

whitby wood

Ferry Island

Surface Water Drainage Strategy

5th December 2021

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1.0 BELOW GROUND DRAINAGE

Whitby Wood are responsible for the design of the onsite foul and surface water below ground drainage from where it passes under the lowest slab level of the building. Separate foul and surface water drainage networks will be designed to collect discharges from the building and hardstanding areas, and convey it by gravity where possible to the existing offsite public drainage infrastructure.

2.0 EXISTING SITE

The utility infrastructure assessment has identified that there is existing foul and surface water drainage serving the site which is assumed to discharge unrestricted to the offsite public foul and surface water sewers that are maintained by Thames Water. The existing onsite private drainage will be abandoned where appropriate with new drainage constructed to serve the development.

3.0 DESIGN STANDARDS AND GUIDANCE

The proposed onsite drainage will be designed in accordance with the relevant design standards including Sewers for Adoption, Building Regulations and British Standards where appropriate. The drainage will also be designed in accordance with the relevant policy and guidance published by the London Borough of Haringey, Thames Water, the Environment Agency and the London Plan.

The various guidance recommends that sustainable drainage systems (SuDS) are utilised where possible to manage surface water discharge rates and volumes in line with the following drainage hierarchy:

1. Store rainwater for later use
2. Use infiltration techniques, such as porous surfaces in non-clay areas
3. Attenuate rainwater in ponds or open water features for gradual release
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water sewer/drain
7. Discharge rainwater to the combined sewer.

In a pre-development enquiry undertaken in December 2016, Thames Water advised that the above drainage hierarchy should be considered and that the existing public surface water drainage network could only accommodate storms up to the 1 in 20 return period. Furthermore, a reduction of at least 50% on existing flows from the same site area would be sought for a range of storm conditions.

Haringey has specific guidance which categorises the site as a major scheme that has previously been developed. For such sites, the guidance states that the surface water should be restricted to a rate equivalent to three times the Greenfield runoff rate.

The extract below from the Haringey Guidance outlines the three times greenfield rate for previously developed sites. The QMed value of 12 l/s/ha has been adopted and applied to all storms.

The following table provides a guide to anticipated runoff rates for Haringey based on a clay soil using FEH methodology. Where soils are free draining and there are no constraints on infiltration, then it is anticipated that drainage scheme will be designed to infiltrate.

Table 2: Runoff rates

Return period	Greenfield sites – allowable discharge rate (l/s/ha)	PDL sites – 3 times Greenfield runoff (l/s/ha)	**PDL sites 50% Betterment allowable discharge rate (l/s/ha)
1 in 1 year	3.4	10.2	8
1 in 2.year (Qmed)	4.0	12.0	20
1 in 30 year	9.3	27.9	63
1 in 100 year	12.9	38.7	63

**PDL 50% betterment rates are displayed on Table 2 for guidance purposes only. The applicant must demonstrate that they have calculated the capacity of the existing site drainage (i.e. drainage solely serving the site), upon which any allowable 50% Betterment rate will be based.

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Figure 1: Extract from Haringey Guidance

The table below details the existing surface water discharge rates from the site alongside the proposed discharge rates, calculated as per Haringey requirements.

Site	Site Area (ha)*	Site Status	Discharge Rate (l/s)		
			1 in 2yr	1 in 30yr	1 in 100yr
Ferry Island	0.600	Existing	62.4	118.6	153.1
		Proposed	7.2	7.2	7.2
		Reduction	88%	94%	95%

*Areas are based on received boundaries

Table 1: Existing and proposed discharge rates

The Haringey guidance therefore requires that the surface water discharge rate be restricted to 7.2 l/s for Ferry Island. This represents approximately a 95% decrease in surface water discharge rates from the site compared to existing (for 1:100 year storm). Therefore storage systems will be required onsite to store attenuated surface water. This guidance is more stringent than the Thames Water recommended 50% reduction.

The proposed scheme and discharge rates were presented to the LBH SuDS Officer who confirmed that it was acceptable in principle. The LBH SuDS proforma and supporting information have been submitted to the SuDS officer for approval prior to and during the planning process.

4.0 PROPOSED DRAINAGE

Foul and surface water drainage connections will be constructed up to the site boundary by others as part of the offsite infrastructure works. Onsite drainage will then be designed by Whitby Wood.

A proposed surface water drainage network has been designed to adhere to the discharge restrictions outlined above, whilst utilising sustainable drainage techniques to manage surface water and provide the required attenuation.

All potential sustainable drainage strategies have been considered and implemented where appropriate. The network will be designed to accommodate a 1 in 100 year storm event without flooding, whilst also providing an allowance of 40% increase in rainfall intensity for climate change. The proposed drainage system has been modelled using Windes MicroDrainage hydraulic modelling software. Hydraulic modelling calculations are included in Appendix A.

The discharge from the site is proposed to connect into the existing offsite Thames Water sewers by gravity via a new connection to the offsite drainage constructed up to the site boundary by others.

Refer to drainage drawings in Appendix B which show the proposed drainage strategy layout and details.

It is proposed to utilise the available roof areas for blue roof water storage as shown on the drawing. This storage can be provided within the construction of the roof finishes to provide a permanently dry amenity area if required. From there, the surface water will discharge at a restricted rate into the below ground drainage network.

The below ground drainage network provided at ground floor level will collect the surface water discharge from the ground floor hardstanding areas outside the buildings, in addition to the water discharging from the roofs. Additional storage is required at ground floor level due to the restricted discharge rate from the site. The ground floor storage is proposed in the form of cellular tanks that will be lined to stop any water movement around the building foundations.

A flow control chamber is provided at the boundary of the site to restrict surface water discharge from the site to a maximum of 7.2 l/s.

5.0 EXCEEDANCE FLOWS

Flood flow paths have been considered in the event of blockage of the drainage network or the occurrence of an exceedance event. A flood flow paths drawing has been developed and is included in Appendix C. It can be seen that levels fall away from the building, to either the parking areas or offsite highways.

6.0 SUSTAINABLE DRAINAGE SYSTEMS

Outlined below are sustainable drainage options that are being utilised for the site. Each system is briefly outlined below.

A SuDS Maintenance Schedule is provided in Appendix D.

Blue Roof

A blue roof comprises a multi-layered system that covers the roof of a building or podium structure with a deep layer of attenuation along with various layers of insulation, water proofing and roofing material. These systems are designed to intercept and retain precipitation, increasing the time of concentration and reducing the volume of runoff and attenuating peak flows.

The system is designed to restrict the rainwater discharge from the roof to allow the surface water to build up on the roof for a period of time while slowly releasing the water down the drain pipe and into the below ground drainage system.

These roofs vary in specification and can be designed to accommodate any type of roof material which allows infiltration into the attenuation layer below.

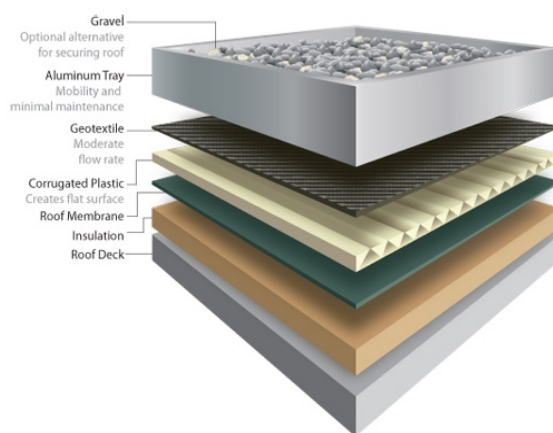


Figure 2: Typical Blue Roof details

Advantages:	Can decrease/eliminate the requirement for below ground drainage attenuation and the excavation for it; reduces the number of internal rainwater down points within the building; with the use of planting within the roof water quality can be improved; with systems of 85mm attenuation or lower, the structure is generally unaffected.
Disadvantages	Cost of the system itself may be more than the saving, depending on attenuation requirements and the impact of the system on the building structure. With systems greater than 85mm there may be an implication to the structure, roof height is increased slightly, design and exposure may preclude use.

Below Ground Cellular Attenuation

Cellular attenuation involves storing surface water within pipework or underground tanks prior to controlled discharge into the public sewer. Typically the cellular attenuation is formed with plastic crates wrapped in impermeable geotextiles as indicated in Figure 2.

Details of the proposed attenuation system and specific maintenance requirements are provided in Appendix E.



Figure 3: Typical Cellular Attenuation Tank (Hydro Stormbloc)

Advantages:	Effective storage of surface water, can be used below trafficked areas, can be used below public open areas, minimum maintenance.
Disadvantages	Cost of excavation. Sometimes complicated integration with foundations. No water quality treatment.

7.0 APPENDIX

Appendix A – Proposed Hydraulic Modelling Calculations

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<u>STORM SEWER DESIGN by the Modified Rational Method</u> <u>Design Criteria for Storm</u> Pipe Sizes STANDARD Manhole Sizes STANDARD FSR Rainfall Model - England and Wales <table> <tr> <td>Return Period (years)</td> <td>100</td> <td>PIMP (%)</td> <td>100</td> </tr> <tr> <td>M5-60 (mm)</td> <td>20.800</td> <td>Add Flow / Climate Change (%)</td> <td>0</td> </tr> <tr> <td>Ratio R</td> <td>0.438</td> <td>Minimum Backdrop Height (m)</td> <td>0.200</td> </tr> <tr> <td>Maximum Rainfall (mm/hr)</td> <td>50</td> <td>Maximum Backdrop Height (m)</td> <td>1.500</td> </tr> <tr> <td>Maximum Time of Concentration (mins)</td> <td>30</td> <td>Min Design Depth for Optimisation (m)</td> <td>1.200</td> </tr> <tr> <td>Foul Sewage (l/s/ha)</td> <td>0.000</td> <td>Min Vel for Auto Design only (m/s)</td> <td>1.00</td> </tr> <tr> <td>Volumetric Runoff Coeff.</td> <td>0.750</td> <td>Min Slope for Optimisation (1:X)</td> <td>500</td> </tr> </table> Designed with Level Soffits			Return Period (years)	100	PIMP (%)	100	M5-60 (mm)	20.800	Add Flow / Climate Change (%)	0	Ratio R	0.438	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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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.021	0.021	0.021
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.039	0.039	0.039
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.017	0.017	0.017
2.001	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.000	0.000	0.000
2.003	-	-	100	0.047	0.047	0.047
3.000	-	-	100	0.037	0.037	0.037
4.000	-	-	100	0.027	0.027	0.027
4.001	-	-	100	0.055	0.055	0.055
5.000	-	-	100	0.032	0.032	0.032
6.000	-	-	100	0.061	0.061	0.061
6.001	-	-	100	0.093	0.093	0.093
7.000	-	-	100	0.025	0.025	0.025
7.001	-	-	100	0.000	0.000	0.000
7.002	-	-	100	0.000	0.000	0.000
7.003	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.017	0.017	0.017
				Total	Total	Total
				0.471	0.471	0.471

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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S1.007	S	8.720	6.949	6.950	0	0
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Simulation Criteria for Storm

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	4
Number of Online Controls	4	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

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<u>Synthetic Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Profile Type</td> <td>Summer</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>M5-60 (mm)</td> <td>20.800</td> <td>Storm Duration (mins)</td> <td>30</td> </tr> <tr> <td>Ratio R</td> <td>0.438</td> <td></td> <td></td> </tr> </table>			Rainfall Model	FSR	Profile Type	Summer	Return Period (years)	100	Cv (Summer)	0.750	Region	England and Wales	Cv (Winter)	0.840	M5-60 (mm)	20.800	Storm Duration (mins)	30	Ratio R	0.438		
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Online Controls for Storm

Orifice Manhole: SBR1.1, DS/PN: S1.001, Volume (m³): 0.0

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 14.849

Orifice Manhole: SBR2.1, DS/PN: S2.001, Volume (m³): 0.0

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 14.849

Orifice Manhole: SBR3.1, DS/PN: S7.001, Volume (m³): 0.0

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 14.843

Hydro-Brake® Optimum Manhole: SWMH5.01, DS/PN: S1.007, Volume (m³): 2.1

Unit Reference	MD-SHE-0122-7200-1200-7200
Design Head (m)	1.200
Design Flow (l/s)	7.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	122
Invert Level (m)	7.039
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	7.2
Flush-Flo™	0.350	7.2
Kick-Flo®	0.755	5.8
Mean Flow over Head Range	-	6.3

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	4.4	1.200	7.2	3.000	11.1	7.000	16.6
0.200	6.8	1.400	7.7	3.500	11.9	7.500	17.2
0.300	7.2	1.600	8.2	4.000	12.7	8.000	17.7
0.400	7.2	1.800	8.7	4.500	13.4	8.500	18.2
0.500	7.0	2.000	9.1	5.000	14.1	9.000	18.7
0.600	6.8	2.200	9.6	5.500	14.8	9.500	19.2
0.800	6.0	2.400	10.0	6.000	15.4		
1.000	6.6	2.600	10.4	6.500	16.0		

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Storage Structures for Storm

Cellular Storage Manhole: SBR1.0, DS/PN: S1.000

Invert Level (m) 14.900 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	210.0	0.0	0.086	0.0	0.0
0.085	210.0	0.0			

Cellular Storage Manhole: SBR2, DS/PN: S2.000

Invert Level (m) 14.900 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	160.0	0.0	0.086	0.0	0.0
0.085	160.0	0.0			

Cellular Storage Manhole: SBR3.0, DS/PN: S7.000

Invert Level (m) 14.900 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	250.0	0.0	0.086	0.0	0.0
0.085	250.0	0.0			

Cellular Storage Manhole: STANK, DS/PN: S1.006

Invert Level (m) 7.100 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	340.0	0.0	0.661	0.0	0.0
0.660	340.0	0.0			

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<u>1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)</u> <u>for Storm</u>							
<u>Simulation Criteria</u>							
Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000							
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000							
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 Input Hydrographs 0 Number of Storage Structures 4							
Number of Online Controls 4 Number of Time/Area Diagrams 0							
Number of Offline Controls 0 Number of Real Time Controls 0							
<u>Synthetic Rainfall Details</u>							
Rainfall Model FSR Ratio R 0.437							
Region England and Wales Cv (Summer) 0.750							
M5-60 (mm) 20.600 Cv (Winter) 0.840							
Margin for Flood Risk Warning (mm) 300.0							
Analysis Timestep 2.5 Second Increment (Extended)							
DTS Status OFF							
DVD Status ON							
Inertia Status ON							
Profile(s) Summer and Winter							
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440							
Return Period(s) (years) 1, 30, 100							
Climate Change (%) 40, 40, 40							
PN	US/MH Name	Storm	Return Climate Period Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	SBR1.0	240 Winter	1 +40%				
S1.001	SBR1.1	240 Winter	1 +40%				
S1.002	SBR1.3	240 Winter	1 +40%	30/15 Summer			
S1.003	SW9	15 Winter	1 +40%	30/15 Summer			
S1.004	SW10	15 Winter	1 +40%	30/15 Summer			
S1.005	SW11	15 Winter	1 +40%	30/15 Summer			
S2.000	SBR2	120 Winter	1 +40%				
S2.001	SBR2.1	120 Winter	1 +40%				
S2.002	SBR2.2	120 Winter	1 +40%	30/15 Summer			
S2.003	SW8	15 Winter	1 +40%	30/15 Summer			
S3.000	SW04	15 Winter	1 +40%	30/15 Summer			
S4.000	SW6	15 Winter	1 +40%				
S4.001	SW7	15 Winter	1 +40%				
S5.000	SW5	15 Winter	1 +40%	100/60 Winter			
S6.000	SW1	15 Winter	1 +40%	30/15 Winter			
S6.001	SW2	15 Winter	1 +40%	30/15 Summer			
S7.000	SBR3.0	240 Winter	1 +40%				
S7.001	SBR3.1	240 Winter	1 +40%	100/60 Winter			
S7.002	SBR3.2	240 Winter	1 +40%	100/120 Winter			
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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S7.003	SW3	240 Winter	1	+40%	100/120 Winter			
S1.006	STANK	120 Winter	1	+40%	1/30 Winter			
S1.007	SWMH5.01	120 Winter	1	+40%	1/15 Winter			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S7.003	SW3	7.581	-0.134	0.000	0.03		0.4	OK	
S1.006	STANK	7.250	0.031	0.000	0.61		6.7	SURCHARGED*	
S1.007	SWMH5.01	7.239	0.050	0.000	0.36		6.8	SURCHARGED	

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<u>30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)</u> <u>for Storm</u>							
<u>Simulation Criteria</u>							
Areal Reduction Factor 1.000		Additional Flow - % of Total Flow 0.000					
Hot Start (mins) 0		MADD Factor * 10m³/ha Storage 2.000					
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 Input Hydrographs 0		Number of Storage Structures 4					
Number of Online Controls 4		Number of Time/Area Diagrams 0					
Number of Offline Controls 0		Number of Real Time Controls 0					
<u>Synthetic Rainfall Details</u>							
Rainfall Model		FSR Ratio R 0.437					
Region England and Wales Cv (Summer) 0.750							
M5-60 (mm)		20.600 Cv (Winter) 0.840					
Margin for Flood Risk Warning (mm)		300.0					
Analysis Timestep 2.5 Second Increment (Extended)							
DTS Status		OFF					
DVD Status		ON					
Inertia Status		ON					
Profile(s)		Summer and Winter					
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440							
Return Period(s) (years)		1, 30, 100					
Climate Change (%)		40, 40, 40					
PN	US/MH Name	Storm	Return Climate Period Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	SBR1.0	120 Winter	30 +40%				
S1.001	SBR1.1	120 Winter	30 +40%				
S1.002	SBR1.3	15 Winter	30 +40%	30/15 Summer			
S1.003	SW9	15 Winter	30 +40%	30/15 Summer			
S1.004	SW10	15 Winter	30 +40%	30/15 Summer			
S1.005	SW11	15 Winter	30 +40%	30/15 Summer			
S2.000	SBR2	120 Winter	30 +40%				
S2.001	SBR2.1	120 Winter	30 +40%				
S2.002	SBR2.2	15 Summer	30 +40%	30/15 Summer			
S2.003	SW8	15 Summer	30 +40%	30/15 Summer			
S3.000	SW04	15 Winter	30 +40%	30/15 Summer			
S4.000	SW6	15 Winter	30 +40%				
S4.001	SW7	15 Winter	30 +40%				
S5.000	SW5	15 Winter	30 +40%	100/60 Winter			
S6.000	SW1	15 Winter	30 +40%	30/15 Winter			
S6.001	SW2	120 Winter	30 +40%	30/15 Summer			
S7.000	SBR3.0	120 Winter	30 +40%				
S7.001	SBR3.1	120 Winter	30 +40%	100/60 Winter			
S7.002	SBR3.2	120 Winter	30 +40%	100/120 Winter			
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Checked by

Network 2018.1.1

		Water	Surcharged	Flooded			Pipe		
	US/MH	Level	Depth	Volume	Flow /	Overflow	Flow		Level
PN	Name	(m)	(m)	(m³)	Cap.	(l/s)	(l/s)	Status	Exceeded
S1.000	SBR1.0	14.937	-0.063	0.000	0.09		0.5	FLOOD	RISK
S1.001	SBR1.1	14.934	-0.015	0.000	0.09		0.5	FLOOD	RISK
S1.002	SBR1.3	8.352	0.152	0.000	0.41		2.3	SURCHARGED	
S1.003	SW9	8.362	0.216	0.000	1.63		18.5	SURCHARGED	
S1.004	SW10	8.268	0.155	0.000	1.38		18.5	SURCHARGED	
S1.005	SW11	8.053	0.053	0.000	1.48		18.4	SURCHARGED	
S2.000	SBR2	14.936	-0.064	0.000	0.09		0.5	FLOOD	RISK
S2.001	SBR2.1	14.934	-0.015	0.000	0.13		0.5	FLOOD	RISK
S2.002	SBR2.2	8.465	0.065	0.000	0.08		0.4	SURCHARGED	
S2.003	SW8	8.464	0.114	0.000	1.76		25.8	SURCHARGED	
S3.000	SW04	7.899	0.039	0.000	1.40		18.7	SURCHARGED	
S4.000	SW6	8.690	-0.060	0.000	0.66		13.7		OK
S4.001	SW7	8.563	-0.078	0.000	0.75		43.5		OK
S5.000	SW5	7.584	-0.066	0.000	0.60		16.3		OK
S6.000	SW1	7.636	0.011	0.000	0.67		31.1	SURCHARGED	
S6.001	SW2	7.545	0.035	0.000	0.33		23.2	SURCHARGED	
S7.000	SBR3.0	14.938	-0.062	0.000	0.09		0.5	FLOOD	RISK
S7.001	SBR3.1	14.935	-0.008	0.000	0.13		0.5	FLOOD	RISK
S7.002	SBR3.2	7.623	-0.077	0.000	0.12		0.5		OK



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File IS LARGE SITE.MDX

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XP Solutions

Network 2018.1.1

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S7.003	SW3	120 Winter	30	+40%	100/120 Winter			
S1.006	STANK	120 Winter	30	+40%	1/30 Winter			
S1.007	SWMH5.01	120 Winter	30	+40%	1/15 Winter			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S7.003	SW3	7.584	-0.131	0.000	0.04		0.5	OK	
S1.006	STANK	7.544	0.325	0.000	0.65		7.1	SURCHARGED*	
S1.007	SWMH5.01	7.532	0.343	0.000	0.38		7.2	SURCHARGED	

		Page 12						
								
Date 19/03/2019 23:14		Designed by andrew.orourke						
File IS LARGE SITE.MDX		Checked by						
XP Solutions		Network 2018.1.1						
<u>100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm</u>								
<u>Simulation Criteria</u>								
Areal Reduction Factor 1.000		Additional Flow - % of Total Flow 0.000						
Hot Start (mins) 0		MADD Factor * 10m³/ha Storage 2.000						
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 Input Hydrographs 0 Number of Storage Structures 4								
Number of Online Controls 4 Number of Time/Area Diagrams 0								
Number of Offline Controls 0 Number of Real Time Controls 0								
<u>Synthetic Rainfall Details</u>								
Rainfall Model		FSR Ratio R 0.437						
Region England and Wales		Cv (Summer) 0.750						
M5-60 (mm)		20.600 Cv (Winter) 0.840						
Margin for Flood Risk Warning (mm)		300.0						
Analysis Timestep 2.5 Second Increment (Extended)								
DTS Status		OFF						
DVD Status		ON						
Inertia Status		ON						
Profile(s) Summer and Winter								
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440								
Return Period(s) (years)		1, 30, 100						
Climate Change (%)		40, 40, 40						
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	SBR1.0	120 Winter	100	+40%				
S1.001	SBR1.1	120 Winter	100	+40%				
S1.002	SBR1.3	15 Winter	100	+40%	30/15 Summer			
S1.003	SW9	15 Winter	100	+40%	30/15 Summer			
S1.004	SW10	15 Winter	100	+40%	30/15 Summer			
S1.005	SW11	15 Winter	100	+40%	30/15 Summer			
S2.000	SBR2	120 Winter	100	+40%				
S2.001	SBR2.1	120 Winter	100	+40%				
S2.002	SBR2.2	15 Summer	100	+40%	30/15 Summer			
S2.003	SW8	15 Summer	100	+40%	30/15 Summer			
S3.000	SW04	15 Winter	100	+40%	30/15 Summer			
S4.000	SW6	15 Winter	100	+40%				
S4.001	SW7	15 Winter	100	+40%				
S5.000	SW5	240 Winter	100	+40%	100/60 Winter			
S6.000	SW1	15 Winter	100	+40%	30/15 Winter			
S6.001	SW2	240 Winter	100	+40%	30/15 Summer			
S7.000	SBR3.0	120 Winter	100	+40%				
S7.001	SBR3.1	120 Winter	100	+40%	100/60 Winter			
S7.002	SBR3.2	240 Winter	100	+40%	100/120 Winter			
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XP Solutions

Network 2018.1.1

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

PN	US/MH Name	Water	Surcharged	Flooded	Flow / Cap.	Overflow (l/s)	Pipe	Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m³)			Flow (l/s)		
S1.000	SBR1.0	14.950	-0.050	0.000	0.10		0.5	FLOOD RISK	
S1.001	SBR1.1	14.947	-0.002	0.000	0.10		0.5	FLOOD RISK	
S1.002	SBR1.3	8.594	0.394	0.000	0.60		3.3	SURCHARGED	
S1.003	SW9	8.594	0.448	0.000	2.04		23.2	FLOOD RISK	
S1.004	SW10	8.453	0.340	0.000	1.71		23.0	FLOOD RISK	
S1.005	SW11	8.114	0.114	0.000	1.85		23.0	SURCHARGED	
S2.000	SBR2	14.950	-0.050	0.000	0.10		0.5	FLOOD RISK	
S2.001	SBR2.1	14.947	-0.002	0.000	0.14		0.5	FLOOD RISK	
S2.002	SBR2.2	8.585	0.185	0.000	0.09		0.5	SURCHARGED	
S2.003	SW8	8.584	0.234	0.000	2.29		33.5	SURCHARGED	
S3.000	SW04	7.964	0.104	0.000	1.81		24.3	SURCHARGED	
S4.000	SW6	8.737	-0.013	0.000	0.86		17.7	OK	
S4.001	SW7	8.594	-0.047	0.000	0.98		56.4	OK	
S5.000	SW5	7.733	0.083	0.000	0.14		3.8	SURCHARGED	
S6.000	SW1	7.744	0.119	0.000	0.88		41.0	SURCHARGED	
S6.001	SW2	7.733	0.223	0.000	0.24		17.4	SURCHARGED	
S7.000	SBR3.0	14.951	-0.049	0.000	0.10		0.6	FLOOD RISK	
S7.001	SBR3.1	14.948	0.005	0.000	0.14		0.6	FLOOD RISK	
S7.002	SBR3.2	7.736	0.036	0.000	0.13		0.6	SURCHARGED	

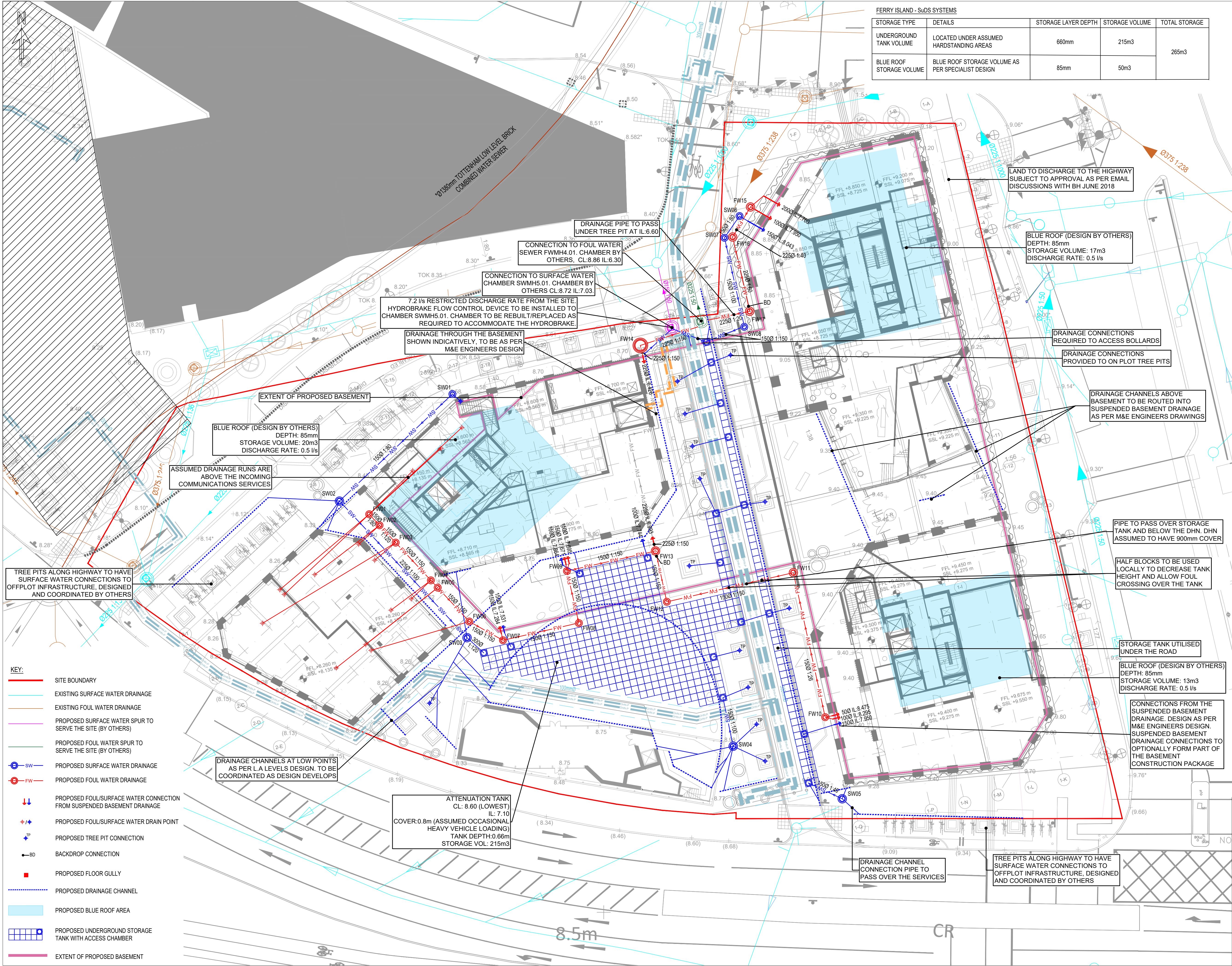
Designed by andrew.orourke
Checked by

Network 2018.1.1

PN	US/MH		Return	Climate	First (X)	First (Y)	First (Z)	Overflow
	Name	Storm						
S7.003	SW3	240 Winter	100	+40%	100/120 Winter			
S1.006	STANK	240 Winter	100	+40%	1/30 Winter			
S1.007	SWMH5.01	240 Winter	100	+40%	1/15 Winter			

S7.003	SW3	7.733	0.018	0.000	0.04	0.6	SURCHARGED
S1.006	STANK	7.732	0.513	0.000	0.64	7.1	SURCHARGED*
S1.007	SWMH5.01	7.722	0.533	0.000	0.38	7.2	SURCHARGED

Appendix B - Proposed Drainage Layout and Details Drawings



FERRY ISLAND - SuDS SYSTEMS				
STORAGE TYPE	DETAILS	STORAGE LAYER DEPTH	STORAGE VOLUME	TOTAL STORAGE
UNDERGROUND TANK VOLUME	LOCATED UNDER ASSUMED HARDSTANDING AREAS	660mm	215m3	265m3
BLUE ROOF STORAGE VOLUME	BLUE ROOF STORAGE VOLUME AS PER SPECIALIST DESIGN	85mm	50m3	

HEALTH AND SAFETY INFORMATION

CONSTRUCTION

1.POTENTIAL CONTAMINATION IN MADE GROUND. REFER TO GIR

2.HIGH WATER TABLE DURING CONSTRUCTION - REFER TO GIR

MAINTENANCE/CLEANING/OPERATION.

DECOMMISSIONING/DEMOLITION.

NOTES

DO NOT SCALE FROM THIS DRAWING. ONLY FIGURED DIMENSIONS ARE TO BE USED.

ALL DIMENSIONS ARE IN MILLIMETRES U.N.O.

ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.

DRAINAGE LAYOUTS ARE INDICATIVE AT THIS STAGE AND TO BE CONFIRMED AS THE DESIGN PROGRESSES.

FOUL AND SURFACE WATER DISCHARGE LOCATIONS AND RATES ARE SUBJECT TO APPROVAL BY THE SEWERAGE UNDERTAKER AND LPA.

OFFSITE DRAINAGE IS TO BE DESIGNED BY OTHERS AS PART OF THE OFFSITE INFRASTRUCTURE PACKAGE.

ALL EXISTING DRAINAGE INVERT LEVELS ARE TO BE CONFIRMED ONSITE PRIOR TO CONSTRUCTION.

STORAGE VOLUMES AND SuDS LAYOUTS ARE APPROXIMATE AT THIS STAGE AND ARE TO BE CONFIRMED AT THE NEXT DESIGN STAGE

COVER LEVELS ARE ESTIMATED AND TO BE CONFIRMED AS THE DESIGN PROGRESSES.

ALL CONNECTIONS FROM BUILDING DRAIN POINTS AND DRAINAGE CHANNELS ARE TO BE DN100 U.N.O. DRAIN POINT CONNECTIONS PIPE DIAMETERS TO BE AS PER ABOVE GROUND DRAINAGE PIPE DIAMETERS U.N.O

ALL DRAIN POINTS TO BE RODDABLE FROM ABOVE GROUND

MINIMUM SCOPE OF BELOW GROUND DRAINAGE FOR BASEMENT CONTRACT TO INCLUDE ALL DRAINAGE BELOW SLABS IN CONTACT WITH GROUND. CONTRACTOR TO DETERMINE PREFERENCE TO CAP DRAINAGE AT SLAB EDGE OR CONSTRUCT DRAINAGE TO FIRST MANHOLE OR BEYOND

P04	27/08/21	PRELIMINARY ISSUE	AP	JR	SL
P03	19/06/20	PRELIMINARY ISSUE	AP	JR	SL
P02	09/04/20	REVISED AS CLOURED	AP	JR	SL
P01	22/03/19	PRELIMINARY ISSUE	AP	JB	SL

REV	DATE	DESCRIPTION	DRN	CHK	APD
KEY PLAN					

CLIENT

ARGENT RELATED

PROJECT

FERRY ISLAND

PRELIMINARY

DRAWING TITLE

BELOW GROUND DRAINAGE LAYOUT
GROUND FLOOR

DATE	SCALES @ A1	DRAWN BY	CHECKED	APPROVED
22/03/19	1:200	AP	JB	SL

DRAWING No	REVISION
P450040-BA-C-100	P04

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450mm DIA COVER - REFER TO
MANHOLE SCHEDULE FOR COVER LOAD

CLASS B ENGINEERING BRICKS SET IN
CLASS 1 MORTAR

150mm DEEP
CONCRETE COLLAR

SHUTTERING TO
EXTERNAL RIBS

450mm DIA SHAFT

COMPACTED BACKFILL -
'AS-DUG' OR GRANULAR
BEDDING MATERIAL

110/160mm DIA PIPE

GRANULAR
BEDDING MATERIAL

ROCKER PIPE

22mmØ GAVANISED MILD STEEL
TUBES TO BS 1387 (WHEN CHAMBER
IS DEEPER THAN 1200mm TO INVERT)

300

300

CONCRETE BED AND SURROUND SHALL BE INTERRUPTED AT EACH PIPE JOINT USING 25mm THICK FIBRE BOARD TO THE FULL AREA OF THE CONCRETE - SEE DETAIL BELOW

USE CLASS Z CONCRETE BED AND SURROUND UNDER ALL FOUNDATIONS AND FLOOR SLABS, WHERE COVER TO CROWN OF PIPE IS LESS THAN 0.75m IN VEHICULAR ACCESS AREAS, AND WHERE PIPES ARE LAID WITHIN 1.0m OF FOUNDATIONS

25mm FIBREBOARD OR SIMILAR COMPRESSIBLE MATERIAL

MINIMUM 150mm C20P CONCRETE SURROUND

DIRECTION OF FLOW

TRENCH BACKFILL:

1. UNDER ROADS AND FOOTPATHS USE TYPE 1 GRANULAR MATERIAL COMPACTED IN 150mm LAYERS TO THE UNDERSIDE OF SURFACING CONSTRUCTION.
2. ELSEWHERE USE SELECTED EXCAVATED MATERIALS COMPACTED IN 150mm LAYERS

FIRST 300mm OF BACKFILL ABOVE CROWN OF PIPE TO BE FREE FROM STONES EXCEEDING 40mm

MINIMUM 150mm BED AND SURROUND AS DETAILED IN TABLE BELOW

USE CLASS S BED AND SURROUND WHERE COVER TO PIPE IS BETWEEN 0.75m AND 1.2m IN VEHICULAR ACCESS AREAS AND LESS THAN 0.45m UNDER FOOTPATHS/PAVED AREAS

PIPE DIAMETER:	BEDDING MATERIAL:
100Ø	10mm SINGLE SIZE AGGREGATE
1010 - 150Ø	10mm OR 14mm SINGLE SIZE AGGREGATE
1510 - 500Ø	10mm, 14mm OR 20mm SINGLE SIZE AGGREGATE

NOTE:
THE ABOVE MATERIALS ARE FOR GUIDANCE OTHER BEDDING MATERIALS CAN BE USED IN ACCORDANCE WITH THE PIPE MANUFACTURERS RECOMMENDATIONS I.E. SINTERED PULVERISED FUEL ASH AND AIR COOLED BLAST FURNACE SLAGS

TRENCH BACKFILL:

1. UNDER ROADS AND FOOTPATHS USE TYPE 1 GRANULAR MATERIAL COMPACTED IN 150mm LAYERS TO THE UNDERSIDE OF SURFACING CONSTRUCTION.
2. ELSEWHERE USE SELECTED EXCAVATED MATERIALS COMPACTED IN 150mm LAYERS.

FIRST 300mm OF BACKFILL ABOVE CROWN OF PIPE TO BE FREE FROM STONES EXCEEDING 40mm

MINIMUM 150mm BED AND SURROUND AS DETAILED IN TABLE BELOW

CLASS B BED TO BE USED WHERE COVER TO CROWN OF PIPE IS GREATER THAN 1.2m IN VEHICULAR ACCESS AREAS AND 0.45m IN FOOTPATHS/PAVED AREAS

PIPE DIAMETER:	BEDDING MATERIAL:
100Ø	10mm SINGLE SIZE AGGREGATE
101Ø - 150Ø	10mm OR 14mm SINGLE SIZE AGGREGATE
151Ø - 500Ø	10mm, 14mm OR 20mm SINGLE SIZE AGGREGATE
501Ø AND ABOVE	10mm, 14mm, 20mm OR 40mm SINGLE SIZE CRUSHED ROCK

NOTE:
THE ABOVE MATERIALS ARE FOR GUIDANCE OTHER BEDDING MATERIALS CAN BE USED IN ACCORDANCE WITH THE PIPE MANUFACTURERS RECOMMENDATIONS I.E. SINTERED PULVERISED FUEL ASH AND AIR COOLED BLAST FURNACE SLAGS

PERMISSIBLE ANGLES

ROCKER PIPE

600mm

BEND

45° BRANCH ROCKER PIPE

ROCKER PIPE

600

600

BENDS MORE ACUTE THAN 45° SHALL NOT BE USED.

150 MAX 600 MAX

JOINTS OR COUPLINGS

DETAIL 1

DRAIN WITH GRANULAR SURROUND

150 MAX 600 MAX

18mm FLEXCELL SPACERS
36mm ON DRAINS 450Ø & ABOVE

DETAIL 2

DRAIN WITH CONCRETE SURROUND

YARD GULLY WITH MEDIUM DUTY (5 TONNE) GRATING

FINISHES TO ARCHITECTS DETAIL

G.L.

MINIMUM 150 CONCRETE BED AND SURROUND

FILTER/SILT BUCKET

ROCKER PIPE

800

1000 CONNECT TO SURFACE WATER SYSTEM

250x250x100 DEEP BOX OUT IN SLAB FOR TERMINATION OF DRAIN POINT

FLOOR FINISHES TO ARCHITECTS DETAIL.

DRAIN POINT IN BOX OUT TO BE TEMPORARILY SEALED DURING CONSTRUCTION WORKS TO PREVENT INGRESS OF BUILDERS MATERIALS AND MIS-USE

REFER TO STRUCTURAL ENGINEERS DESIGN FOR SLAB DETAILS

450mm MIN AND 750mm MAX FOR 3 STORES AND ABOVE

STRUCTURAL SLAB

150

150

75

DROPHILIC TYPE WATER STOP AS HOTITE C/J OR PUDDLE FLANGE ON PENETRATIONS THROUGH SLAB.

CONCRETE BED AND SURROUND WHEN UNDER BUILDING UNLESS NOTED OTHERWISE WITHIN THE CONTRACT DOCUMENTS

FLEXIBLE JOINT

600 ROCKER PIPE

Technical drawing of the ACO M1000 R10 Ramp Unit, showing top and side views with dimensions and labels.

Top View Dimensions:

- Overall width: 605
- Overall height: 350mm
- Unit label: ACO M1000 R10 RAMP UNIT

Side View Dimensions and Labels:

- Concrete bed and haunch minimum compressive strength: 25 N/mm²
- ACO Multi Channel
- Trapped Outlet
- Minimum depth of concrete: 200mm MIN
- Minimum depth of haunch: 200mm MIN

CONCRETE BED & HAUNCH MINIMUM COMPRESSIVE STRENGTH 25 N/mm²

ACO MULTI CHANNEL

BLOCK BEDDED USING EPOXY MORTAR

BLOCK

BLOCK

150mm

150mm

GRATING TO SUIT
PROPOSED FLOOR FINISH

RAISING PIECES TO SUIT

CONCRETE SURROUND

HYDROPHILIC WATER BARRIER

ADAPTOR TO VITRIFIED CLAY

CONCRETE SURROUND MONOLITHIC WITH THE STRUCTURE.

VITRIFIED CLAY

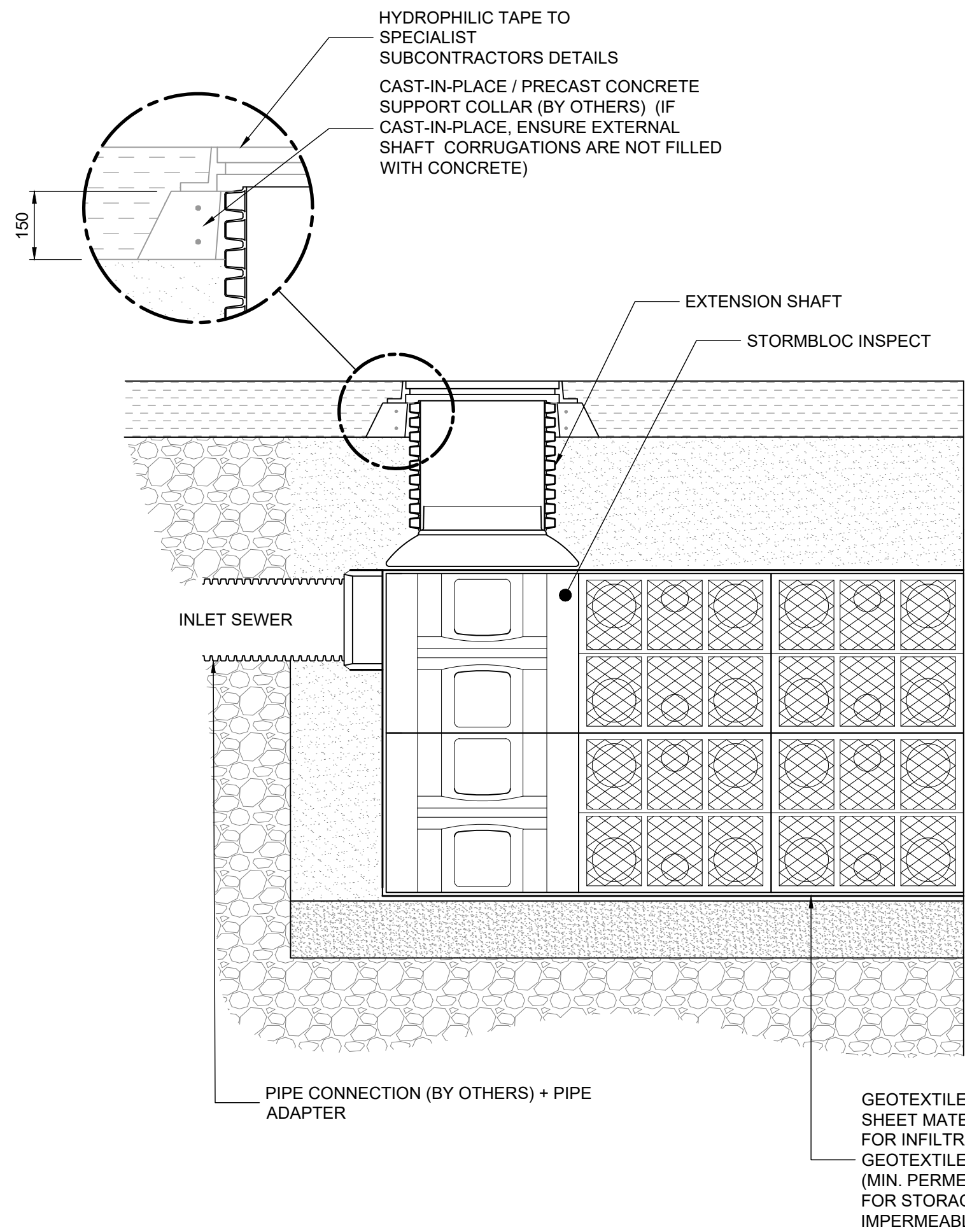
WATERPROOFING AS PER ARCHITECTS DETAILS

P01 27/03/20	PRELIMINARY ISSUE	AP JR SL
REV DATE	DESCRIPTION	DRN CHK APD
KEY PLAN		

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DRAINAGE DETAILS DRAWING
BUILDING 3
SHEET 1

DATE	SCALES @ A1	DRAWN BY	CHECKED	APPROVED
27/03/20	NTS	AP	JR	SL
PROJECT No.	DRAWING No.			REVISION
P450040	C-403			P01



STORMBLOC STORAGE SYSTEM

MINIMUM GROUND COVER DEPTH GUIDE*

GENERAL USE	MINIMUM GROUND COVER
LANDSCAPED AREAS (NON TRAFFICKED)	500mm
CAR PARKS, VEHICLE MASS ≤ 2500 kg	600mm
CAR PARKS, OCCASIONAL VEHICLE MASS > 2500 kg	800mm
ROADS, TRAFFIC LOADING < 44 tonnes	1000mm

* MINIMUM GROUND COVER SHOWN IS THE TOTAL DEPTH FROM THE TOP OF THE BLOCK TO FINISHED SURFACE. SHALLOWER COVER DEPTHS MAY BE PERMISSIBLE DEPENDING ON THE TYPE OF BACKFILL AND PAVEMENT CONSTRUCTION. PLEASE CONTACT HYDRO INTERNATIONAL FOR FURTHER ADVICE.

FINISHED SURFACE

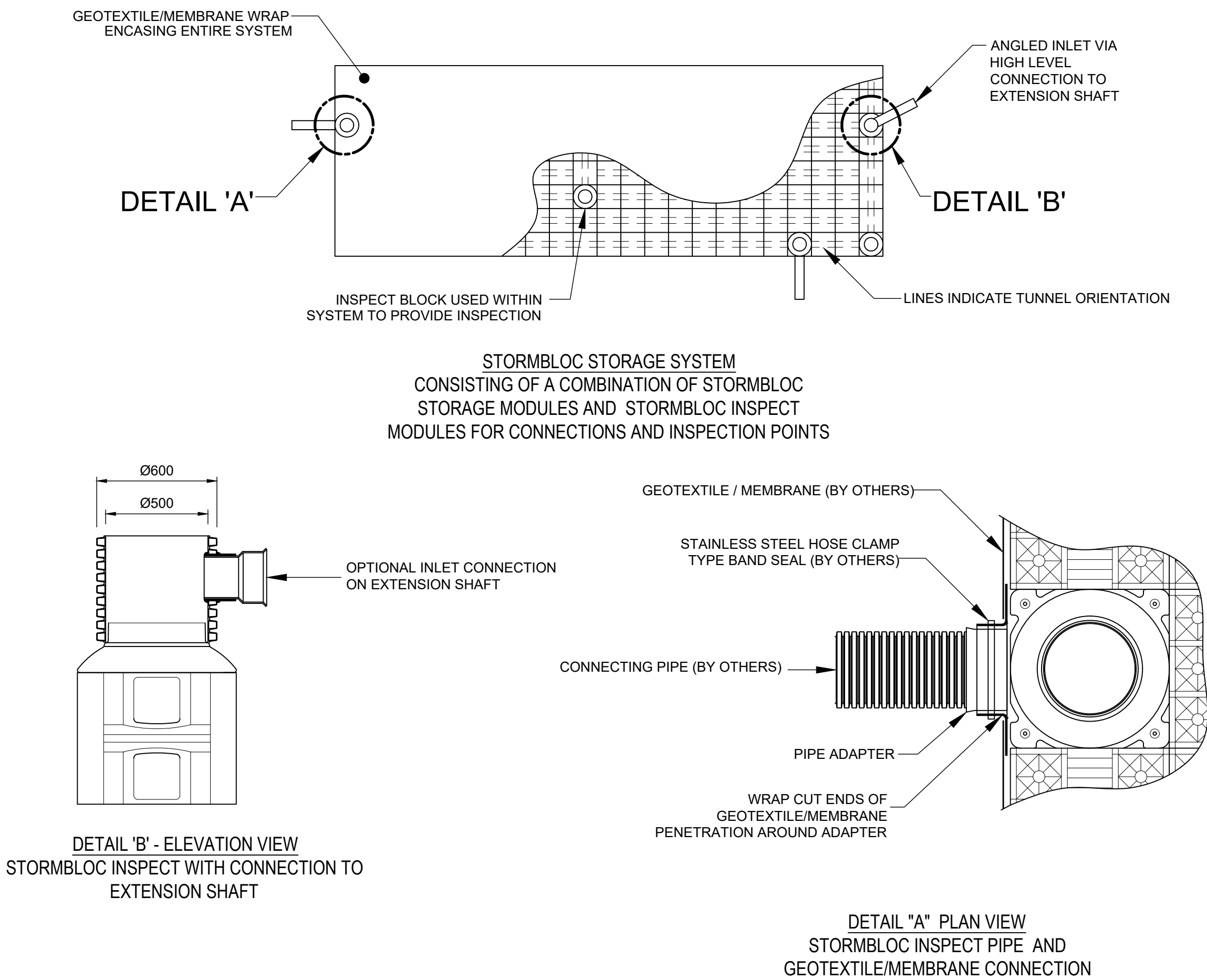
TOP AND SIDE FILL
GRANULAR STRUCTURAL FILL
OR NATIVE EARTH MIXTURE
SURROUNDING ENTIRE SYSTEM
REFER TO PROJECT PLANS AND SPECIFICATIONS.

GROUND COVER DEPTH
REFER TO TABLE ABOVE

STORMBLOC SYSTEM
BETWEEN 0.5 AND 3.5 BLOCK'S DEEP
FULL BLOCK LAYER HEIGHT = 660mm
HALF BLOCK LAYER HEIGHT = 350mm
ALL BLOCKS AND INSPECT CHAMBERS = 800mm LONG x 800mm WIDE

STORMBLOC BASE
MINIMUM 100mm DEEP COARSE SAND / GRAVEL

UNDISTRIBUTED EARTH OR PREPARED SUBGRADE
STRUCTURALLY SOUND, LEVEL AND FREE OF DEBRIS.
REFER TO PROJECT PLANS AND SPECIFICATIONS.



HEALTH AND SAFETY INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING AND REFER TO WW RISK ASSESSMENT CONSTRUCTION.

MAINTENANCE/CLEANING/OPERATION.

DECOMMISSIONING/DEMOLITION.

NOTES

DO NOT SCALE FROM THIS DRAWING. ONLY FIGURED DIMENSIONS ARE TO BE USED.

ALL DIMENSIONS ARE IN MILLIMETRES U.N.O.

ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.

DRAINAGE DETAILS TO BE CONFIRMED BY THE ARCHITECT INCLUDING DRAINAGE CHANNEL TYPES/FINISHES, REQUIREMENT FOR RECESSED MANHOLE COVERS ETC

WATERPROOFING AS PER ARCHITECTS DETAILS

P01 27/03/20 PRELIMINARY ISSUE AP JR SL

REV DATE DESCRIPTION DRN CHK APD

KEY PLAN

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CLIENT
ARGENT RELATED

PROJECT
ISLAND SITES
TOTENHAM HALE

PRELIMINARY

DRAWING TITLE
DRAINAGE DETAILS DRAWING
BUILDING 3
SHEET 2

DATE	27/03/20	SCALES @ A1	NTS	DRAWN BY	AP	CHECKED	JR	APPROVED	SL
PROJECT No.	P450040	DRAWING No.	C-404					REVISION	P01

Appendix C – Drainage Exceedance Flow Paths



HEALTH AND SAFETY INFORMATION

CONSTRUCTION
1.POTENTIAL CONTAMINATION IN MADE GROUND. REFER TO GIR
2.HIGH WATER TABLE DURING CONSTRUCTION - REFER TO GIR

MAINTENANCE/CLEANING/OPERATION.

DECOMMISSIONING/DEMOLITION.

NOTES

DO NOT SCALE FROM THIS DRAWING. ONLY FIGURED DIMENSIONS ARE TO BE USED.

ALL DIMENSIONS ARE IN MILLIMETRES U.N.O.

ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.

LEVELS ARE INDICATIVELY ONLY AND BASED ON LEVELS DESIGN BY OTHERS. LEVELS DESIGN TO BE CONFIRMED BY LANDSCAPE ARCHITECTS.

EXCEEDANCE FLOW ROUTES

P01	21/09/22	PRELIMINARY ISSUE	AP	JB	SL
REV	DATE	DESCRIPTION	DRN	CHK	APD
KEY PLAN					

whitby wood

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CLIENT
ARGENT RELATED

PROJECT
FERRY ISLAND

PRELIMINARY

DRAINAGE EXCEEDANCE FLOW PATHS

DATE	21/09/22	SCALES @ A1	1:200	DRAWN BY	AP	CHECKED	JB	APPROVED	SL
DRAWING No.	P450040-BA-C-150							REVISION	P01

Appendix D –SuDS Maintenance Schedule

SuDS Maintenance Schedule

1.0 INTRODUCTION

This document outlines the operation and maintenance requirements for drainage features utilised in the development.

2.0 DESIGN

Below ground drain pipes for both the surface and foul water networks have been designed to achieve self-cleansing velocity.

3.0 GUIDANCE

- Approved Document H: Drainage and waste disposal
- BS 8301: 1985 Code of practice for Building Drainage
- CIRIA SuDS Manual

4.0 GENERAL

An 'as built' drainage drawing supported by a CCTV survey carried out post construction will be made available to the site's management company.

Sewers, manholes and drainage channels are unlikely to require maintenance other than periodic inspections, unless a blockage occurs.

The following should be carried out on an annual basis:

- Covers of inspection chambers and manholes should be removed and the sides, benching and channels cleaned.
- Deposits in channels and gullies should be removed. The traps should be plunged and thoroughly flushed out with clean water.
- Main and branch drains should be rodded, jetted and then flushed with clean water.
- Any obstructions should be removed.
- Note that correct ends of rods should be used to avoid damage to pipes and them becoming detached.

Reference should be made to the manufacturer's information and maintenance requirements for recommended intervals and safe methods of cleaning for the following proprietary systems which are formerly recorded on the 'As built' drawings:

- storm water storage system
- drainage channels
- flow controls such as hydrobrakes and orifices

A full CCTV survey will also be carried out at 10 yearly intervals to assess the condition of the drainage system.

In all instances, inspection and cleaning is to be carried out only by a suitable Specialist Contractor, following the guidelines given in BE EN 752 Part 7 1998 “Maintenance and Operations” and “Safe Working in Sewers and at Sewage Works”, published by the National Joint Health and Safety Committee for the Water Services.

All underground and under-floor drains and manholes represent confined spaces. Appropriate precautions will be taken before entering drains and manholes. Access will only be undertaken by appropriately trained personnel.

5.0 RESPONSIBILITY

A maintenance company shall be contracted to include these inspection works within their plan.

6.0 ATTENUATION TANKS

Maintenance Schedule	Required action	Typical frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary	Annually.
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

Appendix E - Proposed Attenuation Tank Details

Polystorm & Polystorm Lite Technical Guide



Water Management Solutions
Design, planning, specification and installation guidelines

Water Management Solutions

Modular Cell Systems

Design, planning, specification and installation guidelines

From the **technical specialists**, Polypipe Water Management Solutions. The Polystorm range of products and solutions for **attenuation and soakaway** applications.

This document describes the products from Polypipe Water Management Solutions for implementing a **stormwater management** system that meets the requirements for **Sustainable Drainage Systems** (SUDS).

Purpose of this document

This document provides full technical details on Polypipe WMS Polystorm products and explains how to:

- select products to provide the best solution for your specific stormwater requirements
- incorporate products into your project's design
- install products on-site

Other relevant documents from Polypipe WMS

- Ridgidrain/Ridgisewer and Polysewer Design and Installation Manuals
- Forms for specifying your requirements for Catchpits and Stormcheck chambers

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Index - how this document is organised



The document is presented in clearly marked sections to help you navigate and find the information you require quickly and easily.

- Section 1 - provides an overview of SUDS.
- Section 2 - provides guidance on drainage design and helps you select which product to use for managing a site's stormwater run-off.
- Section 3 - provides testing and certification information.
- Section 4 & 5 - describe design protocol, installation and maintenance.
- Section 6 - provides information on associated products.
- Section 7 - shows project solutions.
- Section 8 - company overview.

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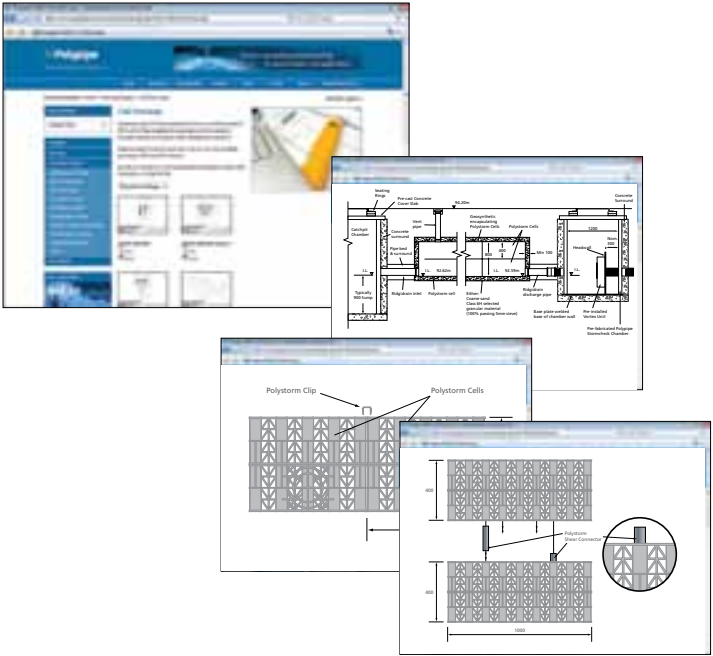
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* Please note:

Illustrations shown within this publication are available as downloadable CAD drawings from www.polypipewms.co.uk



1.0 Overview

Polypipe Water Management Solutions

Part of the overall Polypipe Civils business, the Polypipe Water Management Solutions (WMS) team includes some of the most talented Civil Engineers and Water Management Specialists within the industry to provide dedicated knowledge, support and technical expertise for a wide range of sustainable drainage systems (SUDS) and water management projects.

Today, the concept of sustainable water management is a major driver in the UK construction industry. Planning Policy Statement 25 (PPS25) requires local planning authorities to institute policies that enforce, wherever possible, the use of Sustainable Drainage Systems or SUDS. Combine this with the Floods and Water Management Act and it becomes obvious that specifying the correct sustainable drainage solution is vital.



Polypipe WMS are totally dedicated to focusing on the legislative drivers and industry developments in order to provide innovative, future proof sustainable Water Management Solutions to our customers and the UK construction industry.

Overview

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1.1 SUDS - sustainable drainage best practise and building regulations

Sustainable drainage systems are an alternative to the traditional approach of collecting stormwater in pipes and discharging it into treatment works or watercourses. SUDS best practice limits the flow of rainwater which runs off a site or is piped away, protects local watercourses from the contamination carried in surface run-off, encourages natural groundwater recharge (where appropriate) and reduces the likelihood of downstream flooding.



1.1.1 Building regulations

The Building Regulations Approved Document H3, Rainwater Drainage, which came into effect on 1st April 2002, prioritises drainage requirements. In short, it requires that rainwater from the roof of a building or from a paved area may either be gathered for re-use in a rainwater tank or be discharged into one of the following, listed in order:

- (a) an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practical,
- (b) a watercourse; or, where that is not reasonably practical,
- (c) a sewer.

In other words, the traditionally preferred method of rainwater disposal, i.e. totally discharging to a sewer, may now only be considered after other forms of re-use or drainage have been considered.

1.1.2 SUDS Best Practice CIRIA C697

The SUDS Manual, published by CIRIA 2007 (CIRIA C697) defines that a sustainable urban drainage system should consider certain basic requirements, including:

- Run-off from a developed area should be no greater than the run-off prior to development
- Run-off from a developed area should not result in any down-grading of downstream watercourses or habitat
- Consideration should be given at the development feasibility stage to water resource management and control in the developed area
- Run-off should replicate as far as possible the natural response of the site to rainfall

SUDS best practice limits the flow of rainwater which runs off a site or is piped away, protects local watercourses from contamination carried in surface run-off, encourages natural groundwater recharge (where appropriate) and reduces the likelihood of downstream flooding.

1.1.3 The Code for Sustainable Homes

The Building Regulations also provide guidance on the construction of rainwater harvesting systems for the first time. The newly published Guidance Document entitled 'The Code for Sustainable Homes' indicates the Government's intentions to further drive developers towards building sustainable homes.

As well as covering energy efficiency, water usage and waste, the Code also proposes a minimum standard for surface water management. This minimum standard will require peak run-off rates or annual run-off volumes of surface water to be no more than the original conditions of the site.

The challenge each developer faces on both greenfield and brownfield developments is what to do with the excess run-off generated by a development which has to be retained in and around the site.

Polypipe WMS

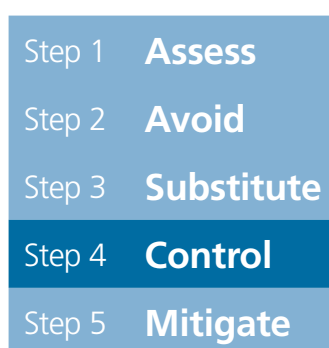
provide the developer, both large and small, with flexible value engineered solutions which cater for almost any site conditions and restraints.



1.2 Drainage design - planning, cost effective techniques, site evaluation, adoption and future maintenance



Many authorities will expect planning applications, whether outline or detailed, to demonstrate how a more sustainable approach to drainage is to be incorporated into development proposals.



Step 4 requires planners to use SUDS as a form of control for surface water.

1.2.1 Key elements of Planning Policy Statement 25 (PPS25)

- Covers all types of flooding
- Flooding considered at all stages of the planning process
- Risk-based sequential approach
- Safe development of sustainable communities

1.2.2 Planning

Planning authorities will set a limit to the rate of stormwater flow from a site via sewers as a condition of planning consent. In recognition of this, Local Planners increasingly state that all applications should, in the first instance, aim to incorporate SUDS into development proposals. SUDS are also considered suitable for mitigating adverse impacts and supporting water conservation objectives.

1.2.3 Cost effective techniques

SUDS incorporate cost-effective techniques that are applicable to a wide range of schemes, from small developments to major residential, leisure, commercial or industrial operations with large roof spaces and large hardstanding areas. They can also be successfully retrofitted to existing developments. Planning policy guidance on development and flood risk emphasises the role of SUDS and introduces a general presumption that they will be used.

1.2.4 Site evaluation

As with other key considerations in the planning process - transport, landscape, heritage and nature conservation - incorporating SUDS needs to be considered early in the site evaluation and planning process, as well as at the detailed design stage.

1.2.5 Floods & Water Management Act

Sir Michael Pitt completed his independent review of the 2007 flooding emergency in June 2008, forming the catalyst for major legislative change. The report proposed 92 recommendations to improve UK surface water management and has called for significant investment from the Government in sustainable drainage techniques and flood management strategy.

The Floods and Water Management Act sets out a more joined-up approach to flood risk prevention and management and has been developed to implement the majority of the recommendations set out in the Pitt Review. It gives local authorities the lead role in managing local flood risk, as well as the responsibility for adopting and maintaining sustainable drainage schemes. This will then enable the Environment Agency to adopt a strategic overview role for all forms of flood risk, including groundwater and surface water.

1.2.6 Adoption and future maintenance

In the early stages of design, consideration should be given to the arrangements for adoption and future maintenance of the system. This is likely to influence the design just as much as technical considerations. For private, or non-adopted systems, maintenance will be the responsibility of the owner and future developments may be affected by covenants. For systems serving more than one residential property it is recommended that maintenance should be the responsibility of a publicly accountable body, which will often necessitate the payment of a commuted sum or a legal agreement, possibly backed by the deposit of a financial bond. The adopting organisation should approve the design before construction.



2.0 Polystorm modular cell system

attenuation and soakaway solutions

Average UK temperatures are expected to rise by up to 3/5°C by 2080, resulting in a dramatic change in the seasonal distribution of rainfall and subsequent weather patterns. The flooding witnessed during recent years is a clear indication that climate change is causing more frequent and extreme weather events and innovative solutions are required to cope with increased pressure on our existing drainage and water management networks.



Planning Policy Statement 25 - Development and flood risk

Planning Policy Statement 25 (PPS25) sets out Government policy on development and flood risk. Its aim is to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. Where new development is exceptionally necessary in such areas, policy aims to make it safe, without increasing flood risk elsewhere and where possible, reducing flood risk overall.

Planning Policy Statement 25: Development and Flood Risk (PPS25), published in June 2008.

Polystorm modular solution

The Polystorm range of modular cells are designed to address the above legislation on minimising flood risk. The cells retain large volumes of water and fit together to create a modular underground water tank. The tank can then be modified to be either an attenuation or soakaway solution.

Products

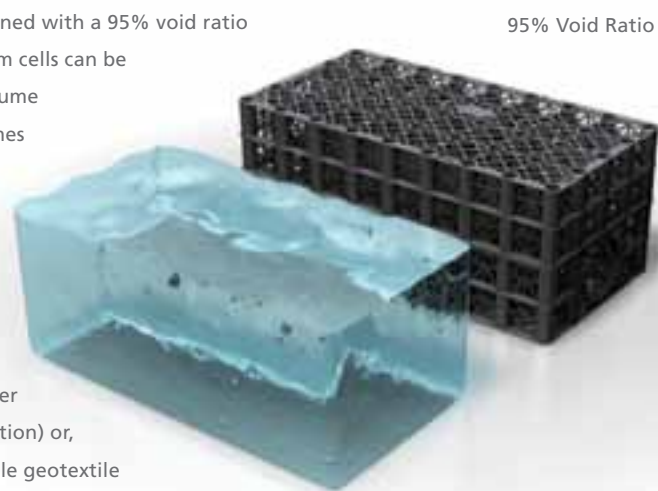
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2.1 Polystorm modular cell system - three types of Polystorm cells

2.1.1 The Polystorm principles

The Polystorm range of modular cell systems are designed with a 95% void ratio to retain large volumes of water run-off. The Polystorm cells can be designed and built to a specific size to a total void volume requirement dependent upon the water run-off volumes required on a particular project (i.e. car park, road or building). The Polystorm range of water storage cells are structurally strong, individual modular cells which can be built up to form a structure of any shape or size. The structure is wrapped in a non permeable, geomembrane which can receive rainwater collected from the roof gutter system or surface drains and either releases the water within set discharge limits (attenuation) or, where soil conditions allow, be wrapped in a permeable geotextile and slowly release the water back into the surrounding soil (soakaway).



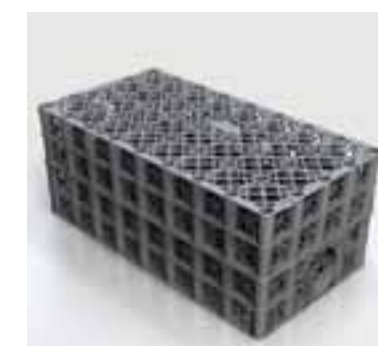
95% Void Ratio



Polystorm Lite 20T



Polystorm Lite



Polystorm 40T



Polystorm



Key benefits

- **95% void ratio:** Providing greater water storage capacity and reduced excavation and disposal costs
- **Modular units:** Allow flexibility of shape - ideal for shallow excavation systems, narrow strips or use in restricted areas
- **Light weight yet robust:** Excellent Health and Safety and installation benefits
- **Easy to handle:** Unique rounded corners for ease of handling and reduces likelihood of punctures to membranes
- **Cost effective:** Especially when used as a hybrid, value engineered system
- **Recyclable:** 100% recyclable at the end of its useful life
- **Range:** Spans from 20 tonnes per square metre load bearing capacity up to a maximum of 80 tonnes per square metre load bearing capacity
- The range can be designed for non-trafficked, trafficked or heavy trafficked applications
- Suitable for both attenuation and soakaway systems
- 50 year design life
- BBA Approved
- Hybrid Solutions

There are three different types of Polystorm cells which are Polystorm Lite, Polystorm and Polystorm Xtra. Each Polystorm cell type has a different surface load specification.

- **Polystorm Lite** is designed for use in landscaped pedestrian or other non-loaded applications
- **Polystorm** is designed for use in light trafficked and loaded applications

The Polystorm Technical Manual is available to download at:
www.polypipewms.co.uk/downloads

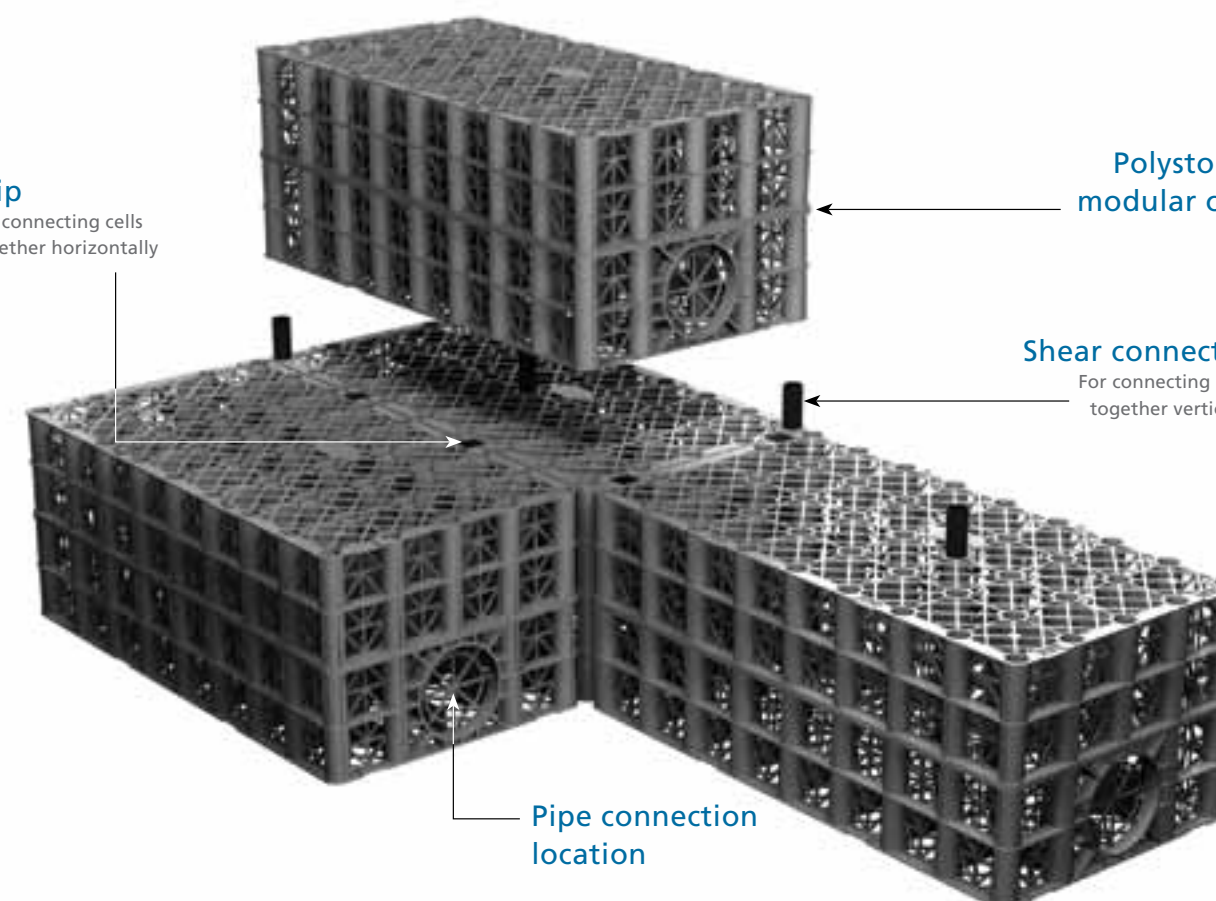
Clip

For connecting cells together horizontally

Polystorm modular cell

Shear connector

For connecting cells together vertically



Pipe connection location

2.2 Polystorm Lite

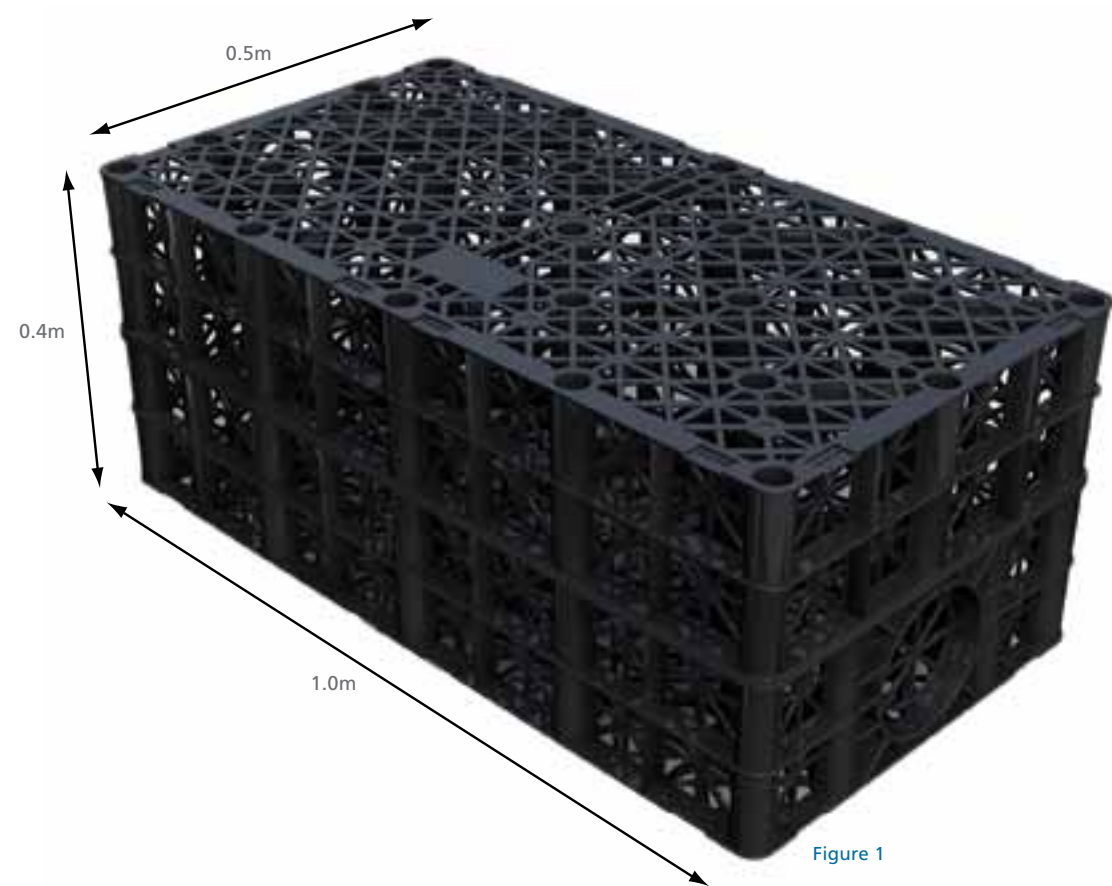


Figure 1

Designed for use in landscaped, pedestrian or other non-loaded applications with a load bearing capacity of:

20 tonnes

Technical specification overview	
Unit type	Polystorm Lite
Product code	PSM2*
Dimensions	1m x 0.5m x 0.4m high
Total volume	0.2m per cube
Unit weight	7kgs**
Cube storage volume	0.19m³ (190 litres)
Surface area	55% perforated
Compressive strength	Maximum 20 tonnes per sq metre
Maximum burial depth	2.5m***

* Each unit includes 4 clips and 2 shear connectors. Please note that brick bond connector may be required at additional cost.

** Pallet weight dependent upon order quantity and transport type.

*** In weak clay soil conditions the maximum burial depth is 1.5 metres. Polystorm Lite should not be installed below the water table.

Table 1

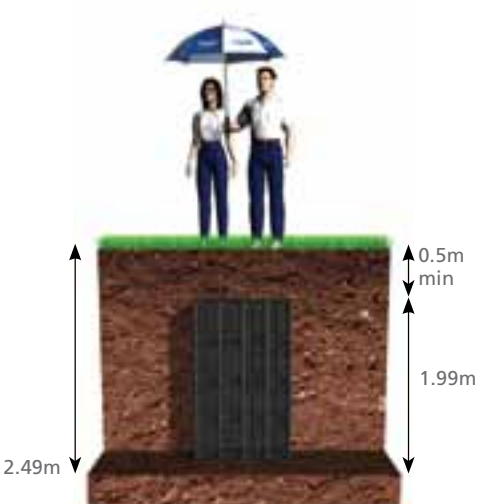


Figure 2

Polystorm Lite has been specifically designed for non-trafficked applications. With a 20 tonne per square metre compressive strength it will however take general maintenance vehicles such as grass cutters. Polystorm Lite can be used for both attenuation and soakaway applications. The modular structure receives rainwater collected from roofs or surface drains ready to release within a set drainage limit. Polystorm Lite can be used typically for landscaped areas, pedestrian or public open spaces such as underneath playgrounds.

Polystorm Lite		
Description	Code	Pack quantity
Polystorm Lite cell 1000 x 500 x 400mm	PSM2	15
Polystorm Lite flow control unit	PSMFC160/30	1
Brick bond shear connector	PSMBBSC	30
Clips	PSMCLIP	60
Shear connector	PSMSC	30
EN1401 flange adaptor - 110mm	PSMFA110	1
Ridgidrain flange adaptor - 150mm	PSMFA150	1
EN1401 flange adaptor - 160mm	PSMFA160	1
Basic silt trap	PSMST160	1
Advanced silt trap - 15 litres/sec	PSMSTA160/15	1
Mini silt trap for Polystorm Lite	PSMST110	1
Cover & frame (round)	UG501	1
Cover & frame (square)	UG502	1
450mm silt trap lid & frame	UG512	1
460mm lockable plastic cover & frame	UG511	1
Polypropylene cover & frame	ICDC1	1
Chamber riser section	ICDR1	1
Silt trap sealing ring	UG488	1

Table 2



Note: Minimum cover and burial depths may vary depending on load and ground conditions. Please contact Polypipe WMS for further information. All grades of Polystorm units may be used in situations outside of those recommended above, through the use of the appropriate protective measures designed to reduce the imposed loading on the proposed Polystorm structures.

2.3 Polystorm

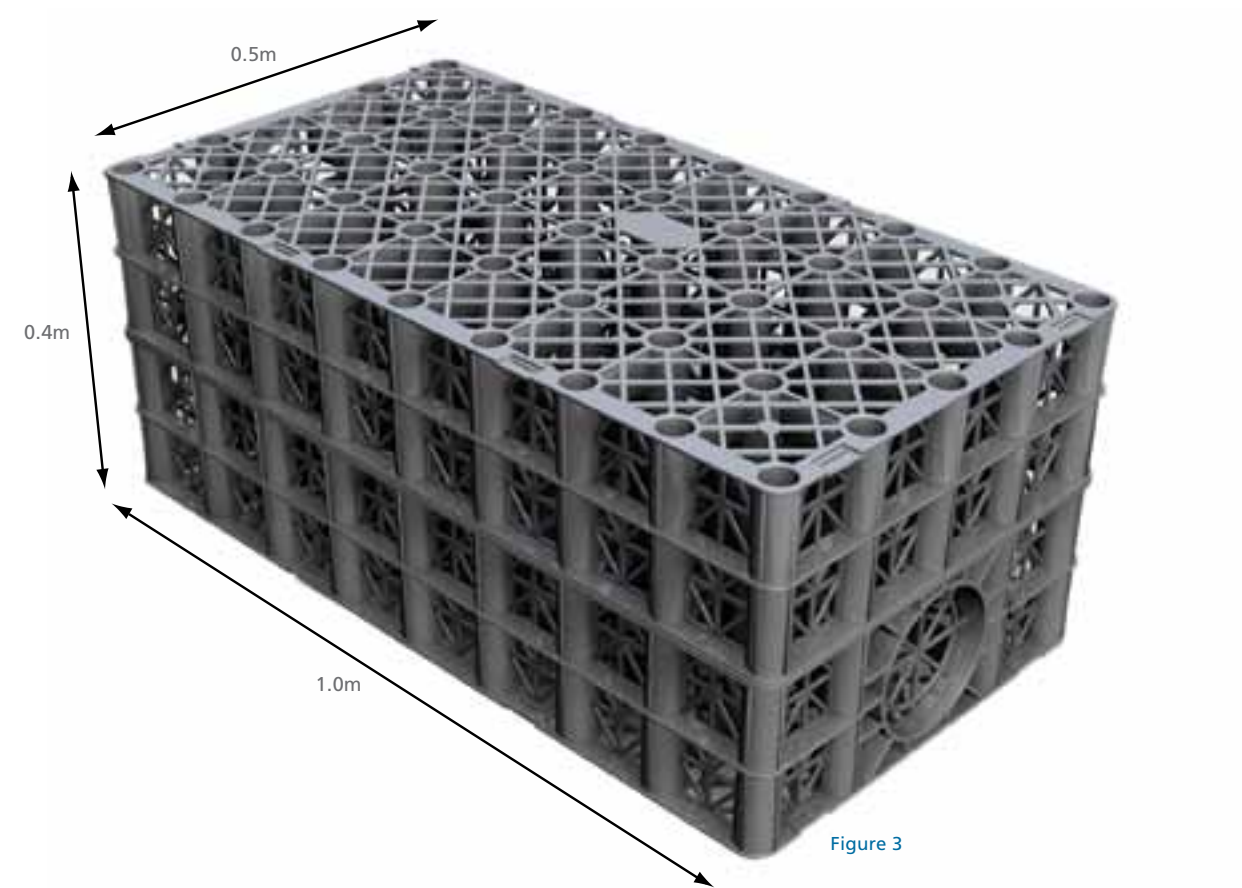


Figure 3

Designed for use in trafficked and loaded applications with a load bearing capacity of:

40 tonnes

Technical specification overview	
Unit type	Polystorm
Product code	PSM1*
Dimensions	1m x 0.5m x 0.4m high
Total volume	0.2m per cube
Unit weight	9kgs**
Cube storage volume	0.19m³ (190 litres)
Surface area	48% perforated
Compressive strength	Maximum 40 tonnes per sq metre
Maximum burial depth	3.7 metres***

* Each unit includes 4 clips and 2 shear connectors. Please note that brick bond connector may be required at additional cost.

** Pallet weight dependent upon order quantity and transport type.

*** In weak clay soil conditions the maximum burial depth is reduced, please consult Polypipe WMS Technical Team on 01509 615100.

Table 3

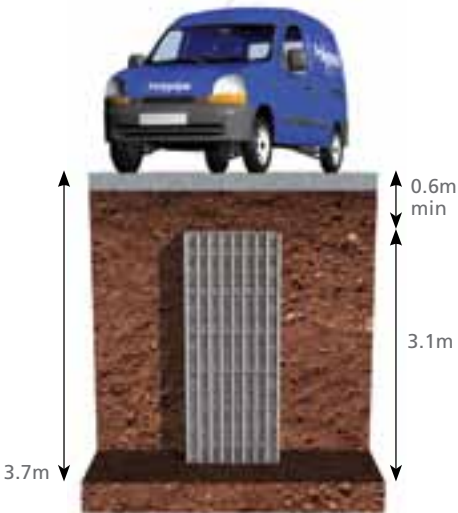


Figure 4

Polystorm features individual modular cells that can be built up to form a load-bearing tank structure of any shape or size to receive rainwater collected from the gutter system or surface drains ready to release within a set discharge limit. Polystorm has a 40 tonne per square metre compressive strength and is ideally suited for light trafficked and loaded applications. Polystorm can be used for both attenuation and soakaway applications and typically for housing developments, small car parks and light commercial developments.

Polystorm		
Description	Code	Pack quantity
Polystorm cell 1000 x 500 x 400mm	PSM1	15
Polystorm cell with 225mm connector	PSMCRD225	1
Polystorm cell with 300mm connector	PSMCRD300	1
Brick bond shear connector	PSMBBSC	30
Clips	PSMCLIP	60
Shear connector	PSMSC	30
EN1401 flange adaptor - 110mm	PSMFA110	1
Ridgidrain flange adaptor - 150mm	PSMFA150	1
EN1401 flange adaptor - 160mm	PSMFA160	1
Basic silt trap	PSMST160	1
Advanced silt trap - 15 litres/sec	PSMSTA160/15	1
Cover & frame (round)	UG501	1
Cover & frame (square)	UG502	1
450mm silt trap lid & frame	UG512	1
460mm lockable plastic cover & frame	UG511	1
Polypropylene cover & frame	ICDC1	1
Chamber riser section	ICDR1	1
Silt trap sealing ring	UG488	1

Table 4

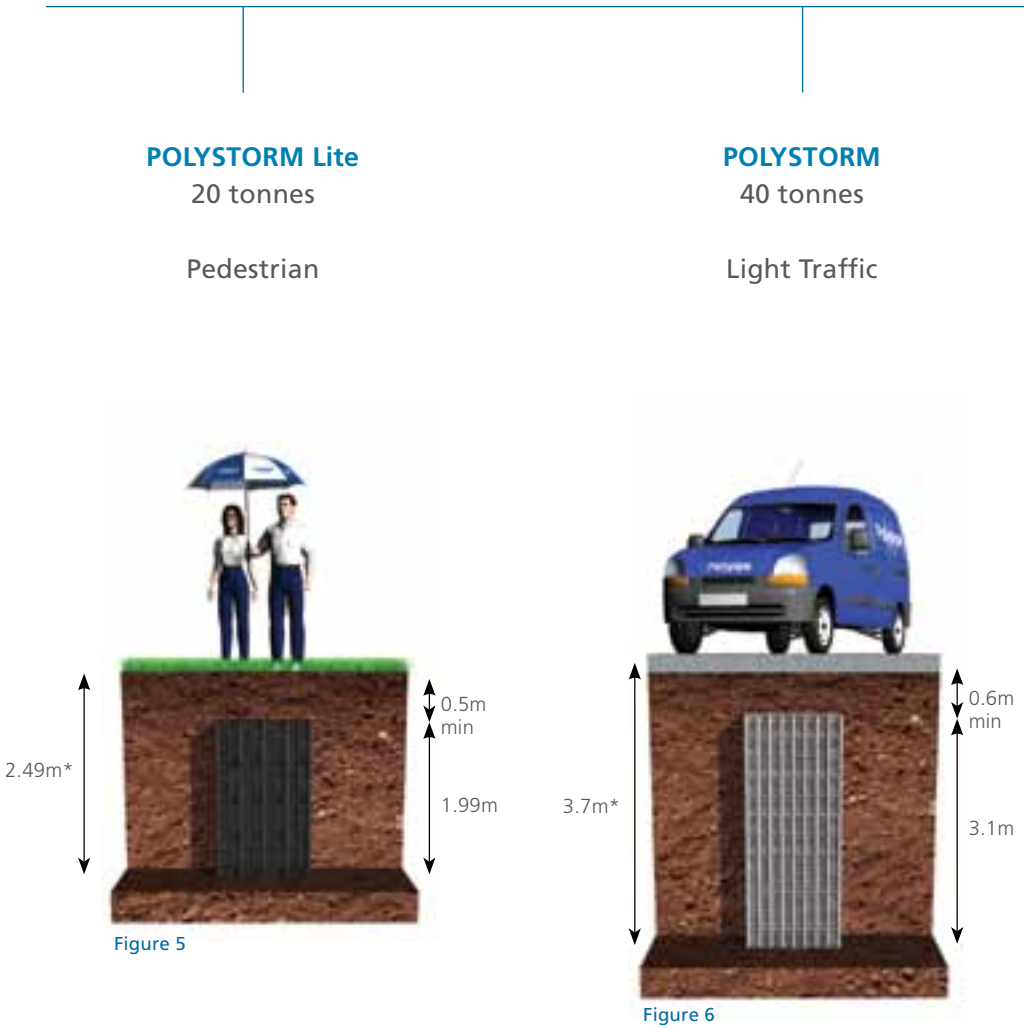


Note: Minimum cover and burial depths may vary depending on load and ground conditions. Please contact Polypipe WMS for further information. All grades of Polystorm units may be used in situations outside of those recommended above, through the use of the appropriate protective measures designed to reduce the imposed loading on the proposed Polystorm structures.

2.4 Hybrid - Polystorm range of modular cells creating a cost-effective hybrid construction

The following illustrations indicate maximum burial depths for Polystorm Lite and Polystorm modular cell systems.

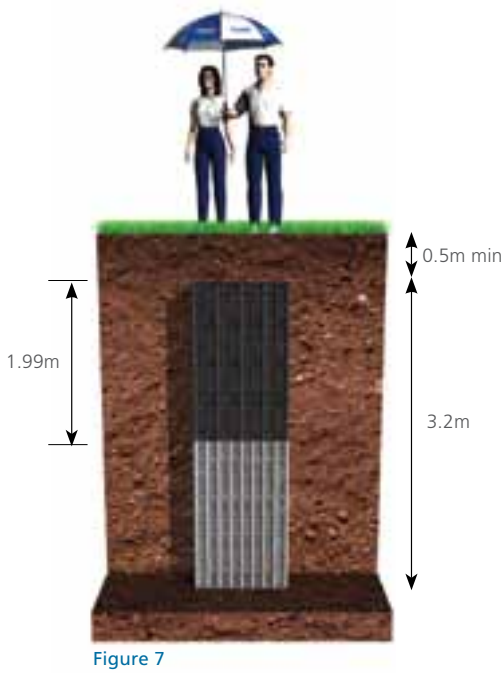
Polystorm Lite and Polystorm



Note: * Based on ground conditions being dense sand and gravel.
Minimum cover and burial depths may vary depending on load and ground conditions.
Please contact Polypipe WMS for further information. All grades of Polystorm units may be used in situations outside of those recommended above, through the use of the appropriate protective measures, designed to reduce the imposed loading on the proposed Polystorm structures.

Hybrid Solution VALUE ENGINEERED STRUCTURES

POLYSTORM Lite
POLYSTORM
Pedestrian



Value engineered structures

Polypipe are the only manufacturer who can offer a complete value engineered hybrid system utilising Polystorm Lite or Polystorm cells to create a bespoke solution based on the load requirements and burial depths for any given project.

When integrated as a hybrid structure, a complete value engineered solution can be adopted for any given project. To reduce costs, it's possible to construct a hybrid tank, which contains all types of cells, the stronger Polystorm cells at the bottom and Polystorm Lite cells at the top. For further details contact Polypipe WMS technical support team. Refer to tables 8, 9 and 10 (page 39) for burial depths in different soil conditions.

3.0 Testing and certification - laboratory testing and protocol

At Polypipe WMS we pride ourselves on providing a consistently high level of product quality. All our products undergo stringent testing and quality control and where possible, are covered by third party certification. Our manufacturing processes are also accredited to ISO 9001:2008. There are two quality control labs in operation 12 hours a day.



Testing and certification

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3.1 Testing and certification

As a manufacturer of plastic below-ground water management products, Polypipe WMS invests heavily in British Board of Agrément (BBA) approval and is a supporter of the criteria used to assess each product. By achieving BBA approval, Polypipe WMS can pass on to our customers confidence in the performance of all our products.



Figure 8 Compression test rig

Increasingly new products are being introduced within the UK water management markets with no independent approvals. This can create potential issues for product specifications unsupported by independent testing and assessment and may not correlate with the performance parameters of the product. BBA approved products offer our customers a safety net and further reassurances that the product will perform in-line with our claims when installed in accordance with the BBA certificate.

3.1.1 Laboratory testing

Laboratory testing to determine the structural performance of the Polystorm cells were carried out in accordance with the laboratory protocol provided by the British Board of Agrément (BBA) for products of this type. Direct compression tests were conducted at Polypipe's research and development laboratory in accordance with ISO 9001:2008 to determine the vertical and lateral strength of the Polystorm cells. Vertical creep tests were undertaken at the UKAS accredited Berry and Hayward laboratory.

3.1.2 Test protocol

Laboratory testing to determine the structural performance of the Polystorm cells has followed the protocol agreed with the British Board of Agrément (BBA). Direct loading tests were carried out on single cells. Individual cells were load tested until failure (i.e. the point at which they could not sustain further load).

Tests were carried out along two axes (Figure 9).

- Vertical compression test; with load applied down the y-axis, via a 300mm ϕ platen, at two positions (Figure 10)
- Vertical compression test; with load applied down the y-axis via a platen covering the full area of the cellular unit (0.5 x 1.0m)
- Lateral compression test; with load applied along the x-axis via a platen covering the full area of cellular unit (0.4 x 1.0m). A simultaneous restraining load, representing the vertical load that may be expected at the units recommended maximum burial depth, was also applied

Creep tests were carried out on single Polystorm cells for a minimum period of 90 days.

- Vertical creep test; with a constant load applied down the y-axis, via a 300mm ϕ platen at position (Figure 9). The applied test load was equivalent to 75% of the vertical compressive design load; with the design load calculated by applying an appropriate material factor of safety (2.75 recommended by CIRIA) to the lowest vertical compressive yield test result

Polystorm cell; direction of applied load and platen location

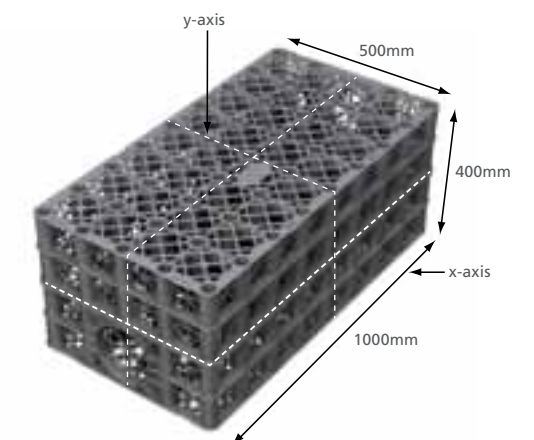


Figure 9 Unit axis; direction of applied load

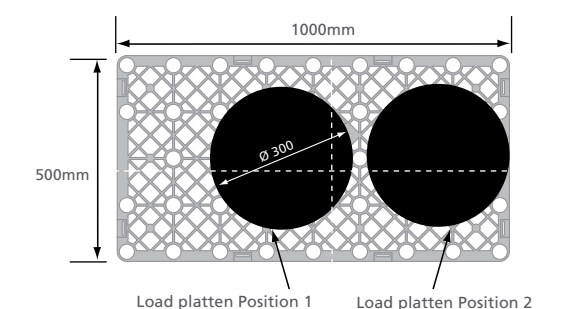


Figure 10 Position of load platens; point load resistance



Figure 11 Creep test rig

3.2 Summary of test results

3.2.1 Unit specifications

Figure 12 shows the dimensions of Polystorm Lite cells.

Figure 13 shows the dimensions of the Polystorm cells.

Table 5 shows the technical data for Polystorm Lite and Polystorm cells.

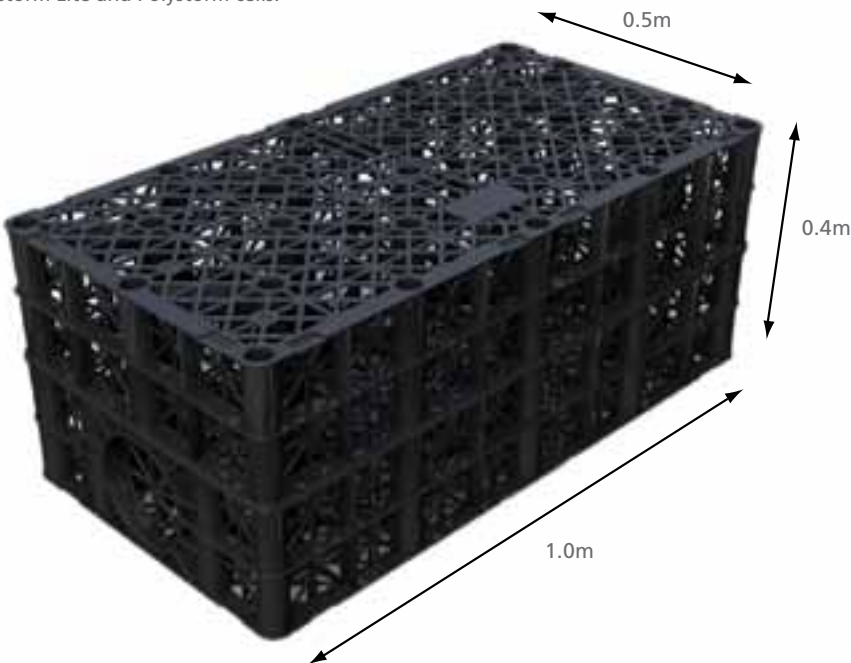


Figure 12 Dimensions of Polystorm Lite cell

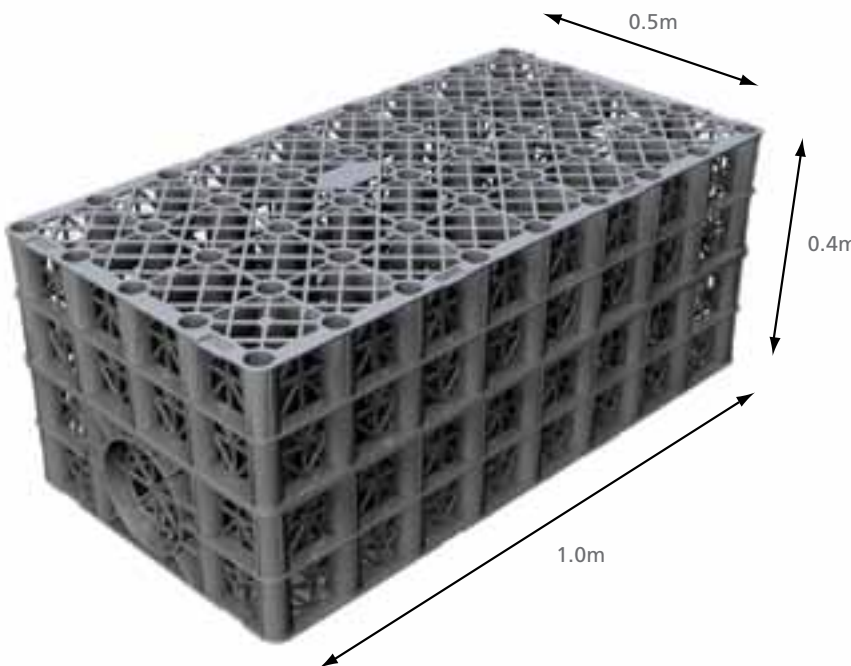


Figure 13 Dimensions of Polystorm cell

Technical data of Polystorm Lite and Polystorm cells		
	Polystorm Lite	Polystorm
Unit dimensions (nom) (mm)	1000 x 500 x 400	1000 x 500 x 400
Unit volume (nom) (m³)	0.2	0.2
Storage volume (nom) (m³)	0.19	0.19
Porosity (void ratio) (%)	95	95
Perforation of surface area (%)	55	48
Weight (kg)	7	9
Ultimate compressive strength at yield (kN/m²) ⁽¹⁾ : Vertical loading on top face	200	440
Lateral loading on side face	40	63
Short vertical loading on top side face (kN/m²)	1 per 43	1 per 83
Estimated long-term deflection ⁽²⁾ (Ln) ⁽³⁾	0.773	0.2796
Max burial depth (m)*	2.5m	3.7m

⁽¹⁾ = Applied load ⁽²⁾ = At up to 20 years @ 20°C @ 127kN/m² load (Polystorm) ⁽³⁾ = Time in hours
⁽²⁾ = At up to 20 years @ 20°C @ 54kN/m² load (Polystorm Lite)

* Maximum burial depth dependant upon soil conditions, see page 39 for further details.

Table 5

3.2.2 Durability

When installed in accordance with Polypipe WMS recommendations, the design life of Polystorm Lite and Polystorm cells exceeds 50 years. Please refer to BBA certificate.

3.2.3 Chemical resistance

Polystorm Lite and Polystorm cells are suitable for use in contact with chemicals likely to be found in rainwater. They are also resistant to all compounds occurring naturally in soils. For guidance on using Polystorm cells in contaminated ground, contact Polypipe WMS technical support team.



4.0 Design protocol



Polypipe WMS provide a full in-house design facility. Upon consultation our team of designers and technical advisors will guide you as to the best solution for your individual situation considering timescales and costs.



Design protocol

Contents

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4.1 Detail design protocol

4.1.1 Structural design

4.1.1 Structural design

When designing plastic geocellular structure for soakaway or attenuation tanks care has to be taken to ensure the finished system is safe to carry the loads they will be subject to. The diagram below outlines a safe route to the design and installation of Polystorm modular stormwater tanks.

Applied loads

- Distributed
- Concentrated
- Traffic
- Backfill
- Stockpiles
- Earth pressure
- Construction traffic
- Cranes
- Uplift

Laboratory testing

- Ultimate compressive strength at yield
- Deflection parameters
- Creep



Partial factors of safety

- On material properties
- On loads
- Follow BPF and CIRIA guidance

Analysis

- Failure
- Deflection (movement under load)
- Creep
- Flotation

Figure 14

Listed below are the four main reasons for failure of the system:

- 1 Structural failure or collapse - when the structure cannot support the applied loads.
- 2 Excessive deflection or movement when vehicles passing over the tank cause movement and the surface above may crack or displace.
- 3 Creep - excessive movement or loss of strength over a period of time which can occur under a constant load.
- 4 Flotation: Constructing a tank below the groundwater table can create uplift.

4.1.2 Limit state design, 4.1.3 Industry standards, 4.1.4 Factors of safety

4.1.2 Limit state design

In the design of any load carrying system, there needs to be factors of safety to allow for any variation in either the applied load or cellular unit strength. Limit state design does not use a single overall factor of safety; the method looks at 'limit states' and applies partial factors of safety to the various design parameters depending on the consequences of the limit state being exceeded. In the case of Polystorm drainage tanks the two limit states to be considered are:

• Ultimate limit state (ULS)

This is when the strength of the cell is exceeded by the applied loads and the tank collapses. This is obviously serious and the partial factors of safety used in this assessment are chosen to ensure there is a negligible risk of a collapse occurring.

• Serviceability limit state (SLS)

This considers the operational behaviour of a tank to ensure that the installation remains serviceable. For the structural calculations this means that deflections are not excessive and do not cause damage to overlying surfaces (such as asphalt) or cause a significant reduction in the storage volume of the tank. The Polystorm Lite cell is recommended for use in landscaped areas, where deflections would have a negligible effect. SLS would therefore not play a significant role in Polystorm Lite structural design.

4.1.3 Industry standards

There are currently no design standards or guides specific to generic modular plastic stormwater tanks, with each manufacturer within the marketplace providing their own guidelines that tend to be specific to their own cells. However, a generic design method has been developed that can be applied to most types of cells, using basic structural design theory and relevant British Standards. In particular the loading on plastic tanks may be considered to be the same as a buried concrete or steel tank and so the loads and partial factors of safety for loads have been taken from the following:

1. **British Standards Institution (1997).** British Standard BS8110, Part 1: 1997; Structural use of concrete: Code of practice for design and construction. BSI
2. **British Standards Institution (1996).** British Standard BS 6399: Part 1: 1996: British Standard Loadings for Buildings. Part 1 Code of Practice for dead and imposed loads. BSI

The only available guidance relating to plastic materials in similar situations to buried cellular tanks is that for plastic geosynthetics in soil strengthening and reinforcement. The information in the following British Standard has been used as a guide to the choice of partial material factors used for the design:

1. **British Standards Institution (1995).** British Standard BS8006: 1995; Code of practice for strengthened/reinforced soils and other fills. BSI

4.1.4 Factors of safety

To ensure that the risk of exceeding the limit states is minimal, factors of safety are applied to the cellular unit's ultimate compressive strength and to any applied loads; these are known as partial factors of safety.



4.1.5 Material factors

4.1.5 Material factors

The ultimate compressive strength of the Polystorm cells has been obtained from laboratory testing on samples. To take account of other factors such as variations due to manufacturing processes, variability and uncertainties in material strength (e.g. due to extrapolation of data), damage during installation and environmental effects, a design strength is derived by dividing the cell's characteristic strength by a material partial factor of safety (f_m), appropriate to the material and limit state. There is no guidance on the choice of material factors for plastic storage tanks.

Partial material factors of safety: Polystorm Lite & Polystorm	
Limit state	f_m
Ultimate limit state	2.75
Serviceability limit state	1.5

Table 6

The partial factor f_m is made up of several components:

f_{m1}

This is applied to the characteristic strength of Polystorm. It covers possible reductions in strength from the control test specimens and inaccuracies in the assessment of the resistance of a structural element resulting from modelling errors. For tightly controlled Polystorm production f_{m1} would normally be between 1.05 and 1.1. Because a limited number of compression tests have been undertaken on the Polystorm cells in addition to this property not being measured as part of the quality control program, a conservative value has been adopted. Compression tests were undertaken at points judged by inspection to be the weakest however the cell is a complex three dimensional structure, therefore an allowance must be made for this. In view of the preceding factors and the conservative choice of design parameters already undertaken, a value of $f_{m1}=1.20$ has been adopted for the ULS and 1.1 for the SLS. This can be reviewed if the compressive strength is measured as part of the manufacturing quality control procedure.

f_{m12}

This is applied to take account of the extrapolation of creep test data. It is also used in the case of the Polystorm cells to allow for the absence of fatigue testing. A suggested value of f_{m12} is given by $\text{Ingoldv} = \text{Log}(\text{td}/\text{tt})$ where td = design life, tt is duration of creep test. This gives a value for the ULS, with a design life of 20 years, of $f_{m12} = 1.9$. Although the cells will be under compressive loads and appear to fail in compression at the internal columns, they are complex structures. Some of the elements will be acting in tension and when polypropylene is subject to creep under long term tensile loads it can lose strength over time. Therefore the values taken from reinforced earth applications are considered reasonable. For serviceability, which is not so critical, a value of 1.25 is adopted.

f_{m21}

This is applied to take account of damage during installation. The Polystorm cells are robust and not particularly susceptible to damage and therefore, in the absence of specific damaged strength testing, a factor of 1.1 for the ULS and 1.0 for the SLS has been used.

f_{m22}

This is applied to take account of environmental conditions. The polypropylene used in the manufacture of the Polystorm units is resistant to all contaminants that are naturally found in soil and rainwater. No specific test results are available and so a value of f_{m22} for both ULS and SLS of 1.1 has been adopted; which is the minimum value recommended for reinforced earth applications by Ingoldv. With the total value of $f_m = f_{m11} \times f_{m12} \times f_{m21} \times f_{m22}$

Therefore, for the following limit state, f_m will equate to:

Ultimate limit state:	Serviceability limit state:
$1.2 \times 1.9 \times 1.1 \times 1.1 = 2.75$	$1.1 \times 1.25 \times 1.0 \times 1.1 = 1.5$

The use of conservative factors also allows for synergistic effects (i.e. the combined effect of construction damage, environmental effects and lower than expected cell strength) that may result in a greater combined effect than the three factors acting individually. These factors are only applicable for temperate climate conditions such as in the UK. Although the strength of polypropylene varies with temperature, this will not be significant for installation in the UK where the temperature in the ground (at the typical depth of installation) remains between 0°C and 20°C with a mean value of around 10°C.

4.1.6 Applied loads and load factors



4.1.6 Applied loads and load factors

Loads that may be imposed on a cellular storage structure such as Polystorm, can be broken down into the following types:

- **Dead Loads**

Permanent loads applied to the cells, including the weight of backfill material placed over the top and lateral (horizontal) earth and water pressure loads acting on the side of the system.

- **Live Loads**

Loads due to pedestrian, vehicle and construction traffic that are not permanent. Traffic wheel loads are normally given as static loads, with a factor applied to allow for dynamic effects (a moving wheel will impose more force on the ground than a static one).

A design load is obtained by applying a partial factor of safety to the estimated characteristic load. This allows for unforeseen variations of loading and also the severity of the consequences of the limit state occurring. The loads on cellular units will be similar to loads applied in the design of structures using rigid materials such as concrete and therefore the partial safety factors for loads that are appropriate to the design of plastic storage systems are taken from British Standard BS 8110.

Partial factors of safety for applied loads			
Limit state	Imposed vertical dead load f_m	Imposed earth pressure dead load f_m	Imposed live load f_m
Ultimate limit state	1.40	1.40	1.60
Serviceability limit state (Polystorm only)	1.0	1.0	1.0

Table 7

Thermal expansion of the cells will be negligible because temperature variations that are likely to occur in the ground should not be significant. These loads are therefore not considered in this design.

4.2 Distributed loads

4.2.1 Example of calculation methods

The structural design of the cells needs to consider a number of different loads and their effects.

What load is applied to the tank?

1. Dead (permanent) loads such as the weight of soil placed over the top of the cells or long term stockpiles of containers or materials (anything that will be applying load for a lengthy period of time).
2. Surcharge loads. From stored materials or to allow for traffic.

How is this analysed?

The weight of the fill material is calculated from the depth of soil and its cell weight. The traffic loads that are typically used are: Car Parks - 2.5kPa. HGV Loading - 10kPa.

Example: 1.5m cover depth over the top of Polystorm - Car Park.

Design against collapse (ultimate limit state)

Weight of soil = 1.5m x 20kN/m³.

Partial factor of safety = 1.4.

Surcharge = 2.5 kPa, Partial factor of safety = 1.6.

Total design load = (1.5 x 20 x 1.4) + (2.5 x 1.6) = **46kPa**.

Polystorm ultimate compressive strength at yield = 440kPa.

Partial factor of safety = 2.75.

Design strength of Polystorm = 440/2.75 = **160kPa**.

Design strength is greater than factored loads so the design is ok.

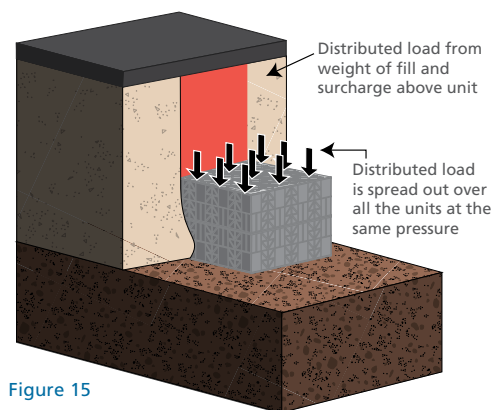


Figure 15

Check deflection (serviceability limit state)

Partial factor on load = 1.0.

Design load = (1.5 x 20 x 1.0) + (2.5 x 1.0) = **32.5kPa**.

Deflection of Polystorm = 1mm per 83kPa load.

Partial factor of safety = 1.5.

So elastic deflection of Polystorm = 32.5 x 1.5/83 = **0.6mm**.

Most of the deflection is due to the permanent load and so it will be acceptable.

Check creep (serviceability limit state)

Long term creep deflection = 0.2794Ln (design life in hours).

For a load less than 100kPa.

So if design life is 20 years

Creep = 0.2794 Ln (20 x 365 x 24) = **3.4mm**.

What load is applied to the tank?

3. Concentrated loads for example those from:

- Wheels of cars or trucks
- Container feet
- Construction vehicles
- Crane spreader plates or legs

How is this analysed?

The load from the wheel is spread out through the soil or pavement materials over the top of the tank.

The heavier the load the greater the thickness of material that is required over the top of the tank. However there is a practical minimum of about 0.5m in most cases to avoid damage to the tank during installation and after construction.

Example:

Polystorm is to be used under a car park that may be occasionally crossed by delivery trucks or refuse collection lorries (maximum gross vehicle weight 31,000 kg).

Polystorm is covered by 1.2m of Type 1 sub-base and asphalt pavement construction.

Design against collapse (ultimate limit state)

Load from wheel = 35kN.

Assume contact patch is 0.135m by 0.275m.

Trucks will be moving slowly but turning therefore dynamic factor = 1.5.

Cover depth of soil is 1.2m and assume a 26.6° load spread.

Contact area on top of tank is:

0.275 + 1.2 by 0.135 + 1.2 = 1.97m².

Applied pressure from wheel is 35 x 1.5/1.97 = 26.6kPa.

Factor of safety = 1.6

and factored pressure = 26.6 x 1.6 = **42.6kPa**.

Pressure from soil is 1.2m x 20kN/m³ = 24kPa.

Factor of safety = 1.4

and factored pressure = 24 x 1.4 = **33.6kPa**.

Total pressure = 42.6 + 33.6 = 76.2kPa.

As in previous example design strength of

Polystorm = 160Kpa and this is greater than the applied load and so it is acceptable.

4.3 Lateral loading - calculation example

4.3.1 Check deflection (serviceability limit state)

In this case we are interested in the continuous and repeated deflections under wheel loads only.

Partial factor on load = 1.0.

Applied pressure from wheel (above) is **26.6kPa**.

Design pressure = 26.6 x 1.0 = 26.6kPa.

Deflection of Polystorm = 1mm per 83kPa load.

Partial factor of safety = 1.5.

So elastic deflection of Polystorm = 26.6 x 1.5/83 = 0.5mm.

This will be repeated each time a wheel passes over the tank. This is acceptable for an asphalt pavement.

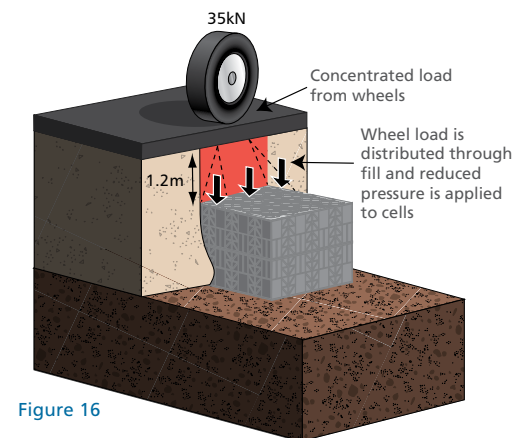


Figure 16

What load is applied to the tank?

4. Earth and groundwater pressure from the surrounding ground. Note that account must be taken of sloping ground, pre-existing shear planes and groundwater. If in doubt obtain expert advice from Polypipe WMS technical support team.

How is this analysed?

The earth pressure applied to the side of the tank by the soil and groundwater. The weaker the soil the greater the pressure it applies to the side of the tank. Water also applies pressure to the side of a tank. The calculations are based on standard earth pressure theory.

Example

The bottom of a modular tank is located 2.5m below ground level. The excavation is surrounded by medium dense sand and gravel with an angle of friction of 34°.

The groundwater is below the base of the tank.

Allow for a 10kN/m² surcharge.

To allow for load distribution on the side of the tank, the design uses the earth pressure at a depth of 0.25m above the base of the tank.

Therefore; Design depth = 2.5 – 0.25 = 2.25m.

For an angle of friction of 34° the coefficient of active earth pressure is 0.282.

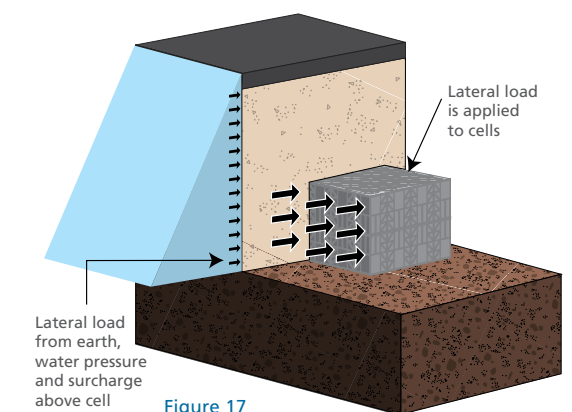


Figure 17

Design against collapse (ultimate limit state)

Partial factor of safety for earth pressure = 1.35.

Partial factor of safety for earth pressure = 1.5.

The applied pressure from the soil is given by;

Applied pressure =

0.282 x 2.25m x 20kN/m³ x 1.35 + 0.282 x 10kN/m³ x 1.5.

Applied pressure = **21.4kN/m²**.

Polystorm ultimate strength at yield for lateral loading = 63kN/m².

Material partial factor of safety = 2.75.

Design strength = 63/2.75 = **22.9kN/m²**.

This is greater than the applied load and so it is acceptable.

Deflections can be estimated using the same approach as for the vertical loads with a partial load factor of 1.0 in all cases.

Note: Where groundwater is present the submerged density must be used to calculate the earth pressure on the side of the tank from the soils below the groundwater table.

4.3 Lateral loading - calculation example



What load is applied to the tank?

5. Uplift pressure from groundwater of the tank is constructed below the groundwater table.

How is this analysed?

A tank is constructed 1m below the groundwater table and has a soil cover over the top of 0.8m.

Will uplift occur?

Design against floatation

Uplift pressure equals weight of water displaced by tank.

Partial factor safety on uplift force = 1.5.

Uplift pressure = 1 x 10 x 1.5 = **15kN/m²**.

Weight of soil resisting uplift

Partial factor of safety = 0.95.

Weight = 0.8 x 20 x 0.95 = **15.2kN/m²**.

The weight of soil is sufficient to present uplift.

Note: An assessment would need to be made of the risk of ground levels being reduced or groundwater levels rising after completion of construction.

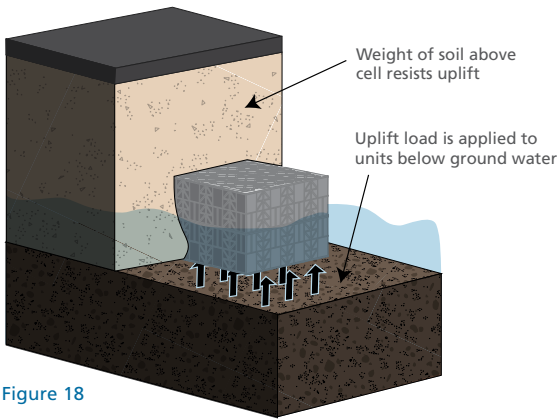


Figure 18

4.4 Maximum burial depths

4.4.1 Recommended maximum installation depths

Polystorm Lite and Polystorm cells can be buried to the maximum depths detailed below. Actual maximum burial depths will depend on soil conditions applicable, however in some circumstances both Polystorm Lite and Polystorm can be buried to greater depths when special measures are carried out. For examples of such measures please refer to page 40.

Polystorm Lite - maximum depth of installation (to base of cells) (m)			
Typical soil type	Typical angle of shearing resistance ϕ	Without groundwater (below base of cells) normal case	With groundwater at 1m below ground level and units wrapped in geomembrane
		Non-trafficked	Non-trafficked
Stiff over consolidated clay e. g. London Clay	24	1.49	1.41
Normally consolidated silty sandy clay e.g. Alluvium, Made Ground	26	1.60	1.48
Loose sand and gravel	30	1.77	1.60
Medium dense sand and gravel	33	2.05	1.69
Dense sand and gravel	38	2.49	1.83

Table 8

Polystorm - maximum depth of installation (to base of cells) (m)					
Typical soil type	Typical angle of shearing resistance ϕ	Without groundwater (below base of cells) normal case		With groundwater at 1m below ground level and units wrapped in geomembrane	
		Trafficked (cars only)	Non-trafficked	Trafficked (cars only)	Non-trafficked
Stiff over consolidated clay e. g. London Clay	24	2.1	2.2	1.5	1.6
Normally consolidated silty sandy clay e.g. Alluvium, Made Ground	26	2.3	2.4	1.5	1.6
Loose sand and gravel	30	2.5	2.7	1.6	1.7
Medium dense sand and gravel	33	3.0	3.1	1.7	1.7
Dense sand and gravel	38	3.7	3.8	1.8	1.8

Table 9

Polystorm Lite & Polystorm - minimum cover levels (to top of cells) (m)			
Live load conditions	Field (Polystorm Lite & Polystorm)	Light trafficking (Polystorm only)	
		Car park with vehicle mass <2500kg	Car park with occasional vehicle mass >2500kg
Minimum cover depth required (m)	0.50	0.60	0.80

Table 10

Please note that the maximum burial depths above are based on the partial factors of safety derived during consultation with the British Board of Agrément (BBA) prior to the publication of CIRIA C680. The BBA has used higher partial factors of safety than CIRIA C680. For further information of the design method detailed in CIRIA C680 please contact our technical support team.

4.5 Special measures - relieving earth pressure for deeper installations

4.5.1 Special measures

The earth pressure at the design depth for the tank may exceed the lateral strength of Polystorm Lite and Polystorm cells (once it has been factored down). If this is the case there are a number of solutions:

1. Redesign the drainage system to make the invert of the tank shallower.
2. Place the cells in a stepped configurations where the tank gets wider from the base to the top (Figure 19).
3. Reinforce the lower part of the backfill with geogrids (Figure 20).
4. Use mass concrete backfill in the lower part of the backfill (Figure 21).

Reducing lateral pressure on a Polystorm Tank

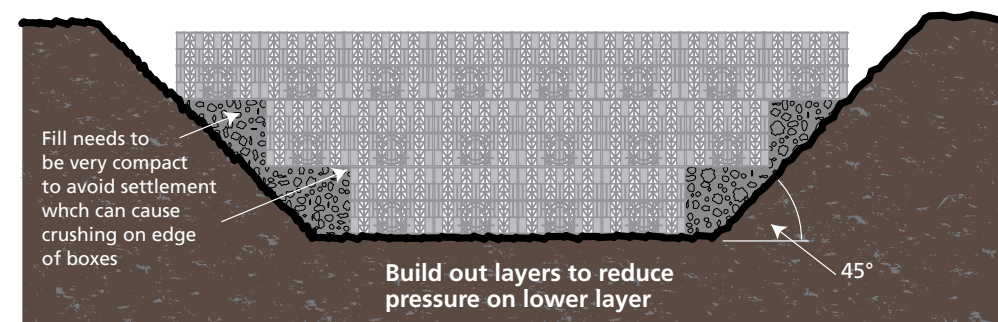


Figure 19

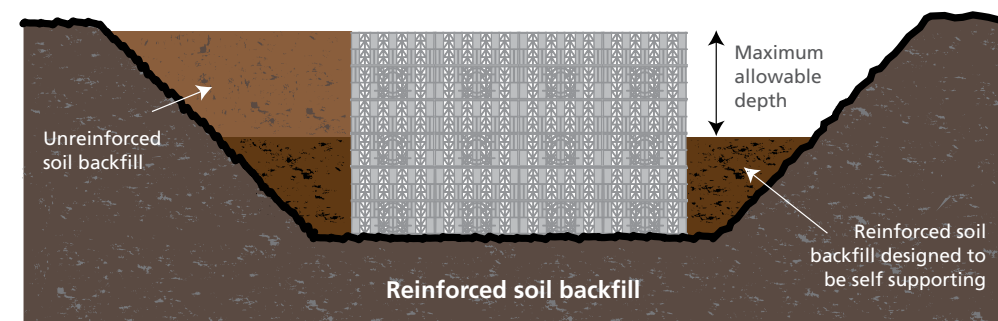


Figure 20

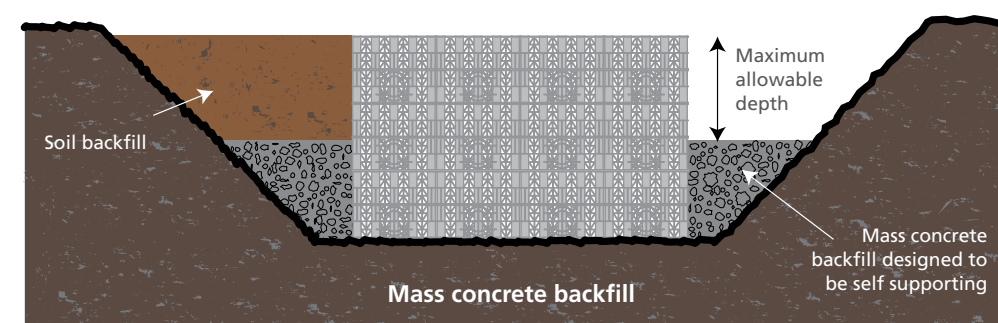


Figure 21

4.6 Hydraulic design

4.6.1 Hydraulic design

Hydraulic design calculations provide the storage volume required on any particular site that is required to reduce the speed, frequency and volume of rainfall run-off into rivers or sewers. The required volume depends on the site location, the size of the area being drained, the soil infiltration rate (for soakaways) or allowable discharge rate (for attenuations systems).

The design of SUDS should follow the requirements in the CIRIA Report C 697 The SUDS Manual.

This identifies three types of storage that are required:

- **Interception storage** - this is not actually storage - the aim is to reduce the frequency of run-off and prevent run-off from sites for rainfall events up to 5mm in order to simulate the behaviour of greenfield catchments more closely. This is achieved using infiltration or source control methods where evapotranspiration can reduce the volume of run-off.
- **Attenuation storage** - used to reduce the peak discharge rate from a site (i.e. how fast water flows off the site) and is used to store excess water where the rate of discharge is limited to greenfield run-off rates (or other agreed rate). It is designed to operate for a range of annual probabilities (typically 1 in 30 years and 1 in 100 years).
- **Long term storage** - used to reduce the additional volume of run-off caused by developments. Stores excess water that is the difference in total volume of run-off between the developed and greenfield site for a 1 in 100 year 6 hour rainfall event. Outflow from the long term storage should be to either infiltration or to a water course or sewer at 2 l/s/ha or less.

Polystorm can be used to provide attenuation, long term storage and can be designed into systems that provide interception storage (e.g. soakaways or below swales or infiltration basins). The SUDS manual also requires treatment of pollution in run-off and Polystorm can help these treatment systems work more effectively by controlling the flow of water through them (for example by providing attenuation storage upstream of a wetland). The exact design requirements for any site should be agreed with the Environment Agency.

4.6.2 Design of attenuation storage

The volume of Polystorm required for attenuation storage is typically calculated using drainage design software based on the Wallingford Procedure. The volume of temporary run-off storage required is shown in Figure 22 and is simply the difference between the volume of run-off that enters the tank during a design storm and the volume of water that is allowed to flow out in the same period (which is governed by the discharge rate allowed by the regulators). In this way Polystorm can be used to limit the peak rate of run-off from a site (usually to the greenfield run-off rate). The calculations are completed for a range of return periods and durations.

Attenuation storage volume

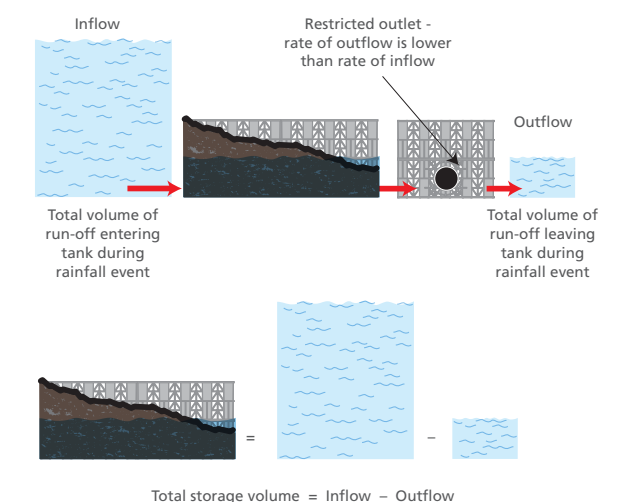


Figure 22

4.7 Hydrological rainfall

4.7.1 Hydrological rainfall zones for the UK

(HR Wallingford, Use of SUDS in high density developments, defining hydraulic performance criteria, Report SR 640, December 2003).

The table below can be used to size a Polystorm tank. The tables are based on the hydrological rainfall regions shown on the map.

The tables are based on the following assumptions:

- Storage is provided for development design events of 1 in 30 years, 1 in 100 years and 1 in 100 years plus 20% increase for climate change but the greenfield run-off rate is always considered to be 5 l/s/ha
- Time of entry and time of concentration within the drainage system is not considered
- 100% run-off is assumed

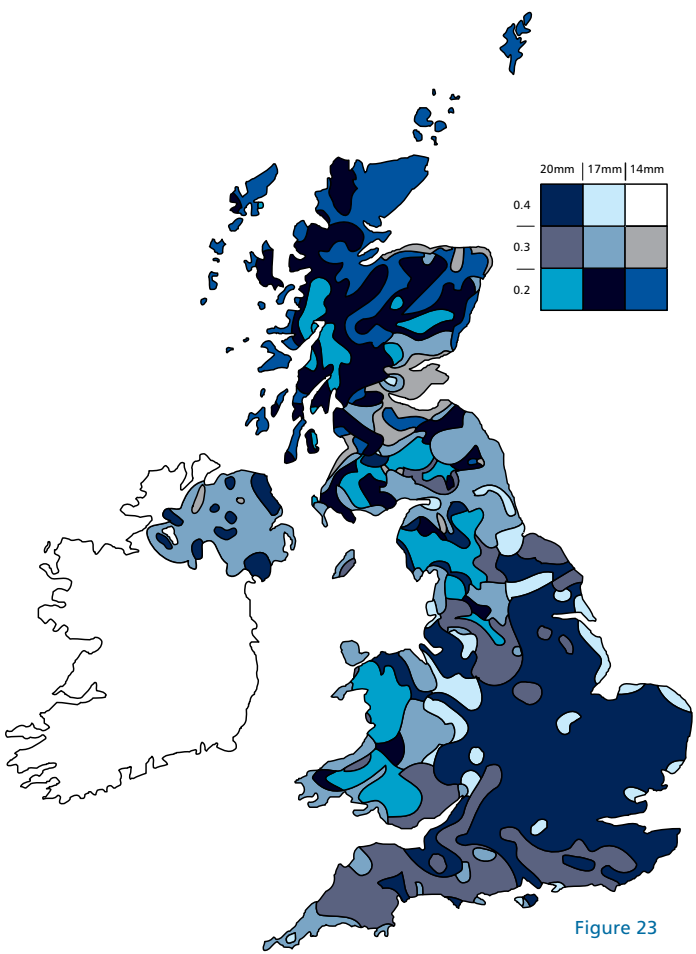


Figure 23

Required attenuation storage (m³ of storage per Ha of impermeable area)				
	r	1 in 30 year design event	1 in 100 year event	1 in 100 year event plus 20% climate change
Ms-60 = 20mm	0.4	357	510	643
	0.3	413	583	749
	0.2	556	770	968
Ms-60 = 17mm	0.4	293	419	545
	0.3	335	483	631
	0.2	444	637	822
Ms-60 = 40mm	0.3	258	383	511
	0.2	335	500	665

Table 11

Note: Volumes include allowance for 95% void ratio of Polystorm.
Polystorm has a void ratio of 95% (i.e. for every 1m³ there is 0.95m³ of space available for water storage).
The volume of Polystorm required is therefore calculated by dividing the required storage volume by 0.95.
This factor is allowed for in the design table.

Example of Polystorm sizing for attenuation storage

Site in London has an impermeable area as follows:

1200m² roof area

1475m² car park and other areas

Therefore the total impermeable area = 2675m².

Assume the required return period for the drainage design is 1 in 100 years as agreed with the Environment Agency.

From Table 11 London is in the region where

Ms-60=20mm ad r=0.4.

Therefore from the table the volume of the Polystorm tank required is 510m³/ha.

Required attenuation storage on this site

= 510 x 2675/10000 = 136.4m³.

Design of long term storage

Long term storage can be designed using the volumes in CIRIA C697 The SUDS manual and these are summarised in the table below.

Long term storage volumes (CIRA C697)	
Soil type (from maps in Wallingford Procedure for Europe of Flood Studies Report)	Storage volume (m³/ha)
1	320
2	180
3	130
4	60
5	20

Table 12

The discharge rate for the long term storage is 2 l/s/ha or to infiltration (soakaway).

The long term storage is part of the attenuation storage but it is normally located in a separate tank that is restricted to an outflow of 2 l/s/ha. Alternatively one large tank can be fitted with an outlet control that achieves the different discharge criteria for the different storage volumes.

Example of Polystorm sizing for long term storage

As for the previous example consider a site in London which has an impermeable area as follows:

1200m² roof area

1475mm² car park and other areas

Therefore the total impermeable area = 2675m²

The attenuation storage is provided by Polystorm that has a volume of 86m³ and the flow out of this is restricted to 7 l/s/ha.

Assume the site is over Soil type 3.

From Table 12 the long term storage required is 130m³/ha

So required long term storage on this site

= 130 x 2675/10000 = 34.7m³

Redistribution of storage requirements gives:

Attenuation storage tank = 136.4 – 34.7

= 101.7m³ with an outflow of 1.2 l/s

Long term storage tank = 34.7m³ with an outflow of 0.4 l/s

4.7.2 Siltation

The drainage system upstream of Polystorm tanks should be designed so that silt and other debris is removed from the run-off and is prevented from entering the tank. This can be achieved using silt traps, permeable pavement or other methods. Polystorm can be used below basins and swales to provide underdrainage. This has the advantage of preventing silt entering the tank but also makes the swale more effective at removing pollution and makes it more aesthetically pleasing by keeping the base dry. If silt does enter the Polystorm tanks it may be difficult to remove. However after a site is completed the level of silt entering the tank is relatively small on most sites. It is simple to make an allowance for loss of storage due to siltation and the tank can be over designed by the amount (typically a 10% increase in tank size will deal with any siltation over a 50 year period). Off line tanks are less prone to siltation because the low flows (which contain most of the silt) bypass the tank. Soakaways are very prone to siltation if upstream treatment is not provided to remove silt. It is critical that silt from the construction site is not allowed to enter the Polystorm tank.

Typical silt trap

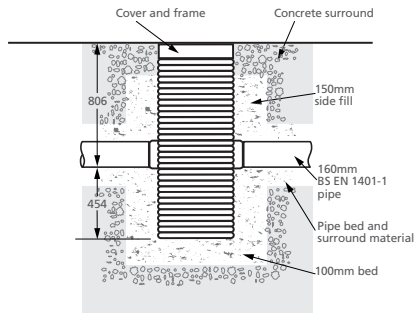


Figure 24

4.8 Soakaway design

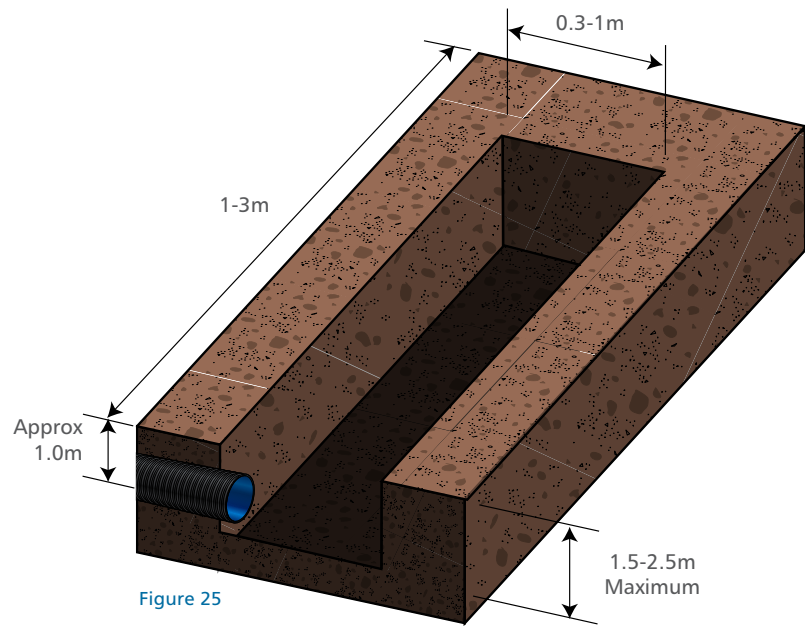
4.8.1 Percolation test for designing a soakaway system

This percolation test follows the procedures laid out by the BRE Digest 365

Step 1 - Dig a trial hole

- The base of the trial hole should be approximately the same depth as anticipated in the full size soakaway
- Overall excavation depth is typically: 1.5m-2.5m for areas <100m²
- The test hole should be typically 0.3m-1m wide and 1m-3m long (make a record of the test hole dimensions)

Step 2 - Fill the hole with water



- Fill trial hole with water - this needs to be done rapidly to mimic a real storm event
- Record the time taken for the water level to fall within the trial hole from 75% to 25% full
- Repeat 3 times, allowing the trial hole to drain between tests
- Best practice for soakaways longer than 25m is to perform a second percolation test at a different location to that of the 1st test site

Step 3 - The results - Soil infiltration rate

$$f = \frac{V_{(p75-25)}}{a_{(p50)} \times t_{(p75-25)}}$$

$V_{(p75-25)}$ = Volume of the hole from 25% to 75% depth

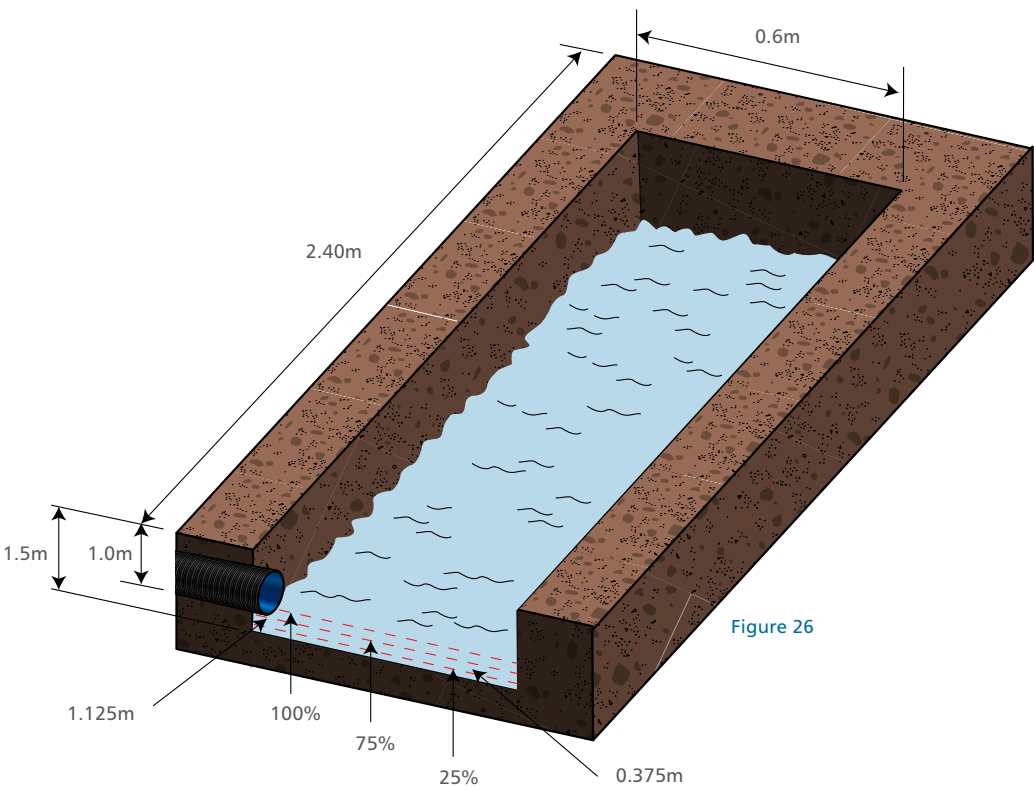
$a_{(p50)}$ = Internal surface area of the hole up to 50% of the depth and including the base area

$t_{(p75-25)}$ = The time for the hole to drain from 75% to 25% full in seconds

- Contact the Polypipe WMS technical support team and advise them of the dimensions of the test hole and lowest timed result (in minutes)
- Polypipe WMS will take this data and estimate the soakaway size required

Worked example

Invert of the discharge drain - 1.0m below the surface. When cleaned and trimmed the test hole was 2.51m deep, 2.40m long and 0.60m wide. An effective storage depth of 1.5m therefore adopted.



Test hole volume between 75% and 25% effective depth:

$V_{(p75-25)} = 2.40 \times 0.60 \times (1.125 - 0.375) = 1.08\text{m}^3$

Test hole depth at 75% and 25%

The mean surface area through which outflow occurs, taken to be the hole sides at 50% effective depth, including the base of the pit:

$a_{(p50)} = 0.75[2(2.40 + 0.6)] + (2.4 \times 0.6) = 0.75(6) + 1.44 = 5.94\text{m}^2$

The time taken for water to drain from 75% to 25% full:

$t_{(p75-25)} = 102 - 11 = 91 \text{ minutes}$

Number of minutes to drain from 75% to 25% depth

Soil Infiltration rate $\frac{1.08}{5.94 \times (91 \times 60)} = 3.33 \times 10^{-5} \text{ m/sec}$

4.8 Soakaway design

4.8.2 Infiltration

Calculation principles

There are two approaches, either of which may be adopted: the Construction Industry Research and Information Association (CIRIA) Report 156 Infiltration Drainage - Manual of Good Practice or BRE Digest 365 Soakaway Design.

A simplified approximate approach can be used on a very small site (i.e. a single house development) where detailed site infiltration rate information may not be required nor available (see table below). Approved document H3 (refer to 1.1, page 10) allows a storage volume equal to the area to be drained multiplied by 10mm for areas up to 25m². Beyond this size, design should be carried out in accordance with BS EN 752-4 : 1998 or BRE Digest 365. BS EN 752-4 : 1998 suggests a storage volume equal to 20mm multiplied by the area to be drained.

Guidance on soakaway for single house development ⁽¹⁾		
Number of units	Storage volume (m ³)	Max area to be drained (m ²)
1	0.19	19.0 ⁽²⁾
2	0.38	25.0 ⁽²⁾
3	0.57	28.5 ⁽³⁾
4	0.76	38.0 ⁽³⁾
5	0.95	47.5 ⁽³⁾
6	1.14	57.0 ⁽³⁾

Table 13

- (1) When doubt exists over suitability of ground for infiltration permeability figures should be derived by test (see BRE Digest 365).
- (2) In accordance with Approved Document H3 (refer to 1.1 page 10).
- (3) In accordance with BS EN 752-4 : 1998, Clause NG 2.4.

When the BRE or CIRIA approach is used, the design volumes and areas for trench or cuboid type installations can be found from Tables 14 and 15.

Volumetric data per linear metre for one cell (0.5m) wide trench configuration			
Number of cells high	Storage volume (m ³)	Side areas (m ²)	Base area (m ²)
1	0.19	0.8	0.5
2	0.38	1.6	0.5
3	0.57	2.4	0.5

Table 14

Volumetric data for 3D usage - two cells high									
Cells long (1m side)	2 wide (0.5m side)			4 wide (0.5m side)			8 wide (0.5m side)		
	Vol m ³	Side m ²	Base m ²	Vol m ³	Side m ²	Base m ²	Vol m ³	Side m ²	Base m ²
1	0.76	3.2	1.0	1.52	4.8	2.0	3.04	8.0	4.0
2	1.52	4.8	2.0	3.04	6.4	4.0	6.08	9.6	8.0
4	3.04	8.0	4.0	60.8	9.6	8.0	12.16	12.8	16.0
8	6.08	14.4	8.0	12.16	16.0	16.0	24.32	19.2	32.0
10	7.60	17.6	10.0	15.20	19.2	20.0	30.40	22.4	40.0
100	76.00	161.6	100.0	152.00	163.2	200.0	304.00	166.4	400.0

Table 15

Concrete ring converter

Table 16 enables the conversion of a specified nominal diameter pre-cast concrete ring soakaway volume into the equivalent number of Polystorm Lite and Polystorm cells.

Concrete Ring conversion						
Depth of soakaway	900	1050	1200	1300	1500	1800
0.25	1	2	2	2	3	4
0.50	2	3	4	4	5	7
0.75	3	4	5	6	8	11
1.00	4	5	7	8	10	14
1.25	5	6	8	10	12	17
1.50	6	8	10	12	15	21
1.75	7	9	11	14	17	24
2.00	7	10	13	16	20	27
2.25	8	10	13	16	20	29
2.50	8	11	14	18	22	31
2.75	9	12	16	20	24	34
3.00	11	14	18	21	28	41

Table 16