

BMC

BELL MUNRO CONSULTING LTD.

**Altrincham Retail Park,
Altrincham**

**Drainage Calculations
September 2019**

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Ref: J6377

TITLE DRAINAGE DESIGN	JOB NO. J6377	PAGE NO. 1.0	REVISION
LOCATION ALTRINCTHAM RETAIL PARK	CALCULATION BY TN	CHECKED BY SB	DATE 09/19

EXISTING HARDSTANDING AREA = 5016 M²

∴ EXISTING RUNOFF BASED ON 50MM/HR RAINFALL

$$\text{EXISTING RUNOFF} = 5016 \text{ M}^2 \times 50 \text{ MM/HR} / 3600 \text{ S} = 70 \text{ L/S}$$

$$\text{NEW 50\% BETTERMENT DISCHARGE RATE} = 70 \text{ L/S} \times 0.5 = 35 \text{ L/S}$$

$$\begin{aligned} \text{EXISTING GREEN AREA TURNING INTO HARD LAND SLAPING} &= 539 \text{ M}^2 \times 50 \text{ MM/HR} / 3600 \text{ S} \\ &= 7.48 \text{ L/S} \end{aligned}$$

$$\therefore 35 \text{ L/S} - 7.48 \text{ L/S} = 27.52 \text{ L/S}$$

∴ THE DESIGN FOR THE DEVELOPMENT HAS BEEN BASED ON ACHIEVING A 50% BETTERMENT ON THE DISCHARGE RATES AS PER THE LK'S FRA.

DOE TO THE HIGH WATER TABLE AS PER GROUND TEST CONSULTING SI (A038/804) INFILTRATION HAS BEEN DEEMED NOT FEASIBLE

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 20 minutes.


Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m ³)	Status
15 min Summer	26.119	0.589	0.0	16.5	16.5	28.0	O K
30 min Summer	26.176	0.646	0.0	16.9	16.9	30.7	O K
60 min Summer	26.163	0.633	0.0	16.9	16.9	30.1	O K
120 min Summer	26.060	0.530	0.0	16.1	16.1	25.2	O K
180 min Summer	25.944	0.414	0.0	15.4	15.4	19.7	O K
240 min Summer	25.835	0.305	0.0	15.4	15.4	14.5	O K
360 min Summer	25.631	0.101	0.0	15.4	15.4	4.8	O K
480 min Summer	25.540	0.010	0.0	15.4	15.4	0.5	O K
600 min Summer	25.530	0.000	0.0	13.7	13.7	0.0	O K
720 min Summer	25.530	0.000	0.0	11.9	11.9	0.0	O K
960 min Summer	25.530	0.000	0.0	9.5	9.5	0.0	O K
1440 min Summer	25.530	0.000	0.0	6.9	6.9	0.0	O K
2160 min Summer	25.530	0.000	0.0	5.0	5.0	0.0	O K
2880 min Summer	25.530	0.000	0.0	4.0	4.0	0.0	O K
4320 min Summer	25.530	0.000	0.0	2.9	2.9	0.0	O K
5760 min Summer	25.530	0.000	0.0	2.3	2.3	0.0	O K
7200 min Summer	25.530	0.000	0.0	1.9	1.9	0.0	O K
8640 min Summer	25.530	0.000	0.0	1.6	1.6	0.0	O K
10080 min Summer	25.530	0.000	0.0	1.4	1.4	0.0	O K
15 min Winter	26.217	0.687	0.0	17.2	17.2	32.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
15 min Summer	121.766	0.0	42.9	16
30 min Summer	80.495	0.0	56.0	25
60 min Summer	50.812	0.0	70.6	42
120 min Summer	31.064	0.0	86.7	76
180 min Summer	23.012	0.0	95.8	110
240 min Summer	18.501	0.0	103.0	142
360 min Summer	13.493	0.0	112.9	198
480 min Summer	10.768	0.0	120.1	248
600 min Summer	9.042	0.0	126.1	0
720 min Summer	7.836	0.0	131.2	0
960 min Summer	6.246	0.0	139.4	0
1440 min Summer	4.530	0.0	151.7	0
2160 min Summer	3.280	0.0	164.7	0
2880 min Summer	2.606	0.0	174.5	0
4320 min Summer	1.881	0.0	189.0	0
5760 min Summer	1.492	0.0	199.8	0
7200 min Summer	1.245	0.0	208.4	0
8640 min Summer	1.074	0.0	215.7	0
10080 min Summer	0.947	0.0	222.0	0
15 min Winter	121.766	0.0	47.3	16

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E (l/s)	Max Outflow Volume (m³)	Status
30 min Winter	26.292	0.762	0.0	17.7	17.7	36.2	O K
60 min Winter	26.259	0.729	0.0	17.5	17.5	34.6	O K
120 min Winter	26.087	0.557	0.0	16.3	16.3	26.4	O K
180 min Winter	25.908	0.378	0.0	15.4	15.4	18.0	O K
240 min Winter	25.733	0.203	0.0	15.4	15.4	9.6	O K
360 min Winter	25.530	0.000	0.0	14.8	14.8	0.0	O K
480 min Winter	25.530	0.000	0.0	11.8	11.8	0.0	O K
600 min Winter	25.530	0.000	0.0	9.9	9.9	0.0	O K
720 min Winter	25.530	0.000	0.0	8.6	8.6	0.0	O K
960 min Winter	25.530	0.000	0.0	6.9	6.9	0.0	O K
1440 min Winter	25.530	0.000	0.0	5.0	5.0	0.0	O K
2160 min Winter	25.530	0.000	0.0	3.6	3.6	0.0	O K
2880 min Winter	25.530	0.000	0.0	2.9	2.9	0.0	O K
4320 min Winter	25.530	0.000	0.0	2.1	2.1	0.0	O K
5760 min Winter	25.530	0.000	0.0	1.6	1.6	0.0	O K
7200 min Winter	25.530	0.000	0.0	1.4	1.4	0.0	O K
8640 min Winter	25.530	0.000	0.0	1.2	1.2	0.0	O K
10080 min Winter	25.530	0.000	0.0	1.0	1.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	80.495	0.0	63.0	27
60 min Winter	50.812	0.0	79.1	46
120 min Winter	31.064	0.0	97.2	82
180 min Winter	23.012	0.0	107.7	116
240 min Winter	18.501	0.0	116.1	150
360 min Winter	13.493	0.0	126.5	0
480 min Winter	10.768	0.0	134.6	0
600 min Winter	9.042	0.0	141.3	0
720 min Winter	7.836	0.0	146.9	0
960 min Winter	6.246	0.0	156.1	0
1440 min Winter	4.530	0.0	169.9	0
2160 min Winter	3.280	0.0	184.5	0
2880 min Winter	2.606	0.0	195.4	0
4320 min Winter	1.881	0.0	211.6	0
5760 min Winter	1.492	0.0	223.7	0
7200 min Winter	1.245	0.0	233.4	0
8640 min Winter	1.074	0.0	241.6	0
10080 min Winter	0.947	0.0	248.6	0

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XP Solutions	Source Control 2015.1	

Rainfall Details

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)	18.000	Shortest Storm (mins)	15
Ratio R	0.388	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram


Total Area (ha) 0.186

Time (mins)	Area
From:	To: (ha)
0	5 0.186

Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area
From:	To: (ha)
0	4 0.000

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Model Details

Storage is Online Cover Level (m) 27.040

Cellular Storage Structure

Invert Level (m) 25.530 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	50.0	50.0	0.900	0.0	74.0
0.800	50.0	74.0			

Hydro-Brake Optimum® Outflow Control

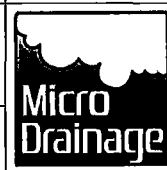
Unit Reference MD-SHE-0179-1590-1000-1590
 Design Head (m) 1.000
 Design Flow (l/s) 15.9
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Diameter (mm) 179
 Invert Level (m) 25.030
 Minimum Outlet Pipe Diameter (mm) 225
 Suggested Manhole Diameter (mm) 1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	15.9
Flush-Flo™	0.324	15.8
Kick-Flo®	0.703	13.5
Mean Flow over Head Range	-	13.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.3	1.200	17.3	3.000	26.8	7.000	40.4
0.200	15.2	1.400	18.6	3.500	28.9	7.500	41.8
0.300	15.8	1.600	19.9	4.000	30.8	8.000	43.1
0.400	15.7	1.800	21.0	4.500	32.6	8.500	44.4
0.500	15.4	2.000	22.1	5.000	34.3	9.000	45.6
0.600	14.9	2.200	23.1	5.500	35.9	9.500	46.8
0.800	14.3	2.400	24.1	6.000	37.5		
1.000	15.9	2.600	25.1	6.500	39.0		

Turing House
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Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 17 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	26.236	0.306	0.0	11.7	11.7	18.6	O K
30 min Summer	26.270	0.340	0.0	12.1	12.1	20.7	O K
60 min Summer	26.259	0.329	0.0	12.0	12.0	20.0	O K
120 min Summer	26.201	0.271	0.0	11.6	11.6	16.5	O K
180 min Summer	26.130	0.200	0.0	11.6	11.6	12.2	O K
240 min Summer	26.071	0.141	0.0	11.6	11.6	8.6	O K
360 min Summer	25.999	0.069	0.0	11.3	11.3	4.2	O K
480 min Summer	25.973	0.043	0.0	9.8	9.8	2.6	O K
600 min Summer	25.958	0.028	0.0	8.5	8.5	1.7	O K
720 min Summer	25.948	0.018	0.0	7.5	7.5	1.1	O K
960 min Summer	25.934	0.004	0.0	6.2	6.2	0.2	O K
1440 min Summer	25.930	0.000	0.0	4.6	4.6	0.0	O K
2160 min Summer	25.930	0.000	0.0	3.3	3.3	0.0	O K
2880 min Summer	25.930	0.000	0.0	2.6	2.6	0.0	O K
4320 min Summer	25.930	0.000	0.0	1.9	1.9	0.0	O K
5760 min Summer	25.930	0.000	0.0	1.5	1.5	0.0	O K
7200 min Summer	25.930	0.000	0.0	1.3	1.3	0.0	O K
8640 min Summer	25.930	0.000	0.0	1.1	1.1	0.0	O K
10080 min Summer	25.930	0.000	0.0	1.0	1.0	0.0	O K
15 min Winter	26.286	0.356	0.0	12.3	12.3	21.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	121.766	0.0	27.9	16
30 min Summer	80.495	0.0	37.1	25
60 min Summer	50.812	0.0	47.0	42
120 min Summer	31.064	0.0	57.2	76
180 min Summer	23.012	0.0	63.6	108
240 min Summer	18.501	0.0	68.2	136
360 min Summer	13.493	0.0	74.7	192
480 min Summer	10.768	0.0	79.5	250
600 min Summer	9.042	0.0	83.5	310
720 min Summer	7.836	0.0	86.7	370
960 min Summer	6.246	0.0	92.2	490
1440 min Summer	4.530	0.0	100.3	0
2160 min Summer	3.280	0.0	108.9	0
2880 min Summer	2.606	0.0	115.4	0
4320 min Summer	1.881	0.0	125.0	0
5760 min Summer	1.492	0.0	132.1	0
7200 min Summer	1.245	0.0	137.8	0
8640 min Summer	1.074	0.0	142.6	0
10080 min Summer	0.947	0.0	146.8	0
15 min Winter	121.766	0.0	31.6	16

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	26.325	0.395	0.0	12.8	12.8	24.0	O K
60 min Winter	26.302	0.372	0.0	12.5	12.5	22.6	O K
120 min Winter	26.205	0.275	0.0	11.6	11.6	16.8	O K
180 min Winter	26.094	0.164	0.0	11.6	11.6	10.0	O K
240 min Winter	26.018	0.088	0.0	11.5	11.5	5.4	O K
360 min Winter	25.969	0.039	0.0	9.5	9.5	2.3	O K
480 min Winter	25.949	0.019	0.0	7.7	7.7	1.2	O K
600 min Winter	25.937	0.007	0.0	6.5	6.5	0.4	O K
720 min Winter	25.930	0.000	0.0	5.7	5.7	0.0	O K
960 min Winter	25.930	0.000	0.0	4.5	4.5	0.0	O K
1440 min Winter	25.930	0.000	0.0	3.3	3.3	0.0	O K
2160 min Winter	25.930	0.000	0.0	2.4	2.4	0.0	O K
2880 min Winter	25.930	0.000	0.0	1.9	1.9	0.0	O K
4320 min Winter	25.930	0.000	0.0	1.4	1.4	0.0	O K
5760 min Winter	25.930	0.000	0.0	1.1	1.1	0.0	O K
7200 min Winter	25.930	0.000	0.0	0.9	0.9	0.0	O K
8640 min Winter	25.930	0.000	0.0	0.8	0.8	0.0	O K
10080 min Winter	25.930	0.000	0.0	0.7	0.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	80.495	0.0	41.6	26
60 min Winter	50.812	0.0	52.2	46
120 min Winter	31.064	0.0	64.5	82
180 min Winter	23.012	0.0	71.4	112
240 min Winter	18.501	0.0	76.4	138
360 min Winter	13.493	0.0	83.7	192
480 min Winter	10.768	0.0	89.0	252
600 min Winter	9.042	0.0	93.4	312
720 min Winter	7.836	0.0	97.1	0
960 min Winter	6.246	0.0	103.3	0
1440 min Winter	4.530	0.0	112.3	0
2160 min Winter	3.280	0.0	122.0	0
2880 min Winter	2.606	0.0	129.2	0
4320 min Winter	1.881	0.0	140.0	0
5760 min Winter	1.492	0.0	148.0	0
7200 min Winter	1.245	0.0	154.4	0
8640 min Winter	1.074	0.0	159.8	0
10080 min Winter	0.947	0.0	164.4	0

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Rainfall Details

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)	18.000	Shortest Storm (mins)	15
Ratio R	0.388	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram


Total Area (ha) 0.123

Time (mins)	Area
From: To:	(ha)
0	5 0.123

Time Area Diagram

Total Area (ha) 0.000

Time (mins)	Area
From: To:	(ha)
0	4 0.000

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Model Details

Storage is Online Cover Level (m) 27.040

Cellular Storage Structure

Invert Level (m) 25.930 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	64.0	64.0	0.500	0.0	76.8
0.400	64.0	76.8			

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0163-1160-0400-1160
 Design Head (m) 0.400
 Design Flow (l/s) 11.6
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Diameter (mm) 163
 Invert Level (m) 25.830
 Minimum Outlet Pipe Diameter (mm) 225
 Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	11.6
Flush-Flo™	0.226	11.6
Kick-Flo®	0.343	10.8
Mean Flow over Head Range	-	8.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.8	1.200	19.5	3.000	30.3	7.000	45.7
0.200	11.5	1.400	21.0	3.500	32.6	7.500	47.4
0.300	11.3	1.600	22.4	4.000	34.8	8.000	48.9
0.400	11.6	1.800	23.7	4.500	36.6	8.500	50.5
0.500	12.9	2.000	24.9	5.000	38.6	9.000	51.9
0.600	14.0	2.200	26.1	5.500	40.5	9.500	53.4
0.800	16.1	2.400	27.2	6.000	42.3		
1.000	17.9	2.600	28.2	6.500	44.1		