BELLWAY HOMES EASTERN COUNTIES
DEVELOPMENT AT BIRCH AVENUE, BACTON
DRAINAGE REPORT

AUGUST 2021

REF 1061-00-001Rev A

Infrastructure Design Limited
Consulting Engineers

33 The Point, Rockingham Road
Market Harborough
Leicestershire LE16 7QU
Tel: 01858 411570
Fax: 01858 411571

iD LTD
INFRASTRUCTURE DESIGN LIMITED

Detailed Design of Surface Water Drainage Scheme

Drawing 1061-00-03 (Appendix A) shows the layout of the SW drainage. Appendix B shows Qbar calculations based HR Wallingford assessment of Greenfield Runoff rates. Within Appendix C, are a full set of Calculations and Data sheets. Appendix D includes plan ref 1061-00-05 which shows levels design and Exceedance Routing for drainage. The Maintenance and Management plan for the SW system is shown within Appendix E.

Further to the above information highlighted, key points which highlights the key points of compliance for the drainage strategy for the site.

1. SW Drainage Scheme
    - ❖ The surface water system is to comprise, mainly of an underswale type construction with a perforated pipe laid under a swale, this will allow all surface runoff to enter the swale, and then into the pipe network below, providing the first treatment train for water.
    - ❖ The pond is to be a shallow wet pond, again providing a treatment train for surface water runoff. The pond has been designed in 0.6m lifts at 1:4 slope, with 1.5m margins at each lift, there is also a 3m wide maintenance margin around the hole pond for access.

2. Greenfield Runoff Rates
    - ❖ To ensure Betterment is provided flow rates restricted to Qbar of 11l/s for design storm events up to and including the 1 in 100 year event plus climate change event, for development area.
    - ❖ Modelling utilising Causeway Flow is appended showing the Simulations for various storm event, including allowances for climate change of 20% and 40% in line with normal practice of design for 20% CC and test system for 40% CC and Urban Creep allowances of 10%.

3. Exceedance Routing
    - ❖ The results of the modelling within Appendix C show that no flooding occurs, even when tested with 40% climate change and 10% Urban Creep.
    - ❖ The areas of potential flooding caused by exceedance of the system identified and within Appendix D, exceedance routing has shown where exceedance flows can be directed, via the road corridors, safely to areas of POS and/or the attenuation ponds.

4. Fluvial Flooding
    - ❖ There are no areas identified within FRA.

5. Groundwater Flooding
    - ❖ None identified within FRA within the site.

    Pluvial/Surface Water Flooding
    - ❖ Areas identified within FRA as potential SW Flooding, were identified as likely flooding from on site self catchment, as the site will be fully drained this will be taken within the on site drainage and swale system running along the southern boundary of the site.
6. SuDS
    - Use of SuDS to improve water quality and flow.
        - ❖ The use of Swales and Water Basin with permanent water provides sufficient treatment train to improve the water quality in line with the requirements of C753 and the FRA, see table 1 below, all drives and parking bays are to be tanked porous paving, connecting into the drainage system.
        - ❖ SUDS Risk assessment is included with Appendix F

Table 1 Proposed runoff treatment – Roofs, Roads and hardstandings

Roof & access road		Treatment Required[1]		Proposed Treatment		
Pollution Hazard[1]	Low		Basin individual indices[2]	Swales individual indices[2]	Porous Paving Indices[2]	Total SuDS Mitigation Index
	Total suspended solids indices	0.5	0.7	0.5	0.7	0.75
	Metals indices	0.4	0.7	0.6	0.6	1.0
	Hydrocarbons indices	0.4	0.5	0.6	0.7	0.8

Notes:
1 - C753 table 26.2
2 - C753 table 26.3

The appended drawings, design and data sheets show that the scheme complies with the requirements of Suffolk County Council in all key points for strategy.

Certificate of Compliance Signed  **Rob Hill BSc MCIHT** Director For **Infrastructure Design Ltd** **16.9.21**	

Appendix A
Detailed Drainage Layout

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node	Dia (mm)	DS Node	Dia (mm)
1.000	14.688	146.9	225 Pipe		61.497	59.500	1.772	62.008	59.400	2.383	1	1500	2	1500
1.001	17.521	140.2	225 Pipe		62.008	59.400	2.383	62.060	59.275	2.560	2	1500	3	1500
1.002	17.601	140.8	225 Pipe		62.060	59.275	2.560	61.470	59.150	2.095	3	1500	4	1500
2.000	31.463	28.6	225 Pipe		61.547	60.250	1.072	61.470	59.150	2.095	20	1500	4	1500
1.003	18.541	123.6	225 Pipe		61.470	59.150	2.095	61.201	59.000	1.976	4	1500	5	1500
25.000	18.541	74.2	300 swale		61.470	61.150	0.020	61.201	60.900	0.001	4	1500	5	1500
3.000	13.954	15.5	225 Pipe		61.365	59.900	1.240	61.201	59.000	1.976	30	1500	5	1500
1.004	27.301	78.0	300 Pipe		61.201	58.925	1.976	60.995	58.575	2.120	5	1500	6	1500
26.000	27.301	109.2	300 swale		61.201	60.900	0.001	60.995	60.850	0.045	5	1500	6	1500
1.005	25.294	84.3	300 Pipe		60.995	58.575	2.120	60.791	58.275	2.216	6	1500	7	1500
1.006	17.834	79.3	300 Pipe		60.791	58.275	2.216	60.566	58.050	2.216	7	1500	8	1500
1.007	59.928	79.9	300 Pipe		60.566	58.050	2.216	59.863	57.350	2.213	8	1500	9	1500
1.008	26.727	76.4	375 Pipe		59.863	57.275	2.213	59.530	56.925	2.230	9	1500	10	1500
4.000	17.961	143.7	225 Pipe		59.400	57.975	1.200	59.530	57.850	1.455	40	1500	10	1500
1.009	17.595	140.8	450 Pipe		59.530	56.850	2.230	59.301	56.725	2.126	10	1500	11	1500
1.010	29.984	148.5	450 Pipe		59.301	56.725	2.126	58.252	56.550	1.252	11	1500	12	1500
1.011	20.407	91.0	450 Pipe		58.252	56.550	1.252	57.677	56.150	1.077	12	1500	13	1500
1.012	13.588	135.9	450 Pipe		57.677	56.150	1.077	57.650	56.050	1.150	13	1500	14	1500
1.013	22.325	297.7	450 Pipe		57.650	56.050	1.150	57.650	55.975	1.225	14	1500	15	
21.000	72.062	42.4	300 swale		60.931	60.600	0.031	59.253	58.900	0.053	100		85	1500
6.000	12.864	73.5	225 Pipe		61.037	59.150	1.662	60.867	58.975	1.667	80	1200	81	1200
6.001	47.283	67.5	225 Pipe		60.867	58.975	1.667	60.153	58.275	1.653	81	1200	82	1500
30.000	47.283	72.7	300 swale		60.867	60.500	0.067	60.153	59.850	0.003	81	1200	82	1500
7.000	13.486	13.2	225 Pipe		60.791	59.300	1.206	60.153	58.275	1.653	70	1200	82	1500
6.002	18.650	74.6	375 Pipe		60.153	58.125	1.653	59.884	57.875	1.634	82	1500	83	1500
6.003	34.326	98.1	375 Pipe		59.884	57.875	1.634	59.542	57.525	1.642	83	1500	84	1500
31.000	34.326	98.1	300 swale		59.884	59.550	0.034	59.542	59.200	0.042	83	1500	84	1500
6.004	14.630	53.2	375 Pipe		59.542	57.525	1.642	59.253	57.250	1.628	84	1500	85	1500
21.001	36.189	78.2	375 Pipe		59.253	57.250	1.628	58.807	56.800	1.632	85	1500	101	1500
32.000	36.189	88.0	300 swale		59.253	58.900	0.053	58.807	58.500	0.007	85	1500	101	1500
10.002	14.182	70.9	375 Pipe		58.807	56.800	1.632	58.598	56.600	1.623	101	1500	84	1500
33.000	14.182	56.7	450 swale		58.807	58.350	0.007	58.598	58.100	0.048	101	1500	84	1500
8.000	19.304	48.3	225 Pipe		59.281	57.850	1.206	58.874	57.450	1.199	90	1200	91	1200
8.001	37.258	71.0	300 Pipe		58.874	57.375	1.199	58.750	56.850	1.600	91	1200	82	1500
9.000	29.418	168.1	225 Pipe		59.200	57.175	1.800	58.900	57.000	1.675	90	1200	91	1200
9.001	11.082	147.8	225 Pipe		58.900	57.000	1.675	58.750	56.925	1.600	91	1200	82	1500
8.002	34.829	232.2	375 Pipe		58.750	56.775	1.600	58.592	56.625	1.592	82	1500	83	1500
27.000	34.829	278.6	300 swale		58.750	58.400	0.050	58.592	58.275	0.017	82	1500	83	1500
8.003	3.338	133.5	375 Pipe		58.592	56.625	1.592	58.598	56.600	1.623	83	1500	84	1500
28.000	3.338	19.1	450 swale		58.592	58.275	-0.133	58.598	58.100	0.048	83	1500	84	1500
10.003	66.455	265.8	450 Pipe		58.598	56.525	1.623	57.994	56.275	1.269	84	1500	102	
34.000	66.455	110.8	450 swale		58.598	58.100	0.048	57.994	57.500	0.044	84	1500	102	
21.003	46.956	294.9	450 Pipe		57.994	56.275	1.269	57.527	56.100	0.977	102		103	
35.000	46.956	92.7	450 swale		57.994	57.500	0.044	57.527	57.000	0.077	102		103	
11.000	28.778	178.5	225 Pipe		58.520	57.100	1.195	58.181	56.850	1.006	110	1200	111	1200
11.001	40.029	64.0	225 Pipe		58.181	56.950	1.006	57.527	56.325	0.977	111	1200	109	
21.004	8.910	138.2	450 Pipe		57.527	56.100	0.977	57.650	56.050	1.150	109		104	1500
10.006	23.208	185.7	450 Pipe		57.650	56.050	1.150	57.650	55.925	1.275	104	1500	105	
5.000	19.038	380.8	450 Pipe		57.650	55.900	1.300	57.650	55.850	1.350	16		80	1800
5.001	7.138	142.8	225 Pipe		57.650	55.850	1.575	56.800	55.800	0.775	80	1800	81	

Proposed runoff treatment - Roads and hardstandings - All Indicatvie SuDS mitigation indices for discharge to surface water show each treatment > Pollution Hazard Indices as below (C753 Tables 26.2 & 26.3

Roof, Parking & access road	Treatment Required	Proposed Treatment individual indices		
Pollution Hazard	Low	Basin	Permeable Pavement	Swale
Total suspended solids indices	0.5	0.7	0.7	0.5
Metals indices	0.4	0.7	0.6	0.6
Hydrocarbons indices	0.4	0.5	0.7	0.6

Pond

Pond Base 55.60
Permanent Water Level 55.9
2 Year 56.235
30 year 56.634
100 year + 20% 56.975
100 year + 40% CC & 10% UC 57.181
Top of Bank 57.50

S50 Hydrobrake Chamber rated at 11l/s @ 1.5m head (Qbar)

S51 55.825 (225)IL

PRETYMAN AVENUE

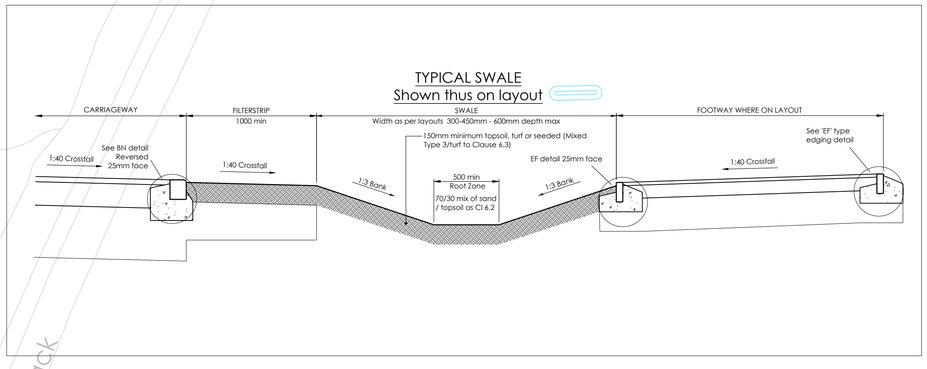
Future development to have Greenfield runoff allowance of 0.5l/s

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14 S15 S16 S20 S30 S40 S60 S61 S62 S63 S64 S65 S70 S80 S81 S82 S83 S84 S90 S91 S100 S101 S102 S103 S104 S105 S110 S111

Sub Station

Bell / Cycle Store

TYPICAL SWALE
Shown thus on layout



0 5 10 15 20 25 30 35 40 45 50
0 10 20 30 40 50

Bellway

Bellway Homes Limited (Eastern Counties)
3 Percy Road
Huntingdon
Cambridgeshire
PE29 6SZ

S7 1.900 (225i) 1.775 (375i) 1.650 r

Adopted Surface Water System

3.55 FFL Finished Floor Level

All parking bays and drives, should be in porous paving. Type B method, so draining into system, via porous pipe. This will give treatment train requirements in conjunction with online pond.

Pipe codes reference pipes and swales. For clarity and to simplify the drainage modelling only main runs of Underswales have been modelled as pipes and swales and are shown with twin Pipe codes. Refer to schedule for further details. Where the drainage model has omitted the swale eg S6-S10 for simplisity, the results shown will be worst case with improvements if swale included.

Within schedule DIA for swale denotes depth. Swales as per detail on side slopes etc

REV	DESCRIPTION	REV	DESCRIPTION	DATE

STATUS: Planning Submission

SCALE : 1:500 @ A1
DATE : May 2021
DRAWN : RAH

TITLE : Surface Water Drainage Strategy

PROJECT : Land at Birch Avenue, Bacton

DRG. No: 1061-00-03 Rev B

iD LTD
INFRASTRUCTURE DESIGN LIMITED
33 The Point
Market Harborough
Leicestershire LE16 7QU
Tel: 01858 411570 Fax: 01858 411571

Appendix B
HR Wallingford Greenfield Runoff

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Rob Hill
Site name:	Birch Road
Site location:	Bacton

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	52.26222° N
Longitude:	1.01259° E
Reference:	1289135905
Date:	Aug 22 2021 13:56

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 4.8

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	3	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.37	0.37

Hydrological characteristics

	Default	Edited
SAAR (mm):	579	579
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	11.04	11.04
1 in 1 year (l/s):	9.61	9.61
1 in 30 years (l/s):	27.06	27.06
1 in 100 year (l/s):	39.32	39.32
1 in 200 years (l/s):	46.49	46.49

Appendix C
Detailed Drainage Calculations and Supporting Plans

Nodes

Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.020	5.00		61.497	1500	605757.082	267065.858	1.997
2	0.020	5.00		62.008	1500	605764.186	267053.002	2.608
3	0.020	5.00		62.080	1500	605778.260	267042.566	2.805
20		5.00		61.547	1500	605805.204	267008.698	1.297
4	0.020	5.00		61.470	1500	605778.273	267024.965	2.320
30		5.00	0.5	61.365	1500	605774.677	267006.539	1.465
5	0.037	5.00		61.201	1500	605763.093	267014.319	2.276
6	0.030	5.00		60.995	1500	605748.636	266991.160	2.420
7	0.079	5.00		60.791	1500	605725.801	267002.038	2.516
8	0.000	5.00		60.566	1500	605707.967	267001.961	2.516
9	0.192	5.00		59.863	1500	605652.657	267010.249	2.588
40	0.065	5.00		59.400	1500	605621.941	266989.636	1.425
10	0.000	5.00		59.530	1500	605626.116	267007.105	2.680
11	0.000	5.00		59.301	1500	605609.838	267013.784	2.576
12	0.095	5.00		58.252	1500	605584.083	267010.341	1.702
13	0.037	5.00		57.677	1500	605563.726	267008.909	1.527
14	0.056	5.00		57.650	1500	605550.146	267009.388	1.600
100	0.064	5.00		60.931		605741.753	266863.115	0.331
60	0.089	5.00		61.037	1200	605752.370	266978.608	1.887
61	0.053	5.00		60.867	1200	605741.048	266984.716	1.892
70	0.105	5.00		60.731	1200	605730.062	266936.847	1.431
62	0.037	5.00		60.153	1500	605718.224	266943.307	2.028
63	0.060	5.00		59.884	1500	605709.278	266926.943	2.009
64	0.035	5.00		59.542	1500	605692.769	266896.848	2.017
65	0.000			59.253	1500	605678.140	266896.972	2.003
101	0.077	5.00		58.807	1500	605643.130	266893.426	2.007
80	0.061	5.00		59.281	1200	605681.319	266944.393	1.431
81	0.091	5.00		58.874	1200	605662.118	266946.382	1.499
90	0.032	5.00		59.200	1200	605619.007	266976.847	2.025
91	0.023	5.00		58.900	1200	605624.588	266947.963	1.900
82	0.052	5.00		58.750	1500	605626.066	266936.980	1.975
83				58.592	1500	605632.101	266902.678	1.967
84	0.025	5.00		58.598	1500	605630.450	266899.777	2.073
102				57.994		605570.821	266929.113	1.719
110	0.040	5.00		58.520	1200	605595.822	266954.061	1.420
111	0.063	5.00		58.181	1200	605569.103	266952.315	1.231
103				57.527		605529.175	266949.472	1.427
104				57.650	1500	605528.218	266956.315	1.600
105				57.650		605519.405	266977.785	1.740
15	0.000			57.650		605527.852	267010.569	1.740
16	0.000	5.00		57.650		605524.359	267021.432	1.750
50	0.000	5.00		57.650	1800	605522.086	267040.334	1.800
51				56.800		605515.041	267041.485	1.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)
1.000	1	2	14.688	0.600	59.500	59.400	0.100	146.9	225	Pipe	5.23
1.001	2	3	17.521	0.600	59.400	59.275	0.125	140.2	225	Pipe	5.49
1.002	3	4	17.601	0.600	59.275	59.150	0.125	140.8	225	Pipe	5.76
2.000	20	4	31.463	0.600	60.250	59.150	1.100	28.6	225	Pipe	5.21
1.003	4	5	18.541	0.600	59.150	59.000	0.150	123.6	225	Pipe	6.02
25.000	4	5	18.541	0.030	61.150	60.900	0.250	74.2	300	swale	5.26
3.000	30	5	13.954	0.600	59.900	59.000	0.900	15.5	225	Pipe	5.07
1.004	5	6	27.301	0.600	58.925	58.575	0.350	78.0	300	Pipe	6.28
26.000	5	6	27.301	0.030	60.900	60.650	0.250	109.2	300	swale	5.46
1.005	6	7	25.294	0.600	58.575	58.275	0.300	84.3	300	Pipe	6.52
1.006	7	8	17.834	0.600	58.275	58.050	0.225	79.3	300	Pipe	6.69
1.007	8	9	55.928	0.600	58.050	57.350	0.700	79.9	300	Pipe	7.22
1.008	9	10	26.727	0.600	57.275	56.925	0.350	76.4	375	Pipe	7.44
4.000	40	10	17.961	0.600	57.975	57.850	0.125	143.7	225	Pipe	5.28
1.009	10	11	17.595	0.600	56.850	56.725	0.125	140.8	450	Pipe	7.61
1.010	11	12	25.984	0.600	56.725	56.550	0.175	148.5	450	Pipe	7.87
1.011	12	13	20.407	0.600	56.550	56.150	0.400	51.0	450	Pipe	7.99
1.012	13	14	13.588	0.600	56.150	56.050	0.100	135.9	450	Pipe	8.12
1.013	14	15	22.325	0.600	56.050	55.975	0.075	297.7	450	Pipe	8.43
21.000	100	65	72.062	0.030	60.600	58.900	1.700	42.4	300	swale	5.76
6.000	60	61	12.864	0.600	59.150	58.975	0.175	73.5	225	Pipe	5.14
6.001	61	62	47.283	0.600	58.975	58.275	0.700	67.5	225	Pipe	5.64
30.000	61	62	47.283	0.030	60.500	59.850	0.650	72.7	300	swale	5.65
7.000	70	62	13.486	0.600	59.300	58.275	1.025	13.2	225	Pipe	5.06

Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)
1.000	1	2	1.076	42.8	2.7	1.772	2.383	0.020
1.001	2	3	1.102	43.8	5.4	2.383	2.580	0.040
1.002	3	4	1.100	43.7	8.1	2.580	2.095	0.060
2.000	20	4	2.455	97.6	0.0	1.072	2.095	0.000
1.003	4	5	1.174	46.7	10.8	2.095	1.976	0.080
25.000	4	5	1.195	609.3	0.0	0.020	0.001	0.000
3.000	30	5	3.339	132.8	0.5	1.240	1.976	0.000
1.004	5	6	1.782	125.9	16.4	1.976	2.120	0.117
26.000	5	6	0.985	502.1	0.0	0.001	0.045	0.000
1.005	6	7	1.713	121.1	20.4	2.120	2.216	0.147
1.006	7	8	1.767	124.9	31.1	2.216	2.216	0.226
1.007	8	9	1.760	124.4	31.1	2.216	2.213	0.226
1.008	9	10	2.075	229.2	57.1	2.213	2.230	0.418
4.000	40	10	1.088	43.3	8.8	1.200	1.455	0.065
1.009	10	11	1.711	272.2	66.0	2.230	2.126	0.483
1.010	11	12	1.666	265.0	66.0	2.126	1.252	0.483
1.011	12	13	2.851	453.4	78.8	1.252	1.077	0.578
1.012	13	14	1.742	277.1	83.8	1.077	1.150	0.615
1.013	14	15	1.173	186.5	91.4	1.150	1.225	0.671
21.000	100	65	1.580	806.0	8.7	0.031	0.053	0.064
6.000	60	61	1.527	60.7	12.1	1.662	1.667	0.089
6.001	61	62	1.593	63.3	19.2	1.667	1.653	0.142
30.000	61	62	1.206	615.3	0.0	0.067	0.003	0.000
7.000	70	62	3.626	144.2	14.2	1.206	1.653	0.105

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)
6.002	62	63	18.650	0.600	58.125	57.875	0.250	74.6	375	Pipe	5.80
6.003	63	64	34.326	0.600	57.875	57.525	0.350	98.1	375	Pipe	6.11
31.000	63	64	34.326	0.030	59.550	59.200	0.350	98.1	300	swale	5.55
6.004	64	65	14.630	0.600	57.525	57.250	0.275	53.2	375	Pipe	6.21
21.001	65	101	35.189	0.600	57.250	56.800	0.450	78.2	375	Pipe	6.49
32.000	65	101	35.189	0.030	58.900	58.500	0.400	88.0	300	swale	5.53
10.002	101	84	14.182	0.600	56.800	56.600	0.200	70.9	375	Pipe	6.60
33.000	101	84	14.182	0.030	58.350	58.100	0.250	56.7	450	swale	5.14
8.000	80	81	19.304	0.600	57.850	57.450	0.400	48.3	225	Pipe	5.17
8.001	81	82	37.258	0.600	57.375	56.850	0.525	71.0	300	Pipe	5.50
9.000	90	91	29.418	0.600	57.175	57.000	0.175	168.1	225	Pipe	5.49
9.001	91	82	11.082	0.600	57.000	56.925	0.075	147.8	225	Pipe	5.66
8.002	82	83	34.829	0.600	56.775	56.625	0.150	232.2	375	Pipe	6.15
27.000	82	83	34.829	0.030	58.400	58.275	0.125	278.6	300	swale	5.94
8.003	83	84	3.338	0.600	56.625	56.600	0.025	133.5	375	Pipe	6.19
28.000	83	84	3.338	0.030	58.275	58.100	0.175	19.1	450	swale	5.02
10.003	84	102	66.455	0.600	56.525	56.275	0.250	265.8	450	Pipe	7.50
34.000	84	102	66.455	0.030	58.100	57.500	0.600	110.8	450	swale	5.89
21.003	102	103	46.356	0.600	56.275	56.100	0.175	264.9	450	Pipe	8.12
35.000	102	103	46.356	0.030	57.500	57.000	0.500	92.7	450	swale	5.57
11.000	110	111	26.776	0.600	57.100	56.950	0.150	178.5	225	Pipe	5.46
11.001	111	103	40.029	0.600	56.950	56.325	0.625	64.0	225	Pipe	5.87
21.004	103	104	6.910	0.600	56.100	56.050	0.050	138.2	450	Pipe	8.18
10.006	104	105	23.208	0.600	56.050	55.925	0.125	185.7	450	Pipe	8.44

Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)
6.002	62	63	2.099	231.9	38.5	1.653	1.634	0.284
6.003	63	64	1.829	202.0	46.6	1.634	1.642	0.344
31.000	63	64	1.039	529.8	0.0	0.034	0.042	0.000
6.004	64	65	2.488	274.8	51.4	1.642	1.628	0.379
21.001	65	101	2.050	226.4	60.0	1.628	1.632	0.443
32.000	65	101	1.097	559.4	0.0	0.053	0.007	0.000
10.002	101	84	2.154	237.9	70.5	1.632	1.623	0.520
33.000	101	84	1.737	1797.8	0.0	0.007	0.048	0.000
8.000	80	81	1.887	75.0	8.3	1.206	1.199	0.061
8.001	81	82	1.868	132.1	20.6	1.199	1.600	0.152
9.000	90	91	1.005	40.0	4.3	1.800	1.675	0.032
9.001	91	82	1.073	42.7	7.5	1.675	1.600	0.055
8.002	82	83	1.185	130.8	35.1	1.600	1.592	0.259
27.000	82	83	0.616	314.4	0.0	0.050	0.017	0.000
8.003	83	84	1.566	173.0	35.1	1.592	1.623	0.259
28.000	83	84	2.995	3099.7	0.0	-0.133	0.048	0.000
10.003	84	102	1.242	197.5	109.0	1.623	1.269	0.804
34.000	84	102	1.243	1286.1	0.0	0.048	0.044	0.000
21.003	102	103	1.244	197.9	109.0	1.269	0.977	0.804
35.000	102	103	1.358	1406.0	0.0	0.044	0.077	0.000
11.000	110	111	0.975	38.8	5.4	1.195	1.006	0.040
11.001	111	103	1.637	65.1	14.0	1.006	0.977	0.103
21.004	103	104	1.727	274.7	122.9	0.977	1.150	0.907
10.006	104	105	1.488	236.7	122.9	1.150	1.275	0.907

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)
5.000	16	50	19.038	0.600	55.900	55.850	0.050	380.8	450	Pipe	5.31
5.001	50	51	7.138	0.600	55.850	55.800	0.050	142.8	225	Pipe	5.42

Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)
5.000	16	50	1.036	164.7	0.0	1.300	1.350	0.000
5.001	50	51	1.092	43.4	0.0	1.575	0.775	0.000

Simulation Settings

Rainfall Methodology	FEH-13	Skip Steady State	✓	Check Discharge Volume	✓
Summer CV	0.750	Drain Down Time (mins)	240	100 year 360 minute (m³)	
Winter CV	0.840	Additional Storage (m³/ha)	20.0		
Analysis Speed	Detailed	Check Discharge Rate(s)	✓		

Storm Durations

15	60	180	360	600	960	2880	8640
30	120	240	480	720	1440	5760	10080

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	20	0	0
100	40	10	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)		Betterment (%)	0
SAAR (mm)		QBar	
Soil Index	1	Q 1 year (l/s)	
SPR	0.10	Q 30 year (l/s)	
Region	1	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)		Storm Duration (mins)	360
Soil Index	1	Betterment (%)	0
SPR	0.10	PR	
CWI		Runoff Volume (m³)	

Node 50 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	55.850	Product Number	CTL-SHE-0145-1100-1500-1100
Design Depth (m)	1.500	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	11.0	Min Node Diameter (mm)	1500

Node 105 Online Orifice Control

Flap Valve	x	Invert Level (m)	55.910	Discharge Coefficient	1.000
Replaces Downstream Link	x	Diameter (m)	0.525		

Node 15 Online Orifice Control

Flap Valve	x	Invert Level (m)	55.910	Discharge Coefficient	1.000
Replaces Downstream Link	x	Diameter (m)	0.525		

Node 16 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	10.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	55.900	Main Channel Slope (1:X)	1000.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.030

Inlets

105	15

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	267.0	0.0	0.600	754.0	0.0	1.200	1382.0	0.0	1.800	2105.0	0.0
0.010	427.0	0.0	0.610	984.0	0.0	1.210	1648.0	0.0			

Results for 2 year Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	59.538	0.038	2.8	0.0752	0.0000	OK
15 minute winter	2	10	59.453	0.053	5.5	0.1025	0.0000	OK
15 minute winter	3	11	59.342	0.067	8.1	0.1285	0.0000	OK
15 minute summer	20	1	60.250	0.000	0.0	0.0000	0.0000	OK
15 minute winter	4	11	59.225	0.075	10.7	0.1461	0.0000	OK
15 minute summer	30	8	59.910	0.010	0.5	0.0181	0.0000	OK
15 minute winter	5	11	58.997	0.072	15.9	0.1510	0.0000	OK
15 minute winter	6	11	58.657	0.082	19.9	0.1647	0.0000	OK
15 minute winter	7	11	58.381	0.106	30.1	0.2538	0.0000	OK
15 minute winter	8	12	58.151	0.101	30.0	0.1779	0.0000	OK
15 minute winter	9	11	57.405	0.130	54.2	0.4222	0.0000	OK
15 minute winter	40	10	58.047	0.072	9.1	0.1916	0.0000	OK
15 minute winter	10	11	57.009	0.159	62.7	0.2812	0.0000	OK
15 minute winter	11	11	56.881	0.156	62.5	0.2759	0.0000	OK
15 minute winter	12	11	56.676	0.126	74.7	0.3638	0.0000	OK
15 minute winter	13	11	56.342	0.192	79.0	0.4332	0.0000	OK
15 minute winter	14	12	56.266	0.216	85.1	0.5331	0.0000	OK
15 minute winter	100	12	60.629	0.029	9.0	0.1123	0.0000	OK
15 minute winter	60	10	59.222	0.072	12.5	0.1484	0.0000	OK
15 minute winter	61	11	59.062	0.087	19.8	0.1464	0.0000	OK
15 minute winter	70	10	59.350	0.050	14.7	0.1305	0.0000	OK
15 minute winter	62	10	58.233	0.108	38.7	0.2298	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	2.7	0.471	0.064	0.0855	
15 minute winter	2	1.001	3	5.4	0.632	0.123	0.1501	
15 minute winter	3	1.002	4	8.1	0.755	0.185	0.1899	
15 minute summer	20	2.000	4	0.0	0.000	0.000	0.1771	
15 minute winter	4	1.003	5	10.5	0.932	0.225	0.2092	
15 minute winter	4	25.000	5	0.0	0.000	0.000	0.0003	
15 minute summer	30	3.000	5	0.5	0.799	0.004	0.0087	
15 minute winter	5	1.004	6	15.9	1.112	0.126	0.3896	
15 minute winter	5	26.000	6	0.0	0.000	0.000	0.0004	
15 minute winter	6	1.005	7	19.7	1.056	0.162	0.4775	
15 minute winter	7	1.006	8	30.0	1.404	0.240	0.3816	
15 minute winter	8	1.007	9	29.5	1.445	0.237	1.1423	
15 minute winter	9	1.008	10	53.9	1.660	0.235	0.8677	
15 minute winter	40	4.000	10	8.8	0.844	0.204	0.1889	
15 minute winter	10	1.009	11	62.5	1.264	0.230	0.8704	
15 minute winter	11	1.010	12	62.1	1.479	0.234	1.1066	
15 minute winter	12	1.011	13	74.1	1.477	0.163	1.0303	
15 minute winter	13	1.012	14	78.5	1.122	0.283	0.9500	
15 minute winter	14	1.013	15	85.9	1.187	0.460	1.6146	
15 minute winter	100	21.000	65	7.4	0.437	0.009	1.2118	
15 minute winter	60	6.000	61	12.4	0.999	0.204	0.1595	
15 minute winter	61	6.001	62	19.4	1.396	0.306	0.6556	
15 minute winter	61	30.000	62	0.0	0.000	0.000	0.0007	
15 minute winter	70	7.000	62	14.6	2.280	0.101	0.0863	
15 minute winter	62	6.002	63	38.5	1.310	0.166	0.5491	

Results for 2 year Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	63	11	58.002	0.127	46.8	0.3009	0.0000	OK
15 minute winter	64	11	57.643	0.118	51.6	0.2487	0.0000	OK
15 minute winter	65	11	57.383	0.133	59.0	0.2348	0.0000	OK
15 minute winter	101	11	56.953	0.153	69.1	0.3870	0.0000	OK
15 minute winter	80	10	57.902	0.052	8.6	0.1039	0.0000	OK
15 minute winter	81	10	57.457	0.082	21.2	0.1921	0.0000	OK
15 minute winter	90	10	57.225	0.050	4.5	0.0721	0.0000	OK
15 minute winter	91	11	57.066	0.066	7.6	0.0912	0.0000	OK
15 minute winter	82	11	56.911	0.136	35.1	0.3127	0.0000	OK
15 minute winter	83	11	56.782	0.157	35.6	0.2771	0.0000	OK
15 minute winter	84	11	56.760	0.235	106.5	0.4717	0.0000	OK
15 minute winter	102	12	56.506	0.231	106.5	0.0000	0.0000	OK
15 minute winter	110	10	57.157	0.057	5.6	0.0960	0.0000	OK
15 minute winter	111	11	57.021	0.071	14.3	0.1530	0.0000	OK
15 minute winter	103	12	56.336	0.236	118.9	0.0000	0.0000	OK
15 minute winter	104	13	56.280	0.230	117.4	0.4058	0.0000	OK
240 minute winter	105	196	56.237	0.327	27.7	0.0000	0.0000	OK
240 minute winter	15	192	56.236	0.326	20.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	63	6.003	64	47.0	1.505	0.233	1.0719	
15 minute winter	63	31.000	64	0.0	0.000	0.000	0.0005	
15 minute winter	64	6.004	65	51.9	1.611	0.189	0.4715	
15 minute winter	65	21.001	101	58.9	1.530	0.260	1.3556	
15 minute winter	65	32.000	101	0.0	0.000	0.000	0.0005	
15 minute winter	101	10.002	84	68.5	1.597	0.288	0.6163	
15 minute winter	101	33.000	84	0.0	0.000	0.000	0.0002	
15 minute winter	80	8.000	81	8.4	1.235	0.113	0.1321	
15 minute winter	81	8.001	82	20.7	1.361	0.157	0.5676	
15 minute winter	90	9.000	91	4.4	0.543	0.109	0.2387	
15 minute winter	91	9.001	82	7.4	0.788	0.174	0.1046	
15 minute winter	82	8.002	83	35.6	0.926	0.272	1.3893	
15 minute winter	82	27.000	83	0.0	0.000	0.000	0.0005	
15 minute winter	83	8.003	84	34.7	0.941	0.201	0.1476	
15 minute winter	83	28.000	84	0.0	0.000	0.000	0.0001	
15 minute winter	84	10.003	102	106.5	1.286	0.539	5.5029	
15 minute winter	84	34.000	102	0.0	0.000	0.000	0.0010	
15 minute winter	102	21.003	103	106.1	1.277	0.536	3.8517	
15 minute winter	102	35.000	103	0.0	0.000	0.000	0.0007	
15 minute winter	110	11.000	111	5.5	0.596	0.141	0.2472	
15 minute winter	111	11.001	103	13.9	1.308	0.214	0.4263	
15 minute winter	103	21.004	104	117.4	1.420	0.427	0.5714	
15 minute winter	104	10.006	105	117.8	1.490	0.498	1.8361	
240 minute winter	105	Flow through pond	16	29.6	0.026	0.000	168.3983	
240 minute winter	15	Flow through pond	16	29.6	0.026	0.000	168.3983	

Results for 2 year Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	16	196	56.235	0.335	29.6	0.0000	0.0000	OK
240 minute winter	50	196	56.235	0.385	11.3	0.9802	0.0000	SURCHARGED
15 minute summer	51	1	55.800	0.000	10.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	16	5.000	50	11.3	0.298	0.069	2.5805	
240 minute winter	50	Hydro-Brake®	51	11.0				258.4

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	59.563	0.063	7.6	0.1245	0.0000	OK
15 minute winter	2	10	59.493	0.093	15.1	0.1791	0.0000	OK
15 minute winter	3	11	59.397	0.122	22.4	0.2321	0.0000	OK
15 minute summer	20	1	60.250	0.000	0.0	0.0000	0.0000	OK
15 minute winter	4	11	59.288	0.138	29.5	0.2683	0.0000	OK
15 minute summer	30	20	59.910	0.010	0.5	0.0181	0.0000	OK
15 minute winter	5	11	59.050	0.125	43.1	0.2607	0.0000	OK
15 minute winter	6	11	58.723	0.148	53.9	0.2985	0.0000	OK
15 minute winter	7	11	58.473	0.198	82.2	0.4735	0.0000	OK
15 minute winter	8	11	58.233	0.183	82.4	0.3237	0.0000	OK
15 minute winter	9	11	57.517	0.242	149.4	0.7875	0.0000	OK
15 minute winter	40	10	58.103	0.128	24.7	0.3424	0.0000	OK
15 minute winter	10	11	57.152	0.302	173.2	0.5337	0.0000	OK
15 minute winter	11	11	57.012	0.287	173.2	0.5074	0.0000	OK
15 minute winter	12	11	56.797	0.247	207.2	0.7122	0.0000	OK
240 minute winter	13	232	56.638	0.488	43.6	1.0996	0.0000	SURCHARGED
240 minute winter	14	232	56.636	0.586	46.2	1.4459	0.0000	SURCHARGED
15 minute winter	100	11	60.652	0.052	24.3	0.2004	0.0000	OK
15 minute winter	60	10	59.284	0.134	33.8	0.2786	0.0000	OK
15 minute winter	61	11	59.137	0.162	53.5	0.2731	0.0000	OK
15 minute winter	70	10	59.387	0.087	39.9	0.2250	0.0000	OK
15 minute winter	62	10	58.324	0.199	105.3	0.4248	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	7.5	0.611	0.175	0.1811	
15 minute winter	2	1.001	3	14.8	0.795	0.338	0.3268	
15 minute winter	3	1.002	4	22.3	0.946	0.510	0.4176	
15 minute summer	20	2.000	4	0.0	0.000	0.000	0.3871	
15 minute winter	4	1.003	5	29.5	1.203	0.631	0.4540	
15 minute winter	4	25.000	5	0.0	0.000	0.000	0.0003	
15 minute summer	30	3.000	5	0.5	0.799	0.004	0.0455	
15 minute winter	5	1.004	6	43.2	1.387	0.343	0.8508	
15 minute winter	5	26.000	6	0.0	0.000	0.000	0.0004	
15 minute winter	6	1.005	7	54.0	1.297	0.446	1.0611	
15 minute winter	7	1.006	8	82.4	1.751	0.659	0.8409	
15 minute winter	8	1.007	9	80.9	1.860	0.650	2.4450	
15 minute winter	9	1.008	10	149.4	2.070	0.652	1.9382	
15 minute winter	40	4.000	10	24.1	1.086	0.558	0.4000	
15 minute winter	10	1.009	11	173.2	1.575	0.636	1.9344	
15 minute winter	11	1.010	12	173.2	1.796	0.654	2.5448	
15 minute winter	12	1.011	13	208.1	1.643	0.459	2.4877	
240 minute winter	13	1.012	14	42.3	0.879	0.153	2.1529	
240 minute winter	14	1.013	15	44.8	0.799	0.240	3.5373	
15 minute winter	100	21.000	65	21.4	0.600	0.027	2.5717	
15 minute winter	60	6.000	61	33.4	1.215	0.551	0.3551	
15 minute winter	61	6.001	62	52.3	1.758	0.826	1.4070	
15 minute winter	61	30.000	62	0.0	0.000	0.000	0.0007	
15 minute winter	70	7.000	62	39.6	2.963	0.275	0.1804	
15 minute winter	62	6.002	63	104.4	1.608	0.450	1.2145	

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	63	10	58.105	0.230	127.2	0.5432	0.0000	OK
15 minute winter	64	11	57.749	0.224	139.6	0.4727	0.0000	OK
15 minute winter	65	12	57.599	0.349	160.7	0.6158	0.0000	OK
15 minute winter	101	12	57.408	0.608	180.2	1.5406	0.0000	SURCHARGED
15 minute winter	80	10	57.940	0.090	23.2	0.1778	0.0000	OK
15 minute winter	81	10	57.513	0.138	57.5	0.3243	0.0000	OK
15 minute winter	90	12	57.347	0.172	12.2	0.2487	0.0000	OK
15 minute winter	91	13	57.340	0.340	32.7	0.4671	0.0000	SURCHARGED
15 minute winter	82	12	57.317	0.542	96.5	1.2440	0.0000	SURCHARGED
15 minute winter	83	12	57.267	0.642	81.5	1.1348	0.0000	SURCHARGED
15 minute winter	84	12	57.254	0.729	239.5	1.4634	0.0000	SURCHARGED
15 minute winter	102	12	56.855	0.580	240.5	0.0000	0.0000	SURCHARGED
15 minute winter	110	10	57.197	0.097	15.2	0.1643	0.0000	OK
15 minute winter	111	10	57.073	0.123	38.8	0.2661	0.0000	OK
240 minute winter	103	236	56.637	0.537	63.6	0.0000	0.0000	SURCHARGED
240 minute winter	104	236	56.636	0.586	61.5	1.0358	0.0000	SURCHARGED
240 minute winter	105	236	56.644	0.734	60.4	0.0000	0.0000	OK
240 minute winter	15	244	56.636	0.726	44.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	63	6.003	64	127.1	1.827	0.629	2.3893	
15 minute winter	63	31.000	64	0.0	0.000	0.000	0.0005	
15 minute winter	64	6.004	65	139.3	1.891	0.507	1.2677	
15 minute winter	65	21.001	101	151.7	1.677	0.670	3.8200	
15 minute winter	65	32.000	101	0.0	0.000	0.000	0.0005	
15 minute winter	101	10.002	84	167.0	1.627	0.702	1.5642	
15 minute winter	101	33.000	84	0.0	0.000	0.000	0.0002	
15 minute winter	80	8.000	81	22.9	1.612	0.305	0.2740	
15 minute winter	81	8.001	82	57.2	1.575	0.433	1.8779	
15 minute winter	90	9.000	91	12.6	0.692	0.315	1.0637	
15 minute winter	91	9.001	82	22.0	0.974	0.515	0.4407	
15 minute winter	82	8.002	83	81.5	0.994	0.623	3.8415	
15 minute winter	82	27.000	83	0.0	0.000	0.000	0.0005	
15 minute winter	83	8.003	84	86.4	0.905	0.499	0.3682	
15 minute winter	83	28.000	84	0.0	0.000	0.000	0.0001	
15 minute winter	84	10.003	102	240.5	1.518	1.218	10.5294	
15 minute winter	84	34.000	102	0.0	0.000	0.000	0.0010	
15 minute winter	102	21.003	103	240.2	1.516	1.214	7.3448	
15 minute winter	102	35.000	103	0.0	0.000	0.000	0.0007	
15 minute winter	110	11.000	111	14.9	0.772	0.385	0.5176	
15 minute winter	111	11.001	103	38.5	1.626	0.591	1.2354	
240 minute winter	103	21.004	104	61.5	1.155	0.224	1.0948	
240 minute winter	104	10.006	105	60.4	0.788	0.255	3.6772	
240 minute winter	105	Flow through pond	16	57.7	0.028	0.000	481.1947	
240 minute winter	15	Flow through pond	16	57.7	0.028	0.000	481.1947	

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	16	240	56.634	0.734	57.7	0.0000	0.0000	SURCHARGED
240 minute winter	50	240	56.633	0.783	11.7	1.9938	0.0000	SURCHARGED
15 minute summer	51	1	55.800	0.000	11.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	16	5.000	50	11.7	0.327	0.071	3.0164	
240 minute winter	50	Hydro-Brake®	51	11.0				275.5

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	59.580	0.080	11.8	0.1567	0.0000	OK
15 minute winter	2	10	59.522	0.122	23.4	0.2349	0.0000	OK
15 minute winter	3	11	59.443	0.168	34.8	0.3208	0.0000	OK
15 minute summer	20	1	60.250	0.000	0.0	0.0000	0.0000	OK
15 minute winter	4	11	59.347	0.197	45.6	0.3826	0.0000	OK
15 minute summer	30	21	59.910	0.010	0.5	0.0181	0.0000	OK
15 minute winter	5	11	59.088	0.163	66.0	0.3407	0.0000	OK
15 minute winter	6	12	58.859	0.284	82.8	0.5715	0.0000	OK
15 minute winter	7	12	58.729	0.454	126.5	1.0865	0.0000	SURCHARGED
15 minute winter	8	12	58.493	0.443	120.4	0.7832	0.0000	SURCHARGED
15 minute winter	9	11	57.885	0.610	230.5	1.9839	0.0000	SURCHARGED
15 minute winter	40	10	58.152	0.177	38.5	0.4729	0.0000	OK
15 minute winter	10	11	57.509	0.659	252.5	1.1640	0.0000	SURCHARGED
15 minute winter	11	11	57.354	0.629	246.5	1.1106	0.0000	SURCHARGED
15 minute winter	12	11	57.150	0.600	291.6	1.7295	0.0000	SURCHARGED
480 minute winter	13	464	56.978	0.828	40.8	1.8656	0.0000	SURCHARGED
480 minute winter	14	464	56.979	0.929	44.2	2.2929	0.0000	SURCHARGED
15 minute winter	100	11	60.666	0.066	37.9	0.2565	0.0000	OK
15 minute winter	60	12	60.011	0.861	52.7	1.7853	0.0000	SURCHARGED
15 minute winter	61	12	59.916	0.941	77.4	1.5908	0.0000	SURCHARGED
15 minute winter	70	12	59.431	0.131	62.1	0.3409	0.0000	OK
15 minute winter	62	12	59.201	1.076	155.7	2.2933	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	11.6	0.675	0.272	0.2541	
15 minute winter	2	1.001	3	23.0	0.858	0.525	0.4680	
15 minute winter	3	1.002	4	34.4	1.018	0.786	0.6046	
15 minute summer	20	2.000	4	0.0	0.000	0.000	0.5592	
15 minute winter	4	1.003	5	45.0	1.289	0.963	0.6484	
15 minute winter	4	25.000	5	0.0	0.000	0.000	0.0003	
15 minute summer	30	3.000	5	0.5	0.799	0.004	0.0986	
15 minute winter	5	1.004	6	66.1	1.491	0.525	1.4227	
15 minute winter	5	26.000	6	0.0	0.000	0.000	0.0004	
15 minute winter	6	1.005	7	80.9	1.319	0.668	1.7627	
15 minute winter	7	1.006	8	120.4	1.829	0.964	1.2559	
15 minute winter	8	1.007	9	123.7	1.919	0.994	3.9384	
15 minute winter	9	1.008	10	215.0	2.039	0.938	2.9479	
15 minute winter	40	4.000	10	37.5	1.184	0.866	0.5703	
15 minute winter	10	1.009	11	246.5	1.631	0.906	2.7878	
15 minute winter	11	1.010	12	239.8	1.770	0.905	4.1170	
15 minute winter	12	1.011	13	288.5	1.821	0.636	3.2334	
480 minute winter	13	1.012	14	40.5	0.780	0.146	2.1529	
480 minute winter	14	1.013	15	43.8	0.631	0.235	3.5373	
15 minute winter	100	21.000	65	34.3	0.683	0.043	3.6189	
15 minute winter	60	6.000	61	47.9	1.269	0.789	0.5116	
15 minute winter	61	6.001	62	69.6	1.750	1.099	1.8805	
15 minute winter	61	30.000	62	0.0	0.000	0.000	0.0007	
15 minute winter	70	7.000	62	64.2	3.187	0.445	0.4302	
15 minute winter	62	6.002	63	141.2	1.652	0.609	2.0570	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	63	12	59.103	1.228	174.6	2.9024	0.0000	SURCHARGED
15 minute winter	64	13	58.891	1.366	187.1	2.8878	0.0000	SURCHARGED
15 minute winter	65	13	58.752	1.502	197.3	2.6534	0.0000	SURCHARGED
15 minute winter	101	13	58.371	1.571	220.0	3.9810	0.0000	SURCHARGED
15 minute winter	80	12	58.446	0.596	36.1	1.1827	0.0000	SURCHARGED
15 minute winter	81	12	58.391	1.016	89.8	2.3826	0.0000	SURCHARGED
15 minute winter	90	13	58.297	1.122	18.9	1.6230	0.0000	SURCHARGED
15 minute winter	91	13	58.280	1.280	46.3	1.7572	0.0000	SURCHARGED
15 minute winter	82	13	58.253	1.478	110.3	3.3909	0.0000	SURCHARGED
15 minute winter	83	13	58.148	1.523	101.8	2.6913	0.0000	SURCHARGED
15 minute winter	84	13	58.118	1.593	325.0	3.1993	0.0000	SURCHARGED
15 minute winter	102	14	57.418	1.143	319.2	0.0000	0.0000	SURCHARGED
15 minute winter	110	12	57.295	0.195	23.7	0.3299	0.0000	OK
15 minute winter	111	12	57.268	0.318	61.0	0.6857	0.0000	SURCHARGED
480 minute winter	103	464	56.980	0.880	57.6	0.0000	0.0000	SURCHARGED
480 minute winter	104	464	56.978	0.928	57.1	1.6400	0.0000	SURCHARGED
480 minute winter	105	480	56.975	1.065	57.0	0.0000	0.0000	OK
480 minute winter	15	472	56.985	1.075	43.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	63	6.003	64	167.6	1.854	0.829	3.7861	
15 minute winter	63	31.000	64	0.0	0.000	0.000	0.0005	
15 minute winter	64	6.004	65	171.8	1.912	0.625	1.6136	
15 minute winter	65	21.001	101	186.5	1.691	0.824	3.8812	
15 minute winter	65	32.000	101	0.0	0.000	0.000	0.0005	
15 minute winter	101	10.002	84	211.7	1.920	0.890	1.5642	
15 minute winter	101	33.000	84	3.5	0.310	0.002	0.1615	
15 minute winter	80	8.000	81	35.9	1.753	0.478	0.7677	
15 minute winter	81	8.001	82	78.5	1.579	0.594	2.6237	
15 minute winter	90	9.000	91	18.1	0.728	0.452	1.1700	
15 minute winter	91	9.001	82	25.0	0.932	0.587	0.4407	
15 minute winter	82	8.002	83	101.8	1.009	0.778	3.8415	
15 minute winter	82	27.000	83	0.0	0.000	0.000	0.0005	
15 minute winter	83	8.003	84	101.9	0.924	0.589	0.3682	
15 minute winter	83	28.000	84	0.0	0.000	0.000	0.0175	
15 minute winter	84	10.003	102	318.1	2.008	1.610	10.5294	
15 minute winter	84	34.000	102	1.2	0.167	0.001	0.4940	
15 minute winter	102	21.003	103	319.0	2.014	1.612	7.3448	
15 minute winter	102	35.000	103	0.0	0.000	0.000	0.0007	
15 minute winter	110	11.000	111	23.7	0.828	0.611	1.0216	
15 minute winter	111	11.001	103	55.6	1.695	0.854	1.5920	
480 minute winter	103	21.004	104	57.1	0.970	0.208	1.0948	
480 minute winter	104	10.006	105	57.0	0.761	0.241	3.6772	
480 minute winter	105	Flow through pond	16	70.7	0.022	0.000	883.7959	
480 minute winter	15	Flow through pond	16	70.7	0.022	0.000	883.7959	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	16	472	56.975	1.075	70.7	0.0000	0.0000	SURCHARGED
480 minute winter	50	472	56.975	1.125	11.4	2.8619	0.0000	SURCHARGED
15 minute summer	51	1	55.800	0.000	11.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	16	5.000	50	11.4	0.294	0.069	3.0164	
480 minute winter	50	Hydro-Brake®	51	11.0				390.1

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	13	59.787	0.287	15.2	0.5703	0.0000	SURCHARGED
15 minute winter	2	13	59.781	0.381	30.3	0.7380	0.0000	SURCHARGED
15 minute winter	3	13	59.753	0.478	41.5	0.9192	0.0000	SURCHARGED
15 minute summer	20	1	60.250	0.000	0.0	0.0000	0.0000	OK
15 minute winter	4	13	59.690	0.540	53.6	1.0576	0.0000	SURCHARGED
15 minute summer	30	22	59.910	0.010	0.5	0.0181	0.0000	OK
15 minute winter	5	12	59.571	0.646	78.9	1.3727	0.0000	SURCHARGED
15 minute winter	6	12	59.501	0.926	90.3	1.8883	0.0000	SURCHARGED
15 minute winter	7	12	59.383	1.108	138.9	2.7236	0.0000	SURCHARGED
15 minute winter	8	12	59.129	1.079	127.7	1.9069	0.0000	SURCHARGED
15 minute winter	9	12	58.463	1.188	252.9	4.0368	0.0000	SURCHARGED
15 minute winter	40	10	58.219	0.244	49.4	0.6772	0.0000	SURCHARGED
15 minute winter	10	12	57.988	1.138	279.2	2.0106	0.0000	SURCHARGED
15 minute winter	11	12	57.781	1.056	276.8	1.8655	0.0000	SURCHARGED
15 minute winter	12	12	57.508	0.958	340.6	2.8693	0.0000	SURCHARGED
480 minute winter	13	480	57.181	1.031	51.1	2.3720	0.0000	SURCHARGED
480 minute winter	14	472	57.182	1.132	55.3	2.8707	0.0000	SURCHARGED
15 minute winter	100	11	60.676	0.076	48.6	0.3232	0.0000	OK
15 minute winter	60	11	60.770	1.620	67.6	3.5129	0.0000	FLOOD RISK
15 minute winter	61	12	60.555	1.580	98.1	2.7598	0.0000	SURCHARGED
15 minute winter	70	12	60.054	0.754	79.7	2.0706	0.0000	SURCHARGED
15 minute winter	62	12	59.776	1.651	171.9	3.5800	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	15.1	0.693	0.353	0.5842	
15 minute winter	2	1.001	3	26.5	0.872	0.604	0.6968	
15 minute winter	3	1.002	4	38.4	1.042	0.878	0.7000	
15 minute summer	20	2.000	4	0.0	0.000	0.000	0.6257	
15 minute winter	4	1.003	5	52.4	1.328	1.122	0.7374	
15 minute winter	4	25.000	5	0.0	0.000	0.000	0.0003	
15 minute summer	30	3.000	5	0.5	0.799	0.004	0.2818	
15 minute winter	5	1.004	6	77.8	1.503	0.618	1.9225	
15 minute winter	5	26.000	6	0.0	0.000	0.000	0.0004	
15 minute winter	6	1.005	7	91.3	1.430	0.754	1.7812	
15 minute winter	7	1.006	8	127.7	1.831	1.022	1.2559	
15 minute winter	8	1.007	9	131.2	1.982	1.054	3.9384	
15 minute winter	9	1.008	10	231.6	2.100	1.011	2.9479	
15 minute winter	40	4.000	10	47.6	1.222	1.099	0.6661	
15 minute winter	10	1.009	11	276.8	1.747	1.017	2.7878	
15 minute winter	11	1.010	12	278.4	1.757	1.051	4.1170	
15 minute winter	12	1.011	13	336.6	2.124	0.742	3.2334	
480 minute winter	13	1.012	14	50.6	0.751	0.183	2.1529	
480 minute winter	14	1.013	15	55.1	0.666	0.296	3.5373	
15 minute winter	100	21.000	65	44.5	0.733	0.055	4.3772	
15 minute winter	60	6.000	61	60.3	1.515	0.993	0.5116	
15 minute winter	61	6.001	62	70.6	1.775	1.114	1.8805	
15 minute winter	61	30.000	62	15.8	0.473	0.026	1.5824	
15 minute winter	70	7.000	62	74.9	3.189	0.520	0.5364	
15 minute winter	62	6.002	63	163.7	1.653	0.706	2.0570	

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	63	12	59.592	1.717	199.3	4.1627	0.0000	FLOOD RISK
15 minute winter	64	13	59.228	1.703	211.2	3.6607	0.0000	SURCHARGED
15 minute winter	65	13	58.978	1.728	250.3	3.0538	0.0000	FLOOD RISK
15 minute winter	101	13	58.463	1.663	285.1	4.3418	0.0000	SURCHARGED
15 minute winter	80	12	58.946	1.096	46.3	2.2686	0.0000	SURCHARGED
15 minute winter	81	12	58.808	1.433	104.5	3.5364	0.0000	FLOOD RISK
15 minute winter	90	11	58.590	1.415	24.3	2.0927	0.0000	SURCHARGED
15 minute winter	91	12	58.542	1.542	39.5	2.1548	0.0000	SURCHARGED
15 minute winter	82	13	58.482	1.707	173.4	4.0035	0.0000	FLOOD RISK
15 minute winter	83	13	58.302	1.677	145.8	2.9635	0.0000	FLOOD RISK
15 minute winter	84	14	58.257	1.732	441.5	3.5187	0.0000	SURCHARGED
15 minute winter	102	15	57.627	1.352	405.3	0.0000	0.0000	SURCHARGED
15 minute winter	110	12	57.790	0.690	30.4	1.2090	0.0000	SURCHARGED
15 minute winter	111	12	57.716	0.766	73.1	1.7290	0.0000	SURCHARGED
15 minute winter	103	16	57.242	1.142	435.8	0.0000	0.0000	FLOOD RISK
480 minute winter	104	472	57.185	1.135	73.3	2.0052	0.0000	SURCHARGED
480 minute winter	105	464	57.189	1.279	73.1	0.0000	0.0000	OK
480 minute winter	15	472	57.185	1.275	55.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	63	6.003	64	183.5	1.870	0.908	3.7861	
15 minute winter	63	31.000	64	7.0	0.323	0.013	0.7524	
15 minute winter	64	6.004	65	208.1	1.898	0.757	1.6136	
15 minute winter	65	21.001	101	215.6	1.955	0.952	3.8812	
15 minute winter	65	32.000	101	27.9	0.530	0.050	1.8654	
15 minute winter	101	10.002	84	218.6	1.982	0.919	1.5642	
15 minute winter	101	33.000	84	84.6	0.692	0.047	1.9608	
15 minute winter	80	8.000	81	39.4	1.764	0.525	0.7677	
15 minute winter	81	8.001	82	97.9	1.577	0.741	2.6237	
15 minute winter	90	9.000	91	23.1	0.725	0.577	1.1700	
15 minute winter	91	9.001	82	38.4	0.994	0.899	0.4407	
15 minute winter	82	8.002	83	137.2	1.244	1.049	3.8415	
15 minute winter	82	27.000	83	12.1	0.282	0.038	1.5691	
15 minute winter	83	8.003	84	142.2	1.289	0.822	0.3682	
15 minute winter	83	28.000	84	10.1	0.131	0.003	0.3143	
15 minute winter	84	10.003	102	317.0	2.001	1.605	10.5294	
15 minute winter	84	34.000	102	103.1	0.695	0.080	9.9303	
15 minute winter	102	21.003	103	332.8	2.100	1.682	7.3448	
15 minute winter	102	35.000	103	84.6	0.482	0.060	10.9581	
15 minute winter	110	11.000	111	28.1	0.828	0.725	1.0649	
15 minute winter	111	11.001	103	64.0	1.657	0.983	1.5920	
15 minute winter	103	21.004	104	391.4	2.471	1.425	1.0948	
480 minute winter	104	10.006	105	73.1	0.816	0.309	3.6772	
480 minute winter	105	Flow through pond	16	67.0	0.013	0.000	1184.5394	
480 minute winter	15	Flow through pond	16	67.0	0.013	0.000	1184.5394	

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.08%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	16	472	57.181	1.281	67.0	0.0000	0.0000	SURCHARGED
480 minute winter	50	472	57.181	1.331	11.4	3.3880	0.0000	SURCHARGED
15 minute summer	51	1	55.800	0.000	11.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	16	5.000	50	11.4	0.311	0.069	3.0164	
480 minute winter	50	Hydro-Brake®	51	11.0				414.5

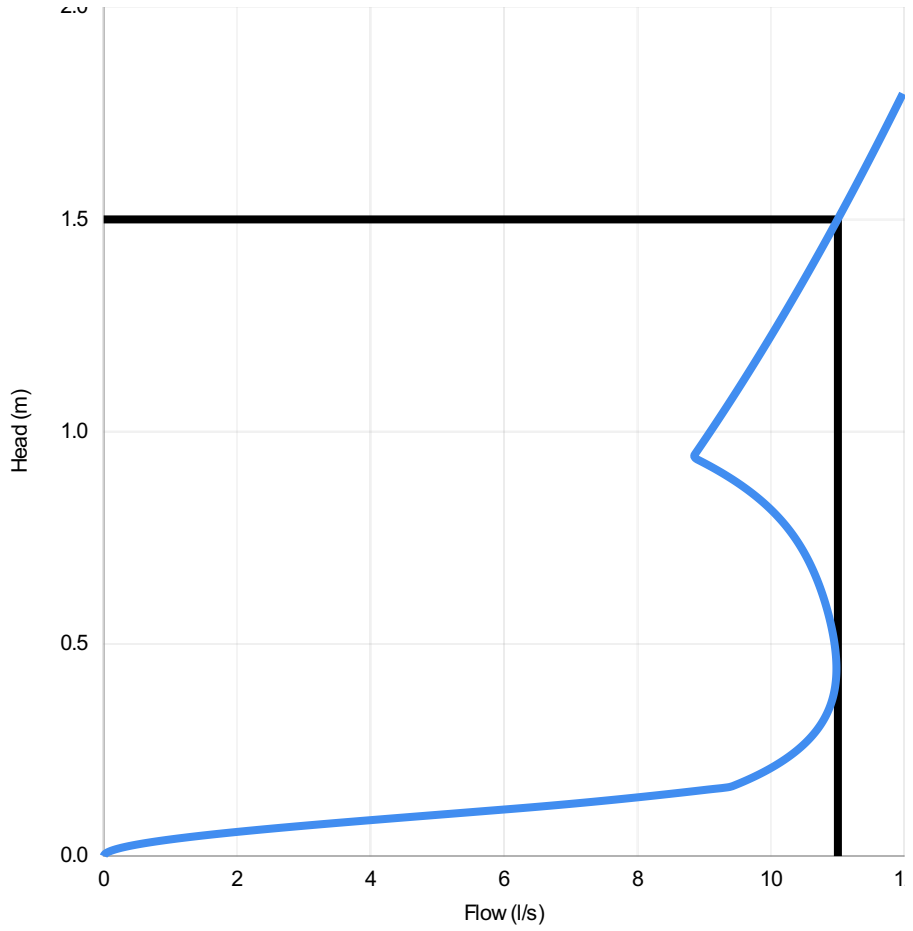
Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.500	11.000
Flush-Flo	0.442	10.978
Kick-Flo®	0.939	8.822
Mean Flow		9.573

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4596

WRc APPROVED
PT/329/0412

hydro-int.com/patents



Head (m)	Flow (l/s)
0.000	0.000
0.052	1.670
0.103	5.494
0.155	8.963
0.207	9.990
0.259	10.458
0.310	10.744
0.362	10.903
0.414	10.970
0.466	10.973
0.517	10.932
0.569	10.859
0.621	10.760
0.672	10.630
0.724	10.461
0.776	10.232
0.828	9.921
0.879	9.499
0.931	8.937
0.983	9.014
1.034	9.233
1.086	9.447
1.138	9.656
1.190	9.859
1.241	10.059
1.293	10.253
1.345	10.444
1.397	10.632
1.448	10.816
1.500	10.996

DESIGN ADVICE

The head/flow characteristics of this SHE-0145-1100-1500-1100 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

! **The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International®

DATE	22/08/2021 15:25
Site	Bacton
DESIGNER	Rob Hill
Ref	1061

SHE-0145-1100-1500-1100

Hydro-Brake Optimum®

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.500	11.000
Flush-Flo™	0.442	10.978
Kick-Flo®	0.939	8.822
Mean Flow		9.573

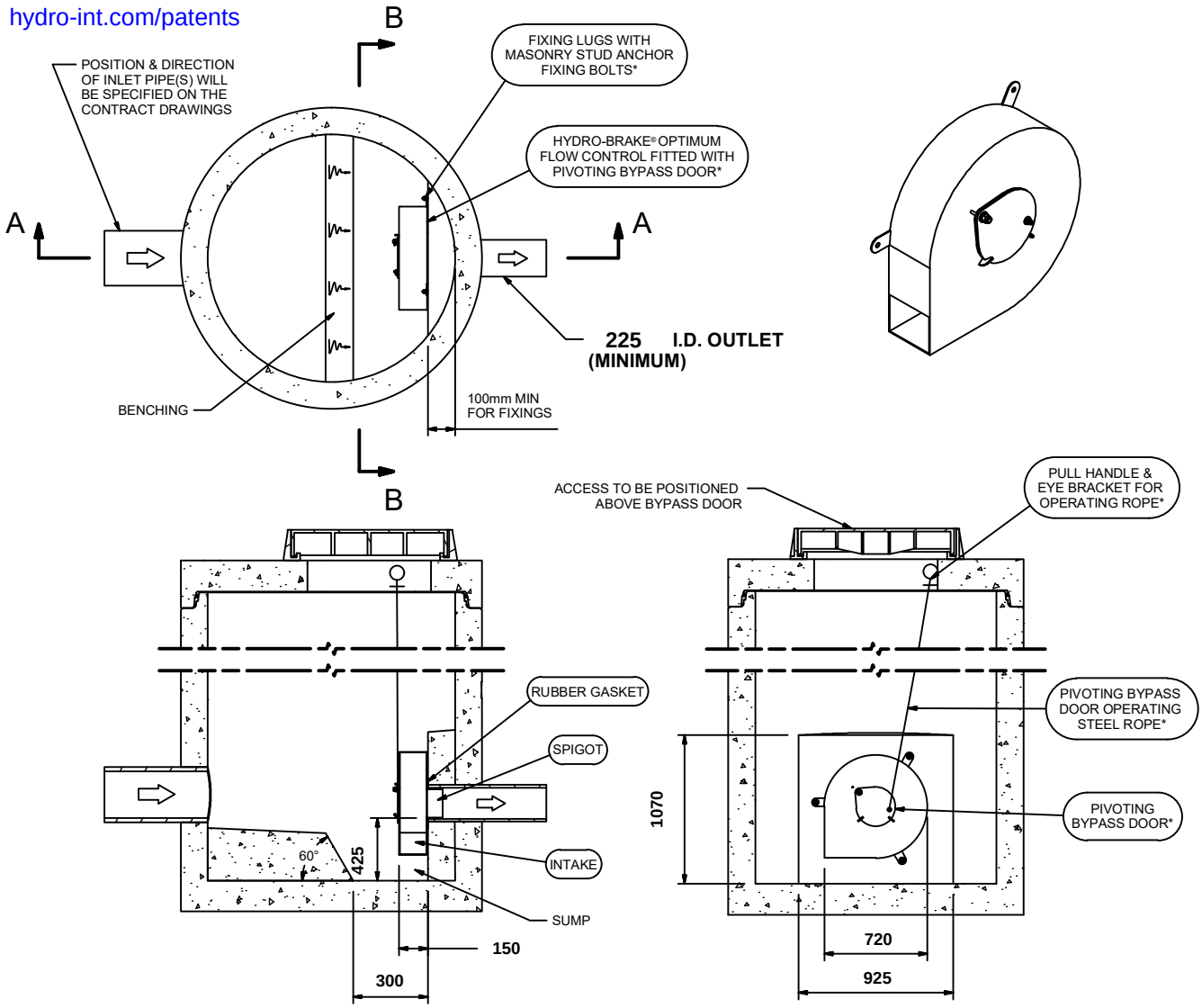
Hydro-Brake® Optimum Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 08/4596

WRc Approved PT/329/0412

hydro-int.com/patents



SECTION A-A

SECTION B-B

IMPORTANT: ⬭ LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE® OPTIMUM FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.

DESIGN ADVICE

The head/flow characteristics of this SHE-0145-1100-1500-1100 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro International®

DATE	8/22/2021 3:25 PM
SITE	Bacton
DESIGNER	Rob Hill
REF	1061

SHE-0145-1100-1500-1100
Hydro-Brake® Optimum

rob@infrades.co.uk

Appendix D
Levels and Exceedance Routing

Pond

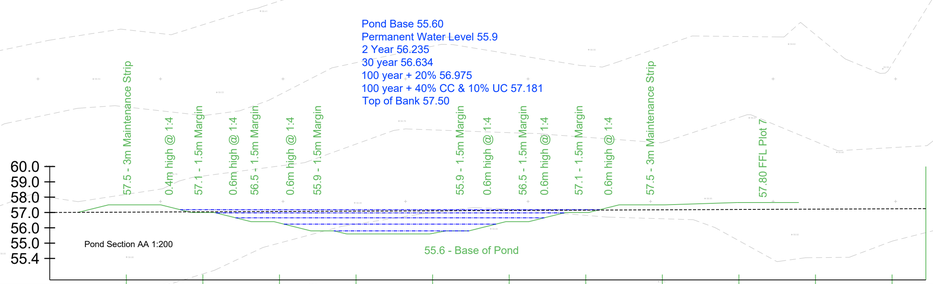
Should Pond overspill then water will fall towards ditch and track, which has ditches either side

Pond Base 55.60
Permanent Water Level 55.9
2 Year 56.235
30 year 56.634
100 year + 20% 56.975
100 year + 40% CC & 10% UC 57.181
Top of Bank 57.50

Sec AA

Toe of Pond 57.5
POND SIDE SLOPES 1:4
BERM 57.1
POND SIDE SLOPES 1:4
BERM 56.5
POND SIDE SLOPES 1:4
WET MARGIN 1.5m WIDE 55.9
BASE 55.6

Should this swale overflow then the water will follow the same corridor. House FFLs are minimum of 300mm above top of swale level along this stretch.



0 5 10 15 20 25 30 35 40 45 50
0 10 20 30 40 50

Flood Exceedance Routing, either to pond/swales or Ditch Course

Swale Exceedance Routing, drive crossovers dished to ensure any overflow keeps within swale/drive corridor.

5.20 FFL Proposed Finished Floor Level

5.00 Proposed Finished Road Level Contours

Figures in grey - existing survey detail

Bellway Homes Limited (Eastern Counties)
3 Percy Road
Huntingdon
Cambridgeshire
PE29 6SZ

REV	DESCRIPTION	DATE
C	Levels amended and swale exceedance routes added.	16.9.21

STATUS: Planning Submission

SCALE : 1:500 @ A1
DATE : May 2021
DRAWN : RAH

TITLE : Finished Levels Strategy

PROJECT : Land at Birch Avenue, Bacton

DRG. No: 1061-00-05 Rev C

INFRASTRUCTURE DESIGN LIMITED
33 The Point
Market Harborough
Leicestershire LE16 7QU
Tel: 01858 411570 Fax: 01858 411571

Appendix E
Management and Maintenance Plan

Detailed scheme for the ownership and scheduled maintenance

The Freeholders

The responsibility for maintenance of all elements of the development remain with Bellway Homes until handed over to the Anglian Water, Freeholders, or a Management Company.

Handover of external works to the Freeholders coincides with completion and sale of each respective residential unit.

At handover, the Freeholders will receive as built information together with (where applicable) operating and maintenance manuals which detail all maintenance protocols.

Surface Water Sewers

The principle means of surface water disposal from the development is by way of an adopted gravity sewer system, ultimately discharging into watercourse on the northern boundary of the site. The main drainage runs will be adopted by Anglian Water and maintenance will ultimately pass onto them as the sewers are formerly adopted. Up to that point Bellway Homes will be responsible for the sewers and will follow the same maintenance regime as detailed for the management company.

A Management Company will be commissioned to maintain the private shared storm water drainage system, where not adopted and the Management Company responsibilities will include the swales, ponds etc and all inflow and outflow structures and the outlets, where not adopted by Anglian Water.

The remaining shared storm water drainage system where located within the individual plot curtilage, will be the responsibility of the homeowner.

Quarterly (by Management Company)

A system of regular inspections should be established, initially these inspections should be carried out in October and March, however, this may be modified to suit observations over time. Items to be observed and cleared are high levels of grit, leaves and other such detritus. The main aim of these inspections will be to prevent siltation of the system, which, if allowed to develop will reduce the effectiveness of the system.

The following elements should be inspected and cleaned as part of this preventative routine:

Chambers

Road gullies

Linear drainage channels/gullies located within communal areas.

Quarterly (by Plot Freeholder)

It is also recommended that each homeowner regularly cleans and inspects rainwater pipes, gullies/linear drainage channels, where located within their plot curtilage as a preventative measure to minimise the ingress of detritus into the storm water system. It is suggested that new homeowners are informed of such responsibilities in their welcome packs or within their conveyancing.

Ponds, Swales

Ponds and swales are to be maintained by a Management Company. Their maintenance regime shall be as follows: -

Inspections to identify any areas not operating correctly, eroded areas, pollution, blocked outlets, standing water, and reinstate design levels, repair eroded or damaged areas by returfing or reseeding.

Collect and remove from site all extraneous rubbish that is detrimental to the operation or detract from the appearance of the site, including paper, bottles, cans and similar debris.

Maintain grass height at no less than 100mm. Ensure that soil and grass does not become compacted. Do not cut during periods of drought or when ground conditions or grass is wet.

Maintenance of the pond is to be carried out in the vicinity of the inlets and outlets, monthly during growing seasons, and at least once every two months within the remainder of the pond, or else as required.

Maintenance of the swales are to be carried out monthly during growing seasons, or else as required.

Remove sediment as it builds up, ensuring that design storage volumes are not reduced by more than 10%.

Headwalls

Headwalls are to be maintained by either Anglian Water or a Management Company. Their maintenance regime shall be as follows: -

Initially the headwalls shall be inspected on a monthly basis. All extraneous material such as litter and rubble be removed and cleared. After this initial three months the Headwalls themselves are to be checked for structurally integrity on a six monthly inspection and any issues made good as per the original design drawings. Ensure water flows freely by removal of vegetation and siltation, as necessary.

Hydro-brake and Orifice Flow Control Chambers

Hydrobrake are to be maintained by either Anglian Water or Management Company. Their maintenance regime shall be as follows: -

Following installation of the Hydro-Brake Flow Control any extraneous material i.e., Building materials are removed from the unit and the chamber. After the system is made live, the unit is to be inspected monthly for three months and thereafter at six monthly intervals with hose down if required. Hydro-Brake Flow Controls are fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should blockages occur. Following the drain down and clearance of the blockage the pivoting by-pass door must be returned to the closed position to enable the hydrobrake to function as designed.

The chamber is to be cleared checked for structural integrity at the six-monthly interval. Any damage/problems should be made good as per the original design drawings.

Porous Drives

Visual inspections should be made to ascertain where depressions, rutting and cracked or broken blocks are considered to be detrimental to the structural performance of the pavement or a hazard to users, this will require appropriate corrective action.

The paving should be agitated (e.g. brushed, vacuumed, etc.) at least twice a year, to ensure no vegetation of any sort is allowed to grow and develop in the joints. Ideally, this should be carried out in the spring and autumn seasons.

The paving should be inspected after any heavy precipitation to ensure there is no displacement of any organic matter onto the surface of the pavement.

For winter maintenance, the controlled use of de-icing may be used without causing significant detrimental effects towards the permeable pavements performance. When used carefully, the use of these chlorides will not result in an increase in the chloride levels in the local ground.

Depending on the amount of usage and the environment the permeable pavement has received and been exposed to, the laying course material may require either cleaning after a 25 to 30 year period. This would be evident if the infiltration rate of the paving became prolonged, allowing ponding to develop. Should this occur, the uplifting and cleaning (or replacing), of the laying course maybe considered. The laying course material, jointing and blocks may be reused, minimising costs.

NB. Material removed from the voids or the layers below the surface may contain heavy metals and hydrocarbons and as such may need to be disposed of as ‘controlled waste’.

Appendix F
SUDS Risk Assessment

Sustainable Drainage Risk Assessment

Development	Birch Avenue, Bacton, Suffolk
Project Reference	1061-00-002
Assessment by	Rob Hill
Date	15.9.21
Description of SuDS	Swales and Attenuation Pond

Infrastructure Design Limited
Consulting Engineers

33 The Point, Rockingham Road
Market Harborough
Leicestershire LE16 7QU
Tel: 01858 411570
Fax: 01858 411571

INFRASTRUCTURE DESIGN LIMITED

Design Factors	
Item	**Comments**
Age profile of persons in close proximity to the SuDS	Full Range of age groups potentially as part of Residential Site, close to right of way footpath link – Play areas on opposite side of site to the pond so unlikely that under 5s would be left unsupervised in this location.
Consider visibility and natural surveillance of the proposed SuDS feature	Several Properties face on to the pond and all swales have some frontage development to them. The main pond has a public footway with links to right of way and village centre to provide natural surveillance.
Type and nature of water edge planting – Consider time taken to mature and precautions required to protect feature during this period	See landscape plans, if necessary, temporary fencing may be required until such time as planting matured enough to provide suitable safety barrier/deterrent.
Gradient and extent of slopes above, at and below the water level	Slopes on swales are 1:3 maximum with depths no greater than 450mm. Pond has slopes of 1:4 with 1.5m wide Berm set at every 600mm depth, with permanent water depth no greater than 300mm
Definition of water edge and nature of ground	Permanent Waters edge on pond will be a 1.5m wide wet, soft landscaped margin
Water depth profile	Generally the swales will reach depths of water of no more than 150mm during the most severe storm events (1:100 year +CC+UC), and no more than 50mm within storm events upto 30 year The pond has standing water of 300mm, with 0.635 depth in 2 year event, 1.034m in 30 year event and maximum of 1.581m in the 100year +40%CC and 10% UC event.
Water surface area	Perm water area of Pond 176m2 2 Year 462m2 100 + 40% + 10% 1540m2
Underwater obstacles or traps	None
Potential currents, velocities	Maximum velocity in pond 0.028m/s, very low

Evaluation of Risk

Likelihood (L)	
1	Rare
2	Unlikely
3	Possible
4	Probable
5	Almost Certain

Consequence (C)	
1	No injury
2	Minor injury or health effects
3	Injury not life threatening
4	Serious injury or heath effects
5	Potential of Fatality

Risk = L x C

1-4 Acceptable
5-10 Change design if it is practicable to do so to reduce residual risk
11-25 Unacceptable – change design concept to suit

Hazard	Potential Factors of Harm		Risk (LxC)	Control Measures within design (Consider children < 5ys, children >5yrs and adults)	Residual Factors		Risk (LxC)	Further controls required
	L	C			L	C		
Drowning or falling throughIce in the winter	**2**	**3**	**6**	Pond with standing water, maximum depth 0.3m during normal time. Aquatic margins prior to standing water. Deterrent planting/fencing.	**I**	**2**	**2**	None required
Slips/Trips	**2**	**2**	**4**	The pond designed to hold water at depth the area will be grassed, dry and damp benches included at locations within the banks and max gradient of 1:4. Under high rainfall events, there will be more water within the pond, but likelihood of Children being out in such events would be expected to much diminished. Under extreme storm event maximum water depth is 1.6m before, prior to this there is a level platform 1.5m wide and another every 0.6m depth below this maximum water level. Other swales will only hold water during rain storms and are no deeper than 450mm	**2**	**2**	**4**	None required
Entry into Pipes/ConfinedSpaces	**2**	**2**	**4**	Entry within pipes to be negated by use of grilles on larger pipe diameters.	**I**	**2**	**2**	None required
Water Quality - Health Risks	**2**	**I**	**2**	The use of swales and porous paving through the site should mean that contaminated water is less likely.	**I**	**I**	**I**	None required