


Woods Hardwick		Page 0
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:15 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for 17694_STORM2.SWS

Pipe Sizes SW NETWORK 1 Manhole Sizes SW NETWORK 1

FSR Rainfall Model - England and Wales

Return Period (years)	2	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.385	Maximum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	0	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	0.75
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits






Time Area Diagram for 17694_STORM2.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.279	4-8	0.164	8-12	0.032	12-16	0.032	16-20	0.032	20-24	0.022

Total Area Contributing (ha) = 0.560


Total Pipe Volume (m³) = 15.390

Network Design Table for 17694_STORM2.SWS



PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	23.446	0.075	312.6	0.100	20.00	0.0	0.600	o	300	
1.001	13.359	0.050	267.2	0.000	0.00	0.0	0.600	o	300	
1.002	56.937	0.200	284.7	0.120	0.00	0.0	0.600	o	300	
2.000	48.603	0.175	277.7	0.060	20.00	0.0	0.600	o	300	
1.003	49.862	0.200	249.3	0.125	0.00	0.0	0.600	o	300	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	20.44	36.825	0.100	0.0	0.0	0.0	0.88	62.5	0.0
1.001	0.00	20.67	36.725	0.100	0.0	0.0	0.0	0.96	67.7	0.0
1.002	0.00	21.70	36.675	0.220	0.0	0.0	0.0	0.93	65.5	0.0
2.000	0.00	20.86	36.650	0.060	0.0	0.0	0.0	0.94	66.3	0.0
1.003	0.00	22.54	36.475	0.405	0.0	0.0	0.0	0.99	70.1	0.0


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Network Design Table for 17694_STORM2.SWS

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.004	17.109	0.075	228.1	0.135	0.00	0.0	0.600	o	300	
1.005	14.943	0.100	149.4	0.020	0.00	0.0	0.600	o	225	

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)
1.004	0.00	22.81	36.275	0.540	0.0	0.0	0.0	1.04	73.3	0.0
1.005	0.00	5.23	36.200	0.000	6.5	0.0	0.0	1.07	42.4	6.5

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Manhole Schedules for 17694_STORM2.SWS

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)	
SB1	38.084	1.259	Open Manhole	1500	1.000	36.825	300				
SB2	38.119	1.394	Open Manhole	1500	1.001	36.725	300	1.000	36.750	300	25
SB3	38.019	1.344	Open Manhole	1500	1.002	36.675	300	1.001	36.675	300	
SB4	37.900	1.250	Open Manhole	1500	2.000	36.650	300				
SB5	37.559	1.084	Open Manhole	1500	1.003	36.475	300	1.002	36.475	300	
								2.000	36.475	300	
SB6	37.692	1.417	Open Manhole	1500	1.004	36.275	300	1.003	36.275	300	
SB7	37.524	1.324	Open Manhole	2400	1.005	36.200	225	1.004	36.200	300	
SB8	37.049	0.949	Open Manhole	1500		OUTFALL		1.005	36.100	225	

Free Flowing Outfall Details for 17694_STORM2.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D, L (mm)	W (mm)
1.005	SB8	37.049	36.100	0.000	1500	0


Simulation Criteria for 17694_STORM2.SWS

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 Storage Structures	2
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	0.385		

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Online Controls for 17694_STORM2.SWS


Hydro-Brake Optimum® Manhole: SB7, DS/PN: 1.005, Volume (m³): 7.1

Unit Reference	MD-SHE-0099-4800-1300-4800
Design Head (m)	1.300
Design Flow (l/s)	4.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	99
Invert Level (m)	36.200
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.300	4.8
Flush-Flo™	0.387	4.8
Kick-Flo®	0.798	3.8
Mean Flow over Head Range	-	4.2

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	4.6	3.000	7.1	7.000	10.5
0.200	4.4	1.400	4.9	3.500	7.6	7.500	10.9
0.300	4.7	1.600	5.3	4.000	8.1	8.000	11.2
0.400	4.8	1.800	5.6	4.500	8.5	8.500	11.6
0.500	4.7	2.000	5.8	5.000	9.0	9.000	11.9
0.600	4.6	2.200	6.1	5.500	9.4	9.500	12.2
0.800	3.8	2.400	6.4	6.000	9.8		
1.000	4.2	2.600	6.6	6.500	10.2		

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Storage Structures for 17694_STORM2.SWS

Complex Manhole: SB4, DS/PN: 2.000

Cellular Storage

Invert Level (m) 36.650 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	180.0	180.0	0.401	0.0	208.8
0.400	180.0	208.8			


Porous Car Park

Infiltration Coefficient Base (m/hr) 0.00000 Width (m) 10.0
 Membrane Percolation (mm/hr) 1000 Length (m) 50.0
 Max Percolation (l/s) 138.9 Slope (1:X) 500.0
 Safety Factor 2.0 Depression Storage (mm) 5
 Porosity 0.30 Evaporation (mm/day) 3
 Invert Level (m) 37.050 Cap Volume Depth (m) 0.000

Cellular Storage Manhole: SB7, DS/PN: 1.005

Invert Level (m) 36.200 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	350.0	0.0	0.401	0.0	0.0
0.400	350.0	0.0			

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 17694_STORM2.SWS

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 Storage Structures 2
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 0.385
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 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS 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 (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SB1	30 Winter	1	+0%	100/15 Summer			
1.001	SB2	30 Winter	1	+0%	100/15 Summer			
1.002	SB3	15 Winter	1	+0%	100/15 Summer			
2.000	SB4	240 Winter	1	+0%	100/60 Summer			
1.003	SB5	15 Winter	1	+0%	30/15 Summer	100/360 Winter		
1.004	SB6	15 Winter	1	+0%	30/15 Summer			
1.005	SB7	360 Winter	1	+0%	30/30 Summer	100/240 Winter		

PN	US/MH Name	Water			Surcharged		Flooded		Pipe	
		Level (m)	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status	Level Exceeded	
1.000	SB1	36.891	-0.234	0.000	0.11		6.2	OK		
1.001	SB2	36.801	-0.224	0.000	0.11		6.3	OK		
1.002	SB3	36.784	-0.191	0.000	0.27		17.0	OK		
2.000	SB4	36.670	-0.280	0.000	0.01		0.9	OK		
1.003	SB5	36.615	-0.160	0.000	0.43		28.6	OK	2	
1.004	SB6	36.453	-0.122	0.000	0.65		40.9	OK		
1.005	SB7	36.367	-0.058	0.000	0.11		4.2	OK	4	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for 17694_STORM2.SWS

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 Storage Structures 2
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

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Rainfall Model FSR Ratio R 0.385
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 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS 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 (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SB1	15 Winter	30	+0%	100/15 Summer			
1.001	SB2	15 Winter	30	+0%	100/15 Summer			
1.002	SB3	15 Winter	30	+0%	100/15 Summer			
2.000	SB4	240 Winter	30	+0%	100/60 Summer			
1.003	SB5	15 Winter	30	+0%	30/15 Summer	100/360 Winter		
1.004	SB6	360 Winter	30	+0%	30/15 Summer			
1.005	SB7	360 Winter	30	+0%	30/30 Summer	100/240 Winter		

PN	US/MH Name	Water			Surcharged		Flooded		Pipe	
		Level (m)	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status	Level Exceeded	
1.000	SB1	36.948	-0.177	0.000	0.24		13.4		OK	
1.001	SB2	36.930	-0.095	0.000	0.31		17.5		OK	
1.002	SB3	36.923	-0.052	0.000	0.69		42.7		OK	
2.000	SB4	36.731	-0.219	0.000	0.05		3.0		OK	
1.003	SB5	36.836	0.061	0.000	0.92		60.8	SURCHARGED		2
1.004	SB6	36.736	0.161	0.000	0.37		23.4	SURCHARGED		
1.005	SB7	36.731	0.306	0.000	0.13		4.7	SURCHARGED		4

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 17694_STORM2.SWS

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 Storage Structures 2
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 0.385
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 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS 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 (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SB1	240 Winter	100	+40%	100/15 Summer			
1.001	SB2	360 Winter	100	+40%	100/15 Summer			
1.002	SB3	360 Winter	100	+40%	100/15 Summer			
2.000	SB4	360 Winter	100	+40%	100/60 Summer			
1.003	SB5	480 Winter	100	+40%	30/15 Summer	100/360 Winter		
1.004	SB6	480 Winter	100	+40%	30/15 Summer			
1.005	SB7	480 Winter	100	+40%	30/30 Summer	100/240 Winter		

PN	US/MH Name	Water			Surcharged		Flooded		Pipe		Level Exceeded
		Level (m)	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status			
1.000	SB1	37.569	0.444	0.000	0.21		11.5	SURCHARGED			
1.001	SB2	37.567	0.542	0.000	0.15		8.5	SURCHARGED			
1.002	SB3	37.565	0.590	0.000	0.30		18.8	SURCHARGED			
2.000	SB4	37.562	0.612	0.000	0.07		4.6	SURCHARGED			
1.003	SB5	37.561	0.786	1.586	0.33		21.7	FLOOD		2	
1.004	SB6	37.555	0.980	0.000	0.47		29.5	FLOOD RISK			
1.005	SB7	37.550	1.125	25.540	0.13		4.9	FLOOD		4	