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Sheppard Lockton House Cafferata Way Newark, NG24 2TN	Site off Fenside Road Boston 30yr and 100_40 FSR	
Date 05/03/2020 16:16 File 20.03.04 original_with ...	Designed by PAE Checked by	
Innovyze	Network 2019.1	

### 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	PIMP (%)	100
M5-60 (mm)	18.800	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.500
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	60	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


#### Network Design Table for Storm


« - 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	22.932	0.050	458.6	0.089	5.00	0.0	0.600	o	450	Pipe/Conduit	
2.000	44.951	0.090	499.5	0.056	5.00	0.0	0.600	o	900	Pipe/Conduit	
1.001	48.075	0.167	287.9	0.085	0.00	0.0	0.600	o	900	Pipe/Conduit	
3.000	27.361	0.055	497.5	0.052	5.00	0.0	0.600	o	450	Pipe/Conduit	
3.001	17.105	0.311	55.0	0.031	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.002	20.420	0.070	291.7	0.026	0.00	0.0	0.600	o	900	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	63.87	5.41	1.310	0.089	0.0	0.0	0.0	0.94	149.9	15.4
2.000	63.19	5.54	1.350	0.056	0.0	0.0	0.0	1.40	887.6	9.5
1.001	61.09	5.97	1.260	0.229	0.0	0.0	0.0	1.84	1171.6	38.0
3.000	63.36	5.50	1.909	0.052	0.0	0.0	0.0	0.90	143.9	9.0
3.001	62.84	5.61	1.854	0.083	0.0	0.0	0.0	2.75	436.7	14.2
1.002	60.23	6.16	1.093	0.339	0.0	0.0	0.0	1.83	1163.8	55.3

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<u>Network Design Table for Storm</u>												
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
4.000	7.509	0.012	625.8	0.000	5.00	0.0	0.600	o	600	Pipe/Conduit		
1.003	22.790	0.084	271.3	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit		
5.000	28.006	0.056	500.1	0.042	5.00	0.0	0.600	o	900	Pipe/Conduit		
5.001	8.663	0.017	509.6	0.018	0.00	0.0	0.600	o	900	Pipe/Conduit		
1.004	10.758	0.039	275.8	0.043	0.00	0.0	0.600	o	900	Pipe/Conduit		
6.000	18.878	0.076	248.4	0.037	5.00	0.0	0.600	o	300	Pipe/Conduit		
6.001	9.078	0.036	252.2	0.008	0.00	0.0	0.600	o	300	Pipe/Conduit		
1.005	10.088	0.020	504.4	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit		
1.006	38.872	0.078	498.4	0.068	0.00	0.0	0.600	o	900	Pipe/Conduit		
7.000	42.500	0.085	500.0	0.081	5.00	0.0	0.600	o	900	Pipe/Conduit		
1.007	20.116	0.040	502.9	0.028	0.00	0.0	0.600	o	900	Pipe/Conduit		
1.008	24.119	0.050	482.4	0.053	0.00	0.0	0.600	o	900	Pipe/Conduit		
1.009	25.287	0.050	505.7	0.031	0.00	0.0	0.600	oo	900	Double Pipe		
1.010	30.834	0.062	497.3	0.064	0.00	0.0	0.600	oo	900	Double Pipe		
1.011	14.835	0.100	148.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit		
<u>Network Results Table</u>												
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	65.33	5.13	1.035	0.000	0.0	0.0	0.0	0.97	273.2	0.0		
1.003	59.35	6.36	1.023	0.339	0.0	0.0	0.0	1.90	1207.1	55.3		
5.000	64.23	5.33	1.012	0.042	0.0	0.0	0.0	1.39	887.0	7.2		
5.001	63.69	5.44	0.956	0.060	0.0	0.0	0.0	1.38	878.6	10.3		
1.004	58.93	6.45	0.939	0.441	0.0	0.0	0.0	1.88	1197.0	70.4		
6.000	64.33	5.32	1.212	0.037	0.0	0.0	0.0	0.99	70.2	6.4		
6.001	63.53	5.47	1.136	0.044	0.0	0.0	0.0	0.99	69.7	7.6		
1.005	58.42	6.57	0.900	0.486	0.0	0.0	0.0	1.39	883.2	76.9		
1.006	56.54	7.04	0.880	0.554	0.0	0.0	0.0	1.40	888.5	84.8		
7.000	63.34	5.51	0.887	0.081	0.0	0.0	0.0	1.39	887.1	13.9		
1.007	55.62	7.28	0.802	0.662	0.0	0.0	0.0	1.39	884.5	99.7		
1.008	54.58	7.56	0.762	0.716	0.0	0.0	0.0	1.42	903.3	105.8		
1.009	53.51	7.87	0.712	0.747	0.0	0.0	0.0	1.39	1763.9	108.3		
1.010	52.29	8.23	0.662	0.811	0.0	0.0	0.0	1.40	1778.9	114.9		
1.011	51.33	8.53	0.600	0.811	0.0	0.0	0.0	0.82	14.5	114.9		
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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m <sup>3</sup> /ha Storage	0.000
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 Storage Structures	1
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	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.800	Storm Duration (mins)	30
Ratio R	0.400		

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Online Controls for Storm


Hydro-Brake® Optimum Manhole: 21, DS/PN: 1.011, Volume (m³): 52.4

Unit Reference MD-SHE-0088-4700-2100-4700  
Design Head (m) 2.100  
Design Flow (l/s) 4.7  
Flush-Flo™ Calculated  
Objective Minimise upstream storage  
Application Surface  
Sump Available Yes  
Diameter (mm) 88  
Invert Level (m) 0.600  
Minimum Outlet Pipe Diameter (mm) 100  
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.100	4.7
Flush-Flo™	0.384	3.7
Kick-Flo®	0.783	3.0
Mean Flow over Head Range	-	3.7

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	2.7	1.200	3.6	3.000	5.5	7.000	8.3
0.200	3.5	1.400	3.9	3.500	6.0	7.500	8.5
0.300	3.7	1.600	4.1	4.000	6.4	8.000	8.8
0.400	3.7	1.800	4.4	4.500	6.7	8.500	9.1
0.500	3.7	2.000	4.6	5.000	7.1	9.000	9.3
0.600	3.6	2.200	4.8	5.500	7.4	9.500	9.6
0.800	3.0	2.400	5.0	6.000	7.7		
1.000	3.3	2.600	5.2	6.500	8.0		


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Storage Structures for Storm

Tank or Pond Manhole: 7, DS/PN: 4.000

Invert Level (m) 2.050

Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )
0.000	723.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	761.0	0.701	0.0	1.500	0.0	2.200	0.0
0.200	800.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	839.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	879.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	919.0	1.200	0.0	1.900	0.0		
0.600	960.0	1.300	0.0	2.000	0.0		

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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 \* 10m<sup>3</sup>/ha Storage 0.000  
 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 Storage Structures 1  
 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      FSR      Ratio R 0.400  
 Region England and Wales Cv (Summer) 0.750  
 M5-60 (mm)      18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm)      450.0  
 Analysis Timestep 2.5 Second Increment (Extended)  
 DTS Status      OFF  
 DVD Status      OFF  
 Inertia Status      OFF


Profile(s) Summer and Winter  
 Duration(s) (mins)      15, 30, 60  
 Return Period(s) (years)      30, 100  
 Climate Change (%)      0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Winter	30	+0%	100/30 Winter			
2.000	2	15 Winter	30	+0%				
1.001	3	60 Winter	30	+0%	100/60 Winter			
3.000	4	15 Winter	30	+0%				
3.001	5	15 Winter	30	+0%				
1.002	6	60 Winter	30	+0%	100/60 Winter			
4.000	7	60 Winter	30	+0%	100/30 Summer	100/60 Winter		
1.003	8	60 Winter	30	+0%	100/60 Summer			
5.000	9	60 Winter	30	+0%	100/60 Summer			
5.001	10	60 Winter	30	+0%	100/60 Summer			
1.004	11	60 Winter	30	+0%	100/60 Summer			
6.000	12	60 Winter	30	+0%	100/15 Winter			
6.001	13	60 Winter	30	+0%	30/60 Winter			
1.005	14	60 Winter	30	+0%	100/60 Summer			
1.006	15	60 Winter	30	+0%	100/60 Summer			
7.000	16	60 Winter	30	+0%	100/60 Summer			
1.007	17	60 Winter	30	+0%	100/30 Winter			
1.008	18	60 Winter	30	+0%	100/30 Winter			
1.009	19	60 Winter	30	+0%	100/30 Summer			

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

PN	US/MH Name	Water		Surcharged		Flooded		Pipe		Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)				
1.000	1	1.478	-0.282	0.000	0.22		27.5		OK		
2.000	2	1.475	-0.775	0.000	0.02		17.1		OK		
1.001	3	1.470	-0.690	0.000	0.04		36.6		OK		
3.000	4	2.023	-0.336	0.000	0.13		16.3		OK		
3.001	5	1.943	-0.361	0.000	0.08		26.1		OK		
1.002	6	1.470	-0.523	0.000	0.07		51.7		OK		
4.000	7	1.470	-0.165	0.000	0.00		0.0		OK		1
1.003	8	1.470	-0.453	0.000	0.06		47.3		OK		
5.000	9	1.470	-0.442	0.000	0.01		6.1		OK		
5.001	10	1.470	-0.386	0.000	0.01		5.3		OK		
1.004	11	1.470	-0.369	0.000	0.08		51.2		OK		
6.000	12	1.470	-0.042	0.000	0.10		6.0		OK		
6.001	13	1.470	0.034	0.000	0.13		7.0	SURCHARGED			
1.005	14	1.470	-0.330	0.000	0.15		55.0		OK		
1.006	15	1.470	-0.310	0.000	0.09		62.8		OK		
7.000	16	1.470	-0.317	0.000	0.02		12.0		OK		
1.007	17	1.470	-0.232	0.000	0.10		50.2		OK		
1.008	18	1.470	-0.192	0.000	0.08		50.4		OK		
1.009	19	1.470	-0.142	0.000	0.03		43.4		OK		

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

US/MH		Return Climate		First (X)		First (Y)		First (Z)		Overflow	Water Level
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.			(m)
1.010	20	60 Winter	30	+0%	100/30 Summer						1.470
1.011	21	60 Winter	30	+0%	30/15 Summer						1.470

US/MH		Surcharged Flooded		Pipe		Level	
PN	Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status Exceeded
1.010	20	-0.092	0.000	0.02		31.3	OK
1.011	21	0.720	0.000	0.28		3.7	SURCHARGED

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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	0.000
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 Storage Structures	1
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	FSR	Ratio R	0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.700	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	450.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	OFF


  

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60
Return Period(s) (years)	30, 100
Climate Change (%)	0, 40


PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1 60	Winter	100	+40%	100/30	Winter		
2.000	2 60	Winter	100	+40%				
1.001	3 60	Winter	100	+40%	100/60	Winter		
3.000	4 60	Winter	100	+40%				
3.001	5 60	Winter	100	+40%				
1.002	6 60	Winter	100	+40%	100/60	Winter		
4.000	7 60	Winter	100	+40%	100/30	Summer	100/60	Winter
1.003	8 60	Winter	100	+40%	100/60	Summer		
5.000	9 60	Winter	100	+40%	100/60	Summer		
5.001	10 60	Winter	100	+40%	100/60	Summer		
1.004	11 60	Winter	100	+40%	100/60	Summer		
6.000	12 60	Winter	100	+40%	100/15	Winter		
6.001	13 60	Winter	100	+40%	30/60	Winter		
1.005	14 60	Winter	100	+40%	100/60	Summer		
1.006	15 60	Winter	100	+40%	100/60	Summer		
7.000	16 60	Winter	100	+40%	100/60	Summer		
1.007	17 60	Winter	100	+40%	100/30	Winter		
1.008	18 60	Winter	100	+40%	100/30	Winter		
1.009	19 60	Winter	100	+40%	100/30	Summer		

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

PN	US/MH Name	Water		Surcharged		Flooded		Pipe		Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)				
1.000	1	2.214	0.454	0.000	0.21		26.5	FLOOD RISK			
2.000	2	2.215	-0.035	0.000	0.02		16.3	OK			
1.001	3	2.216	0.056	0.000	0.13		121.1	SURCHARGED			
3.000	4	2.152	-0.207	0.000	0.13		15.8	OK			
3.001	5	2.151	-0.153	0.000	0.12		39.2	OK			
1.002	6	2.223	0.230	0.000	0.30		235.0	SURCHARGED			
4.000	7	2.113	0.478	49.333	1.09		198.4	FLOOD			1
1.003	8	2.240	0.317	0.000	0.50		415.9	SURCHARGED			
5.000	9	2.331	0.419	0.000	0.02		13.1	SURCHARGED			
5.001	10	2.331	0.475	0.000	0.12		49.6	SURCHARGED			
1.004	11	2.332	0.493	0.000	0.72		469.2	SURCHARGED			
6.000	12	2.401	0.889	0.000	0.17		10.3	SURCHARGED			
6.001	13	2.403	0.967	0.000	0.29		15.4	SURCHARGED			
1.005	14	2.407	0.607	0.000	1.31		474.9	SURCHARGED			
1.006	15	2.480	0.700	0.000	0.61		425.7	SURCHARGED			
7.000	16	2.595	0.808	0.000	0.03		23.2	FLOOD RISK			
1.007	17	2.595	0.893	0.000	0.68		357.6	SURCHARGED			
1.008	18	2.659	0.997	0.000	0.47		299.5	FLOOD RISK			
1.009	19	2.708	1.096	0.000	0.17		206.4	FLOOD RISK			

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

US/MH		Return Climate		First (X)		First (Y)		First (Z)		Overflow	Water Level
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.			(m)
1.010	20	60 Winter	100	+40%	100/30 Summer						2.721
1.011	21	60 Winter	100	+40%	30/15 Summer						2.725

US/MH		Surcharged		Flooded		Pipe		Level	
PN	Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status	Exceeded	
1.010	20	1.159	0.000	0.07		95.3	FLOOD RISK		
1.011	21	1.975	0.000	0.35		4.6	FLOOD RISK		