


Woods Hardwick		Page 0
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 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


Woods Hardwick		Page 1
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

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

Woods Hardwick		Page 2
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

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	
SB6	37.692	1.417	Open Manhole	1500	1.004	36.275	300	2.000	36.475	300	
SB7	37.524	1.324	Open Manhole	2400	1.005	36.200	225	1.003	36.275	300	
SB8	37.049	0.949	Open Manhole	1500		OUTFALL		1.004	36.200	300	
								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 <sup>3</sup> /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	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		

Woods Hardwick		Page 3
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions	Network 2015.1	

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		

Woods Hardwick		Page 4
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

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 <sup>2</sup> )	Inf. Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Inf. Area (m <sup>2</sup> )
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 <sup>2</sup> )	Inf. Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Inf. Area (m <sup>2</sup> )
0.000	350.0	0.0	0.401	0.0	0.0
0.400	350.0	0.0			

Woods Hardwick		Page 5
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

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 \* 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 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, 20

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	SB1	30 Winter	1	+0%	100/15 Summer				36.891
1.001	SB2	30 Winter	1	+0%	100/15 Summer				36.801
1.002	SB3	15 Winter	1	+0%	100/15 Summer				36.784
2.000	SB4	240 Winter	1	+0%	100/60 Winter				36.670
1.003	SB5	15 Winter	1	+0%	30/15 Summer				36.615
1.004	SB6	15 Winter	1	+0%	30/15 Summer				36.453
1.005	SB7	360 Winter	1	+0%	30/30 Summer				36.367

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

Woods Hardwick		Page 6
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

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 \* 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 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, 20

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	SB1	15 Winter	30	+0%	100/15 Summer				36.948
1.001	SB2	15 Winter	30	+0%	100/15 Summer				36.930
1.002	SB3	15 Winter	30	+0%	100/15 Summer				36.923
2.000	SB4	240 Winter	30	+0%	100/60 Winter				36.731
1.003	SB5	15 Winter	30	+0%	30/15 Summer				36.836
1.004	SB6	360 Winter	30	+0%	30/15 Summer				36.736
1.005	SB7	360 Winter	30	+0%	30/30 Summer				36.731

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

Woods Hardwick		Page 7
15-17 Goldington Road Bedford Bedfordshire MK40 3NH		
Date 30/01/2018 10:08 File 17694_STORM2.MDX	Designed by p.kennerley Checked by	
XP Solutions		Network 2015.1

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 \* 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 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, 20

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	SB1	360 Winter	100	+20%	100/15 Summer				37.405
1.001	SB2	360 Winter	100	+20%	100/15 Summer				37.403
1.002	SB3	360 Winter	100	+20%	100/15 Summer				37.402
2.000	SB4	360 Winter	100	+20%	100/60 Winter				37.397
1.003	SB5	360 Winter	100	+20%	30/15 Summer				37.399
1.004	SB6	360 Winter	100	+20%	30/15 Summer				37.395
1.005	SB7	360 Winter	100	+20%	30/30 Summer				37.391

PN	US/MH Name	Surcharged Flooded		Pipe		Level Exceeded
		Depth (m)	Volume (m <sup>3</sup> )	Flow / Cap. (l/s)	Overflow Flow (l/s) Status	
1.000	SB1	0.280	0.000	0.13	7.3 SURCHARGED	
1.001	SB2	0.378	0.000	0.13	7.3 SURCHARGED	
1.002	SB3	0.427	0.000	0.26	16.1 SURCHARGED	
2.000	SB4	0.447	0.000	0.07	4.4 SURCHARGED	
1.003	SB5	0.624	0.000	0.38	24.9 FLOOD RISK	
1.004	SB6	0.820	0.000	0.54	33.9 FLOOD RISK	
1.005	SB7	0.966	0.000	0.13	4.7 FLOOD RISK	