


Shape Consulting Engineers		Page 0
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

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)	19.800	Add Flow / Climate Change (%)	0
Ratio R	0.398	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	0.269	4-8	0.060

Total Area Contributing (ha) = 0.329

Total Pipe Volume (m³) = 6.172


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	32.998	0.220	150.0	0.030	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	36.949	0.246	150.2	0.035	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	23.557	0.157	150.0	0.040	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	5.840	0.039	150.0	0.045	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	24.317	0.162	150.1	0.035	5.00	0.0	0.600	o	150	Pipe/Conduit	
3.000	19.419	0.162	119.9	0.035	5.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul Flow (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.67	46.310	0.030	0.0	0.0	0.0	0.82	14.5	4.1
1.001	48.80	6.25	46.015	0.065	0.0	0.0	0.0	1.06	42.3	8.6
1.002	47.69	6.56	45.694	0.105	0.0	0.0	0.0	1.28	90.6	13.6
1.003	47.42	6.63	45.537	0.150	0.0	0.0	0.0	1.28	90.6	19.3
2.000	50.00	5.50	46.720	0.035	0.0	0.0	0.0	0.82	14.5	4.7
3.000	50.00	5.35	46.720	0.035	0.0	0.0	0.0	0.92	16.2	4.7


Shape Consulting Engineers		Page 1
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

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
2.001	15.610	0.104	150.1	0.055	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	1.099	0.007	150.0	0.054	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.005	4.976	0.100	50.0	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)
2.001	50.00	5.70	46.408	0.125	0.0	0.0	0.0	1.28	90.6	16.9
1.004	47.37	6.65	45.498	0.329	0.0	0.0	0.0	1.28	90.6	42.2
1.005	47.17	6.71	45.443	0.329	0.0	0.0	0.0	1.43	25.2«	42.2

Shape Consulting Engineers		Page 2
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

Manhole Schedules for Surface Network 1

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	Pipe Out PN	Invert Level (m)	Diameter (mm)	Pipes In PN	Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	47.240	0.930	Open Manhole	450	1.000	46.310	150				
S2	47.240	1.225	Open Manhole	450	1.001	46.015	225	1.000	46.090	150	
S3	47.240	1.546	Open Manhole	600	1.002	45.694	300	1.001	45.769	225	
S4	47.240	1.703	Open Manhole	600	1.003	45.537	300	1.002	45.537	300	
S7	47.320	0.600	Open Manhole	450	2.000	46.720	150				
S11	47.320	0.600	Open Manhole	450	3.000	46.720	150				
S8	47.320	0.912	Open Manhole	450	2.001	46.408	300	2.000	46.558	150	
								3.000	46.558	150	
S10	47.240	1.742	Open Manhole	600	1.004	45.498	300	1.003	45.498	300	
								2.001	46.304	300	806
S5	47.240	1.797	Open Manhole	1200	1.005	45.443	150	1.004	45.491	300	197
S6	47.240	1.896	Open Manhole	1200		OUTFALL		1.005	45.344	150	

Shape Consulting Engineers		Page 3
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	


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	S1	47.240	46.310	0.780	Open Manhole	450
1.001	o	225	S2	47.240	46.015	1.000	Open Manhole	450
1.002	o	300	S3	47.240	45.694	1.246	Open Manhole	600
1.003	o	300	S4	47.240	45.537	1.403	Open Manhole	600
2.000	o	150	S7	47.320	46.720	0.450	Open Manhole	450
3.000	o	150	S11	47.320	46.720	0.450	Open Manhole	450
2.001	o	300	S8	47.320	46.408	0.612	Open Manhole	450
1.004	o	300	S10	47.240	45.498	1.442	Open Manhole	600
1.005	o	150	S5	47.240	45.443	1.647	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	32.998	150.0	S2	47.240	46.090	1.000	Open Manhole	450
1.001	36.949	150.2	S3	47.240	45.769	1.246	Open Manhole	600
1.002	23.557	150.0	S4	47.240	45.537	1.403	Open Manhole	600
1.003	5.840	150.0	S10	47.240	45.498	1.442	Open Manhole	600
2.000	24.317	150.1	S8	47.320	46.558	0.612	Open Manhole	450
3.000	19.419	119.9	S8	47.320	46.558	0.612	Open Manhole	450
2.001	15.610	150.1	S10	47.240	46.304	0.636	Open Manhole	600
1.004	1.099	150.0	S5	47.240	45.491	1.449	Open Manhole	1200
1.005	4.976	50.0	S6	47.240	45.344	1.746	Open Manhole	1200

Shape Consulting Engineers		Page 4
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

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	S1	150	0.780	1.000	Unclassified	450	0	0.780	Unclassified
1.001	S2	225	1.000	1.246	Unclassified	450	0	1.000	Unclassified
1.002	S3	300	1.246	1.403	Unclassified	600	0	1.246	Unclassified
1.003	S4	300	1.403	1.442	Unclassified	600	0	1.403	Unclassified
2.000	S7	150	0.450	0.612	Unclassified	450	0	0.450	Unclassified
3.000	S11	150	0.450	0.612	Unclassified	450	0	0.450	Unclassified
2.001	S8	300	0.612	0.636	Unclassified	450	0	0.612	Unclassified
1.004	S10	300	1.442	1.449	Unclassified	600	0	1.442	Unclassified
1.005	S5	150	1.647	1.746	Unclassified	1200	0	1.647	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)
---------------------	--------------	--------------	--------------	------------------	----------	--------

1.005	S6	47.240	45.344	0.000	1200	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 * 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)	19.800	Storm Duration (mins)	30
Ratio R	0.398		

Shape Consulting Engineers		Page 5
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

Online Controls for Surface Network 1


Hydro-Brake® Optimum Manhole: S5, DS/PN: 1.005, Volume (m³): 2.0

Unit Reference	MD-SHE-0112-6500-1500-6500
Design Head (m)	1.500
Design Flow (l/s)	6.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	112
Invert Level (m)	45.443
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	6.5	Kick-Flo®	0.926	5.2
Flush-Flo™	0.450	6.5	Mean Flow over Head Range	-	5.7

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	3.9	1.200	5.9	3.000	9.0	7.000	13.4
0.200	5.8	1.400	6.3	3.500	9.7	7.500	13.9
0.300	6.3	1.600	6.7	4.000	10.3	8.000	14.3
0.400	6.5	1.800	7.1	4.500	10.9	8.500	14.8
0.500	6.5	2.000	7.4	5.000	11.5	9.000	15.2
0.600	6.4	2.200	7.8	5.500	12.0	9.500	15.6
0.800	5.9	2.400	8.1	6.000	12.5		
1.000	5.4	2.600	8.4	6.500	13.0		

Shape Consulting Engineers		Page 6
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

Storage Structures for Surface Network 1


Cellular Storage Manhole: S5, DS/PN: 1.005

Invert Level (m) 45.500 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	162.0	162.0	0.900	0.0	205.2
0.800	162.0	205.2			

Manhole Headloss for Surface Network 1

PN	US/MH Name	US/MH Headloss
1.000	S1	0.500
1.001	S2	0.500
1.002	S3	0.500
1.003	S4	0.500
2.000	S7	0.500
3.000	S11	0.500
2.001	S8	0.500
1.004	S10	0.500
1.005	S5	0.500

Shape Consulting Engineers		Page 7
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

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) 19.800 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.398 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, 30

										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	S1 15	Winter	1	+0%	100/15 Summer				46.366	-0.094
1.001	S2 15	Winter	1	+0%	100/15 Summer				46.084	-0.156
1.002	S3 15	Winter	1	+0%	30/15 Summer				45.774	-0.220
1.003	S4 15	Winter	1	+0%	30/15 Summer				45.690	-0.147
2.000	S7 15	Winter	1	+0%	100/15 Summer				46.782	-0.088
3.000	S11 15	Winter	1	+0%	100/15 Summer				46.778	-0.092
2.001	S8 15	Winter	1	+0%					46.502	-0.206
1.004	S10 15	Winter	1	+0%	30/15 Summer				45.682	-0.116
1.005	S5 60	Winter	1	+0%	1/15 Summer				45.635	0.041

		Flooded		Pipe			
PN	US/MH Name	Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.000	0.30		4.1	OK	
1.001	S2	0.000	0.20		8.2	OK	
1.002	S3	0.000	0.16		12.7	OK	
1.003	S4	0.000	0.29		17.9	OK	
2.000	S7	0.000	0.35		4.8	OK	
3.000	S11	0.000	0.31		4.7	OK	
2.001	S8	0.000	0.21		16.0	OK	
1.004	S10	0.000	0.68		39.2	OK	
1.005	S5	0.000	0.29		5.8	SURCHARGED	

Shape Consulting Engineers		Page 8
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

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) 19.800 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.398 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, 30

								Water Surcharged	
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)
1.000	S1	15 Winter	30	+0%	100/15 Summer				46.406
1.001	S2	15 Winter	30	+0%	100/15 Summer				46.136
1.002	S3	15 Winter	30	+0%	30/15 Summer				46.031
1.003	S4	15 Winter	30	+0%	30/15 Summer				45.995
2.000	S7	15 Winter	30	+0%	100/15 Summer				46.828
3.000	S11	15 Winter	30	+0%	100/15 Summer				46.821
2.001	S8	15 Winter	30	+0%					46.571
1.004	S10	15 Winter	30	+0%	30/15 Summer				45.971
1.005	S5	120 Winter	30	+0%	1/15 Summer				45.910

		Flooded		Pipe			
PN	US/MH Name	Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.000	0.71		9.9	OK	
1.001	S2	0.000	0.54		21.5	OK	
1.002	S3	0.000	0.44		35.1	SURCHARGED	
1.003	S4	0.000	0.80		48.9	SURCHARGED	
2.000	S7	0.000	0.85		11.7	OK	
3.000	S11	0.000	0.76		11.6	OK	
2.001	S8	0.000	0.56		42.6	OK	
1.004	S10	0.000	1.88		107.6	SURCHARGED	
1.005	S5	0.000	0.33		6.5	SURCHARGED	

Shape Consulting Engineers		Page 9
Amber House Green Lane, Old Swan Liverpool, L13 7GD	Upper Parliament St Surface Water Drainage Calcs	
Date 19/02/2019 File 1168 DESIGN REVA.MDX	Designed by ejc Checked by	
Innovyze	Network 2017.1.2	

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) 19.800 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.398 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, 30

									Water	Surcharged	
	US/MH			Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level	Depth
PN	Name	Storm		Period	Change	Surcharge	Flood	Overflow	Act.	(m)	(m)
1.000	S1	15 Winter		100	+30%	100/15 Summer				46.896	0.436
1.001	S2	15 Winter		100	+30%	100/15 Summer				46.633	0.393
1.002	S3	120 Winter		100	+30%	30/15 Summer				46.559	0.565
1.003	S4	120 Winter		100	+30%	30/15 Summer				46.545	0.708
2.000	S7	15 Winter		100	+30%	100/15 Summer				47.025	0.155
3.000	S11	15 Winter		100	+30%	100/15 Summer				46.971	0.101
2.001	S8	15 Winter		100	+30%					46.636	-0.072
1.004	S10	120 Winter		100	+30%	30/15 Summer				46.540	0.742
1.005	S5	120 Winter		100	+30%	1/15 Summer				46.454	0.861

Flooded			Pipe		Level	
PN	US/MH Name	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status
						Exceeded
1.000	S1	0.000	1.16		16.1	SURCHARGED
1.001	S2	0.000	0.82		32.7	SURCHARGED
1.002	S3	0.000	0.21		17.2	SURCHARGED
1.003	S4	0.000	0.41		24.9	SURCHARGED
2.000	S7	0.000	1.39		19.1	FLOOD RISK
3.000	S11	0.000	1.27		19.4	SURCHARGED
2.001	S8	0.000	0.90		68.4	OK
1.004	S10	0.000	1.00		57.1	SURCHARGED
1.005	S5	0.000	0.33		6.5	SURCHARGED