SITE DRAINAGE DESIGN CALCULATIONS

HOUSING DEVELOPMENT

DROVE ROAD

SHEPEAU STOW

SPALDING

Issue	Date	Description	By
1	05/10/2020	Report issued.	SLB

bds
Construction Management
1 Wray Close, Waltham Grimsby
0794 1688881

1.0 INTRODUCTION

This drainage design is compiled to support an application to the local Inland Drainage Board for consent to discharge into their network. The development comprises the construction of:

5No detached houses and driveways

2.0 EXISTING SITE

The existing site is classified as greenfield having an approximate area of 2148 sq.m. The O.S. grid reference for the site is TF 31026 12152. Drove Road to the north boundary of the site is substantially higher than the general level of the development site but is protected from flows from the highway by a shallow a grass embankment – See Appendix 1.The site has a gentle gradient from north to south.

Drove Road does not contain a convenient sewer for foul water and surface disposal. To the west there is a number of possible drainage dykes under riparian ownership or that of the Inland Drainage Board.

3.0 POLICY

The purpose of this report is to demonstrate that development complies with the requirements of The National Planning Policy Framework (NPPF) and its associated technical guidance states that priority should be given to sustainable drainage and discusses the impact of new development on flood risk. Paragraph 103 maintains strong policy on avoiding and managing flood risk, based on local planning authorities preparing local plans and deciding planning applications and granting planning permissions.

Generally, the aim of the guidance is to encourage the surface runoff as high up the following hierarchy of drainage options as reasonably practicable.

1. Into the ground (infiltration)
2. To a surface water body
3. To a surface water sewer, highway drain or another drainage system
4. To a combined sewer.

4.0 SURFACE WATER DRAINAGE

It is evident from the existing Geology of the site and from the excavation of trial pits that surface water disposal cannot not be achieved by Infiltration due the presence of clay soils. A suitable water course is available close to the site that is maintained by South Holland Drainage Board.

Guidelines for drainage design for undeveloped sites state that the peak runoff rate from the development to any drain, sewer or surface water body for a 1 in 1 year rainfall event and a 1 in 100 year rainfall event shouldn't be more than the greenfield runoff rate for the same rainfall events.

Appendix 2 calculates the greenfield run off rates as 0.3l/s for a 1 in1 year event and 1.2 l/s for a 1:100 year event. These rates are extremely low even allowing for growth factors and it usual as minimum that a design a peak flow rate of 5.0 l/s is usually acceptable to prevent blockages.

Guidelines also state that the drainage system shall be designed so that flooding does not occur on any part of the site for a 1 in 30 year rainfall event and that flooding does not occur during a 1 in 100 year rainfall event in any part of a building within the development.

SuDS principles of design will be applied to this site as a whole and for each individual dwelling impermeable paved areas and water from roof areas will drain into a series of interconnected underground water storage crates – See Appendix 3 showing the basic layout for the proposed scheme. A hydrobrake will attenuate the flows to a maximum proposed rate of 5l/s prior to being discharged via gravity drainage into the Drainage Boards system. A headwall will be constructed at the final discharge point with the Drainage Boards drain.

For the foul water discharge this will flow into a biodisc sewage treatment plant, one for each property. It is recommended that only a product that is equal or better than that manufactured by Kingspan Klargester giving effluent qualities of 8 mg/l BOD, 13 mg/l SS, 4 mg/l ammonia and 2 mg/l phosphate should be used in this project. The flows from the treatment will discharge into the storage crates for individual properties. The maximum treated water discharge from each four bedroomed property has been calculated as 1 cu.m per day.

Appendix 04 are the Hydraulic Calculations for the scheme storm of water drainage.

APPENDIX 01 – SITE PLAN



MasterDrain
HY 10.07

BDS Architecture www.bdsarchitecture.com	1 Wray Close, Waltham, Grimsby, DN37 0XR Tel: 01472 824146 Mob:07941 688881 email: info@bdsarchitecture.com	Job No.	
		Sheet no.	1
		Date	02/10/20
Project: Drove Lane Spalding		By	Checked / Reviewed
Title: IoH 124 (Qbar(urban))Runoff calcs for SPALDING			

Hydrological Data:-

FSR Hydrology:-

Location	= SPALDING	Grid reference	= TF2422
M5-60 (mm)	= 18.8	r	= 0.41
Soil runoff	= 0.30	SAAR (mm/yr)	= 560
WRAP	= 2	Area = England & Wales	
Hydrological area = 5		Hydrological zone = 8	

Soil classification for WRAP type 2
i) Very permeable soils with shallow ground water;
ii) Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils; (fragipan - a natural subsurface horizon having a higher bulk density than the solum above. Seemingly cemented when dry but showing moderate to weak brittleness when moist. The layer is low in organic matter, mottled and slowly or very slowly permeable to water. It is found in profiles of either cultivated or virgin soils but not in calcareous material).
iii) Moderately permeable soils, some with slowly permeable subsoils.

Design data:-

Area = 0.002418 Km^2 - 0.242 Ha - 2418 m^2 % Urbanisation = 0.00%

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(urban);} = Q_{BAR(rural)} (1 + URBAN)^{2NC}[1 + URBAN\{(21/CIND) - 0.3\}]$$

where:-

NC varies with the value of SAAR:-
for 500<SAAR<1100 mm then NC = 0.92 - 0.00024SAAR
for 1100<SAAR<3000 mm then NC = 0.74 - 0.000082SAAR

CIND = 102.4SOIL + 0.28(CWI - 125) CWI = Catchment Wetness Index

so

CIND =10.950 CWI =54.391 NC =0.786

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.005

$Q_{BAR(rural)}$ = 0.339 (l/s)

$Q_{BAR(urban)}$ = 0.339 (l/s)

$Q_{BAR(urban)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Mean Annual Peak Flow $Q_{BAR(urban)}$ = 0.34 l/s

Values for $Q_{BAR(urban)}$

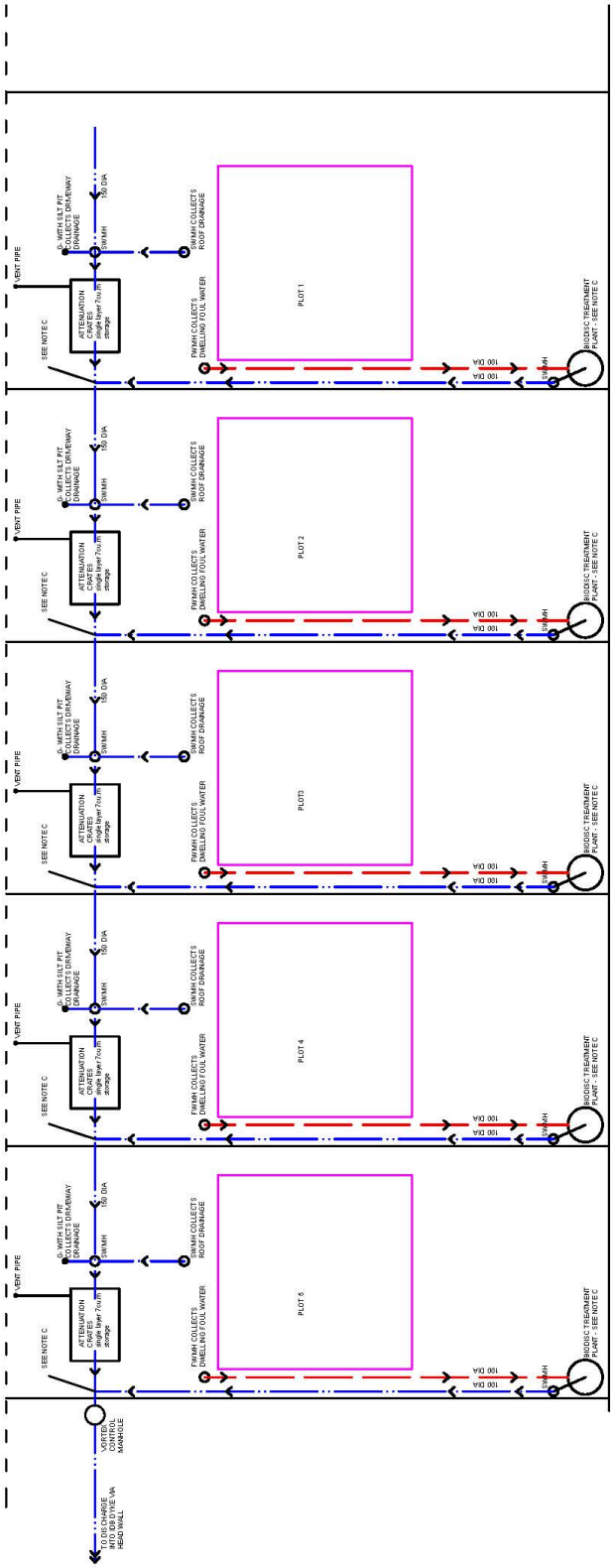
Ret. per.	m³/hr	l/s	l/s/ha	Ret. per.	m³/hr	l/s	l/s/ha
1yr	0.000	0.288	1.193	100yr	0.001	1.188	4.913
2yr	0.000	0.302	1.249	100yr+20%	0.001	1.426	5.895
5yr	0.000	0.441	1.825	100yr+30%	0.002	1.544	6.387
10yr	0.001	0.560	2.316	200yr	0.001	1.476	6.106
30yr	0.001	0.791	3.271	200yr + 30%	0.002	1.919	7.938
50yr	0.001	0.961	3.972	500yr	0.002	1.704	7.047
				1000yr	0.002	1.955	8.085

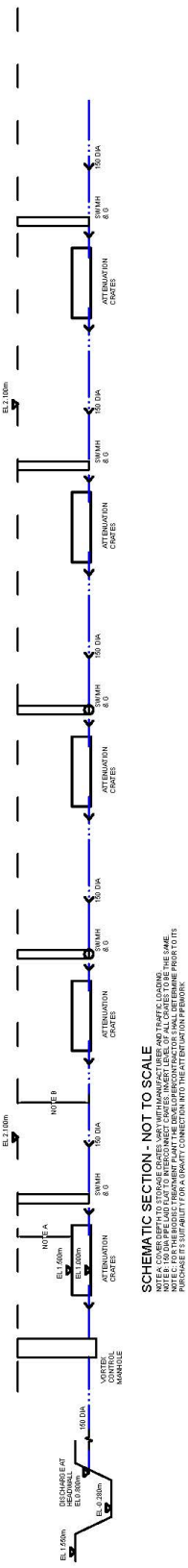
Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.89	1.30	1.65	2.33	2.83	3.50	4.35	5.02	5.76

The above is based on the Institute of Hydrology Report 124 to which you are referred for further details (see Sect 7). Note that the 200 year growth curve was taken from W5-074/A.

For WRAP type 1 soils, CIND can become negative for lower values of SAAR. In this case the CIND value is multiplied by -1 to return a positive value (CIND is very small at this point).


PLOT 1
PLOT 2
PLOT3
PLOT 4
PLOT 5
RODISC TREATMENT PLANT - SEE NOTE C
VORTEX CONTROL MANHOLE
TO DISCHARGE HEADWALL NOTE 6A HEAD WALL
SCHEMATIC REPRESENTATION OF DRAINAGE SCHEME - NOT TO SCALE


SCHEMATIC SECTION - NOT TO SCALE
NOTE A: COVER DEPTH TO STORAGE CRATES VARY WITH MANUFACTURER AND TRAFFIC LOADING
NOTE B: FOR CLARITY ONLY ONE SET OF ATTENUATION CRATES ARE SHOWN BUT ALL ARE OF THE SAME
NOTE C: FOR THE RODISC TREATMENT PLANT THE DEVELOPER/CONTRACTOR SHALL DETERMINE PRIOR TO ITS PURCHASE IT'S SUITABILITY FOR A GRAVITY CONNECTION INTO THE ATTENUATION PIPEWORK

Storage calculations for 100 year event with a limited discharge of 5 l/s.

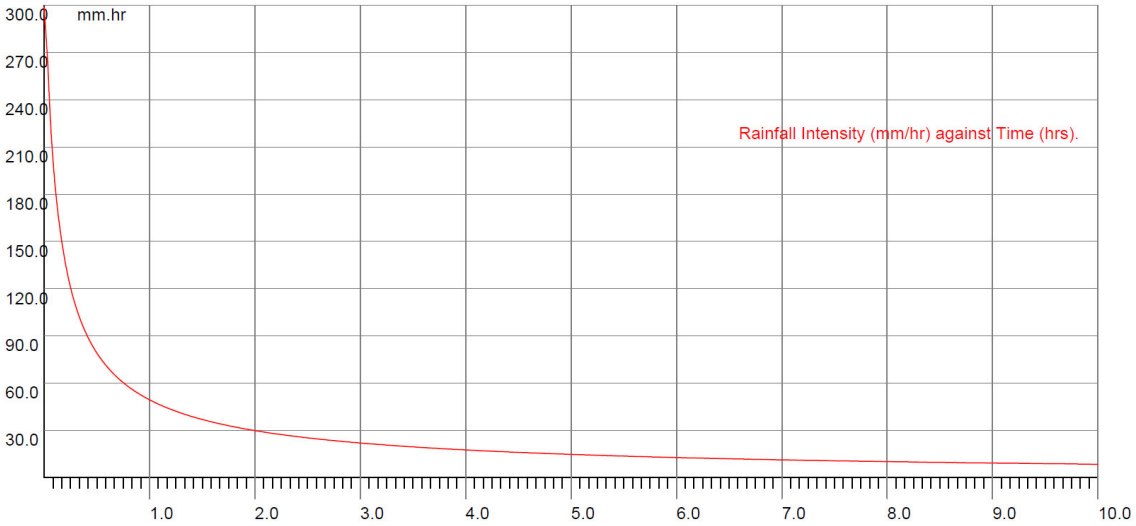
MasterDrain SW

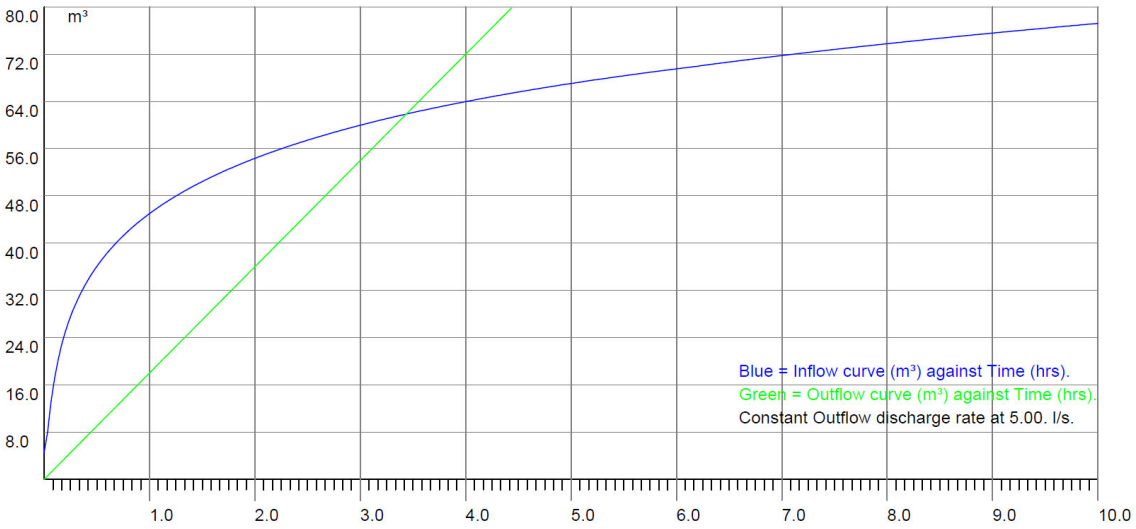
BDS Architecture www.bdsarchitecture.com	1 Wray Close, Waltham, Grimsby, DN37 0XR Tel: 01472 824146 Mob:07941 688881 email: info@bdsarchitecture.com	Job No.	
		Sheet no.	2
		Date	16/09/20
Project Drove Road		By	Checked
Title Storage			

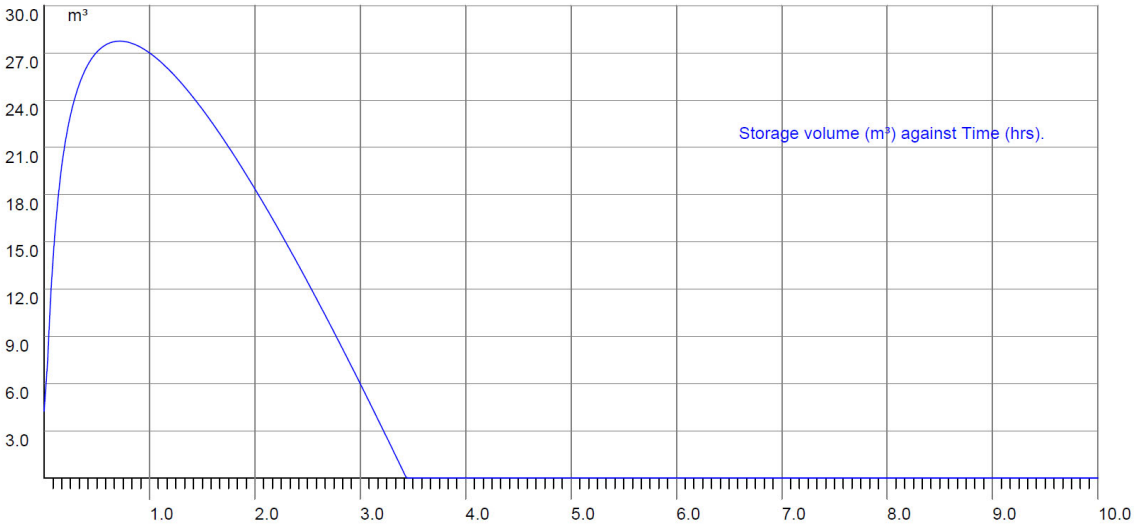
Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	150.0	22.823	3.000	19.823
20	102.0	31.019	6.000	25.019
30	79.0	36.055	9.000	27.055
40	65.0	39.718	12.000	27.718
50	56.0	42.608	15.000	27.608
60	49.0	45.003	18.000	27.003
70	44.0	47.050	21.000	26.050
80	40.0	48.840	24.000	24.840
90	37.0	50.431	27.000	23.431
100	34.0	51.863	30.000	21.863
110	32.0	53.166	33.000	20.166
120	30.0	54.361	36.000	18.361
130	28.0	55.464	39.000	16.464
140	27.0	56.488	42.000	14.488
150	25.0	57.444	45.000	12.444
160	24.0	58.340	48.000	10.340
170	23.0	59.182	51.000	8.182
180	22.0	59.977	54.000	5.977
190	21.0	60.729	57.000	3.729
200	20.0	61.442	60.000	1.442
210	19.0	62.121	63.000	0.000
220	19.0	62.767	66.000	0.000
230	18.0	63.384	69.000	0.000
240	18.0	63.975	72.000	0.000
250	17.0	64.540	75.000	0.000
260	16.0	65.082	78.000	0.000
270	16.0	65.603	81.000	0.000
280	16.0	66.104	84.000	0.000
290	15.0	66.586	87.000	0.000
300	15.0	67.050	90.000	0.000
310	14.0	67.498	93.000	0.000
320	14.0	67.931	96.000	0.000
330	14.0	68.349	99.000	0.000
340	13.0	68.754	102.000	0.000
350	13.0	69.145	105.000	0.000
360	13.0	69.525	108.000	0.000
370	12.0	69.892	111.000	0.000
380	12.0	70.301	114.000	0.000
390	12.0	70.683	117.000	0.000
400	12.0	71.056	120.000	0.000
410	11.0	71.422	123.000	0.000
420	11.0	71.780	126.000	0.000
430	11.0	72.130	129.000	0.000
440	11.0	72.474	132.000	0.000
450	11.0	72.811	135.000	0.000
460	10.0	73.142	138.000	0.000
470	10.0	73.467	141.000	0.000
480	10.0	73.786	144.000	0.000
490	10.0	74.099	147.000	0.000
500	10.0	74.407	150.000	0.000
510	10.0	74.710	153.000	0.000
520	9.0	75.007	156.000	0.000
530	9.0	75.300	159.000	0.000
540	9.0	75.588	162.000	0.000
550	9.0	75.872	165.000	0.000
560	9.0	76.151	168.000	0.000
570	9.0	76.426	171.000	0.000
580	9.0	76.697	174.000	0.000
590	9.0	76.963	177.000	0.000
600	8.0	77.227	180.000	0.000

Storage volume (m^3) = 27.7 m^3


mm.hr
300.0
270.0
240.0
210.0
180.0
150.0
120.0
90.0
60.0
30.0
Rainfall Intensity (mm/hr) against Time (hrs).
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0


m³
80.0
72.0
64.0
56.0
48.0
40.0
32.0
24.0
16.0
8.0
Blue = Inflow curve (m³) against Time (hrs).
Green = Outflow curve (m³) against Time (hrs).
Constant Outflow discharge rate at 5.00. l/s.
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0


m³
30.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
Storage volume (m³) against Time (hrs).
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0

Explanatory notes for Peak Flow Storage

1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
2) The balance is calculated from the inflow minus the outflow.
3) The storage volume is the maximum value of the balance curve.
4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
5) References to 'storm duration' relate only to the hydrograph method (qv).
6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

1) The user has the choice of Summer or Winter curves
2) The mean intensity varies with the duration of the storm curve
3) There are always 120 steps in the calculation process, irrespective of storm duration.
4) The balance is calculated from the inflow minus the outflow.
5) The storage volume is the sum of the balance values for each step.
6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

BDS Architecture www.bdsarchitecture.com	1 Wray Close, Waltham, Grimsby, DN37 0XR Tel: 01472 824146 Mob:07941 688881 email: info@bdsarchitecture.com	Job No.		
		Sheet no.	1	
		Date	15/09/20 15:19	
Project: Drove Road Spalding		By	Checked	Reviewed
Title: Calculations (100 yrs storm) for SW DRAIN DATA FILE.SW				

Entry No.	Section No.	Diam mm	Fall mm	Grad 1 in	Length m	Imperm. area	Perm area	Flow l/s	Pipe cap full l/s	Depth of flow %	H.M.D.	Veloc. m/s	Proport. vel. m/s	Time of flow m:s	Time of conc m:s	Rain mm/hr	System vol
1	1.01	150	150	89	13.4	159	0	7.9	18.8	43.9	0.92	1.06	1.00	0:13	6:13	142.5	
2	1.02	150	125	96	12.0	196	0	17.3	18.1	91.5	1.18	1.02	1.14	0:12	6:24	140.7	
3	1.03	225	125	96	12.0	196	0	26.7	53.0	50.0	1.00	1.33	1.33	0:09	6:33	139.4	
4	1.04	225	125	96	12.0	196	0	35.8	53.0	64.2	1.15	1.33	1.46	0:09	6:42	138.1	
5	1.05	225	125	116	14.5	159	0	42.9	48.2	83.5	1.22	1.21	1.38	0:12	6:54	136.4	

BDS Architecture www.bdsarchitecture.com	1 Wray Close, Waltham, Grimsby, DN37 0XR Tel: 01472 824146 Mob:07941 688881 email: info@bdsarchitecture.com	Job No.		
		Sheet no.	3	
		Date	15/09/20 15:19	
Project: Drove Road Spalding		By	Checked	Reviewed
Title: Calculations (100 yrs storm) for SW DRAIN DATA FILE.SW				

Location	Nat. Grid ref:	M5-60	r	wrapx	SAAR
SPALDING	TF2422	18.8	0.41	2	560

Data summary for printout

Design data

Maximum rainfall rate allowed	= unlimited	Return period	= 100
Urban creep factor (%)	= 0	Growth period (years)	= 0
Minimum velocity (m/s)	= 0.75	Percentage gradient	= 80%
Pipe roughness factor (mm)	= 0.60	Maximum depth of flow	= 100%

System data

System volume (m^3)	= 2	Total flow rate (l/s)	= 42.9
Final Rainfall rate (mm/hr)	= 136.4		
Total fall of index run (m)	= 0.65	Total length of index run (m)	= 63.9
Total permeable area (Ha)	= 0.0	Total impermeable area (Ha)	= 0.0906
Time of concentration (mins)	= 6.9	Time of entry (mins)	= 6.0
Outfall diameter (mm)	= 225	Percentage impermeable area	= 100.00

Calculated variables

Routing coefficient (Cr)	= 1.3	Volumetric coefficient (Cv)	= 0.980
UCWI	= 54.39	Areal reduction factor	= 0.998

Notes:-

Default values for runoff used :-
Runoff factor for impervious areas = 98.0
Runoff factor for pervious areas = 20.0

Note 1 = Not applicable
Note 2 - Rainfall calculated using FSR data.
Note 4 - ‡ against diameter indicates preferred diameter used.
Note 5 - ¤ against diameter indicates preferred diameter too small and therefore not used.
Note 6 - § against diameter indicates throttle pipe used.
Note 7 - « against diameter indicates carrier pipe used in cellular storage.

Pipe sizes

The pipe definition file used for these calculations allows the following diameters:-

100	allowed	375	allowed	600	allowed	900	allowed	1200	allowed	1800	allowed
150	allowed	400	allowed	700	allowed	1000	allowed	1350	allowed	1950	allowed
225	allowed	450	allowed	750	allowed	1050	allowed	1500	allowed	2100	allowed
300	allowed	500	allowed	800	allowed	1125	allowed	1650	allowed	2400	allowed

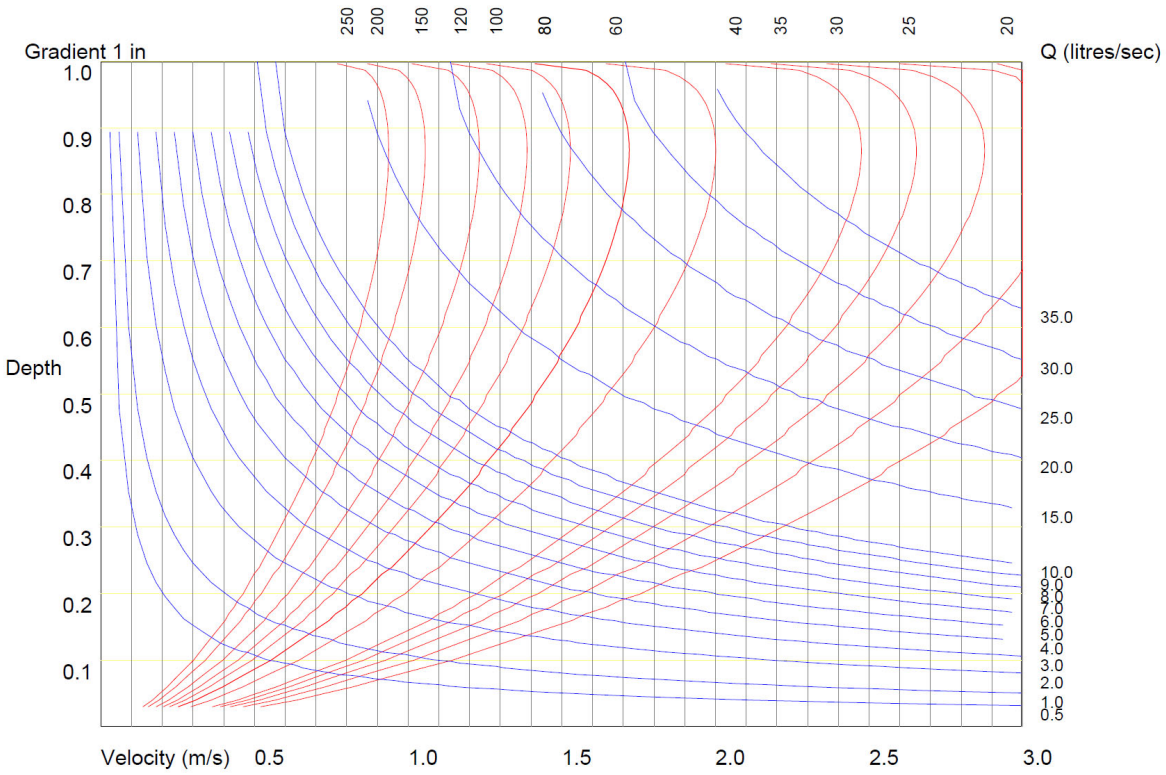
BDS Architecture www.bdsarchitecture.com	1 Wray Close, Waltham, Grimsby, DN37 0XR Tel: 01472 824146 Mob:07941 688881 email: info@bdsarchitecture.com	Job No.	
		Sheet no.	1
		Date	15/09/20 16:45
Project: Drove Road Spalding		By	Checked / Reviewed
Title: Design chart for 150mm circular pipe with roughness k=0.0600mm			

Design data

Diameter (mm) = 150 mm
Gradient (1 in XXX) = 150
Flow rate (l/s) = 5.000 l/s
Roughness (mm) = 0.06mm

Calculated data

Pipe cap full = 0.018 m³/s
Area of flow (%) = 27.963
Vel full (m/s) = 1.012 m/s
Flow Depth % = 32.49
HMD = 0.730
Prop. vel. = 0.738m/s



Calculations extracted from Masterdrain Surface Water design program - www.mstdrain.co.uk

MasterDrain
SW 16.07

BDS
Architecture
www.bdsarchitecture.com
1 Wray Close,
Waltham,
Grimsby, DN37 0XR
Tel: 01472 824146 Mob:07941 688881
email: info@bdsarchitecture.com

Job No.			
Sheet no.	1		
Date	05/10/20		
Project	Vortex control design - Radial Unit	By	Checked / Reviewed
Title			

Design Parameters

Design flowrate : 5.00 l/s

Flush Flow: 7.06 l/s @ 0.24 m

Design Head: 0.5 m

Initiation point: 3.61 l/s @ 0.26 m

Orifice diameter: 108.0 mm

Calculations:

Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.06	2.01	10.02
0.05	0.63	2.05	10.12
0.10	1.79	2.10	10.25
0.15	3.28	2.15	10.37
0.20	5.05	2.20	10.49
0.25	7.06	2.25	10.61
0.30	3.87	2.30	10.72
0.35	4.18	2.35	10.84
0.40	4.47	2.40	10.95
0.45	4.74	2.45	11.07
0.50	5.00	2.50	11.18
0.55	5.24	2.55	11.29
0.60	5.48	2.60	11.40
0.65	5.70	2.65	11.51
0.70	5.92	2.70	11.62
0.75	6.12	2.75	11.73
0.80	6.32	2.80	11.83
0.85	6.52	2.85	11.94
0.90	6.71	2.90	12.04
0.95	6.89	2.95	12.14
1.00	7.07	3.00	12.25
1.05	7.25	3.05	12.35
1.10	7.42	3.10	12.45
1.15	7.58	3.15	12.55
1.20	7.75	3.20	12.65
1.25	7.91	3.25	12.75
1.30	8.06	3.30	12.85
1.35	8.22	3.35	12.94
1.40	8.37	3.40	13.04
1.45	8.51	3.45	13.13
1.50	8.66	3.50	13.23
1.55	8.80	3.55	13.32
1.60	8.94	3.60	13.42
1.65	9.08	3.65	13.51
1.70	9.22	3.70	13.60
1.75	9.35	3.75	13.69
1.80	9.49	3.80	13.78
1.85	9.62	3.85	13.87
1.90	9.75	3.90	13.96
1.95	9.87	3.95	14.05
2.00	10.00	4.00	14.14

Calculation data provided by Crown Water Ltd, SL5 7NT

MasterDrain
SW 16.07

BDS Architecture www.bdsarchitecture.com	1 Wray Close, Waltham, Grimsby, DN37 0XR Tel: 01472 824146 Mob:07941 688881 email: info@bdsarchitecture.com	Job No.	
		Sheet no.	2
		Date	05/10/20
Project: **Vortex control design - Radial Unit**		By	Checked / Reviewed
Title:			

Discharge curve - head (m) against flow (l/s)

