



BELL MUNRO CONSULTING LTD.

27/29 Trenchard Drive

**Hydraulic Calculations
March 2023**

	Initials	Signature	Date
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	18.500	Add Flow / Climate Change (%)	0
Ratio R	0.330	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.043	4-8	0.020

Total Area Contributing (ha) = 0.063

Total Pipe Volume (m³) = 2.694

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	18.532	0.124	150.0	0.018	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	15.840	0.106	150.0	0.011	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	13.058	0.087	150.0	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	12.125	0.081	150.0	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	4.357	0.015	300.0	0.000	5.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.38	99.127	0.018	0.0	0.0	0.0	0.82	14.5	2.4
1.001	50.00	5.70	99.004	0.029	0.0	0.0	0.0	0.82	14.5	3.9
1.002	50.00	5.97	98.898	0.037	0.0	0.0	0.0	0.82	14.5	5.0
1.003	50.00	6.21	98.811	0.047	0.0	0.0	0.0	0.82	14.5	6.4
2.000	50.00	5.08	98.595	0.000	0.0	0.0	0.0	0.90	63.8	0.0

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Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.004	17.146	0.057	300.0	0.016	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.005	6.881	0.023	300.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.004	50.00	6.53	98.580	0.063	0.0	0.0	0.0	0.90	63.8	8.5
1.005	50.00	6.73	98.523	0.063	0.0	0.0	0.0	0.58	10.2	8.5

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Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.018	0.018	0.018
1.001	User	-	100	0.011	0.011	0.011
1.002	User	-	100	0.008	0.008	0.008
1.003	User	-	100	0.010	0.010	0.010
2.000	-	-	100	0.000	0.000	0.000
1.004	User	-	100	0.016	0.016	0.016
1.005	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.063	0.063	0.063

Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1
Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Storm Duration (mins)	30
Ratio R	0.330		

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S8, DS/PN: 1.005, Volume (m³): 1.3

Unit Reference	MD-SHE-0107-5000-0900-5000
Design Head (m)	0.900
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	107
Invert Level (m)	98.523
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	5.0
Flush-Flo™	0.271	5.0
Kick-Flo®	0.590	4.1
Mean Flow over Head Range	-	4.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.7	3.000	8.8	7.000	13.1
0.200	4.9	1.400	6.1	3.500	9.4	7.500	13.6
0.300	5.0	1.600	6.5	4.000	10.1	8.000	14.0
0.400	4.9	1.800	6.9	4.500	10.6	8.500	14.4
0.500	4.6	2.000	7.2	5.000	11.2	9.000	14.8
0.600	4.1	2.200	7.6	5.500	11.7	9.500	15.2
0.800	4.7	2.400	7.9	6.000	12.2		
1.000	5.2	2.600	8.2	6.500	12.7		

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<u>Storage Structures for Surface Network 1</u> <u>Cellular Storage Manhole: S6, DS/PN: 2.000</u> Invert Level (m) 98.595 Safety Factor 2.0 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Side (m/hr) 0.00000 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>36.0</td><td>36.0</td><td>0.500</td><td>0.0</td><td>45.6</td></tr><tr><td>0.400</td><td>36.0</td><td>45.6</td><td></td><td></td><td></td></tr></table>			Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	36.0	36.0	0.500	0.0	45.6	0.400	36.0	45.6			
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)															
0.000	36.0	36.0	0.500	0.0	45.6															
0.400	36.0	45.6																		
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