.002	8	0.500
1.004	9	0.500
1.005	10	0.500
1.006	11	0.500

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 Coefficient 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 1 Number of Real Time Controls 0


Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.361
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

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) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1 15	Winter	1	+0%	100/15	Summer			146.714
1.001	2 15	Winter	1	+0%	100/15	Winter			146.386
1.002	3 15	Winter	1	+0%	100/15	Summer			146.106
2.000	4 15	Winter	1	+0%					147.030
1.003	5 15	Winter	1	+0%	30/15	Winter			146.031
3.000	6 15	Winter	1	+0%	100/15	Summer			146.808
3.001	7 15	Winter	1	+0%	100/15	Summer			146.238
3.002	8 15	Winter	1	+0%	30/15	Winter			146.037
1.004	9 60	Winter	1	+0%	30/15	Summer			145.620
1.005	10 60	Winter	1	+0%	30/15	Summer			145.622
1.006	11 60	Winter	1	+0%					145.446

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged		Flooded	Flow / Overflow Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Overflow Cap. (l/s)					
1.000	1	-0.261	0.000	0.17			23.7	OK	
1.001	2	-0.272	0.000	0.17			29.4	OK	
1.002	3	-0.259	0.000	0.21			29.8	OK	
2.000	4	-0.120	0.000	0.09			3.3	OK	
1.003	5	-0.200	0.000	0.45			34.8	OK	
3.000	6	-0.192	0.000	0.27			28.7	OK	
3.001	7	-0.190	0.000	0.29			28.6	OK	
3.002	8	-0.156	0.000	0.46			28.5	OK	
1.004	9	-0.155	0.000	0.25		30	22.3	OK	
1.005	10	-0.070	0.000	0.36			21.7	OK	
1.006	11	-0.219	0.000	0.16			21.7	OK	

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

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 Coefficient 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 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.361
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840


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) 1, 30, 100
Climate Change (%) 0, 0, 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	1 15	Winter	30	+0%	100/15	Summer			146.786
1.001	2 15	Winter	30	+0%	100/15	Winter			146.467
1.002	3 15	Winter	30	+0%	100/15	Summer			146.285
2.000	4 15	Winter	30	+0%					147.047
1.003	5 15	Winter	30	+0%	30/15	Winter			146.233
3.000	6 15	Winter	30	+0%	100/15	Summer			146.884
3.001	7 15	Winter	30	+0%	100/15	Summer			146.322
3.002	8 15	Winter	30	+0%	30/15	Winter			146.205
1.004	9 60	Winter	30	+0%	30/15	Summer			145.989
1.005	10 60	Winter	30	+0%	30/15	Summer			145.991
1.006	11 30	Winter	30	+0%					145.478

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

PN	US/MH Name	Surcharged		Flooded	Flow / Overflow Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Overflow Cap. (l/s)					
1.000	1	-0.189	0.000	0.42			58.0	OK	
1.001	2	-0.191	0.000	0.47			82.9	OK	
1.002	3	-0.080	0.000	0.59			85.2	OK	
2.000	4	-0.103	0.000	0.21			8.1	OK	
1.003	5	0.002	0.000	1.30			101.6	SURCHARGED	
3.000	6	-0.116	0.000	0.67			70.4	OK	
3.001	7	-0.106	0.000	0.71			69.9	OK	
3.002	8	0.012	0.000	1.14			69.9	SURCHARGED	
1.004	9	0.214	0.000	0.51		33	45.8	SURCHARGED	
1.005	10	0.299	0.000	0.69			41.8	SURCHARGED	
1.006	11	-0.187	0.000	0.30			41.7	OK	

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

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 Coefficient 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 1 Number of Real Time Controls 0


Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.361
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

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) 1, 30, 100
Climate Change (%) 0, 0, 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	1 15	Winter	100	+40%	100/15	Summer			147.144
1.001	2 60	Winter	100	+40%	100/15	Winter			146.811
1.002	3 60	Winter	100	+40%	100/15	Summer			146.719
2.000	4 15	Winter	100	+40%					147.065
1.003	5 60	Winter	100	+40%	30/15	Winter			146.634
3.000	6 15	Winter	100	+40%	100/15	Summer			147.277
3.001	7 60	Winter	100	+40%	100/15	Summer			146.719
3.002	8 60	Winter	100	+40%	30/15	Winter			146.662
1.004	9 60	Winter	100	+40%	30/15	Summer			146.628
1.005	10 60	Winter	100	+40%	30/15	Summer			146.648
1.006	11 60	Winter	100	+40%					145.478

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Date 14/09/2023 14:30 File 14.09.23 NETWORK.MDX	Designed by James Checked by	
Innovyze	Network 2020.1.3	

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

PN	US/MH Name	Surcharged		Flooded	Flow / Overflow Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Volume (m ³)					
1.000	1	0.169	0.000	0.000	0.73		100.0	SURCHARGED	
1.001	2	0.153	0.000	0.000	0.53		93.4	SURCHARGED	
1.002	3	0.354	0.000	0.000	0.62		88.8	SURCHARGED	
2.000	4	-0.085	0.000	0.000	0.39		14.7	OK	
1.003	5	0.403	0.000	0.000	1.38		107.2	SURCHARGED	
3.000	6	0.277	0.000	0.000	1.08		113.5	FLOOD RISK	
3.001	7	0.291	0.000	0.000	0.71		70.1	SURCHARGED	
3.002	8	0.469	0.000	0.000	1.14		69.8	SURCHARGED	
1.004	9	0.853	0.000	0.000	0.59	46	52.8	SURCHARGED	
1.005	10	0.956	0.000	0.000	0.69		41.9	SURCHARGED	
1.006	11	-0.187	0.000	0.000	0.30		41.9	OK	