



CALCULATIONS

DOCUMENT No
104-013-UA-001881-02

OFFICE

PROJECT TITLE

NW Bicester Eco Development - Exemplar Site

SUBJECT

S38 Northern spine road drainage

SHEET No

1 OF 14

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
2	14	MP	31/10/12	SJ	02/11/12	SAD	02/11/12	

SUPERSEDES DOC No

DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

Introduction

This calculation covers the design of the proposed SuDS network incorporating soakaways, pipes and pond and swale as detailed on drawings 7253 to 7256.

The drained areas are shown on drawings 103-015 and 103-016.

The network has been assessed using WinDES software, a widely used industry standard package for drainage design produced by MicroDrainage.

The individual swale designs have been included in calculation 104-012.

Soakways 12 to 9 are linked via pipe overflows and have been simulated as a cascade for a variety of rainfall events. Any overflow passed forward is accommodated within the next soakaway in the chain before discharging to the pipe network. This pass-forward flow is recorded as a hydrograph and input to the pipe network and simulated accordingly.


Assumptions

- 1) Design to accommodate 100 yr rainfall events with a variety of durations
- 2) Climate change factor of 30% applied to rainfall
- 3) Ground infiltration rate derived from site investigation as per calculation 104-012

Results

The calculation shows the following key results:

- No flooding during any of the rainfall events
- Peak discharges at the outfall meet the discharge restriction of 10l/s set for this catchment within the drainage strategy
- Pond surface water storage requirement of 80m² plan area with 0.5m depth. Future stages of residential design may require additional storage within this pond.
- Discharge swale surface water storage requirement of 60m² plan area with 1.2m depth.

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Micro Drainage	Network W.12.4	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.000
Ratio R	0.400	Maximum Backdrop Height (m)	20.000
Maximum Rainfall (mm/hr)	0	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.00	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

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	16.466	0.100	164.7	0.000	4.00	0.0	0.600	o	300
1.001	54.060	0.320	168.9	0.040	0.00	0.0	0.600	o	300
2.000	9.430	0.250	37.7	0.000	4.00	0.0	0.600	o	225
1.002	46.707	0.285	163.9	0.000	0.00	0.0	0.600	o	300
1.003	24.518	0.150	163.5	0.057	0.00	0.0	0.600	o	300
1.004	13.533	0.080	169.2	0.000	0.00	0.0	0.600	o	300
1.005	11.216	0.070	160.2	0.000	0.00	0.0	0.600	o	225
1.006	76.900	0.450	170.9	0.036	0.00	0.0	0.600	o	225
1.007	24.068	0.145	166.0	0.065	0.00	0.0	0.600	o	225
1.008	53.620	0.425	126.2	0.000	0.00	0.0	0.600	o	225

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ Area (ha)	Σ DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	4.22	89.025	0.000	0.0	0.0	0.0	1.22	86.4	0.0
1.001	0.00	4.97	88.925	0.040	0.0	0.0	0.0	1.21	85.3	0.0
2.000	0.00	4.07	89.000	0.000	0.0	0.0	0.0	2.14	85.0	0.0
1.002	0.00	5.61	88.605	0.040	0.0	0.0	0.0	1.23	86.6	0.0
1.003	0.00	5.94	88.320	0.097	0.0	0.0	0.0	1.23	86.7	0.0
1.004	0.00	6.13	88.170	0.097	0.0	0.0	0.0	1.21	85.2	0.0
1.005	0.00	6.31	88.090	0.097	0.0	0.0	0.0	1.03	41.0	0.0
1.006	0.00	7.59	88.020	0.133	0.0	0.0	0.0	1.00	39.7	0.0
1.007	0.00	7.99	87.570	0.198	0.0	0.0	0.0	1.01	40.2	0.0
1.008	0.00	8.76	87.425	0.198	0.0	0.0	0.0	1.16	46.2	0.0

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.009	17.147	0.200	85.7	0.040	0.00	0.0	0.600	o	225
1.010	22.111	0.600	36.9	0.064	0.00	0.0	0.600	o	225
1.011	46.197	2.000	23.1	0.000	0.00	0.0	0.600	o	225
1.012	5.456	2.000	2.7	0.000	0.00	0.0	0.600	o	225

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ Area (ha)	Σ DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.009	0.00	8.96	87.000	0.238	0.0	0.0	0.0	1.41	56.2	0.0
1.010	0.00	9.13	86.800	0.302	0.0	0.0	0.0	2.16	86.0	0.0
1.011	0.00	9.41	86.200	0.302	0.0	0.0	0.0	2.73	108.7	0.0
1.012	0.00	9.42	83.500	0.302	0.0	0.0	0.0	7.98	317.3	0.0

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Diam., L*W (mm)	Pipe Out			Pipes In			Backdrop (mm)
				PN	Invert Level (m)	Diameter (mm)	PN	Invert Level (m)	Diameter (mm)	
S100	91.100	2.075	1200	1.000	89.025	300				
S101	91.000	2.075	1200	1.001	88.925	300	1.000	88.925	300	
S102	91.000	2.000	1200	2.000	89.000	225				
S103	90.750	2.145	1200	1.002	88.605	300	1.001	88.605	300	
							2.000	88.750	225	70
S104	90.350	2.030	1200	1.003	88.320	300	1.002	88.320	300	
H101/H102	90.330	2.160	1200	1.004	88.170	300	1.003	88.170	300	
S105	90.330	2.240	1200	1.005	88.090	225	1.004	88.090	300	
S106	90.250	2.230	1200	1.006	88.020	225	1.005	88.020	225	
S107	89.700	2.130	1200	1.007	87.570	225	1.006	87.570	225	
S108	89.200	1.775	1200	1.008	87.425	225	1.007	87.425	225	
S109	88.500	1.500	1050	1.009	87.000	225	1.008	87.000	225	
S110	88.300	1.500	1050	1.010	86.800	225	1.009	86.800	225	
S111	88.100	1.900	1200	1.011	86.200	225	1.010	86.200	225	
H103/H104	85.000	1.500	1050	1.012	83.500	225	1.011	84.200	225	700
	83.000	1.500	0		OUTFALL		1.012	81.500	225	

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH DIAM., L*W (mm)
1.000	o	300	S100	91.100	89.025	1.775	1200
1.001	o	300	S101	91.000	88.925	1.775	1200
2.000	o	225	S102	91.000	89.000	1.775	1200
1.002	o	300	S103	90.750	88.605	1.845	1200
1.003	o	300	S104	90.350	88.320	1.730	1200
1.004	o	300	H101/H102	90.330	88.170	1.860	1200
1.005	o	225	S105	90.330	88.090	2.015	1200
1.006	o	225	S106	90.250	88.020	2.005	1200
1.007	o	225	S107	89.700	87.570	1.905	1200
1.008	o	225	S108	89.200	87.425	1.550	1200
1.009	o	225	S109	88.500	87.000	1.275	1050
1.010	o	225	S110	88.300	86.800	1.275	1050
1.011	o	225	S111	88.100	86.200	1.675	1200
1.012	o	225	H103/H104	85.000	83.500	1.275	1050

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH DIAM., L*W (mm)
1.000	16.466	164.7	S101	91.000	88.925	1.775	1200
1.001	54.060	168.9	S103	90.750	88.605	1.845	1200
2.000	9.430	37.7	S103	90.750	88.750	1.775	1200
1.002	46.707	163.9	S104	90.350	88.320	1.730	1200
1.003	24.518	163.5	H101/H102	90.330	88.170	1.860	1200
1.004	13.533	169.2	S105	90.330	88.090	1.940	1200
1.005	11.216	160.2	S106	90.250	88.020	2.005	1200
1.006	76.900	170.9	S107	89.700	87.570	1.905	1200
1.007	24.068	166.0	S108	89.200	87.425	1.550	1200
1.008	53.620	126.2	S109	88.500	87.000	1.275	1050
1.009	17.147	85.7	S110	88.300	86.800	1.275	1050
1.010	22.111	36.9	S111	88.100	86.200	1.675	1200
1.011	46.197	23.1	H103/H104	85.000	84.200	0.575	1050
1.012	5.456	2.7		83.000	81.500	1.275	0

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)
1.012		83.000	81.500	0.000	0	0

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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
PIMP (% impervious)	100	Additional Flow - % of Total Flow	30.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Run Time (mins)	120
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	2
Number of Input Hydrographs	1	Number of Storage Structures	2
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0		

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	60
Ratio R	0.400		

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Online Controls for Storm

Hydro-Brake® Manhole: S105, DS/PN: 1.005, Volume (m³): 3.4

Design Head (m) 0.650 Diameter (mm) 102
Design Flow (l/s) 5.0 Invert Level (m) 88.090
Hydro-Brake® Type Md5 SW Only

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	6.9	3.000	10.8	7.000	16.6
0.200	4.2	1.400	7.4	3.500	11.7	7.500	17.1
0.300	4.1	1.600	7.9	4.000	12.5	8.000	17.7
0.400	4.2	1.800	8.4	4.500	13.3	8.500	18.3
0.500	4.5	2.000	8.9	5.000	14.0	9.000	18.8
0.600	4.9	2.200	9.3	5.500	14.7	9.500	19.3
0.800	5.6	2.400	9.7	6.000	15.3		
1.000	6.3	2.600	10.1	6.500	16.0		

Hydro-Brake® Manhole: H103/H104, DS/PN: 1.012, Volume (m³): 3.1

Design Head (m) 1.200 Diameter (mm) 126
Design Flow (l/s) 10.0 Invert Level (m) 83.500
Hydro-Brake® Type Md6 SW Only

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.1	1.200	9.9	3.000	15.7	7.000	24.0
0.200	8.0	1.400	10.7	3.500	16.9	7.500	24.8
0.300	8.5	1.600	11.5	4.000	18.1	8.000	25.6
0.400	8.1	1.800	12.2	4.500	19.2	8.500	26.4
0.500	7.8	2.000	12.8	5.000	20.3	9.000	27.2
0.600	7.8	2.200	13.4	5.500	21.2	9.500	27.9
0.800	8.3	2.400	14.0	6.000	22.2		
1.000	9.1	2.600	14.6	6.500	23.1		

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Date 05/11/2012 17:44
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Storage Structures for Storm

Tank or Pond Manhole: H101/H102, DS/PN: 1.004

Invert Level (m) 88.245

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	80.0	0.500	80.0	0.501	0.0

Tank or Pond Manhole: H103/H104, DS/PN: 1.012

Invert Level (m) 83.500

Depth (m)	Area (m ²)
0.000	65.0

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Summary of Results for 60 minute 100 year Winter (Storm)

Margin for Flood Risk Warning (mm) 0.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m ³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	S100	89.075	-0.250	0.000	0.00	0.0	0.2	OK
1.001	S101	89.081	-0.144	0.000	0.43	0.0	34.9	OK
2.000	S102	89.000	-0.225	0.000	0.00	0.0	0.0	OK
1.002	S103	88.752	-0.153	0.000	0.45	0.0	36.2	OK
1.003	S104	88.743	0.123	0.000	0.64	0.0	49.8	SURCHARGED
1.004	H101/H102	88.737	0.267	0.000	0.08	0.0	5.6	SURCHARGED
1.005	S105	88.826	0.511	0.000	0.15	0.0	5.0	SURCHARGED
1.006	S106	88.118	-0.127	0.000	0.39	0.0	14.9	OK
1.007	S107	87.741	-0.054	0.000	0.92	0.0	34.2	OK
1.008	S108	87.574	-0.076	0.000	0.77	0.0	34.1	OK
1.009	S109	87.169	-0.056	0.000	0.91	0.0	45.8	OK
1.010	S110	86.957	-0.068	0.000	0.82	0.0	64.6	OK
1.011	S111	86.329	-0.096	0.000	0.62	0.0	64.6	OK
1.012	H103/H104	84.683	0.958	0.000	0.05	0.0	9.9	SURCHARGED

Input Hydrograph Manhole S101, DS/PN 1.001 (Storm)

60 minute 100 year Winter

Input Hydrograph Type: User Defined

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	14	0.0	26	0.0	38	11.8	50	2.9	62	0.0
4	0.0	16	0.0	28	0.0	40	11.8	52	2.5	64	0.0
6	0.0	18	0.0	30	6.6	42	7.9	54	2.5	66	0.0
8	0.0	20	0.0	32	24.0	44	6.6	56	2.3	68	0.0
10	0.0	22	0.0	34	13.5	46	4.7	58	2.0	70	0.0
12	0.0	24	0.0	36	17.8	48	3.5	60	1.3		

Cascade Summary of Results for Soakaway 9.srcx


Upstream Outflow To Overflow To
Structures

Soakaway 10.srcx (None) (None)
Soakaway 11.srcx
Soakaway 12.srcx

Half Drain Time : 101 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Overflow (1/s)	Max Σ Outflow (1/s)	Max Volume (m ³)	Status
15 min Summer	91.003	0.483	0.3	101.4	101.7	2.0	O K
30 min Summer	91.000	0.480	0.3	95.9	96.2	2.0	O K
60 min Summer	90.988	0.468	0.3	75.9	76.2	2.0	O K
120 min Summer	90.974	0.454	0.3	53.8	54.1	1.9	O K
180 min Summer	90.963	0.443	0.3	37.7	37.9	1.9	O K
240 min Summer	90.957	0.437	0.3	30.6	30.9	1.8	O K
360 min Summer	90.950	0.430	0.3	21.9	22.1	1.8	O K
480 min Summer	90.946	0.426	0.2	17.6	17.8	1.8	O K
600 min Summer	90.942	0.422	0.2	14.1	14.4	1.8	O K
720 min Summer	90.940	0.420	0.2	12.3	12.5	1.8	O K
960 min Summer	90.937	0.417	0.2	9.2	9.5	1.7	O K
1440 min Summer	90.933	0.413	0.2	6.1	6.4	1.7	O K
2160 min Summer	90.929	0.409	0.2	3.8	4.0	1.7	O K
2880 min Summer	90.927	0.407	0.2	2.6	2.9	1.7	O K
4320 min Summer	90.925	0.405	0.2	1.4	1.6	1.7	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m ³)	Time-Peak (mins)
15 min Summer	128.285	30.2	10
30 min Summer	84.226	44.9	18
60 min Summer	52.662	58.8	34
120 min Summer	31.800	70.2	62
180 min Summer	23.353	74.4	90
240 min Summer	18.644	75.7	122
360 min Summer	13.543	75.6	182
480 min Summer	10.792	74.2	244
600 min Summer	9.043	72.3	308
720 min Summer	7.823	70.0	364
960 min Summer	6.219	65.1	488
1440 min Summer	4.493	55.7	720
2160 min Summer	3.241	43.9	1040
2880 min Summer	2.568	35.3	1416
4320 min Summer	1.847	24.0	2120

Hyder Consulting Limited		Page 2
5th Floor, The Pithay All Saints Street Bristol BS1 2LZ		
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Cascade Summary of Results for Soakaway 9.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m ³)	Status
5760 min Summer	90.923	0.403	0.2	0.8	1.0	1.7	O K
7200 min Summer	90.923	0.403	0.2	0.6	0.9	1.7	O K
8640 min Summer	90.922	0.402	0.2	0.5	0.7	1.7	O K
10080 min Summer	90.922	0.402	0.2	0.3	0.6	1.7	O K
15 min Winter	91.005	0.485	0.3	106.0	106.3	2.0	O K
30 min Winter	90.999	0.479	0.3	95.0	95.3	2.0	O K
60 min Winter	90.982	0.462	0.3	66.2	66.4	1.9	O K
120 min Winter	90.964	0.444	0.3	39.0	39.2	1.9	O K
180 min Winter	90.955	0.435	0.3	28.2	28.4	1.8	O K
240 min Winter	90.950	0.430	0.3	21.9	22.1	1.8	O K
360 min Winter	90.944	0.424	0.2	15.6	15.8	1.8	O K
480 min Winter	90.940	0.420	0.2	12.3	12.5	1.8	O K
600 min Winter	90.938	0.418	0.2	10.5	10.7	1.7	O K
720 min Winter	90.935	0.415	0.2	8.0	8.3	1.7	O K
960 min Winter	90.933	0.413	0.2	6.1	6.4	1.7	O K
1440 min Winter	90.930	0.410	0.2	4.1	4.3	1.7	O K
2160 min Winter	90.926	0.406	0.2	2.1	2.3	1.7	O K
2880 min Winter	90.925	0.405	0.2	1.4	1.6	1.7	O K
4320 min Winter	90.923	0.403	0.2	0.8	1.0	1.7	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m ³)	Time-Peak (mins)
5760 min Summer	1.461	16.0	2896
7200 min Summer	1.217	11.9	3648
8640 min Summer	1.048	9.4	4488
10080 min Summer	0.923	7.1	4872
15 min Winter	128.285	36.4	9
30 min Winter	84.226	53.0	18
60 min Winter	52.662	68.9	32
120 min Winter	31.800	82.5	62
180 min Winter	23.353	87.9	92
240 min Winter	18.644	90.0	120
360 min Winter	13.543	90.4	186
480 min Winter	10.792	88.9	238
600 min Winter	9.043	86.3	306
720 min Winter	7.823	83.5	372
960 min Winter	6.219	77.2	490
1440 min Winter	4.493	63.9	734
2160 min Winter	3.241	47.1	1076
2880 min Winter	2.568	36.7	1468
4320 min Winter	1.847	21.1	2096

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Micro Drainage

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Cascade Summary of Results for Soakaway 9.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m ³)	Status
5760 min Winter	90.922	0.402	0.2	0.5	0.7	1.7	O K
7200 min Winter	90.922	0.402	0.2	0.3	0.6	1.7	O K
8640 min Winter	90.921	0.401	0.2	0.2	0.4	1.7	O K
10080 min Winter	90.921	0.401	0.2	0.1	0.3	1.7	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m ³)	Time-Peak (mins)
5760 min Winter	1.461	14.9	3064
7200 min Winter	1.217	10.6	3808
8640 min Winter	1.048	6.9	4760
10080 min Winter	0.923	3.8	5032

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Cascade Rainfall Details for Soakaway 9.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.056

Time **Area**
(mins) **(ha)**

0-4 0.056

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Cascade Model Details for Soakaway 9.srcx

Storage is Online Cover Level (m) 91.970

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.05600	Trench Width (m)	0.7
Infiltration Coefficient Side (m/hr)	0.05600	Trench Length (m)	20.8
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	90.520	Cap Infiltration Depth (m)	0.000

Weir Overflow Control

Discharge Coef 0.544 Width (m) 2.500 Invert Level (m) 90.920