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241 The Broadway London SW19 1SD	King's House School Richmond	
Date 22/12/2021 File 2180308 - SW NW.MDX	Designed by ARa Checked by TKe	
Innovyze	Network 2020.1.3	

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)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.410	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)	Time (mins)	Area (ha)
0-4	0.044	4-8	0.045	8-12	0.001

Total Area Contributing (ha) = 0.091

Total Pipe Volume (m<sup>3</sup>) = 1.790

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	17.568	0.180	97.6	0.025	6.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	19.669	0.290	67.8	0.015	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	8.435	0.110	76.7	0.000	6.00	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	6.29	21.690	0.025	0.0	0.0	0.0	1.02	18.0	3.4
1.001	50.00	6.56	21.510	0.040	0.0	0.0	0.0	1.22	21.6	5.4
2.000	50.00	6.12	21.330	0.000	0.0	0.0	0.0	1.15	20.3	0.0

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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
1.002	5.638	0.070	80.5	0.011	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	15.496	0.135	114.8	0.027	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	3.929	0.000	0.0	0.013	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	3.547	0.000	0.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.006	2.574	0.020	128.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.007	15.075	0.075	201.0	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)
1.002	50.00	6.64	21.220	0.051	0.0	0.0	0.0	1.12	19.8	6.9
1.003	50.00	6.92	21.150	0.077	0.0	0.0	0.0	0.94	16.6	10.5
1.004	50.00	7.45	20.940	0.091	0.0	0.0	0.0	0.12	4.9«	12.3
1.005	50.00	7.93	20.940	0.091	0.0	0.0	0.0	0.12	4.9«	12.3
1.006	50.00	7.98	20.940	0.091	0.0	0.0	0.0	0.88	15.6	12.3
1.007	50.00	8.34	20.920	0.091	0.0	0.0	0.0	0.71	12.5	12.3



Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	Pipe Out			Pipes In			Backdrop (mm)
					PN	Invert Level (m)	Diameter (mm)	PN	Invert Level (m)	Diameter (mm)	
SW1	22.750	1.060	Open Manhole	1200	1.000	21.690	150				
SW2	22.750	1.240	Open Manhole	1200	1.001	21.510	150	1.000	21.510	150	
SW2A	22.570	1.240	Open Manhole	1200	2.000	21.330	150				
SW3	23.080	1.860	Open Manhole	1200	1.002	21.220	150	1.001	21.220	150	
								2.000	21.220	150	
SW4	22.500	1.350	Open Manhole	1200	1.003	21.150	150	1.002	21.150	150	
SW5	22.300	1.360	Open Manhole	1200	1.004	20.940	225	1.003	21.015	150	
TANK	22.300	1.360	Junction		1.005	20.940	225	1.004	20.940	225	
SW7	22.300	1.360	Open Manhole	1200	1.006	20.940	150	1.005	20.940	225	
SW8	22.300	1.380	Open Manhole	1200	1.007	20.920	150	1.006	20.920	150	
OUTFALL	22.000	1.155	Open Manhole	0		OUTFALL		1.007	20.845	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SW1	518750.971	174735.496	518750.971	174735.496	Required	
SW2	518733.403	174735.579	518733.403	174735.579	Required	
SW2A	518719.984	174741.354	518719.984	174741.354	Required	
SW3	518719.801	174749.787	518719.801	174749.787	Required	
SW4	518716.843	174754.586	518716.843	174754.586	Required	
SW5	518716.833	174770.082	518716.833	174770.082	Required	
TANK	518712.904	174770.137			No Entry	
SW7	518709.358	174770.137	518709.358	174770.137	Required	
SW8	518706.793	174770.355	518706.793	174770.355	Required	

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Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
OUTFALL	518696.809	174781.649			No Entry	



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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	150	SW1	22.750	21.690	0.910	Open Manhole	1200
1.001	o	150	SW2	22.750	21.510	1.090	Open Manhole	1200
2.000	o	150	SW2A	22.570	21.330	1.090	Open Manhole	1200
1.002	o	150	SW3	23.080	21.220	1.710	Open Manhole	1200
1.003	o	150	SW4	22.500	21.150	1.200	Open Manhole	1200
1.004	o	225	SW5	22.300	20.940	1.135	Open Manhole	1200
1.005	o	225	TANK	22.300	20.940	1.135	Junction	
1.006	o	150	SW7	22.300	20.940	1.210	Open Manhole	1200
1.007	o	150	SW8	22.300	20.920	1.230	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	17.568	97.6	SW2	22.750	21.510	1.090	Open Manhole	1200
1.001	19.669	67.8	SW3	23.080	21.220	1.710	Open Manhole	1200
2.000	8.435	76.7	SW3	23.080	21.220	1.710	Open Manhole	1200
1.002	5.638	80.5	SW4	22.500	21.150	1.200	Open Manhole	1200
1.003	15.496	114.8	SW5	22.300	21.015	1.135	Open Manhole	1200
1.004	3.929	0.0	TANK	22.300	20.940	1.135	Junction	
1.005	3.547	0.0	SW7	22.300	20.940	1.135	Open Manhole	1200
1.006	2.574	128.7	SW8	22.300	20.920	1.230	Open Manhole	1200
1.007	15.075	201.0	OUTFALL	22.000	20.845	1.005	Open Manhole	0

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.025	0.025	0.025
1.001	-	-	100	0.015	0.015	0.015
2.000	-	-	100	0.000	0.000	0.000
1.002	User	-	100	0.011	0.011	0.011
1.003	User	-	100	0.027	0.027	0.027
1.004	User	-	100	0.013	0.013	0.013
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.091	0.091	0.091

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)
1.007	OUTFALL	22.000	20.845	20.845	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 <sup>3</sup> /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 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)	20.000	Storm Duration (mins)	30
Ratio R	0.410		

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Online Controls for Storm


Hydro-Brake® Optimum Manhole: SW7, DS/PN: 1.006, Volume (m³): 1.7

Unit Reference	MD-SHE-0069-2000-0900-2000
Design Head (m)	0.900
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	69
Invert Level (m)	20.940
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	2.0
Flush-Flo™	0.278	2.0
Kick-Flo®	0.568	1.6
Mean Flow over Head Range	-	1.8

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	1.7	1.200	2.3	3.000	3.5	7.000	5.2
0.200	2.0	1.400	2.4	3.500	3.7	7.500	5.3
0.300	2.0	1.600	2.6	4.000	4.0	8.000	5.5
0.400	1.9	1.800	2.7	4.500	4.2	8.500	5.7
0.500	1.8	2.000	2.9	5.000	4.4	9.000	5.8
0.600	1.7	2.200	3.0	5.500	4.6	9.500	6.0
0.800	1.9	2.400	3.1	6.000	4.8		
1.000	2.1	2.600	3.2	6.500	5.0		

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Storage Structures for Storm


Cellular Storage Manhole: TANK, DS/PN: 1.005

Invert Level (m) 20.940 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 <sup>2</sup> )	Inf. Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Inf. Area (m <sup>2</sup> )
0.000	44.0	0.0	0.801	0.0	0.0
0.800	44.0	0.0			






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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		Half Drain Pipe		Status	Level Exceeded
		Depth (m)	Volume (m <sup>3</sup> )	Cap.	(l/s)	Time (mins)	Flow (l/s)		
1.003	SW4	-0.065	0.000	0.60			9.2	OK	
1.004	SW5	-0.082	0.000	0.25			6.3	OK	
1.005	TANK	-0.083	0.000	0.06		51	1.8	OK*	
1.006	SW7	-0.007	0.000	0.16			1.7	OK	
1.007	SW8	-0.112	0.000	0.15			1.7	OK	



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

PN	US/MH Name	Surcharged Flooded		Half Drain Pipe		Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m <sup>3</sup> )	Flow / Overflow Cap. (l/s)	Time (mins)			
1.003	SW4	0.146	0.000	1.44		22.1	SURCHARGED	
1.004	SW5	0.167	0.000	0.37		9.5	SURCHARGED	
1.005	TANK	0.165	0.000	0.08	101	2.3	SURCHARGED*	
1.006	SW7	0.249	0.000	0.18		2.0	SURCHARGED	
1.007	SW8	-0.108	0.000	0.17		2.0	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 \* 10m<sup>3</sup>/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 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 0.410  
Region England and Wales Cv (Summer) 0.750  
M5-60 (mm)                      20.000 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	SW1	15 Winter	100	+40%	100/15 Summer				22.289
1.001	SW2	15 Winter	100	+40%	100/15 Summer				22.193
2.000	SW2A	15 Winter	100	+40%	30/15 Summer				21.970
1.002	SW3	15 Winter	100	+40%	30/15 Summer				21.974
1.003	SW4	15 Winter	100	+40%	30/15 Summer				21.859
1.004	SW5	120 Winter	100	+40%	30/15 Summer				21.829
1.005	TANK	120 Winter	100	+40%	30/15 Summer				21.741
1.006	SW7	120 Winter	100	+40%	30/15 Summer				21.827
1.007	SW8	60 Summer	100	+40%					20.962

PN	US/MH Name	Depth (m)	Volume (m <sup>3</sup> )	Flow / Overflow Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW1	0.449	0.000	0.73		12.3	SURCHARGED	
1.001	SW2	0.533	0.000	0.86		17.5	SURCHARGED	
2.000	SW2A	0.490	0.000	0.09		1.6	SURCHARGED	
1.002	SW3	0.604	0.000	1.33		21.7	SURCHARGED	

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PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Half Drain	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m <sup>3</sup> )	Cap.	(l/s)	Time (mins)	Flow (l/s)		
1.003	SW4	0.559	0.000	2.08			31.9	SURCHARGED	
1.004	SW5	0.664	0.000	0.62			15.8	SURCHARGED	
1.005	TANK	0.576	0.000	0.08		198	2.5	SURCHARGED*	
1.006	SW7	0.737	0.000	0.18			2.0	SURCHARGED	
1.007	SW8	-0.108	0.000	0.17			2.0	OK	