Attenuation

Installation guide for rainwater attenuation

Overview

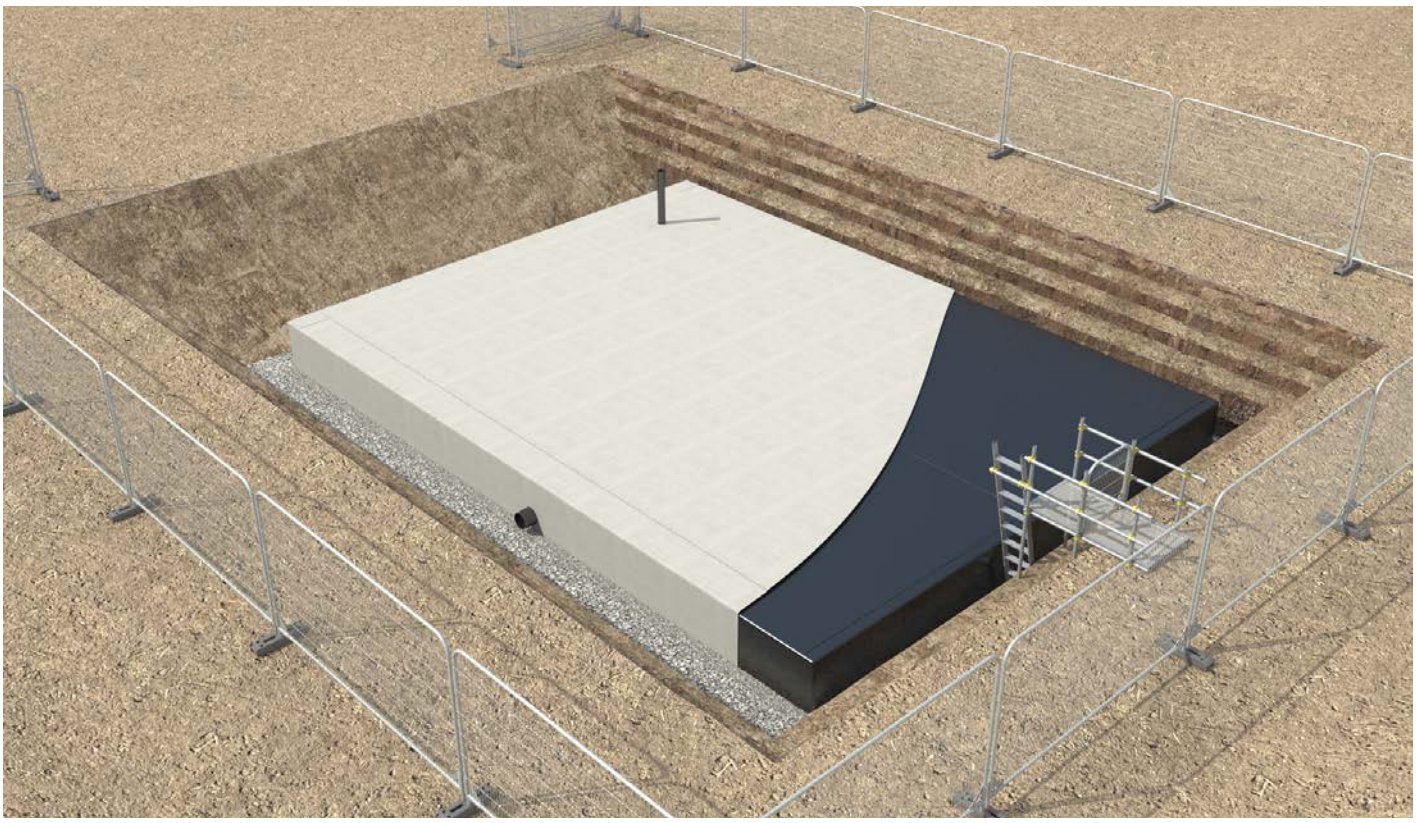
Attenuation tanks store surface water allowing it to be gradually released in a controlled way back into the environment or drainage system.

Effective water attenuation can be achieved with modular storage systems using high quality injection moulded units. We have a range of products and solutions to suit all design criteria, this includes:

- Shallow installation
- Deep installation (5m+)
- Irregular shapes
- Systems requiring inspection and maintenance

All Hydro WMS attenuation tanks are fully welded using proprietary wedge welding techniques in accordance with CIRIA guidelines.

Hydro WMS soakaways are modular systems designed and installed utilising the same high quality injection moulded units combined with a non-woven geotextile.



Section diagram shown in greater detail and description on page 4

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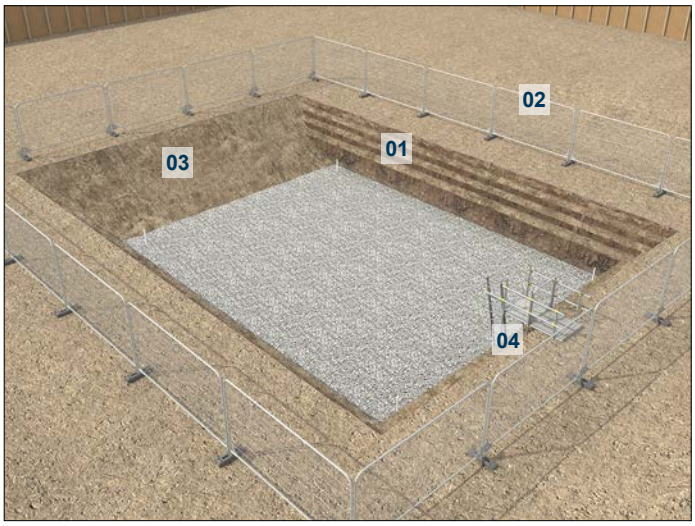
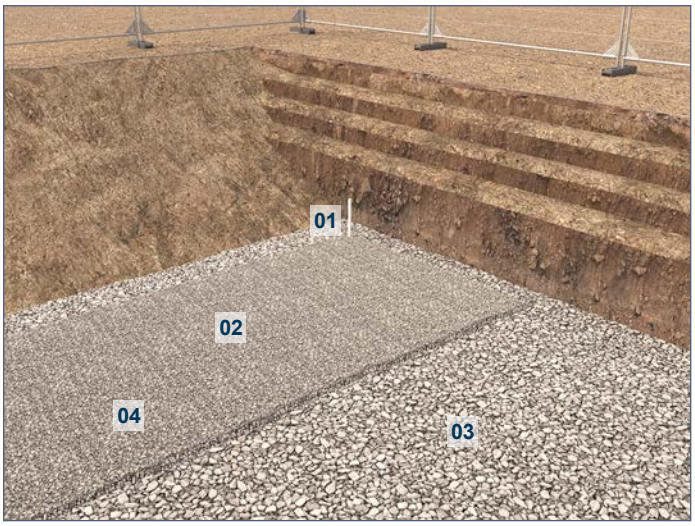


01

1. Excavation suitably battered
2. Safety barriers around excavation
3. First point of access/egress is a ramp into excavation
4. Second point of access/egress can be a ladder

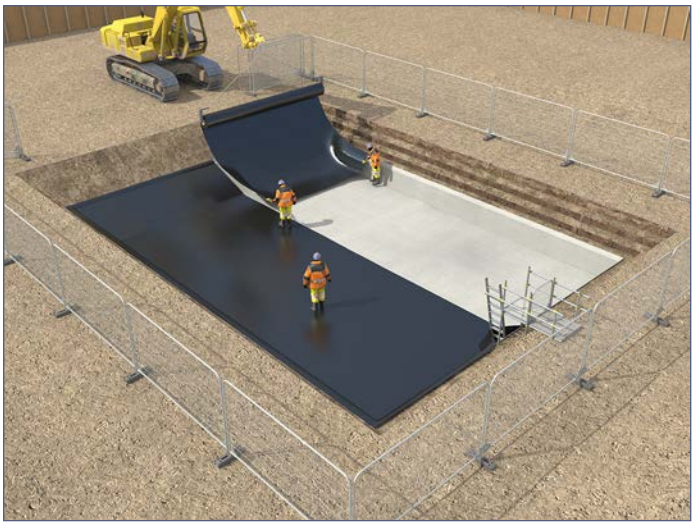


02

1. Corners measured and pegged with 300 - 500mm of workspace outside
2. 100mm pipe bedding or Type 6H material
3. Formation to have minimum CBR of 3 - 5%
4. Ensure blinding layer is flat and free from sharp objects
5. Soft spots to be dugout & replaced with appropriate material to give minimum CBR

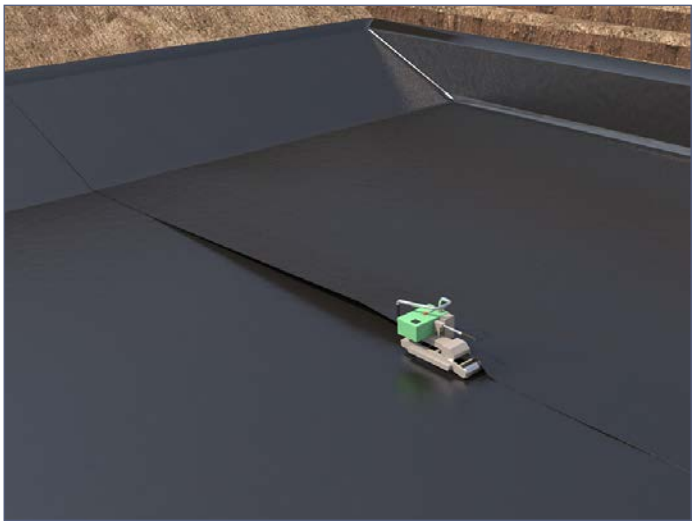
03

- Attendance required to lift geo-textile protection layer into excavation using suitable mechanical lifting equipment
- Geo-textile laid with suitable overlap by Hydro WMS operatives



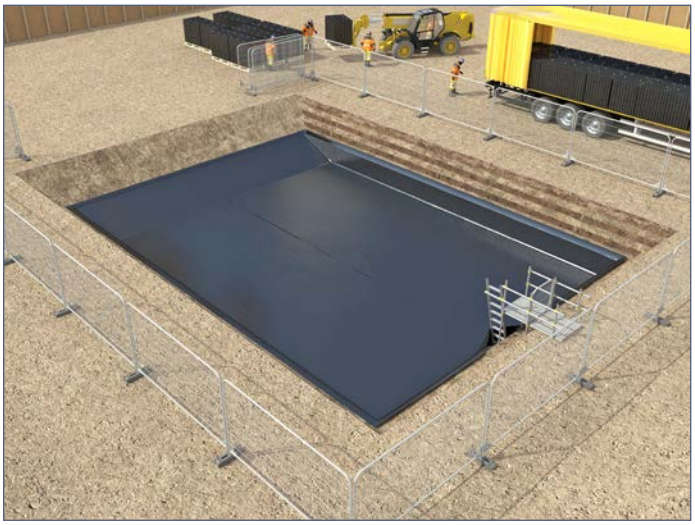
04

- Attendance required to lift rolls of geo-membrane into excavation using suitable mechanical lifting equipment
- Maximum weight not exceeding 1,300kgs
- Geo-membrane laid in excavation for welding by Hydro WMS operatives



05

- Geo-membrane wedge welded together
- Joints tested with non-destructive method



06

- Delivery by articulated curtain sided vehicle
- Ensure lift plan is in place
- Palletised cellular tank components unloaded by telehandler with forks - by contractor
- Placed beside excavation and within reach of the excavator - by contractor

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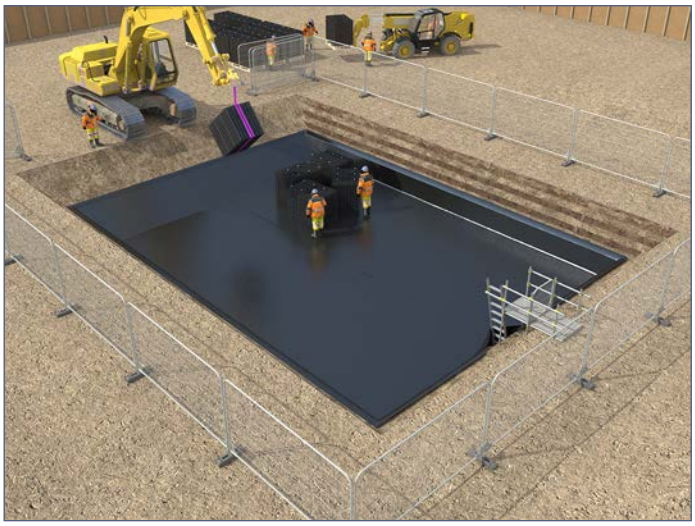
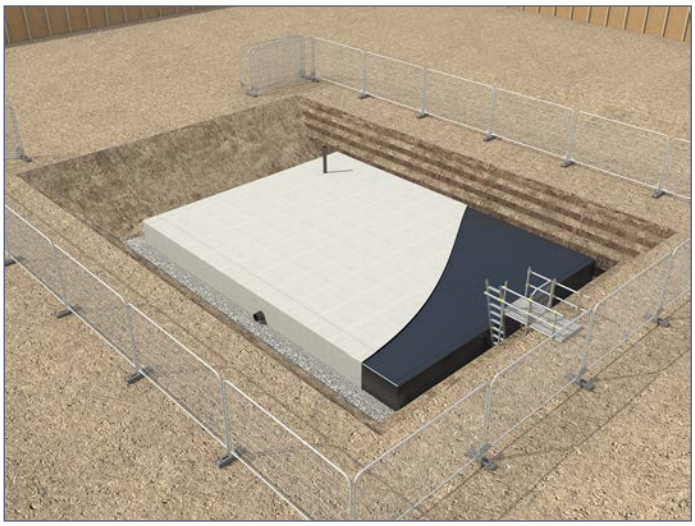


07

- Slinger banksman required to coordinate lowering cellular units into excavation
- Attendance required to lift cellular units into excavation using suitable mechanical lifting equipment
- Hydro WMS operatives to form tank

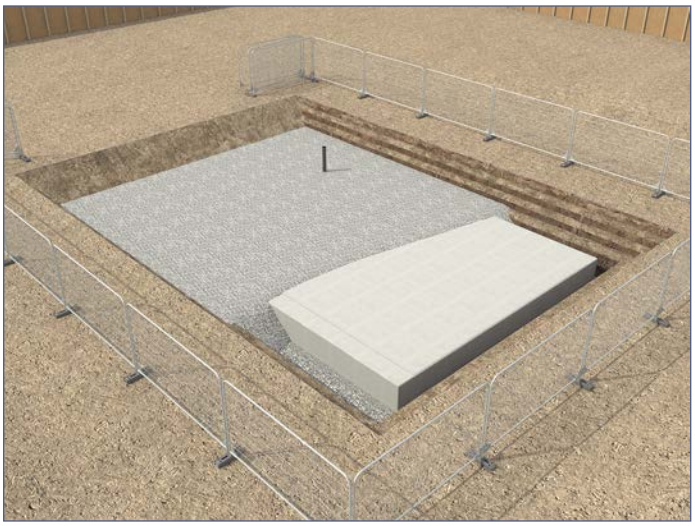
08

- Geo-membrane is folded on top of tank
- Low level pipe seal formed
- Corners trimmed and formed
- Staged backfill may be required



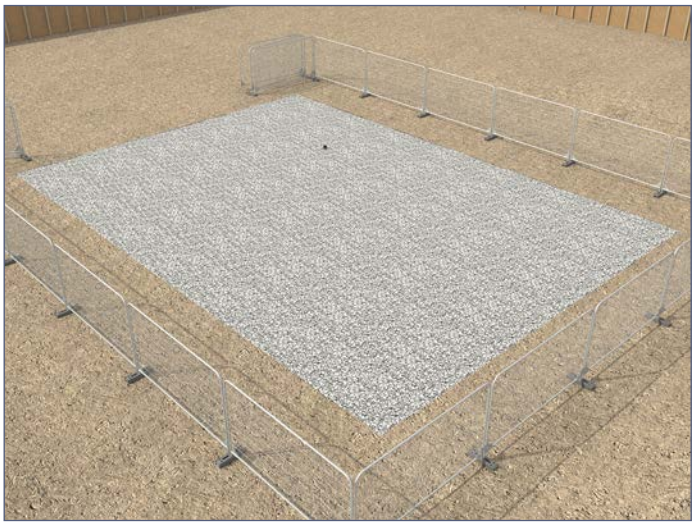
09

- Attendance required to lift geo-membrane and geo-textile to complete tank
- Lid of tank formed and wedge welded
- Vent pipe installed
- Geo-textile protection laid tvo top and sides of tank



10

- Minimum of 100mm protection layer over top of tank
- Suitable small particle aggregate to be used
- Contractor to backfill working space with agreed material
- Protection board may be required for larger particle sizes



11

IMPORTANT!

The construction loads from items of plant such as excavators and rollers are typically relatively low and deflections are not a significant consideration since the surfacing will not be completed when construction traffic is passing over

It is however recommended that other construction traffic is prevented from crossing the tank and in particular that cranes and other similar items are not located on the tanks (including any part of a mobile crane such as spreaders) unless a site-specific design check for this loading has been undertaken.

For light excavators, up to 14 tonnes and small double wheeled rollers a minimum of 300mm of cover fill should be placed over the units before trafficking; this is to prevent physical damage to them. Excavators should also be prevented from slewing when over the top of the units.

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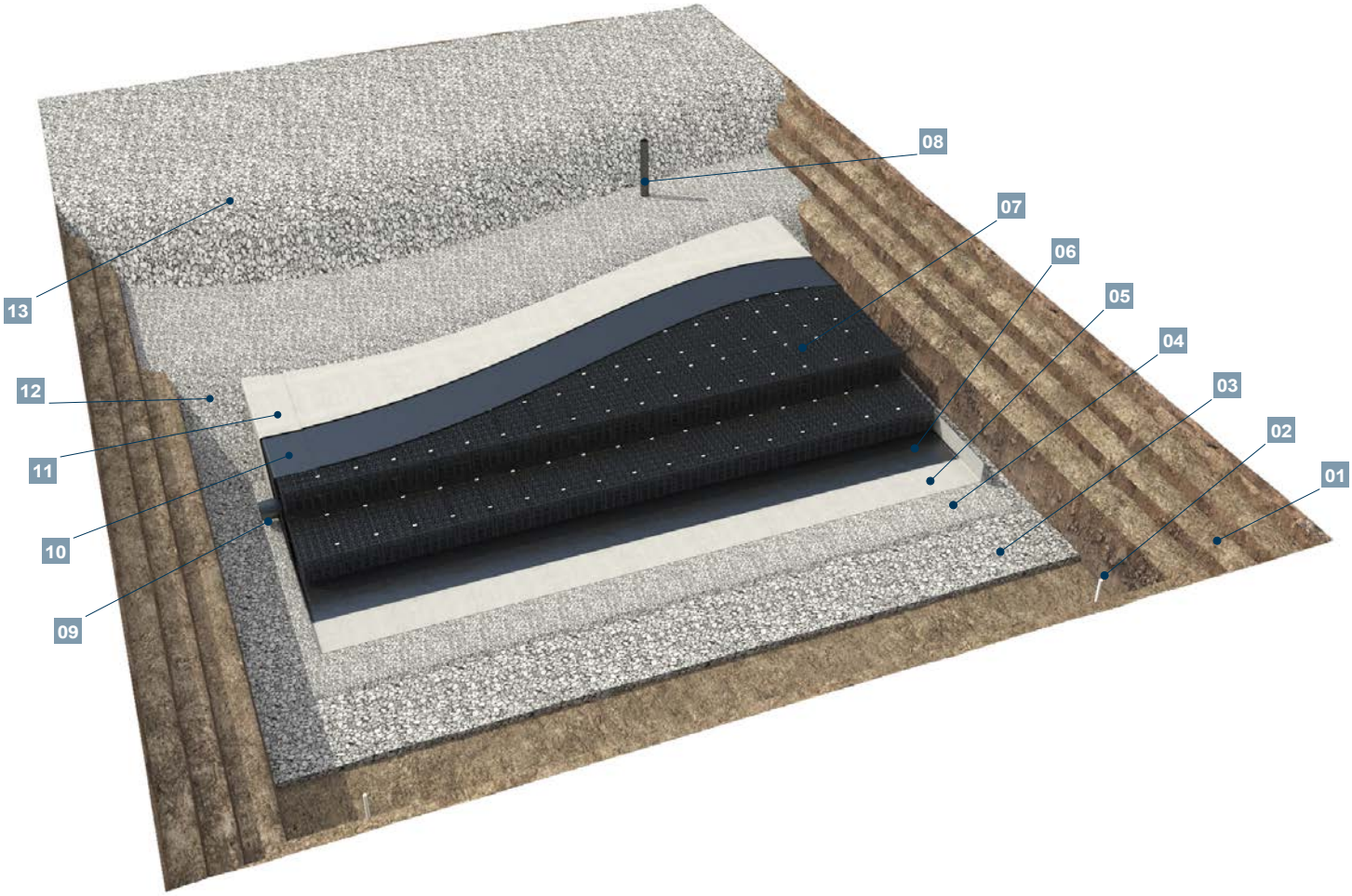
Component Details



Component information

1. Excavation suitably battered
2. Corners measured and pegged with 300 - 500mm of workspace outside
3. Formation / capping layer (where required)
4. Pipe bedding / 6H aggregate blinding layer
5. Geo-textile protective fleece
6. Geo-membrane welded layer
7. Cellular units
8. Air vent pipe
9. Water outlet pipe
10. Geo-membrane welded layer
11. Geo-textile protective fleece
12. Small particle aggregate protection layer
13. Sub-base aggregate / bulk backfill

Disclaimer

This illustration is intended as a guide for information only. Please refer to the site specific Method Statement and Risk assessment issued prior to installation.
Hydro Water Managment Solutions Limited reserve the right to change the specifications without prior notice.

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Hydro Water Management Solutions Maintenance Requirements

Regular inspection and maintenance is required to ensure the effective long term operation of below ground modular storage systems. The following table details the recommended maintenance requirements for modular systems.

Maintenance schedule	Required action	Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required take remedial action.	Monthly for 3 months then annually
	Debris removal from catchment surface (where may cause risk to performance)	Monthly or as required
	Remove sediment from pre-treatment structures and/or manifold connections	Monthly or as required
Remedial actions	Repair/rehabilitation of inlets/outlets, overflows and vents	Annual inspection or as required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build up and remove if necessary	Annually and after large storms

The maintenance plan and schedule should be developed during the design phase. Specific maintenance requirements should be identified based on upstream drainage sedimentation controls and the schedule developed to suit these needs.

Maintenance details should be detailed in the project Health & safety file and a risk assessment should be undertaken and recorded.

Note,
It is generally recommended that the cells be flushed through with large volumes of water under low pressure.

Certain modular units will allow higher pressure jetting to remove larger objects or heavier deposits of sediment. These modules can be accessed via integral access chambers (where applicable) and surveyed/flushed in a linear fashion or alternately water can be flushed/jetted through via the inlet/outlet pipe connections.

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Hydro WMS Ltd - 1.0mm PE Geomembrane Specification

Properties	Test Method	Nominal Values
Thickness (mm)	ASTM D 5199/ UNE-EN ISO 1849-2	1.0
Low temperature brittleness (ºC)	ASTM D 746, cond B	70
Oxidative induction time (minutes)	ASTM D 3895/ EN ISO 11357-3 (200ºC,Pure O_2 1Atm)	100
Dimensional stability (each direction) %	ASTM D 1204 (100ºC 1 hour)	±2
Melt flow Index g/10 minutes	ASTM D 1238	≤1.2
Water Permeability (m^3/m^2/day)	UNE-EN 14150	$<1.1^{-6}$
Stress Crack Resistance (h)	UNE-EN 14576 ASTM D 5397	>300
		Minimum Values
Thickness (mm)	ASTM D 5199/ UNE-EN ISO 1849-2	0.91
Density (g/cm^3)	ASTM D 792/1505A/ UNE-EN ISO 1183	0.92
Tensile Strength at break (MPa)	UN-EN ISO 527-3 Type 5	30 (26)
Elongation at break (%)	UN-EN ISO 527-3 Type 5	800 (≥700)
Tear resistance (N/mm)	ASTM D 1004/ UNE-ISO 34-1	≤100
Puncture resistance (kN)	SM D 4833/ UNE-EN ISO 12236	2.5
Carbon Black content (%)	ASTM D 1603/ UNE 53375-2 ISO 18553	2.0 – 3.0

*Values shown are nominal with 95% confidence level
**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.

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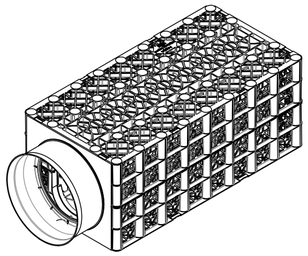
Hydro WMS Ltd - 300gsm Protection Geotextile Specification

Needle punched, thermally bonded non-woven Polypropylene geotextile

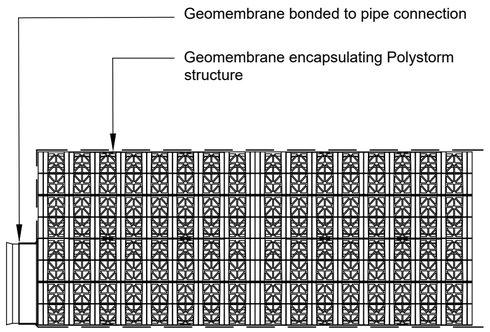
	Test Method	Typical Value
Mechanical Properties		
Tensile strength MD	EN ISO 10319	24 kN/m
Tensile strength CD		24 kN/m
Elongation MD	EN ISO 10319	65%
Elongation CD		75.0%
Static puncture Resistance - CBR	EN ISO 12236	3.7 kN
Dynamic perforation resistance cone drop	EN ISO 13433	15.0 mm
Protection efficiency	EN ISO 14574	300 KPA – 2.17 600 KPA – 3.98 1200 KPA – 6.89
Hydraulic Properties		
Water permeability normal to the plane	EN ISO 11058	34 x10^{-3} m/s
Water flow normal to the plane	EN ISO 11058	34 l/m^2.s
Water flow capacity in the plane 20kPa	EN ISO 12958	8 x 10-6 m^2/s
Characteristic opening size (AO3)	EN ISO 12956	50.0µm
Physical Properties		
Thickness under 2 kPa	EN ISO 9853-1	1.25 mm
Weight	EN ISO 9864	300 g/m^2
Composition	100% Polypropylene non-woven geotextile	

A2

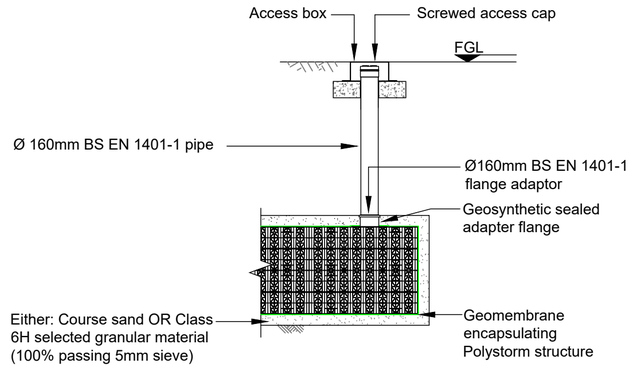
PSM4CRD Pipe Conection Unit



Isometric View (Scale 1:20)



Section View (Scale 1:20)



Ventilation System (Scale 1:40)

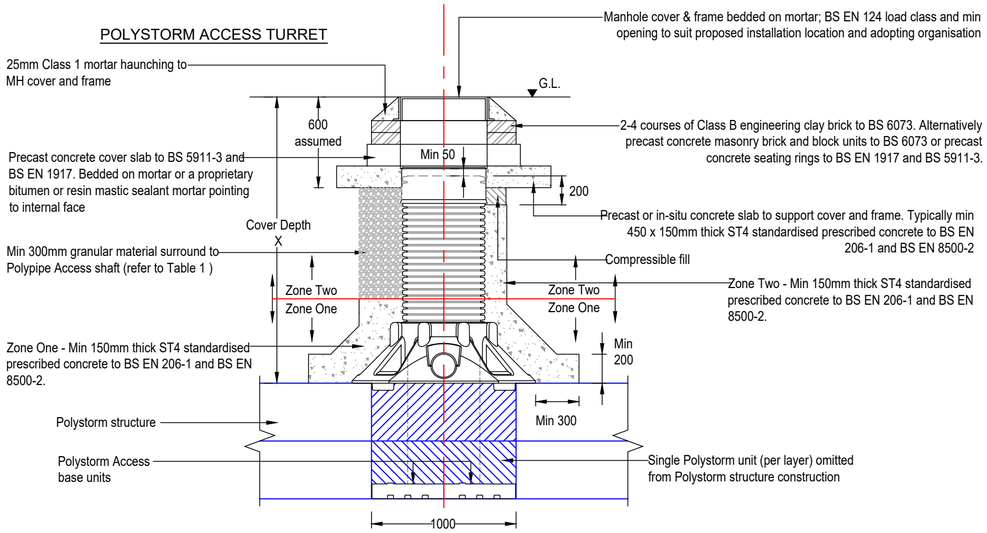
NOTES

1. Proposed Hydro WMS layout.
2. All dimensions are in millimetres, all elevations in metres unless otherwise stated.
3. All temporary and enabling works by others.
4. All dimensions of fabricated items are nominal and may vary within manufacturing tolerances.

Pipe connections and Vent Pipe seals

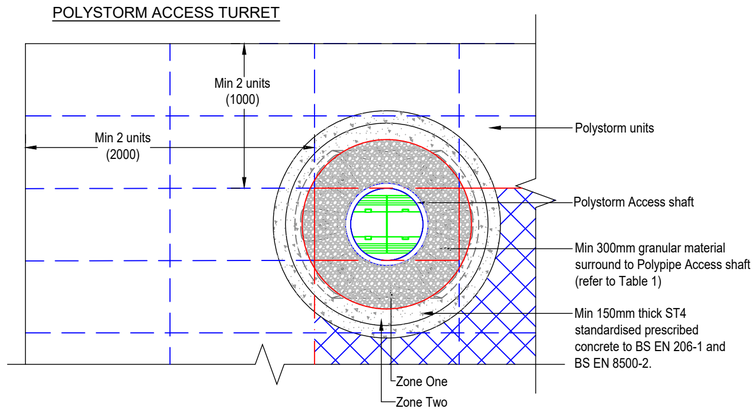
- Wherever possible low level pipe connections are fitted during installation of the first level of cellular units. Cellular units are temporarily placed where pipe connections are required, and the membrane marked to note the position of the required hole.
- An aperture 70mm less than the pipe fitting being used, is cut into the membrane and the pipe fitting cleaned around the outside where the liner is to make contact. A 50mm wide strip of BDST sealing tape is then bonded in place around the fitting.
- The membrane is then lifted, the fitting aligned with the aperture, and heat of 450°c applied for 6 seconds. The liner is then pressed over the pipe fitting, to form a 'Top Hat' style connection aided by the BDST sealing tape. Additionally, a worm-driven jubilee band is tightened over the membrane seal to further aid adhesion.
- Pipe connections at 225mm & 300mm are formed using specialised cellular connection units - (PSM4CRD225 & PSM4CRD300) as shown.
- Vent pipe and smaller connections formed using twinwall pipe are to be made using “Flange Adaptors” which should be fixed into position using self-tapping screws.
- Where connection is required using 150mm PVC pipe these can be formed by pushing a short pipe section into the “knockout” part of the Polystorm unit and sealing as described above.

POLYSTORM ACCESS TURRET



Typical Elevation(Scale 1:30)

POLYSTORM ACCESS TURRET



Plan View (Scale 1:30)

REV	AMENDMENT	DATE

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CLIENT	STATUS	DATE	DRAWN	CHECKED	APPROVED
-	FOR INFORMATION	04/05/2020	MA	-	-

JOB TITLE	DRAWING TITLE	SCALE	PROJECT No.
-	Pipe Connection Details - Polystorm	As Ind'd @ A2	-

DRAWING No.	REV.
001	-

Construction Sequence

Installation procedures should be carried out in accordance with the Health and Safety at Work Etc. Act (1974) and any other relevant legislation. Special attention should be paid to temporary work requirements in excavations.

Excavate to the required plan dimensions and level, ensuring that the excavation orientation will allow easy installation of connecting pipework. Consideration should be given to maintaining construction plant access for reinstating around the installed Polystorm units. A minimum 300mm working space is required around the structure but 500mm is recommended for safe working practice.

Ensure that the ground bearing capacity at the formation level is sufficient for the proposed operational loads. The base of the excavation should be smooth and level, free of large stones and soft spots. Any soft spots should be excavated and replaced with suitable compacted granular material.

The type of geosynthetic material used to encapsulate the Polystorm units 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.

a) Attenuation Application

Place and compact a 100mm thick bedding layer of coarse sand. Line the base and sides of the excavation with a protective geotextile before placement of the impermeable geomembrane. Install the geomembrane, Hydro WMS sealing joints by wedge welding in accordance Ciria 698 site handbook for the construction of SUDS, making an allowance for the connecting pipework or adapters. To ensure that the integrity of the geomembrane has been maintained, it is recommended that an inspection of the material is carried out, and welded joints are air tested in accordance with Ciria 698.

If water is present, we recommend that the excavation depth is over dug by 200mm, with a base layer of 'TERRAM', overlaid by 150mm of compacted 'Type 1 road stone', topped off with a 50mm layer of pipe bedding.

Polystorm shear connectors are placed between all layers of Polystorm units to give structural support to the tank. Sufficient Polystorm clips are placed connecting Polystorm units to maintain rigidity of the tank prior to backfilling the sides, the adjacent units being connected with two Polystorm clips.

Place the Polystorm shear connector into the recess created by the unit columns, two number per unit. Install the next layer of Polystorm units, positioning the units in the upper layer so that they exactly mirror the position of the units in the lower layer. Repeat the above procedure until the necessary depth of Polystorm structure has been achieved.

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. Specially fabricated Polystorm units are available that allow connection of 225 & 300mm Ridgidrain pipes. A Polystorm structure requires ventilation (attenuation application only) to ensure proper hydraulic performance. Consideration should be given as to how this ventilation is to be installed.

Complete the geosynthetic encapsulation of the entire Polystorm structure, forming joints where appropriate. Re-examine the geotextile for damage and joint integrity.

Contractor

Backfill around the sides of the encapsulated units, forming a thick layer of coarse sand or Class 6H selected granular material immediately adjacent to the units. 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.

Above the wrapped Polystorm units, place and lightly compact a minimum 100mm thick layer of either coarse sand or Class 6H selected granular material (with 100% passing the 5mm sieve), in accordance with MCHW, Volume 1, Series 600.

Final backfilling of the installation is dependent on the expected operational loads.
(NB Compaction plant over and immediately adjacent to the Polystorm units shall not exceed 2300 kg/m width).

Field conditions (eg landscaped areas)

The backfill material that lies within 300mm above the Polystorm units should be free from particles exceeding 40mm in diameter, in accordance with Class 8 material to Series 600, Volume 1, MCHW. 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 (eg restricted access car park

Backfill with Class 1 or 2 material in accordance with MCHW, Volume 1, Series 600. Backfill material should be placed and compacted in layers not greater than 150mm. Where the Polystorm units are installed beneath a paved area, the pavement sub-base may form part of the backfill material provided that minimum cover depths are maintained.

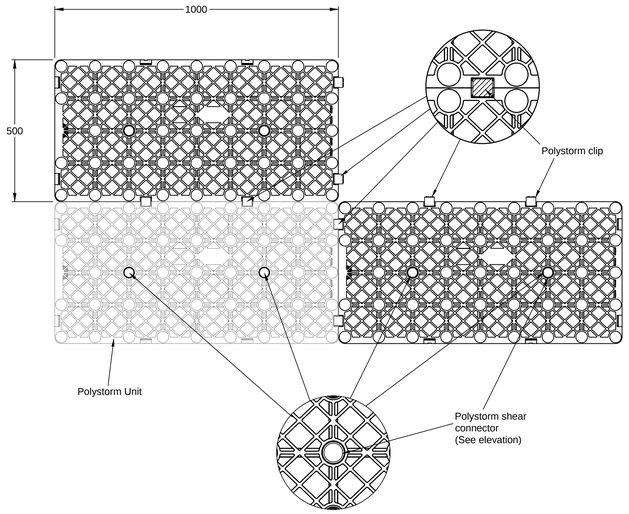
Heavily trafficked (eg service areas or roads)

Contact Hydro WMS Technical Services for further information and guidance.

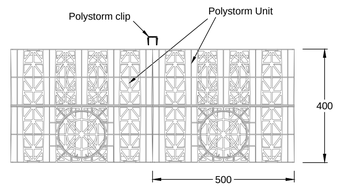
Complete pavement construction or landscaping over the Polystorm system.

It should be noted that infiltration systems are not generally installed under roads due to the reduction in load bearing capacity of saturated soils. Specialist advice should be sought where this type of installation is proposed.

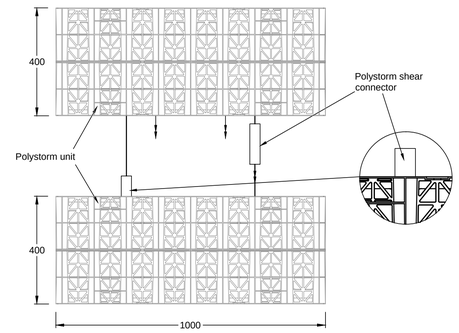
In attenuation systems, where groundwater may be present, a boyancy check should be undertaken to ensure that the imposed overburden pressure exceeds any uplift forces generated.



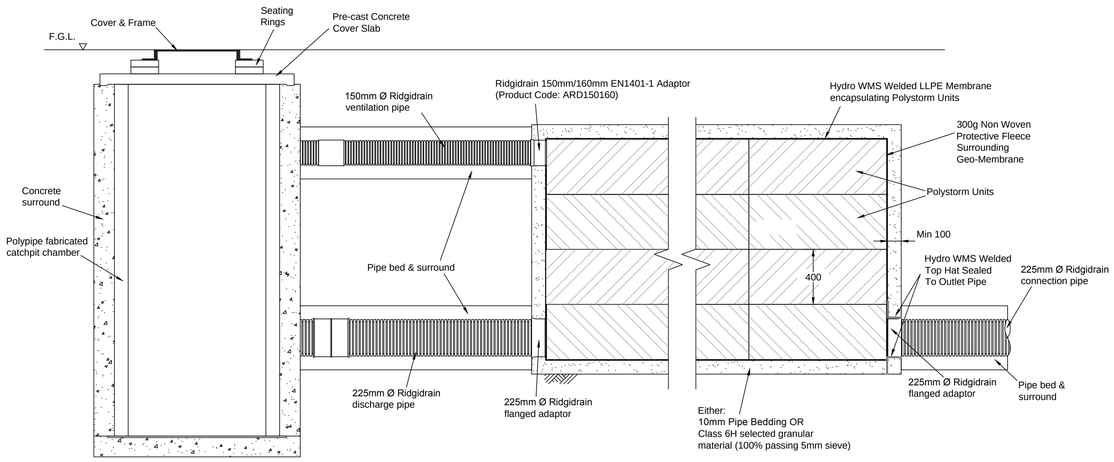
POLYSTORM CONNECTORS
PLAN VIEW
(Scale 1:10)



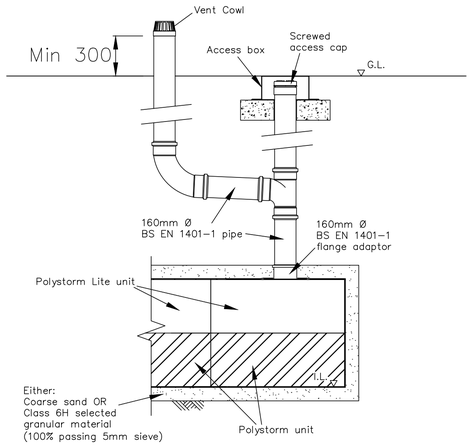
POLYSTORM CONNECTORS
END VIEW
(Scale 1:10)



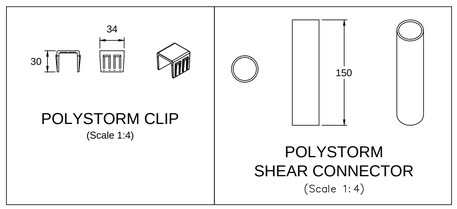
POLYSTORM CONNECTORS
ELEVATION
(Scale 1:10)



HYDRO WMS ATTENUATION
TYPICAL INSTALLATION DETAIL
(Scale 1:20)



VERTICAL VENT PIPE CONNECTION
[DETAIL 2]
(Scale 1:20)



POLYSTORM CLIP
(Scale 1:4)

POLYSTORM
SHEAR CONNECTOR
(Scale 1:4)

Technical Specification Overview	
Unit Type	Polystorm-R
Product Code	PSM1A
Dimensions	(w) 1 x (d) 0.5 x (h) 0.4m
Total Volume	0.2m³
Unit Weight	9.0Kg (Approx)
Water Storage Volume	0.19m³ (190 litres)
Void Ratio	95%
Ultimate Vertical Compressive Strength	Maximum 650 kN/m²
Ultimate Lateral Compressive Strength	Maximum 63 kN/m²
Short-Term Vertical Deflection	Maximum 70.1 kN/m² per mm
Short-Term Lateral Deflection	Maximum 4.4 kN/m² per mm
Estimated Long Term Vertical Deflection (creep)	0.2798 Ln (design life in hrs)
	[Based on an applied test load = 162 kN/mm²]
	Creep data limit 60 years
Estimated Long Term Lateral Deflection (creep)	1.0192 Ln (design life in hrs)
	[Based on an applied test load = 30.8 kN/mm²]
	Creep data limit 60 years

REV	AMENDMENT	DATE

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CLIENT

JOB TITLE
POLYSTORM STORMWATER MANAGEMENT SYSTEMS

DRAWING TITLE
HYDRO WMS ATTENUATION CONSTRUCTION DETAILS

STATUS
FOR INFORMATION ONLY

SCALE	DATE	DRAWN	CHECKED
Various	20/08/15	MB	

PROJECT No.	DRAWING No.	REV

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Agrément Certificate
06/4297
Product Sheet 3

POLYSTORM STORMWATER MANAGEMENT SYSTEMS

POLYSTORM-R STORMWATER MANAGEMENT SYSTEM

This Agrément Certificate Product Sheet[1] relates to the Polystorm-R Stormwater Management System, an attenuation and infiltration system comprising recycled polypropylene modular units for use in storm water management systems as below-ground water storage or as a soakaway to manage run-off from impermeable surfaces.

(1) Hereinafter referred to as 'Certificate'.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Hydraulic design — data is provided in this Certificate to assist in the design of a below-ground stormwater management system (see section 6).

Structural performance — the system has adequate strength and stiffness to resist long- and short-term loading when used in accordance with this Certificate (see section 7).

Maintenance — data is provided to assist in planning the maintenance of a completed system installation (see section 11).

Durability — the system will have a service life in excess of 60 years when installed in accordance with this Certificate (see section 12).

The BBA has awarded this Certificate to the company named above for the system described herein. This system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

[redacted] [redacted]

Date of First issue: 16 April 2014

Brian Chamberlain
Head of Approvals — Engineering

Claire Curtis-Thomas
Chief Executive

The BBA is a UKAS accredited certification body — Number 113. The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

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Regulations

In the opinion of the BBA, the Polystorm-R Stormwater Management System, if installed, used and maintained in accordance with this Certificate, will meet or contribute to meeting the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):

The Building Regulations 2010 (England and Wales) (as amended)

Requirement:	H3(3)	Rainwater drainage
Comment:		The system can be used in a construction to meet this Requirement. See sections 6.1 to 6.9 of this Certificate.
Regulation	7	Materials and workmanship
Comment:		The units are acceptable. See section 12 and the *Installation* part of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	8(1)(2)	Fitness and durability of materials and workmanship
Comment:		The units can contribute to satisfying this Regulation. See sections 11.1 to 11.6, 12 and the *Installation* part of this Certificate.
Regulation:	9	Building standards applicable to construction
Standard:	3.6	Surface water drainage
Comment:		The system can contribute to a construction satisfying this Standard, with reference to clauses 3.6.1[(1)(2)] to 3.6.5[(1)(2)]. See sections 6.1 to 6.9 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The units can contribute to meeting the relevant requirements of Regulation 9, Standards 1 to 6 and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard.

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

The Building Regulations (Northern Ireland) 2012

Regulation:	23(a)(i)(iii)(b)	Fitness of materials and workmanship
Comment:		The units are acceptable. See section 12 and the *Installation* part of this Certificate.
Regulation:	82	Rainwater drainage
Comment:		The system can be used in a construction to satisfy this Regulation. See sections 6.1 to 6.9 of this Certificate.

Construction (Design and Management) Regulations 2007

Construction (Design and Management) Regulations (Northern Ireland) 2007

Information in this Certificate may assist the client, CDM co-ordinator, designer and contractors to address their obligations under these Regulations.

See sections: 3 *Delivery and site handling* (3.3, 3.5 and 3.6) and 15 *Procedure* (15.1 and 15.10) of this Certificate.

Additional Information

NHBC Standards 2014

In the opinion of the BBA, the use of the Polystorm-R Stormwater Management System, in relation to this Certificate, is not subject to the requirements of these Standards.

Technical Specification

1 Description

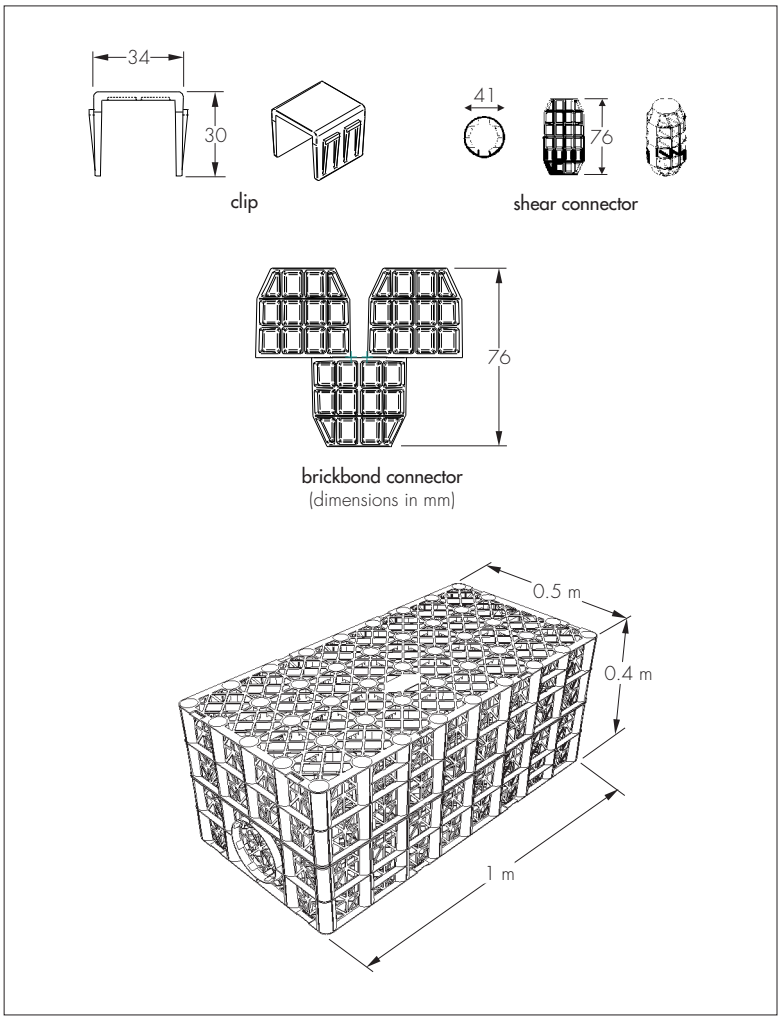
1.1 The Polystorm-R Stormwater Management System comprises modular units manufactured from recycled polypropylene (see Table 1 and Figure 1). The units have pre-formed sockets to enable connection with 160 mm diameter pipework (to BS EN 1401-1 : 1998). Alternatively, connection to 150 mm Ridgidrain, 110 mm or 100 mm pipework is possible using suitable adaptors.

Table 1 Characteristics of modular unit

Characteristic (unit)	Value
Dimensions (nominal) (l x w x h) (mm)	1000 x 500 x 400
Volume (nominal) (m^3)	0.20
Storage volume (nominal) (m^3)	0.19
Porosity (void ratio) (%)	95

1.2 Clips, shear and brick bond connectors are manufactured from black polypropylene and used to secure the units together.

Figure 1 Modular unit and components



1.3 Items used with the units to form a stormwater management system but outside the scope of this Certificate include:

- Adaptors and connecting pipework
- permeable geotextile —wrapped around each assembly when used for infiltration.
- geomembrane — wrapped around each assembly when used for storage (attenuation).
- air vents/connections/pipework
- silt traps
- flow control/chamber devices
- granular material/coarse sand.

2 Manufacture

2.1 The units are manufactured by injection moulding the recycled polypropylene material to one specification.

2.2 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested, calibrated and operated by trained personnel
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.3 The management system of Polypipe Civils has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2000 by BSI (Certificate Q06225).

3 Delivery and site handling

3.1 The units are supplied to site in packs of 12 or 15 units secured to a wooden pallet. Each pack carries a label bearing the product name, quantity, operator initials and pallet number.

3.2 Clips, shear connectors and brick bond connectors are packed in sealed polythene bags of 60, 30 and 30 respectively.

3.3 The unit packs should be carefully placed on level ground and should not be stacked on site. Loose individual units should not be stored more than two units high.

3.4 The units contain an inhibitor to resist the effects of ultraviolet light for up to six months. However, prolonged storage in direct sunlight and high temperatures should be avoided.

3.5 The units should not be stored near fuel bowsers, fuel tanks or other solvents to avoid potential chemical spillages.

3.6 The units are resistant to damage likely to be caused during normal handling. However, they should be stored in locations where impacts from vehicles and other construction plant will be avoided.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the Polystorm-R Stormwater Management System.

Design Considerations

4 General

4.1 The design of the Polystorm-R Stormwater Management System must be in accordance with the Certificate holder's design guidelines. Guidance on the application of sustainable drainage systems (SUDS) for new developments can also be found in the Communities and Local Government Planning Policy Statement PPS25 and the Construction Industry Research and Information Association (CIRIA) Report C697.

4.2 The system is suitable for the surface water management system of stormwater run-off from impermeable surfaces and can be utilised in two main ways (see Figure 2):

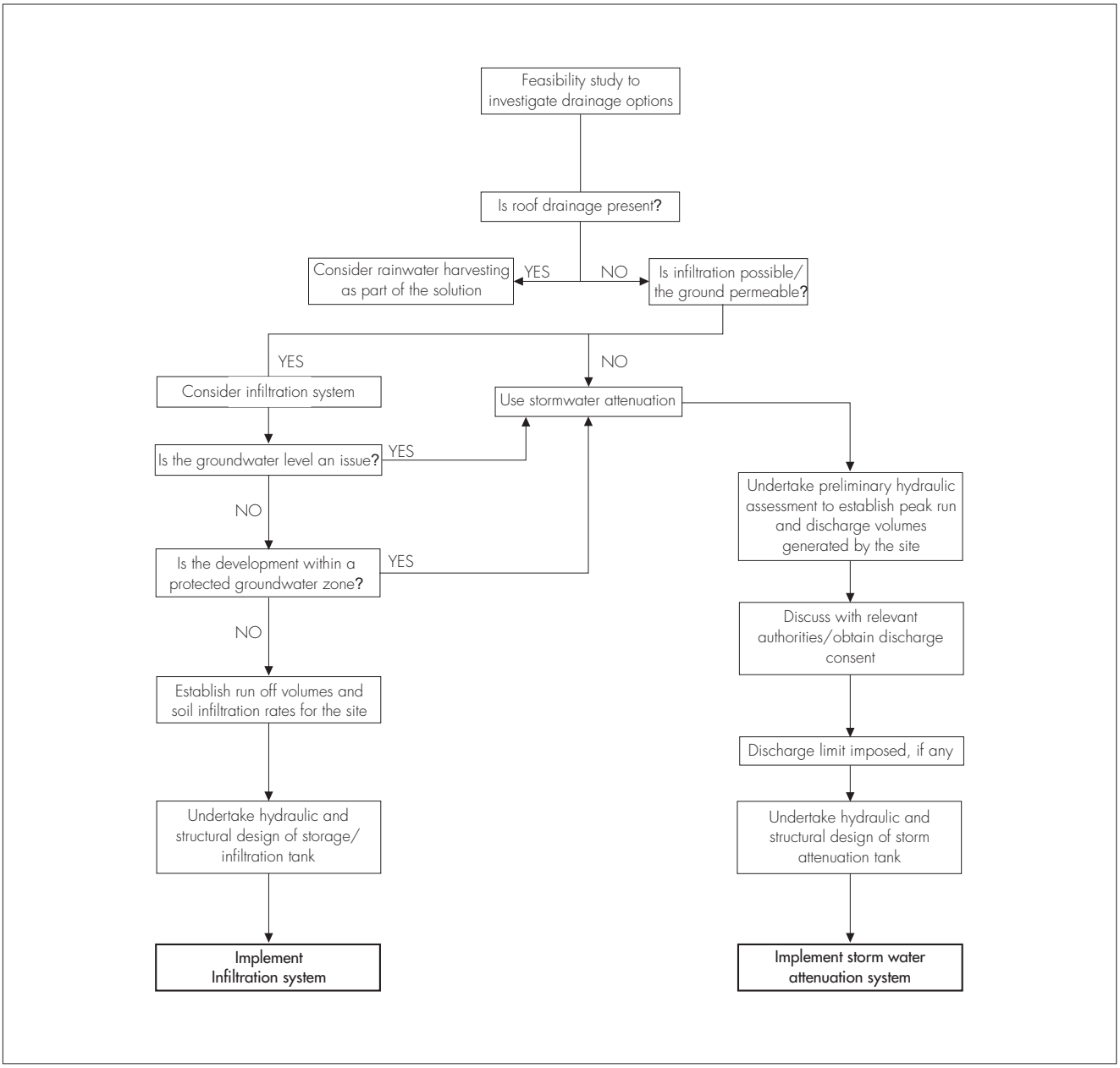
- infiltration — stormwater is collected in the units during rainfall and allowed to drain away by soaking into the surrounding ground over a substantial period of time after rainfall
- attenuation — stormwater is collected in the units during rainfall and released at a reduced flow rate through a flow control device into an appropriate outfall. This reduces peak flows in the watercourse and thereby, minimising the risk of flooding
- a combination of infiltration and attenuation.

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

- existing factors and considerations applicable to the site
- predicted factors relating to the site's use following the planned development, and the parameters within which the installation is required to function
- the type of function of application suggested by this audit.

4.4 Once the project criteria have been established from the site audit, there are two main parts to the design procedure of individual installations; hydraulic design and structural design.

Figure 2 Sustainable drainage system selection and design



5 Practicability of installation

The system is designed to be installed by a competent general builder, or a contractor, experienced with this type of system.

6 Hydraulic design

Infiltration

Calculation principles

6.1 There are two approaches, either of which may be adopted: the Construction Industry Research and Information Association (CIRIA) Report 156 or BRE Digest 365. Further information on the design of SUDS may be obtained from CIRIA Report C697.

6.2 A simplified approximate approach can be used on a small site (ie a single-house development), where detailed site infiltration rate information may not be required nor available (see Table 2). From Approved Document H of the England and Wales Building Regulations, a storage volume equal to the area to be drained multiplied by 10 mm, for areas up to 25 m^2 is allowed. Beyond this size, design should be carried out in accordance with BS EN 752 : 2008 or BRE Digest 365. It is suggested in BS EN 752 : 2008 that a storage volume equal to 20 mm multiplied by the area to be drained may be used. In Scotland, guidance for the design of single-house soakaways is given in Mandatory Standard 3.6, clause 3.6.5[1]

(1) Technical Handbook (Domestic).

Table 2 Simplified soakaway design for single-house development[1]

Number of units	Storage volume (m^3)	Maximum area to be drained (m^2)
1	0.19	19.0[2]
2	0.38	25.0[2]
3	0.57	28.5[3]
4	0.76	38.0[3]
5	0.95	47.5[3]
6	1.14	57.0[3]

(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 H.
(3) In accordance with BS EN 752 : 2008, clause NA 4.4.8.

6.3 When the BRE or CIRIA approach is used, the design volumes and areas for trench or cuboid type installations can be found from Tables 3 and 4.

Table 3 Data for use in hydraulic design — one unit wide trench configurations

Number of units high	System volume (m^3)	Vertical surface area around sides and ends of tank (m^2)	Surface area beneath base of tank (m^2)
1	0.19	1.2	0.5
2	0.38	2.4	0.5

Table 4 Data for use in hydraulic design — three-dimensional system, two units high

System length (units long) (1 m side)	2 wide (0.5 m side)			4 wide (0.5 m side)			8 wide (0.5 m side)		
	volume (m^3)	side (m^2)	base (m^2)	volume (m^3)	side (m^2)	base (m^2)	volume (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	6.08	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

6.4 For calculations, the size and volume of the units are given in Table 1. The total areas of the base and sides are required as water is absorbed through the geotextile soil interface. Storage volume is 95% of the total volume. As an example, using Table 4, for a typical system 1 metre wide (two units) linear trench 40 m long and two units high, the volume is 0.76 x 40 = 30.4 m^3 and the side area 3.2 x 40 = 128 m^2.

Attenuation

Calculation principles

6.5 The anticipated total run-off volume from the site is estimated. The most commonly-used method for evaluating storm rainfall events in the UK is the Wallingford Procedure by which the total rainfall level of storms over defined time periods ranging from five minutes up to 48 hours is assessed. The allowable discharge rate from the site to an appropriate outfall is established, which will normally be set by the Environment Agency, Scottish Environmental Protection Agency or Planning Authorities. The volume to be stored underground in the system is then determined and the number of units needed to contain this volume is calculated on the basis that the storage volume is equal to 95% of the total volume of the system.

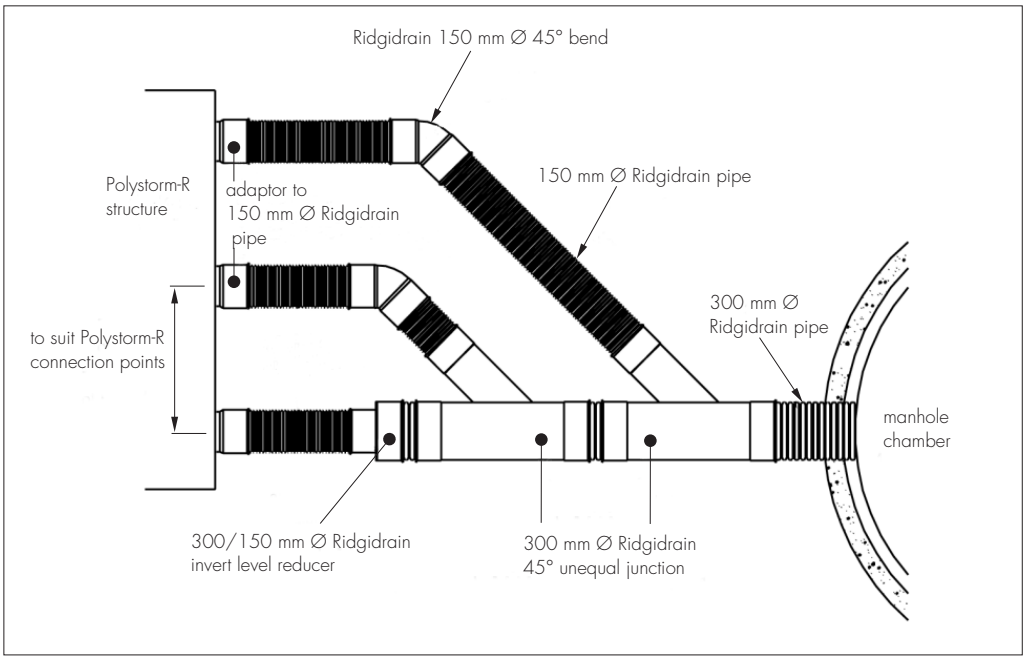
Connections

6.6 Connection is made to the system using a preformed socket and adaptor.

Manifold design

6.7 The units are manufactured to allow a connection to be formed by insertion of 160 mm diameter BS EN 1401-1 : 2009 pipes into the convenient knock-out incorporated in each cell. The capacity of a 160 mm pipe is limited and may be insufficient for the anticipated design flow. The flow may be split amongst a number of 160 mm pipes connected to a manifold to provide increased hydraulic capacity (see Figure 3). The system designer should ensure the pipework connecting the Polystorm-R units to the drainage system has sufficient capacity to cope with the design flow.

Figure 3 Typical manifold design



Flow control

6.8 The outflow from the system must be controlled to comply with the discharge rate consent of the site. The main methods to achieve outflow control are: orifice plate, vortex control or small pipe. Comparative features and benefits of these various control flow devices should be considered prior to selection.

Outflow positioning and head calculations

6.9 The invert level of the outflow pipe should be flush with the bottom of the lowest unit to allow the system to drain. As the system fills, a depth of water develops on the upstream side of the outflow control. For a system with two layers of units, this depth is 0.8 m when the units are full, creating a driving head to push the flow through the control device. For design purposes, the head used in calculations is taken as that at the invert line of the outflow device.

7 Structural performance

General

7.1 The structural design of each installation incorporating the system should be verified by a suitably qualified and experienced engineer.

7.2 Guidance on the design and installation of systems incorporating the units can be found in CIRIA Report C680. Consideration should be given to the effects of cumulative deflection in systems comprising several layers of units.

7.3 The system can be placed under landscaped or car park areas. For areas where greater loads are anticipated, these applications are outside the scope of this Certificate. Advice should be sought from the Certificate holder.

7.4 Care should be taken when the system is used for infiltration below trafficked areas and close to structures. It is important to ensure that the infiltrating water will not soften the soils or cause loss of fines and settlement.

7.5 The engineer responsible for the design of the installation must confirm that the ground-bearing capacity at the formation level is sufficient for the proposed operational loads. In areas of weak or compressible soils, advice should be sought from a geotechnical engineer.

7.6 When the system is wrapped in an impermeable geomembrane and placed below the groundwater table, flotation may occur. To prevent this, the weight of the soil over the top of the system must be greater than the uplift force caused by the system's buoyancy in the water. This can be achieved with most types of fill if the depth of cover fill is equal to, or greater than, the depth of penetration of the system below groundwater level.

Unit performance characteristics

7.7 Characteristic compressive strength at the yield point and elastic deflection values for the system have been determined from independent, short-term tests (see Table 5).

Table 5 Short-term performance values

Element (unit)	Value
Characteristic compressive strength at yield (kN·m^{-2})	
vertical loading on top face	610
lateral loading on side face	63
Short-term deflection (mm per kN·m^{-2}) (applied load)	
vertical loading on top side face	1 per 60
lateral loading on side face	1 per 4.4

7.8 The following equations have been established from creep tests, on a single unit, exceeding 9,000 hours and can be used to estimate the long-term vertical and lateral deflection for periods up to 60 years at 20°C (see Table 6).

Table 6 Equations for estimating long-term creep deflection

For loads up to (kN·m^{-2})	Equation for estimation of long-term deflection
162 (vertical)	Deflection = 0.2798 Ln [time (hours)] + 0.4855
31 (lateral)	Deflection = 1.0192 Ln [time (hours)] – 3.8674

7.9 The following partial load and material factors, as defined in CIRIA Report C680, should be used for design (Table 7).

Table 7 Partial factors for loads and materials

Description	Ultimate limit state	Serviceability limit state
Partial factors for loads		
Vertical dead-load (F_{dl})	1.40	1.00
Earth pressure (horizontal) + hydrostatic (horizontal) load (F_{ep})	1.35	1.00
Imposed live-load (F_{ll})	1.60	1.00
Partial safety factors for materials (F_m)	2.75	1.50

7.10 Example maximum installation depths and minimum depths of cover calculated as described in this section and in accordance with CIRIA Report C680 are shown in Tables 8, 9 and 10:

For small-scale applications such as soakaways for individual house roof drainage — the system is located below a garden a minimum of 5 m from the building, inaccessible to motor vehicles. Table 8 indicates the maximum depth and minimum cover.

Table 8 Design criteria for use of Polystorm-R as soakaway for an individual house(1)

Criterion	Value
Maximum depth to base of system (m)	2.74
Minimum depth of cover required over system to prevent accidental damage (m)	0.50

(1) The following assumptions apply:
- soakaway constructed in sandy gravels with a soil weight not exceeding 20 kg.m^{-3} and angle of shearing resistance for surrounding soil not less than 30°
- groundwater at least one metre below the base of the units
- soakaway located beneath small gardens or landscaped areas, no vehicles in accordance with CIRIA C680, Table 4.2.

For installation below landscaped and lightly-trafficked areas — the information given in Tables 9 and 10 are only applicable in temperate climate conditions such as those in the UK. Site specific calculations should be carried out for configurations and prevailing ground conditions other than those shown.

Table 9 Maximum installation depths (to base of system)

Typical soil type	Soil weight ($kN \cdot m^{-3}$)	Angle of friction (φ)	Maximum installation depth (from invert of structure) (m)			
			No groundwater present		Groundwater level 1.0 m below ground level (attenuation structure	
			Trafficked (cars only)[1]	Non-trafficked[2]	Trafficked (cars only)[1]	Non-trafficked[2]
Over consolidated stiff clay	20	24°	1.96	2.21	1.65	1.79
Silty sandy clay	19	26°	2.22	2.48	1.76	1.90
Loose sand and gravel	18	30°	2.74	3.02	1.93	2.06
Medium-dense sand and gravel	19	34°	3.09	3.35	1.98	2.09
Dense sand and gravel	20	38°	3.51	3.76	2.08	2.18

(1) Trafficked areas taken as driveways to individual houses and car parks with height barrier to limit vehicle size with vehicles up to 3,000 kg gross vehicle weight (GVW), defined in CIRIA C680, Table 4.2.

(2) Non-trafficked areas taken as small gardens or landscaped areas where no vehicles are used, defined in CIRIA C680, Table 4.2.

Notes:

- Calculations are based on tanks comprising two layers of units.
- The load spread through asphaltic surfaces (for trafficked areas) is assumed to be 27°. The load spread through landscaped areas is taken as ϕ.
- Ground surface is horizontal.
- Shear planes or other weaknesses are not present within the structure of the soil.
- Weight of ground water taken as 10 $kN \cdot m^{-3}$.
- Accidental loading is not considered.
- Partial load and material factors shall be as defined in Table 7.

Table 10 Minimum cover depths over Polystorm-R

Live load conditions	Landscaped area[1]	Trafficked	
		Car park with vehicle mass <3000 kg[2]	Car park with occasional vehicle mass <9000 kg[3]
Minimum cover depth required (m)	0.50	0.50	0.85

(1) Landscaped areas taken as small gardens or landscaped areas where no vehicles are used, defined in CIRIA C680, Table 4.2.

(2) Trafficked areas taken as driveways to individual houses and car parks with height barrier to limit vehicle size with vehicles up to 3,000 kg gross vehicle weight (GVW), defined in CIRIA C680, Table 4.2.

(3) Trafficked areas taken as car parks with vehicles up to 9,000 kg gross vehicle weight (GVW), defined in CIRIA C680, Table 4.2.

Notes:

- Calculations are based on tanks comprising one layer of units.
- Assumes angle of friction of the surrounding soil of 38° and a soil weight of 20 $kN \cdot m^{-3}$. Groundwater must be at least one metre below base of units.
- The load spread through asphaltic surfaces (for trafficked areas) is assumed to be 27°. The load spread through landscaped areas is taken as ϕ.
- Ground surface is horizontal.
- Shear planes or other weaknesses are not present within the structure of the soil.
- Calculations based on there being no groundwater present.
- Accidental loading is not considered.
- Partial load and material factors shall be as defined in Table 7.

8 Geotextiles and geomembranes

Infiltration

8.1 The system requires a geotextile wrapping when used as an infiltration device to prevent:

- silt that may be contained in the surface water run-off from contaminating the surrounding soil, in addition to reducing its permeability
- surrounding soil from entering the units.

8.2 Selection of an appropriate geotextile requires careful consideration (see section 8.6).

Attenuation

8.3 The system requires a sealed geomembrane wrapping to create an attenuation storage tank and prevent:

- the release of surface water into the surrounding ground
- inflow of groundwater that may overload downstream systems and contain pollutants on contaminated sites.

8.4 Site conditions may require the use of a thick, protective geotextile to prevent puncture or excessive strain in the geomembrane, on which further advice should be sought from the geomembrane manufacturer.

8.5 Selection of an appropriate geomembrane requires careful consideration (see section 8.6).

8.6 A recognised design methodology is to follow these steps:

- define the application filter requirements — retention (attenuation storage) or permeability (soakaway)
- define boundary conditions — site investigation to establish in-situ soil parameters, enabling lateral earth pressures and water flow conditions to be calculated

- determine soil retention requirements — using the in-situ soil parameters, determine if additional bed and surround measures should be specified
- determine geosynthetic permeability requirements — the breakthrough head should be considered in addition to water flow rates
- determine anti-clogging requirements (infiltration only) — ensure that the porosity of the geotextile in conjunction with the specified bed and surround is sufficient to prevent the geotextile from prematurely clogging
- determine resistance to mechanical damage requirements — the geosynthetic should be sufficiently robust to survive installation activities
- determine durability requirements — consideration should be given as to whether the geosynthetic will be subjected to a significant chemical exposure, either present in the ground or rainwater run off
- miscellaneous design considerations:
  - — intrusion of geosynthetic into drainage layer
  - — biological and bio-chemical clogging factors
  - — safety factors.

8.7 All joints should be sealed, using proprietary techniques recommended by the manufacturer. Advice on seam testing procedures is given in CIRIA Report SP124.

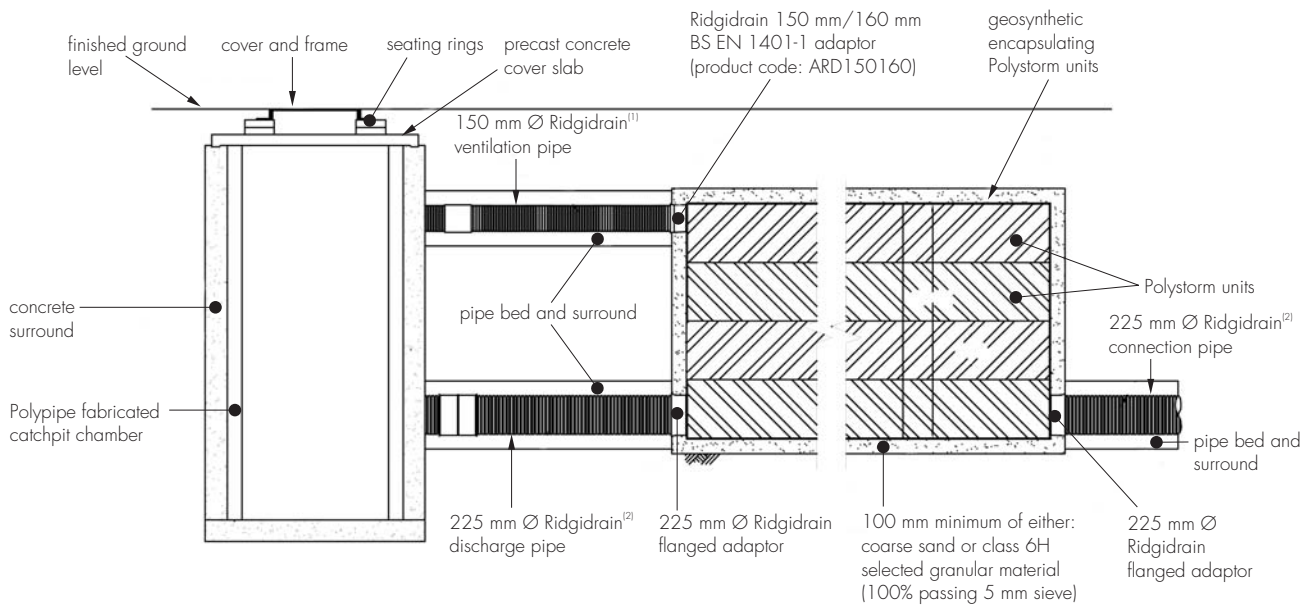
8.8 The designer/installer should confirm with the geosynthetic manufacturer that the specification of the proposed material is suitable for the application and site conditions by following the design methodology (see section 8.6).

9 Venting

9.1 Adequate venting must be provided to the system. As a minimum, one 110 mm diameter air vent is required per 7500 m^2 of impermeable catchment area to be drained (see Figure 4). Air vent connections and pipework for use with this system are outside the scope of this Certificate.

9.2 Typical air vent connectors and pipework can be seen in the Certificate holder's *Design Manual*. It is recommended that all air vent installations in storage applications (using a geomembrane) are made using a flange adaptor. Thermal welding, adhesive or double-sided tape should be used between the geomembrane and flange adaptor to ensure a watertight seal.

Figure 4 Typical Polystorm-R arrangement including ventilation pipe



(1) Alternative ventilation pipes are 160 mm pipes to BS EN 1401-1 : 2009 or 150 mm Polysewer.
(2) Alternative discharge and connection pipes are pipes to BS EN 1401-1 : 2009 or 225 mm Polysewer.

10 Resistance to chemicals

10.1 An assessment by the BBA indicates that the components of the system are suitable for use in contact with the chemicals likely to be found in rainwater.

10.2 An assessment of the suitability for use of the system on brownfield sites should be made only after a suitable site (outside the scope of this Certificate) investigation to determine the possibility for chemical attack. Particular care must be taken where acids and organic solvents are present at high concentrations. Further information can be obtained from the Certificate holder.

11 Maintenance

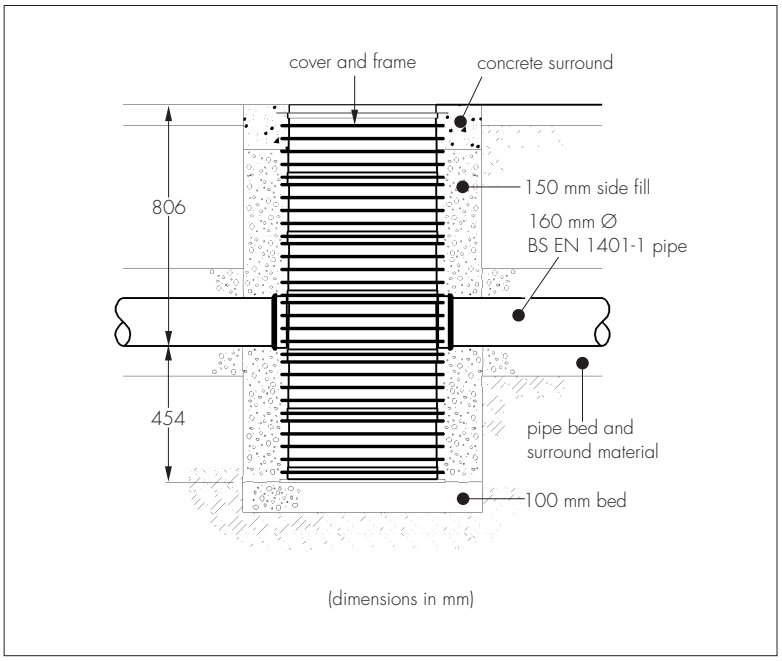
11.1 The owner of the structure is responsible for maintenance.

11.2 For soakaways to individual houses, the only necessary maintenance of the system is to keep all gullies clear of debris such as leaves.

11.3 For large installations or where the receiving waters are environmentally sensitive, a system of regular inspections should be established to prevent siltation of the system which, if allowed to develop, would reduce effectiveness. They should also be inspected after every major storm event.

11.4 It is recommended that a silt trap is incorporated into the pipework at the inlet to the tank (see Figure 5). There must be a maintenance plan that ensures regular cleaning of the trap to ensure correct performance.

Figure 5 Typical silt trap



11.5 For all flow control devices it is sensible to incorporate access (via a manhole or similar) to the location of the pipe entry, orifice or vortex control. This will enable easy removal of any blockage. The orifice itself may be protected by a debris screen.

11.6 Paved surface areas above an installation should be inspected at the same time to ensure the system continues to provide the required structural support.

12 Durability

The structural properties of the recycled polypropylene used in the components of the system will deteriorate with time and should be taken into account at the design stage by the application of suitable safety factors. In the opinion of the BBA, the system, when used in accordance with this Certificate, will have a life in excess of 60 years.

13 Reuse and recyclability

The units consist of polypropylene material which is readily recyclable.

14 General

The Polystorm-R Stromwater Management System should be installed in accordance with the Certificate holder's installation instructions and relevant legislation. Special attention should be paid to temporary work requirements in excavations.

15 Procedure

15.1 The hole or trench is excavated to the required plan, dimensions and level ensuring that the excavation will allow installation of connecting pipework. It must be ensured that sufficient construction plant access is maintained for reinstating around the installed system. The base must be smooth and level without sharp drops or humps. Slopes must be cut to a safe angle or adequately supported and safe access must be provided to allow personnel to enter the excavation. Excavation should be carried out in accordance with BS 6031 : 2009, with particular attention paid to safety procedures.

15.2 It must be ensured that the ground-bearing capacity at formation level is adequate for the design loads.

15.3 The base must be inspected for soft spots in the formation — any present must be excavated and replaced with compacted granular fill material.

15.4 For an attenuation application, a 100 mm thick bedding layer of coarse sand is laid on the base of the excavation. The geotextile protection fleece is laid on base and sides, if required. The geomembrane is laid over the sand bedding/fleece and up the sides of the excavation. Joints should be made in accordance with the manufacturer's recommendations with allowance made for connecting pipework or adaptors. The geomembrane and joints are inspected for damage.

15.5 For an infiltration application, a 100 mm thick bedding of either coarse sand or Class 6H selected granular material [with 100% passing the 5 mm sieve, in accordance with the Manual of Contract Documents for Highway Works (MCHW), Volumes 1 and 2] is laid on the base of the excavation. The geotextile is laid over the bedding and up the sides of the excavation and joints formed in accordance with the manufacturer's recommendations, and allowance made for connecting pipework or adaptors.

15.6 The system is installed in accordance with the installation schedule for correct orientation. Wherever possible, continuous vertical joints should be avoided. The units are arranged within the system so that preformed sockets are in the correct alignment for inlet and outlet pipes. For single-layer applications, Polystorm clips (four per unit) are used only and for multi-layers Polystorm clips, in conjunction with shear connectors and brick-bond connectors (when using brick-bond arrangement) are used.

15.7 The geotextile or geomembrane encapsulation to base, sides and top of installation, including protective geotextile (where required) is completed. Geomembranes must be welded in accordance with the manufacturer's recommendations. The geomembrane and/or geotextile are inspected for damage and all welds are tested as required.

15.8 Drainage connections are made to the installation using proprietary adaptors. Preformed socket positions for pipe connections must be located at the correct position for receiving pipework. In attenuation applications, all pipe connections penetrating the geomembrane must be adequately sealed.

15.9 The installation is backfilled around the side of the encapsulated system to form a 100 mm layer of coarse sand or Class 6H selected granular material immediately adjacent to the system. Any remaining excavated areas around the system are backfilled with Class 6N or 6P selected granular material in accordance with the MCHW, Volumes 1 and 2. The backfill is compacted in 150 mm layers.

15.10 A coarse sand protection layer 100 mm thick should be placed over the top of the system that are wrapped in either a geotextile (infiltration system) or a geomembrane with protective geotextile (attenuation system). Backfilling is continued with:

- trafficked areas (eg restricted access car parks) — Type 1 or 2 sub-base material compacted in 150 mm layers in accordance with the MCHW, Volumes 1 and 2. Compaction plant over the top of the system must not exceed 2300 kg per metre width. Where the system is to be installed beneath a paved area the pavement sub-base may form part of the backfill material provided minimum cover depths are maintained
- landscaped and non-trafficked areas — selected as-dug material with size of particles less than 40 mm within 300 mm of top of system. Above this level selected as-dug material may be used. Backfill is placed and compacted in layers no greater than 300 mm thick. Compaction plant over top of system must not exceed 2300 kg per metre width.

15.11 The pavement construction or landscaping is completed over the system.

Technical Investigations

16 Tests

Tests were carried out on the system to determine:

- short-term resistance to vertical and horizontal loading
- long-term resistance to vertical and horizontal loading
- volumetric capacity.

17 Investigations

17.1 The manufacturing process was examined including the method adopted for quality control, and details obtained on the quality and composition of the material used.

17.2 An assessment of the system was made in relation to:

- material properties
- design procedures.

17.3 A site visit was made to assess the practicability and ease of installation and connection.

Bibliography

BRE Digest 365 *Soakaway Design.*

BS 6031 : 2009 *Code of practice for earthworks*

BS EN 752 : 2008 *Drain and sewer systems outside buildings*

BS EN 1401-1 : 2009 *Plastics piping systems for non-pressure underground drainage and sewerage. Unplasticized poly(vinylchloride) (PVC-U) — Specifications for pipes, fittings and the system*

BS EN ISO 9001 : 2000 *Quality management systems — Requirements*

CIRIA Report 156 *Infiltration drainage — Manual of good practice*

CIRIA Report C680 *Structural design of modular geocellular drainage tanks*

CIRIA Report C697 *The SUDS manual*

CIRIA Report SP124 : 1996 *Barriers, liners and cover systems for containment and control of land contamination*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works*

Manual of Contract Documents for Highway Works, Volume 2 *Notes for Guidance on the Specification for Highway Works*

PPS25, *Development and Flood Risk.*

18 Conditions

18.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page — no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

18.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

18.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

18.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

18.5 In issuing this Certificate, the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

18.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

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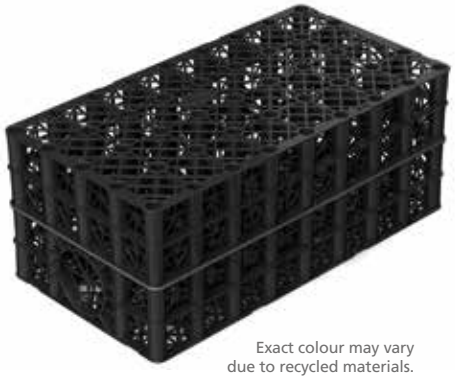
Polystorm-R Modular Cell

Data Sheet

Product code: PSM1A

The Polystorm-R modular cell is ideally suited for loaded applications at greater depths, such as housing, commercial and infrastructure projects and has a compressive strength of up to 61 tonnes/m². It offers all the proven performance of the Polystorm cell, with the added benefits of being manufactured from over 90% recycled material content.

Wherever performance criteria and standards allow, we will always maximise the sustainability of our products by using post consumer plastics in their manufacture. By sourcing and carefully controlling the quality of the recycled material we use our precision injection moulding. Therefore we are able to guarantee consistent quality in our recycled plastic, giving you the confidence and the performance levels you expect from the market leader.



Exact colour may vary due to recycled materials.

Key Benefits

- Made from specially selected and controlled recycled materials
- Environmentally friendly, sustainable solution
- Has undergone stringent testing to ensure product performance
- Compressive strength of 61 tonnes/m²
- Ideal for retention, attenuation and infiltration applications with a suitable geomembrane or geotextile
- BBA approved
- Allow flexibility of shape - ideal for shallow excavation systems, narrow strips or use in restricted areas
- Can be used as part of a value engineered hybrid system with Polystorm, Polystorm Lite and Polystorm Xtra
- Integrated inlet and outlet
- 3D flow throughout the structure
- 95% void ratio
- Light weight yet robust - excellent Health and Safety and installation benefits
- 60 years creep limited life expectancy

Technical Support

Detailed guidance and assistance is available.
For further information, please contact our Technical Team on **+44 (0) 1509 615100** or email **civils@polypipe.com**

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ELEMENT	VALUE
PHYSICAL PROPERTIES	
Length	1m
Width	0.5m
Depth	0.4m
Total volume	0.2m³
Unit weight	9kg (approx)
Unit storage volume	0.19m³ (190 litres)
Void ratio	95%
SHORT TERM COMPRESSIVE STRENGTH	
Vertical	610 kN/m² **
Lateral	63 kN/m² **
SHORT TERM DEFLECTION	
Short-term vertical deflection	60 kN/m² per mm
LONG TERM DEFLECTION	
Estimated long term vertical deflection (creep)	0.2798 Ln (design life in hrs) +0.485 [Based on an applied test load = 162 kN/m²] Creep data limit 60 years
Estimated long term lateral deflection (creep)	1.0192 Ln (design life in hrs) -3.864 [Based on an applied test load = 30.8 kN/m²] Creep data limit 60 years

Note: Polystorm-R is ideal for use in trafficked and pedestrian applications subject to a structural design check and suitable installation conditions

* Each unit includes 4 Clips and 2 Shear Connectors.

** Compressive strength at yield, maximum recommended value for design purposes.

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Polypipe

RECOMMENDED MAXIMUM DEPTH OF INSTALLATION (to cell invert) [m]

TYPICAL SOIL TYPE	TYPICAL ANGLE OF SHEAR RESISTANCE	SOIL WEIGHT kN/m³	WITHOUT GROUNDWATER (below base of cells) NORMAL CASE		WITH GROUNDWATER AT 1M BELOW GROUND LEVEL AND UNITS WRAPPED IN GEOMEMBRANE	
			Pedestrian	Trafficked (cars) <3000kg GVW	Pedestrian	Trafficked (cars) <3000kg GVW
Stiff over consolidated clay e.g. London clay	24	20.0	2.2	1.9	1.8	1.6
Normally consolidated silty sandy clay e.g. alluvium, made ground	26	19.0	2.4	2.2	1.9	1.7
Loose sand and gravel	30	18.0	3.0	2.7	2.0	1.9
Medium dense sand and gravel	33	19.0	3.2	2.9	2.0	1.9
Dense sand and gravel	38	20.0	3.7	3.5	2.1	2.0

Note:
1) Stated depths based on the calculation methodology detailed within CIRIA C680 (2008)
2) Assuming water density = 10.0kN/m³
3) Assumed ultimate limit state (ULS) partial factor of safety applied to: Material = 2.75 Lateral pressure = 1.35

Durability

The polymer material used in the manufacture of the Polystorm-R unit has an adequate resistance to attack from the type and quantities of chemicals that may be expected to naturally occur in uncontaminated soils and rainwater runoff. When installed in accordance with our recommendations, it is expected that the Polystorm-R unit will have a design life in excess of 60 years*. The installer of a proposed geocellular structure should ensure that an appropriate design check has been undertaken, in accordance with the recommended methodology and factors of safety given in CIRIA C680 (2008), Structural Design of Modular Geocellular Drainage Tanks, prior to the commencement of construction activities.

* Derived from long term extrapolated creep testing

Notes

1. Unless stated, all values are nominal and may vary within normal production tolerances.
2. The characteristic unit parameters stated have been based on Polypipe BBA certificate N° 06/4297, sheet 3.
3. Polypipe reserve the right to change product specifications without prior notice.
4. This document is uncontrolled and updates will not be issued automatically.

RECOMMENDED MINIMUM COVER LEVELS [m]

LIVE LOAD CONDITIONS	PEDESTRIAN	LIGHT TRAFFICKED	
		Car park with vehicle mass <GVW	
Minimum cover depth required (m)	0.50	<3000kg 0.50	<9000kg 0.65

Note
1) Stated depths based on the calculation methodology detailed within CIRIA C680 (2008)
2) Assumed serviceability limit state (SLS) partial factor of safety applied to: Material = 1.5 Live load = 1.0 Dead load = 1.0
3) Shallower minimum burial depths may be applicable subject to an assessment of the specific site conditions. For further details please consult our Technical Team on 01509 615100.

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