Polystorm Technical Guide

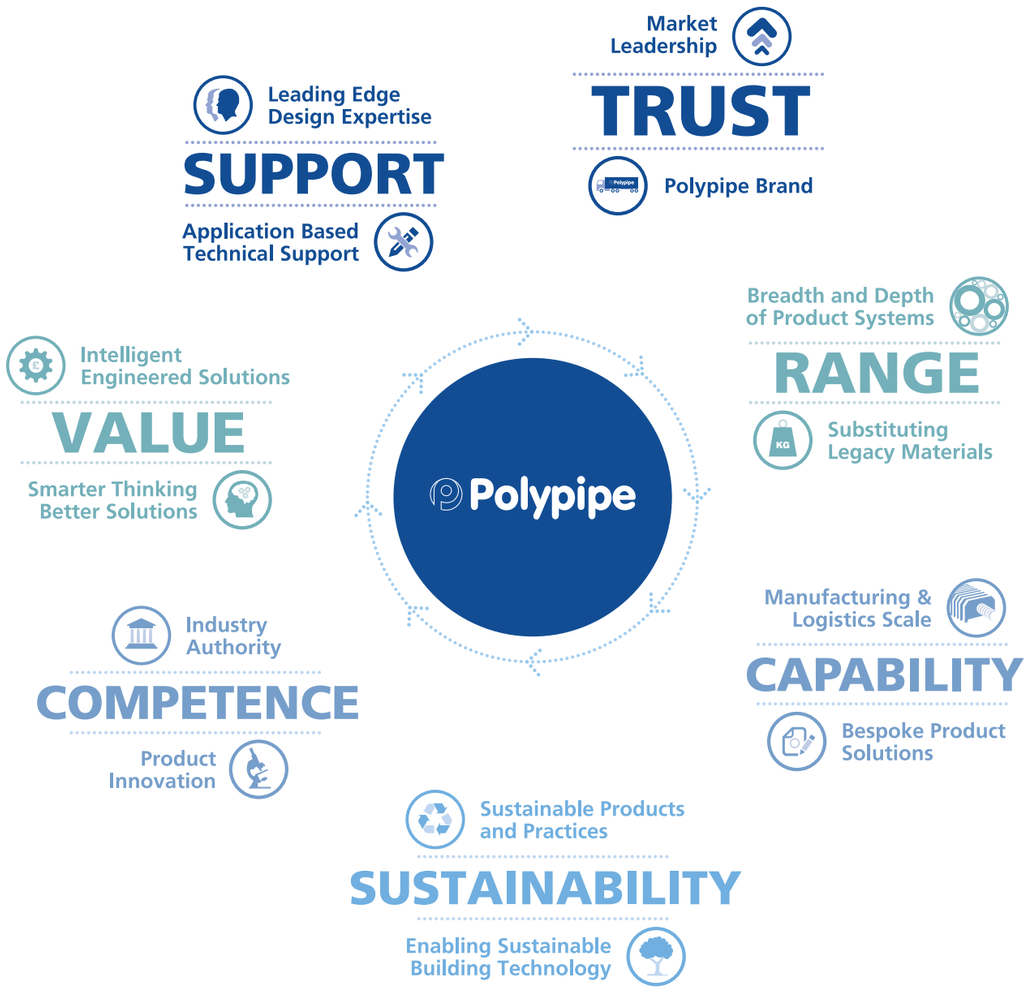
Middle East Edition

Design, planning, specification and installation guidelines

Polypipe

Welcome to Polypipe

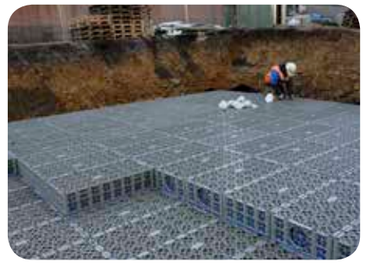
At Polypipe, conceiving, designing, manufacturing and delivering the most advanced products and systems isn't merely an occupation. It's a passion. One that's based around a few simple beliefs. Expertise isn't an option. Quality always beats quantity. Products are nothing without service and support. Sustainability isn't just a 'green' word. And working with our customers is much better than simply supplying them.



Our products offer unrivalled choice and quality. With water management, sewerage and cable protection systems, we offer the industry's widest choice of plastic piping and geocellular solutions.

Polypipe understand the differences in culture and the challenges to landscape that come with designing, developing and manufacturing for projects internationally. With multi-site manufacturing bases in Italy, France and the Middle East, we're the experts in providing a comprehensive range of solutions for a wide range of market sectors in any location.

Contents



Storm/Surface Water Management

Modular Geocellular Systems

Design, planning, specification and installation guidelines

From the technical specialists, Polypipe Water Management Solutions.
The Polystorm range of products and solutions for attenuation, detention 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 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
- installation guidance

Other relevant documents

- Storm/Surface Water Management for buildings & infrastructure
- Step by step Polystorm installation pictorial guide
- Polystorm data sheets

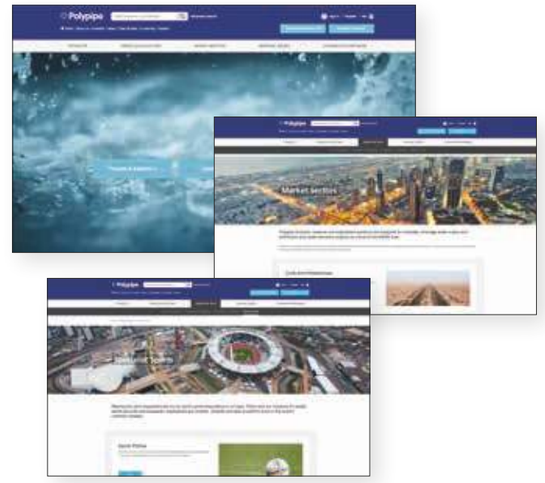
How this document is organised

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

*** Please note:**

Illustrations shown within this publication are available as downloadable CAD drawings from

www.polypipe.com/middleeast



1. Overview - Polypipe Storm/Surface Water Management Solutions

Part of the overall Polypipe Civils business, the Polypipe 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 system (SUDS) and water management projects.

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.

Polypipe 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.

The growing importance of SuDS

Government planning policy has defined the need for Sustainable urban Drainage Systems (SuDS) to ensure that flood risk is taken into account during all stages of the planning process.

CIRIA (SuDS Manual)

The SuDS Manual provides guidance on all aspects of the design, construction, operation and maintenance of SuDS. In particular, it places a real emphasis on the use of source control techniques and requires designers to consider pollution removal.

The SuDS Manual 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

Urbanisation has led to increasing negative impacts on the environment, in particular pollution.

Depending on the land use, the following typical surface pollutants can be found in surface water run-off:

- Hydrocarbons and oils
- Sediments
- Heavy metals
- Fertilisers and pesticides
- Salts
- Animal waste
- Pathogens

Traditionally, pollutants are collected from impermeable surfaces into the drainage systems and treated downstream via large, deep, in-line separators that are typically designed to treat the first ‘flush’ only. Emulsified oils and hydrocarbons can still be discharged downstream, the discharged oil and hydrocarbons constitutes a major pollution source and is a serious threat to groundwater sources.

SuDS Principles

1 PROTECT NATURAL SYSTEMS

2 INTEGRATE STORMWATER TREATMENT WITH URBAN AND LANDSCAPE DESIGN

3 IMPROVE STORMWATER RUN OFF QUALITY

4 REDUCE RUN OFF AND PEAK FLOWS

1.1.1 Local authority legislation & regulations

Rapid urbanisation, climate change, limited network capacity, or no accessible network, has led to new government/ municipality regulations and legislation across the Middle East to find an alternative approach to stormwater management and flood mitigation. This requirement is underpinned further by sustainable codes. Local Authority dictates, whereby a more considered approach to managing water in the built environment and embraces International design principles. Polypipe offer a wide range of systems as part of the water management solutions, providing both deep and shallow geocellular installations to mitigate issues associated with excess storm/surface water run-off. One of the key options for managing storm/surface water run-off is known as "Source Control" which minimises run-off rates and volumes transferred from properties to local infrastructure networks.

The following examples demonstrate a move towards a more sustainable future.

Qatar Green Building Council, Qatar

The mission of the Qatar Green Building Council is in complete alignment with the State of Qatar 2030 Vision. Driven by this vision and the global appreciation of the importance of founding viable futures through sustainable development, the Qatar Green Building Council is combining technical expertise with stakeholder engagement, education, community relations and strategy development to make a unique contribution to the local front of sustainable development. QGBC aims to increase awareness and knowledge of green building practices and build capacity of industry professionals through ongoing professional development and research. QGBC's efforts to build and engage an active membership body and network of stakeholders to champion the Green Building movement also extends to support the adoption, legislation and implementation of green building practice and standards.

Dubai Emirates Green Building Council, Dubai, UAE

The EGBC vision is to be the prime driver in facilitating the nation's rapid evolution as a global leader in reducing the ecological footprint of the built environment.

To achieve this, their focus is to strengthen collaborative efforts with industry leaders, academia, governmental entities and other like-minded organisations.

Abu Dhabi Estidama, Abu Dhabi, UAE

The Abu Dhabi Urban Planning Council (UPC) is recognized internationally for large-scale sustainable urban planning and for rapid growth. Plan Abu Dhabi 2030 urban master plan addresses sustainability as a core principle. Estidama, which is the Arabic word for sustainability, is an initiative developed and promoted by the UPC. Estidama is the intellectual legacy of the late Sheikh Zayed bin Sultan Al Nahyan and a manifestation of visionary governance promoting thoughtful and responsible development.

The leadership of Abu Dhabi are progressing the principles and imperatives for sustainable development, through Estidama, while recognizing that the unique cultural, climatic and economic development needs of the region require a more localized definition of sustainability.

Qatar Sustainability Assessment System, Qatar

Qatar Sustainability Assessment System (QSAS) is a green building certification system developed for the State of Qatar. The primary objective of Qatar Sustainability Assessment System (QSAS) is to create a sustainable built environment that minimises ecological impact while addressing the specific regional needs and environment of Qatar.

Kuwait Green Building Council, Kuwait

The Kuwait Green Building Council is a non-profit organization, the initiate started in 2009 with organizations and businesses from different industries in Kuwait. These include Universities, Local Authorities, Contractors, Architects, Engineers, Energy companies, and other leading private companies. All are united in one common goal to provide leadership and advice to accelerate the rate of change in Kuwait to a sustainable environment.

1.2 Drainage design -
sustainable drainage best practise and building regulations

Regional municipalities increasingly require planners, developers etc for municipality approvals, whether outline or detailed, to demonstrate how a more sustainable approach to drainage is to be incorporated into development proposals.

Step 1	**Assess**
Step 2	**Avoid**
Step 3	**Substitute**
Step 4	**Control**
Step 5	**Mitigate**

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

Local Municipalities may need to limit the rate of surface water discharge into the local network as a condition of planning consent. In areas where networks are already at capacity, or do not exist, then a likely requirement will be to manage discharge within the boundaries of the building plot itself through a localised storm water management system. Incorporating SUDS into a development proposal can effectively mitigate adverse impacts and contribute positively to wider plans relating to establishing a more resilient city.

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.

2.0 Polystorm modular cell system

We have the largest range of geocellular products and systems in the market, allowing you to select the optimum solution for surface water management and pollution control. With a choice of systems for shallow or deep excavations, Polystorm can match your exact site specifications and requirements.

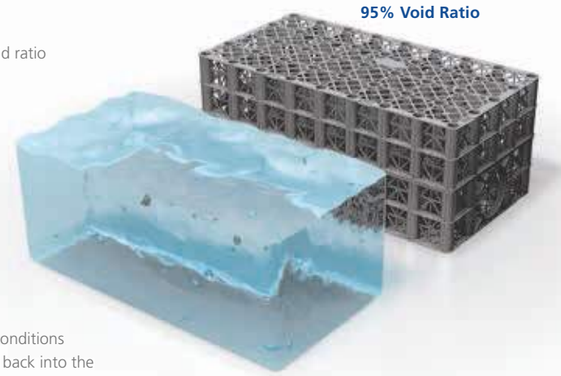
Polystorm modular solution

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 detention or soakaway solution.

2.1 Polystorm modular cell system -
two types of Polystorm cells

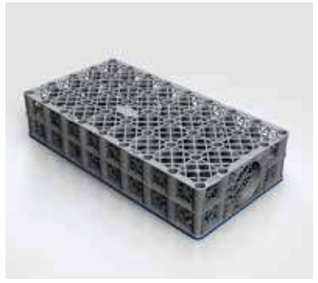
2.1.1 The Polystorm principles

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 stores water for future use (detention) 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).



Polystorm

Polystorm



Polystorm Xtra

Polystorm Xtra

Key benefits

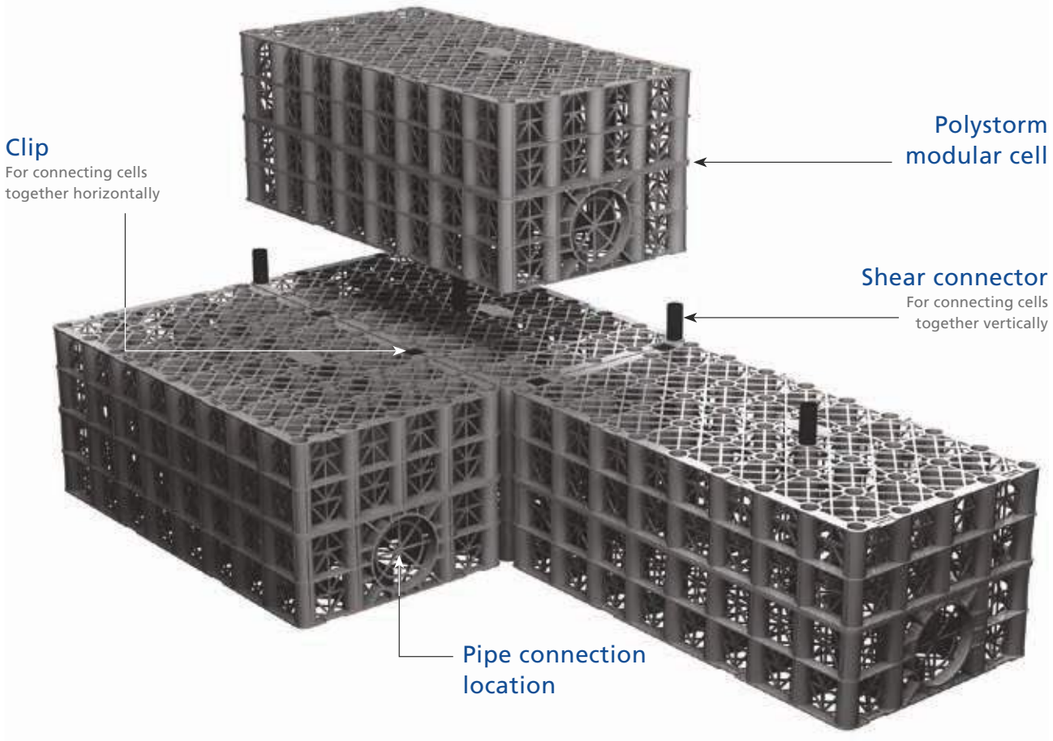
- **95% void ratio:** Providing greater water storage capacity and reduced excavation and disposal costs
- **Modular units:** Allow flexibility of shape - ideal for shallow excavation systems, narrow strips or use in restricted areas
- **Light weight yet robust:** Excellent Health and Safety and installation 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
- **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 (when deisgned in accordance with CIRIA C680 guidelines)
- 100% recyclable at the end of its useful 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 is designed for use in light trafficked and loaded applications.

Polystorm Xtra is designed for areas of higher trafficked landscape as part of a hybrid solution where additional strength is necessary.

The Polystorm Technical Manual is available to download at:
www.polypipe.com/middleeast



2.2 Polystorm

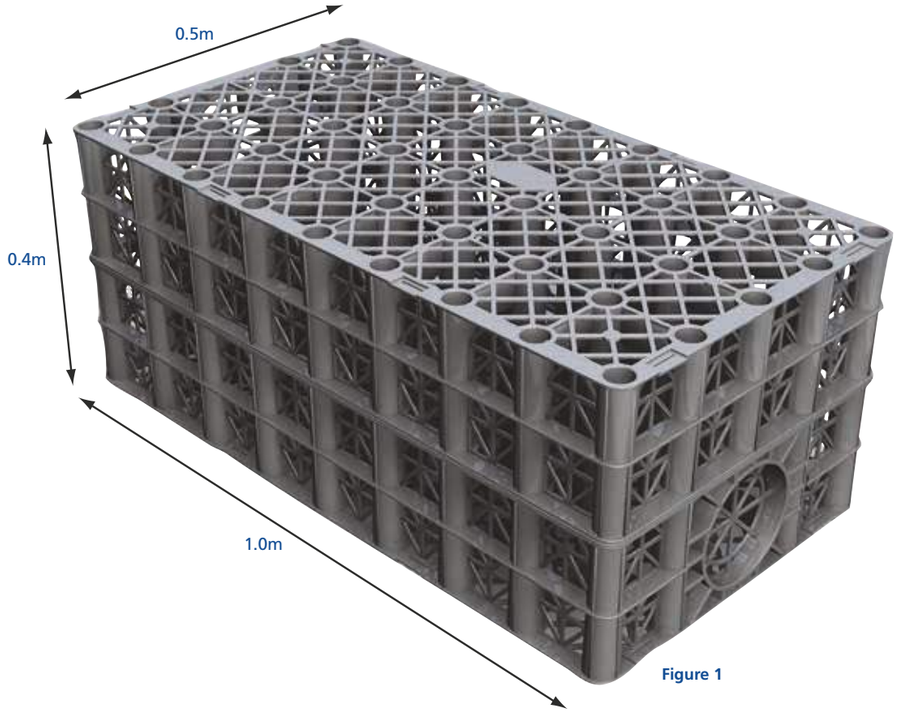


Figure 1

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
Unit volume	0.2m per cubic meter
Unit weight	9kgs**
Unit 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 04 807 3000

Table 1

Minimum Cover
0.5m

Figure 2

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 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 Xtra

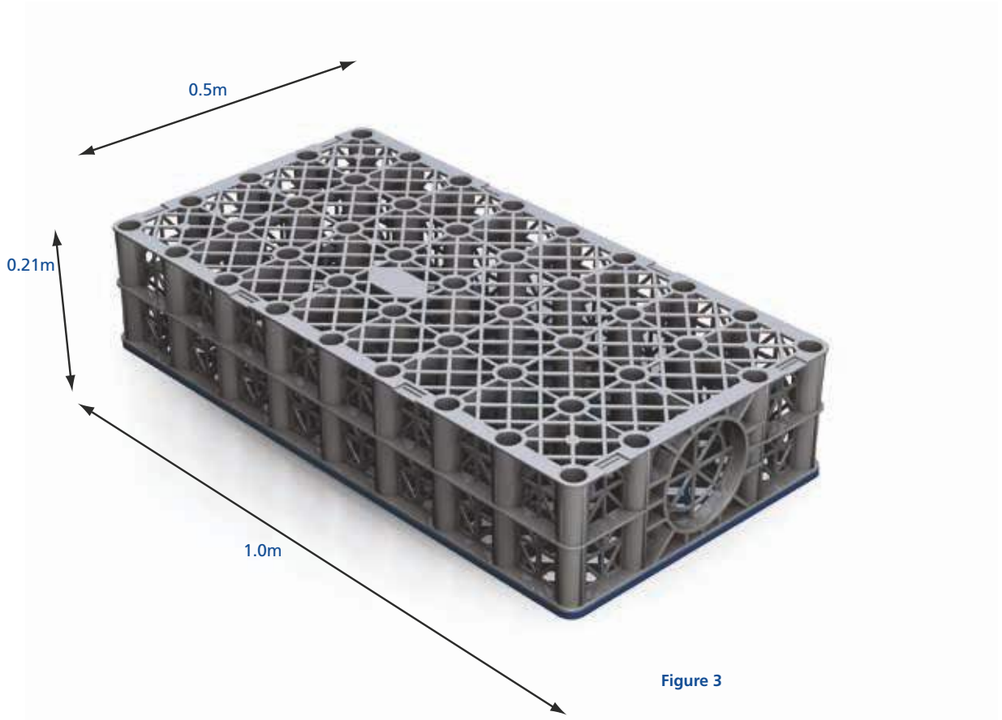


Figure 3

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

60 tonnes

Technical specification overview	
Unit type	Polystorm Xtra
Product code	PSM3*
Dimensions	1m x 0.5m x 0.21m high
Unit volume	.105 cubic meter
Unit weight	6kgs**
Cube storage volume	0.0986m³ (98 litres)
Surface area	48% perforated
Compressive strength	Maximum 8 tonnes per sq metre
Maximum burial depth	4.8 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 04 807 3000

Table 3

Figure 2

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 Xtra		
Description	Code	Pack quantity
Polystorm Xtra cell 1000 x 500 x 210mm	PSM3	15
Polystorm Xtra cell with 225mm connector	PSM3CRD225	1
Polystorm Xtra cell with 300mm connector	PSM3CRD300	1
Clips	PSMCLIP	60
Shear connector	PSM3SC	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

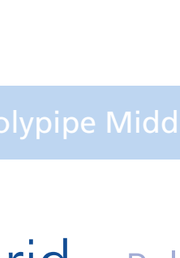
Note: Minimum cover and burial depths may vary depending on load and ground conditions. Please contact Polypipe WMS for further information. All grades of Polystorm units may be used in situations outside of those recommended above, through the use of the appropriate protective measures designed to reduce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

Polystorm & Polystorm Xtra

Polystorm



40 TONNES

Minimum Cover
0.5m

40 TONNES

Minimum Cover
0.6m

Polystorm Xtra

80 TONNES

Minimum Cover
1m

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 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 &
Polystorm Xtra

Pedestrian

Value engineered structures

Polypipe are the only manufacturer who can offer a complete value engineered hybrid system utilising Polystorm Xtra 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 may be 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 the Polypipe technical support team. Refer to tables 8, 9 and 10 (page 39) for burial depths in different soil conditions.

Innovation and research

At Polypipe, we always aim to bring innovative new products to the market in direct response to our customers' needs, requirements and feedback.

Challenging convention

We have always challenged convention by exploring new ways to meet the needs of the construction industry. Chief among them has been the development of thermoplastic piping systems to replace traditional concrete and clay materials. This results in solutions that are lighter in weight whilst also being tougher and more adaptable, ultimately making them more sustainable. Our priority is to always provide the industry with robust and innovative solutions that meet the demanding performance criteria of today's construction projects.

Customer driven innovation

We look to do things efficiently and to the highest standards, not only acting on customer requirements but also being proactive with project demands and meeting all changes in legislation. We value process innovation, strong manufacturing investment and product development. However, our prime concern is always to deliver the very highest quality for our customers in manufacturing, materials, service and supply.

Expert staff

Our materials and product development specialists represent some of the leading authorities in the industry. Many even have actively engaged trade bodies including the British Plastic Federation (BPF), ICE, SoPHE, CIRIA and CIBSE, as well as other local and regional building associations. It is their knowledge and experience that allows us to offer the very highest standards of product design and development.

Quality control

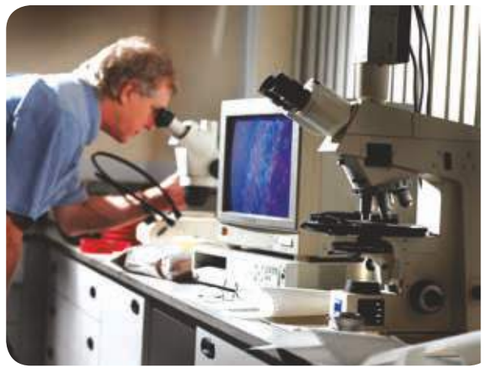
We invest heavily in research and new production technology. This allows us to provide more precise performance specifications, greater reliability and high quality products that are BBA, BSI Kitemark and WRc approved. Supporting our product accreditations, our business systems are regularly assessed by BSI to ensure we maintain our BS EN ISO 9001:2008 and BS EN ISO 14001:2004 certifications. This ensures we conform to regulatory requirements and that we provide greener credentials for our products.

Testing and certification

We work closely with regulatory bodies to ensure our products meet all UK and international regulations for performance and sustainability; a vital consideration in an industry where compliance and certification are absolute priorities. Wherever possible, our products are covered by third party accreditations, including BBA, BSI Kitemark etc.

3.0 Testing and certification -
Laboratory testing and protocol

At Polypipe 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 such as BBA. Our manufacturing processes are also accredited to ISO 9001



Polystorm

Polystorm Xtra

To avoide failure, Polypipe recommend both structural and hydraulic assessments are carried out in accordance with CIRIA design guidelines, using product manufactured from virgin materials, tested in accordance with Middle East ground conditions at 40°c elevated temperatures.

Changing Focus

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 can pass on to our customers confidence in the performance of all our products.

Figure 7 Compression test rig

Increasingly new products are being introduced within 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 we conducted at Polypipe's research and development laboratory in accordance with ISO 900 to determine the vertical and lateral strength of the Polystorm cells. Vertical creep tests were undertaken at UKAS laboratories.

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 are carried out along two axes (Figure 8).

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

Polystorm cell; direction of applied load and platen location

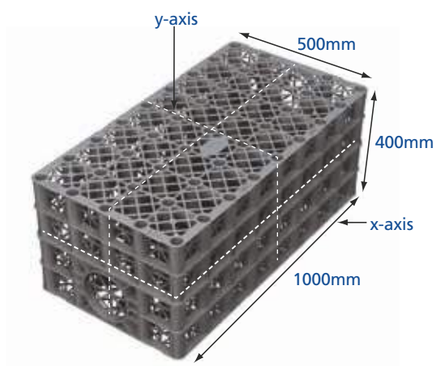


Figure 8 Unit axis; direction of applied load

3.2 Summary of test results

3.2.1 Unit specifications

Figure 12 shows the dimensions of Polystorm cells.

Figure 13 shows the dimensions of the Polystorm Xtra cells.

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

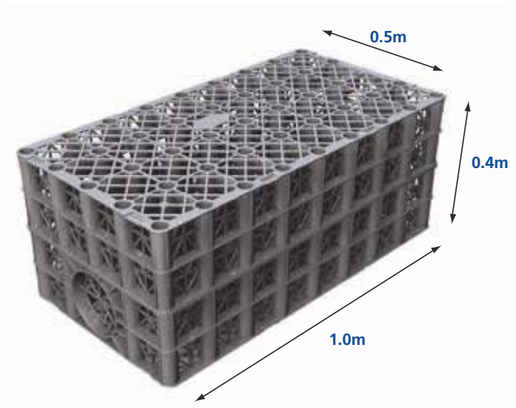


Figure 13 Dimensions of Polystorm cell

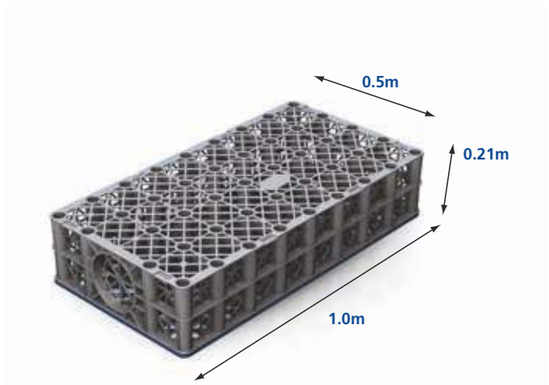


Figure 12 Dimensions of Polystorm Xtra cell

Element	Value
TECHNICAL SPECIFICATION OVERVIEW	
Product code	PSM1*
Length	1m
Width	0.5m
Depth	0.4m
Total volume	0.2m^3
Unit weight	9kg
Unit storage volume	0.19m^3 (190 litres)
Void ratio	95%
Vertical compressive strength	Maximum 440kN/m^2**
Lateral compressive strength	Maximum 63kN/m^2**
Short-term vertical deflection	83kN/m^2 per mm
Short-term lateral deflection	4.2kN/m^2 per mm
Maximum burial depths:	
Light trafficked	3.7m***
Non-trafficked	3.8m***

*Each unit includes 4 Clips and 2 Shear Connectors.
**Compressive strength at yield, maximum recommended value for design purposes.
***Based on ground conditions being dense sand and grave with no groundwater present, using the calculation methodology detailed within CIRIA C680 (2008). Where ground conditions differ, please consult our water management solutions Technical Department on +971 (0) 4 807 3000.

Element	Value
TECHNICAL SPECIFICATION OVERVIEW	
Product code	PSM3*
Length	1m
Width	0.5m
Depth	0.21m
Total volume	0.105m^3
Unit weight	6kg
Unit storage volume	0.0986m^3 (98 litres)
Void ratio	95%
Vertical compressive strength	Maximum 834kN/m^2**
Lateral compressive strength	Maximum 93kN/m^2**
Short-term vertical deflection	97.8kN/m^2 per mm
Short-term lateral deflection	7.1kN/m^2 per mm
Maximum burial depths:	4.8m***
Light trafficked	5.3m***
Non-trafficked	5.45m***

*Each unit includes 4 Clips and 2 Shear Connectors.
**Compressive strength at yield, maximum recommended value for design purposes.
***Based on ground conditions being dense sand and gravel with no groundwater present, using the calculation methodology detailed within CIRIA C680 (2008). Where ground conditions differ, please consult our water management solutions Technical Department on +971 (0) 4 807 3000.

Technical data of Polystorm and Polystorm Xtra cells		
	Polystorm	Polystorm Xtra
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 Lateral loading on side face	200 40	440 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 ???

3.2.2 Durability

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

3.2.3 Chemical resistance

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

4.0 Design protocol

Polypipe 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.

4.1 Detail design protocol

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.

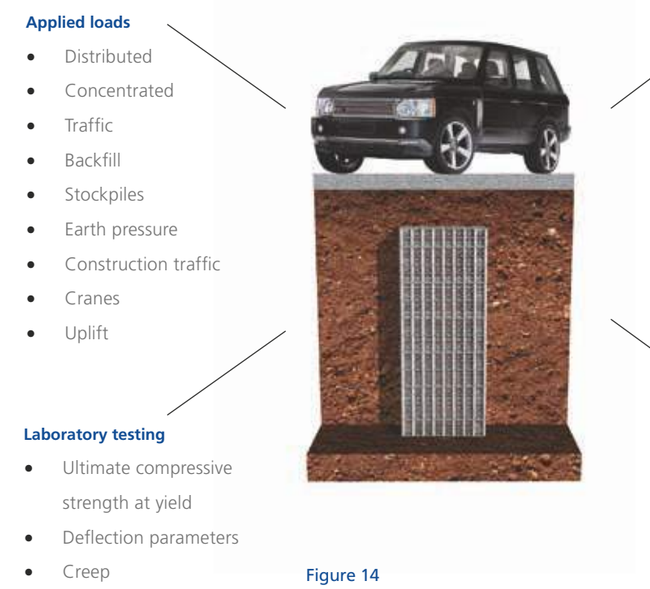


Figure 14

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.

To avoide failure, Polypipe recommend both structural and hydraulic assessments are carried out in accordance with CIRIA design guidelines, using product manufactured from virgin materials, tested in accordance with Middle East ground conditions at 40^{o}c elevated temperatures.

Company overview

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 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 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 forBuildings. 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 StandardBS8006: 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 Detail design protocol

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 (fm), appropriate to the material and limit state.

Refer to regional specifications for guidance on factors of safety.

Partial material factors of safety: Polystorm & Polystorm Xtra

Limit state	fm
Ultimate limit state	2.75
Serviceability limit state	1.5

Table 6

The partial factor fm is made up of several components:

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 applicable for temperate climate conditions such as in the Middle East. The strength of polypropylene varies with temperature, this will be significant for installation in the Middle East where the temperature in the ground (at the typical depth of installation) remains high.

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 geocellular storage systems are taken from CIRIA C680.

Partial factors of safety for applied loads

Limit state	Imposed vertical dead load fm	Imposed earth pressure dead load fm	Imposed live load fm
Ultimate limit state	**1.40**	**1.40**	**1.60**
Serviceability limit state (Polystorm only)	**1.0**	**1.0**	**1.0**

Table 7

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.

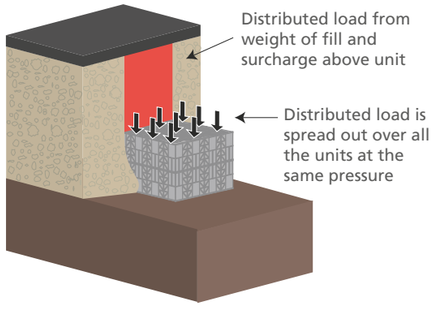
Total design load = (1.5 x 20 x 1.4) + (2.5 x 1.6) = 46kPa.

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.



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.

SUBJECT TO DETAILED REVIEW

4.2 Distributed loads

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.

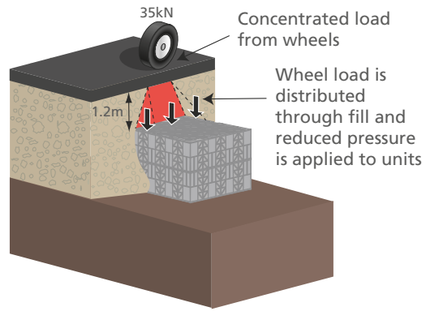


Figure 16

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 greaterthe 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.

Design against collapse (ultimate limit state)

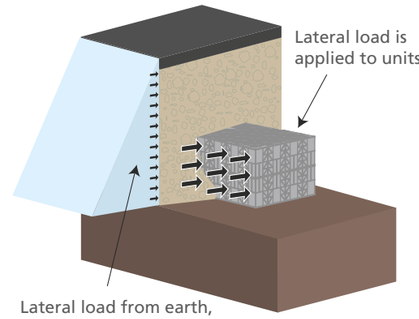


Figure 17

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.

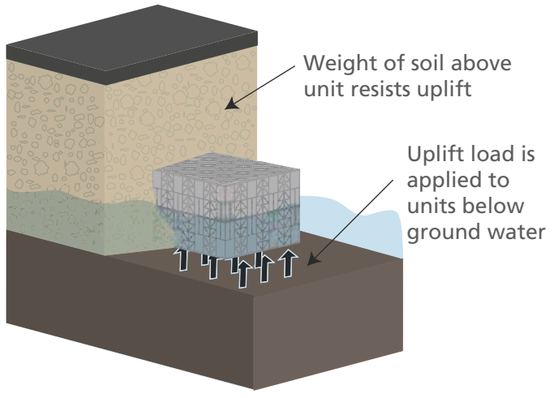
Weight of soil resisting uplift

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.



4.4 Maximum burial depths

4.4.1 Recommended maximum installation depths

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

Polystorm maximum depth of installation (to base of cells) (m)		
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
30	2.6	1.41
35	3.2	1.48
40	4.0	1.60
45	5.1	1.69
51	7.1	1.83

Table 8

Polystorm & Polystorm Xtra - minimum cover levels (to top of cells) (m)			
Live load conditions	Landscaped area	Trafficked area	
		Car park with vehicle mass <2500kg	Car park with occasional vehicle mass >2500kg
Minimum cover depth required (m)	0.50	0.60	1.0

Table 10

Please note: The above data are indicative only and will change for different projects. Also for specific project requirements and detailed calculations, please get in touch with our technical team of experts +971 (0) 4 807 3000.

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 and Polystorm Xtra 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

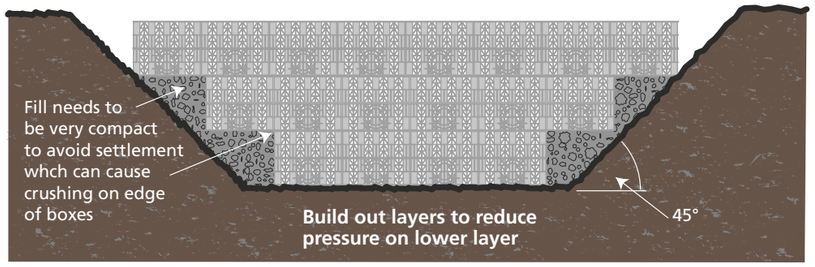


Figure 19

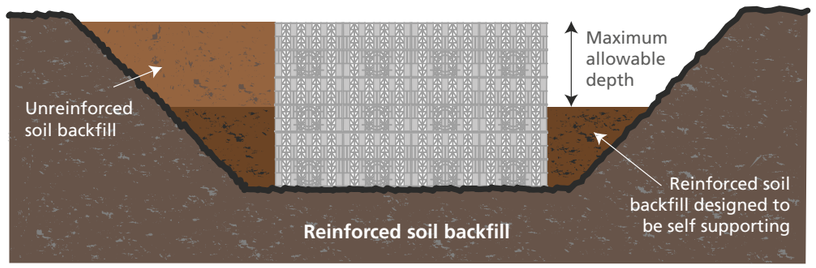


Figure 20

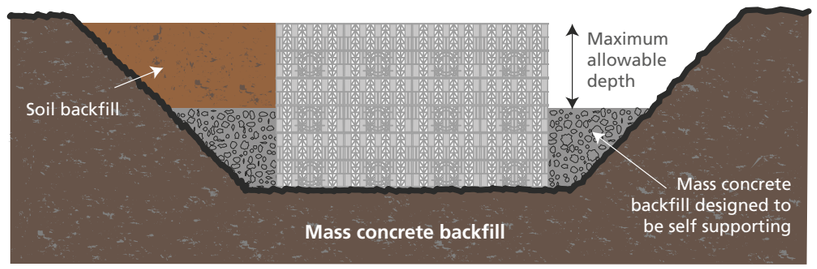


Figure 21

Illustrations are based on CIRIA guidelines

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:

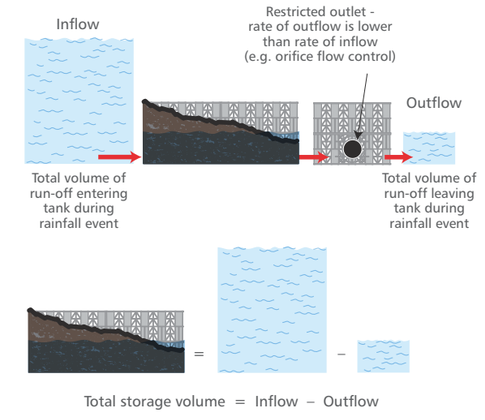
- **Interception storage -** this is not actually storage - the aim is to reduce the frequency of run-off and prevent run-off from sites for rainfall events up to 5mm in order to simulate the behaviour of greenfield catchments more closely. This is achieved using infiltration or source control methods 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



Total storage volume = Inflow – Outflow

4.7 Hydrological rainfall

Note: UK Data is shown as reference only. For calculations local meteorological data should be used.

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

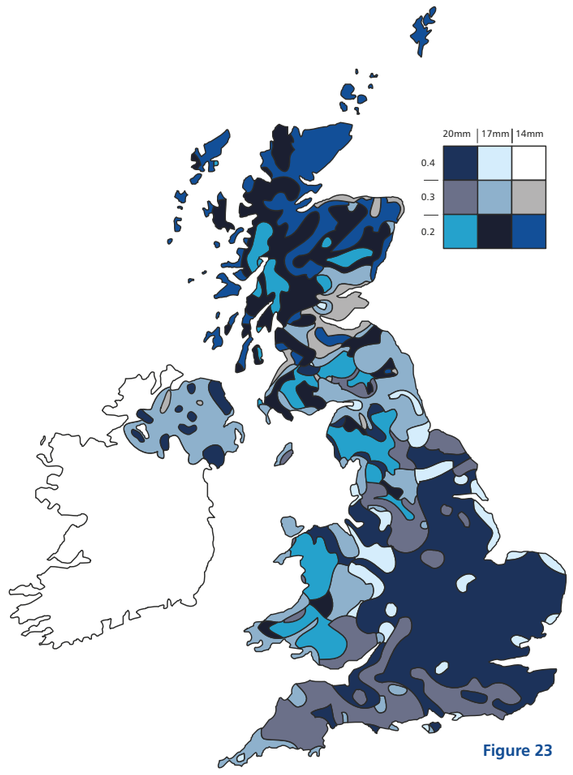


Figure 23

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	5.45
	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)	
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

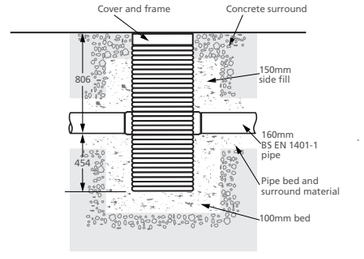
= 101.7m³ with an outflow of 1.2 l/s

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



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)

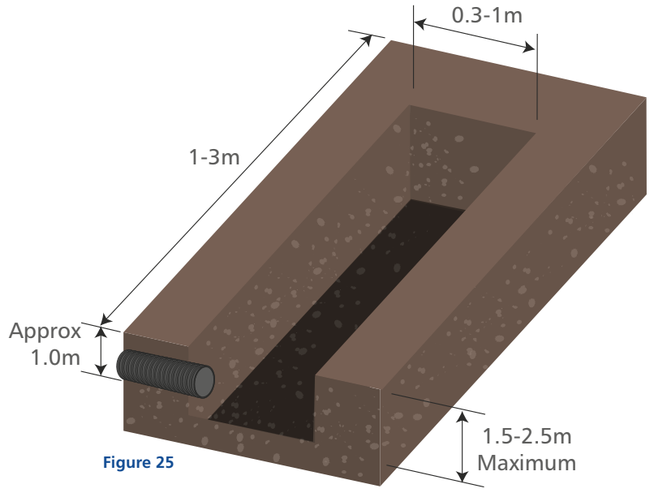


Figure 25

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 technical support team and advise them of the dimensions of the test hole and lowest timed result (in minutes)
- Polypipe 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.

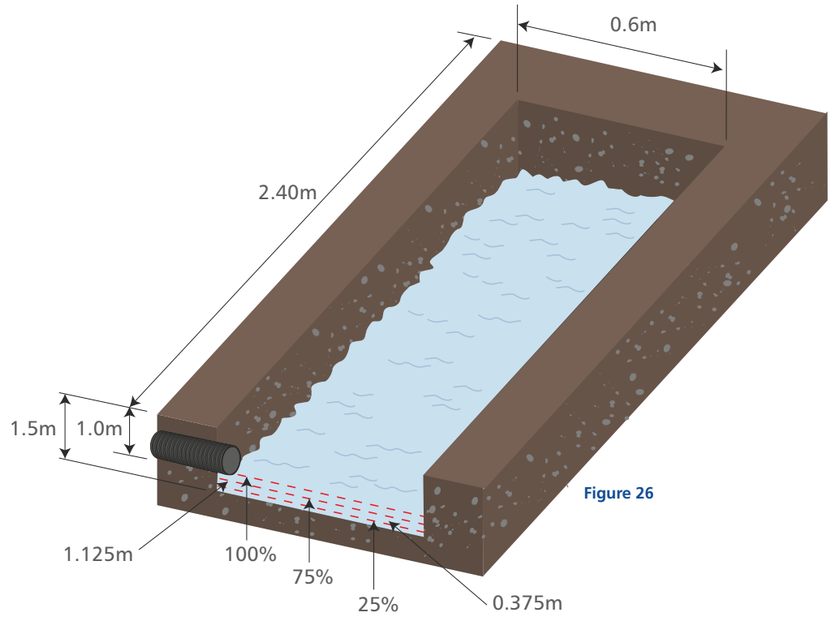


Figure 26

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

$V_{(p75-25)}$ = 2.40 x 0.60 x (1.125 - 0.375) = 1.08m3

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 x 0.6) = 0.75(6) + 1.44 = 5.94m2

Test hole depth at 75% and 25%

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

$t_{(p75-25)}$ = 102 - 11 = 91 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 x 10-5 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 housing development (1)		
Number of units	Storage volume (m3)	Max area to be drained (m2)
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 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

4.9 General layouts - typical arrangement of Polystorm structures and manifolds

Typical arrangement

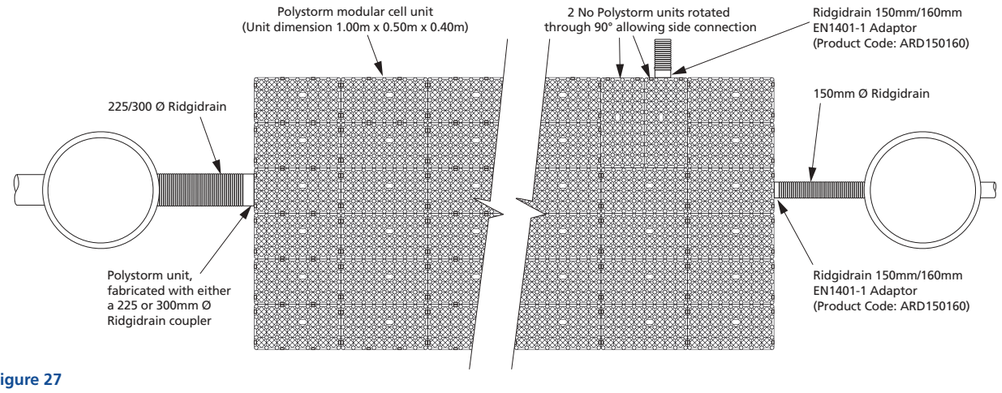


Figure 27

Cross section view of typical arrangement

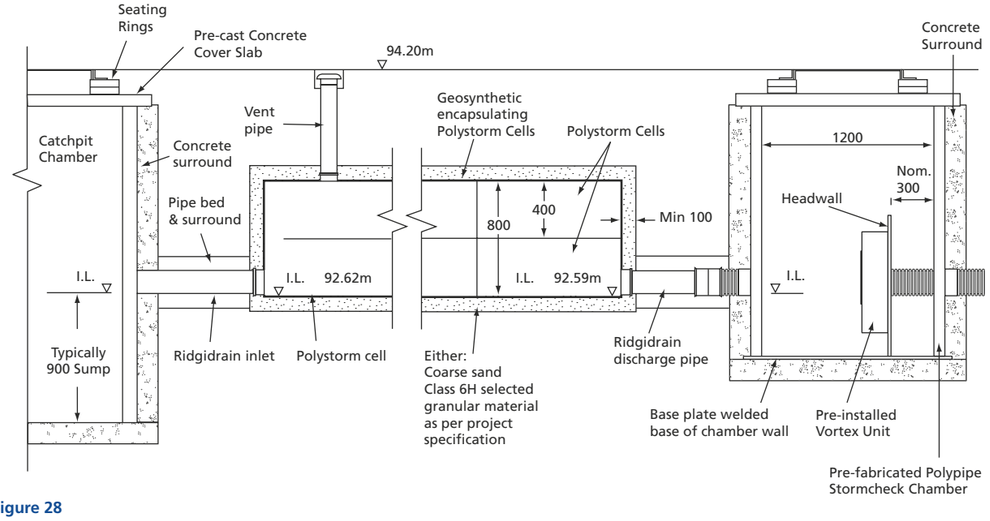


Figure 28

Example of offline solution

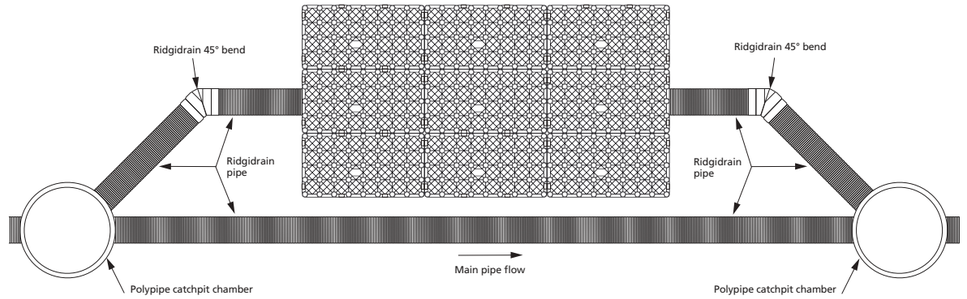


Figure 29

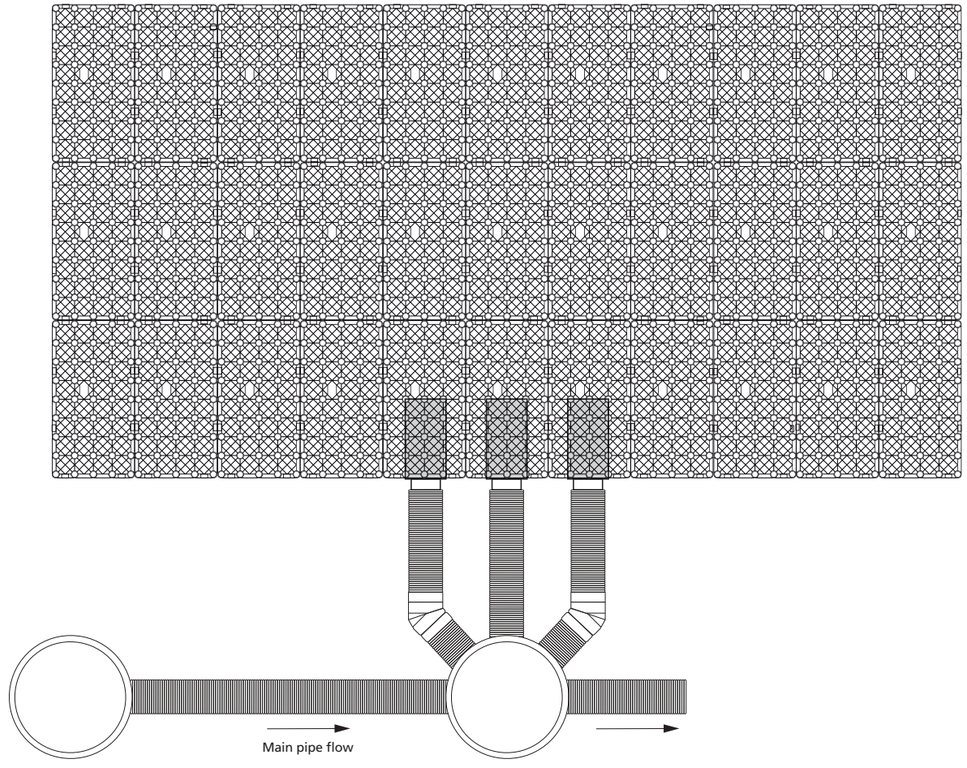


Figure 30

5.0 Installation / Detention -
for attenuation and soakaway systems

The following section outlines site best practice for the installation of Polystorm

5.1 Health, Safety & Environment (HSE)

Health & Safety

Under the Construction (Design and Management) Regulations 2007, unless they are a domestic client, all parties involved in construction or building work have legal duties.

These include:

Clients

- Check competence and resources of all appointees
- Ensure there are suitable management arrangements for the project welfare facilities
- Allow sufficient time and resources for all stages
- Provide pre-construction information to designers and contractors

Designers

- Eliminate hazards and reduce risks during design
- Provide information about remaining risks

Contractors

- Plan, manage and monitor own work and that of workers
- Check competence of all their appointees and workers
- Train own employees
- Provide information to their workers
- Comply with the specific requirements in Part 4 of the regulations
- Ensure there are adequate welfare facilities for workers

It should be noted that additional legal duties are imposed where construction work is notifiable.

All installation activities should be carried out observing the requirements of The Health and Safety at Work Etc. Act 1974; and The Management of Health and Safety at Work Regulations 1999.

Polystorm Benefits for CDM Compliance

(Construction, Design and Management regulations)
Storage applications using Polystorm Water Management Systems are beneficial to CDM compliance. This is because the system avoids or reduces several risks associated with the construction of traditional storage tanks which can involve deep excavations and construction of large engineered structures.

Specific advantages of Polystorm in this respect are:

- Individual Polystorm components are lightweight, making it easier for individual lifting of Polystorm cells.
- Installation of Polystorm is quick, so open excavation time is minimised and high numbers of manpower and machinery is reduced.

Risk Assessment

Contractors are required to submit a method statement which includes a methodology for installation and risk assessment for the work to be carried out.

Ensure that a full risk assessment is carried out prior to commencing any installation.

Excavation should be carried out in accordance with BS6031:2009; paying particular attention to safety procedures.

All relevant regional / local / project specific Health and Safety procedures should be followed.

The Contractor should provide warning signs around the installation that state "limited load bearing area/restricted access" for the duration of the construction works. Once the installation is completed and all backfill consolidated the signs can be removed.

Tank installations within landscaped areas that could be potentially used as temporary car park zones should be cordoned off with barriers to prevent vehicle access.

5.2 Material checklist

Equipment required

- Tools to unload tanks from container (eg. Forklift)
- Measuring tape
- Duct tape - (to hold geotextile in place)
- Razor knife
- Cable ties
- Marking pegs and string line
- Spray paint (for marking)
- Rubber mallets
- Equipment to compact and level the backfill material
  Refer to note on compaction equipment in section 8
- Wacker packer or walk behind trench roller.

Material required

- Polystorm tank units and connectors
- Geotextile (min 300 gsm or as per specification)
- Base Material - [Coarse sand or 5-10mm aggregate or as per project specification] - clay should not be used
- Lateral fill and backfill material (as per specification) - clay should not be used.
- Vent pipes (if any)
- Operation and maintenance provisions or accessories as per construction drawings or as approved by supervising engineer

5.3 General design considerations

1. The Polystorm geocellular system comprises of injection moulded units with closely spaced internal columns restrained by an external lattice framework and internal web framework.

2. The management of stormwater runoff from impermeable surfaces can be done by the following ways:

   a) **Infiltration/Soakaway -** Stormwater is collected in the units during rainfall and allowed to drain away by soaking in to the surrounding ground over a period of time after rainfall.

   b) **Detention -** The collection, storage and detaining of stormwater events to manage peak flows prior to controlled discharge back into the network.

   c) **Attenuation -** An underground structure for the collection and storing of stormwater run-off and re-use as required.

3. Design of the appropriate system for a specific project must always be preceded by a detailed audit of the proposed site to establish:

   a) Existing factors and considerations applicable to the site.

   b) Predicted factors relating to the site's use following the planned development, and the parameters within which the installation is required to function.

   c) The type of function of application suggested by this audit.

4. Once the project criteria has been established from the site audit, there are two main parts of the design procedure - hydraulic design and structural design, these should be carried out by competent drainage and structural engineer.

Structural Design Considerations

The structural design of geocellular structures is to ensure they comprise of the optimum material components and backfill material to suit the inherent external loading.

The following considerations should be analysed in accordance with BS EN 1997-1:2004 Eurocode 7, Geotechnical design, general rules and CIRIA C680, structural design of modular geocellular drainage tanks.

Structural Design Considerations

Minimum cover depth required

- Dictated by the expected surcharge loading

Maximum allowable burial depth

- Verical pressure
- Dead loads e.g. backfill material
- Live loads e.g. vehicle loads
- Hydrostatic loads

Lateral earth pressures

- Dictated by ground conditions

Flotation

Special site considerations

- Slopes or embankments adjacent to tank / trench
- Storage or stockpiling on top of the tank / trench
- Temporary or future use

Surface deflections

- Serviceability limit state

All in accordance with Ciria C680

Applied loads

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

Partial safety factors

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

Laboratory testing

- Ultimate compressive strength
- Deflection parameters
- Creep

Laboratory testing

- Failure
- Deflection
- Creep
- Flotation

For illustrative purposes only

5.4 Delivery and site handling

- Polystorm units are supplied to site in packs of 15 units secured to a wooden pallet. Each pack carries a label bearing the product name, quantity, operator initials, pallet number, product dimensions in mm, date of manufacture and batch number.
- Clips, shear connectors and brick bond connectors are packed in sealed polythene bags of 60, 30 and 30 respectively.

Transportation

Product identification

5.5 Storage of Polystorm tanks on-site

The following are good practice principles for the handling and storage of all Polystorm tanks on site:

- Do not remove UV protecting wrapping until product is required for installation
- If site storage is required for excessive periods, store product under shaded area as shown in the Image B
- Place packs of cells on level ground: **DO NOT** stack filled pallets on-site
- Store loose individual cells no more than 5 cells high
- Ensure a well positioned and secure stand for platform issued to remove the top layer of Polystorm cells from the pallet
- Although Polystorm cells contain an inhibitor giving ultra violet resistance for up to 6 months, avoid prolonged storage in direct sunlight
- **DO NOT** store cells near fuel bowsers, fuel tanks or any other solvents
- Although Polystorm cells are very robust and resistant to damage when handled normally, store in locations where impacts from vehicles and site plant will be avoided
- Ensure Polystorm cells are kept clean at all times. Broken/cracked cells should not be installed.

(A) Storage on-site

(B) Storage in shaded area

5.6 Excavation, base preparation and geotextile

Soakaway Trench

Soakaway Tank

1. Excavate to the required plan dimensions allowing a minimum of 500mm safe working space around the tank / trench, for backfilling and compaction purposes.

2. Ensure that the excavation footprint is as per construction drawings, to allow easy installation of any connecting pipework.

5.6.1 Base preparation

Ensure that the ground bearing capacity at the formation level is sufficient for the proposed operational loads.

1. Place and compact a minimum of 100mm thick layer of bedding material (typically coarse sand). Bedding material should be either coarse sand or selected granular material (5 - 10 mm dia or as per project specification).
2. The base of the excavation should be compacted and levelled, free of large or sharp stones and soft spots to avoid punctures or tears of the geotextile.
3. Any soft spots should be excavated and replaced with suitable compacted granular material.

5.6.2 Place the geotextile

1. The permeable geotextile should be laid over the levelled base.
2. The geotextile should be positioned such that a suitable overlap (min.300 mm) can be achieved.
3. The geotextile should extend at least 600mm beyond the edge of the tank / trench.

All the joints and overlap should be in accordance with the geotextile manufacturer's recommendations and allowance should be made for connecting pipework or adaptors. Geotextile/Geomembrane should be checked for any damages, punctures or tears.

5.7 Polystorm cell installation

5.7.1 Marking the tank / trench area

- To ensure proper orientation and alignment of the tank / trench, use a string line to establish two adjacent edges.
- As per the tank / trench dimensions, the string line should be set with care and should be stretched as tight as possible.
- The starting point for placing the cells should preferably be at the opposite corner.
- Ensure cells are arranged so that they are in the correct alignment with any connecting pipework.

5.7.2 Moving the Polystorm tanks into position

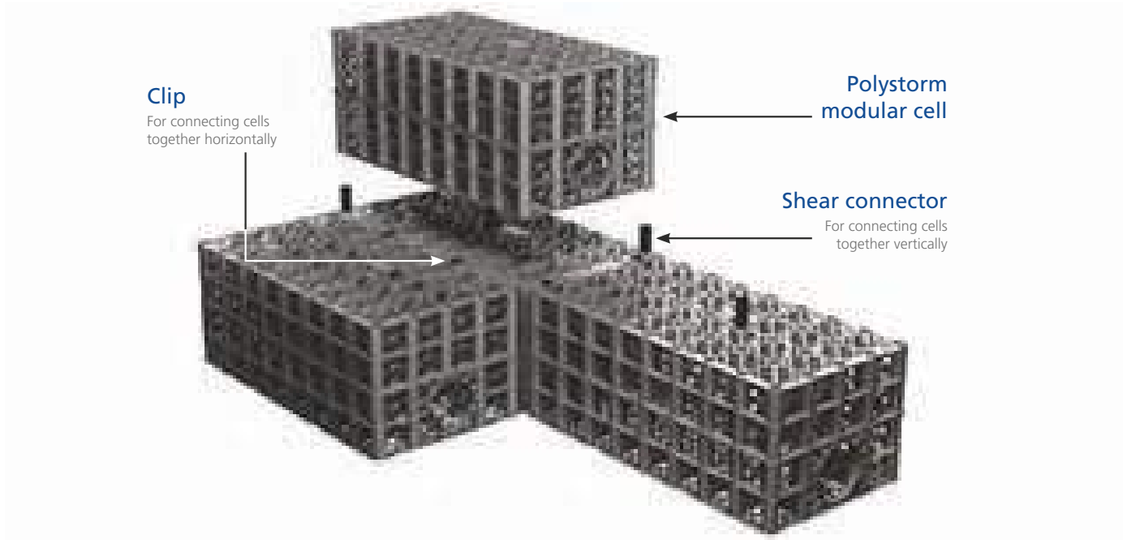
- Individual Polystorm cells weigh 9 kg so they can normally be safely lifted on site in accordance with current manual handling regulations.
- Care must be taken when placing the cells into the excavation.
- Install 1st layer of cells to protect the geotextile from punctures or tearing.

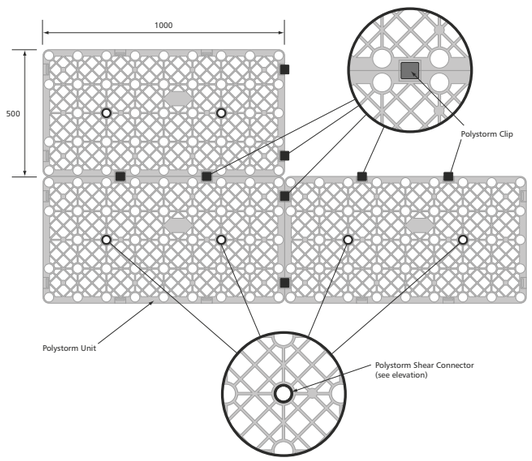
5.8 Polystorm cell installation

6.8.1 Connecting adjacent tanks

- Ensure the Polystorm cells are abut and the corners align with each other.
- During installation, Polystorm cells should be securely connected using clips and shear connectors.
- Clips and shear connectors are supplied in sealed polythene bags of 60 and 30.

LOCATION POINTS FOR CLIPS AND SHEAR CONNECTORS



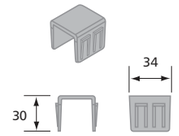


POLYSTORM CLIP

5.8.2 Horizontal connection - clips

Clip Connectors

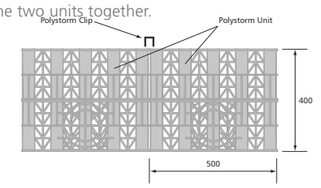
Polypipe clips connect horizontally adjacent units.



Clips and shear details

Clip connector installation

Polystorm cells are adjacently connected by clipping the two units together.



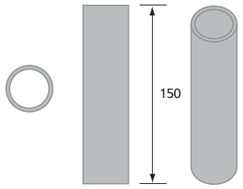
Clip connector installation

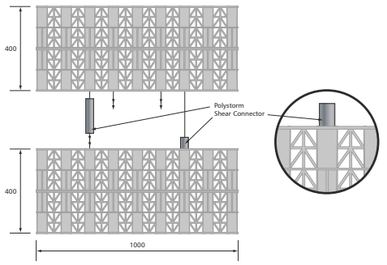
- Polystorm cells are adjacently connected by clipping the two units together.
- 60 clips are packed in a sealed polythene bag.

5.8.3 Vertical connection - shear connectors

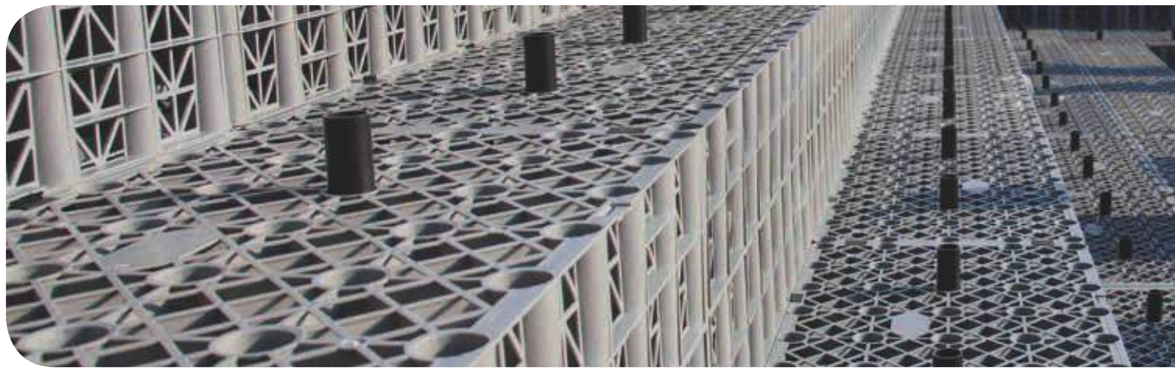
Shear Connector

Vertical connections are formed with the Polypipe shear connector.





- Insert shear connectors into Polystorm cell as shown. Ensure the shear connector is fully inserted before mounting the Polystorm cell.
- 30 shear connectors are packed in sealed polythene bags.

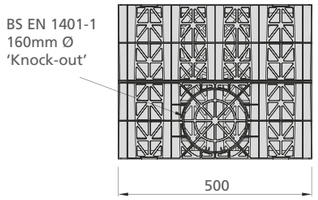


5.8 Polystorm cell installation

5.8.4 Pipe connections and geotextile

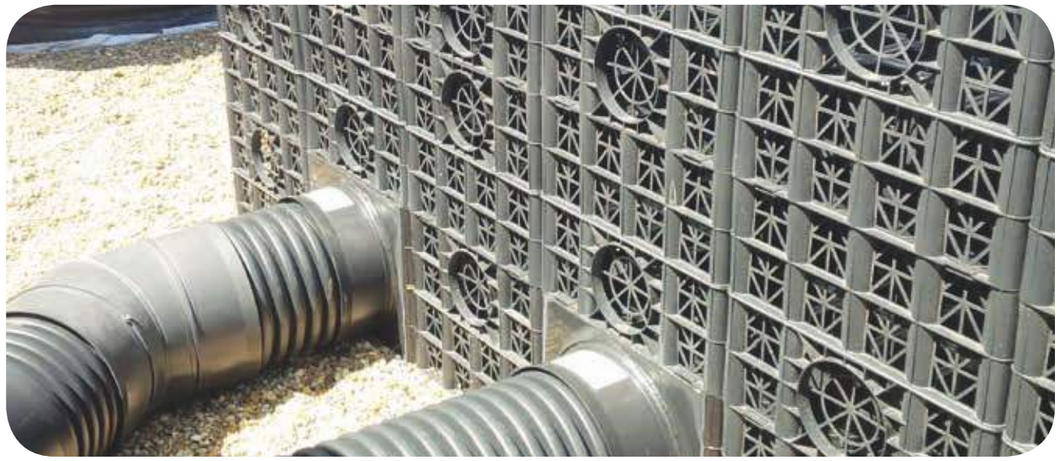
Pipe connections should be made to the tank using proprietary adaptors. Preformed socket position for pipe connections must be located at the correct position for receiving pipework.

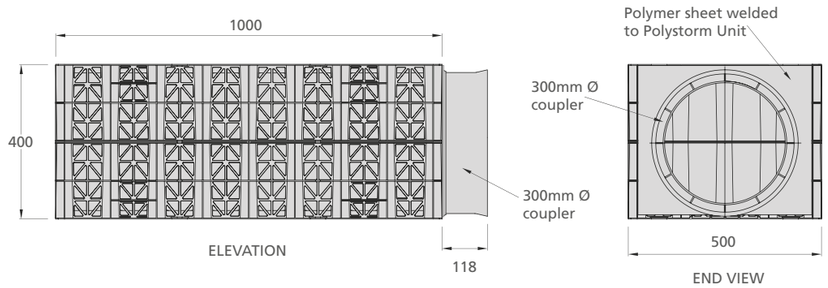
1. 160 ⌀ mm EN 1401-1 pipes connect directly into the convenient knock-out incorporated in the end of each cell.



END VIEW

2. Polystorm cells are also available with a 300mm fabricated pipe connection. For the best hydraulic performance, Polypipe recommends a 300 mm fabricated pipe connection. For diameters greater than 300 mm a manifold arrangement can be proposed.





Backfilling sides

5.8.5 Wrapping geotextile around the Polystorm tank

1. Cut the geotextile roll length to cover the top and the side of the tank with at least 600 mm excess at each end.
2. Ensure each adjacent geotextile strip has at least 300 mm overlap.
3. Folding geotextile around the corners is like making a hospital corner on a bed or wrapping a Christmas present. Lay excess material flat against the tank and secure into position by using a duct tape.
4. When you have a pipe connection, mark the pipe location on the geotextile with a 'X' using a marker or a spray can.
5. At the marked location, cut the geotextile as a (✦). Open the geotextile flaps as shown below. Connect the pipe and then clamp the geotextile folds back on the pipe. Ensure the connection is properly sealed with a cable tie.

6. To prevent the movement of geotextile by wind, place ballast items like sand bags, battens, buckets or a wooden plank above it, remove these items at backfilling stage.
7. Re-examine the geotextile for damage and joint integrity.

Soakaway Tank

Soakaway Trench

5.9 Backfilling sides

1. Once the tank / trench is completely wrapped in geotextile and sealed, you can then start the backfilling around the sides of the tank / trench.

2. Backfill material should be placed and compacted in layers not greater than 300mm. Layers should be compacted to achieve a 95% min. proctor density.

3. Material - as per project specifications or coarse sand or 20 - 40 mm selected granular material.

4. Where required, remaining excavated areas around the units should be backfilled with selected granular material or similarly approved material. Compaction can be done using either a walk behind roller or wacker packer to achieve a compaction of 95% min proctor density.
5. Regardless of the backfill material compaction of side backfill is always required. Care should be taken to avoid any damage to the geotextile during backfilling.

(Note - Compaction plant over and immediately adjacent to the Polystorm cells shall not exceed 2300 kg/m width).

5.10 Backfilling above the tank / trench

1. Above the wrapped Polystorm cells, place and lightly compact a minimum 100mm thick layer of either coarse sand or 5-10 mm selected granular material, or material as per project specification.

2. Final backfilling of the installation can be from 'selected' as dug material and surfacing is dependent on the expected operational loads.

(Note - Compaction plant over and immediately adjacent to the Polystorm cells shall not exceed 2300 kg/m width).

Field conditions (e.g. landscaped areas)

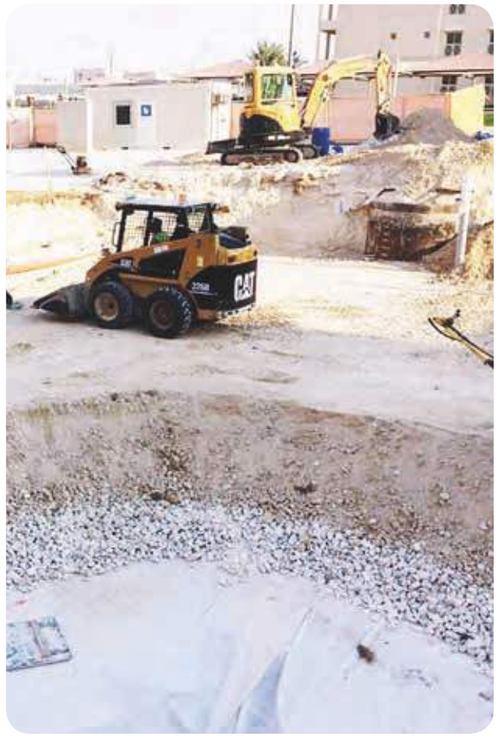
- The backfill material that lies within 300mm above the Polystorm cells should be free from particles exceeding 40mm in diameter.
- Final backfilling up to finished ground level may be achieved using selected as-dug material.
- Backfill material should be placed and compacted in layers no greater than 300mm, or in compliance with the approved specification.

Lightly trafficked (e.g. restricted access car park)

- Backfill with coarse sand or 20 - 40 mm selected granular material.
- Backfill material should be placed and compacted in layers not greater than 150mm.
- Where the Polystorm cells are installed beneath a paved area, the pavement sub-base may form part of the backfill material provided that minimum cover depths are maintained. Complete pavement construction or landscaping over the Polystorm system.

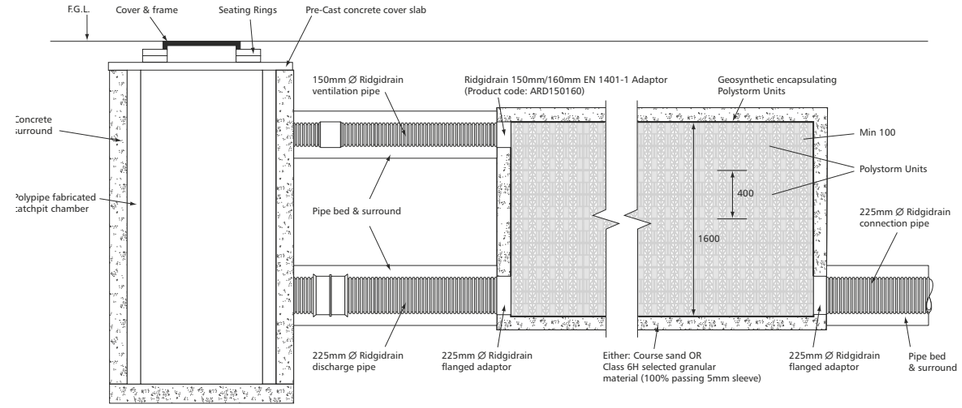
5.11 Backfill compaction

- Final backfilling up to finished ground level may be achieved using selected as-dug material.
- Backfill material should be placed and compacted in layers no greater than 300mm, or in compliance with the approved specification.
- Compaction can be done using either a walk behind roller or wacker packer to achieve a compaction of 95% min proctor density. Regardless of the backfill material compaction of the backfill is always required.



(Note: Compaction plant over and immediately adjacent to the Polystorm cells shall not exceed 2,300kg/m width).

5.12 Air vent connection and installation



Vent Pipe arrangement within the manhole

(alternative vent pipe detail is available if required)

Polystorm tank structures will require ventilation to ensure maximum hydraulic performance and avoid placing additional stress on the encapsulating geotextile. A vent has a minimum size of 110mm diameter.

1. Attach a 110/160mm flange adapter to a Polystorm cell from the top layer using cable ties on all four corners of the adaptor base and seal the geotextile around the flange, the same way as making an inlet or outlet connection and seal.
2. Insert a 110/160mm dia vertical vent pipe into the flange and make connection.
3. Ensure vents are protected from damage during construction.
4. Large Polystorm tanks need a vent for every 7500^{m2} of drained catchment area or the number of vents as per engineers requirements.

5.13 Air vent at finished level

Landscaped area above the tank / trench

Hardscaped - paved area above the tank / trench

5.14 Inspection

After installation and prior to handover, any silt collection chambers or control manholes should be examined to ensure they are free from debris. All chambers and manholes require the insertion of bungs at the inlet and outlet to prevent siltation during construction. Bungs should then be removed at commissioning.

5.15 Operation and Maintenance

Maintenance schedule

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground modular storage systems. Maintenance requirements for modular systems shall be based on the details given in the following table and as per local authority requirements.

Maintenance Schedule	Required Action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Twice a year
	Remove sediment from pre-treatment structures	Twice a year
Remedial actions	Repair/rehabilitation of 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 and before the rainy season

Maintenance plans and schedules shall be developed during the design phase. Specific maintenance needs of the system shall be identified based on upstream drainage sedimentation controls, and maintenance schedules adjusted to suit requirements. Maintenance activities should be detailed in the Health and Safety File and a risk assessment should be undertaken.

For more information on the installation of our Polystorm system, or for on-site support or installation assistance, contact our technical experts:

Tel: +971 (0) 807 3000 or email: middleeast@polypipe.com

5.14 Handling and Installation

All materials used should be checked before and after installation for any damage such as punctures or tears to the membrane. The type of geosynthetic material used to encapsulate the Polystorm cells will determine the installation requirements. Please note the following information is generic and advice from the geosynthetic manufacturer should be sought to ensure that the appropriate protective measures are taken to comply with any proprietary requirements.

Impermeable geomembrane		
Physical properties		
Thickness	Min 0.75 to 1.0mm	ASTM D5199
Density	900kg/m³	ASTM D1505
Mechanical properties		
Tensile strength, at yield	Min 1600N/m³	ASTM D4885
Elongation at break	>500%	ASTM D4885
Puncture resistance	Min 170N	ASTM D4833
Tear resistance	Min 67N	ASTM D1004 Die C
Impact resistance	Min 15 Joules	ASTM 3998 mod
Stress crack resistance	Min 200 hrs	ASTM D5391 (SP=-NCTL)
Permeability coefficient	Max 2.0 x 10-12	ASTM D
pH	Resistant to all naturally occurring soil acids and alkalis	
Chemical/biological resistance	Resistance to all substances found to naturally occur in soils and rainwater. Detailed information would need to be provided to geomembrane manufacturer in instances of contaminated land.	

5.15 Ventilation

5.15.1 Inlet and outlet connections and installations

A flange adapter is attached at both the inlet and outlet points as this gives a flat surface for the membrane to be attached to. The flange adaptor will require a hole punching in each corner of the base. Ensure the flange adaptor is fastened securely to the cell using cable ties. Once the adaptor has been secured, insert the pipe and seal connection.

5.15.2 Sealing and testing connections

All pipes entering and leaving the structure must be sealed in accordance to the contractor's method statement. Ensure the geomembrane around all connection areas are clean and free from moisture before sealing. All sealing equipment should be tested at the start of each day to ensure consistency is maintained throughout the installation of the structure. The inlet and outlet connections need a bung inserted into the hole to prevent siltation and water entering the structure whilst installation is carried out. Once the connections have been sealed, testing should be carried out to check for leaks. This procedure should be carried out in accordance to the contractor's method statement. All testing equipment should be tested at the start of each day.

For advice on procedures for testing joints refer to CIRIA SP 124 – Barriers, liners and cover systems for containment and control of land contamination.

5.15.3 Encasing geotextile

Complete the geosynthetic encapsulation of the entire Polystorm structure, forming joints where appropriate. Re-examine the geomembrane and/or geotextiles for damage and joint integrity. Avoid walking on the geosynthetic as this may cause punctures or tears to the material. The equipment used to form joints must be tested at the start of each day to ensure consistency is maintained throughout the process. For advice on procedures for testing joints refer to CIRIA SP 124 – barriers, liners and cover systems for containment and control of land contamination.

5.15.4 Lateral backfilling

Backfill around the sides of the encapsulated units, forming a 100mm thick layer of coarse sand or Class 6H selected granular material immediately adjacent to the cells. Where required, remaining excavated areas around the units should be backfilled with Class 6N or 6P selected granular material, in accordance with MCHW, Volume 1, or similarly approved specification.

5.16 Connections

5.16.1 Types of connections 160mm – 300mm (direct to cells)

160mm EN 1401-1 pipes connect directly into the convenient knock-out incorporated in the end of each cell. Connection to 110mm EN 1401-1 pipes or other products is accommodated through the use of standard Polypipe adapters.
Polystorm cells are also available with either a 225mm or 300mm fabricated Ridgidrain pipe connection.

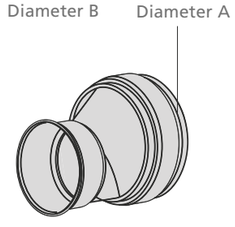


Figure 36
160/110mm invert level reducer

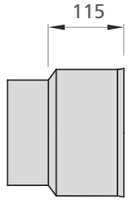


Figure 37
160mm diameter adaptor

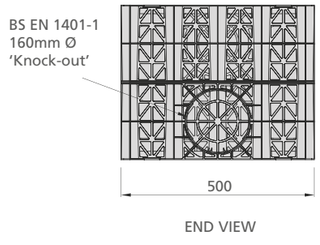


Figure 38
Polystorm cell 160mm diameter knockout

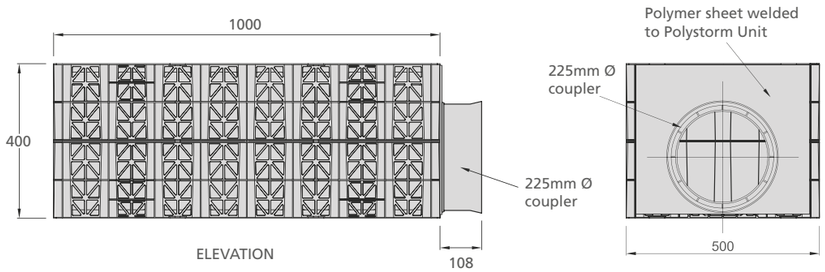


Figure 39 Fabricated Polystorm cell allowing 225mm diameter pipe connection

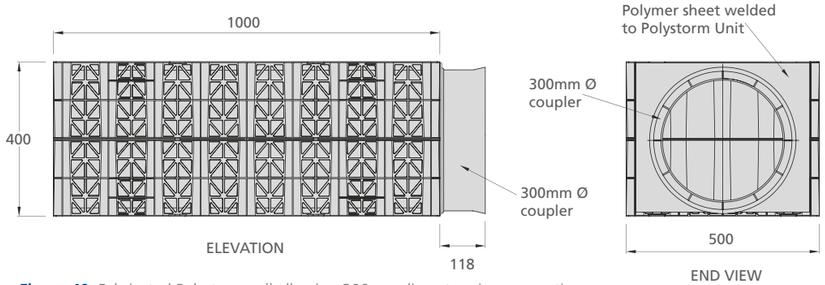


Figure 40 Fabricated Polystorm cell allowing 300mm diameter pipe connection

5.16.2 Types of connections 450mm – 600mm (direct to cells)

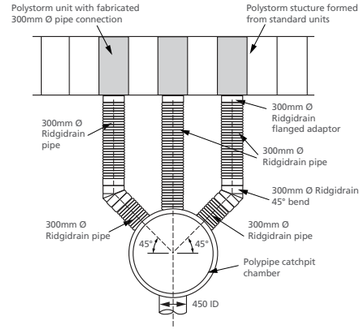


Figure 41 Typical Polystorm 450mm inlet manifold detail

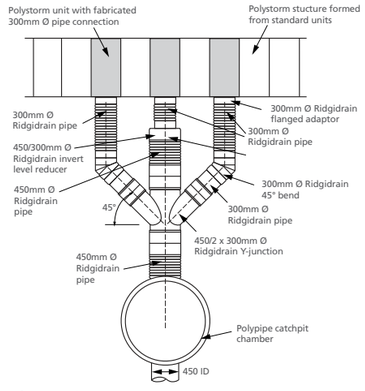


Figure 42
Typical Polystorm 450mm inlet manifold detail

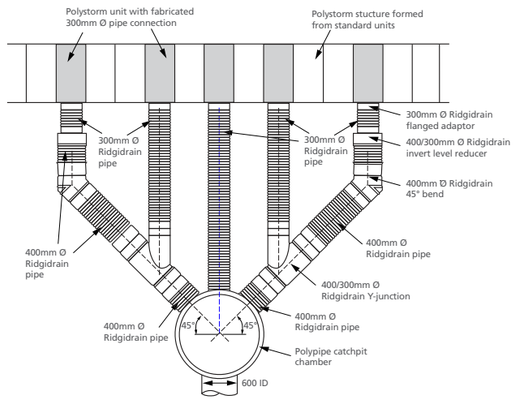


Figure 43 Typical Polystorm manifold detail

Note: For inlets larger than 600mm please contact Polypipe WMS technical team. Please also visit

www.polypipe.com/middleeast
for downloadable Auto CAD files of the illustrations on this page.

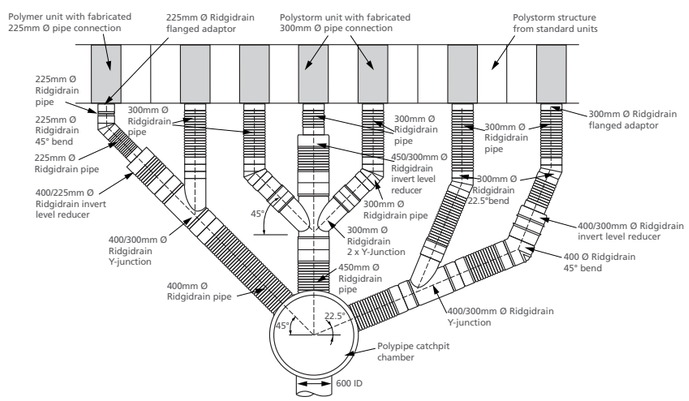


Figure 44
Typical Polystorm 600mm inlet manifold detail

Fabrications overview

Our ability to provide pre-fabricated, engineered solutions offer a range of benefits that will not only ensure undertaking your project is more effective and efficient, it will also result in measurable cost savings. Our modern methods of manufacturing reduce installation time and costs on-site and also minimise Health and Safety risks during handling, storage and installation.

In-house fabrications department

Providing a unique and comprehensive service through our in-house fabrication facility, we are able to create fully engineered solutions to precisely match specific project requirements. Whether you require a one piece manhole, catchpit, flow control device or treatment filter, a customised fitting or specialist bend, our team can engineer the right system accurately and to the highest quality.

Seamless integration

Our pre-fabricated solutions are designed to integrate seamlessly within existing drainage or water management systems, including our Ridgidrain, Ridgisewer or Ridgistorm-XL systems, or can be engineered to connect to other materials.

Other fabrications are available for our drainage and sewer ranges.

WRc TM Approved PT/284/0609

Off-site construction

We can help you to meet your project deadlines by delivering your ready-to-install, pre-fabricated system to site. Our solutions are manufactured in our factory-controlled environment, ensuring a superior finish in comparison to those constructed on-site. Additionally, the wastage usually associated with on-site construction is removed, so we are not only saving time and money, but we are also providing more environmentally friendly products and systems.

The products included over the following pages are only an example of what is possible.

For more technical and dimensions on fabrications please visit our website **www.polypipe.com/middleast**

Other Ridgistorm-XL fabricated solutions available include:

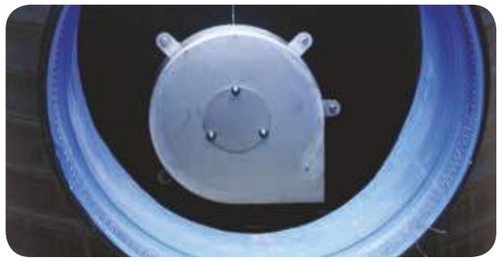
- Bends
- Junctions
- Reducers
- Dual run H chambers

Fabrications key benefits

- Tailor-made, fully-welded, watertight structured wall chambers to suit project-specific requirements
- One-piece installation, off-site construction - delivered ready-to-install reducing installation time and costs
- Strong but light in weight, minimising Health and Safety risks in handling and installation
- Manufactured in a factory controlled environment for improved quality of finish
- Eliminates wastage associated with in-situ construction
- WRc approved

RIDGISTORMCheck Vortex Flow Control Chamber

Where flows within a drainage system are required to be limited or checked (i.e. prior to discharge from site), with improved hydraulic performance and reduced maintenance, we are able to offer our RIDGISTORMCheck Vortex Flow Control Chamber.



Pre-fabricated under factory controlled conditions, our RIDGISTORMCheck Chamber is available in a range of diameters from 1050-3000mm and incorporates a vortex flow control unit, fitted onto a preformed headwall. Each vortex flow control unit is manufactured to suit the unique hydraulic characteristics of the site's drainage system design. RIDGISTORMCheck Vortex Flow Control Chambers are typically supplied as a single unit, allowing simple installation and eliminating a number of construction risks associated with in-situ construction. When installed in conjunction with our range of pipe systems, they offer a fully integrated drainage system.

RIDGISTORMCheck Vortex Flow Control Chamber key benefits

- Self-activating vortex flow controller which controls forward flow of water
- No moving parts - virtually maintenance free
- Manufactured with an integral sump for silt catchment/removal
- Available as non-bypass or manual bypass with built in overflow
- Manufactured to adoptable standards
- Multiple inlet and outlet options, allowing quick and seamless connection to pipelines
- Depths can be tailored to suit project requirements
- Step rungs to BS EN 13101 and ladders to BS EN 14396
- Integral lifting points available on request to improve Health and Safety during handling and installation

Applications

Site specific RIDGISTORMCheck Vortex Flow Control Chambers are engineered to suit a range of stormwater systems, providing a hydraulically efficient means of flow regulation that does not use moving parts or require power to operate.

Performance

RIDGISTORMCheck Vortex Flow Control Chambers are fabricated from Ridgistorm-XL pipework, which is manufactured to meet the material requirements of BS EN 13476:2007 (Part 1-3).

Manual Bypass Design

The manual bypass design offers a bypass to the flow control device to facilitate maintenance. Manually operated from the surface, the activation of the bypass system opens a door in the head-wall allowing water in the chamber to drain down via the bypass pipe.

Non-Bypass Chamber

For sites where discharge rates must be guaranteed to not exceed a prescribed limit(s).

Element	Value
Physical properties	
Diameter mm	1050-3000
Depth	To suit requirements
Material	HDPE
Colour	Black with blue interior
Flow control units	Grade 304 Stainless Steel
Chemical resistance	HDPE is naturally resistant to most chemicals associated with stormwater drainage systems
Inlets/outlets mm	100-3000
Hydraulic performance	Vortex flow control unit to suit site specific flow rates and head

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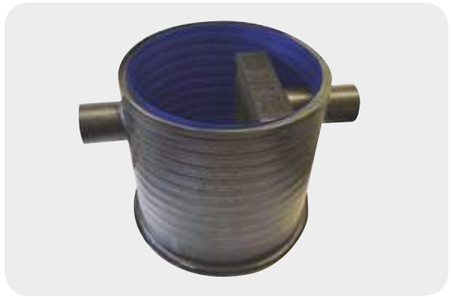
RIDGISTORMCheck Orifice Plate Flow Control Chamber

Where flows within a drainage system are required to be limited or checked (i.e. prior to discharge from site), in a simple and cost effective design, we are able to offer our RIDGISTORMCheck Orifice Plate Flow Control Chamber. Incorporating an integral orifice plate flow control with an optional removable Permavoid filter unit wrapped in a 2mm polyethylene mesh, to provide filtration and ease of maintenance.



RIDGISTORMCheck Orifice Plate Flow Control Chamber offers a cost-effective means of limiting flows, particularly when used in conjunction with our range of attenuation systems on smaller scale projects.

Applications

Site specific RIDGISTORMCheck Orifice Plate Flow Control Chambers are engineered to suit a range of stormwater attenuation and infiltration systems, providing a means of flow regulation and are used regularly when designing to source control principles. The optional filter unit on the outlet provides a filtration system for reduced maintenance.

Performance

RIDGISTORMCheck Orifice Plate Flow Control Chambers are fabricated from Ridgistorm-XL pipework, which is manufactured to meet the material requirements of BS EN 13476:2007 (Part 1-3).

For the full datasheets and standard details, for both of the RIDGISTORMCheck Chambers, please visit our website www.polypipe.com/toolbox

RIDGISTORMCheck Orifice Plate Flow Control Chamber key benefits

- Manufactured with an integral sump for silt detention
- One-piece installation, off-site construction, delivered ready-to-install reducing installation time and costs
- Multiple inlet and outlet options, supplied with integral sockets as standard allowing quick and seamless connection to pipeline
- Depths can be tailored to suit project requirements
- Step rungs to BS EN 13101 and ladders to BS EN 14396
- Integral lifting points available on request to improve Health and Safety of handling and installation

Element	Value
Physical properties	
Diameter mm	500-3000
Depth	To suit requirements
Material	HDPE
Colour	Black with blue interior
Chemical resistance	HDPE is naturally resistant to most chemicals associated with stormwater drainage systems
Inlets/outlets mm	100-3000
Hydraulic performance	Orfice plate flow controls to suit site specific flor rates and head

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RIDGISTORMControl Penstock and Valve Chambers

Where a drainage or sewer system design requires the inclusion of control devices to limit or isolate flows, our range of RIDGISTORMControl Chambers are available with pre-installed Penstocks, Flap Valves and Gate Valves.

Flap Valve

Penstock

RIDGISTORMControl Chambers are typically supplied as single units, manufactured in factory controlled conditions to improve the quality of finish and eliminate wastage associated with in-situ construction.

Applications

Our pre-fabricated RIDGISTORMControl Chambers incorporate a range of flow control devices to limit or isolate flows within surface water, sewer and combined sewer systems.

Typical valves include:

Gate Valves

Gate Valves are used to permit or prevent the flow of water and can isolate drainage sections. The valve opens by lifting a wedge out of the path of the flow of water.

Flap Valves

Flap Valves are non-return hinge valves to prevent backflow upstream. They can also be used for outflow applications such as ponds, ditches, swales and tidal.

Penstocks

Penstocks consist of a gate which can isolate or control water flow. The gate can also be used as a flow control device to limit the flow of water passing through the system.

Performance

RIDGISTORMControl Penstock and Valve Chambers are fabricated from Ridgistorm-XL pipework, which is manufactured to meet the material requirements of BS EN 13476:2007 (Part 1-3).

RIDGISTORMControl Penstock and Valve Chamber key benefits

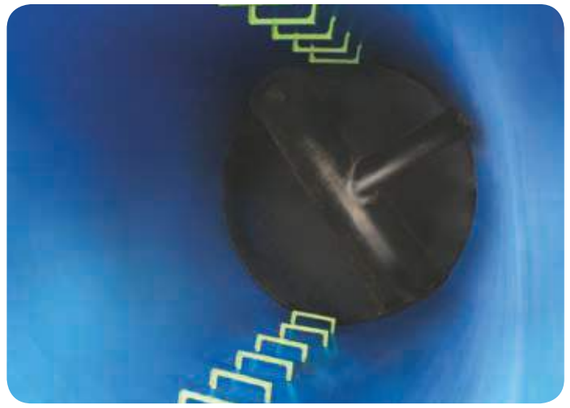
- Facilitates maintenance, controls system flows and protects the drainage system from surcharging
- System components available include: Penstocks, Gate Valves and Flap Valves
- Multiple inlet and outlet options, supplied with integral sockets as standard allowing quick and seamless connection to pipeline
- Chamber depths are tailored to suit project requirements
- Lockable steel covers available
- Integral benching
- Step rungs to BS EN 13101 and ladders to BS EN 14396
- Optional riser section
- Integral lifting points available on request to improve Health and Safety of handling and installation

Element	Value
Physical properties	
Diameter mm	1200-3000
Depth	To suit requirements
Material	HDPE
Colour	Black with blue interior
Loading	Determined by structural design
Chemical resistance	HDPE is naturally resistant to most chemicals associated with stormwater drainage systems
Inlets/outlets mm	100-3000

WRc™ Approved PT/284/0609

RIDGISTORMAccess Manholes

Whether your project calls for stormwater, foul water or combined sewer systems, we can manufacture high density polyethylene (HDPE) pre-fabricated manholes, to provide easy access into and maintenance of a pipeline. RIDGISTORMAccess Manholes are utilised where pipe runs change direction, combine, change invert level, diameter or pipe material.



Applications

RIDGISTORMAccess Manholes are engineered for use in stormwater, foul and combined sewer applications to enable access to the pipework system for inspection and maintenance. Factory installed, preformed benching and channelling is available to spring line (SHW) or soffit (SFA) depending on the specification required. RIDGISTORMAccess Manholes can be pre-fabricated with a number of features to reduce the need for direct access into the pipe, such as an offset channel, or maximising step landing width, or to minimise operational Health and Safety risks with the pre-fabrication of Safety Chain Assembly and Guardrail Assembly.

Compatibility

RIDGISTORMAccess Manholes can be integrated into our surface water (Ridgidrain and Ridgistorm-XL) and sewer (Polysewer, Ridgisewer and Ridgistorm-XL) pipework systems, or engineered to connect to other pipe materials.

Performance

RIDGISTORMAccess Manholes are fabricated from Ridgistorm-XL pipework, which is manufactured to meet the material requirements of BS EN 13476:2007 (Part 1-3).

RIDGISTORMAccess Manholes key benefits

- Provides easy access for maintenance
- Manufactured to adoptable standards
- Full range of accessories available including Safety Chain Assembly and Guardrail Assembly
- Multiple inlet and outlet options, supplied with integral sockets as standard allowing quick and seamless connection to pipeline
- Depths can be tailored to suit project requirements
- Factory installed, high quality integral benching
- Step rungs to BS EN 13101 and ladders to BS EN 14396
- Optional riser section
- Riser location ring
- Integral lifting points available on request to improve Health and Safety of handling and installation

Element	Value
Physical properties	
Diameter mm	900-3000
Depth	To suit requirements
Material	HDPE
Colour	Black with blue interior
Loading	Determined by structural design
Chemical resistance	HDPE is naturally resistant to most chemicals naturally found in stormwater run-off and uncontaminated ground
Inlets/outlets mm	100-3000

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RIDGISTORMSeparate Silt Traps

Located upstream of detention, attenuation and infiltration drainage systems, RIDGISTORMSeparate Silt Traps capture and retain silt and separate out other particles by encouraging settlement in the unit sump, preventing ingress into Sustainable urban Drainage Systems (SuDS). This range of small diameter silt traps are standard stock items and are readily available.

Mini silt trap
Product code: PSMST110

Advanced silt trap
Product code: PSMST160/15

Basic silt trap
Product code: PSMST160

RIDGISTORMSeparate Silt Traps key benefits

- Improves water quality by removing silt, grit and litter, protecting downstream elements of the drainage systems
- Self cleansing
- Prevents the ingress of debris, silt and litter into the structure
- Multiple inlet and outlet options, supplied with integral sockets as standard allowing quick and seamless connection to pipeline
- Plastic or lockable steel covers available from Polypipe Building Products

Applications

For use in stormwater drainage systems typically located upstream of detention, attenuation and infiltration drainage elements to protect the ingress of silt and other particles.

SILT TRAP ASSOCIATED PRODUCTS		
Physical properties	Description	Code
PVC 320mm cover & frame (round)	320mm sealed screw down cover & frame, includes seals and fixing screws	UG501
PVC 320mm cover & frame (square)	320mm square plastic cover with PP frame, includes seals and fixing screws	UG502
460mm silt trap cover & frame (round)	Round cover complete with seals and fixing screws (35kN test load)	UG511
450mm silt trap cover & frame (square)	Square PP cover complete with seals and fixing screws (35kN test load)	UG512
Polypropylene cover & frame	Reduced access square PP cover and frame with seals and fixing screws (35kN test load)	ICDC1
Chamber riser section	Silt trap side riser (215mm effective height)	ICDR1
Silt trap sealing ring	EPDM 110mm seal	UG488

Note: Polypropylene (PP)

Physical properties	Mini	Basic	Advanced
Nominal diameter mm	320	460	460
Depth mm	440	1220	830
Inlet and Outlet mm	110 (BS EN 1401-1)	160 (BS EN 1401-1)	160 (BS EN 1401-1)
Sump depth mm	250	420	280
Material	Polypropylene	Polypropylene	Polypropylene
Colour	Black chamber	Black chamber	Black chamber
Chemical resistance	Polypropylene is resistant to the most chemicals associated with stormwater drainage systems	Polypropylene is resistant to the most chemicals associated with stormwater drainage systems	Polypropylene is resistant to the most chemicals associated with stormwater drainage systems

Note: For a Basic Silt Trap risers and seals are required. The bucket and filter are easily removable from the Advanced Silt Trap to enable cleaning.

RIDGISTORMSeparate Catchpits

Our purpose-built large diameter high density polyethylene (HDPE) pre-fabricated catchpits are ideal for stormwater and land drainage applications and are the simplest and most cost-effective way of separating out silt and debris, providing an easily maintainable drainage system.

RIDGISTORMSeparate Catchpits are designed to separate silt and other particles from stormwater, helping to protect the downstream drainage system and local environment. They can be integrated into our range of pipe systems, such as Ridgidrain and Ridgistorm-XL, to offer a fully integrated drainage system.

Applications

RIDGISTORMSeparate Catchpits are pre-fabricated for use in a range of stormwater systems requiring silt and debris separation and detention.

Performance

RIDGISTORMSeparate Catchpits are fabricated from Ridgistorm-XL pipework, which is manufactured to meet the material requirements of BS EN 13476:2007 (Part 1-3).

Network Rail

WRc™ Approved PT/284/0609

For the full RIDGISTORMSeparate datasheets and standard details, please visit our website www.polypipe.com/toolbox

RIDGISTORMSeparate Catchpits key benefits

- Provides easy access for silt collection
- Network Rail Parts and Drawing System (PADS) approved for use in access areas
- Separates silt and debris from the downstream drainage system
- Fully-welded, watertight structured wall chambers to suit project-specific requirements
- One-piece installation, off-site construction, delivered ready-to-install reducing installation time and costs
- Multiple inlet and outlet options, supplied with integral sockets as standard allowing quick and seamless connection to pipeline
- Depths can be tailored to suit project requirements
- Step rungs to BS EN 13101 and ladders to BS EN 14396
- Integral lifting points available on request to improve Health and Safety of handling and installation

Element	Value
Physical properties	
Diameter mm	450–3000
Depth	To suit requirements
Sump depth	To suit (min. 50mm)
Material	HDPE
Colour	Black with blue interior
Chemical resistance	HDPE is naturally resistant to most chemicals associated with stormwater drainage systems
Inlets/outlets mm	100-3000

RIDGISTORMSeparate Weir and Baffle Chamber

RIDGISTORMSeparate Weir and Baffle Chambers can be installed within new installations or retrofit into existing drainage systems. They are designed to provide basic silt and oil separation, retaining these pollutants in the drainage system and protecting downstream systems.

RIDGISTORMSeparate Weir and Baffle Chambers can be integrated into our range of pipe systems, such as Ridgidrain and Ridgistorm-XL, or even engineered to connect to other materials to offer a fully integrated drainage system.

Applications

RIDGISTORMSeparate Weir and Baffle Chambers are pre-fabricated for use in a range of stormwater attenuation and infiltration systems requiring 'in-line' silt and oil separation.

Element	Value
Physical properties	
Diameter mm	900-3000
Depth	To suit requirements
Sump depth	To suit (min. 50mm)
Material	HDPE
Colour	Black with blue interior
Chemical resistance	HDPE is naturally resistant to most chemicals associated with stormwater drainage systems
Inlets/outlets mm	100-3000

RIDGISTORMSeparate Weir and Baffle Chamber key benefits

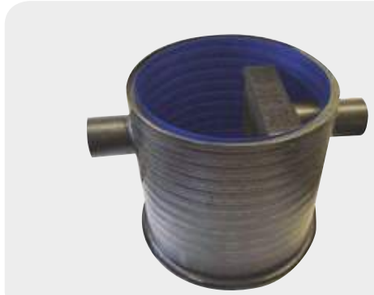
- Separates silt and oil to protect the downstream drainage network
- Tailor-made, fully-welded, watertight pre-fabricated chambers to suit project-specific requirements
- One-piece installation, off-site construction - delivered ready-to-install reducing installation time and costs
- Multiple inlet and outlet options allowing quick and seamless connection to pipelines
- Depths can be tailored to suit project requirements
- Step rungs to BS EN 13101 and ladders to BS EN 14396
- Integral lifting points

WRc™ Approved PT/284/0609

For the full RIDGISTORMSeparate datasheets and standard details, please visit our website www.polypipe.com/toolbox

RIDGISTORMSeparate Filter Chamber

RIDGISTORMSeparate Filter Chambers incorporate both a sump and removable filter unit on the chamber outlet to capture silt and debris. The filter unit is easily removed for maintenance purposes and can also be incorporated into Catchpits and Weir and Baffle Chambers.



RIDGISTORMSeparate Filter Chambers can be integrated into our range of pipe systems, such as Ridgidrain and Ridgistorm-XL, to offer a fully integrated drainage system.

Applications

RIDGISTORMSeparate Filter Chambers are pre-fabricated for use in a range of stormwater systems requiring silt and debris separation.

Performance

RIDGISTORMSeparate Filter Chambers are fabricated from Ridgistorm-XL pipework, which is manufactured to meet the material requirements of BS EN 13476:2007 (Part 1-3).

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RIDGISTORMSeparate Filter Chamber key benefits

- Easily accessible removable filter
- Washable filter unit
- Multiple inlet and outlet options, supplied with integral sockets as standard allowing quick and seamless connection to pipeline
- Depths can be tailored to suit project requirements
- Step rungs to BS EN 13101 and ladders to BS EN 14396
- Integral lifting points available on request to improve Health and Safety of handling and installation

Element	Value
Physical properties	
Diameter mm	500-3000
Depth	To suit requirements
Sump depth	To suit (min. 50mm)
Material	HDPE
Colour	Black with blue interior
Chemical resistance	HDPE is naturally resistant to most chemicals associated with stormwater drainage systems
Inlets/outlets mm	100-3000

Downstream Defender®

Manufactured by Hydro International

Advanced vortex separation maximizes sediment removal while controlling costs.

The Downstream Defender® is an advanced vortex separator used to treat stormwater run-off in pre-treatment or stand-alone applications. Its unique flow-modifying internal components distinguish the Downstream Defender® from conventional and simple swirl separators that typically bypass untreated peak flows to prevent washout of captured pollutants. Its wide treatment flow range, low headloss, small footprint and low-profile make it a compact and economical solution for capturing non-point source pollution.

1. **Inlet to Pre-cast Vortex Chamber**
2. **Cylindrical Baffle**
3. **Centre Shaft**
4. **Outlet Pipe**
5. **Sediment Storage Sump**
6. **Access Lid**

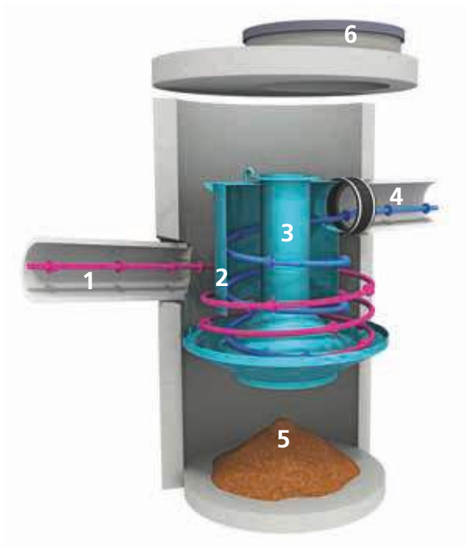


Fig.1 The Downstream Defender® has internal components designed to maximize pollutant capture and minimize pollutant washout.

Applications

- Removal of total suspended solids (TSS), floatable trash and petroleum products from stormwater run-off
- New construction or redevelopment of commercial and residential sites
- Pollutant hotspots such as maintenance yards, parking lots, gas stations, streets, highways, airports and transportation hubs
- Site constrained LID or green infrastructure based developments
- LEED® development projects

Performance

Advanced hydrodynamic vortex separation is a complex hydraulic process that augments gravity separation with low-energy rotary forces. The flow modifying internal components used in the Downstream Defender® harness the energy from vortex flow and maximize the time for separation to occur while deflecting high scour velocities (Fig.1).

Polluted stormwater is introduced tangentially into the side of the pre-cast vortex chamber to establish rotational flow. A cylindrical baffle with an inner centre shaft creates an outer (magenta arrow) and inner (blue arrow) spiraling column of flow and ensures maximum residence time for pollutant travel between the inlet and outlet.

Oil, trash and other floating pollutants are captured and stored on the surface of the outer spiraling column. Low energy vortex motion directs sediment into the protected sump region. Only after following a long three-dimensional flow path is the treated stormwater discharged from the outlet pipe. Maintenance ports at ground level provide access for easy inspection and clean-out.

Downstream Defender® key benefits

- Special internal components maximize pollutant capture and minimize footprint, headloss and washout
- Captures and retains a wide range of TSS particles
- High peak treatment flow rates
- Treats the entire storm with no washout or untreated bypass flows
- Low maintenance requirements - no dredging required, and no screens or media to block
- Variable inlet/outlet angles for ease of site layout

Design

Drainage profile

The Downstream Defender® is designed with a submerged tangential inlet to minimise turbulence within the device. Turbulence increases system headlosses and reduces performance by keeping pollutant particles in suspension.

The inlet elevation of the Downstream Defender® is located one inlet pipe diameter lower than the elevation of the outlet invert (Fig.2). This arrangement ensures that influent flows are introduced to the treatment chamber quiescently below the water surface elevation, minimising turbulence.

The unique flow-modifying internal components also minimise hydraulic losses. There are no internal weirs or orifices; large clear openings ensure low headloss at peak flow rates with little risk of blockages that cause upstream flooding.

Sizing and design

The Downstream Defender® can be used to meet a wide range of stormwater treatment objectives. It is available in 5 pre-cast models that fit easily into the drainage network (see table below). Selection and layout of the appropriate Downstream Defender® model depends on site hydraulics, site constraints and local regulations. Both online (Fig.3a) and offline (Fig.3b) configurations are common.

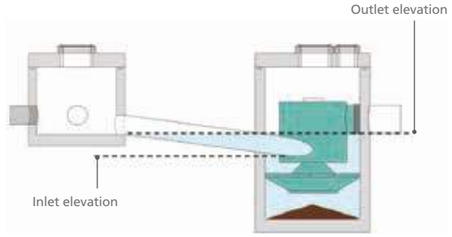


Fig.2 The Downstream Defender® has a submerged inlet that reduces headloss and improves efficiency of pollutant capture.

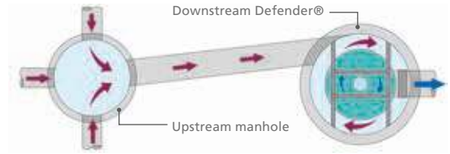


Fig.3a The Downstream Defender® in an online configuration.

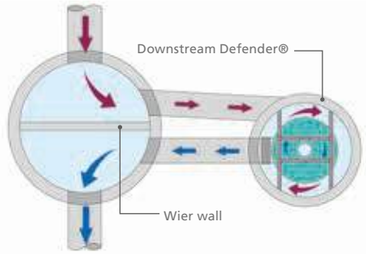


Fig.3b The Downstream Defender® in an offline configuration.

DOWNSTREAM DEFENDER® DESIGN CHART

Model number & diameter		Peak treatment flow rate		Maximum pipe diameter		Oil storage capacity		Sediment storage capacity		Minimum distance from outlet invert to top of rim		Standard height from outlet invert to sump floor	
ft	m	cfs	L/s	in	mm	gal	L	yd³	m³	ft	m	ft	m
4	1.2	3.0	85	12	300	70	265	0.70	0.53	2.8	0.85	4.1	1.25
6	1.8	8.0	227	18	450	216	818	2.10	1.61	3.2	0.98	5.9	1.80
8	2.4	15.0	425	24	600	540	2,044	4.65	3.56	4.2	1.28	7.7	2.35
10	3.0	25.0	708	30	750	1,050	3,975	8.70	6.65	5.0	1.52	9.4	2.85
12*	3.7	38.0	1,076	36	900	1,770	6,700	14.70	11.24	5.6	1.71	11.2	3.41

*Not available in all areas. Contact Hydro International for details.

First Defense®

Manufactured by Hydro International

Cost-effective stormwater treatment with adaptability to meet demanding site requirements.

The First Defense® is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with an integral peak flow bypass. It efficiently removes sediment total suspended solids (TSS), trash and hydrocarbons from stormwater run-off without washing out previously captured pollutants. The First Defense® is available in several model configurations to accommodate a wide range of pipe sizes, peak flows and depth constraints.

1. **Inlet Grate (optional)**
2. **Inlet Chute**
3. **Inlet Pipe (optional)**
4. **Floatables Draw Off Slot (not pictured)**
5. **Pre-cast Vortex Chamber**
6. **Internal Bypass**
7. **Outlet Chute**
8. **Outlet Pipe**
9. **Oil and Floatables Storage**
10. **Sediment Storage Sump**

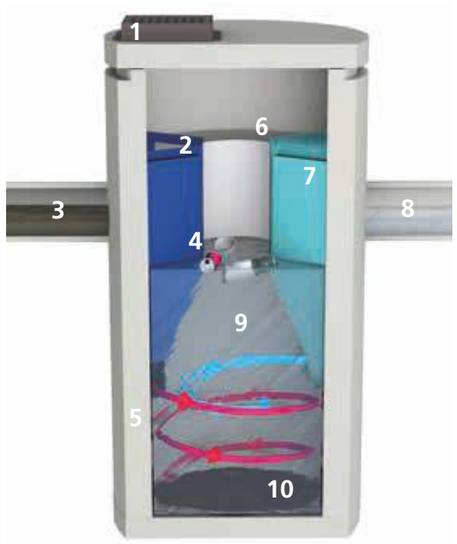


Fig.1 The First Defense® has internal components designed to efficiently capture pollutants and prevent washout at peak flows.

Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pre-treatment for filters, infiltration and storage

Performance

The First Defense® has internal components designed to remove and retain gross debris, total suspended solids (TSS) and hydrocarbons (Fig.1).

Contaminated stormwater run-off enters the inlet chute from a surface grate and/or inlet pipe. The inlet chute introduces flow into the chamber tangentially to create a low energy vortex flow regime (magenta arrow) that directs sediment into the sump while oils, floating trash and debris rise to the surface.

Treated stormwater exits through a submerged outlet chute located opposite to the direction of the rotating flow (blue arrow). Enhanced vortex separation is provided by forcing the rotating flow within the vessel to follow the longest path possible rather than directly from inlet to outlet.

Higher flows bypass the treatment chamber to prevent turbulence and washout of captured pollutants. An integral bypass conveys infrequent peak flows directly to the outlet chute, eliminating the need for, and expense of, external bypass control structures. Floatables are diverted away fromthe bypass into the treatment chamber through the floatables draw off slot.

First Defense® key benefits

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for “offline” arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 500% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

Maintenance

The First Defense® needs minimal maintenance, but like all structural best management practices maintenance is necessary for the long-term protection of the environment. Sediments captured by the First Defense® are stored in the sump; floatable trash and hydrocarbons are stored on the surface of the standing water. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.2).

More information can be found in the First Defense® Operation and Maintenance Manual, available at **www.hydro-int.com/us/products/first-defense.**

Fig.2 Maintenance is performed with a standard sump vac.

Sizing and design

Design options for inlet and internal bypass arrangements

For maximum flexibility the First Defense® inlet and internal bypass arrangements are available in several configurations (Fig.3a - 3c). Model parameters and design criteria are shown in the table below.

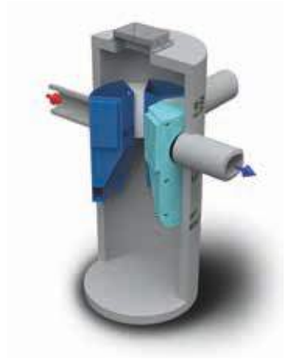


Fig.3a Inlet configurations for all models include options for inlet grates and multiple inlet pipes.

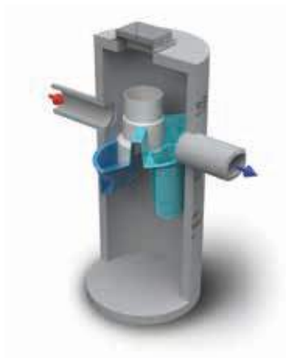


Fig.3b First Defense®-4HC with higher capacity internal bypass and larger maximum pipe diameter.

Fig.3c First Defense®-6DB with higher capacity dual internal bypass and larger maximum pipe diameter.

FIRST DEFENSE® MODELS AND DESIGN CRITERIA

Model number	Diameter	Typical flow rates for TSS treatment		Peak online flow rate	Maximum pipe diameter	Oil storage capacity	Minimum sediment storage capacity[2]	Minimum distance from outlet to top of rim[3]	Standard distance from outlet invert to sump floor[1]
		106µm	230µm						
	ft / m	cfs / L/s	cfs / L/s	cfs / L/s	in / mm	gal / L	yd³ / m³	ft / m	ft / m
FD-4	4 / 1.2	0.7 / 20	1.2 / 34	6.0 / 170	18 / 457	180 / 681	0.23 / 0.18	3.1 / 1.07	5.0 / 1.52
FD-4HC				15.0 / 425	24 / 610			2.3-4.0 / 0.7-1.2	
FD-6	6 / 1.8	2.2 / 63	3.8 / 108	18.0 / 510	24 / 610	420 / 1,590	0.52 / 0.40	4.0 / 1.22	6.0 / 1.83
FD-6DB				25.0 / 708	30 / 762				

[1] Contact Hydro International when larger pipe sizes are required.
[2] Contact Hydro International when custom sediment storage capacity is required.
[3] The minimum distance for the 4HC and 6DB models depends on pipe diameter.

Up-Flo® Filter

Manufactured by Hydro International

Highest stormwater quality. Lowest upkeep.

The Up-Flo® Filter is a multi-stage stormwater treatment system that combines pre-reatment with fluidized bed filtration technology for superior filtration rates and media longevity. The Up-Flo® Filter optimizes the balance between high treatment performance and total cost of ownership.

1. **Inlet grate (pictured) or Inlet Pipe (not shown)**
2. **Pre-cast Filtration Chamber**
3. **Filter Module**
4. **4mm Screening**
5. **Bypass Hood/Siphon**
6. **Outlet Module with Drain Down Filter**
7. **Pollutant Storage Sump**
8. **Media bags**

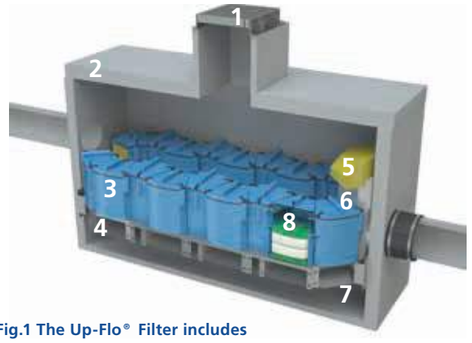


Fig.1 The Up-Flo® Filter includes sedimentation, screening and filtration in a single device.

Applications

- Removal of sediment, nutrients and metals from run-off
- Source control for redevelopment or new construction
- Treatment downstream of Water Quality Volume detention systems
- Sites operating under an industrial or multi-sector general permits
- Protection for groundwater recharge systems
- LEED® construction projects

How it works

1. **Pre-treatment:** Oil and floatables rise to the surface while sediment settles in the sump.
2. **Screening:** Flow is directed upward through an angled screen to remove debris before entering the filter module.
3. **Filtration:** Water flows upwards through engineered media bags (see Fig.2) before leaving the outlet module to be discharged through the outlet pipe.

During peak flows, excess water is siphoned through the yellow bypass hood which also prevents the escape of oil and trash. As water levels return to normal, captured pollutants are washed off media bags, preventing blinding and prolonging media life.

Filter Module components

Each Filter Module contains two filter bags containing an engineered media mix designed to optimize pollutant removal by evenly spreading the flow across the entire surface area.

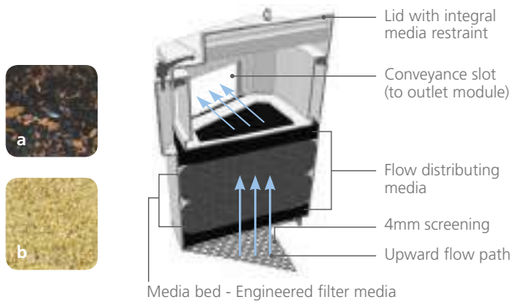


Fig.2 Engineered media mixes, include (a) CPZ™ Mix for TSS, Nutrients, Metals and Organics removal or (b) Hydro Filter Sand for TSS, Particle-bound Nutrients and Metals removal.

Up-Flo® key benefits

- Sedimentation, screening and filtration in one structure
- Upflow fluidised bed technology prevents clogging of filter media
- Includes an integral high flow bypass and trap for oils and trash
- Economical media bag replacement process requires neither heavy lifting equipment nor purchase of entirely new cartridge
- Independently verified through TARP field monitoring program

UP-FLO® FILTER DIMENSIONS

Chamber	Diameter	Maximum filter modules	Height	Sump depth	Inlet/outlet drop	Maximum Pipe Diameter	Operating head	Maximum treatment flow
	ft / m	No.	ft / m	ft / m	ft / m	in / mm	ft / m	cfs / L/s
Round Manhole	4 / 1.2	6	7.5 / 2.29	3.0 / 0.91	0.8 / 0.24	15 / 375	2.5 / 0.76	0.056 cfs per module
Rectangular Vault	6 x 8 / 1.8 x 2.4	7	6.5 / 1.98	2.0 / 0.60		24 / 609		
	6 x 13 / 1.8 x 3.9	18						
	8.5 x 13 / 2.5 x 3.9	36						
	15 x 13 / 4.5 x 3.9	54						

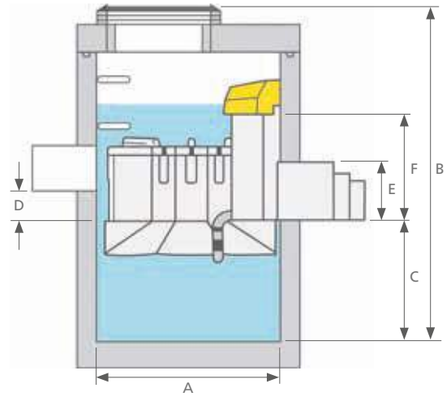


Fig.3 Key dimensions of the Up-Flo® Filter.

Sizing and design

The modular design of the Up-Flo® Filter ensures that project specific treatment goals are easily met. Standard and typical dimensions listed above. Use our sizing calculator to determine appropriate site-specific sizing.

Maintenance

Easy: Maintenance is simple with easy access to the sump and replaceable media packs. A vactor truck is used to remove sediment and debris from the sump (Fig.4a).

Light in weight: Unlike other filter systems whose media cartridges weigh upwards of 250lbs, our light-weight media bags can be manually replaced without removing the entire module (Fig.4b).

Fig.4a Sediment is removed with a standard vactor truck.

Fig.4b Media bags are replaced manually with no heavy lifting equipment required.

Hydro-Brake® Optimum

Manufactured by Hydro International

The Hydro-Brake® Optimum is Hydro International's flagship passive flow control device and the most advanced vortex flow control available. Hydro-Brake® Optimum is the only vortex flow control for which the head and discharge relationship can be fine-tuned to optimise your design. Designers can size a Hydro-Brake® Optimum to achieve the perfect hydraulic performance curve and engineer the best possible passive flow control performance.

Applications

- Surface water management and SuDS
- Combined drainage systems and CSOs
- Watercourse flood prevention
- Sewer network optimisation
- Wastewater treatment plants

Performance

There is no equivalent: Hydro-Brake® Optimum dispenses with the need to choose from a range of sizes and types and instead offers built-in flexibility to size each unit for absolute fit. Each Hydro-Brake Optimum® is individually-sized, so you achieve performance without compromise for every project.

Maximise storage savings: The increased hydraulic efficiency of the Hydro-Brake® Optimum means you can reduce on-site storage by up to 15% than if an alternative vortex control is used. With reduced storage, you can lower construction and excavation costs as well as saving project time and overall land-use.

Best value for every project: Selecting the superior performance of Hydro-Brake® Optimum does not mean a higher cost for your project. On the contrary, because your upstream storage can be fine-tuned to achieve the smallest volumes, construction, excavation and material costs are reduced.

Easy to install: Hydro-Brake® Optimum comes with a range of installation options and accessories to make construction and installation as simple as possible.

Setting the standard: The Hydro-Brake® Optimum is the culmination of more than 35 years of research and development by Hydro International, and the company continues to take an international lead in vortex technology and expertise. Hydro-Brake® Optimum is the only vortex flow control to be independently certified by BBA and WRc.

Minimal maintenance: With up to 20% larger outlet clearances compared to other vortex devices, there is significantly less risk of blockage with a Hydro-Brake® Optimum. With no power source or moving parts, it offers minimal, predictable maintenance.

Future-proofed: Hydro-Brake® Optimum can be supplied with an adjustable inlet so flows can be altered by up to 40% post-installation, to allow for future changes in operating conditions, for example as a result of site expansion or climate change.

Flow control chamber: A Hydro-Brake® Optimum flow control can be supplied pre-fitted in a pre-cast reinforced concrete chamber. Custom options including high level emergency bypass, rodding pipe and removable units are also available.

Hydro-Brake® key benefits

- No external energy source
- No moving parts
- Future-proof
- Large outlet clearances prevent blockages
- Minimal Maintenance
- Easy to Install

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE No. 08/4598

WRc™ Approved PT/329/0412

Hydro-Brake® Flow Control Series Selection Guide

The Hydro-Brake® Flow Control Series is a versatile toolbox for surface water, fluvial, foul water, and sewer network flow control. No matter what the site and budget, every flow control offers the same precision-engineered performance.

UP-FLO® FILTER DIMENSIONS				
Features	Hydro-brake® flood alleviation	Hydro-brake® optimum	Hydro-brake® agile	Hydro-brake® orifice
	ft / m	No.	ft / m	ft / m
Suitability	For watercourses; Flood storage reservoirs	Most sites, from very low to very high flow rates	Constrained sites with stringent discharge consents	Unconstrained sites with generous discharge consents
Flow Range (l/s) *	550 - 12000	0.7 - 550	4.5 - 35	2.5 - 100
Head Range (m) *	1.5 - 10	0.4 - 4.0	0.5 - 1.4	0.25 - 2.0
Ability to Match Greenfield Discharge Rate	N/A	Very good	Good	Not suited to all sites
Moving Parts	No	No	Yes	No
External Power Requirement	No	No	No	No
Constant Discharge	No	No	Yes	No
On-site Storage	Low	Low	Very Low	Unconstrained
Risk of Blockage	Very Low	Very Low	Not suited to all sites	Not suited to all sites

*Flows and heads outside of these ranges may be possible (contact Hydro International to discuss).

Expert Design Support

No matter how big or small the project, Hydro International's professional engineers are on hand to provide free support to designers and specifiers to aid with the correct selection and configuration of Hydro flow controls for each project design.

Our dedicated design support team advises on best-practice sizing, flow and storage calculations for the Hydro-Brake® Flow Control Series within your surface water, fluvial, sewer or wastewater plant design.

Consultancy

Hydro International's Consultancy team is available for civil engineering, flood risk management and hydraulic system modelling for new and retrofit development, fluvial or wastewater treatment plant projects.

Documentation

Our dedicated design support team can assist with the output of hydraulic data to support your system design and dimensioned installation drawings, as well as advising on successful integration with other Hydro International water treatment and storage products.

7.0 Project solutions

We have considerable project experience in sustainable drainage projects, providing tailor made solutions for our customers' requirements.

Case study – Kent College, Dubai, UAE

Whilst initial site plans included the specification of a traditional concrete soakaway tank, the client opted for a Polystorm tank to provide necessary stormwater soakaway on-site.

Dubai residents have another first class education option for their children with the introduction of the brand-new Kent College. The ultra-modern campus, which also boasts a sister school in Canterbury (UK), will offer a British education to children aged 3-18, while being grounded with local values and customs.

As part of this ambitious project, the appointed MEP Contractor, Power Point Electrical and Mechanical Works called on Polypipe to assist with a suitable drainage solution, having successfully used the company's drainage solutions on previous projects.

Ted Jacobs Engineering, the chosen MEP Consultant, originally opted for a Push-Fit drainage system for the school. After visiting Polypipe's Technical Centre, the consultant recognised the benefits that the Terrain Solvent Weld system could offer.

Thanks to its unique joint integrity, Ted Jacobs opted or Terrain Solvent Weld to manage the school's soil and waste drainage.

Visiting Polypipe's state-of-the-art Technical Centre also presented the opportunity for Ted Jacobs' staff to appreciate the benefits of utilising Polystorm, Polypipe's internationally recognised engineered stormwater geocellular solution.

Choosing a Polystorm geocellular solution versus the traditional alternative meant that the College would benefit from a soakaway solution to sit beneath the grounds of the campus. The 95% void fill ratio of Polystorm means that any storm event can be adequately captured within the system, with stormwater discharged in a controlled manner into the surrounding area.

The significant time and cost savings offered using the Polystorm system, combined with a local manufacturing base in the UAE ensured that materials were readily available resulting in Polypipe supplying a 157m3 tank to the Main Contractor Chicago Maintenance & Construction Co LLC for the project and provide technical support throughout the installation process.

Case study – Jebel Ali Hills Development, Dubai, UAE

Polypipe worked closely with international infrastructure consultants, Parsons to design and determine a suitable stormwater management strategy, given the lack of local drainage networks and need to address rainfall events.

This substantial new development by Meraas is located close to the new Dubai Theme Parks, south of Jebel Ali. Polystorm geocellular solutions were specified due to their third-party accredited structural capability in a challenging environment, where long term performance and durability were critical for such a prestigious development.

Case study – Northgate Mall, Doha, Qatar

The $290m North Gate Shopping Mall project in Doha, on Al Shamal North Road, provides an exceptional, international standard mixed-use project offering a unique point of difference in Qatar.

Following detailed consideration, Polystorm Geocellular Stormwater Solutions were proposed by Habtoor Leighton Group as an alternative to traditional concrete tanks to form part of the developments' stormwater management strategy. Polystorm provided substantial cost savings, installation speed and durability relative to the local environment and ground conditions in Doha. This was successfully installed in a fraction of the time when compared to conventional methods.

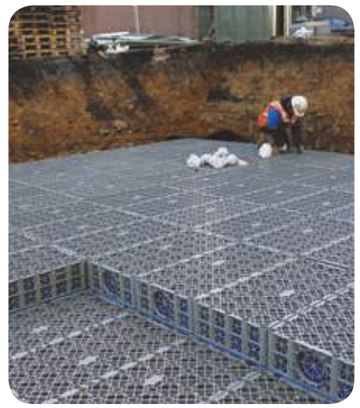
Case study – Etihad Museum, Dubai, UAE

Dubai is home to a new Etihad Museum, telling the story of the union between the seven Emirates after the treaty was signed in 1971.

Working with Al Shafar Group and MEP Consultants CH2M Hill, Polystorm Geocellular Systems was specified and installed on this futuristic new development.

Polystorm geocellular tanks were designed to manage large discharge requirements during storm events, utilised to detain and control the water during peak flows. Polystorm was specifically manufactured to meet the regions' extreme environment, whilst also achieving demanding structural requirements to ensure maximum design life.

Case study – Sharjah Shopping Mall, UAE



The Polypipe technical team were hands-on throughout this project, ensuring they were always available to provide technical support throughout the installation process, offering crucial assistance at key milestones.

Trusted by consultants worldwide, Polypipe's relationship with WSP Middle East is no different. Enlisted by the consultants for its expertise in storm/surface water management solutions, Polypipe were asked to assist with the design of Juraina Mall, a $14 million development, in Sharjah. The neighbourhood mall, a retail centre development created by Sharjah Holding, is home to 35 outlets and is situated in a key residential area. Site limitations, combined with cost concerns from the client, meant that Polypipe faced a handful of challenges. Firstly, the recommended solution had to take into account site restrictions that determined that the tank was to be installed at a shallow depth below the surface area, yet had to be able to withstand heavy loads. In addition, the costs for the set up of an internal network or a pumping station to control the water during stormwater events had to be eliminated. Polypipe expertly specified a soakaway solution using Polystorm Xtra, a 40°c tested product, to overcome these obstacles. With its ability to withstand a compressive strength of 83 tonnes/m2 and having been designed with heavy trafficked conditions in mind, this solution was the only one proposed that met with the strict structural limitations.

The robust solution that Polystorm Xtra offered, coupled with its cost effectiveness, outranked the competition and was quickly chosen as the most suitable and superior solution.

BBA certified and with a high void ratio, Polystorm Xtra provides the perfect solution for projects with stringent site limitations.
With heavy involvement throughout the sales process, Polypipe's technical team were able
to provide a robust and reliable solution that met with the CIRIA C680 guidelines and was approved both by WSP Middle East and the local municipality.

Company overview

Polypipe is the UK's largest plastic pipe systems manufacturer, employing over 2,000 people with an increasing international presence in the Middle East.

Unrivalled service

At Polypipe, we design, manufacture and deliver some of the most advanced thermoplastic products and systems available. Through our commitment to industry expertise and our dedication to the highest standards of quality, we not only provide superior products, but superior standards of service. Our Support Teams are here to help you at every stage of your project, from planning through to maintenance. Through our sustainability drive you can be rest assured that by using a Polypipe product, you are ensuring that your project takes the utmost environmental considerations into account.

The broadest product range

Offering well over 20,000 product lines, Polypipe has an enviable reputation amongst installers, contractors, stockists and specifiers for being able to provide exactly the right solution for any project. With over 100 product systems, our unmatched portfolio offers dependable, innovative solutions for pressure and non-pressure applications, enabling the movement of water, air, power, chemicals and telecommunications throughout the built environment.

Market leadership

As a respected industry leader, Polypipe continues to develop innovative products and solutions to meet changing market needs and growing demands. Customers trust us to provide fully engineered solutions for the growing diversity and complexity of the construction challenges they face. We have a significant UK manufacturing base that guarantees availability through a nationwide network of stockists and a dedicated, owned and managed logistics fleet.

Brand values

At Polypipe, we seek to deliver constant improvements in construction industry best practice by leading the way in product research and innovation, employing and retaining some of the most respected experts in the field and delivering the highest standards of customer service, value and reliability. We also define and drive quality in pipe manufacture and performance and use leading-edge technology to deliver whole-life value and sustainability by providing systems engineered to perform.

teppfa Channelling Performance
Supporter susdrain
BRITISH WATER expertise worldwide
BPF
PLASTIC PIPES GROUP
Q 06225
EMS 535794

Innovation and research

At Polypipe, we always aim to bring innovative new products to the market in direct response to our customers' needs, requirements and feedback.







Challenging convention

We have always challenged convention by exploring new ways to meet the needs of the construction industry. Chief among them has been the development of thermoplastic piping systems to replace traditional concrete and clay materials. This results in solutions that are lighter in weight whilst also being tougher and more adaptable, ultimately making them more sustainable. Our priority is to always provide the industry with robust and innovative solutions that meet the demanding performance criteria of today's construction projects.

Customer driven innovation

We look to do things efficiently and to the highest standards, not only acting on customer requirements but also being proactive with project demands and meeting all changes in legislation. We value process innovation, strong manufacturing investment and product development. However, our prime concern is always to deliver the very highest quality for our customers in manufacturing, materials, service and supply.

Expert staff

Our materials and product development specialists represent some of the leading authorities in the industry. Many even have actively engaged trade bodies including the British Plastic Federation (BPF), ICE, SoPHE, CIRIA and CIBSE, as well as other local and regional building associations. It is their knowledge and experience that allows us to offer the very highest standards of product design and development.

Quality control

We invest heavily in research and new production technology. This allows us to provide more precise performance specifications, greater reliability and high quality products that are BBA, BSI Kitemark and WRc approved. Supporting our product accreditations, our business systems are regularly assessed by BSI to ensure we maintain our BS EN ISO 9001:2008 and BS EN ISO 14001:2004 certifications. This ensures we conform to regulatory requirements and that we provide greener credentials for our products.

Testing and certification

We work closely with regulatory bodies to ensure our products meet all UK and international regulations for performance and sustainability; a vital consideration in an industry where compliance and certification are absolute priorities. Wherever possible, our products are covered by third party accreditations, including BBA, BSI Kitemark etc.

Polypipe project and technical support

10

LONG TERM ALLOWANCES

Sustainable solutions designed to provide the appropriate design life and durability.

1

PLANNING

Civil Engineers and Drainage Specialists on-hand to offer guidance on appropriate project solutions.

9

MAINTENANCE GUIDANCE

Full maintenance guidance available from our Water Management Solutions Technical Team.

2

DESIGN

Design assistance utilising CAD, microdrainage and deformation calculations available at every stage of the project.

8

ON-SITE GUIDANCE

Dedicated Product Support Team on-hand to offer advice and support on-site.

3

PRODUCT PERFORMANCE CALCULATIONS

Project specific design calculations can be provided to support our solutions and ensure effective long-term performance.

7

INSTALLATION SERVICES

Detailed installation guides offer contractors and groundworkers defined parameters to help when installing our products. We work with preferred supply and fit partners to deliver a complete installation service if desired.

4

PRODUCT SOLUTION

Utilising best engineering practice combined with the knowledge of the latest legislation and standards to specify the most appropriate solution.

POLYPIPE INTELLIGENT ENGINEERING

6

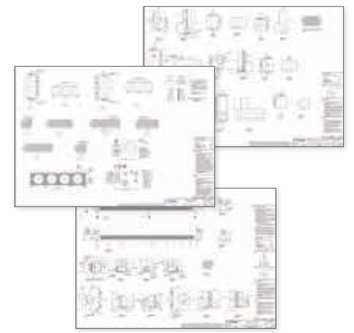
HEALTH & SAFETY

Products are designed with Health and Safety in mind and full guidance for the safe handling and storage of our products is available.

5

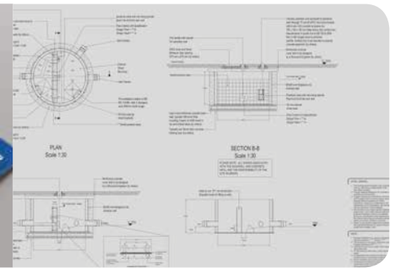
MODULARISATION

Off-site manufacture using modern methods of fabrication. A wide range of bespoke pre-fabricated chambers and fittings from our in-house Fabrications Team.



Technical resources

At Polypipe, we offer a comprehensive selection of downloadable product and technical literature that is available on our website to provide you with detailed information about our systems and solutions.



www.polypipe.com/toolbox

Brochures and technical manuals

We provide an extensive range of brochures and technical manuals, which contain topics including:

- Structural design
- Hydraulic performance
- Chemical resistance
- Applications
- Installation guidance
- Maintenance
- Structural performance
- Pollution control
- Minimum cover depths

Technical bulletins

These bulletins offer an overview of the benefits offered by our products and guidance on the typical applications they can be used for, as well as explanations of compliance requirements.

Technical Centre

The Polypipe Technical Centre in Dubai is designed to enhance knowledge and demonstrate the movement and management of water. Our state-of-the-art training facility will give you a unique insight into the future of how water can be managed more effectively in today's fast moving and developing construction industry.

Standards, approvals and certifications

All BBA and WRC certificates required to support your specification or contract are available to download.

Specification clauses, CAD drawings and technical datasheets

Our toolbox contains downloadable CAD drawings and specification clauses to ensure full design, manufacture and installation compliance, plus a full range of technical datasheets covering every product.

Installation guides, Health and Safety and COSHH datasheets

Guidance for easy, safe product handling, loading, off-loading and installation is available along with product safety information (COSHH) – supported by materials safety datasheets – which are also available to download from our website.

Case studies

Our website provides a broad range of recent case studies, including everything from infrastructure projects for roads, motorways, airports and energy, residential developments, education and commercial buildings.

Enabling sustainable building technology

At Polypipe, we provide plastic piping systems that enable the effective installation and performance of sustainable building technology, helping meet the twin global challenges of carbon reduction and water management.

Water management solutions

Roof to River

Offering a comprehensive range of standalone and modular SuDS products, rainwater harvesting and surface water treatment solutions, plus legislative and technical support services, our water management solutions team address the requirements of every construction and civil engineering project.

Carbon efficient solutions

Sustainable indoor environments

Ever stricter building regulations and an increasing number of environmentally conscious customers are driving the demand for greener building products and technologies. We fulfill this demand with a full range of systems that enable collection, transmission, emission and control in heating, ventilation and cooling systems.

Sector focus

Our product systems respond directly to sector-specific requirements thanks to focused Technical and Development Teams with hands on expertise in the following areas:

Civils and Infrastructure

Delivering performance and sustainability, our surface water drainage and cable management systems, supported by our in-house Fabrications Team, offer civils and infrastructure project planners a complete suite of solutions.

Buildings

We offer the broadest range of residential product and service solutions, as well as innovative solutions in response to legislative and industry targets for more sustainable developments. This includes major commercial projects from car parks and high rise office and residential buildings to hospitals, educational premises and shopping centres which have all benefited from our range of value engineered products and comprehensive service support.

Online technical resource

Product literature

Solutions literature

Applications literature

Data sheets

Certificates

Find us online

To stay in touch with the latest news, case studies and literature from Polypipe.

News

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Literature

www.polypipe.com/middleeast

Soakway – Infiltration Tank / Trench

Polystorm Installation Guide

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