



BELL MUNRO CONSULTING LTD.

**Ducie Arms
Longsight, Manchester**

**Drainage Calculations
Rev. A
January 2025**

	Initials	Signature	Date
Prepared by:	R.C		01/25
Checked by:	S.J.B		01/25
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XP Solutions Network 2020.1.3		

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.359	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

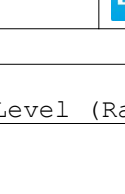
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Online Controls for Storm Hydro-Brake® Optimum Manhole: S05, DS/PN: 1.002, Volume (m³): 2.7 Unit Reference MD-SHE-0096-5500-2000-5500 Design Head (m)2.000 Design Flow (l/s)5.5 Flush-Flo™Calculated ObjectiveMinimise upstream storage ApplicationSurface Sump AvailableYes Diameter (mm)96 Invert Level (m)47.563 Minimum Outlet Pipe Diameter (mm)150 Suggested Manhole Diameter (mm)1200 <table><tr><td>Control Points</td><td>Head (m)</td><td>Flow (l/s)</td><td>Control Points</td><td>Head (m)</td><td>Flow (l/s)</td></tr><tr><td>Design Point (Calculated)</td><td>2.000</td><td>5.5</td><td>Kick-Flo®</td><td>0.857</td><td>3.7</td></tr><tr><td>Flush-Flo™</td><td>0.418</td><td>4.7</td><td>Mean Flow over Head Range</td><td>-</td><td>4.4</td></tr></table> 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 <table><tr><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td></tr><tr><td>0.100</td><td>3.1</td><td>1.200</td><td>4.3</td><td>3.000</td><td>6.6</td><td>7.000</td><td>9.9</td></tr><tr><td>0.200</td><td>4.3</td><td>1.400</td><td>4.7</td><td>3.500</td><td>7.1</td><td>7.500</td><td>10.2</td></tr><tr><td>0.300</td><td>4.6</td><td>1.600</td><td>4.9</td><td>4.000</td><td>7.6</td><td>8.000</td><td>10.6</td></tr><tr><td>0.400</td><td>4.7</td><td>1.800</td><td>5.2</td><td>4.500</td><td>8.0</td><td>8.500</td><td>10.9</td></tr><tr><td>0.500</td><td>4.6</td><td>2.000</td><td>5.5</td><td>5.000</td><td>8.4</td><td>9.000</td><td>11.2</td></tr><tr><td>0.600</td><td>4.5</td><td>2.200</td><td>5.7</td><td>5.500</td><td>8.8</td><td>9.500</td><td>11.5</td></tr><tr><td>0.800</td><td>4.0</td><td>2.400</td><td>6.0</td><td>6.000</td><td>9.2</td><td></td><td></td></tr><tr><td>1.000</td><td>4.0</td><td>2.600</td><td>6.2</td><td>6.500</td><td>9.6</td><td></td><td></td></tr></table> <tr><td colspan="4">©1982-2020 Innovyze</td></tr>				Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	2.000	5.5	Kick-Flo®	0.857	3.7	Flush-Flo™	0.418	4.7	Mean Flow over Head Range	-	4.4	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	3.1	1.200	4.3	3.000	6.6	7.000	9.9	0.200	4.3	1.400	4.7	3.500	7.1	7.500	10.2	0.300	4.6	1.600	4.9	4.000	7.6	8.000	10.6	0.400	4.7	1.800	5.2	4.500	8.0	8.500	10.9	0.500	4.6	2.000	5.5	5.000	8.4	9.000	11.2	0.600	4.5	2.200	5.7	5.500	8.8	9.500	11.5	0.800	4.0	2.400	6.0	6.000	9.2			1.000	4.0	2.600	6.2	6.500	9.6			©1982-2020 Innovyze			
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XP Solutions	Network 2020.1.3																			
Storage Structures for Storm Cellular Storage Manhole: S04, DS/PN: 2.001 Invert Level (m) 47.600 Safety Factor 2.0 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Side (m/hr) 0.00000 <table><thead><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></thead><tbody><tr><td>0.000</td><td>16.0</td><td>16.0</td><td>1.300</td><td>0.0</td><td>40.0</td></tr><tr><td>1.200</td><td>16.0</td><td>40.0</td><td></td><td></td><td></td></tr></tbody></table>			Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	16.0	16.0	1.300	0.0	40.0	1.200	16.0	40.0			
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0.000	16.0	16.0	1.300	0.0	40.0															
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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000	Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0	MADD Factor * 10m³/ha Storage 1.000
Hot Start Level (mm) 0	Inlet Coefficient 0.800
Manhole Headloss Coeff (Global) 0.500	Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000	

Number of Input Hydrographs 0	Number of Offline Controls 0	Number of Time/Area Diagrams 0
Number of Online Controls 1	Number of Storage Structures 1	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R 0.359
Region England and Wales	Cv (Summer) 0.750	
M5-60 (mm)	18.000	Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0	DVD Status OFF
Analysis Timestep	Fine Inertia Status OFF
DTS Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S02	15 Winter	1	+0%					49.039
1.001	S03	15 Winter	1	+0%	100/15 Summer				48.850
2.000	S01	15 Winter	1	+0%					49.036
2.001	S04	30 Winter	1	+0%	30/15 Summer				47.699
1.002	S05	15 Winter	1	+0%	30/15 Summer				47.700

PN	US/MH Name	Depth (m)	Surcharged Volume (m³)	Flooded Flow / Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Level Status	Exceeded
1.000	S02	-0.111	0.000	0.16		2.9	OK	
1.001	S03	-0.097	0.000	0.27		4.1	OK	
2.000	S01	-0.114	0.000	0.13		2.2	OK	
2.001	S04	-0.051	0.000	0.24	12	2.2	OK	

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<u>30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)</u> <u>for Storm</u>								
		Surcharged	Flooded		Half Drain	Pipe		
	US/MH	Depth	Volume	Flow /	Time	Flow		Level
PN	Name	(m)	(m³)	Cap.	(l/s)	(mins)	(l/s)	Status Exceeded
1.002	S05	0.267	0.000	0.43			4.6	SURCHARGED

for Storm

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	1.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Rainfall Model	FSR	Ratio R	0.359
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

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Analysis Timestep   Fine Inertia Status OFF
      DTS Status      ON
```

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
n Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

									Water
	US/MH			Return	Climate	First (X)	First (Y)	First (Z)	Overflow
PN	Name	Storm		Period	Change	Surcharge	Flood	Overflow	Act.
1.000	S02	15	Winter	100	+40%				
1.001	S03	15	Summer	100	+40%	100/15	Summer		
2.000	S01	15	Winter	100	+40%				
2.001	S04	60	Winter	100	+40%	30/15	Summer		
1.002	S05	60	Winter	100	+40%	30/15	Summer		

PN	US/MH Name	Surcharged	Flooded	Flow / Cap.	Overflow (l/s)	Half Drain	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m³)			Time (mins)	Flow (l/s)		
1.000	S02	-0.058	0.000	0.69			12.8	OK	
1.001	S03	0.032	0.000	1.29			19.4	SURCHARGED	
2.000	S01	-0.069	0.000	0.57			9.7	OK	
2.001	S04	0.840	0.000	0.47		46	4.3	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

		Surcharged	Flooded			Half Drain	Pipe		
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Time (mins)	Flow (l/s)	Status	Level Exceeded
1.002	S05	0.872	0.000	0.43			4.6	SURCHARGED	

Technical Specification

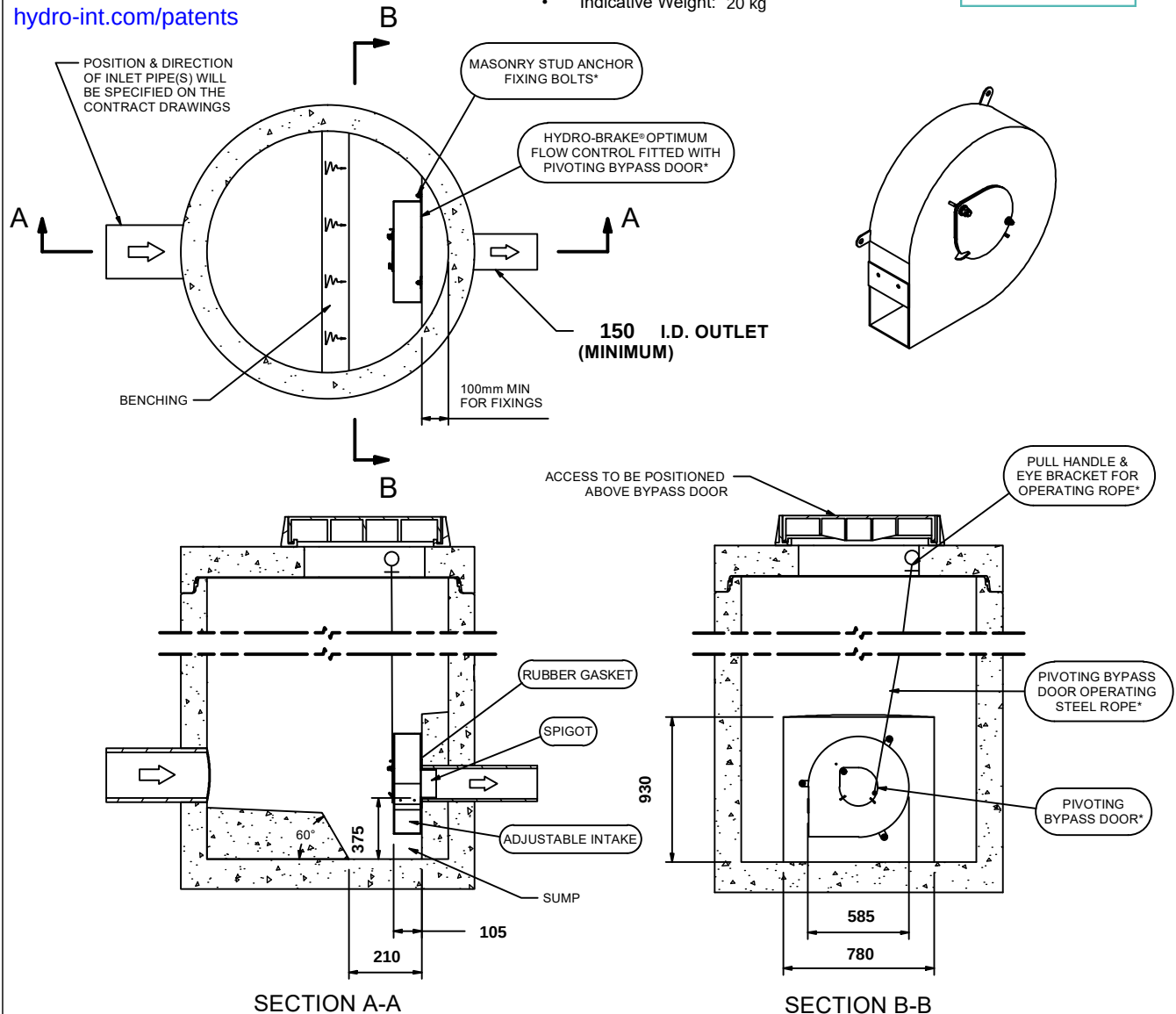
Control Point	Head (m)	Flow (l/s)
Primary Design	2.000	5.500
Flush-Flo™	0.418	4.654
Kick-Flo®	0.857	3.707
Mean Flow		4.387

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
- Variable flow rate post installation via adjustable inlet
- Indicative Weight: 20 kg



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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-0096-5500-2000-5500 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**
A CRH COMPANY

DATE	13/01/2025 15:04
SITE	
DESIGNER	Richard Cliffe
REF	Ducie Arms

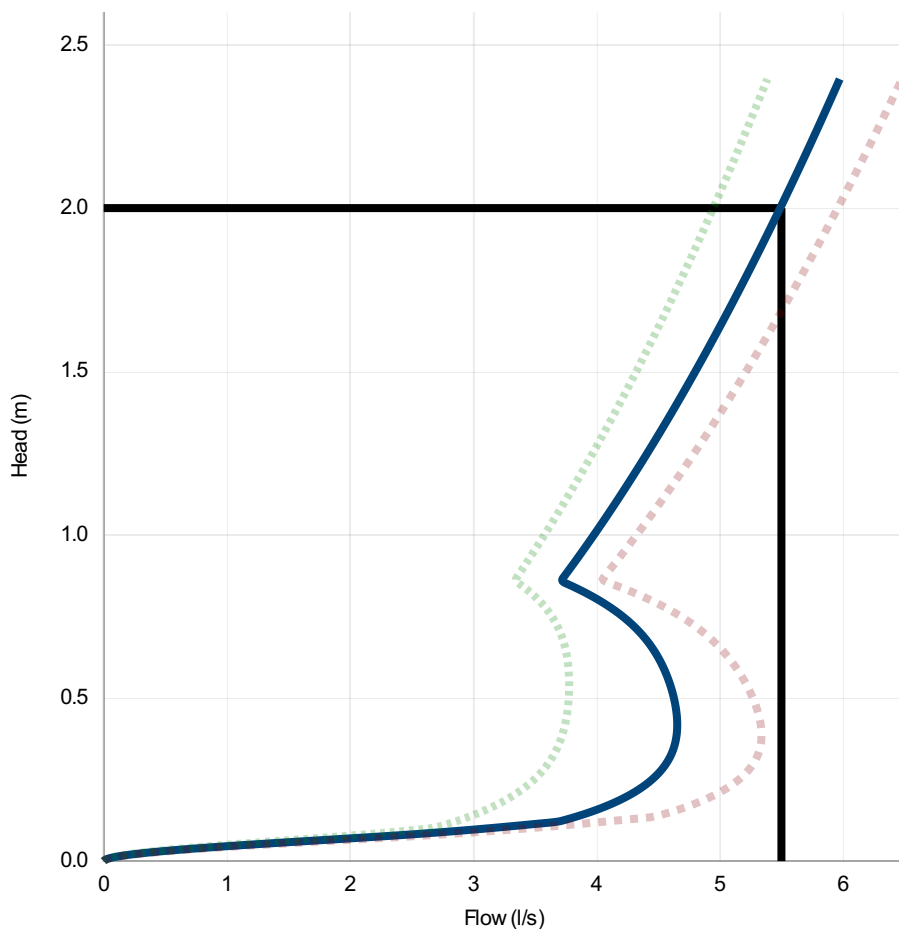
SHE-0096-5500-2000-5500
Hydro-Brake® Optimum

Technical Specification

	Original Setting		Minimum Setting		Maximum Setting	
Control Point	Head (m)	Flow (l/s)	Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
Primary Design	2.000	5.500	2.000	4.947	2.000	5.957
Flush-Flo™	0.418	4.654	0.540	3.777	0.387	5.339
Kick-Flo®	0.857	3.707	0.858	3.333	0.859	4.037
Mean Flow		4.387		3.813		4.849



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Head (m)	Flow (l/s)
0.000	0.000
0.069	1.972
0.138	3.850
0.207	4.288
0.276	4.519
0.345	4.625
0.414	4.654
0.483	4.637
0.552	4.587
0.621	4.504
0.690	4.377
0.759	4.180
0.828	3.881
0.897	3.785
0.966	3.916
1.034	4.043
1.103	4.165
1.172	4.283
1.241	4.398
1.310	4.510
1.379	4.618
1.448	4.724
1.517	4.827
1.586	4.928
1.655	5.026
1.724	5.123
1.793	5.217
1.862	5.310
1.931	5.401
2.000	5.490

DESIGN ADVICE



The head/flow characteristics of this SHE-0096-5500-2000-5500 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.

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Site

DESIGNER Richard Cliffe

Ref Ducie Arms

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Hydro-Brake® Optimum