STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
Site Location	GB 528450 185200 TQ 28450 85200
C (1km)	-0.026
D1 (1km)	0.331
D2 (1km)	0.331
D3 (1km)	0.240
E (1km)	0.334
F (1km)	2.478
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.000
Maximum Backdrop Height (m)	0.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

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	5.418	0.064	84.7	0.011	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	8.371	0.105	79.7	0.009	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	7.000	0.080	87.5	0.025	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	8.000	0.100	80.0	0.006	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	4.346	0.072	60.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	5.072	0.049	103.5	0.010	5.00	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	5.08	41.147	0.011	0.0	0.0	0.0	1.09	19.3	1.5
1.001	50.00	5.21	41.083	0.020	0.0	0.0	0.0	1.13	19.9	2.7
1.002	50.00	5.31	40.978	0.045	0.0	0.0	0.0	1.08	19.0	6.1
1.003	50.00	5.43	40.098	0.051	0.0	0.0	0.0	1.12	19.9	6.9
1.004	50.00	5.49	39.998	0.051	0.0	0.0	0.0	1.30	22.9	6.9
2.000	50.00	5.09	41.000	0.010	0.0	0.0	0.0	0.99	17.4	1.4

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
1.005	13.152	0.329	40.0	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	2.000	0.020	100.0	0.006	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.006	9.063	0.228	39.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.007	7.431	0.186	40.0	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)
1.005	50.00	5.59	39.851	0.066	0.0	0.0	0.0	2.08	82.5	8.9
3.000	50.00	5.04	41.000	0.006	0.0	0.0	0.0	0.77	6.0	0.8
1.006	50.00	5.67	39.522	0.072	0.0	0.0	0.0	2.08	82.7	9.7
1.007	50.00	5.75	39.294	0.072	0.0	0.0	0.0	1.60	28.2	9.7

North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	668050 - Kiln Court Units 2,3,6
Date November 2017 File 668050-CALC-SBU-C-Netwo...	Designed by Darragh O'Connell Checked by CB/BF
XP Solutions	Network 2016.1

Manhole Schedules for Storm

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)
S3.0	42.230	1.083	Open Manhole	450	1.000	41.147	150				
S3.1	42.230	1.147	Open Manhole	450	1.001	41.083	150	1.000	41.083	150	
S3.2	42.230	1.252	Open Manhole	1200	1.002	40.978	150	1.001	40.978	150	
Tank	42.200	2.102	Sealed Manhole	1200	1.003	40.098	150	1.002	40.898	150	800
Outlet	42.000	2.002	Open Manhole	600	1.004	39.998	150	1.003	39.998	150	
S4.0	41.250	0.250	Open Manhole	1200	2.000	41.000	150				
S3.3	41.250	1.399	Open Manhole	600	1.005	39.851	225	1.004	39.926	150	
								2.000	40.951	150	1025
Porous	41.250	0.250	Open Manhole	1200	3.000	41.000	100				
S3.4	41.390	1.868	Open Manhole	1200	1.006	39.522	225	1.005	39.522	225	
								3.000	40.980	100	1333
S3.5	41.940	2.646	Open Manhole	600 x 600	1.007	39.294	150	1.006	39.294	225	
	41.940	2.832	Open Manhole	0		OUTFALL		1.007	39.108	150	

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	S3.0	42.230	41.147	0.933	Open Manhole	450
1.001	o	150	S3.1	42.230	41.083	0.997	Open Manhole	450
1.002	o	150	S3.2	42.230	40.978	1.102	Open Manhole	1200
1.003	o	150	Tank	42.200	40.098	1.952	Sealed Manhole	1200
1.004	o	150	Outlet	42.000	39.998	1.852	Open Manhole	600
2.000	o	150	S4.0	41.250	41.000	0.100	Open Manhole	1200
1.005	o	225	S3.3	41.250	39.851	1.174	Open Manhole	600
3.000	o	100	Porous	41.250	41.000	0.150	Open Manhole	1200
1.006	o	225	S3.4	41.390	39.522	1.643	Open Manhole	1200
1.007	o	150	S3.5	41.940	39.294	2.496	Open Manhole	600 x 600

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	5.418	84.7	S3.1	42.230	41.083	0.997	Open Manhole	450
1.001	8.371	79.7	S3.2	42.230	40.978	1.102	Open Manhole	1200
1.002	7.000	87.5	Tank	42.200	40.898	1.152	Sealed Manhole	1200
1.003	8.000	80.0	Outlet	42.000	39.998	1.852	Open Manhole	600
1.004	4.346	60.4	S3.3	41.250	39.926	1.174	Open Manhole	600
2.000	5.072	103.5	S3.3	41.250	40.951	0.149	Open Manhole	600
1.005	13.152	40.0	S3.4	41.390	39.522	1.643	Open Manhole	1200
3.000	2.000	100.0	S3.4	41.390	40.980	0.310	Open Manhole	1200
1.006	9.063	39.8	S3.5	41.940	39.294	2.421	Open Manhole	600 x 600
1.007	7.431	40.0		41.940	39.108	2.682	Open Manhole	0

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.011	0.011	0.011
1.001	-	-	100	0.009	0.009	0.009
1.002	-	-	100	0.025	0.025	0.025
1.003	-	-	100	0.006	0.006	0.006
1.004	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.010	0.010	0.010
1.005	-	-	100	0.005	0.005	0.005
3.000	-	-	100	0.006	0.006	0.006
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.072	0.072	0.072

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		41.940	39.108	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 * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	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	3
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	FEH
Return Period (years)	100
Site Location	GB 528450 185200 TQ 28450 85200
C (1km)	-0.026
D1 (1km)	0.331
D2 (1km)	0.331
D3 (1km)	0.240
E (1km)	0.334
F (1km)	2.478
Summer Storms	Yes
Winter Storms	No
Cv (Summer)	0.750

Synthetic Rainfall Details

Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Hydro-Brake Optimum® Manhole: S3.5, DS/PN: 1.007, Volume (m³): 1.3

Unit Reference	MD-CHE-0087-4000-1200-4000
Design Head (m)	1.200
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	No
Diameter (mm)	87
Invert Level (m)	39.294
Minimum Outlet Pipe Diameter (mm)	Error (Contact Hydro International)
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	4.0
Flush-Flo™	0.214	3.7
Kick-Flo®	0.315	2.1
Mean Flow over Head Range	-	2.9

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	2.2	1.200	4.0	3.000	6.3	7.000	9.5
0.200	3.6	1.400	4.3	3.500	6.8	7.500	9.8
0.300	2.1	1.600	4.6	4.000	7.2	8.000	10.1
0.400	2.3	1.800	4.9	4.500	7.6	8.500	10.5
0.500	2.6	2.000	5.1	5.000	8.1	9.000	10.7
0.600	2.9	2.200	5.4	5.500	8.4	9.500	11.0
0.800	3.3	2.400	5.6	6.000	8.8		
1.000	3.7	2.600	5.8	6.500	9.2		

Storage Structures for Storm

Cellular Storage Manhole: Tank, DS/PN: 1.003

Invert Level (m) 40.151 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	24.0	24.0	1.300	0.0	50.4
1.200	24.0	50.4			

Porous Car Park Manhole: S4.0, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	9.0
Membrane Percolation (mm/hr)	1000	Length (m)	6.0
Max Percolation (l/s)	15.0	Slope (1:X)	250.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	41.000	Cap Volume Depth (m)	0.250

Porous Car Park Manhole: Porous, DS/PN: 3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	8.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.0
Max Percolation (l/s)	15.6	Slope (1:X)	2500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	41.000	Membrane Depth (mm)	0

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 Coeffiecient	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	3
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	FEH
Site Location GB 528450 185200 TQ 28450 85200	
C (1km)	-0.026
D1 (1km)	0.331
D2 (1km)	0.331
D3 (1km)	0.240
E (1km)	0.334
F (1km)	2.478
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	100.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	OFF

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 (%)	30, 30, 30

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	S3.0	15 Winter	1	+30%	30/15 Summer				41.182
1.001	S3.1	15 Winter	1	+30%	30/15 Summer				41.127
1.002	S3.2	15 Winter	1	+30%	30/15 Summer				41.047
1.003	Tank	15 Winter	1	+30%	30/15 Summer				40.172
1.004	Outlet	15 Winter	1	+30%	1/15 Summer				40.169
2.000	S4.0	15 Winter	1	+30%					41.025
1.005	S3.3	15 Winter	1	+30%	1/15 Summer				40.167
3.000	Porous	120 Winter	1	+30%					41.016
1.006	S3.4	15 Winter	1	+30%	1/15 Summer				40.163
1.007	S3.5	15 Winter	1	+30%	1/15 Summer				40.159

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S3.0	-0.115	0.000	0.12		1.9	OK	
1.001	S3.1	-0.106	0.000	0.19		3.3	OK	
1.002	S3.2	-0.081	0.000	0.43		7.0	OK	
1.003	Tank	-0.076	0.000	0.41		7.1	OK	
1.004	Outlet	0.021	0.000	0.42		7.1	SURCHARGED	
2.000	S4.0	-0.125	0.000	0.07		0.9	OK	
1.005	S3.3	0.091	0.000	0.12		8.3	SURCHARGED	
3.000	Porous	-0.084	0.000	0.06		0.2	OK	
1.006	S3.4	0.416	0.000	0.07		4.8	SURCHARGED	
1.007	S3.5	0.715	0.000	0.14		3.4	SURCHARGED	

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 Coeffiecient	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	3
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	FEH
Site Location GB 528450 185200 TQ 28450 85200	
C (1km)	-0.026
D1 (1km)	0.331
D2 (1km)	0.331
D3 (1km)	0.240
E (1km)	0.334
F (1km)	2.478
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	100.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	OFF

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 (%)	30, 30, 30

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	S3.0	15 Winter	30	+30%	30/15 Summer				41.361
1.001	S3.1	15 Winter	30	+30%	30/15 Summer				41.347
1.002	S3.2	15 Winter	30	+30%	30/15 Summer				41.292
1.003	Tank	30 Winter	30	+30%	30/15 Summer				40.717
1.004	Outlet	30 Winter	30	+30%	1/15 Summer				40.710
2.000	S4.0	15 Winter	30	+30%					41.061
1.005	S3.3	30 Winter	30	+30%	1/15 Summer				40.706
3.000	Porous	15 Winter	30	+30%					41.048
1.006	S3.4	30 Winter	30	+30%	1/15 Summer				40.700
1.007	S3.5	60 Winter	30	+30%	1/15 Summer				40.697

North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	668050 - Kiln Court Units 2,3,6
Date November 2017 File 668050-CALC-SBU-C-Netwo...	Designed by Darragh O'Connell Checked by CB/BF
XP Solutions	Network 2016.1

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S3.0	0.064	0.000	0.43		6.8	SURCHARGED	
1.001	S3.1	0.114	0.000	0.70		12.2	SURCHARGED	
1.002	S3.2	0.164	0.000	1.71		27.7	SURCHARGED	
1.003	Tank	0.469	0.000	0.50		8.6	SURCHARGED*	
1.004	Outlet	0.562	0.000	0.45		7.6	SURCHARGED	
2.000	S4.0	-0.089	0.000	0.35		4.9	OK	
1.005	S3.3	0.630	0.000	0.11		8.2	SURCHARGED	
3.000	Porous	-0.052	0.000	0.46		1.8	OK	
1.006	S3.4	0.953	0.000	0.07		4.4	SURCHARGED	
1.007	S3.5	1.253	0.000	0.18		4.3	SURCHARGED	

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 Coeffiecient	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	3
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	FEH
Site Location GB 528450 185200 TQ 28450 85200	
C (1km)	-0.026
D1 (1km)	0.331
D2 (1km)	0.331
D3 (1km)	0.240
E (1km)	0.334
F (1km)	2.478
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	100.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	OFF

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 (%)	30, 30, 30

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	S3.0	15 Winter	100	+30%	30/15 Summer				41.788
1.001	S3.1	15 Winter	100	+30%	30/15 Summer				41.760
1.002	S3.2	15 Winter	100	+30%	30/15 Summer				41.630
1.003	Tank	30 Winter	100	+30%	30/15 Summer				41.107
1.004	Outlet	60 Winter	100	+30%	1/15 Summer				41.106
2.000	S4.0	15 Winter	100	+30%					41.084
1.005	S3.3	60 Winter	100	+30%	1/15 Summer				41.106
3.000	Porous	15 Winter	100	+30%					41.071
1.006	S3.4	60 Winter	100	+30%	1/15 Summer				41.102
1.007	S3.5	60 Winter	100	+30%	1/15 Summer				41.097

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S3.0	0.491	0.000	0.67		10.6	SURCHARGED	
1.001	S3.1	0.527	0.000	1.10		19.0	SURCHARGED	
1.002	S3.2	0.502	0.000	2.65		43.0	SURCHARGED	
1.003	Tank	0.859	0.000	0.48		8.4	SURCHARGED*	
1.004	Outlet	0.958	0.000	0.29		4.9	SURCHARGED	
2.000	S4.0	-0.066	0.000	0.59		8.2	OK	
1.005	S3.3	1.030	0.000	0.08		5.6	SURCHARGED	
3.000	Porous	-0.029	0.000	0.85		3.3	OK	
1.006	S3.4	1.355	0.000	0.07		5.0	SURCHARGED	
1.007	S3.5	1.653	0.000	0.20		4.9	SURCHARGED	