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Amber House Green Lane, Old Swan Liverpool, L13 7GD	Ducie Street SW HYdraulic Calcs	
Date 20/12/2021 11:21 File XDRAINAGE 2.MDX	Designed by EJC Checked by	
Innovyze	Network 2018.1.1	

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)	1	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.359	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	0.045	4-8	0.010

Total Area Contributing (ha) = 0.055

Total Pipe Volume (m³) = 0.723

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	11.672	0.120	97.3	0.010	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	18.019	0.240	75.1	0.015	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	14.626	0.360	40.6	0.015	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.002	1.456	0.015	100.0	0.015	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	2.690	0.018	149.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	7.070	0.047	150.4	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	45.78	5.25	46.100	0.010	0.0	0.0	0.0	0.78	6.1	1.2
1.001	44.84	5.51	45.930	0.025	0.0	0.0	0.0	1.16	20.5	3.0
2.000	45.97	5.20	46.100	0.015	0.0	0.0	0.0	1.21	9.5	1.9
1.002	44.76	5.53	45.690	0.055	0.0	0.0	0.0	1.00	17.8	6.7
1.003	44.56	5.59	45.165	0.055	0.0	0.0	0.0	0.82	14.5	6.7
1.004	44.07	5.73	45.147	0.055	0.0	0.0	0.0	0.82	14.4	6.7

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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)
PS1	46.650	0.550	Open Manhole	450	1.000	46.100	100				
PS2	46.650	0.720	Open Manhole	450	1.001	45.930	150	1.000	45.980	100	
PS6	46.650	0.550	Open Manhole	450	2.000	46.100	100				
PS3	46.650	0.960	Open Manhole	450	1.002	45.690	150	1.001	45.690	150	
								2.000	45.740	100	
PS4	46.650	1.485	Open Manhole	1200	1.003	45.165	150	1.002	45.675	150	510
PS5	46.664	1.517	Open Manhole	900	1.004	45.147	150	1.003	45.147	150	
PS7	46.600	1.500	Open Manhole	1200		OUTFALL		1.004	45.100	150	

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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	100	PS1	46.650	46.100	0.450	Open Manhole	450
1.001	o	150	PS2	46.650	45.930	0.570	Open Manhole	450
2.000	o	100	PS6	46.650	46.100	0.450	Open Manhole	450
1.002	o	150	PS3	46.650	45.690	0.810	Open Manhole	450
1.003	o	150	PS4	46.650	45.165	1.335	Open Manhole	1200
1.004	o	150	PS5	46.664	45.147	1.367	Open Manhole	900

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	11.672	97.3	PS2	46.650	45.980	0.570	Open Manhole	450
1.001	18.019	75.1	PS3	46.650	45.690	0.810	Open Manhole	450
2.000	14.626	40.6	PS3	46.650	45.740	0.810	Open Manhole	450
1.002	1.456	100.0	PS4	46.650	45.675	0.825	Open Manhole	1200
1.003	2.690	149.4	PS5	46.664	45.147	1.367	Open Manhole	900
1.004	7.070	150.4	PS7	46.600	45.100	1.350	Open Manhole	1200

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Network Classifications for Surface Network 1

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	PS1	100	0.450	0.570	Unclassified	450	0	0.450	Unclassified
1.001	PS2	150	0.570	0.810	Unclassified	450	0	0.570	Unclassified
2.000	PS6	100	0.450	0.810	Unclassified	450	0	0.450	Unclassified
1.002	PS3	150	0.810	0.825	Unclassified	450	0	0.810	Unclassified
1.003	PS4	150	1.335	1.367	Unclassified	1200	0	1.335	Unclassified
1.004	PS5	150	1.350	1.367	Unclassified	900	0	1.367	Unclassified

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)
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1.004	PS7	46.600	45.100	0.000	1200	0
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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 * 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 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	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.359		

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: PS4, DS/PN: 1.003, Volume (m³): 1.7

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	98
Invert Level (m)	45.165
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)	1.500	5.0	Kick-Flo®	0.878	3.9
Flush-Flo™	0.431	4.9	Mean Flow over Head Range	-	4.3

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	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

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Storage Structures for Surface Network 1

Cellular Storage Manhole: PS4, DS/PN: 1.003

Invert Level (m) 45.200 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	10.5	10.5	0.900	0.0	20.9
0.800	10.5	20.9			

Manhole Headloss for Surface Network 1

PN	US/MH Name	US/MH Headloss
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1.000	PS1	0.500
1.001	PS2	0.500
2.000	PS6	0.500
1.002	PS3	0.500
1.003	PS4	0.500
1.004	PS5	0.500

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1 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 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 M5-60 (mm) 18.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.359 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
 Analysis Timestep Fine Inertia Status OFF
 DTS Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 40

								Water Surcharged	
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)
1.000	PS1 15	Winter	1	+0%	100/15 Summer				46.131
1.001	PS2 15	Winter	1	+0%	100/15 Summer				45.968
2.000	PS6 15	Winter	1	+0%	100/15 Summer				46.130
1.002	PS3 15	Winter	1	+0%	30/15 Summer				45.771
1.003	PS4 15	Winter	1	+0%	30/15 Summer				45.311
1.004	PS5 15	Winter	1	+0%					45.200

		Flooded		Pipe		Level	
PN	US/MH Name	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Exceeded
1.000	PS1	0.000	0.21		1.2	OK	
1.001	PS2	0.000	0.14		2.7	OK	
2.000	PS6	0.000	0.20		1.8	OK	
1.002	PS3	0.000	0.56		6.0	OK	
1.003	PS4	0.000	0.31		3.3	OK	
1.004	PS5	0.000	0.27		3.3	OK	

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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 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 M5-60 (mm) 18.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.359 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
 Analysis Timestep Fine Inertia Status OFF
 DTS Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 40

										Water Surcharged
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)	Depth (m)
1.000	PS1	15 Winter	30	+0%	100/15 Summer				46.151	-0.049
1.001	PS2	15 Winter	30	+0%	100/15 Summer				45.996	-0.084
2.000	PS6	15 Winter	30	+0%	100/15 Summer				46.150	-0.050
1.002	PS3	15 Winter	30	+0%	30/15 Summer				45.891	0.051
1.003	PS4	30 Winter	30	+0%	30/15 Summer				45.629	0.314
1.004	PS5	30 Winter	30	+0%					45.212	-0.085

		Flooded		Pipe			
PN	US/MH Name	Volume (m³)	Flow / Cap.	Flow (l/s)	Status	Level Exceeded	
1.000	PS1	0.000	0.51	2.9	OK		
1.001	PS2	0.000	0.40	7.6	OK		
2.000	PS6	0.000	0.49	4.4	OK		
1.002	PS3	0.000	1.52	16.5	SURCHARGED		
1.003	PS4	0.000	0.45	4.9	SURCHARGED		
1.004	PS5	0.000	0.39	4.9	OK		

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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 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 M5-60 (mm) 18.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.359 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
 Analysis Timestep Fine Inertia Status OFF
 DTS Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 40

										Water Surcharged
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)	Depth (m)
1.000	PS1	30 Winter	100	+40%	100/15 Summer				46.517	0.317
1.001	PS2	30 Winter	100	+40%	100/15 Summer				46.509	0.429
2.000	PS6	30 Winter	100	+40%	100/15 Summer				46.512	0.312
1.002	PS3	30 Winter	100	+40%	30/15 Summer				46.499	0.659
1.003	PS4	30 Winter	100	+40%	30/15 Summer				46.495	1.180
1.004	PS5	15 Summer	100	+40%					45.212	-0.085

		Flooded		Pipe			
PN	US/MH Name	Volume (m³)	Flow / Overflow Cap. (l/s)	Pipe Flow (l/s)	Status	Level Exceeded	
1.000	PS1	0.000	0.74	4.3	FLOOD RISK		
1.001	PS2	0.000	0.56	10.7	FLOOD RISK		
2.000	PS6	0.000	0.71	6.4	FLOOD RISK		
1.002	PS3	0.000	2.17	23.5	FLOOD RISK		
1.003	PS4	0.000	0.45	4.9	FLOOD RISK		
1.004	PS5	0.000	0.39	4.9	OK		