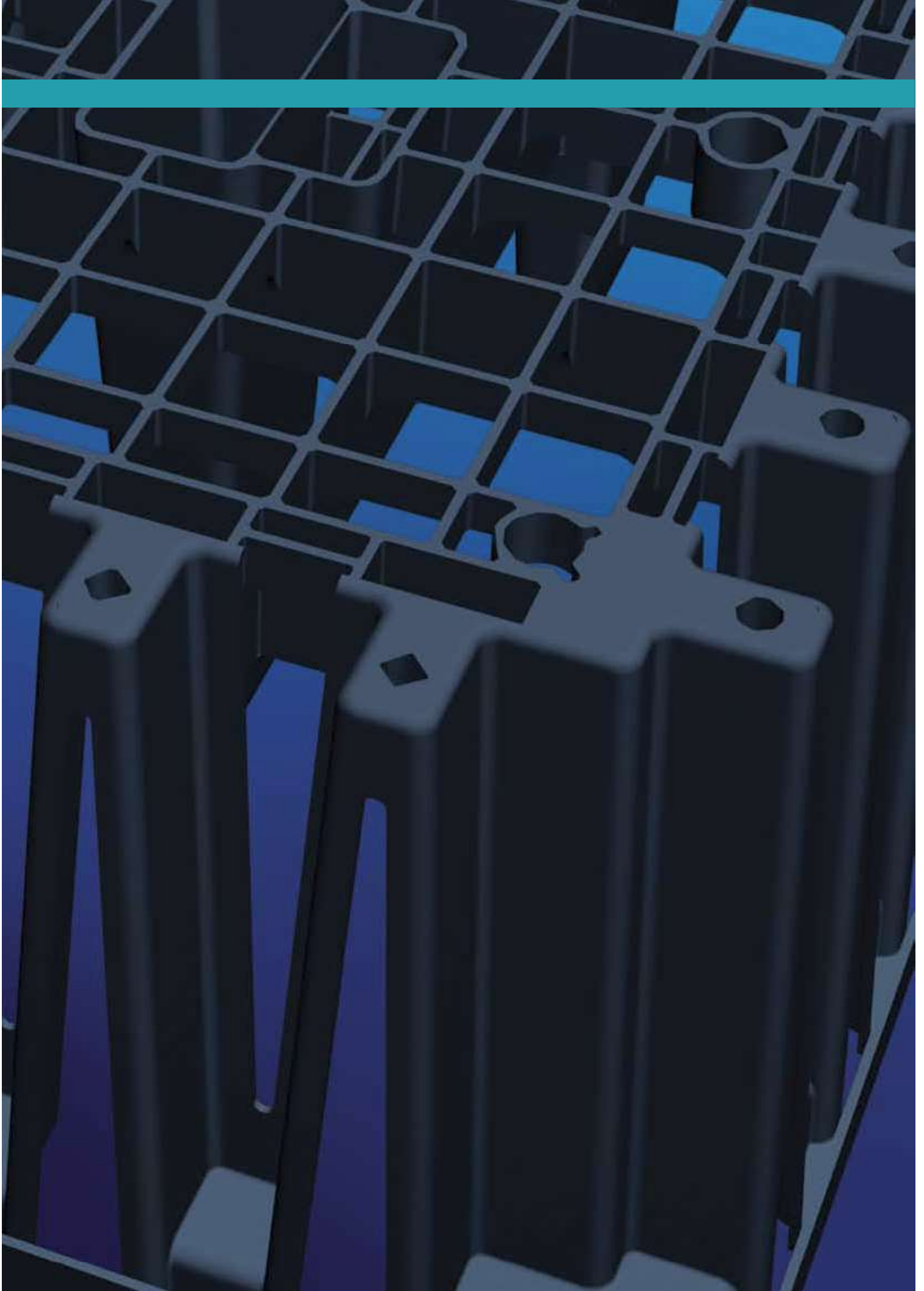


Sustainable drainage systems





The **Waterloc250** modular geocellular unit is the result of extensive research and testing in the UK and across Europe. This improved product forms part of the range of Marley sustainable drainage systems, which also includes the Flowloc vortex controller.

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P.6	Key components
P.10	Regulations and guidance
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The environment



It is now widely recognised that the effects of climate change and the increase in the built environment have necessitated changes to the way in which stormwater is dealt with.

Sustainable drainage systems (SUDS) provide an effective way of mimicking natural drainage before development takes place; whether to counteract the effect of overloading gravity pipelines and watercourses, which can contribute to flooding downstream; or conversely, dealing with rainwater run off on site to replenish ground water levels, particularly in times of water shortage. SUDS are now at the forefront of environmental policy and planning.

sustainable drainage systems

The environment

The advantages of below ground SUDS solutions:

- Low space utilisation
- No health and safety risk
- Adaptability to suit site conditions
- Low vandalism risk
- Low maintenance
- Geocellular units are exceptionally easy to handle on site, allowing rapid construction of the tank
- The modular format allows flexibility in the design of the tank plan area or depth to suit available space and ground water levels.
- A square or rectangular tank configuration minimises the amount of excavated spoil and simplifies the backfilling process
- A porosity ratio of 96% minimises the extent of the excavation for any given tank volume



Environmental policy

Marley Plumbing & Drainage is a leading supplier of products for the building and construction industry. Marley Plumbing & Drainage is part of the Alaxis group of companies, internationally recognised as a major global supplier of construction products.

The Company is actively committed to adopting good sustainable practices. In developing its business, products and services, Marley Plumbing & Drainage will:

- Comply with all relevant environmental legislation, codes of practice and standards relating to quality and the environment.
- Conform to the environmental policy of the Alaxis Group of companies.
- Continually improve the Company's environmental performance, minimising any pollution risk and adopting best industry practice.
- Regularly review performance and set clear objectives and targets to ensure environmental impacts are managed and reduced.
- Increase the use of recycled materials where appropriate.
- Take positive action to reduce waste by promoting energy conservation and recycling.
- Ensure that employees of Marley Plumbing & Drainage have the necessary knowledge, resources and skills to implement the environmental policy of the Company.
- Communicate the Environment Policy of Marley Plumbing & Drainage to customers and other stakeholders to share in the Company's aim of excellence in environmental management.
- Consider the needs and expectations of all customers and other stakeholders.

The Company operates a quality management system which meets the requirements of BS EN ISO 9001:2008.

dhm plastics ltd are certified to BS EN ISO 14001:2004, the worldwide recognised environmental standard.

dhm plastics ltd manufactures products for Durapipe, Hunter Plastics and Marley Plumbing & Drainage at the Company's head office in Kent, South East England.

Brian Blanchard

Brian Blanchard, Managing Director
December 2009



Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2008

This is to certify that:

DHM Plastics Limited
Dickey Lane
Lenham
Maidstone
ME17 2DE
United Kingdom

Holds Certificate No: FM 30037

and operates a Quality Management System which complies with the requirements of ISO 9001:2008 for the following scope:

The manufacture and supply of thermoplastic systems for above and below ground drainage. The manufacture of thermoplastic pressure pipe fittings for the conveyance of water, compressed air, petroleum, corrosive liquid waste and general industrial applications and the design, manufacture and supply of equator mono and multilayer barrier pipe and fittings for hot and cold central heating systems and associated applications. The manufacture and supply of building products.

For and on behalf of BSI:

Brian Blanchard
Managing Director: BSI EMEA

Originally registered: 06/02/1995 Latest issue: 19/10/2009 Expiry Date: 25/01/2012

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The British Standards Institution is incorporated by Royal Charter
BSI (UK) Headquarters: 1, 81, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

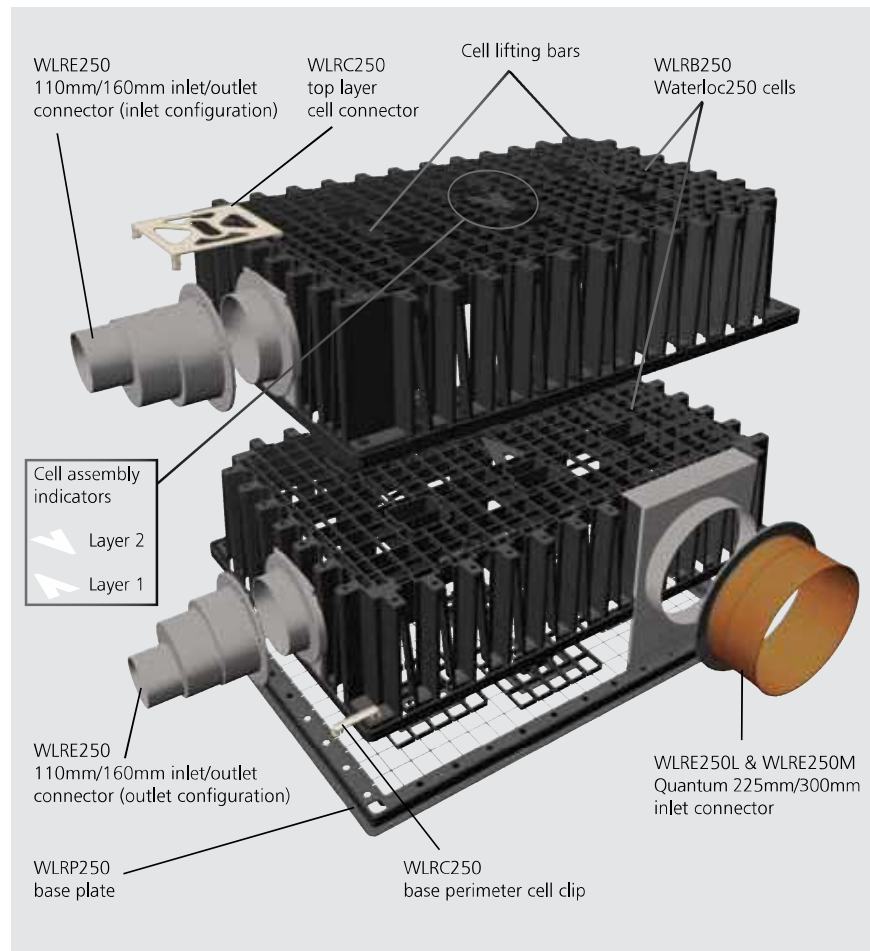
Key components

waterloc²⁵⁰

The Marley Waterloc250 cell is ideal for use in either an underground infiltration or attenuation system. 96% of the cell volume is available to store water, minimising the extent of excavation required for the installation. In addition, the innovative design of Waterloc250 enables the cells to be quickly built into layers and configured to suit the area available.

Waterloc250 benefits

- Unique nesting ability of cells reduces storage on site and transportation costs
- Layers are quickly assembled by rotating alternate cells 180°
- Size (1200mm x 800mm x 290mm high) and modular nature allows for maximum flexibility where space is restricted
- Exceptional vertical and lateral loading capability
- Open cell structure allows rapid dispersion of water
- Range of options making pipe connections quick and easy
- Four Waterloc250 cells = 1m³ making volume calculation straightforward
- BBA 11/4830 certification



sustainable drainage systems

Key components

Waterloc250 specification overview

Colour	Black
Unit dimensions	Length: 1200mm. Width: 800mm. Height 290mm*
Weight	12kg
Void ratio	96%
Storage volume	250 litres
Storage capacity	240 litres
Material	Polypropylene

* Effective depth when installed in multiple layers: 260mm

Waterloc250 key performance criteria

Property	Vertical loading on top face	Lateral loading on side face
Short term characteristic compressive strength	350kN/m ²	82kN/m ²
Short term load to cause 1mm deflection	47kN/m ²	7.1kN/m ²

Waterloc250 key characteristics

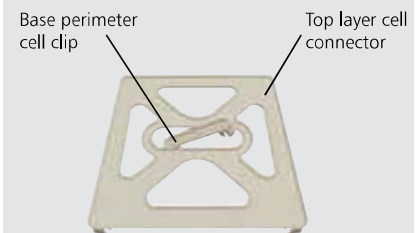
Waterloc250 has lifting bars and an arrow moulded into the top face. The cells are assembled by rotating them by 180° from the nested stack. The cell connector actually consists of two clips; the 'pop-out' clip in the centre is the base cell clip, for securing the base layer, the remainder is the top cell connector, required for the top layer only. No clips are required for the intermediate cell layers.

Pipe connections can be made to allow inlet and outlet connections at any position around the periphery of the tank. A special feature of the spigot connector is a screw fixed mounting plate that enables the geotextile or geomembrane liner to be easily sealed around the connection prior to fitting the pipe. The Marley Inlet chamber also provides a water entry method and / or access for inspection.



Help us to reduce our carbon footprint! Waterloc250 cells, uniquely can be nested for storage and transportation – saving space and the number of lorries needed to deliver to site.

Waterloc250 cell connector, WLRC250



Key components

flowloc

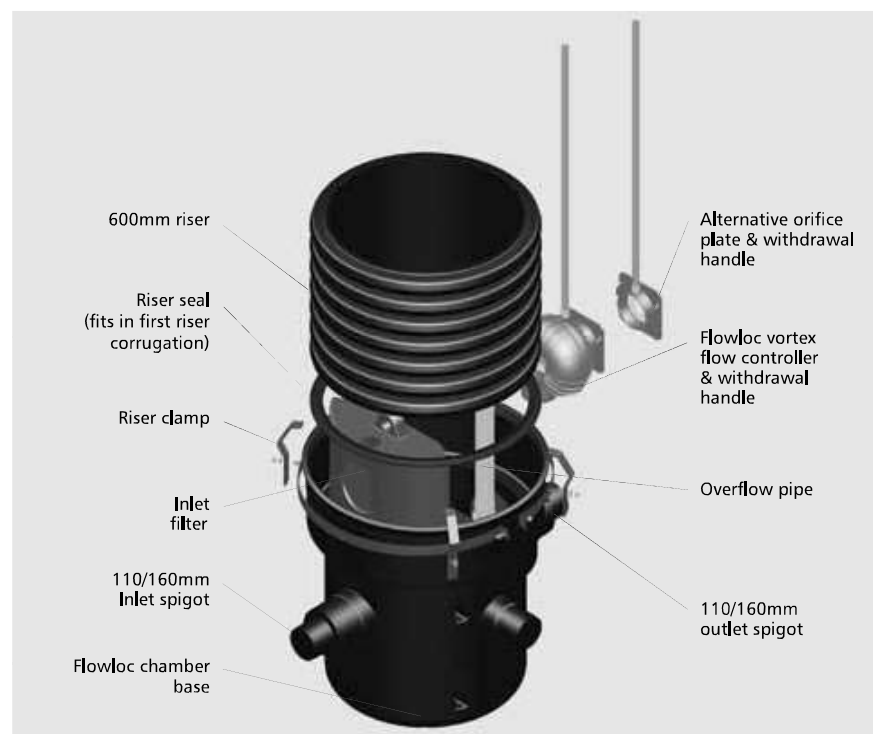
Flowloc is a Vortex flow control unit, which is used as part of an attenuation scheme.

- Heavy duty aluminium flow controller and coupling system, electro coated for long service life. Available to suit a wide range of flow rates. (Refer to performance tables in appendix two on page 29)
- Supplied within a chamber base with an integrated filter providing protection against controller blockage
- Suitable for use with tank depths up to 4m
- All components readily removable from surface for ease of maintenance
- The chamber base is also suitable for installation within a conventional man entry inspection chamber if required

Flowloc controls the rate at which water is discharged to a surface water drain or watercourse. Local Authorities or Water Companies normally set an outflow rate for new developments.

The design of Flowloc is based on the proven vortex principle, and enables a near constant discharge rate to be achieved, independent of the head of water in the tank. Available to accommodate flow rates ranging from 2 l/s to 15 l/s, Flowloc is installed in a chamber base with a withdrawal handle to allow easy access from the surface for maintenance. In the unlikely event of blockage, an overflow pipe allows water to bypass the controller to the outlet.

An extensive range of orifice plate flow control units are also available for applications where very low flow rates are required or for higher flows where there is a less stringent requirement for controlling the water flow rate.

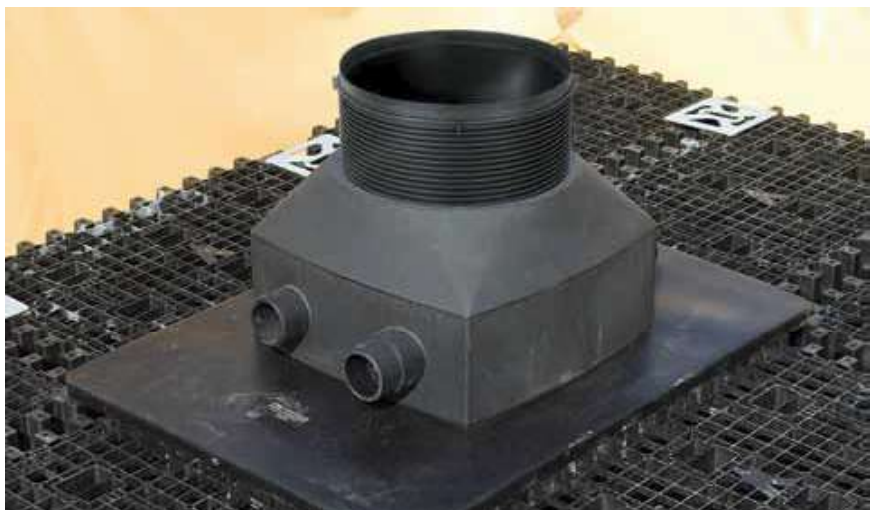


sustainable drainage systems

Key components

Inlet/inspection chamber

The Marley inlet chamber provides access to the soakaway or attenuation scheme for inspection and cleaning. A column of cells is omitted beneath the chamber to provide an inspection well. The chamber is seated into an adaptor tray (ordered separately). It can also be used as an inlet connection or connection for an air vent. For larger installations, multiple inlet chambers can be used, but must be bounded on all sides by cells.



Inlet chamber, UMF21. Adaptor tray, UMF22A



250mm silt trap, UG60



600mm silt trap, USW30 (shown with riser kit)

Silt traps

Available in 250mm and 600mm, with or without additional filters. It is recommended that all stormwater drainage systems that discharge into infiltration or attenuation tanks have upstream filtration to minimise the build up of silt and prevent the ingress of debris. The UG60, 250mm silt trap is suitable for catchment areas up to 250m². For larger catchment areas, the 600mm silt trap, USW30 should be used.

Regulations and guidance

Over recent years a number of studies, recommendations and guidance documents have been published, all of which consider how sustainable drainage should be encouraged and implemented. Added to this, regulatory guidance is also evolving.



Planning Policy Statement 25 (PPS25)

December 2006. Department of Communities and Local Government

Development and flood risk

Published in December 2006, PPS25 sets out the Government's policy on different aspects of land use planning in England. With respect to SUDS, the policy document states that *"Regional planning bodies and local authorities should promote the use of SUDS for the management of run-off. Local planning authorities should ensure that their policies and decisions on applications support and complement Building Regulations."*

The Code for Sustainable Homes

February 2008. Department for Communities and Local Government
Category 4: Surface water run off

This deals with the management of surface water run-off from developments, the stated aim being: *"To design housing developments which avoid, reduce and delay the discharge of rainfall to public sewers and watercourses."*

The Pitt Review

Learning lessons from the 2007 floods. Sir Michael Pitt.

This report contains over 90 recommendations for better flood risk planning in England and Wales. In December 2008, the Government provided a response to the report. A number of the recommendations concern the use and adoption of SUDS; *"Local Surface water management plans (SWMPs) as set out under PPS25 and coordinated by local authorities should provide the basis for managing all local flood risk."* The Government response was to support this recommendation and state the intention that Local Authorities will be responsible for adopting and maintaining sustainable drainage systems (SUDS) in the public realm.

Building Regulations

Department of Communities and Local Government

Approved Document H3: Rainwater drainage, 2002 states *"methods of drainage other than connection to a public surface water sewer are encouraged where they are technically feasible."*

sustainable drainage systems

Regulations and guidance

CIRIA publications

The SUDS Manual 2007. CIRIA C697

This guidance provides best practice advice on the planning, design, construction, operation and maintenance of Sustainable Drainage Systems (SUDS) to facilitate their effective implementation within developments.

Sustainable drainage systems – Hydraulic, structural and water quality advice 2004. CIRIA C609

A report which details the appropriate approach to the successful design and construction of Sustainable Drainage Systems.

Structural design of modular geocellular drainage tanks 2008. CIRIA C680

Co-sponsored by Marley, this report focuses specifically on the different types of underground geocellular modular units. It provides guidance on test methods, structural design and the practical issues that should be considered in the design phase of a project.

Further reference

communities.gov.uk
defra.gov.uk
ciria.org

Specific advice for Scotland

In Scotland, as part of the enabling legislation relating to the Water Framework Directive, the term 'Sewer' was redefined to include SUDS. Through this, Scottish Water was made responsible for the future maintenance and capital replacement of shared public SUDS schemes. These changes were brought in through the enactment of stage 3 of the Water Environment and Water Services (Scotland) Act 2003. Scottish Water will now vest (adopt) detention ponds, basins and underground storage structures designed to attenuate surface water runoff. *Sewers for Scotland 2nd Edition, 2007* now provides guidance on the design, operation, maintenance etc of sustainable drainage systems. *The Scottish Building Standards, section 3: Surface water drainage* also contains specific advice.

Further reference

wrcplc.co.uk
(Sewers for Scotland, 2nd edition)

sepa.org.uk
(Scottish Environment Protection Agency)

sbsa.gov.uk
(Scottish Building Standards Agency)

scottishwater.co.uk

Applications

Infiltration

Infiltration systems are designed to provide temporary storage of surface water run off while natural dispersion into the surrounding soil takes place. Conventional soakaways are the most common example of below ground infiltration. The high void area of Waterloc250 (96%) means that a third of the volume is required compared with a conventional gravel/shingle filled soakaway. The success of any infiltration installation is wholly dependent on the permeability of the surrounding soil. Waterloc250 cells require a geotextile

wrapping in accordance with the specification in appendix one, (page 28) Figure 1 shows a typical infiltration soakaway. Pipe connections can be made to the tank using side inlet connectors or via the unique Marley inlet chamber when incorporated in the design. The inlet chamber additionally provides access to the tank for inspection and cleaning. Inlet chambers can be used purely as access for inspection. Multiple chambers may be appropriate for larger schemes.

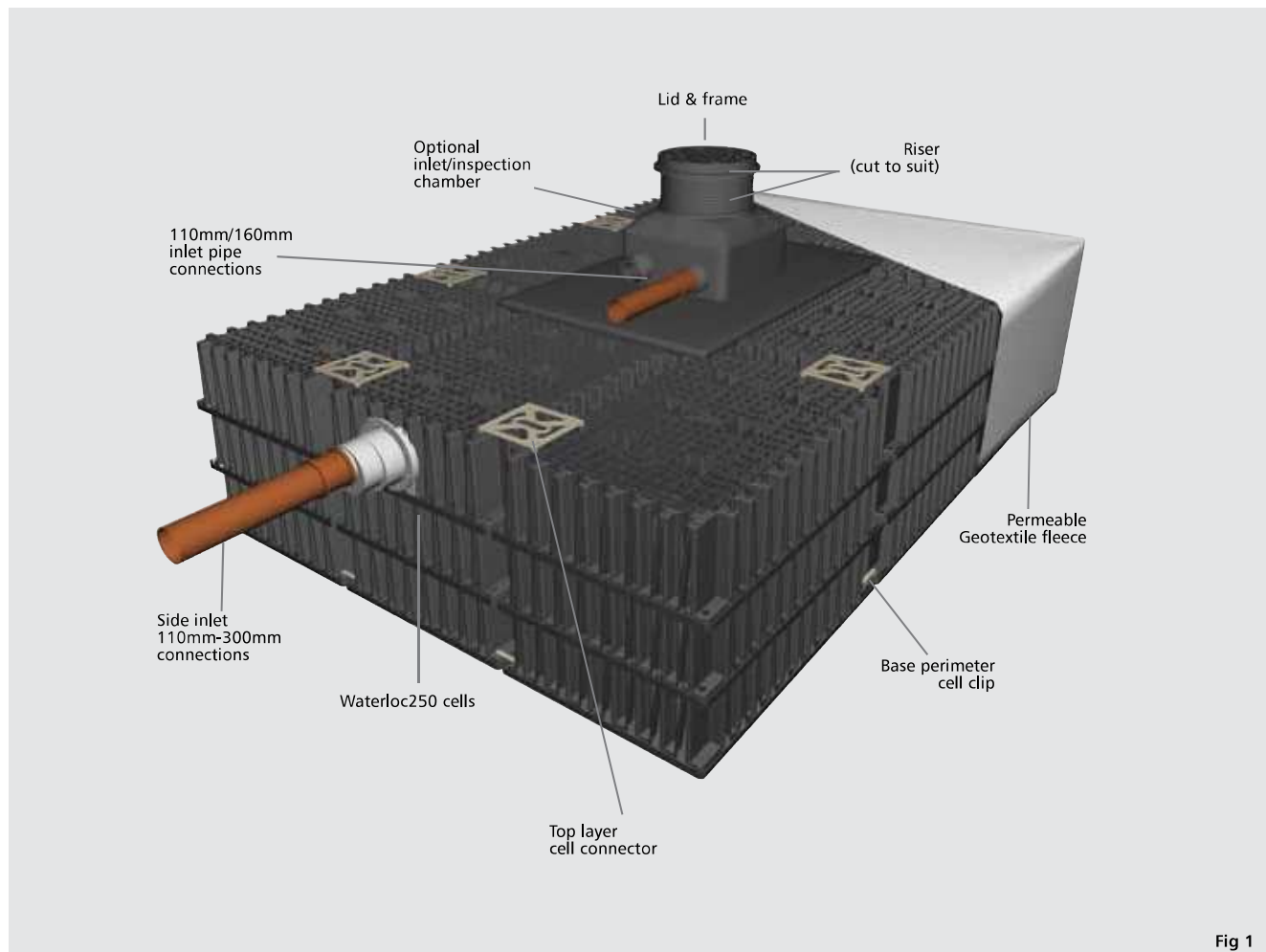
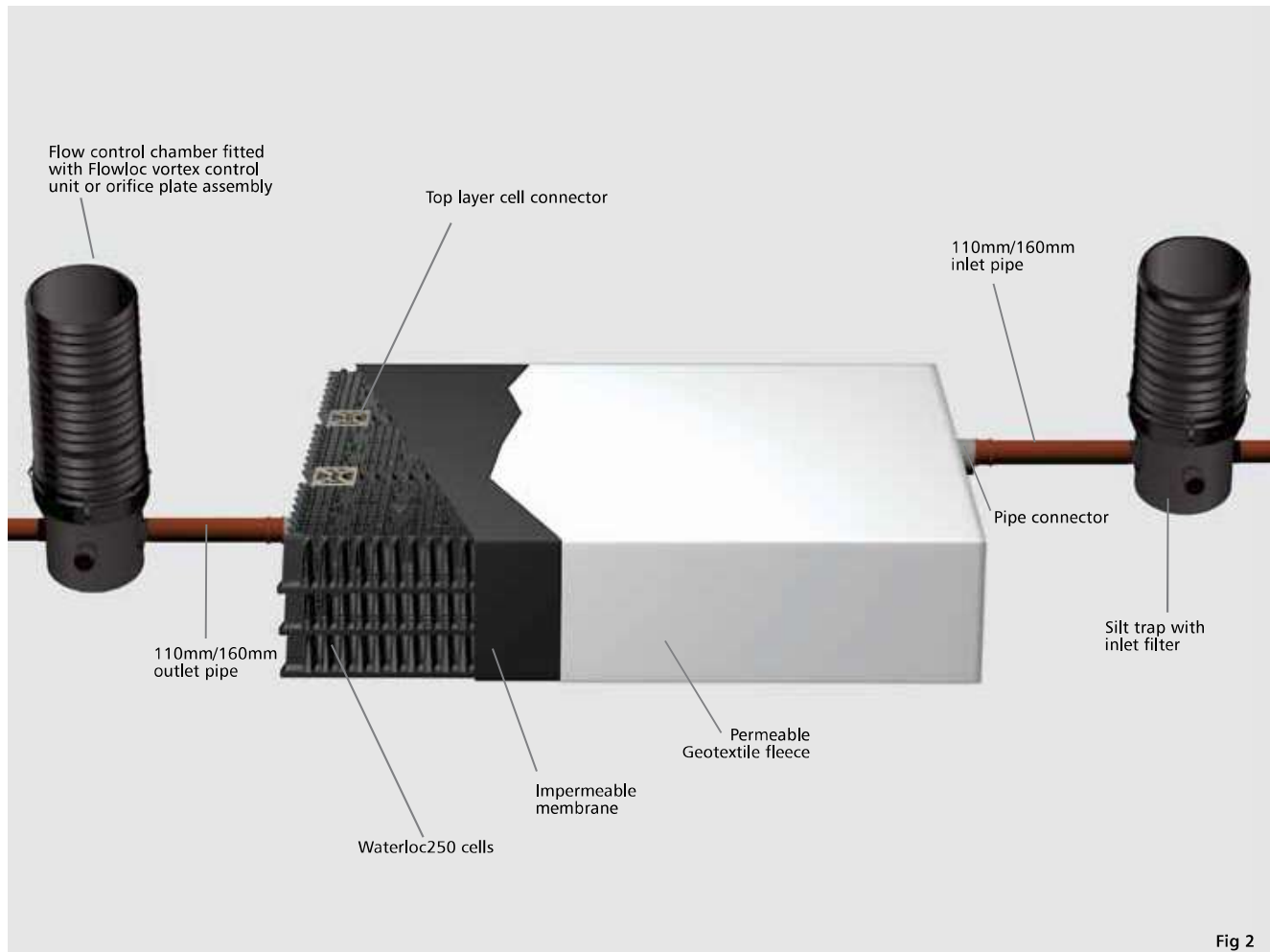


Fig 1

Attenuation

Designed to store stormwater temporarily in a suitable chamber below ground and release it at a pre-determined rate via a vortex flow control unit, such as the Marley Flowloc or an orifice plate. This limits the peak flow of water, thereby reducing the likelihood of overloading pipelines or watercourses downstream. The sizing of the attenuation tank is critical, to allow sufficient capacity to prevent upstream flooding. The Marley Technical Services team offer a design

service to assist with this calculation. Attenuation tanks must be encapsulated within an impermeable membrane and geotextile in accordance with the specification in appendix one, (page 28). Increasingly, as sewer networks approach capacity, attenuation techniques can offer a cost effective solution for accommodating additional catchment areas without increasing the size of the sewer.



Hydraulic design



Rainfall intensity and duration

The level of rainfall a drainage system must cope with varies with the storm duration, the return period of the storm, and the geographical location.

Storm duration

Rainfall intensity varies inversely with the duration of the rainfall, i.e. the shorter the duration the more intense the rain will be. For conventional underground drainage it is common to assume a 3 – 5 minute time of entry to the drainage network, and then add to this the time of flow to obtain the duration. When the outflow is restricted, either by a control device, or by the requirement for infiltration to take place, the critical duration increases. It is therefore important with any storage or infiltration design to determine the critical duration.

Return period

The intensity of a storm is not only governed by its duration, but also how frequently it could be expected to occur. Statistically a storm that occurs every week will be significantly lower in intensity than a storm which will only occur once every 100 years. It is not possible to guarantee that a system will not be overwhelmed, but by selecting a longer storm return period, the designer can reduce the risk factor, (there is a 3650 to 1 chance of a 10 year event happening tomorrow, but a 36,500 to 1 chance of a 100 year event happening). Guidance is available from statutory bodies with regard to return periods. Table 1 gives some of the range of values:

Return periods

Table 1

Source	Applicable to	Return period (yrs)
Part H, Building Regulations ¹	Infiltration	10
BS EN 752-4:2008 ²	Infiltration & Attenuation	30
Sewers for adoption 6 ³	Attenuation	30
Environment agency	Infiltration & Attenuation	100
Environment agency [†]	Infiltration & Attenuation	100+20%

[†] Some Environment Agency offices demand 100 years + 20% on top of calculated rainfall, which is equivalent to 250 years.

Location

The location of the site can have a significant influence on the level of rainfall intensity. Generally the western side of the UK experiences higher levels of longer duration rainfall. The design guidance used by most designers to ascertain rainfall intensity is the Wallingford Procedure⁴, which gives methods for determining the rainfall intensity in any given location based on return period, duration and location. The method given is fairly complex, and a computerised solution is generally used.

References

- 1 Approved document H, The Building Regulations 2000, Her Majesty's Stationery office, 2000, ISBN 0 11 753607 5
- 2 BS EN752-4:2008 Drain and sewer systems outside buildings – Part 4: Hydraulic design and environmental considerations, BSI, 2008, ISBN 978 0 580 55750 7
- 3 Sewers for adoption – a design and construction guide for Developers, Fifth edition, WRc, 2001, ISBN 1 898920 43 5
- 4 Design and analysis of urban storm drainage – The Wallingford Procedure, Volume 1, Department of the Environment, National Water Council Standing Technical committee reports No. 31., 1981, ISBN 0 90109 031 X
- 5 Soakaway Design – BRE Digest 365, Building Research Establishment, Garston, Watford, WD2 7JR, 2007, ISBN 1 86081 604 5
- 6 Infiltration drainage – Manual of good practice, CIRIA Report 156, CIRIA, 6 Storey's Gate, London, SW1P 3AU, 1996, ISBN 0 86017 457 3

sustainable drainage systems

Hydraulic design

Waterloc250 can be designed for use in either infiltration or attenuation applications. The design methods will however differ for each application.

Infiltration

Infiltration is the process of temporarily storing water and allowing it to slowly disperse into the ground and can be designed using one of two methods:

BRE 365⁵ is the traditional method for soakaway design, and uses only the sides of the soakaway for design purposes, assuming that the base will silt up over a period of time. The calculation methods are fairly simple, but the lack of consideration of the base leads to long thin trench soakaways as the most efficient configuration for this method.

CIRIA 156⁶ is a more modern method, which allows the base as well as the sides to be used for infiltration. To counter the effects of siltation, safety factors can be introduced, depending on the risk of failure. The CIRIA design method leads to shallow, flat soakaways, which are usually better suited to Waterloc250 installations.

Attenuation

Attenuation is the process of retaining water on site, before gradually releasing it into a sewer or watercourse at a controlled flow rate.

The required storage volume for an attenuation system can be determined using the following equation:

$$\text{Inflow (m}^3\text{/min)} \times \text{Duration (min)} - \text{Outflow (m}^3\text{/min)} \times \text{Duration (min)} \\ = \text{Storage Volume (m}^3\text{)}$$

It is recommended that this calculation must be repeated at a number of time steps between 5 minutes and 48 hours to determine the critical duration, i.e. the duration which gives the greatest requirement for storage. The smaller the time step, the more accurately this maximum value will be determined.

The level of allowable discharge from the site will vary depending on where the site is and what its previous use was, (brown or green field). Most authorities will not want to accept the full run off. The Environment Agency will often ask for discharge to be reduced to 5 litres per second per hectare (10,000m²) in a 100 year event for an ex-greenfield site. This would only equate to approximately 2% of the unrestricted discharge from the site, and so could require considerable storage. For brownfield sites, the designer must prove how much water previously discharged from the site, and then discuss with the Environment Agency or Water Authority to agree an acceptable discharge. The acceptable discharge is often less than the peak flow from site before re-development.

Whichever infiltration design method is used, there are a number of important considerations for soakaways:

- They must half empty in 24 hours or less, to ensure that if another major storm occurs shortly after the first, the system will be able to cope with it.
- They must be located a minimum distance of 5m from the nearest building, to protect building foundations from damage.
- They must be wrapped in a geotextile fleece to ensure that surrounding soil does not migrate into the soakaway void, reducing its effectiveness. See appendix one, page 28.
- It is vitally important that an accurate soil infiltration rate is established by site testing. A detailed test method is provided in BRE365⁵.
- There should be a minimum of 1m between the highest predicted groundwater level on the site, and the bottom of the soakaway.

Design

Design factors checklist

For accurate sizing of infiltration and attenuation systems it is vital that site specific input data is provided to enable the relevant calculations to be made. The following information is required for sizing a soakaway or attenuation system:

1. The calculation method to be used (BRE or CIRIA)
2. The geographical location of the site (for selection of local rainfall statistics)
3. The storm profiles to be used (return period in years)
4. The catchment areas discharging into the stormwater system (roofs and other hard surfaced areas)
5. Soil infiltration rate (derived from porosity tests conducted on the site)
6. Allowable outflow rate, litres/second (for attenuation systems)
7. Safety Factor to be applied which is normally agreed with the Local Authority, Environment Agency or Water Company (dependent on consequence of flooding)

Sizing calculations for infiltration & attenuation systems

The easiest way to calculate the required size of stormwater management systems is by using tailored computer software. Marley Plumbing & Drainage can offer this service using software which is capable of assessing rainfall for any duration and return period anywhere in UK. Those involved with the construction industry can take advantage of the Marley stormwater design services, provided a commitment is made to specify and use Marley Plumbing & Drainage products.

Soakaways for smaller catchment areas (e.g. single house) can be sized using the recommendations in BS EN 752 – 4 : 2008 National Annex NG (Drain & sewer systems outside buildings). The guidance states that the soakaway should have a capacity equal to 20mm of rainfall over the area being drained. This method assumes that the local soil conditions offer low permeability and therefore stormwater will need to be stored in the soakaway following high intensity storms.

The table below shows the effective height increments of the Waterloc250 cell for use when calculating storage volume.

Effective Height

Number of layers	Overall effective height mm
1	290
2	550
3	810
4	1070
5	1330
6	1590
7	1850
8	2110
9	2370
10	2630
11	2890
12	3150
13	3410

Filtration

Central to the function of any infiltration or attenuation storage system is the protection of the cells and flow control components from the ingress of debris and silts.

For a smaller installation, a 250mm silt trap, UG60 can be installed upstream of the storage system. For improved protection, the UG61 filter can be added, which will retain debris as small as 5mm.

Larger schemes benefit from a 600mm silt trap, USW30, which can be used with or without the USW29 filter which will retain debris particles as small as 10mm.



Air venting

A vent pipe may be required on some installations depending on the configuration (see examples on page 24-27). Venting pipework can be constructed using standard components from the Marley underground and soil ranges. Systems with a single 110mm inlet do not generally require venting. For installations up to 60m³, a 110mm vent is adequate.

Flow control

The benefit of using the Marley Flowloc vortex flow control unit is that the discharge rate varies less with changes in the head of water in the tank. Orifice plates operate by reducing the flow area to a much smaller proportion of its original size, thereby constricting the flow rate. See appendix two for performance tables, page 29.



Structural design

Structural design considerations

The philosophy of limit state design is used for storage tanks, which should be designed to safely support the imposed loads, but allowing for the properties of plastic. The concept of limit state design is to consider the probability distributions of all parameters (applied loads and material strength and stiffness) to provide better control over risk than traditional design methods.

The two most common limit states to be considered are:

1. Ultimate limit state - the structure should not become unstable or collapse under working loads or foreseeable overload.
2. Serviceability limit state of deflection - deflections of the units and the surrounding ground should be at acceptable levels (for example to prevent surface deformation).

Further advice can be found in CIRIA document C680, Structural design of modular geocellular drainage tanks. S Wilson: 2008.

Waterloc250 has been extensively tested to verify the following structural performance figures.

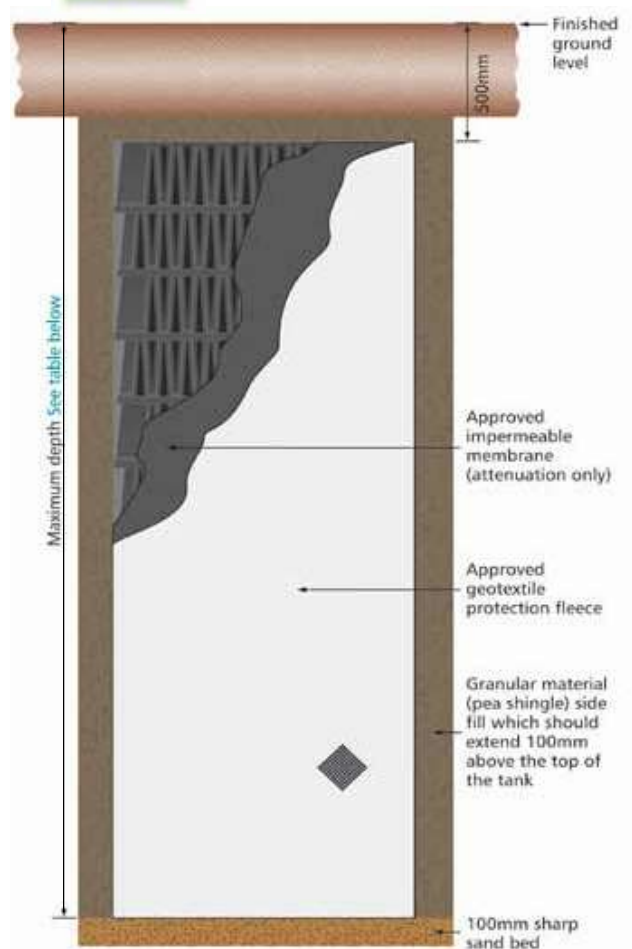
Structural performance figures

Property	Vertical loading on top face	Lateral loading on side face
Short term characteristic compressive strength	350kN/m ²	82kN/m ²
Short term load to cause 1mm deflection	47kN/m ²	7kN/m ²



Light duty applications

Landscaped (Non trafficked areas)



For infiltration applications the base level of the geo-cellular units must be at least one metre above the maximum water table level. For attenuation systems it is recommended that geo-cellular units are not installed below the maximum water table level to avoid the risk of floatation.

Construction plant

A minimum of 300mm cover must be applied before mechanical compaction can take place. Abnormal construction traffic must be prevented from crossing the tank and in particular cranes and other similar plant should not be located over the tank unless a specific site assessment has been undertaken. Once surfacing is complete, heavy construction traffic should be prevented from passing over the installation unless the design specifically allows for this.

Site topography

Where installations are located adjacent to the foot of an embankment or slope, consideration must be given to the increased lateral loading that will be exerted on the cells and the maximum depth may need to be adjusted as appropriate. Guidance on this can be found in the CIRIA guide C680.

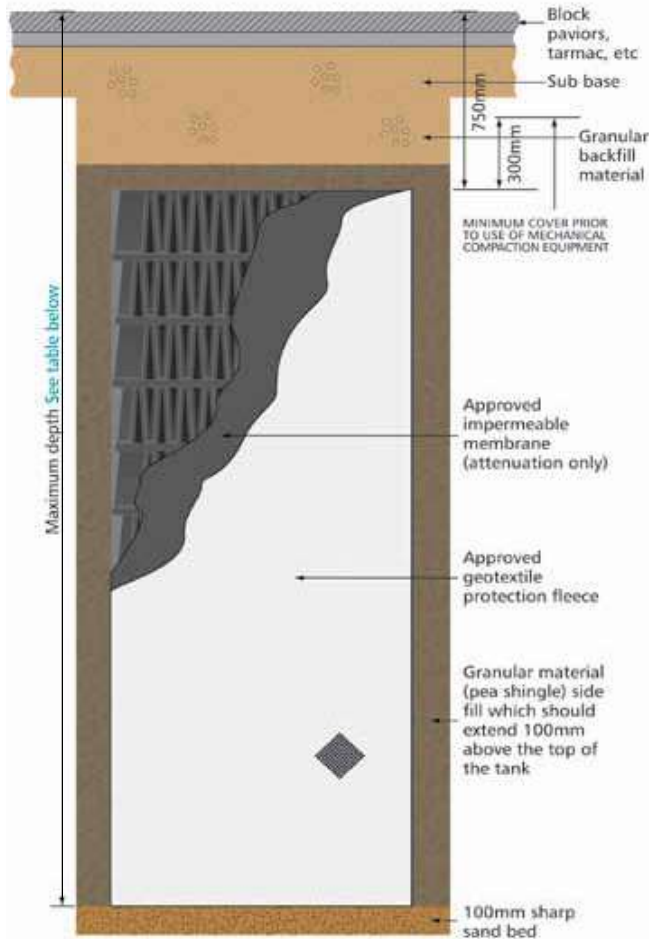
sustainable drainage systems

Structural design



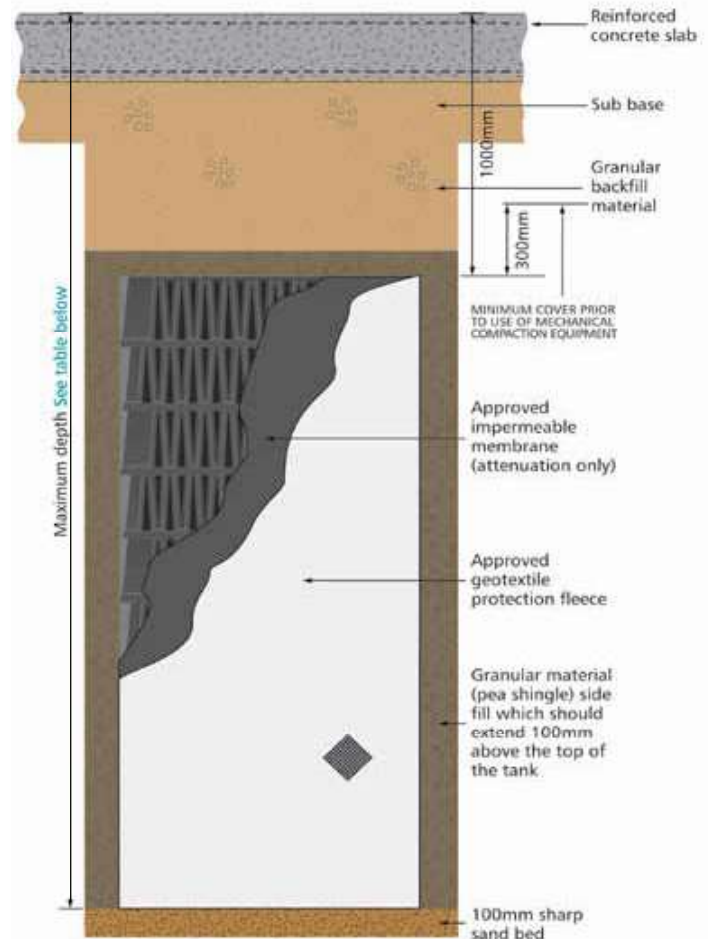
Medium duty applications

Car parks and areas limited to vehicles of 9000kg G.V.W



Heavy duty applications

HGV's up to 44,000kg G.V.W
(Slow moving traffic only)



Installation depths and cover

Maximum installation depths (to base of cells) and minimum cover depths of Waterloc250 cells

	(Φ) ⁽¹⁾ (see note 1)	Applications (non-trafficked areas)	Car Parks and areas limited to vehicles of 9000 kg GVW ⁽²⁾	Area subject to HGV's up to 44,000kg GVW (slow moving traffic only) ⁽³⁾
Minimum Cover (m)		0.5	0.75	1.0
Maximum Installation Depth (Finished ground level to base of cells) (m)	24°	2.86	2.56	2.26
	26°	3.07	2.77	2.47
	28°	3.30	3.00	2.70
	30°	3.56	3.26	2.96
	32°	3.85	3.55	3.25
	34°	4.0 ⁽⁴⁾	3.86	3.56
	36°	4.0 ⁽⁴⁾	4.0 ⁽⁴⁾	3.92
	38°	4.0 ⁽⁴⁾	4.0 ⁽⁴⁾	4.0 ⁽⁴⁾

(1) Assumed angle of shearing resistance of surrounding soil in accordance with CIRIA C680. The design is very sensitive to small changes in the assumed value of Φ , therefore, it should be confirmed by a chartered geotechnical engineer.

(2) Where physical barriers are provided to prevent access to HGV's, if this cannot be guaranteed the structure should be designed to cope with HGV loading.

(3) Assumes a reinforced concrete slab is constructed over the installation.

(4) Maximum recommended depth of Waterloc 250 installations.

Installation data

Waterloc250

The base or first layer of Waterloc250 cells in any installation must first have the base plate fixed to the base of the cell. Because each Waterloc250 cell interlocks vertically, cells on subsequent layers do not require a base plate. The cell should be inverted and the base plate pushed into place (fig 1), making sure the alignment arrows on the cell and the base plate are reversed. The base plate has four clips that locate into the internal pillars of the cell.



The base layer of cells are positioned on the prepared sharp sand bed once the geotextile or impermeable membrane (depending on the application) has been laid. The cells should be positioned so that the alignment arrows point in the same direction.

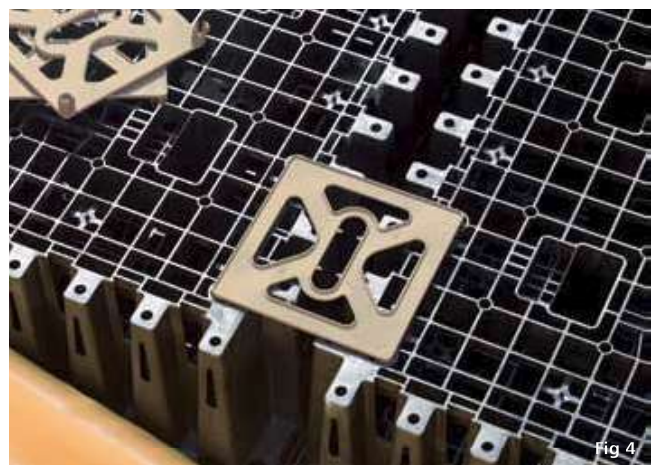
Cell edges should butt together and intersecting corners align. The perimeter of adjacent cells should then be secured using the base cell clip (figs 2 & 3).



Further layers of cells are built up by rotating the cells by 180° so that the alignment arrows on successive layers alternate. No further clips are required on intervening layers as the cells interlock vertically.



The whole construction should be secured by fitting the top cell connector around the edges of the cells and at all intersecting points (fig 4).



Pipe connections

Marley offer a number of options for inlet and outlet pipe connections, from 110mm to 300mm. The WLRE250 can be used for 110mm and 160mm solid wall pipe or 150mm structured wall Quantum pipe. The WLRE250L or M can be used for 225mm and 300mm structured wall Quantum pipe.

110mm, 150mm & 160mm connector, WLRE250.



Fig 5



Fig 6

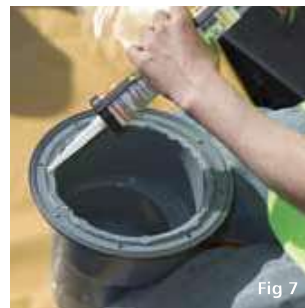


Fig 7



Fig 8

To fit the connector, locate the two mounting plate legs into the rim of the cell and position the upper lugs so that they align with the vertical slots of the cell. Guide the lugs into the slots and snap into position.

Pull the impermeable membrane and/or geotextile taut over the spigot of the mounting plate and use the spigot as a cutting guide to make a close fitting hole in the material.

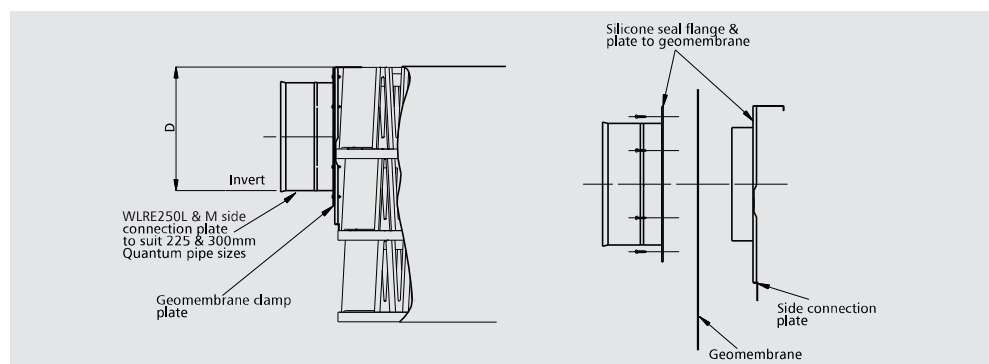
For attenuation tanks, the impermeable membrane should be sealed by applying a double bead of silicone sealant to the face of the mounting plate and between the membrane and the flange of the spigot. If using 160mm or 150mm pipes, remove the 110mm spigot section.

Pull the material tight to the mounting plate and fit the connector so that the keyway recess aligns with the key on the plate. Then fit the screws through the material so that they securely clamp the spigot to the mounting plate. The spigot orientation can be reversed to suit inlet or outlet connections.

225mm & 300mm connectors, WLRE250L WLRE250M

These connectors are fitted in a similar manner, except that the mounting plates span the height of two cells, fixing into the top of the upper cell and the base rim of the lower cell.

Type	Quantum Pipe Size	D (mm)
WLRE250L	225	290
WLRE250M	300	370

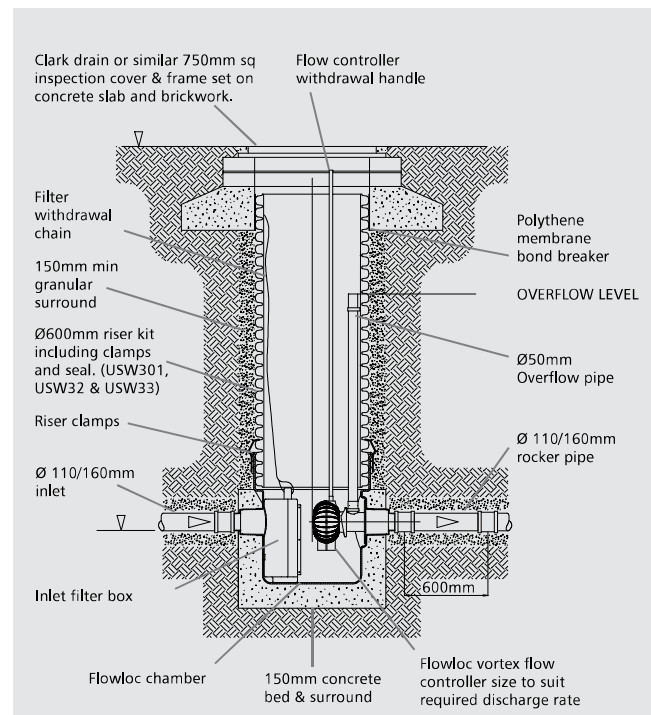


Installation data

600mm silt trap and Flowloc chamber base

The USW30 can be used as a 600mm silt trap, with or without the USW29 filter. It is also used as the housing for the range of Flowloc vortex units and orifice plate flow control units.

The chamber base can be installed within a precast concrete manhole or with a riser piece (available as part of the Waterloc range.) Both installation methods require the base to be level and bedded into a 150mm concrete base and surround. The base has spigot connections suitable for either 110mm or 150mm pipe sizes at the inlet and outlet, with additional 110mm side connections for use in 'off-line' installations. All pipe connections should be fitted with 600mm long rocker pipes to allow for ground movement.



Chamber Riser

To fit the 600mm riser to the chamber base, fit the inlet ring seal into the first corrugation of the riser, lubricate the seal with silicone grease and insert fully into the socket of the base with firm pressure. Fit the clamp ring between the grooves of the base socket and locate the four clamps in the corrugations of the riser before tightening.

Prior to backfilling with granular material, leak test the seal by capping the inlet and outlet connections and filling the riser with water to approximately 0.5m above the seal.

The riser should be cut back to within approximately 200mm of finished ground level before casting a concrete collar with a bond breaker membrane around the riser to prevent load transfer to the shaft. A cast iron inspection cover and frame with a minimum clear opening of 750mm can then be set on engineering brickwork to complete the installation.

Filter

Attach the end of the filter chain to the inside of the riser with the 'P' clip and screw provided, then lower the filter into the base so that it locates against the inlet.

Flowloc vortex flow control unit

Using the solvent cement supplied with the kit, bond the 20mm pipe socket to the length of 20mm pipe, then bond the socket to the handle attachment on the Flowloc device. Allow the solvent to set before lowering the controller into the base and engaging the square flange into the coupling slot. The handle can be cut to length.

To set the overflow level, fit the 50mm pipe into the socket in the chamber base aluminium coupling and mark the pipe at a point coinciding with the top, or just below the top of the storage tank. Cut the pipe at this point and bond into the socket with solvent cement, then secure the open end to the inside of the riser wall with the pipe clip and screws provided.

How many cell connectors are needed for an installation?

	No. of cells – length																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
2		5	8	11	14	17	20	23	26	29	32	35	38	41	44	47	50	53	56	59
3			12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
4				21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101
5					32	38	44	50	56	62	68	74	80	86	92	98	104	110	116	122
6						45	52	59	66	73	80	87	94	101	108	115	122	129	136	143
7							60	68	76	84	92	100	108	116	124	132	140	148	156	164
8								77	86	95	104	113	122	131	140	149	158	167	176	185
9									96	106	116	126	136	146	156	166	176	186	196	206
10										117	128	139	150	161	172	183	194	205	216	227
11											140	152	164	176	188	200	212	224	236	248
12												165	178	191	204	217	230	243	256	269
13													192	206	220	234	248	262	276	290
14														221	236	251	266	281	296	311
15															252	268	284	300	316	332

The above table indicates the maximum number of top cell connectors required for an installation. The connectors are required at each intersection, but for the top layer only. This will also ensure that a sufficient number of base cell connectors (centre pop-out of the connector) are available for the installation.

250mm silt trap, UG60

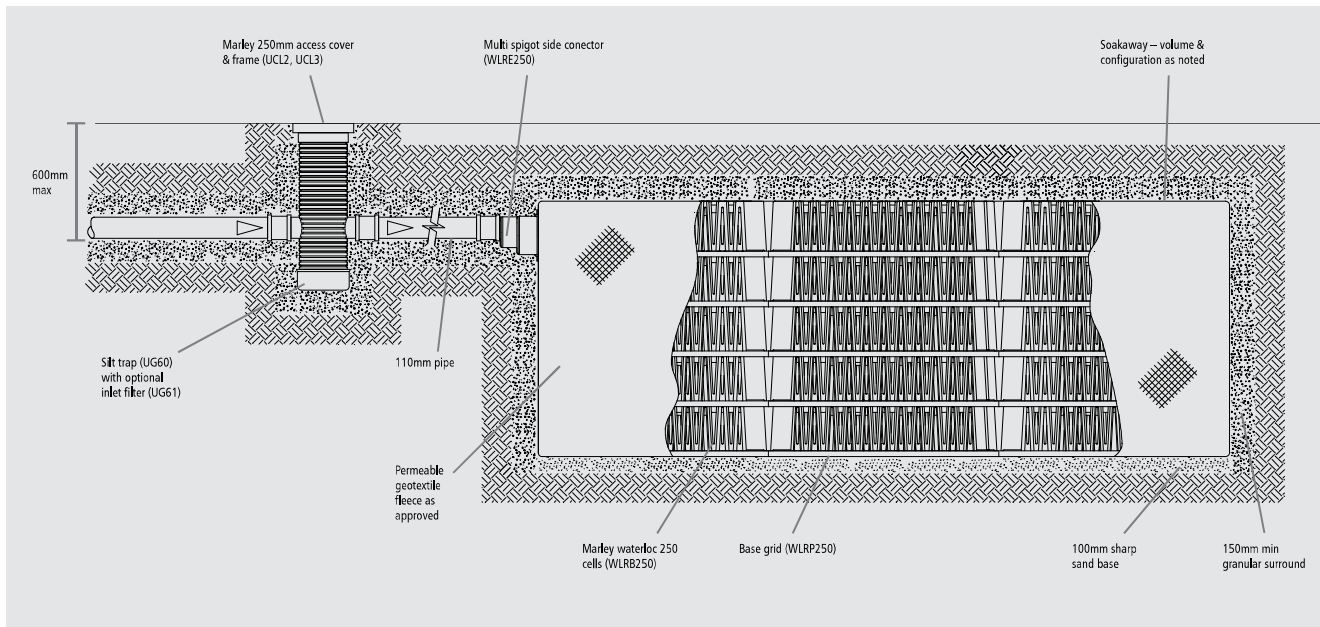
The 250mm silt trap, UG60 can be used with or without a filter, UG61. The 250mm silt trap must be installed with the flow indication arrow in the base of the unit in line with the direction of flow. This will ensure that the filter is always correctly located against the inlet connection, and that the leaf guard is fitted to the outlet.

The silt trap should be installed with a pea shingle bed and surround at the appropriate depth. The riser is then trimmed back to suit the ground level, before the UCL2/3 cover and frame is bonded in place with solvent cement. When inserting the filter into the UG60, make sure that the base is positioned against the location ramps and that the wire retainer is lowered to lock it into position.

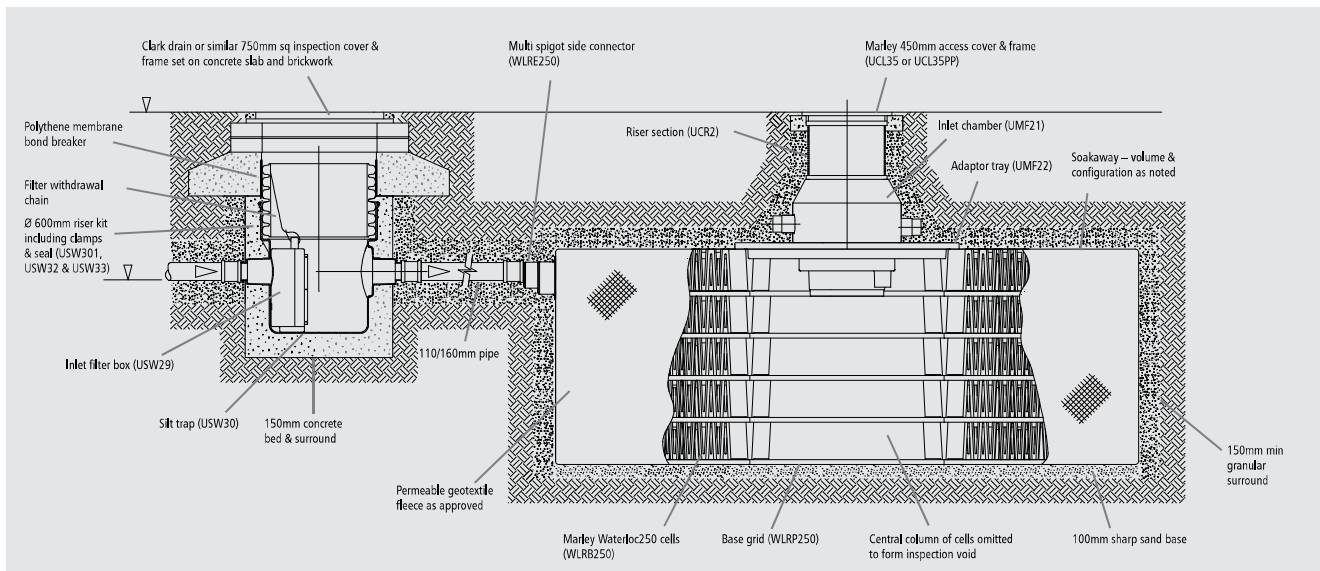


Typical installation details

Soakaway with 250mm silt trap and filter



Soakaway with inlet filter and provision for inspection of tank via inlet chamber in a landscaped area



*Available to download as CAD files from marley.co.uk