

Wavin Limited

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Agrément Certificate
03/4018
Product Sheet 4

WAVIN AQUACELL ATTENUATION AND INFILTRATION SYSTEMS

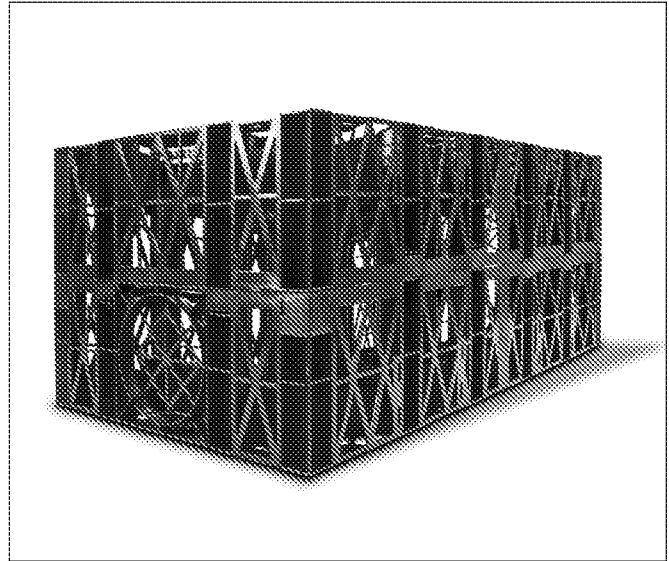
AQUACELL ECO

This Agrément Certificate Product Sheet⁽¹⁾ relates to AquaCell Eco, comprising black recycled polypropylene modular units for use either as below-ground storage tanks 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 water management system incorporating AquaCell Eco (see section 6).

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

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

Durability — the system will have a service life in excess 50 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



Brian Chamberlain
Head of Technical Excellence



Claire Curtis-Thomas
Chief Executive

Date of Second issue: 2 November 2016

Originally certified on 15 June 2012

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, AquaCell Eco, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying 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 section 6 of this Certificate.
Regulation:	7	Materials and workmanship
Comment:		The system components are acceptable. See section 12 and the <i>Installation</i> part of this Certificate.



The Building (Scotland) Regulations 2004 (as amended)

Regulation:	8(1)(2)	Durability, workmanship and fitness of materials
Comment:		The system can contribute to satisfying this Regulation. See sections 11 and 12 and the <i>Installation</i> 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 section 6 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The system 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.
Regulation:	12	Building standards applicable to conversions
Comment:		All comments in relation to the system under Regulation 9, Standards 1 to 6 also apply to this Regulation, with reference to clause 0.12.1 ⁽¹⁾⁽²⁾ and Schedule 6 ⁽¹⁾⁽²⁾ . (1) Technical Handbook (Domestic). (2) Technical Handbook (Non-Domestic).



The Building Regulations (Northern Ireland) 2012 (as amended)

Regulation:	23(a)(i)(iii)(b)	Fitness of materials and workmanship
Comment:		The system is acceptable. See section 12 and the <i>Installation</i> part of this Certificate.
Regulation:	82	Rainwater drainage
Comment:		The system can be used in a construction to satisfy this Regulation. See section 6 of this Certificate.

Construction (Design and Management) Regulations 2015

Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

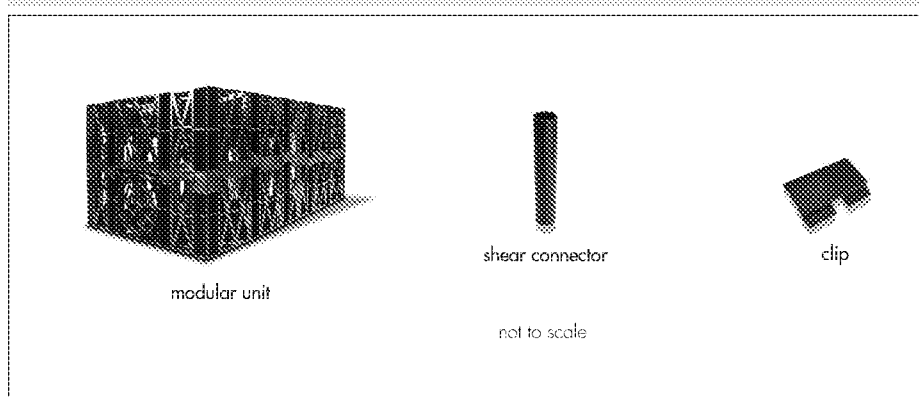
See sections: 1 *Description* (1.2), 3 *Delivery and site handling* (3.1) and 15 *Procedure* (15.1) of this Certificate.

Technical Specification

1 Description

1.1 AquaCell Eco consists of individual recycled black polypropylene modular units, polypropylene shear connectors to hold units together vertically, and polypropylene clips to hold units together horizontally (see Figure 1).

Figure 1 System components



1.2 The overall unit dimensions and characteristics of AquaCell Eco are shown in Table 1.

<i>Table 1 Characteristics of modular units</i>	
Characteristic (unit)	Value
Unit dimensions per storage cell (nominal) (mm) (L x W x H)	1000 x 500 x 400
Unit volume per storage cell (nominal) (m ³)	0.20
Storage volume per storage cell (nominal) (m ³)	0.19
Void ratio (%)	95
Weight (nominal) (kg)	7

1.3 The polypropylene modular units have preformed sockets to enable connection to 160 mm diameter pipework. Alternatively, connection to 150 mm or 225 mm pipework is possible using an adaptor. Adaptors and connecting pipework for use with the system are outside the scope of this Certificate.

1.4 Ancillary items necessary for use with the system (according to best practice), but outside the scope of this Certificate, are:

- adaptors and connecting pipework
- air vents
- inspection points
- inspection chamber modules
- silt traps and sediment separators
- permeable geotextile — wrapped around each assembly when used for infiltration
- geomembrane — wrapped around each assembly when used for storage (attenuation)
- protective fleece — wrapped around each assembly when used for storage (attenuation), to give added protection to the geomembrane
- granular material/coarse sand.

2 Manufacture

2.1 The system components are injection-moulded using recycled polypropylene 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 and calibrated
- 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 Wavin UK (Holdings) Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by SGS UK Ltd (Certificate GB08/74586).

3 Delivery and site handling

3.1 The system is supplied to site in packs of 12 or 15 units, secured with straps, with plastic feet attached to the underside to enable placing and movement by a fork-lift. Each pack of units carries a label bearing the system type, part number, operator's initials, individual pallet sequential number and date of manufacture.

3.2 Each unit is supplied with two shear connectors and three clips.

3.3 The 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 exposure to direct sunlight should be avoided.

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

3.6 The units are resistant to damage that could occur with normal handling. They should be stored away from the possibility of impacts by vehicles and other construction plant.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on AquaCell Eco.

Design Considerations

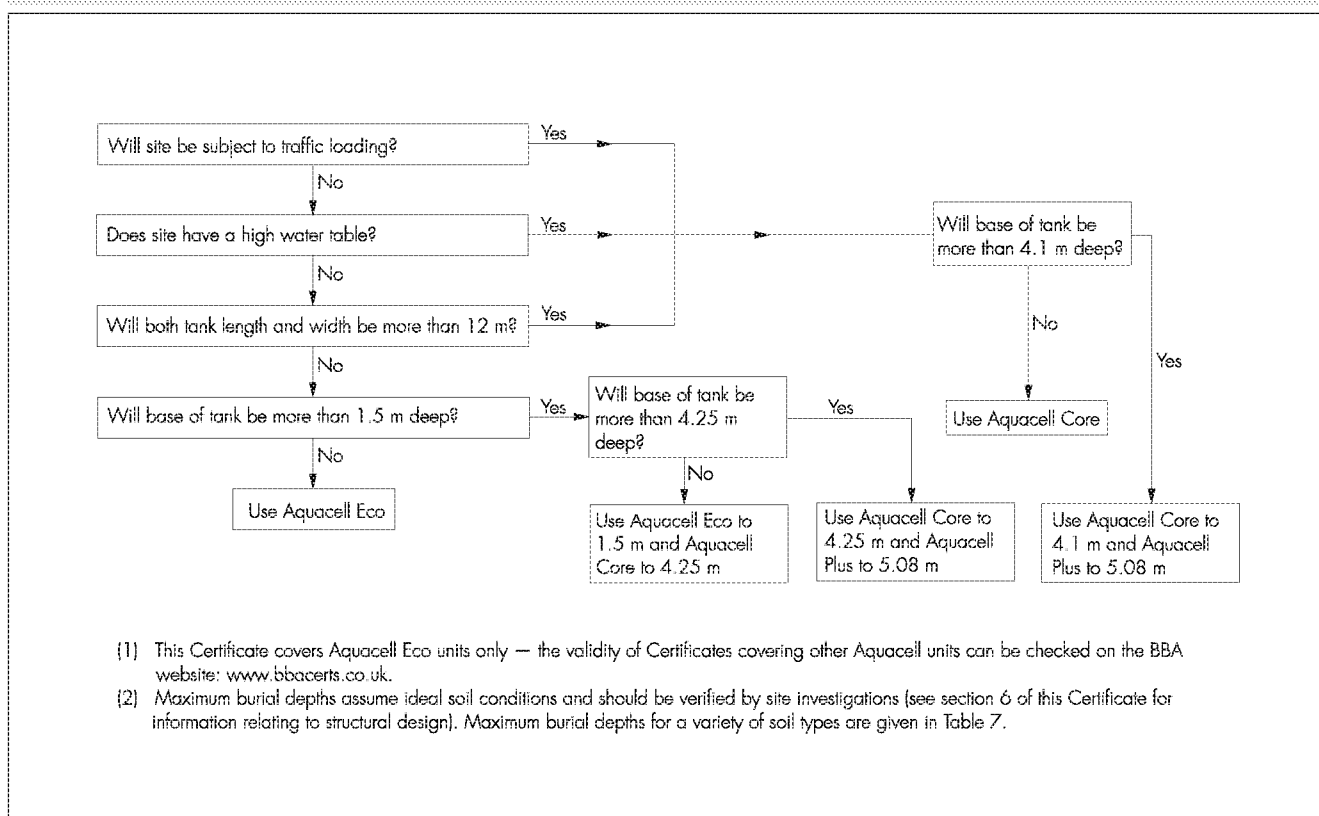
4 General

4.1 The design of AquaCell Eco must be in accordance with the Certificate holder's design guidelines. Guidance on the application of sustainable drainage systems (SUDS) for new developments can be found in The National Planning Policy Framework and The SUDS Manual (C697) published by the Construction Industry Research and Information Association (CIRIA).

4.2 The system is satisfactory for the management of stormwater run-off from impermeable surfaces and can be used in three main ways (see Figure 2):

- infiltration — water is stored within the system during rainfall and allowed to drain away by soaking into the surrounding ground over a period of time after the rain has ceased
- attenuation — water is stored within the system 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, thereby minimising the risk of flooding
- a combination of infiltration and attenuation.

Figure 2 Sustainable drainage system selection and design



4.3 The design of a 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.

5 Practicability of installation

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

6 Hydraulic design

Infiltration

Calculation principles



6.1 There are two approaches, either of which can be adopted: CIRIA Report 156 *Infiltration drainage — Manual of good practice* and BRE Digest 365 *Soakaway design*. Further information on the design of SUDS may be obtained from *The SUDS Manual* (C697).

6.2 A simplified approach can be used on a small site (ie a single-house development), where detailed site infiltration rate information may not be required or available (see Table 2). In Approved Document H, a storage volume equal to the area to be drained multiplied by 10 mm, for areas up to 25 m² is allowed. Beyond this size, design should be carried out in accordance with BS EN 752 : 2008 or BRE Digest 365. BS EN 752 : 2008 suggests a storage volume equal to 20 mm multiplied by the area to be drained. 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 ⁽²⁾
2	0.38	25 ⁽²⁾
3	0.57	28.5 ⁽³⁾
4	0.76	38 ⁽³⁾
5	0.95	47.5 ⁽³⁾
6	1.14	57 ⁽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 in Tables 3 and 4 of this Certificate.

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

Number of units high	System volume (m ³) per metre length of trench	Vertical surface area (m ²) (both sides) per metre length of the system	Area beneath system (m ²) per metre length of trench
1	0.19	0.8	0.5
2	0.38	1.6	0.5

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

System length (number of units long) (1.2 m side)	2 units wide (0.5 m side)			4 units wide (0.5 m side)			8 units wide (0.5 m side)		
	Volume (m ³)	Area around sides and ends (m ²)	Area under base (m ²)	Volume (m ³)	Area around sides and ends (m ²)	Area under base (m ²)	Volume (m ³)	Area around sides and ends (m ²)	Area under 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	7.6	17.6	10.0	15.2	19.2	20.0	30.4	22.4	40.0
100	76.0	161.6	100.0	152.0	163.2	200.0	304.0	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 linear trench 40 m long and two units deep the volume is 0.38 by 40 = 15.2 m³ and the side area 1.6 by 40 = 64 m².

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, but 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

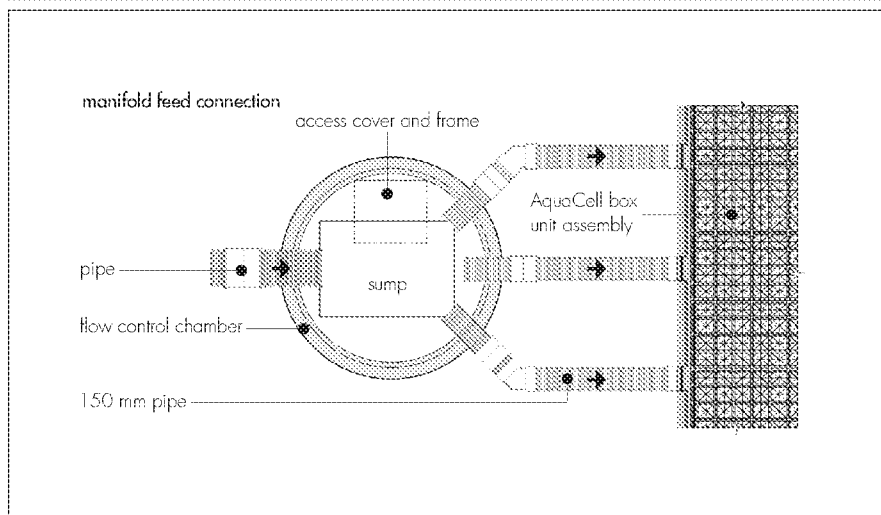
6.6 Connection is made to the units using a preformed socket and adaptor or a flange adaptor.

6.7 It is recommended that all connections into storage applications (using a geomembrane) are made using a flange adaptor. Adhesive or double-sided tape should be used between the geomembrane and flange adaptor to ensure a watertight seal.

Manifold design

6.8 The units are manufactured to allow a connection to be formed by insertion of 160 mm diameter pipes to BS EN 13476-3 : 2007 into the 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 that the pipework connecting the units to the drainage system has sufficient capacity to cope with the design flow.

Figure 3 Typical inlet connection design



Flow control

6.9 When the system is used for attenuation purposes, 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 valve or small pipe. Comparative features and benefits of these various control flow devices should be considered prior to selection.

Outflow positioning and head calculations

6.10 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 design

7.1 The structural design of each installation incorporating the system should be carried out 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 *Structural design of modular geocellular drainage tanks*. 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 a wide variety of landscaped or pedestrian areas where ground water is not present. Design procedures for trafficked applications are outside the scope of this Certificate.

7.4 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.

Performance characteristics

7.5 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

Performance characteristic (unit)	Value
Characteristic compressive strength at the yield point ($\text{kN}\cdot\text{m}^{-2}$)	
vertical loading on top face	213
lateral loading on side face	52
Short-term elastic deflection (mm per $\text{kN}\cdot\text{m}^{-2}$) (applied load)	
vertical loading on top face	1 per 29
lateral loading on side face	1 per 9

7.6 Creep tests indicate that the long-term vertical deflection may be estimated from the equations shown in Table 6. This is valid for loads up to $52 \text{ kN}\cdot\text{m}^{-2}$ for durations of up to 10 years at 20°C . In locations where settlement is not a concern, designs of up to 50 years can be considered.

Table 6 Equations for estimation of long-term deflection

For loads up to ($\text{kN}\cdot\text{m}^{-2}$):	Equations for estimation of long-term deflection (mm)
52	Vertical deflection = $0.1069 \ln [\text{time (days)}] + 1.2561$
13	Lateral deflection = $0.9344 \ln [\text{time (days)}] + 1.3841$

7.7 The partial load and material factors given in Table 7, as defined in CIRIA Report C680, should be used for design.

Table 7 Partial factors for loads and materials

Description	Ultimate limit state	Serviceability limit state
Partial factors for loads		
vertical dead-load (F_d)	1.40	1.00
earth pressure (horizontal) + hydrostatic (horizontal) load (F_{ep})	1.35	1.00
imposed live-load (F)	1.60	1.00
Partial safety factors for materials (F_m)	2.75	1.50

Note: Where applicable, additional factors should be considered for dynamic factor and material factors for creep/fatigue.

7.8 Example maximum installation depths and minimum depths of cover, calculated as described in this Certificate and in accordance with CIRIA Report C680, are shown in Tables 8, 9 and 10. For soakaways serving an individual house, the system is located below a garden a minimum of 5 m from the building, inaccessible to motor vehicles. Table 8 indicates the maximum installation depth and minimum depths of cover.

Table 8 Design criteria for use of the system as a soakaway for an individual house⁽¹⁾

Criterion (unit)	Value
Maximum depth to base of units (m)	2.68
Minimum cover depth (m)	0.50

(1) The following assumptions apply:

- soakaway constructed in sandy gravels with a soil weight not exceeding $20 \text{ kg}\cdot\text{m}^{-3}$ 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 inaccessible to motor vehicles, in accordance with Table 4.2 of CIRIA Report C680.

7.9 For installations below landscaped or pedestrian areas the information given in Tables 9 and 10 is 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 units)

Soil description	Maximum installation depth (from invert of structure) (m)		
	Soil weight (kN·m ⁻³)	Angle of internal friction (degrees)	No groundwater present: landscaped areas ⁽¹⁾
Over consolidated stiff clay	20	24	1.53
Silly sandy clay	19	26	1.68
Loose sand and gravel	18	30	2.08
Medium dense sand and gravel	19	34	2.35
Dense sand and gravel	20	38	2.68

(1) Landscaped area where drive-on mowers are used in accordance with Table 4.2 of CIRIA Report C680.

Notes:

- these values relate to installations where the groundwater is a minimum of one metre below the base of the excavation. AquaCell Eco units should not be used where groundwater is present
- calculations based on systems constructed from two layers of AquaCell Eco units
- no account is taken of accidental loading
- ground surface in vicinity of system assumed to be level
- formation below system assumed to have adequate bearing capacity
- partial load and material factors are defined in Table 7.

Table 10 Minimum cover depth

	Landscaped areas ⁽¹⁾
Minimum cover depth required (m)	0.50

(1) Landscaped areas where drive-on mowers are used in accordance with Table 4.2 of CIRIA Report C680.

Notes:

- calculations based on systems constructed from two layers of AquaCell Eco units
- soil weight and angle of internal friction of the soil above the system taken as 20 kN·m⁻³ and 38° respectively
- calculations based on there being no groundwater present
- angle of spread for wheel loads taken as 27° in car parks with asphaltic surfacing and angle of internal friction of soil in landscaped areas
- no account is taken of accidental loading
- ground surface in vicinity of system assumed to be level
- formation below system assumed to have adequate bearing capacity
- partial load and material factors are defined in Table 7
- values for distributed and concentrated wheel loads/contact as defined in Table 4.1 of CIRIA Report C680.

8 Geotextiles and geomembranes

Infiltration

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

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

8.2 The 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 system, to 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 also require the use of an additional thick, protective geotextile fleece to prevent puncture or excessive strain in the geomembrane. Further advice should be sought from the geomembrane manufacturer.

8.5 Selection of an appropriate geomembrane requires careful consideration (see section 8.7).

Specification of geotextile

8.6 The selection of an appropriate geotextile for a specific AquaCell Eco Infiltration System should be considered carefully, particularly with reference to the surrounding soil properties and required performance. Points to consider are:

- pore size — this should be designed and specified to assist infiltration and prevent migration of fine soil particles
- permeability and breakthrough head — the geotextile should not limit flow of water in the system, and should have a similar or greater permeability than the surrounding ground
- puncture resistance — the geotextile must be able to resist piercing by potentially sharp objects, eg stones in the soil
- tensile strength — the geotextile should have sufficient strength to resist any imposed forces, eg from traffic
- specialist advice should be sought if surrounding soil characteristics exhibit a high degree of fines/low infiltration capacity and/or there is risk of damage from ground contaminants.

Specification of geomembrane

8.7 The specification and selection of the impermeable geomembrane must be correct for the proposed installation, to ensure that it performs to the level required. It is essential that the specified material:

- withstands the rigours of installation
- resists puncture
- resists multi-axial elongation stress and strains associated with settlement
- resists environmental stress cracking
- resists damage from ground contaminants
- remains intact for the full design life.

8.8 A geomembrane less than 1 mm thick is unlikely to meet these criteria (except in shallow, domestic installations), and is not recommended for use with AquaCell Eco. For further details the Certificate holder's advice should be sought.

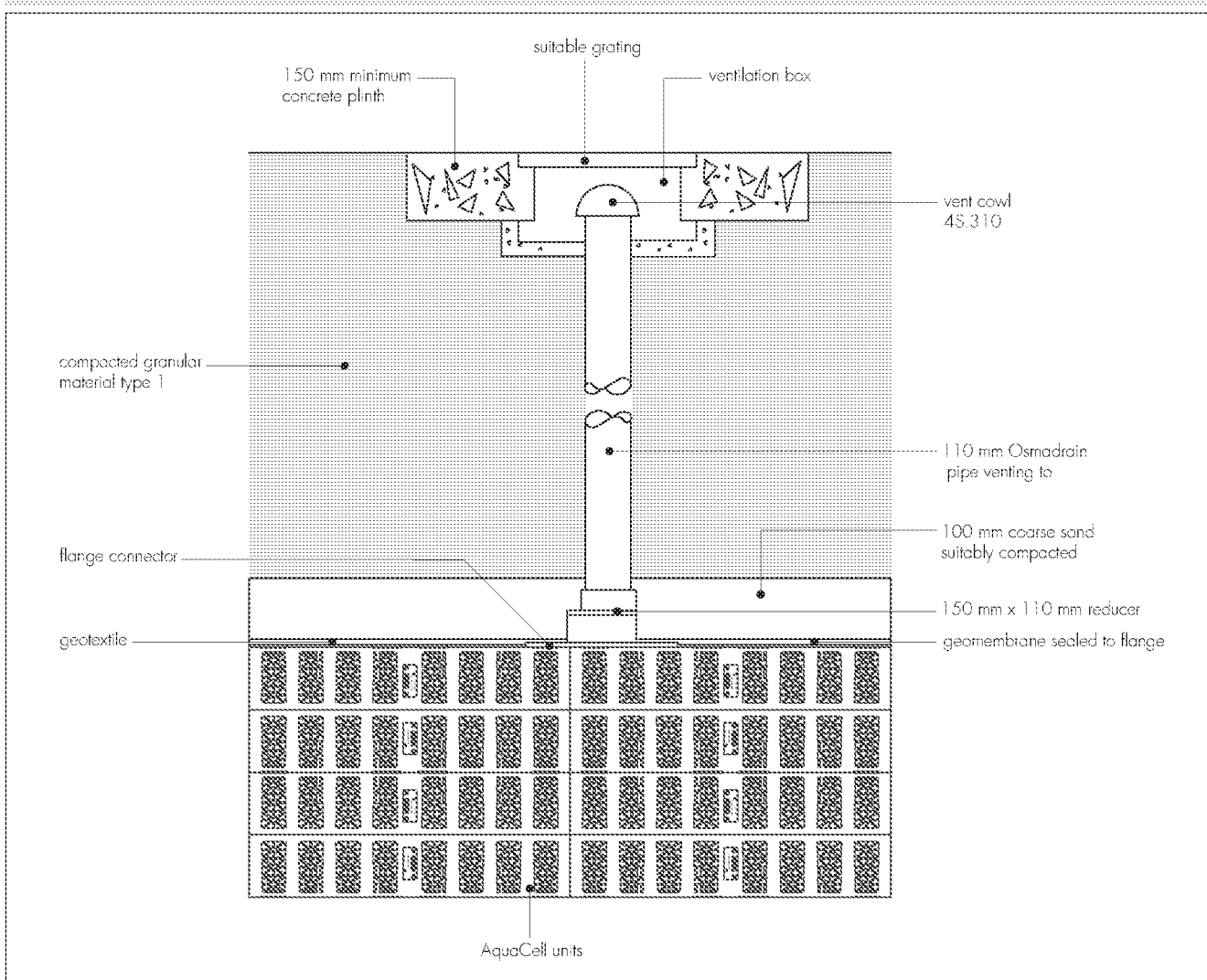
8.9 All joints must be sealed using proprietary techniques recommended by the manufacturer. Advice on seam testing procedures is given in CIRIA Report SP 124 : 1996 *Barriers, liners and cover systems for containment and control of land contamination*.

9 Venting

9.1 Adequate venting must be provided to the system. One 110 mm diameter air vent is required per 7500 m² of impermeable catchment area to be drained (see Figure 4).

9.2 Typical air vent connectors and pipework can be seen in the Certificate holder's *AquaCell Systems — Product and Installation Manual*. It is recommended that all air vent installations in attenuation/storage applications (using an impermeable geomembrane) are made using a flange adaptor. Adhesive or double-sided tape should be used between the geomembrane and flange adaptor to ensure a watertight seal.

Figure 4 Typical air vent system



10 Resistance to chemicals

10.1 An assessment carried out by the BBA indicates that the system components 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 AquaCell Eco units on brownfield sites should be made, only after a suitable site 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

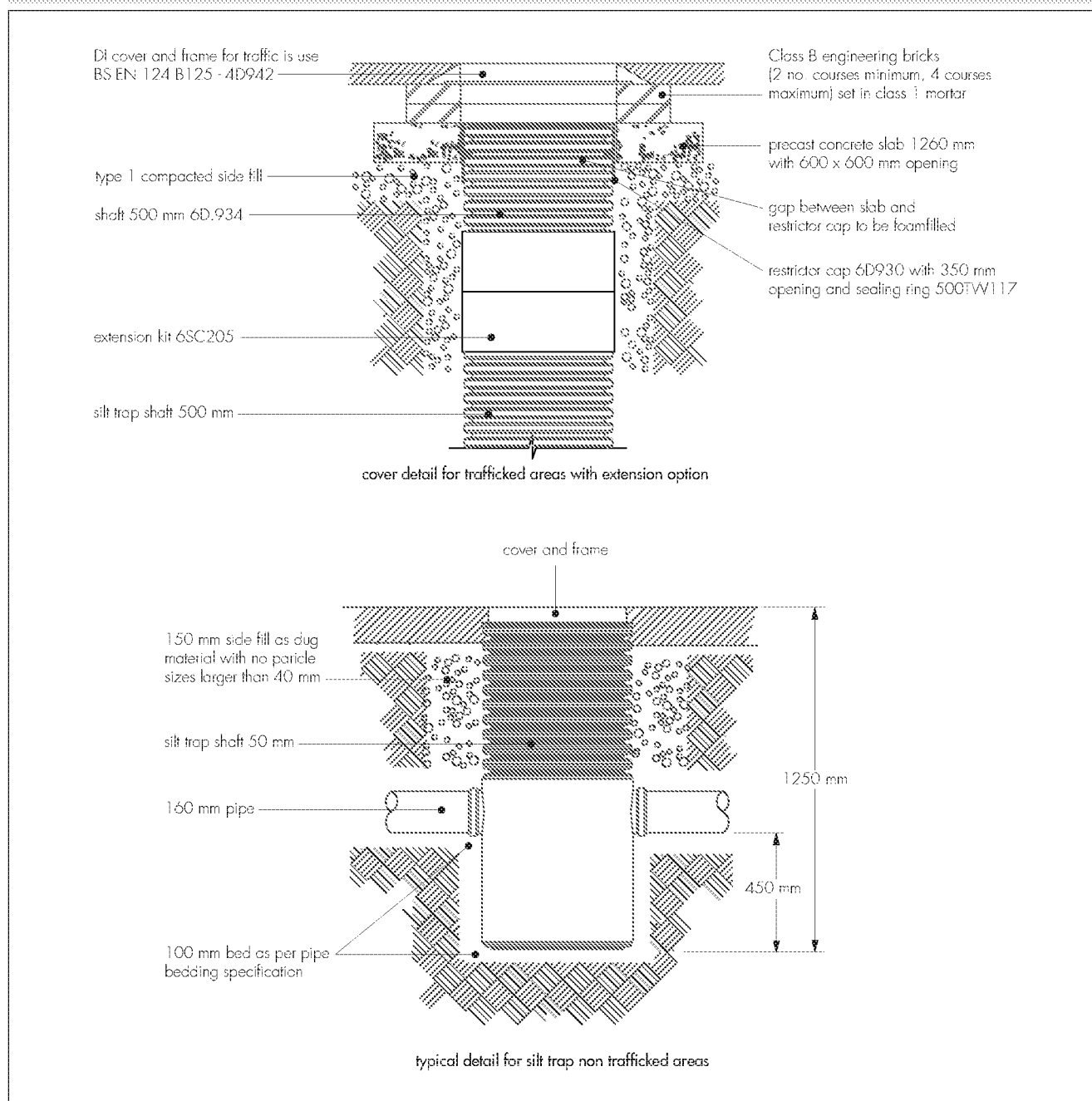
11.1 The owner of the structure is responsible for its maintenance.

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 programme of regular inspections should be established to prevent siltation of the system which, if allowed to develop, would reduce its effectiveness. The system should also be inspected after every major storm event.

11.4 It is recommended that a silt trap or sediment removal separator be installed upstream of the inlet pipework to the system (see Figure 5). A maintenance plan must be in place for regular cleaning of all traps and sumps to ensure correct performance. Silt traps and sediment removal separators for use with the system are outside the scope of this Certificate.

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 valve. 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 as internal inspections, to ensure that the units continue to provide the required structural support.

12 Durability



The structural properties of polypropylene used in the system components will deteriorate with time, and this should be taken into account at the design stage by the application of suitable safety factors. In the opinion of the BBA, AquaCell Eco, when used in accordance with this Certificate, will have a life in excess of 50 years.

13 Reuse and recyclability

The units are made from polypropylene, which can be recycled.

Installation

14 General

The system should be installed in accordance with the Certificate holder's *AquaCell Systems — Product and Installation Manual*.

15 Procedure

15.1 The hole or trench is excavated to the required depth, dimensions and levels. It must be ensured that the plan area is sufficient to allow plant access around sides to compact backfill material (300 mm minimum). 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.

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

15.3 A 100 mm thick bedding layer of coarse sand is laid on the base and sides of the excavation. If required in attenuation systems, a layer of geotextile is laid to protect the impermeable geomembrane.

15.4 The impermeable geomembrane (or geotextile, if in an infiltration system) is laid over the sand bedding layer and up the sides of the excavation. The impermeable geomembrane is inspected for damage and all welds are tested as required. Joints between adjacent sheets of impermeable membrane should be sealed correctly using proprietary techniques with a minimum lap of 50 mm. Jointing with tape is not recommended as the system then becomes reliant on the mechanical properties of the tape to maintain its integrity.

15.5 The AquaCell Eco units are installed in accordance with the installation schedule for correct orientation. Wherever possible, continuous vertical joints should be avoided. The units are arranged so that preformed sockets are in the correct alignment for inlet and outlet pipes. For single-layer applications, AquaCell clips are used and, for multilayers, AquaCell clips and shear connectors.

15.6 The geotextile or impermeable geomembrane encapsulation to base, sides and top of installation, including protective geotextile (if required to protect the geomembrane), is completed. Impermeable geomembranes should be welded with double seams. All welds should be tested as required and the membrane inspected for damage.

15.7 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. Alternatively, flange adaptors are used attached to AquaCell Eco units with adhesive tape and self-tapping screws (flange adaptors cannot be used at the invert of AquaCell Eco units into the preformed socket). It is recommended that all connections and air vent installations, in attenuation/storage applications, are made with a flange adaptor, using adhesive or double-sided tape to form a seal. Alternatively, drainage connections are sealed into a preformed socket using proprietary seals approved by the geomembrane manufacturer.

15.8 A coarse sand protection layer, 100 mm thick, should be placed over the top of the units that have been wrapped. Backfilling is continued with selected as-dug material, with size of pieces less than 75 mm, compacted to 90% maximum dry density. Compaction plant over the top of the system must not exceed 2300 kg per metre width.

15.9 Pavement construction or landscaping over the system is completed.

Technical Investigations

16 Tests

Tests were carried out on the system and the results assessed to determine:

- long- and short-term resistance to loading
- performance and durability
- volumetric capacity and discharge rate.

17 Investigations

17.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

17.2 An assessment of the system was made in relation to material properties and design procedures.

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

Bibliography

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

BS EN 13476-3 : 2007 +A1 : 2009 *Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) — Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B*

BS EN ISO 9001 : 2008 *Quality management systems — Requirements*

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

Conditions of Certification

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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