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FLOOD RISK ASSESSMENT

FOR

**LAND AT WHALLEY ROAD, BARROW
BROOK BUSINESS PARK, CLITHEROE,
LANCASHIRE**

ON BEHALF OF

NEWCLOSE PROPERTIES LIMITED

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**FLOOD RISK ASSESSMENT
FOR
LAND AT WHALLEY ROAD, BARROW BROOK BUSINESS PARK,
CLITHEROE, LANCASHIRE
ON BEHALF OF
NEWCLOSE PROPERTIES LIMITED**

1.00 Introduction:

- 1.01 We have been requested by Newclose Properties Limited to undertake a Flood Risk Assessment off land known as Barrow Brook Business Park, off Whalley Road and the A59, Clitheroe, Lancashire on which it is proposed to provide new business units to replace the former commercial activities (printing) and to include residential units over part of the former commercial area.
- 1.02 The land under consideration forms part of a larger area of land which is known as Barrow Brook Business Park and to date, only two tranches have been developed for commercial purposes. New roads, drainage and footpaths have been provided to enable the balance of the lands to be developed.
- 1.03 The land on which the former commercial premises sat is now the intended area of development.
- 1.04 The land is situated on the southern edge of Clitheroe, with Whalley Road abutting the western boundary, the A59 the eastern boundary and open land and some residential development to the north and south.
- 1.05 Barrow Brook immediately abuts the southern boundary of the site and forms part of the general drainage catchment system for this area.
- 1.06 The brook is fed from the upland catchment area to the east, where a number of small tributaries flow westwards and into large fishery ponds located on the eastern side of the A59, the outfall from which is controlled by large sluice gates before flowing into the brook.
- 1.07 The nearest main watercourse is the River Ribble which discharges its flows into the River Calder, some 2.80 kilometres to the south west of the site under consideration.
- 1.08 The watercourse generally accepts land drainage flows as the area is predominantly rural in character, with unrestricted surface water flows from the relatively small developed catchment areas.
- 1.09 As a consequence of Planning and Policy Statement 25 (PPS25), issued in December 2006, which refers to Flooding and Flood Risk and its' associated Guide Companion, it is necessary to provide an assessment of the potential problems which are associated with:

- a) Permitting the development
- b) Potential risk of flooding from Barrow Brook
- c) Safety of occupants of the dwellings
- d) Impact upon the local hydrological network

- 1.10 The Planning Authority are required to use the policies and the guidance given in PPS25 and the Practice Guide Companion, which indicates to the approving authority that they should ideally only consider development within areas classified under Zones 1 and 2, with sequential testing being applied to the latter.
- 1.11 In order to provide a Flood Risk Assessment, use has to be made of the information contained at the offices of the Environment Agency and also the Indicative Flood Maps for the 1:100 Year Storm Event, which have been produced by the Institute of Hydrology.
- 1.12 A visual inspection of the watercourse has been carried out between the A59 and Whalley Road and it is evident that a large on-site pond also adds its outflow through a small square culvert into Barrow Brook.
- 1.13 The Client has advised that they have knowledge of some large underground storage tanks which they believe were used to store surface water for the former printing works.

2.00 **Information Sources:**

2.01 The principal information sources which have been used for this Flood Risk Assessment are:

- 1) Geological Maps.
- 2) Environment Agency - Flood Defence.
- 3) PPS25: Development and Flood Risk
- 4) Practice Guide Companion to PPS25

2.02 These have been reviewed in conjunction with an inspection of the current:

- 1) Flood maps
- 2) Visual inspection of land and existing watercourses and surrounding area
- 3) Geological Maps.

2.03 Assessment of the usage of the sub-strata has been related to the proposed site and topographical land survey.

3.00 Geology and Hydrogeology:

- 3.01 The British Geological Sheets indicate superficial deposits of Glacial Till (Boulder Clay) and Alluvium at the surface.
- 3.02 The solid geology shows the presence of undifferentiated strata of Carboniferous Limestone
- 3.03 The likely lithology is siltstone and/or shale with the possibility of thin sandstones within the valley bottom with the more major sandstones being dominant in the upper parts of the valley, being the Pendle or Worsley Wise Grits
- 3.04 The solid substrata below is considered to be a minor significant aquifer but due to its' likely depth beneath the subject site, it will not have any direct relationship to the existing watercourse.
- 3.05 The Environment Agency have advised that there are no known abstractions (licensed or unlicensed) within 500 metres of the subject site.
- 3.06 The subject site does not fall within an area designated as a groundwater source protection zone for major public water supply abstraction.
- 3.07 The nearest major watercourse is the River Ribble, approximately 1,700 metres to the west of the subject site.

Groundwater Vulnerability:

- 3.08 Groundwater located within the alluvium would be considered as highly vulnerable due to it being at a relatively shallow depth with the cover over, being potentially permeable and similarly for any water within or below the glacial clay, if encountered within 5 metres of the surface.
- 3.09 The limestones beneath the clays are more likely to be of low to moderate vulnerability, given the protection afforded by the clay cover.

4.00 **Current Environment and Visual Inspection:**

- 4.01 In order to assess the impact of the proposed development upon the existing drainage network, a general visual survey has been undertaken with a reasonably detailed inspection of the watercourse, both upstream and downstream of the subject land.
- 4.02 The land abuts primarily open land with some existing residential development to the north and south, plus commercial development within the business park itself
- 4.03 Barrow Brook is indicated to be a minor watercourse within the overall catchment area
- 4.04 The brook flows along the southern boundary of the whole site and then continues in a large diameter culvert below Whalley Road to the west, where it turns through a right angle and flows parallel to the road in open channel for a distance of about thirty five metres before turning again through another right angle in a closed conduit, to flow westwards and then discharge into an open watercourse which continues in a westerly direction, where it eventually joins into the River Ribble, some 1.70 kilometres to the west (see Appendix)
- 4.05 The watercourse is relatively shallow in depth between the A59 and a point some 290 metres downstream, at which point it has a vertical drop of some 2.00 metres into a lower and deeper channel
- 4.06 Thereafter, the channel has a series of weir drops before passing below Whalley Road in a large diameter culvert.
- 4.07 Downstream of Whalley Road, the existing culvert discharges into a natural earth channel with steep sides and which is heavily treed, some of which have fallen over and are actually forming a blockage within the channel. (see photographs)
- 4.08 An existing surface water pipe was noted as discharging onto the brook via a concrete headwall, just to the rear of existing properties which have been constructed on the west side of Whalley Road and known as Millbrook Place.
- 4.09 The watercourse continues to flow towards the west and eventually discharges into the River Ribble

5.00 **Environment Agency Flood Map:**

- 5.01 The Agency's flood map shows that for the 1:100 year storm event, the flood waters appear to be contained within the outer confines of the watercourse and does not affect land on either side.
- 5.02 As a consequence, the land proposed for redevelopment falls within Zone 1 and thus complies with Table D1 of PPS25.

- 5.03 The Environment Agency has confirmed that as the watercourse is shown to be within Zone 1, they do not need to receive a full flood risk assessment in accordance with PPS25.
- 5.04 However, in order to comply with the requirements of PPS25, it is necessary to consider the impact of the proposed development on the likely flows both upstream and downstream of the development site.

6.00 **Potential Impacts of Development:**

- 6.01 Surface water created from precipitation would normally have to flow into an adopted surface water drainage system and then into a receiving watercourse.
- 6.02 As the proposed development does not intend to increase the present contributory areas to the watercourse by the use of alternative drainage systems, there will be no increase in surface water flows as a consequence.
- 6.03 In order to assess the impact of development upon the existing drainage infrastructure and to consider the effects of the watercourse upon the proposed development land, the following have been used to make that assessment:
- a) Topographical survey of the land under consideration
 - b) Requirements of PPS 25
 - c) Government advice in relation to the protection of properties from flooding

7.00 **Flood Assessment:**

- 7.01 In considering the flood assessment, it is important to firstly establish the reasons and criteria for the assessment and these have previously been set out in Section 2, sub-sections 2.01 and 2.02.
- 7.02 Planning and Policy Statement 25 requires the Developer to demonstrate that his proposals will not exacerbate flooding conditions either upstream and downstream of the proposed development and if necessary, provide solutions to ensuring that occurs.
- 7.03 In historic terms, we cannot find any evidence that the existing buildings and hardstandings have caused the existing watercourse to suffer from flooding problems.
- 7.04 An interrogation of the Environment Agency's website has shown that they do not possess any records indicating flooding problems within the immediate area, or along the length of the watercourse between the A59 and Whalley Road.
- 7.05 Thus, the land proposed for redevelopment falls within the description of Table D1- Zone 1

- 7.06 In relation to the requirements of PPS25, the land must not generate an increase in surface water flows as a consequence of redevelopment, however, it will be necessary to discuss and agree with the Environment Agency the location of the discharge points and the rates of discharge into the receiving watercourse
- 7.07 The Environment Agency is promoting "Best management Practices" for the control of surface water drainage and are seeking a greater use of natural forms of water attenuation with the inclusion of flora and fauna.
- 7.08 To accord with this, it is intended to consider the provision of alternative methods for dealing with surface water, such as the re-use of grey water, possible water harvesting and maybe the re-use of the existing underground storage tanks. It is therefore unlikely that the proposed redevelopment of the land will produce surface water flows which would cause a substantial increase in surface water discharges into the brook.
- 7.09 Should it be found that the sub-strata is suitable for the use of Sustainable Urban Drainage Techniques (SUDS), then it may be possible to also include the use of porous construction for the drives and hardstand areas.
- 7.10 Clearly, from the above, it can be seen that in principle, the proposal complies with the criteria set out in PPS25.
- 7.11 It will be apparent from the aforementioned description of the existing watercourse immediately downstream of Millbrook Place, that some work is necessary to remove the existing fallen trees and other debris from the channel. This is a matter for the current Riparian Owners to deal with and not the Developer of the subject site.
- 7.12 In accordance with the normal recommendations of the Environment Agency, the finished floor levels should be set at least 600mm above existing ground level where the development is in close proximity to a watercourse and where flooding has been, or could be an issue

8.00 **Summary:**

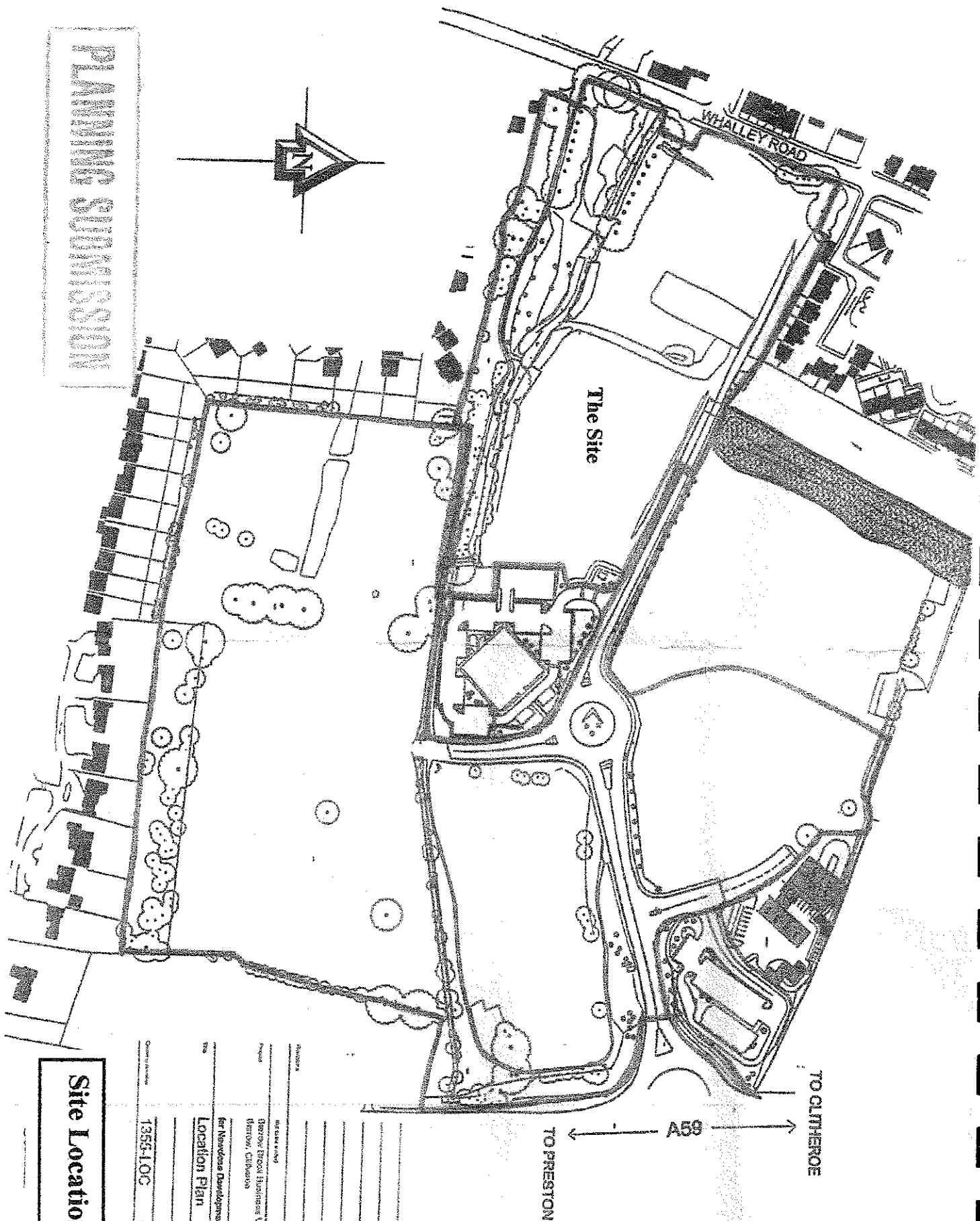
- 8.01 The redevelopment of the land for residential and commercial purposes with separate systems of drainage will require that the surface water generated by the development will discharge to a suitably agreed points
- 8.02 The rates and location of discharges into the brook will need the approval and written consent of the Environment Agency before any works are commenced
- 8.03 Planning and Policy Statement 25, requires the attenuation of surface water discharges to the natural rate of run-off and the proposals as indicated in item 7.08 and 7.09 will meet those objectives
- 8.04 The use of Sustainable Urban Drainage techniques should be considered subject to a suitable sub-soil investigation being undertaken.
- 8.06 Whilst there is a need to allow for possible climate change, the results of the water levels analysis indicates that such allowance will not detrimentally affect the channel and that the current local defences are capable of dealing with such flows.
- 8.07 The subject site does not provide an area which could be designated as flood plain and is therefore outside any major flood zone, thus there is no requirement for the consideration of compensatory storage.
- 8.08 In view of the results of this investigation, it is clear that for the 1:100 year storm event, the occupants of the proposed residential dwellings and commercial unit are not being placed at risk and there is no need for any special evacuation procedures or routes to be considered.
- 8.09 In accordance with the criteria set out in PPS25, the land falls within the classification of Zone 1 and thus does not need to follow the requirements of sequential testing
- 8.10 The existing Riparian Owners to the watercourse downstream of Millbrook Place need to deal with the existing trees and debris within the watercourse channel.

APPENDIX

- 1. Site Location Plan**
- 2. Environment Agency Map showing:**
 - a). the 1:100 Year Indicative Flood Map**
 - b). the Barrow Brook Catchment Area**
- 3. 1:5000 Scale Contour Plan and 1:500 Scale Topographical Survey**
- 4. Environment Agency Advice Notes on Rainwater Reuse**
- 5. Environment Agency Advice Notes on Rainwater Harvesting**
- 6. Environment Agency Advice Notes on Greywater**
- 7. Sustainable Urban Drainage (SUDS)**
- 8. Part BRE EcoHomes 2005 – POL 3**
- 9. Photographs**

Site Location Plan

PLANNING SUBMISSION



Site Location Plan

Client: 1355-10C 12/09 01/07

Location Plan

for Newhouse Developments

Project: Newhouse Developments Vangas
Wotton, Clitheroe

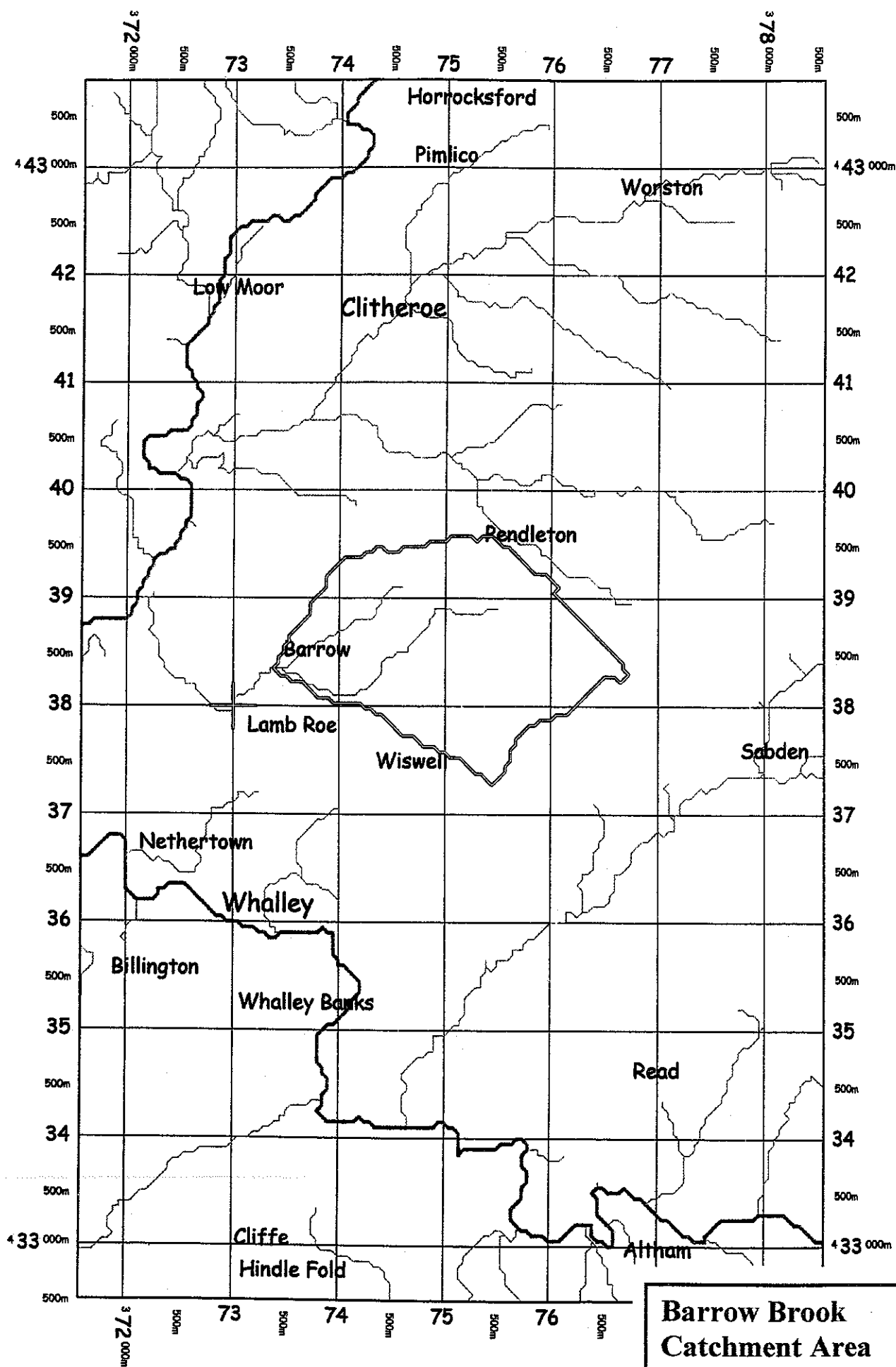
Drawn by: 1355-10C

Scale:

Date:

Environment Agency Map showing:

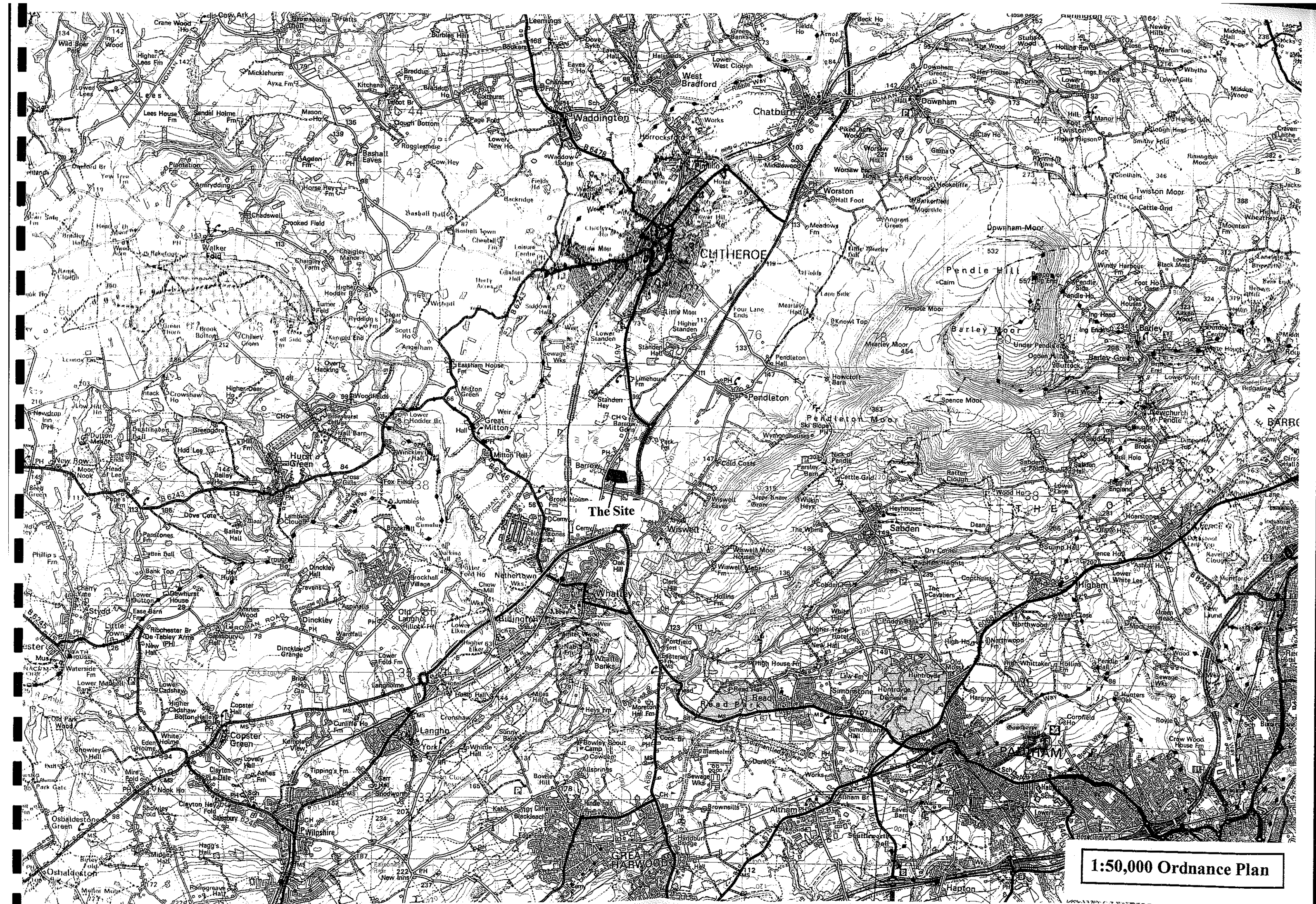
- a). the 1:100 Year Indicative Flood Map**
- b). the Barrow Brook Catchment Area**



1:5000 Scale Contour Plan and 1:500 Scale Topographical Survey



1:5,000 Ordnance Plan



1:50,000 Ordnance Plan



Environment Agency Advice Notes on Rainwater Reuse

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Rainwater reuse

Using rainwater for garden watering, toilet flushing and washing machines can save up to 50 per cent of household water use. How much water can we save?

WCs, washing machines and outdoor use account for about 50 per cent of domestic water consumption. Correctly collected and stored, rainwater can meet all these requirements without further treatment. In practice most domestic roof areas are too small to satisfy all this potential demand regardless of storage cistern size, so it is important to evaluate the potential savings before investing in an expensive installation.

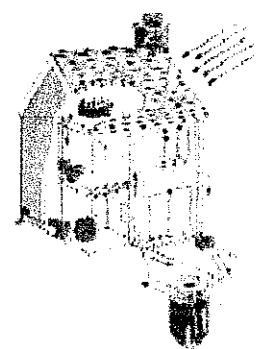
In existing housing, it is generally more economic to employ water-saving measures than to reuse rainwater or greywater (see 3 Greywater). However, with new developments, rainwater reuse becomes a more attractive option.

Rainwater systems in the UK are used primarily for WC flushing and garden watering. Ultimately, rainwater systems installed with filtration and disinfection could potentially supply all domestic water requirements, although this is not currently recommended.

The simplest rainwater collection method is the garden water butt. It requires no treatment or mains backup, and is not required to supply water when temperatures are below freezing (see 2 Gardening). Household rainwater systems are, however, much more sophisticated and their installation is quite complex.

	Plan roof area M ²				
mm rain/year	50	75	100	125	150
600	18	27	36	45	54
800	24	36	48	60	72
1000	30	45	60	75	90
1200	36	54	72	90	108
1400	42	63	84	105	126
1600	48	72	96	120	144

Table showing approximate annual yield of rainwater in cubic metres for a range of roof sizes and average annual rainfall. It is assumed that 60 per cent of the rain falling on the



Rainwater reuse

roof is collected and used.

Cistern sizing

Rainfall is sporadic and so storage is required. A typical tank size for a four-person household is around 2m³, with quickly diminishing returns for larger tanks.

The ease and subsequent cost of installation will depend on a number of factors. A building with multiple downpipes, limited roof area and restricted space for a storage tank is unlikely to be suitable. However, a building with downpipes at one end and a

garage or cellar with a place for a low-cost tank would greatly simplify installation of a rainwater system. Similarly, installation in a new house is easier than fitting a system into an existing one.

System types	
A large number of products is now available, mainly from Germany, where commercial systems are currently installed at a rate of around 50,000 per year. The different formats can be usefully divided into those that pump water direct to appliances and those that pump rainwater to a header tank in the loft:	
Header tank systems	Direct pumped systems
Pros High reliability, reverts to mains water if power or pump fails. Low-cost pump and simple controls possible. Energy-efficient as pump runs at full flow.	Pros Good pressure, ideal for garden hoses and washing machines. No loft tank
Cons Low-pressure water to WC, may fill slowly Pressure may be too low for modern washing machines. Requires loft tank. Few commercial systems available	Cons WC cannot be flushed if power or pump fails (use a bucket to flush). Mains top-up and controls may be more complicated.

Regulations

There are currently no UK regulations relating to required water quality for WC and washing machine use. Extensive studies in Germany have concluded that correctly collected rainwater is suitable for such use without disinfection¹. Mains water backup must be in accordance with the Water Supply (Water Fittings) Regulations 1999 and pipes should be clearly identified. Some countries, or regions within countries, now require new buildings to include rainwater systems, and a minimum cistern volume is often specified.

Other benefits

As it is "soft", rainwater is ideal for clothes washing and toilet flushing. Trials in Germany have shown extended life for washing machines fed with rain rather than hard water.

Further reading

Reclaimed Water Systems; Information About Installing, Modifying or Maintaining
Reclaimed Water Systems. WRAS Information and Guidance note, August 1999 No 9-
02-04
Available from WRAS, tel: 01495 248454.

Rainwater reuse: Suppliers listing (Acrobat, 92KB, 30 seconds)
A list of product suppliers

Conserving Water in Buildings 4: Rainwater reuse (Acrobat, 43KB, 30 seconds)

Water Regulations Advisory Scheme

This information gives guidance only. It should not be treated as a complete and authoritative statement of measures to be adopted and their results. You are advised to make your own investigations before deciding on any course of action. The Environment Agency does not endorse the use, purchase and/or the performance of the goods or services provided by companies mentioned herein.



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4

Conserving water in buildings

Rainwater reuse

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Plan roof area M²

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System types

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Header tank systems

Pros

- High reliability, reverts to mains water if power or pump fails.
- Low-cost pump and simple controls possible.
- Energy-efficient as pump runs at full flow.

Cons

- Low-pressure water to WC, may fill slowly.
- Pressure may be too low for modern washing machines.
- Requires loft tank.
- Few commercial systems available.

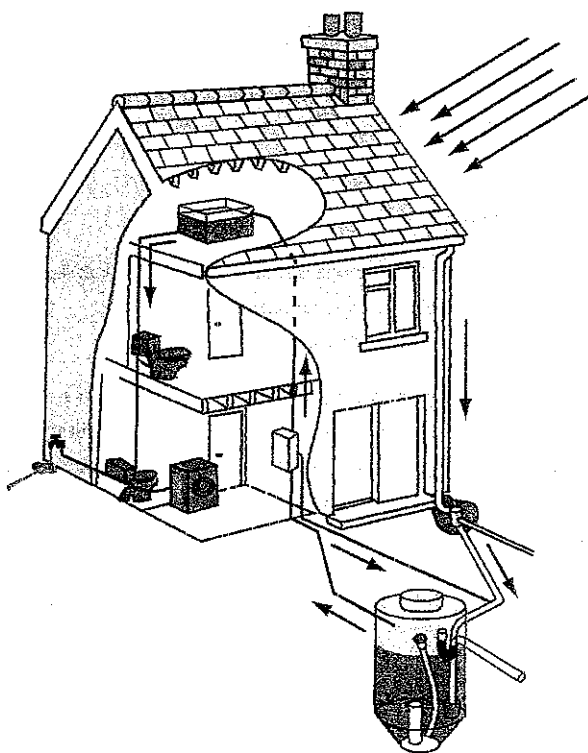
Direct pumped systems

Pros

- Good pressure, ideal for garden hoses and washing machines.
- No loft tank.

Cons

- WC cannot be flushed if power or pump fails (use a bucket to flush).
- Mains top-up and controls may be more complicated.



RainSava system (Acorn Environmental Systems).

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Website: www.wras.co.uk

¹ Lücke 1998, English translation ISBN 0-9517890-1-5

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Further copies of these fact cards are available from the Environment Agency's National Water Demand Management Centre, Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD. Email: paula.wood@environment-agency.gov.uk Telephone: 01903 832073 Website: www.environment-agency.gov.uk/savewater

Environment Agency Advice Notes on Rainwater Harvesting

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Rainwater Harvesting

Rainwater Harvesting is the collection of water that would otherwise have gone down the drain, into the ground or been lost through evaporation. Large surfaces such as roofs or driveways are ideal for rainwater harvesting and can provide up to 100m³ (100,000 litres) of water per year from a medium sized area. This water can be used to flush toilets, water gardens and even feed the washing machine. Rainwater harvesting systems can be installed in both new and existing buildings, and the harvested water used for purposes that do not require drinking water quality. Rainwater harvesting has the potential to save a large volume of mains water and therefore help reduce the pressure on water resources.

Is it for me?

Before deciding whether or not to install a system for home or work, consider the costs of buying, installing and maintaining the system

- Calculate the volume of rainfall that can be collected from roof areas or driveways to see whether rainwater harvesting can meet your requirements
- Work out the potential water and cost savings

For information on how to do this, see our publication, *Harvesting rainwater for domestic uses: an information guide* (click on link at bottom of the page). While many businesses, housing developments and schools would benefit financially from full scale rainwater harvesting systems, most average households find that the humble water butt is sufficient to meet their needs for garden watering and simple efficiency measures are a much cheaper way to save water in the home

How does it work?

A typical rainwater harvesting system comprises a collection surface (roof or driveway), some sort of filter and a means of storage (usually a large underground tank). The storage tank for household water use should be sized to hold 5per cent of the rainwater that can be captured in a year or of your annual demand for water, using the smaller of the two figures.

Stored rainwater is not suitable for drinking, but through a separate pipe network it can be used to supply toilets, outside taps and even washing machines. To achieve higher levels of water quality an ultra violet (UV) system can be added. However, these systems use energy and lamps need replacing annually, affecting the cost effectiveness and environmental benefits of the system.

Many systems use a control unit to monitor the water level in the storage tank and display information to the user. If levels drop too low the system switches to the mains water supply and if levels get too high an overflow trap drains off excess water and allows floating material to be skimmed off to a storm drain.

Are there any grants available?

There are currently no grants available for domestic systems, but the Enhanced Capital Allowance (ECA) scheme allows businesses to claim 100 per cent first year capital allowances on investments in technologies and products included in the ECA list of water efficient technologies. Funding for agricultural schemes may be available through your local Regional Development Agency (RDA).

Will it save me money?

Rainwater harvesting can potentially give significant financial savings, but these depend heavily on a number of factors:

- The water supply being metered. (Advice on whether metering would be right for you is available from your water provider)
- The size of the collection area
- The average annual rainfall (rainfall amounts vary from region to region – the North West can expect double the rainfall of East Anglia in an average year.)
- Whether or not the reduction in metered water consumption translates to a reduction in the wastewater charge – water companies' policies vary across the country.

How much will it cost?

There is an initial outlay of between £2,000 and £3,000 for a good quality domestic system and plumbing and fitting costs vary. Suppliers of rainwater harvesting systems currently claim savings of up to 50 per cent of water used by the average household. Whilst this is feasible, savings are typically closer to 30 per cent and can be less in some properties.

Due to the relatively low cost of mains' water in England and Wales and the variability of savings, the payback time for an individual domestic system may be long. Larger projects, such as housing developments, industry and agriculture will have much shorter payback periods and savings could run into many thousands of pounds.

What do I do now?

These questions and answers are designed as a quick guide as to whether a rainwater harvesting system is the right thing for you.

If you want to know more, there is a detailed information guide available by clicking on the Harvesting rainwater link below or for a hard copy e-mail savewater@environment-agency.gov.uk

Harvesting rainwater for domestic uses: an information guide (Acrobat, 319KB, 3 minutes)

Enhanced Capital Allowance Scheme

Rainwater reuse

If rainwater harvesting is not for you or your business at this particular time, there are still many ways that you can cut down your water use with very little outlay. Water butts can be bought for around £20, dripping taps can be fixed for pennies and the amount of water flushed down the toilet can be cut by up to a third. Something as simple as turning off the tap while you clean your teeth can save half a bathful of water per day if done by a family of four.



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Harvesting rainwater for domestic uses: an information guide

July 2003



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The Environment Agency is the leading public body protecting and improving the environment in England and Wales.

It's our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world.

Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

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1 Introduction

This publication is about rainwater harvesting systems for non-potable domestic uses in houses, gardens, industrial and commercial premises. Intended for homeowners, house builders, planners, plumbers, architects and building managers, it contains information about the benefits of these systems, their design, installation and maintenance requirements and their cost. It also contains examples of housing schemes where these systems are already in use.

Why choose a rainwater harvesting system?

Despite the fact that England and Wales appear to have plenty of rain, our growing population and the potential changes in climate mean that our water resources are under pressure. The large number of new houses to be built over the next few years will increase the competition for available water between the environment and people, especially in south-east of England which has low water resource availability. Reducing demand for mains water can help to reconcile these competing needs. One way of reducing demand is to use a rainwater harvesting system to provide water for domestic uses.

Rainwater harvesting systems can be installed in both new and existing buildings, and the resulting water used for all purposes except drinking. While there are no agreed water quality standards for rainwater use in England and Wales, rainwater is not usually disinfected, if properly collected and only used only for non-potable needs such as toilet flushing. Washing machines can be fed by untreated rainwater, but occasionally colour and odour may cause a problem. When rainwater is used to supply a garden tap or rain water butt, care needs to be taken to ensure that the water can not be accidentally drunk. The recycling of bath and shower water (greywater) is not included in this document, as there may be additional hygiene issues from the risk of direct human contact. The potential savings that can be made depend on both the demand for non-potable water and the amount of rainwater that can be supplied, which depends on the roof area available for collection and the amount of local rainfall. Savings achieved by rainwater harvesting systems will be greater in larger buildings, such as industrial buildings and education establishments, due to their larger roof areas and potentially greater demand.

In addition to the pressures on water resources, there are concerns over rainwater drainage from urban areas. Adverse impacts on flood risk and water quality mean that our existing approach to rainwater drainage systems will have to change. In England, Planning Policy Guidance Note 25 (PPG25) on development and flood risk requires that planning authorities consider the effects of surface water drainage. This will result in increasingly strict controls on runoff from sites. The Environment Agency is promoting the use of Sustainable Drainage Systems (SUDS), including rainwater harvesting, to retain and control surface water. The Clagg Hall case study on page 14 is an example of this. The need to reduce stormwater discharge rates may therefore be an incentive for choosing rainwater harvesting systems.

Rainwater harvesting systems are not yet common in England and Wales, for two main reasons:

- The cost of the systems
- Concern that the quality of the water may pose a health risk

Additionally, only metered customers (all industrial and commercial customers and around 20% of domestic properties are metered) will pay lower charges by using these systems. Although they may have meters fitted free of charge, the majority of domestic customers have no immediate financial incentive.

2 Design considerations

Rainwater can be harvested from roofs and hard standing, such as driveways. The water may be gathered and distributed in several different ways, and suppliers can advise on the best product for a particular situation. Figure 1 shows a diagram of one example of a system.

System Design

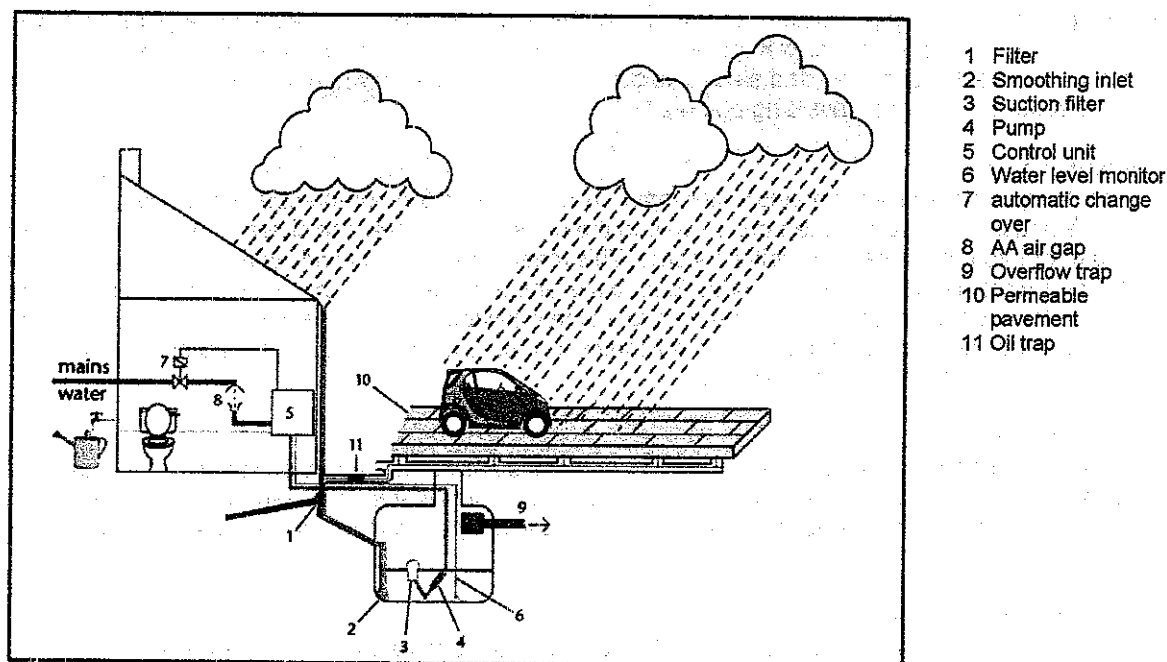


Figure 1 – schematic of a standard rainwater harvesting system

- Rainwater is collected from the roof area or hard standing by downpipes. A filter (1) stops leaves and other large solids from getting into the holding tank. The water enters the tank through a smoothing inlet (2), which stops sediment at the bottom of the tank from being disturbed by heavy rainfall.
- A suction filter (3) prevents the uptake of floating matter when the water is drawn up for use. As the water is non-potable, it travels through a separate set of pipes, as specified in the Water Supply (Water Fittings) Regulations 1999¹. A pump (4) pressurises the water, in this example the pump is a submersible one, although other systems may use suction pumps.
- The control unit (5) monitors the water level in the tank (6) and can display this information to the user. If the water level in the tank drops too low, the control unit will trigger an automatic change over to mains water supply (7). The system must have a type AA air gap (8) installed (see glossary) in order to prevent back flow of rainwater into the mains.
- When the water in the tank reaches a certain level, an overflow trap (9) allows floating material to be skimmed off into the storm drain. A non-return valve should be fitted to prevent contamination of the tank by backflow, together with a rodent barrier (see glossary).
- Water soaking through a permeable pavement (10) can also be collected, although as well as the filter, an oil trap (11) should be fitted. However collecting water from this source increases the potential for oil and animal faeces to contaminate the tank water therefore depending on how the water is to be used, disinfection should be considered.

¹ Water Supply (Water Fittings) Regulations 1999, Statutory Instruments No 1148, No. 1506, Water Industry, England and Wales, HMSO.

Variations on this system

The design shown in figure one and described above is for a system that has a submerged pump and directly feeds the water use appliances. Several variations on this generalised system exist; four commonly selected variations to the system are described here:

1. Header tank

Rainwater is usually pumped from an underground tank to a suitable header tank located at a high level. If rainwater is not available, due to either lack of rain or pump failure, then mains water tops up the tank via the required type AA air gap. Mains water top-up can be achieved using a suitable float-operated valve, which allows water to enter the tank if the level falls below normal. This means that the system is independent of electricity supply and electronic controls. In some cases where levels allow, rainwater may feed the header tank directly, avoiding pumps.

2. Cistern top-up

Different designs are available; mains water top-up is fed either to the non-potable pipes (via a type AA air gap) in the house or into a storage tank. If fed into the underground tank, the cistern top-up water is then pumped back into the house, to fill toilet cisterns. This means that more electricity is used than in systems where mains water is fed into the non-potable pipe system. If power or pump fail, the WC must be flushed manually with a bucket. Since the pump runs every time rainwater is used, electricity costs are higher and the pump's life is reduced compared to internal mains top-up. Electricity costs of the pump are, however, still low compared with total household use.

3. Module system

A number of commercial systems use a variation on what is known as a module system. This usually uses a suction pump, which takes water from the tank or a small mains-water break tank when rainwater levels are low. These systems are easier to install but more technically advanced, so may cost more to buy and repair.

4. Dual-feed WC system

WCs are available or can be adapted with dual feeds for mains and rainwater. A type AA air gap in the WC feed pipe stops mains water contamination. The dual-feed system allows the supply of mains water and pumped rainwater at high pressure, without losing supply if pump or power fails (see Figure 1). In Germany this has been achieved using a valve. In England and Wales, however, one system has been demonstrated that uses water alone to control the mains backup.

These systems consist of components, such as tanks and filters, that are common to all variations of this technology:

Tank

A tank should be located in a place that will moderate the water temperature, reducing bacterial growth in summer and frost damage in winter, for example underground.

As the tank is usually the most expensive part of a rainwater system, cost can be reduced by not over-sizing it. The size of a rainwater holding tank must match the demand for water with its availability as closely as possible. The tank size chosen must be a balance between cost, storage capacity, and the need to enable an overflow at least twice a year, to flush out floating debris.

A common rule of thumb for household water use is to size the tank at 5% of the rainwater supply, or of the annual demand, using the lowest figure of these two. Industrial / commercial premises may need to make more detailed calculations. The tank size is calculated from the catchment area, drainage coefficient and filter efficiency and rainfall.

$$\text{Tank size (litres)} = \text{catchment area} \times \text{drainage coefficient} \times \text{filter efficiency} \times \text{annual rainfall} \times 0.05$$

In order to optimise the tank size for a larger system, a more rigorous analysis is necessary, which can be provided by the supplier of the system. Details of the variables in the above equation are set out overleaf.

Catchment area

The roof area is the length in metres (L) multiplied by the width in metres (W). Figure 2 shows the measurements needed to calculate the catchment area, in metres squared (m^2).

The total rainwater catchment area of a property can include both roof water run-off and hard standing infiltration into Sustainable Drainage System (SUDS), where demand is greater than the roof area alone can supply. (See the examples of Clagg Hall and BedZED on page 14)

The quality of run-off water should be good enough not to need extra treatment other than an oil trap, so an area likely to be contaminated with animal faeces is not suitable

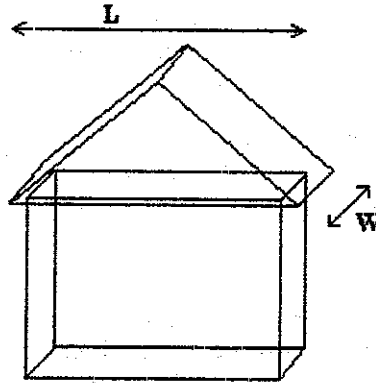


Figure 2 Roof catchment area

Even if rainwater is not collected for non-potable use, a SUDS should be considered as they can improve the quality of run-off water and lengthen the return time of the water to a watercourse, thus reducing peak storm flows. This allows rainwater to be returned to the environment at an appropriate quality and flow rate so as to replenish ground and surface water supplies.

Drainage coefficient

It is difficult to collect every drop of rain and convey it to the tank. Light rainfall will only wet the roof and then evaporate. Heavy rainfall can overflow from the gutters and therefore not be captured. A 'drainage coefficient' is used to adjust the tank size calculation to allow for this. Table 1, below, shows which drainage coefficient (also known as the "run-off factor") to use for different roof types.

Table 1 - Drainage coefficient

Roof type	Drainage coefficient
Pitched roof tiles	0.75 – 0.9
Flat roof smooth tiles	0.5
Flat roof with gravel layer	0.4 – 0.5

Filter efficiency

The amount of water captured also depends on the efficiency of the filter. Not all the water in gutters will reach the holding tank. Most manufacturers recommend that a factor of 90% of the potential input be used. This means that a factor of 0.9 is included in the calculation.

Annual rainfall

Annual rainfall can vary dramatically over a small area, so a reading (in millimetres) within 10 miles of each property is preferable. The local Environment Agency office or the Meteorological Office should be able to supply rainfall data.

Treatment

The first line of treatment is the filter. This should automatically prevent leaves and other solid debris from entering the holding tank. If the water is to be used for purposes where there is no possibility of it being drunk or used for washing, then usually no further treatment is necessary. As this includes WC flushing and garden watering, most rainwater harvesting systems will be in this category. Any taps fed by untreated rainwater should be clearly labelled, and possibly have their handles removed to prevent children from drinking the water.

The use of untreated rainwater for drinking is a contentious issue, and due to the potential for bacterial contamination, is not recommended by the Environment Agency. It is liable to faecal contamination and would require suitable treatment before use.

Pump

Pumps may be fitted either in the tank (a submersible pump), or outside it (a suction pump). Due to their power, if a submersible pump is used then the tank can be some distance from the building. A suction pump, however, must be located relatively close to the tank but in a frost-free place, so usually needs the tank to be located close to the building.

Most commercially available systems use automatic pressure and flow-activated pumps, so that flushing a toilet, for example, switches the pump on and refills the cistern. Alternatively, rainwater is pumped to a header tank from where it is fed to the WC. A suitable cool but frost-free location is required for the header tank. Dry-run protection should also be considered, to protect pumps in dry spells.

Control unit

In dry periods, rainwater may be insufficient for household needs. A display on the control unit can indicate when tank water levels are low, so that system users are aware that they are receiving mains water.

3 Installation and long-term considerations

The installation and maintenance of a rainwater harvesting system is key to ensuring that water is saved. A badly installed or maintained system may result in the owner losing enthusiasm for the system, which in turn may lead to it being less effective or even removed.

Plumbing legislation

If a rainwater harvesting system is inadequately installed, it could become a public health hazard. Of major concern is accidental cross-contamination of rainwater with mains water. The Water Supply (Water Fittings) Regulations 1999¹ are designed to prevent this. The main safe guard that the legislation requires is that a type AA air gap must be used at the point where the mains top-up enters a rainwater harvesting system. A type AA air gap ensures that there is a physical separation between the two types of water, ensuring that no rainwater can be drawn back into the mains water supply.

Advice on the Water Supply (Water Fittings) Regulations 1999 is given by the Water Regulations Advisory Scheme (WRAS). Their Information and Guidance Note number 9-02-05 dictates that all pipework must be marked. Pipes carrying non-potable water must be clearly distinguishable from those carrying mains water, to ensure that there can be no accidental cross-connection. Marking tape and warning labels are available from rainwater harvesting system suppliers.

The WRAS Information and Guidance Note number 9-02-04, Issue 1, aims to "support water conservation and to prevent reclaimed water systems from contaminating potable mains water supplies". The note offers information about installing, modifying and maintaining reclaimed water systems (including rainwater harvesting systems), and encourages a standard approach to their design and fitting. The booklet also provides a method for assessing health risks, depending on the end use of a rainwater harvesting system. It recommends:

- hazard assessments for each project;
- prevention of cross-contamination by clearly labelling pipework;
- screened inlets and outlets for rainwater storage tanks to prevent rodents and faecal matter entering the tank;
- insulation to minimise heat gain and frost damage to the system.

Many companies in England and Wales now offer advice on the planning and fitting of rainwater harvesting systems. A list of suppliers is available free of charge with the publication *Conserving Water in Buildings*², and it can also be viewed on the Environment Agency's savewater webpages³. For a nominal fee the Centre for Alternative Technology⁴ also provide a list of suppliers.

Demand

On average, each person in England and Wales uses around 150 litres of water every day. Metered water bills will show individual household consumption more accurately. Of the total amount of water used, on average 46% is for purposes that could use rainwater instead of mains supply. In a house with four inhabitants, this amounts to a potential saving of about 275 litres per day, or 100 cubic metres (m³) a year. However, for a system to deliver these savings it would require a large catchment area and high rainfall. While water consumption for bathing is generally increasing, in other areas of the home water use is decreasing. Progressively less water is used for toilet flushing, due to changes in technology and legislation (maximum toilet flush has decreased from 7.5 litres to 6 litres). Savings can therefore change in relation not just to the rainwater supplied, but also to the demand for non-potable water.

¹ *Water Supply (Water Fittings) Regulations 1999*, Statutory Instruments No. 1148, No. 1506, Water Industry, England and Wales, HMSO.

² *Conserving Water in Buildings*, Environment Agency, 2001

³ www.environment-agency.gov.uk/savewater

⁴ *Water Supply and Treatment Resource Guide*, Centre for Alternative Technology

The use of rainwater for clothes washing carries the risk of organic contamination that could cause a colour or odour problem in the clothes. However, some rainwater harvesting companies recommend its use. Rainwater is soft (less limescale/hardness content), so substituting rainwater for mains water in hard water areas can reduce the amount of detergent needed and the build-up of scale in washing machines.

The amount of water used for domestic purposes in industrial / commercial premises will vary depending upon the number of non-potable water using devices.

When looking at ways to reduce water consumption, it is also worth considering demand reduction measures. A cost-benefit decision should be made between savings from rainwater harvesting systems and technology that reduces the demand, such as low-flush toilets, spray taps and showerhead flow regulators.

Water quality and standards for rainwater use

Rainwater is the source of all our water: it fills rivers, aquifers and lakes, from where it is then abstracted by Water Companies for the public water supply. Before mains water is distributed, it is treated to make it safe for human consumption. Concerns about rainwater being of lower water quality than mains water are one possible reason for slow uptake of domestic rainwater harvesting schemes. The need to safeguard people against infection means that suppliers are requesting appropriate non-potable water quality standards.

The cost and physical constraints of long-term monitoring of water quality in a domestic rainwater system would be prohibitive. Therefore guidance focuses on ensuring that system design and installation prevents problems from occurring (see page 9), rather than requiring continuous monitoring.

The Water Supply (Water Quality) Regulations 1989 (Amendment) 1999¹ specify the quality standards for drinking water, but experts consider these standards too strict to apply to non-potable harvested rainwater. The bathing water standards are considered, by some, to be more appropriate for non-potable use. It has previously been suggested that these standards are used as the minimum requirement for quality.

The *Buildings that Save Water* (BTSW)² project consulted a variety of microbiologists to investigate the maximum acceptable concentration of bacteria in stored water (see Table 2). The report states:

"There are currently no standards in England and Wales relating directly to domestic greywater and rainwater recycling systems. Subsequently, in order to meet the needs of the increasing number of domestic recycling systems available in the country, the Building Services Research and Information Association (BSRIA) published proposed water quality criteria for recycled greywater and stored rainwater (BSRIA 1997), although these have no statutory obligation. These requirements were recently re-assessed and a less stringent water quality criteria for greywater for toilet flushing was proposed but was subject to further research (BSRIA 1999)."

Guidelines are available with respect to water quality, but their status is guidance only.

Table 2 - BTSW suggested quality standards for harvested rainwater

Applications	Class A Vehicle washing sprays	Class B Drip and sub- surface irrigation	Class C WC flushing (no taps)
Water quality guideline total coliforms cfu/100ml	10	1,000	1,000
Test criteria total coliforms cfu/100ml	1	100	100

¹ Water Supply (Water Quality) Regulations 1989, Statutory Instruments No. 1147, Water, England and Wales, HMSO.

² Rainwater and Greywater Use in Buildings: Project Results from the Buildings That Save Water Project, Decision-Making for Water Conservation (PR90), Best Practice Guidance (C539) and Project Report and Case Studies (TN7/2001), CIRIA, 2001

Potential sources of contamination

In general, rainwater for non-potable use receives no treatment other than primary and secondary filtration. Since bird and animal remains and decomposing leaf litter on roofs and in guttering could pose a health risk, if washed into the rainwater harvesting system, manufacturers of systems advocate the regular clearing of gutters to ensure that such debris is kept to a minimum.

Some types of roof cover are considered less appropriate for rainwater harvesting than others:

- asbestos-cement roofs can cause filters to block, and collected water may pose a health risk;
- metal roofs (except stainless steel) can release small amounts of leachates, which can stain water fixtures, for example green from copper.
- bitumen felt or coated roofs can lead to discoloration and odour problems;
- grass (and other vegetation) covered roofs reduce the amount and speed of run-off water, which might need extra treatment as the water is likely to be discoloured by soil. This type of roof has been used in some situations such as at the BedZED development, but different factors apply (see page 14).

Maintenance

The uptake, sustained use and the efficiency of rainwater harvesting systems depends on the owners perception of the technology and their enthusiasm to make them work. Rainwater harvesting systems will only be bought when the standard of water quality and ease of maintenance are acceptable to the buyer. This is not "fit and forget" technology: if the user is not enthusiastic about the system, routine maintenance might not be carried out and the benefits will be minimal.

The following maintenance is necessary, to keep the system running as close to design specifications as possible and to avoid contamination:

- filters need cleaning around three times a year, depending on tree cover over the catchment area;
- gutters need to be kept free of debris, that could block the system;
- a visual inspection of the tank is recommended at least once a year. If silting of tanks occurs, excessive silt should be removed, although within the layer of settlement a biofilm forms. The film is thought to be beneficial as it provides biological treatment for the rainwater;
- the mains water top-up should be checked once a year, to ensure that it is functioning.

Determining who will be responsible for maintenance, repairs and ownership of rainwater harvesting systems can be a source of contention. A project managed by the Construction Industry Research & Information Association (CIRIA) is working to establish model agreements for the ownership and maintenance of rainwater use systems. If you would like more information, contact CIRIA (see page 17).

For more information on the reliability, efficiency and safety aspects of rainwater harvesting systems, the *Buildings That Save Water* best practice guidance addresses these issues

Benefits

Rainwater harvesting systems remove some of the demand for mains water, and so release that water for other, increasing demands. They reduce the volume of rainwater discharged and hence may contribute to reducing flood risk and the load on combined sewer overflows as well as improved river water quality.

Unlike greywater (see glossary), for most non-potable demands, rainwater does not require chemical, physical nor biological treatment before use, making maintenance of rainwater harvesting systems generally easier and cheaper.

Costs

In addition to the cost of components, there is the cost of having the system installed. Setting the holding tank into the ground requires labour and excavation equipment. Both collection and distribution pipework needs to be fitted by a trained plumber. It costs less to fit a system when a house is being built, than to add it to an existing building.

The cost of the equipment needed for a basic household rainwater system starts at around £1,500. Plumbing and fitting costs can exceed £1,000, depending on factors such as soil type and size of system, and whether excavation equipment is on site. This cost will increase as the size of tank and the installation of a system become more complex.

Any financial gain from a small-scale rainwater harvesting system is minimised by the fairly low cost of mains water in England and Wales compared to other European countries. Rainfall patterns and maintenance needs are among the long-term variables that can also influence the savings made. However, another factor is the potential benefit to the environment from the increased uptake of these systems.

Water bills include both mains water supply and wastewater treatment charges. Wastewater charges to a property on a water meter are calculated on the basis of the amount of mains water supplied to the property. Wastewater companies do not usually account for the effluent from rainwater, as it is not metered. Although the quantities of water involved are minimal, this could be an issue, if there is greater uptake of rainwater harvesting systems in the future. German companies often measure or estimate the amount of rainwater in wastewater discharge, and charge customers accordingly and water companies in England and Wales may use this method, if uptake of rainwater systems increases.

Suppliers of rainwater harvesting systems currently claim that systems save over 14% of water used by the average household. How much is saved depends on the supply of and demand for water, maintenance needs, and the lifetime of parts before they need replacing. Maintenance costs will depend on the user's ability to carry out simple maintenance tasks themselves, for example, cleaning guttering regularly.

Larger-scale housing developments with shared maintenance and possibly infrastructure are more likely to make the systems financially attractive, as building costs should decrease and maintenance programmes can be co-ordinated.

In agricultural and industrial settings, rainwater harvesting could be more cost effective because of the relatively high water use and large harvesting potential of roof and hard-standing areas. Livestock farms should not use water draining from hard standing, since this run-off would have a high bacterial content.

It is worth considering the benefits of water efficient devices to reduce household water demand, and rainwater butts, for garden watering. These hold around 200 litres and cost about £20. They do not offer year-round benefits, but can help to remove the peaks of summer water demand, by reducing the gardener's need for mains water.

4 Examples of small-scale rainwater systems

More than 100 rainwater harvesting schemes are currently in place in England and Wales. Although some urban schemes exist, most of these systems are in rural areas. The following schemes have published detailed reports of the experience gained from installing and monitoring rainwater systems

Housing Co-operative – Hockerton Housing Scheme

In 1998 the Hockerton Housing Co-operative in Nottinghamshire built five homes designed to minimise water and energy use. The site has been designed to allow the occupants to be independent of the mains water system.

Water from the road, hard standing and surrounding fields is collected via a series of dykes and channelled to a sump, from where it is pumped to a reservoir of 150m³ capacity. This water is used for everything apart from drinking. It is passed through a sand filter, which removes particles and has some bacterial action.

In addition to this, the housing scheme collects rainwater falling on the conservatory roofs, which is filtered and treated for drinking water. 90m³ per year can be collected from the 300m² of conservatory roof space on the site.

The costs were calculated and reported in *Saving water on the right track 2*¹. Table 3 summarises the rainwater harvesting section of this report:

Table 3 - Initial outlay costs for the Hockerton Housing Scheme in 1998

Costs – scheme-wide	Unit cost (£)	Total capital cost (£)	Labour installation cost (£)
Fresh water collection and pumps (inc. reservoir)	-	9,000	2,231
Conservatory drainpipes and gutters	1,737	500	-
Foul and rainwater drainage	-	1,776	1,017
Total	1,737	11,276	3,248

Table 4 - Annual maintenance costs

Annual maintenance	Time taken (man days)	Cost (£)
Management of reed beds	2	150
Emptying of septic tanks	0.5	35
Change of filters	1	75
Maintenance of sand filters	2	150
New filters	-	40
Total	5.5	450

The benefits of this project were significant. Savings on water supply and sewerage charges for the five households were £1,000 in the first year alone. There are no external labour costs for the development, as occupants carry out their own maintenance.

¹ *Saving Water on the Right Track 2*, Environment Agency, 1999

Community Housing Development – BedZED

BedZED is a housing development in South London. The developers, the Peabody Trust, are committed to sustainable development. The development comprises 82 homes, with a mix of one, two, three and four-bedroom properties for outright sale, shared ownership and affordable rent. Flexible workspaces and live/work units are also available.

One of the key features of the development is the recycling of wastewater and rainwater to reduce water consumption. They have recognised the need to make the most of rainwater. BedZED aims for a water use one third of that of a normal housing development. They aim to achieve this by installing:

- water-efficient appliances such as low water use washing machines;
- low-flow taps;
- low-volume-capacity baths;
- dual-flush toilets (estimated to save 55,000 litres per year for the entire development);
- rainwater harvesting from roofs and car parks;
- highly visible mains water meters, to promote understanding of the volume of water being used.

It is predicted that nearly a fifth (18%) of daily water consumption at BedZED will be met from rainwater and recycled water, stored in large tanks incorporated into the foundations. The spaces in the car park are made from porous paving laid over gravel. Run-off from roofs, roads and pavements drains to a dry ditch, which has been made into a water feature.

There is also a small-scale sewage-treatment system called the "Living Machine". Blackwater (see glossary) from the houses will be treated in this system when it is established, and this will increase the non-potable water supply.

Community Centre – Clagg Hall

Clagg Hall community centre in Derby included rainwater harvesting for toilet flushing (two urinals and four WCs) in their new building project. As they needed to reduce the speed of rainwater run-off from the site, the decision was made to collect water from the roof and permeable pavement on a SUDS system in the adjacent car park. The rainwater is collected and reused to supply around 75% of the centre's water needs.

International successes

Some other countries have embraced rainwater harvesting technology to a much larger extent than has happened in the UK. Germany alone has over half a million rainwater systems in homes and workplaces.

Political and cultural drivers appear to have a strong influence on uptake in Germany. Subsidies from local government of up to 3000 DM (£1,000) are available in some areas to help with the initial cost of systems. In addition to this, 99% of German homes are on a metered supply, and the higher cost of mains water in Germany than in England and Wales is a good incentive for homeowners to install a rainwater harvesting system.

The DIN 1989 rainwater utilisation system standard was created to cover all aspects of the implementation of the rainwater harvesting systems in Germany. Parts 1 to 4 of this legislation cover the planning, design, operation and maintenance, the filter, the rainwater storage and reservoirs, and the controls and monitoring systems.

As a result of political drivers, Japan has strict regulation to ensure that buildings with space of over 300,000 m² have greywater reuse and rainwater harvesting. Large new buildings, such as hotels, now have systems fitted as standard practice.

In the state of South Australia, 42% of households use rainwater stored in tanks as their main source of drinking water compared with 40% on public mains supply, the remainder using water from private supplies. Interestingly, many householders have opted to keep their rainwater tank despite recent connection to mains water. More examples of the integration of SUDS with rainwater harvesting systems exist in Australia – such as the Atlantis Corp work in Manly, Sydney (see page 17).

5 Conclusions

- Relatively cheap and simple water conservation devices, such as spray taps and simple rainwater butts, can offer short payback periods and should be considered before high-tech rainwater harvesting or recycling of greywater.
- As water is relatively inexpensive in England and Wales, a domestic scale rainwater system can have a long payback period.
- Whilst metered users may save money on their water bills, water company approaches to savings in wastewater charges vary and may reduce savings that can be made.
- Installation of a rainwater harvesting system at the same time as a building is built or refurbished, will significantly reduce the installation costs.
- On larger scale projects, where many houses are built at the same time, the cost of installation, and subsequent maintenance, is lower.
- Public acceptance is imperative for the success of larger schemes such as housing estates, according to recent anthropological studies and opinion surveys.
- Increasing the awareness of builders, plumbers, product manufacturers and architects, etc., of the benefits of rainwater harvesting systems and the combination of these systems with SUDS, could encourage uptake.
- Uptake of water-saving technology is becoming more prevalent in England and Wales, partly because of education on the need to save water. Increased awareness of pressure on our water resources should also lead to a greater interest in rainwater harvesting.
- If you wish to store water only for garden use then a rainwater butt is the cheapest and easiest way of storing rainwater. When combined with a water-efficient garden design, one or more rainwater butts can meet most gardens' watering needs.

Suggested further reading

- *A Study of Domestic Greywater Recycling*, David Sayers, Environment Agency, 1999
- *Conserving Water in Buildings*, Environment Agency, 2001
- *Information for Customers*, Brian Hurst, Free Water UK Ltd., August 2002.
- *Rainwater and Greywater Use in Buildings: Project Results From The Buildings That Save Water Project; Decision-Making for Water Conservation (PR80)*, CIRIA, 2001.
- *Rainwater and Greywater Use in Buildings: Project Results From The Buildings That Save Water Project; Best Practice Guidance (C539)*, CIRIA, 2001.
- *Rainwater and Greywater Use in Buildings: Project Report and Case Studies (TN7/2001)*, CIRIA, 2001.
- *Rainharvesting Systems Water Conservation and Reuse*, Rainwater Harvesting Systems Ltd, Issue 1, 2002.
- *Save Rainwater – Save Money*, Cath Hassell (Construction Resources), Building Engineer, February 2001
- *Saving Water on the Right Track 2*, Environment Agency, 1999.
- *The Rainwater Technology Handbook, Rainharvesting in Building*, Klaus König, Wilo-Bran, 2001.
- *Water Efficiency Awards 2000*, Environment Agency & Water UK, 2000
- *Water Efficiency Awards 2001*, Environment Agency & Water UK, 2001.
- *Water Reclamation Standard and Guidance*, TN 6/2002 and TN 7/2002, BSRIA, 2002
- *Water Supply and Treatment Resource Guide*, Centre for Alternative Technology.
- *WRAS Information and Guidance Note Number 9-02-04 Issue 1, Reclaimed Water Systems*, 1999
- *WRAS Information and Guidance Note Number 9-02-05 Issue 1, Marking and Identification of Pipework for Reclaimed (Greywater) Systems*, 1999

Useful contacts and other example sites

	Web address
Atlantis Corp - Australian example	www.atlantiscorp.com.au
BedZED – British Example	www.bedzed.org.uk
BSRIA - Building Services Research and Information Association	www.bsria.co.uk
Centre for Alternative Technology – suppliers listings and advice provided on systems	www.cat.org.uk
CIRIA – more details, specifically on SUDS	www.ciria.org.uk
Eden Project – a large scale rainwater harvesting system	www.edenproject.com
Environment Agency, Water Demand Management	www.environment-agency.gov.uk/savewater
Hockerton Housing – British Example	www.hockerton.demon.co.uk
Meteorological Office – for rainwater data	www.met-office.gov.uk
WRAS – Water Regulations Advisory Service	www.wras.co.uk

Glossary of terms

Aquifer	Underground water storage in gaps between rock
AA air gap	The inlet supply of potable water to any cistern containing rainwater, greywater or reclaimed water must be protected by an air gap suitable for protection against a Class 5 risk (see Water Supply [Water Fittings] Regulations 1999)
Blackwater	Raw sewage
Cistern	A fixed container for holding water to be used as toilet flush water.
Coliform	Bacteria found in the intestines, faeces, nutrient-rich waters, soil and decaying plant matter
Cross-contamination	Pipes carrying mains water connected to pipes carrying non-potable water
Down pipes	Pipes leading down from roof guttering to drains
Greywater	Wastewater from baths, showers and sinks (kitchen sinks are excluded due to nutrient-rich effluent)
Legionella	A bacterium named <i>Legionella pneumophila</i> that can cause legionnaires' disease (lung infection) in humans
Limescale	Deposit of hardness (calcium or magnesium carbonate) in water conveying devices
Non-return valve	A pipe fitting that limits flow to one direction only
Permeable pavements	Allows water to drain through paved surfaces rather than running off into drains
Potable / mains water	Water company/utility/authority drinking water supply
Rodent barrier	A device on the holding tank overflow pipe to prevent rodents entering into the holding tank.
Rainwater butt	Small scale garden water storage device which collects rainwater from the roof via the drainpipe.
Run-off	Water falling on a surface but flowing into a downpipe, drainage channel or surface water rather than permeating the ground

List of abbreviations

BSRIA	Building Services Research and Information Association
BTSW	Buildings That Save Water
CIRIA	Construction Industry Research and Information Association
DEFRA	Department for the Environment, Food and Rural Affairs
PPG 25	Planning Policy Guidance note 25
SUDS	SUstainable Drainage Systems
WRAS	Water Regulations Advisory Scheme

Annex 1

BTSW: Information checklist for clients considering rainwater systems¹

Actions and items to be considered	
Catchment area	
Measure plan area	
Is it subject to rain shadow?	
Is there a potential for debris (trees, local industry, bird population)?	
Assess surface (flat, gravel, lead etc)	
Assess catchment gradient – is ponding likely?	
Do gutters have sufficient fall to prevent ponding?	
Can water from the catchment area be easily directed to the collection tank?	
Storage	
Is there enough space for the storage tank?	
Are other services likely to be interrupted and can this be avoided with repositioning?	
Do the ground conditions suit an underground storage tank?	
Is the water table near to the surface?	
Is connection to a storm drain soakaway possible?	
Are the ground conditions suitable for a soakaway?	
Are there possible sources of contaminants that could seep into the tank?	
Is lagging required?	
Internal distribution pipework	
Is the pump capable of pumping to the highest supply point?	
Can existing pipework be incorporated in to the system?	
Can the distribution pipework be installed easily and neatly?	
Is there room for a cistern?	
Can mains water easily be diverted to top up the cistern?	
Is the pressure attained from a cistern sufficient for use? (eg washing machines)	
Operation and maintenance	
Is there feedback on the system status to the user? (eg alarms, fault indications, disinfection failure if applied)	
What is the frequency of general operational duties such as filter cleaning, disinfectant top up (if used)?	
What is the frequency for major maintenance? Can this be carried out by the user or is a trained person required?	
Costing	
See Annex 2	

¹ Rainwater and Greywater Use in Buildings: Project Results from the Buildings That Save Water Project, Decision-Making for Water Conservation (PR90), Best Practice Guidance (C539) and Project Report and Case Studies (TN7/2001), CIRIA, 2001

Annex 2

BTSW: Information clients should be provided with (for both rainwater and greywater systems)¹

System Cost	
1. Capital system cost	
2. Cost of preparatory works (excavations, plinths for tanks etc)	
3. Cost of collection pipework and components (installed)	
4. Cost of distribution pipework and components (installed)	
5. Cost of installation and commissioning rainwater or greywater system	
6. Cost of redecorating if retrofit	
7. Estimated time required for installation	
System details	
8. Overall description of the proposed system with schematic	
9. Percentage of collected water that goes to waste due to filter cleaning [if applicable]	
10. Inlet filter particle size rejection [if applicable]	
11. Pump type, location and materials of construction	
12. Power requirements and fusing	
13. Details of sewage backflow protection (for underground tanks)	
14. Proposed disinfectant ... [if applicable]	
15. Details of water quality checks undertaken by the installer during commissioning [if applicable]	
16. Details of mains water makeup compliance with Water Regulations	
Operational and maintenance strategy	
17. Normal operation, temporary diversion of inputs, filter back washing, provisions for extended periods of non-use etc	
18. Tasks to be undertaken by end user or site maintenance personnel and anticipated frequency	
19. Tasks to be undertaken by trained service personnel and anticipated frequency	
20. Major service intervals	
Operation and maintenance costs	
21. Cost of one year of consumables based on projected use	
22. Cost of routine service cover per year and service replacement items included/excluded	
23. Cost of call out if not included above	
24. Anticipated life and replacement cost of major components	
25. Number of years guaranteed availability of spares	

¹ Rainwater and Greywater Use in Buildings: Project Results from the Buildings That Save Water Project, Decision-Making for Water Conservation (PR90), Best Practice Guidance (C539) and Project Report and Case Studies (TN7/2001), CIRIA, 2001

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Environment Agency Advice Notes on Greywater

Text Only 11 December 2007

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Greywater

What is Greywater?

Wastewater from all sources in a property other than toilets is known as greywater

Most greywater recycling systems collect and treat wastewater from showers, baths and wash basins, excluding the more contaminated water from washing machines, kitchen sinks and dishwashers. Greywater recycling systems collect this water, treat it and re-use it for purposes that do not require drinking water quality. This recycled water can be used to flush toilets, water gardens and sometimes feed washing machines

Greywater recycling systems can be installed in new or existing buildings and have the potential to meet a significant proportion of domestic demand for water.

Is it for me?

Before installing a greywater recycling system you should:

- compare how much greywater you are likely to generate (which will depend on the number of baths and showers taken) with your demand for reclaimed water (which will depend on the number of toilet flushes or volume required for the garden);
- consider the potential savings from reduced water consumption against the costs of installation and maintenance

Systems installed in larger buildings tend to be more efficient than those installed in individual properties, as bigger systems can use more sophisticated treatment and can be maintained centrally.

How does it work?

A typical greywater system collects wastewater from baths, showers and washbasins. The water is then treated and pumped to a tank for storage until it is required for toilet flushing or garden watering.

The method and standard of treatment in a greywater system generally varies with the size of the system. Larger greywater systems that supply more than one property tend to use more sophisticated treatment methods than smaller, individual systems. Treatment can be classified as 'physical' or 'biological'. 'Physical' treatment is common in small-scale systems and usually consists of a basic filtration process. Biological treatment is generally used in larger systems and works in a similar way to the processes used at a sewage treatment works. Some systems use a combination of the two methods, giving a 'bio-mechanical' process.

Basic physical systems tend to require the use of chemicals similar to bleach to stop the growth of bacteria while the water is in storage. Care must be taken to ensure no cross connection with mains water occurs. Further guidance is available at the Water Regulations Advisory Scheme (WRAS) website. (Click on link in left hand column)

Will it save me money?

Greywater recycling has the potential to save a third of domestic mains water usage.

If your property is metered, this will reduce your water bill. Your financial savings will depend both on the price of water in your area and the volume of water re-used.

Greywater systems are relatively expensive; therefore it may be some time before the system pays for itself financially. Studies have shown that payback periods for simple, domestic systems can be longer than the life of the system

How much will it cost?

Installing a system for use in an individual property can be expensive. A typical, off the shelf, single house, domestic system may cost in excess of £3,000 to purchase. This system will also incur running costs and installation costs. Systems that are installed in new buildings are usually more cost effective than those retrofitted into existing properties; communal systems are more cost effective than those installed in single properties

Will it benefit the environment?

The potential water savings from widespread greywater reclamation are huge. A well specified, correctly installed, fully operational and well-maintained greywater system could save one third of the water taken from the mains supply by a domestic property. If widespread, this would reduce both the pressure on water resources and the quantity of sewage requiring treatment.

While greywater systems save water, they also use energy. This works against some of the environmental benefits gained from saving water. Cheaper and less energy-intensive ways of saving water include low-flush toilets, low flow taps, low flow showers and waterless urinals.

What do I do now?

There are easier ways to save water. Our publication *Conserving water in buildings* gives a summary of the many ways we can all save water, including greywater reclamation. (Click on the Technology available link in left hand column)

If you have any specific questions about greywater reclamation e-mail us at savewater@environment-agency.gov.uk



Anglian | Midlands | North East | North West | South West | Southern | Thames | Wales

Sustainable Urban Drainage (SUDS)

Introduction

SUDS

SUDS, or sustainable urban drainage systems, are an alternative to the traditional approach of collecting stormwater in pipes and discharging it into treatment works or watercourses.

Flooding is a major issue in the UK.

In 2001, over 10000 UK properties were affected by flooding at a cost of £750 million to insurance companies and legislation is now beginning to force architects, specifiers, engineers and contractors alike to consider the impact on the environment of run-off from the developments they create.



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

Part H3 of the Building Regulations (Rainwater Drainage), was revised for the 2000/2001 edition and places a greater emphasis on the sustainable management of rainwater run-off, to help reduce flash flooding and combined sewer overflow which can result in flooding of watercourses during periods of high rainfall.

Part H requires that rainwater from the roof of a building or from a paved area should be either gathered for reuse using methods such as greywater recycling, or be discharged in one of the following ways. These are in order of priority:

- a. An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- b. a watercourse; or, where that is not reasonably practicable,
- c. a sewer.

Traditionally the preferred method of rainwater disposal was to discharge into a sewer, but with the updated legislation this may now only be considered after other forms of reuse or drainage have been considered.

Implementing SUDS contributes significantly towards achieving sustainable development.

Planning authorities will set a limit to the rate of stormwater flow from a site via sewers as a condition of planning consent. PPG25 states that all applications should consider stormwater run-off and aim to incorporate SUDS into development proposals.

The most appropriate solution is dependent on a number of factors including whether the system is to be adopted, the allowable discharge consent, the storm return period, the extent of the impermeable paving and buildings, the soil type, access issues and the likely quality of the run-off. Hepworth are able to offer specific advice dependent on the project. To request a copy of the Hepworth guide to Stormwater Management and -GEOlight brochure, please complete the response card or visit our website on www.hepworthdrainage.co.uk to download a copy.

Guidance and Legislation

As a constantly developing area, guidance and legislation on SUDS is also growing. Planning Policy Guidance, PPG25, clearly states that Local Planning Authorities should promote SUDS in their policies. Developers are advised to assess the effects of stormwater run-off and where possible minimise its effects by using SUDS principles. As mentioned previously, Building Regulations Document H3 also has an emphasis on SUDS. Other guidance documents on design and implementation are published by CIRIA, with the Environment Agency also offering guidance. Further advice and guidance is available from the Hepworth Technical Department.



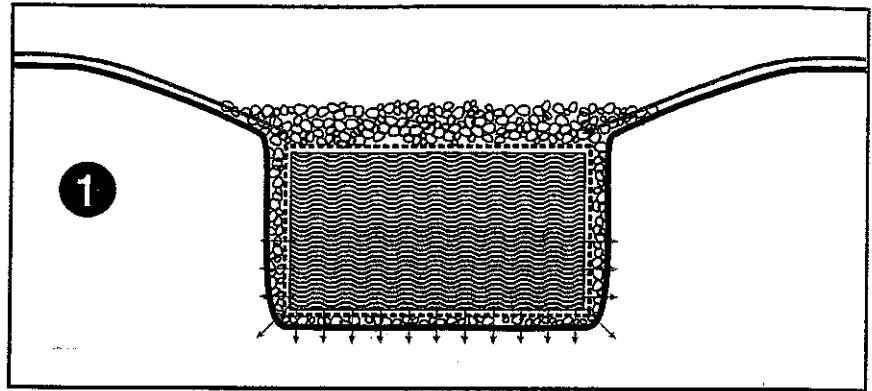
Sustainable Drainage Solutions

A number of solutions are available to meet the new requirements, ranging from landscape solutions, such as creating permeable pavements to attenuation systems that store water in underground tanks or gradual release into the sewer system. The following are a number of solutions provided by Hepworth Drainage

Hepworth Solutions

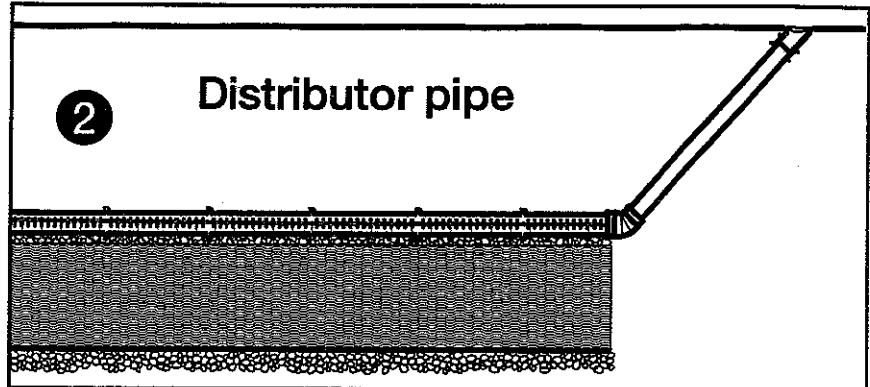
1. Infiltration Trenches

Infiltration trenches contain GEOlight units wrapped in a Geotextile, installed underground to which surface run-off is directed. The stored water gradually disperses into the ground.



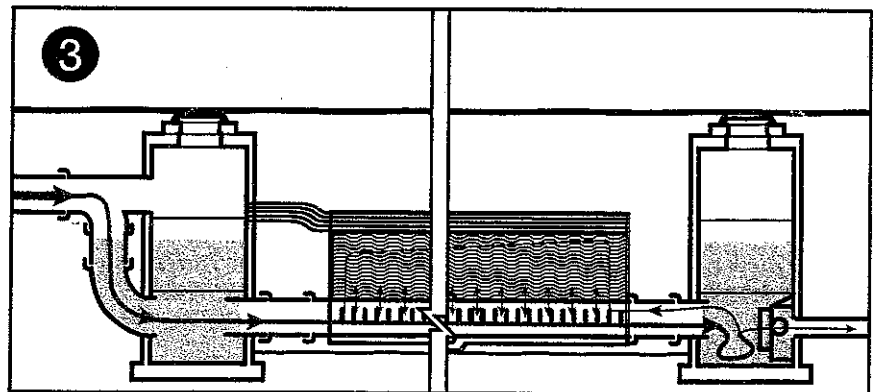
2. Soakaway Trench or Block

Similar to infiltration trenches, soakaways contain GEOlight units, wrapped in a geotextile, laid in trenches or blocks to suit the site topography. A Hepline distributor pipe, connected to the upstream drainage system, is laid above the units, which disperses the surface water vertically and horizontally through the GEOlight. The stored water then infiltrates the ground.



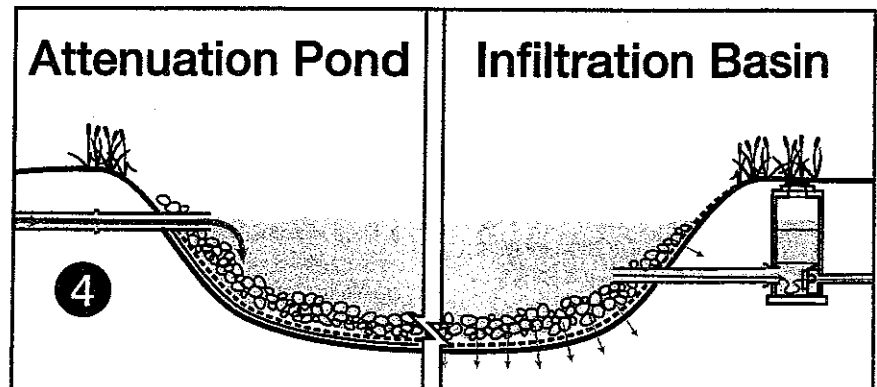
3. Attenuation Tanks

Attenuation tanks contain GEOlight units wrapped in a high performance water barrier (impermeable membrane) forming an underground storage reservoir. A perforated distributor pipe allows the stormwater to fill the GEOlight units, both vertically and horizontally, during peak rainfall periods. Fitted with a flow control system it will discharge water at a controlled rate back into the drainage system.



4. Attenuation Pond/Infiltration Basin

Similar in operation to below ground structures, but left as an open excavation. The stored water forms a pond which either disperses into the ground via a geotextile or is contained by an impermeable membrane and empties via a flow control unit.



GEOlight - Introduction

GEOlight is an ultra lightweight honeycombed modular structure manufactured from recycled PVC. The units are assembled to provide underground storage for the control of stormwater either by attenuation or as a soakaway.

The high void rate, high compressive strength and low resistance to water flow allows the GEOlight system to be an ideal solution for efficient and rapid underground water storage during storm conditions.

GEOlight applications

The Environment Agency is keen to promote the wider use of Sustainable Drainage Systems, which reduce the impact of surface-water run-off. There are two main ways of storing surface water for stormwater management:

- Stormwater attenuation
- Soakaways

Stormwater attenuation

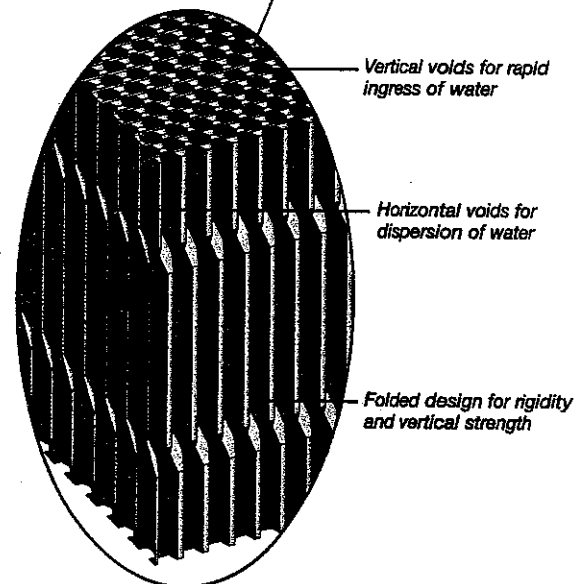
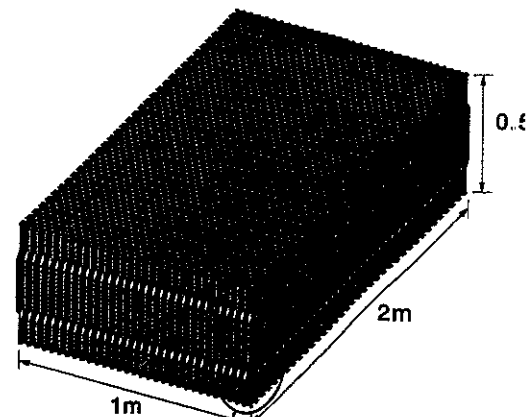
This consists of water storage reservoirs that hold excess surface water during periods of peak rainfall. The stored water is gradually released in a controlled manner into the surface water drainage system or directly into watercourses, reducing the risk of flooding downstream.

Soakaways

Soakaways are designed to store surface water run-off until it can be gradually absorbed by the surrounding ground.

Features and Benefits

- High compressive strength – can be located under roads, car parks and amenity areas
- Reduced excavation costs – the very high void rate (95%) minimises the volume of earthworking required
- Speed of installation – 1000m³ reservoir completed in one week
- The honeycomb structure is highly permeable, offering low resistance to water flow
- GEOlight's unique lateral and vertical filling arrangement reduces the amount of stone used for pipe bedding and water distribution
- Depth of attenuation units reduced by using patented lateral supply
- Simplified distribution pipe network – dispensing with costly and complicated pipework configurations
- Modular format offers flexibility in capacity and geometry of reservoir to overcome topographical restraints and architectural requirements
- Greatly reduces the risk of flooding when used as stormwater storage
- Can also be used for water recycling and combining with irrigation systems
- Can virtually eliminate pollution when used in combination with petrol/oil separators
- Design service available, including calculations



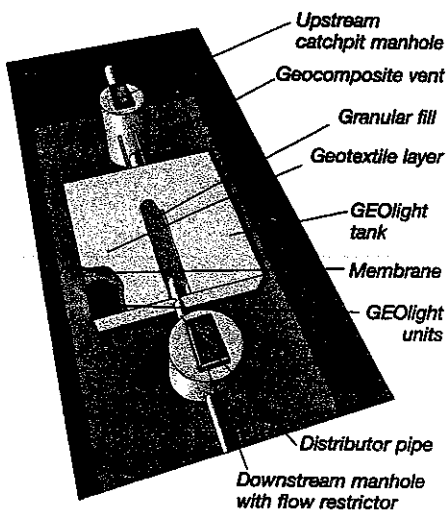
GEOlight Stormwater Attenuation System

The GEOlight Stormwater Attenuation System consists of two manholes (inspection chambers) connected by a length of perforated distribution pipe which feeds the stormwater storage reservoirs on either side formed from GEOlight.

The distribution pipe is normally from 225mm up to 500mm diameter, generally covered in a trench filled with draining material, such as 15/25 clean graded stone, free from fines.

The reservoirs and distribution pipe are wrapped in a waterproof membrane to prevent seepage of water into the surrounding ground. The top of each GEOlight reservoir has a vent which is connected back to the upstream manhole.

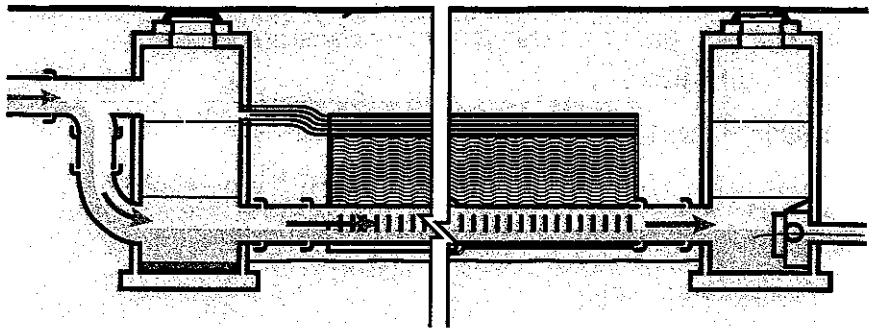
A high flow geotextile is laid between the distribution pipe and GEOlight to prevent the GEOlight units being clogged by the draining materials.



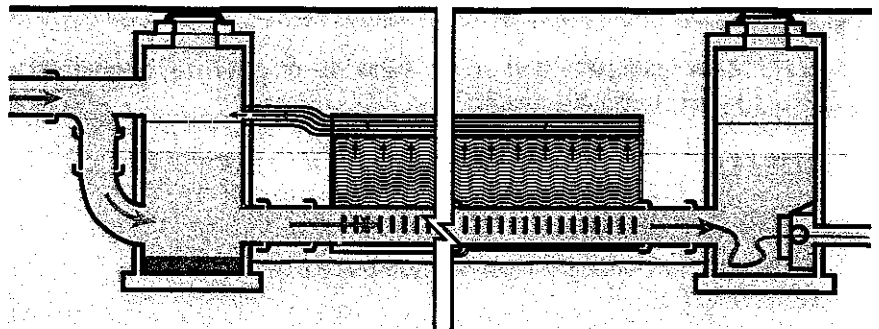
3D overview of typical attenuation system

How does it work?

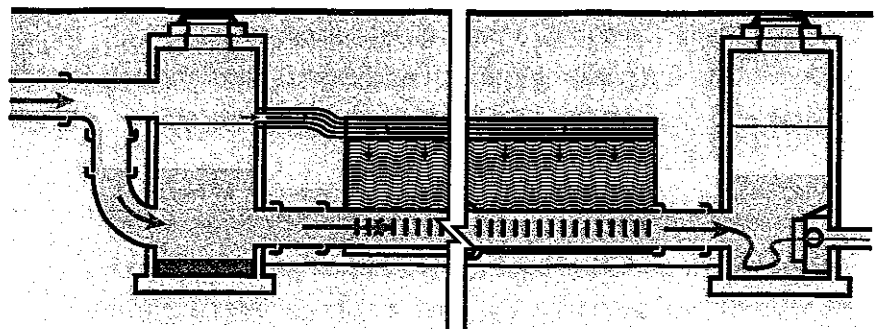
1. In normal conditions, water enters a back drop manhole. This is the upstream manhole and any silt or sediment will collect in the bottom of the chamber. The water then flows along the distribution pipe into the downstream manhole. The upstream pipework is sized to cope with normal flow conditions. The distribution pipe and attenuation tank are sized to cope with storm conditions. The outflow pipe is sized to cope with the permissible discharge.



2. In storm conditions the flow restrictor (vortex flow control or orifice plate) in the downstream manhole limits the amount of water flowing out of the manhole. This causes the water level in the distribution pipe to rise and water to spill into the GEOlight reservoirs on either side. As the water level rises in the reservoirs, air is forced out of the high level vents into the upstream manhole.



3. Once the storm has passed, the water level in the GEOlight reservoirs gradually falls as water passes through the flow restrictor in the downstream manhole. The vents now allow air to return into the GEOlight reservoirs. Gradually the reservoirs empty.

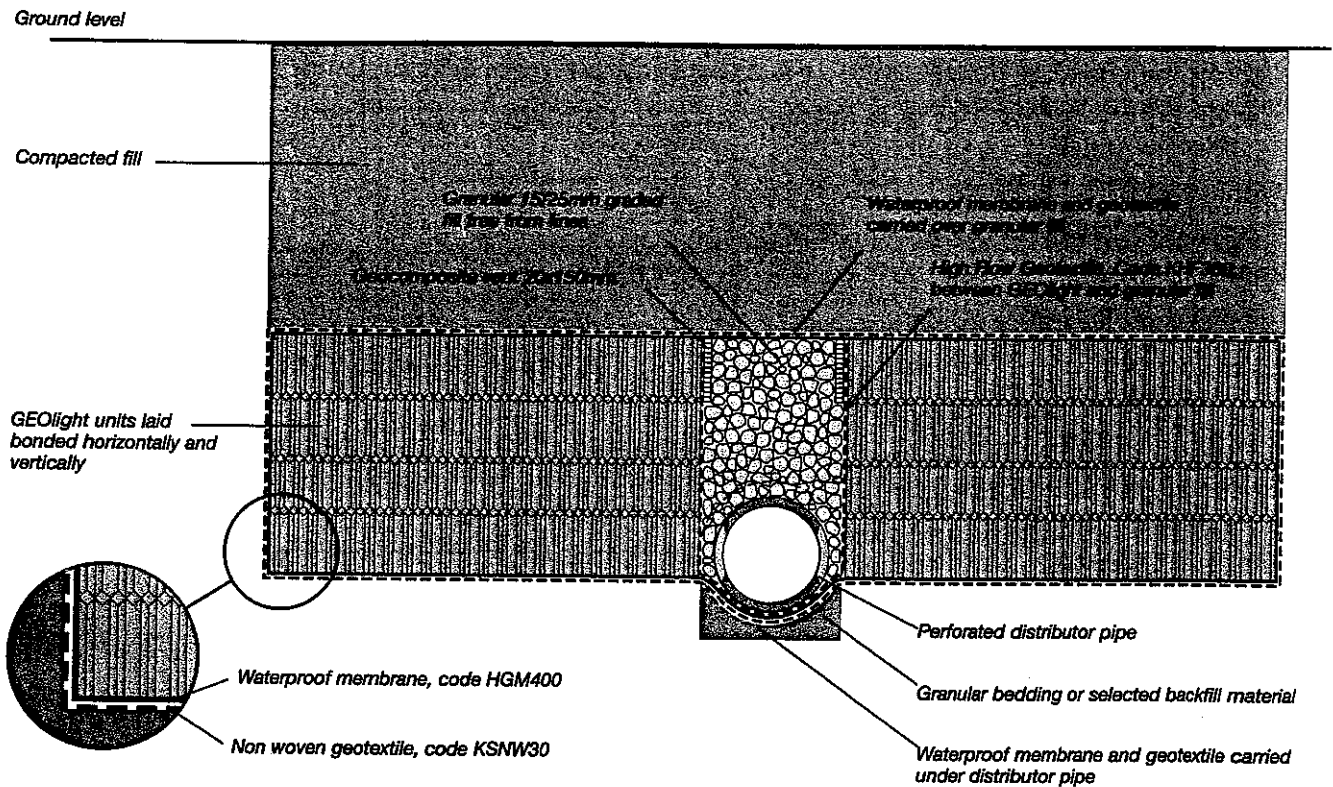


The flow restrictor prevents excess surges of flood water to pass downstream and uses the storage reservoirs to store the water for the period of the storm.



GEOlight Stormwater Attenuation System

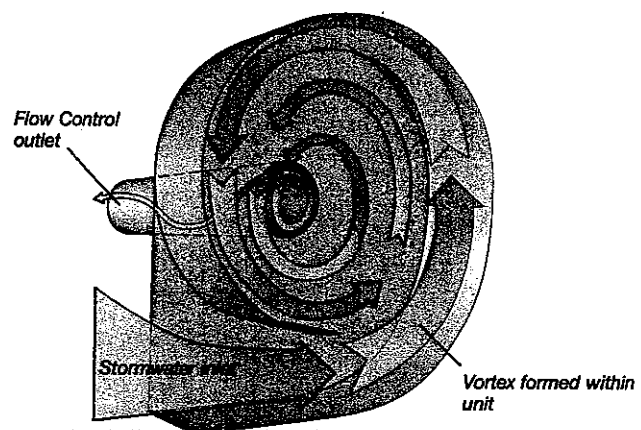
Cross section



Vortex Flow Control

The flow control is used to control the stormwater from a development at the required discharge rate

All units are individually designed to meet the client's specifications





GEOlight Soakaway System

Soakaways are a simple and traditional way of dispersing surface water where connection to the surface water drainage system is impractical. However, as part of the move to Sustainable Urban Drainage Systems and changes in the Building Regulations, the use of soakaways is preferable, where soil conditions allow. Where this is not possible, other options must be considered, such as attenuation to discharge to sewer, with the Water Company's consent.

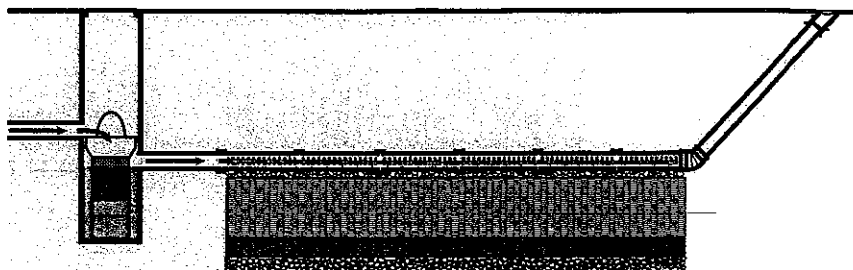
Directing run-off from roofs and hard paved areas directly into the ground via soakaways helps replenish groundwater and can recharge aquifers. Soakaways reduce the burden on treatment works and, by slowly releasing water into the ground, they reduce the risk of flooding.

The modular form of GEOlight means that soakaways can be sized to serve any size of development from a single house to a large industrial/commercial development.

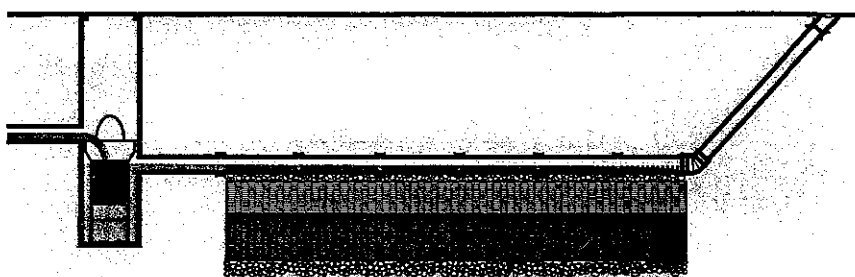
The use of soakaways to serve roads and car parks, where water can become contaminated, will only be acceptable where the water first passes through an oil/petrol separator. A check should be made with the Local Authority and the Environment Agency for their requirements.

How does it work?

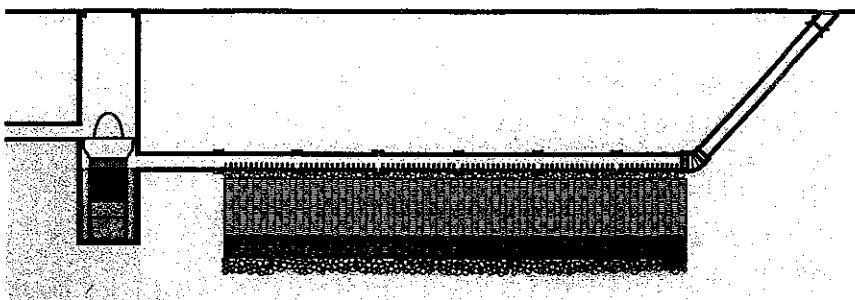
1. Surface water is collected from roofs and hard paved areas into a surface drainage system. This discharges into a silt pit, containing a silt collection bucket. The outlet from the silt pit is to a perforated distributor pipe, from which water discharges into the GEOlight reservoir directly below.



2. During periods of heavy rainfall, the rate at which water is flowing into the GEOlight reservoir is greater than the ground can absorb and the GEOlight reservoir gradually fills with water.



3. Once the flow from the distribution pipe has ceased, the water level in the GEOlight reservoir falls as water gradually seeps into the surrounding ground.



Maintenance

The silt pit has a silt collection bucket, to prevent clogging of the soakaway with silt. The silt collection bucket should be checked every few months and any significant silting-up should be removed.

The silt pit and rodding point provide access to the distribution pipes for inspection, and if required cleaning by jetting.

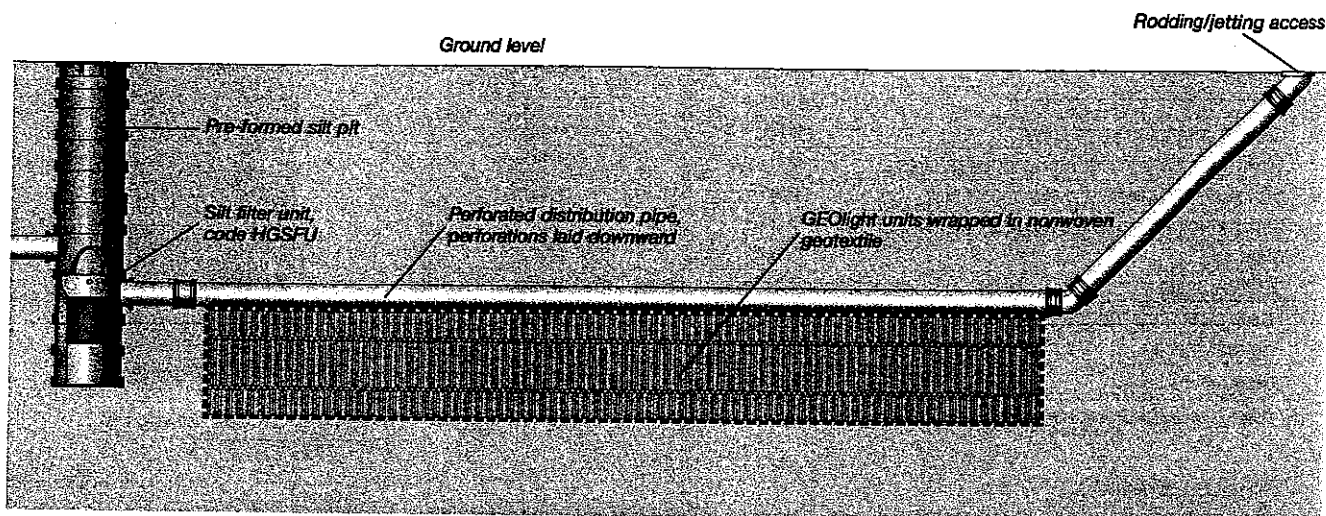
Trafficked areas

It is important that infiltration below trafficked areas and close to structures (5m minimum from a building) will not soften the underlying or surrounding soils. This application should be checked with a Geotechnical Engineer and care taken not to cause settlement.

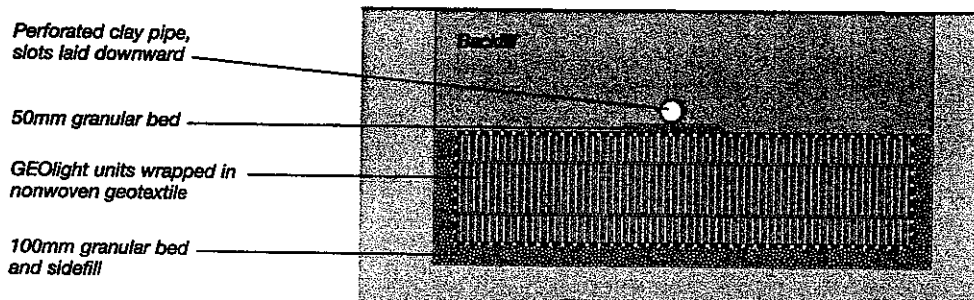


GEOlight Soakaway System

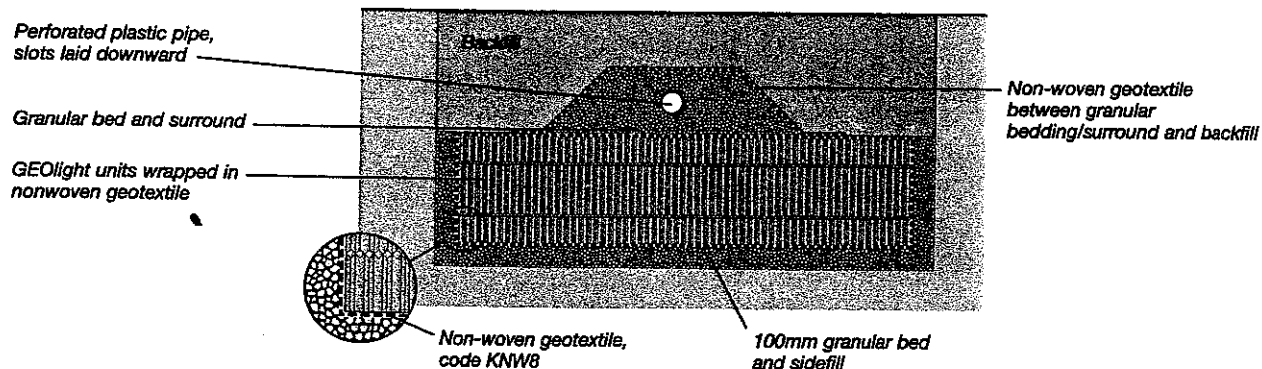
Long section



Cross section – clay distributor pipe



Cross section – plastic distributor pipe





GEOlight – Product Information

Product data

Dimension	2 x 1 x 0.5m	2 x 1 x 0.5m
Average weight	46 kg/m ³	55 kg/m ³
Vertical compressive strength*	200 kN/m ²	400 kN/m ²
Lateral compressive strength	15 kN/m ²	30 kN/m ²
Maximum recommended continuous stress	40 kN/m ²	80 kN/m ²
Minimum thickness of overlying backfill	0.45m	0.45m
Maximum thickness of overlying backfill	1.8m	3.6m
Material	PVC	PVC
UV resistance	Good	Good
Hydrocarbon resistance	Good	Good
Fire resistance	Good	Good
Product code	HG200	HG400

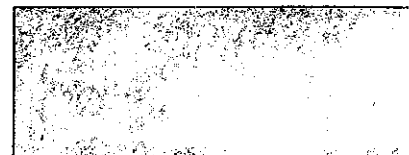
* Note higher compressive strengths available



A sample of GEOlight showing the honeycombed structure

Product Codes

Description	Codes
Geomembrane	HG400
Silt filter unit	HGSFU
Flow control units	HGGSR
Air vent	HGAV
Geotextile - Soakaway applications	
Non woven 45m X 100m roll	KNW8
High flow woven Handy Pack 51.5m ²	KHF360HP
Geotextile - Attenuation applications	
Non woven needle punctured 300g/m ²	KSNW30
Light flow woven Handy Pack 51.5m ²	KHF360HP



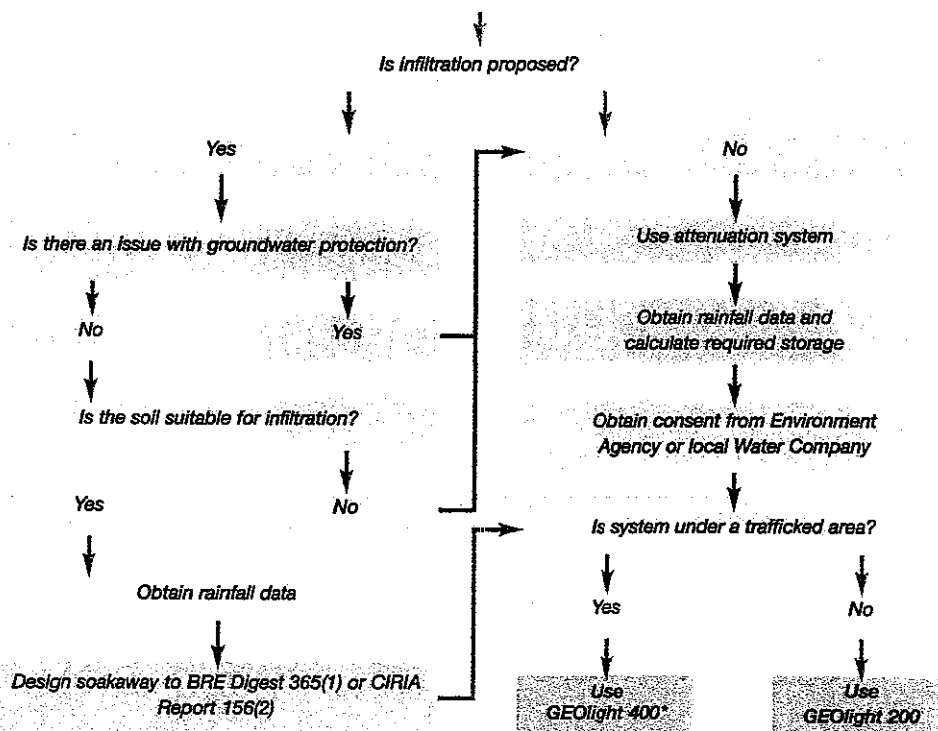
Non woven Geotextiles



Woven Geotextiles

Product Selector

A sustainable drainage system is proposed for stormwater management



1. Building Research Establishment, Soakaway Design, Digest 365, September 1991

2. Roger Bettess, Construction Industry Research and Information Association, Infiltration Drainage – Manual of good practice, CIRIA Report 156, 1996

* GEOlight can be used in areas trafficked by commercial and HGV vehicles, however, specific design advice should be sought from Hapworth for these applications.



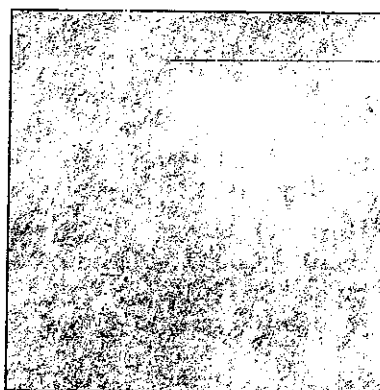
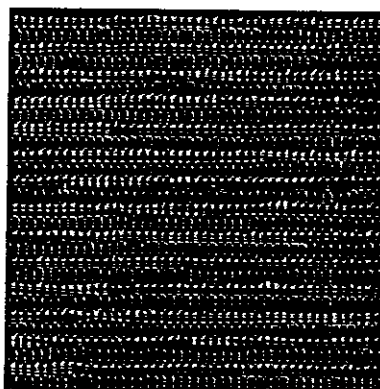
Geotextiles – Introduction

Introduction

Hepworth Drainage supply a wide range of geosynthetics which are manufactured in ISO 9001:2000 Quality assured production plants.

The range includes both woven and non-woven geotextiles manufactured from a selection of man-made polymers.

These include polypropylene, polyethylene and polyester. Polypropylene tends to be the most commonly used due to it being relatively inert and one of the more stable polymers. Polypropylene is well known throughout the construction industry for offering an excellent chemical resistance to acids and alkalis at ambient temperatures.



Woven Geotextiles

Pack	Roll	Mini roll	Sheet (handy pack)
Weight (g/m ²)	82	80	80
Code	KSG18/9	KSGMR	KSG18/9HP

Non-woven Geotextiles

Pack	Roll	Roll
Weight (g/m ²)	90	115
Code	KNW6	KNW9

Geotextiles

Test Description	Test Standard	Woven	Woven	Woven	Nonwoven	Nonwoven	Nonwoven
Mechanical Properties							
Tensile Strength (kN/m)	*MD EN ISO 10319: 1996	18	17	17	6	9	9
	CD EN ISO 10319: 1996	16	14	10	6.6	9	9
Extension at max load (%)	*MD EN ISO 10319: 1996	22	22	22	42	50	50
	CD EN ISO 10319: 1996	14	14	14	42	50	50
CBR Puncture Resistance (N)	EN ISO 12236: 1996	1900	1700	1700	1100	1500	1500
Cone Drop Resistance (mm)	EN 918: 1996	18	22	22	48	37	37
Hydraulic Properties							
Opening Size; O90 (microns)	EN ISO 12956	190	155	155	119	115	115
Waterflow (l/m ² /s)	EN ISO 11058	16	16	16	130	120	120
Physical Properties							
Thickness under 2 kPa (mm)	EN 964	0.14	0.4	0.4	0.9	1.1	1.1
Weight (g/m ²)	EN 965	82	80	80	86	115	115
Form supplied		Roll	Mini roll	Handy pack	Roll	Roll	Roll
Width (m)		4.5	1.0	4.5	4.5	4.5	2.62
Length (m)		100	14	11.1	100	100	100
Diameter (cm)		22	10	—	30	33	33
Roll/pack Weight (kg)		37	12	4	41	54	32
Code		KSG18/9	KSGMR	KSG18/9HP	KNW6	KNW8	KNW8/262

Notes relating to the use of Geotextile products

- The above figures are average values obtained from testing to current EN Geotextile Test Standards.
- Polypropylene is the main polymer used in the production of the above grades.
- It is the responsibility of all potential specifiers/end users to satisfy themselves that the above values are current.
- Hepworth Drainage and Bonar Technical Fabrics cannot accept responsibility for the in-situ performance of these products due to the conditions of use being outside their control.

Further grades of Geotextile include:

- Woven Lightweight, Heavyweight, Highflow, High Strength Grades
- Thermally Bonded and Needle Punched Nonwovens

*MD = Machine direction
sCD = Cross machine direction



Geotextiles – Functions

Geo-functions

There are six main functions of geosynthetics. These include:

Separation – the use of a geosynthetic material to prevent the intermixing of two different soil layers.

Filtration – the use of a geosynthetic material to allow the passage of fluids (most commonly water) from a soil while preventing the uncontrolled passage of soil particles

Drainage – the use of a geosynthetic layer to collect and transport fluids within its thickness

Reinforcement – the use of the tensile properties of a geosynthetic material to resist stresses or contain deformations in soil structures

Erosion Control – the use of a geosynthetic material to prevent the loss of soil particles from water erosion.

Protection – the use of a geosynthetic material as a stress reduction layer to prevent or reduce damage to an adjacent surface or layer.

Separation

When used as a separation layer, the geotextile prevents the intermixing of particles from two soil layers with different properties. Typical separation applications might include the construction of unpaved access roads, railway tracks, domestic drives, paths and patios. The geotextile keeps the sub-base clean and prevents its loss into the underlying sub-grade.

Benefits and features – separation

- The elimination of any initial loss of imported granular fill into the sub-grade
- The prevention of any downward movement of the sub-base into the underlying soft sub-grade
- The sub-grade being restrained from squeezing up between the sub-base particles during the lifetime of the structure keeping the sub-base clean
- To assist in the reclaiming of the sub-base stone after the project is completed
- In unpaved roads, to perform a secondary reinforcement function in the construction that can allow a reduction in the required stone thickness

Filtration

As a filtration layer, geotextiles help establish a soil filter that holds back soil particles, but allows water to flow freely into the drainage system or soakaway. Typical filtration applications might include land drainage, river and coastal defence works, or as an anti-pumping filter below railway ballast

Benefits and features – filtration

- The use of a man made filter with an opening size engineered for specific soil conditions
- The use of a cheaper single-sized drainage stone in place of costly traditional graded granular material
- The use of a smaller drain cross-section due to the larger water conducting capacity of single sized drainage media
- An extended life expectancy for the complete drainage system due to the reduced likelihood of the system clogging



Geotextiles – Range

Our Woven and Nonwoven geotextile products are broken down into the following ranges:

Woven Geotextiles

Manufactured from extruded tapes by a conventional weaving process on a Sulzer loom. The warp tapes (machine direction) are beamed into the loom and the weft tapes (cross-machine direction) are threaded over and then under alternate elements. The woven product that emerges from the loom is then wound into rolls.

Woven Lightweight Product Range – KSG Grades

Ranging in weight from 65 to 192g/m² this range is used primarily in a separation function to prevent good quality granular fill intermixing with the underlying lower quality soil. The materials offer a good mechanical resistance to damage caused during either installation and/or subsequent trafficking. The softer the underlying soil, then the higher (stronger) the grade of geotextile that must be used. In this latter area the geotextile then performs both a separation and reinforcement function.

Typical uses where a geotextile separation layer might be used include new highways, car parks, airport runways, under stone foundation layers to new buildings etc.

Woven Heavyweight Product Range – KSG Grades

Increasing in weight from 254 to 615g/m² and with tensile strengths up to 200kN/m the woven heavyweight geotextiles are used in applications where loadings are very severe. Uses may include short term reinforcement applications, coastal erosion schemes or areas requiring significant soil stabilisation. These products together with those in the upper end of the woven lightweight range regularly compete against geogrid products used in soil stabilisation applications.

Woven High Flow Product Range – KHF grades

These are made from a combination of monofilament and/or multifilament tapes and yarns the High Flow range of products are used where, as their name suggests, there exists a requirement for the quick escape of any excess water. Typical uses include erosion control applications e.g. under concrete revetment blocks or between dissimilar layers of quick draining granular fill e.g. a coarse sand and a rounded gravel.

Woven High Strength Product Range – KHS Grade

This range is the exception to the norm in that all these products are produced from woven polyester yarns. The range is aimed solely at the reinforcement market due to their high strength, low extension and low creep characteristics.

Typical product applications may include use in the construction of vertical walls, steep slopes and embankments over soft soil with a long term life expectancy.

Nonwoven Geotextiles

This manufacturing process involves extruding continuous filaments and then cutting these into short staple fibres for processing on one of several nonwoven lines. Each line involves the continuous laying of fibres onto a moving conveyor belt to form an unbound web. This web passes along the conveyor to be either mechanically (needle punched) or thermally (heat) bonded. After bonding, the finished product is wound into a roll form.

Thermally Bonded Nonwoven Product Range – KNW Grades

Produced using a combination of mechanical and thermal bonding this nonwoven product range is primarily used in the areas of lightweight separation and filtration. Having a smaller opening size and a higher waterflow than the lightweight woven range results in the products being preferred for use in filtration applications. Typical examples of use include as a filter wrap to a trench drain or as a filter between a fill material and a granular drainage blanket.

Needlepunched Nonwoven Product Range – KVNW Grades

Produced with either white or coloured staple fibres these products are available from 200 to 1800g/m². The end products are of a thick felt like appearance and are suited for use in the geotextile functions of protection, drainage and erosion control.

As a protection layer the product is used in both landfill sites and water storage reservoirs to protect the impermeable lining system from damage. As a drainage layer the product has the ability to transmit water along its thickness to a suitable outlet. In erosion control systems the thick nonwoven product may be used as an alternative to heavyweight wovens in the protection of a river bank or coastline.

In this last application geotextiles with a high puncture resistance are required due to the use of large stone armour (often up to 5 tonnes each) being used as the main barrier to the wave action.



Geotextiles – Selector

Selection of suitable Geotextile

Selection of the most appropriate grade for use from each of the geotextile ranges, as described on the previous page, depends on a number of factors. These could include several of the following:

- The strength of the existing soil – the softer the ground the less support to the underside of the geotextile and as a result the stronger the fabric must be
- The type of fill material that will come into direct contact with the geotextile. The larger and heavier the stone fill then the greater the chance of damage being caused to the geotextile during fill placement
- The more angular the stone then the higher the risk again of the product being punctured or torn
- The level of trafficking on the finished road surface. In the case of an unpaved access road will the usage be light, medium or heavy?
- The life expectancy of the structure Is it only temporary e.g. months, or is it 100 years?

Armed with knowledge of the above factors, the technical staff at Hepworth will be able to assist with selection of the most appropriate product type and recommend a specific grade

Guidance on use of Geotextiles

Typical applications	Geo-functions						Weight of Geotextile (g/m²)									
	Separation	Filtration	Drainage	Reinforcement	Erosion control	Protection	100	200	300	400	500	600	700	800	1000	1200
Soil separation	•															
Soil stabilisation	•			•												
Drainage wrap (trench)		•														
Drainage wrap (pipe)		•														
Coastal protection	•	•			•											
Landfill liner protection						•										
In-plane drainage		•	•													
Reinforced soil	•			•												



Thermally bonded nonwoven product range



Needle punched nonwoven product range



Woven high strength product range



Woven lightweight product range



Woven heavyweight product range



Woven highflow product range

Note: this table is offered as an introductory guide only to help specifiers identify suitable geotextiles for use in a particular application. For more detailed design information we recommend you seek further assistance from our Technical Advisory Services, detailed at the bottom of the page.



Geotextiles – Separation Specification

Sample Geotextile separation specification

For separating materials from existing ground

- 1 In areas where the Engineer deems the use of a geotextile necessary, the Contractor shall furnish and place the geotextile as specified and directed by the Engineer. All geotextiles proposed by the Contractor must be approved in writing by the Engineer before they are incorporated in the works.
- 2 Geotextiles shall be woven or non-woven fabrics manufactured from synthetic or other fibres as required therein and be in the form of thin permeable membranes.
- 3 All synthetic geotextiles shall have a design life of not less than 40 years.
- 4 The geotextile shall contain an ultra violet light inhibitor and shall be inert to naturally occurring acids, alkalis, sea water etc. To protect against mechanical or chemical damage the geotextile shall not be removed from its outer packaging between manufacture and incorporation in the works. Temporary exposure shall not exceed 24 hours
- 5 The geotextile shall have the following mechanical and hydraulic properties:
 - i) a minimum tensile strength of 2.5 kN/m at 5% extension in either direction when tested in accordance with EN ISO 10319: 1996.
 - ii) a minimum CBR puncture resistance of 1500 N when tested in accordance with EN ISO 12236: 1996.
 - iii) a size distribution of pore openings such that the mean O90 is between 100 and 300 microns when tested in accordance with EN ISO 12956.
 - iv) allow water to flow through it normal to its principal plane at a rate of not less than 10 litres/m²/second when tested in accordance with EN ISO 11058.

- 6 The surface on which the geotextile is to be placed shall not have protrusions or sharp projections which are likely to damage the geotextile during installation or in service. The method of installation shall make sure that the geotextile is in continuous contact with the surface on which it is to be placed and the geotextile shall not be stretched or bridged over hollows or humps. Operation of construction plant directly on the installed geotextile will not be permitted and its covering with fill material shall take place immediately after its laying. For full installation details reference should be made to the manufacturers recommendations
- 7 Adjacent sheets of geotextiles shall be overlapped by a minimum of 300mm in the transverse direction and 600mm in the longitudinal direction.

Comments on the above Separator Specification

Values of mass per unit area and thickness are not listed since they are only used for identification purposes and have no bearing upon product performance.

Item 3 – The required design life has been specified at 40 years. This may be increased in certain instances if necessary. Contact the geotextile manufacturer for further guidance.

Item 5(i) – By specifying the tensile strength in the above manner covers the actual working strains of the geotextile in-situ.

Item 5(ii) – A puncture resistance of 1500 N will offer a geotextile which is sufficiently robust to resist damage during stone placement. This test adequately covers the mechanical robustness of the geotextile. Tests such as tear and grab strength are not currently recognised European geotextile test methods.

Item 5(iii) – Pore size is of secondary importance in separation applications and the range specified will cover the majority of soil types encountered.

Item 5(iv) – A water flow of 10 l/m²/s through the fabric is many times in excess of a separator's design requirements. This equates to a 600mm depth of water flowing through one square metre of the geotextile's surface area every minute.

You may wish to include an extra item on product compliance

Option 1 – Copies of the manufacturer's literature shall be supplied to the Engineer as evidence that their geotextile product complies with the specification.

Option 2 – The geotextile manufacturer shall supply a test certificate with his material to show that it complies with the specification. Alternatively you may wish to include a statement regarding product testing. A possibility may be:

'All geotextiles shall be tested in accordance with the specified test methods at a rate of one full set of tests per 10,000m²'.



Geotextiles – Filter Specification

Geotextile filter specification

For wrapping free draining filter material in narrow drains

- 1 In areas where the Engineer deems the use of a geotextile necessary, the Contractor shall furnish and place the geotextile as specified and directed by the Engineer. All geotextiles proposed by the Contractor must be approved by the Engineer before they are incorporated in the works.
- 2 Geotextiles shall be woven or non-woven fabrics manufactured from synthetic or other fibres as required therein and be in the form of thin permeable membranes.
- 3 All synthetic geotextiles shall have a design life of not less than 40 years.
- 4 The geotextile shall be inert to naturally occurring acids, alkalis, sea water etc. To protect against mechanical or chemical damage the geotextile shall not be removed from its outer packaging between manufacture and incorporation in the works. Temporary exposure shall not exceed 24 hours.
- 5 The geotextile shall have the following mechanical and hydraulic properties:
 - i) a minimum tensile strength of 6 kN/m at break and a minimum failure strain of 30% in either direction when tested in accordance with EN ISO 10319: 1996.
 - ii) a minimum CBR puncture resistance of 1100 N when tested in accordance with EN ISO 12236: 1996
 - iii) a size distribution of pore openings such that the mean Ø90 is between 70 and 150 microns when tested in accordance with EN ISO 12956.
 - iv) allow water to flow through it normal to its principal plane at a rate of not less than 100 l/m²/s under a constant head of water of 100mm and a maximum breakthrough head of 50mm when tested in accordance with EN ISO 11058.

6 The excavated trench walls and base shall be free of irregularities and to the given dimensions and level. Any rock or other hard protuberances shall be removed leaving the trench walls and base sufficiently clean so as to allow the geotextile to come into close contact with the soil when the granular drainage material is placed inside it.

7 Adjacent sheets of geotextiles shall be overlapped by a minimum of 300mm in the transverse direction and 600mm in the longitudinal direction.

Comments on the above Filter Specification

Item 5 (i) – The tensile load on a geotextile filter is relatively small. The value listed over is our recommended minimum for this application.

Item 5(ii) – A puncture resistance of 1100N will offer a geotextile that is sufficiently robust to resist damage during placement of a rounded gravel in the drainage trench. Values of tear and grab strengths are not listed since these are not recognised European geotextile test methods.

Item 5(iii) – A pore size less than 200 microns is capable of filtering a wide range of soils including silts etc. A much larger pore size is likely to result in piping failure while a much smaller pore size could clog due to soil fines getting trapped in the fabric thickness. In special circumstances the Engineer may wish to alter the pore size value specified.

Item 5(iv) – The flow of 100 l/m²/s through the fabric is many times in excess of a geotextile filters design requirements. In addition the specification includes a maximum breakthrough head. The reason for this is that some geotextile materials require as much as 150mm depth of water over their surface before sufficient pressure is built up to 'break' through.

You may wish to include an extra item on product compliance

Option 1 – Copies of the manufacturers literature shall be supplied to the Engineer as evidence that their geotextile product complies with the specification

Option 2 – The geotextile manufacturer shall supply a test certificate for his material to show that it complies with the specification. Alternatively you may wish to include a statement regarding product testing. A possibility may be:

All geotextiles shall be tested in accordance with the above test methods at a rate of one full set of tests per 10,000m².

Values of mass per unit area (weight) and thickness are not specified since they are only used for identification purposes and have no bearing upon the in-situ performance of a filter geotextile.



Geotextiles – Installation

Installation guidelines

The following guidelines are offered in good faith to assist end users with the installation of Hepworth geotextile products.

Storage advice

The products should be stacked safely in a secure location until ready for use. The protective packing should not be removed until the product is required for use. Temporary exposure of the product to daylight shall not exceed 24 hours.

Subgrade preparation

The geotextile may be laid directly on undisturbed vegetation. Any plant vegetation, large rocks or other similar obstacles must first be removed. All voids, wheel ruts or other deep depressions should be filled.

Product installation

The geotextile should first be rolled out and allowed to follow the contours of the land. It should be kept as taught as possible to minimise folds but not stretched so that it spans over any hollows. Small deposits of fill may need to be placed on the geotextile to hold it in place prior to covering. No vehicle should traffic directly on the geotextile surface at any time.

Product continuity

The easiest method of ensuring product continuity is to overlap adjacent layers. Side by side rolls should have a minimum overlap of 300mm and the ends of rolls should overlap 600mm. Over soft or uneven soils these overlaps may need to be increased. Should there be a special need for a mechanical joint, then further details can be provided.

Cutting product

Product may be cut to length using either a sharp blade or scissors. Should the width need to be reduced then the product may be cut whilst still in a roll format – nonwoven products may be cut with a hand or power saw whilst woven products may be cut using a circular stone cutting saw.

Placement of cover fill

Fill material should be tipped at either the edge of the geotextile or on top of already placed fill being spread to the required depth using a tracked machine. A minimum fill layer thickness over the geotextile of 150mm is recommended prior to trafficking or compaction.

Fill restrictions

The choice of fill placed directly on the geotextile's surface can effect the amount of damage caused to it during installation. A simple piece of guidance to help minimise this damage is to use a maximum stone size no greater than half the fill layer thickness.

Installation damage

Should the geotextile be damaged during fill placement then the surrounding fill should be removed and a second geotextile layer placed over the damaged area. A minimum overlap of 1500mm should be provided between the edge of the damage and the outside edge of the patch.



Part BRE EcoHomes 2005 – POL 3



EcoHomes 2005 – The environmental rating for homes

The Guidance – 2005 / Issue1.1

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bre

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Introduction

This document is the reference guidance that details the credit requirements under BRE's EcoHomes Scheme.

It has been designed for use by individuals trained and licensed as assessors under the scheme, and will be used in conjunction with the EcoHomes Developer Sheets (completed by the Developer) to calculate the EcoHomes rating.

The document is laid out in individual credits within the main credit categories listed in the EcoHomes Scheme, as follows:

- Energy (Credits are coded Ene 1 – Ene 5)
- Transport (Credits are coded Tra1 – Tra 4)
- Pollution (Credits are coded Pol 1 – Pol 4)
- Materials (Credits are coded Mat 1 – Mat 4)
- Water (Credits are coded Wat 1 – Wat 2)
- Land Use and Ecology (Credits are coded Eco 1 – Eco 5)
- Health and Wellbeing (Credits are coded Hea1 – Hea 3)

The Developer is strongly urged to appoint an EcoHomes Assessor as early in the design process as possible to ensure the EcoHomes features can be incorporated smoothly into the development process and at little additional cost.

Applicability of EcoHomes

EcoHomes covers all standard housing developments in England, Scotland, Wales and Northern Ireland:

- private and social housing schemes
- flats/apartments and houses
- new build and major refurbishment

For other types of housing – most sheltered homes, nursing homes, student accommodation etc, a bespoke EcoHomes assessment will have to be carried out. For more information on this, please contact the BRE.

For all dwellings submitted for an EcoHomes award, the SAP assessments undertaken for Building Control purposes must be under; Approved Document Part L1 for England and Wales, Northern Ireland Building Regulations Part F or the Building (Procedure) (Scotland) Regulations as read in conjunction with Part J of the Scottish Technical Standards.

Documentary requirements

For all assessments, it is the Developer's responsibility to ensure that the correct evidence is provided. Without the evidence, the assessor cannot award the credits, and it is to everyone's advantage to ensure that the evidence is as complete as possible when first submitted. Obviously, if a credit is not being sought, evidence need not be provided.

There is a separate document to be completed for the assessment – *EcoHomes: Developer Sheets – 2005*. This can be downloaded from the EcoHomes website: www.ecohomes.org

There **must** be documentary evidence to support the submission, and BRE will accept evidence in the following form(s) (in order of preference):

1. Specific wording in the development specification.

-
2. Specific information on the drawings. (This may be a reference to the relevant clause in the specification.)
 3. A letter of instruction to a contractor/supplier.
 4. A formal letter from the developer to the EcoHomes Assessor, giving the specific undertaking. (This should only be used if there is a late change to the development and options 1-3 cannot be carried out in time for the EcoHomes submission.)

Quality Assurance

As part of the BRE Quality Assurance scheme, BRE reserves the right to audit any assessment. This may include inspection of documentary evidence and the properties submitted for assessment.

Pol 3 Reduction of Surface Runoff

Credits available: 2

Aim

To reduce and delay water run-off from the hard surfaces of a housing development to public sewers and watercourses, thus reducing the risk of localised flooding, pollution and other environmental damage.

Credit Requirements

The development must meet the following criteria.

Credits	
	Where rainwater holding facilities and/ or sustainable drainage techniques are used to provide attenuation of water run-off to either natural watercourses and/or municipal drainage systems, achieve attenuation by 50%* in areas of low probability of flooding, 75%* in areas of medium flood risk and 100%* in areas of high flood risk, at peak times from:
1	• Hard Surfaces
1	• Roofs

* Where a statutory body requires a greater attenuation then the higher requirement should be met in order to achieve these credits.

Applicability

The same approach is taken for both new build and refurbishment.

ALL dwellings throughout the development must meet the requirements.

Main Information to be Provided by the Developer

1. Specifications must state the aim, location and details of any run-off attenuation devices sufficient to meet the *Credit Requirements* and the *Guidance* below.
2. The appropriate drawings should show the location and details of any run-off attenuation devices sufficient to meet the *Credit Requirements* and the *Guidance* below.
3. Design team calculations relevant to the credit Including:
 - The type and storage volume (l) of the attenuation measures.
 - Total area of hard surfaces and roofs (m²), the peak flow rate (l/s) and the rainfall intensity and duration of the design storm event and for soakaways the soil infiltration rate.
4. Written confirmation of advice and approval from the relevant statutory body for the attenuation facilities specified.

Guidance

1. If the details are stated in the specification, they should also be on the drawings.

- Relevant drawings would be the site layout, drainage or similar, where the location and layout is shown and attenuation is stated.
2. The level of attenuation required will vary depending on where (in which flood risk area) the development is being built (see Pol 5 – Flood Risk *Supplementary Guidance A: United Kingdom Flood risk areas*)
 - Where the assessed development is situated in an area (flood zone) that is defined as having a **low annual probability of flooding**, rainwater holding facilities and/ or sustainable drainage techniques need to be able to attenuate at least **50%** of the peak flow during a design storm event.
 - Where the assessed development is situated in an area (flood zone) that is defined as having a **medium annual probability of flooding**, rainwater holding facilities and/ or sustainable drainage techniques need to be able to attenuate at least **75%** of the peak flow during a design storm event.
 - Where the assessed development is situated in an area (flood zone) that is defined as having a **high annual probability of flooding**, rainwater holding facilities and/ or sustainable drainage techniques need to be able to attenuate **100%** of the peak flow during a design storm event.
 3. Note where the local authority (or other statutory body) requires a greater attenuation than the percentages above, and/or a more onerous design flooding frequency than that recommended in BS EN752-4, then the higher requirements must be met in order to achieve the credit.
 4. The requirements for water run-off attenuation in a flood zone defined as having a high annual probability of flooding can be reduced by 25% to 75%, where the site was previously occupied by buildings or hard surfaces. The easing of the requirements in such cases is to recognise the benefit of not locating the development on an undeveloped site in a zone with a high annual probability of flooding, and therefore not contributing further to the flooding risk in such zones.
 5. The credits can be awarded where one or more of the following are provided for run-off from roofs and hard areas, subject to them meeting the full criteria and other guidance:
 - Holding ponds, swales, reed beds etc.
 - Permeable paving (in areas where local geological and hydrological conditions allow this to function), e.g. block paved surface on permeable sub-base over gravel bed to store the water and allow it to seep in to the soil (in less-permeable soil the gravel layer might be deeper and the water taken through to a soakaway)
 - Local or centralised soakaways either as full systems or as 'overflow' or 'holding' systems (in areas where local geological and hydrological conditions allow them to function)
 - For all the above when used to collect run-off from vehicular areas and other areas subject to potential pollution risks, they must be covered by appropriate pollution – control measures such as interceptors etc. Specialist advice should be sought from the local authority and/ or Environment Agency or other statutory body on what is appropriate in such instances.
 - Run-off from roofs is collected as a part of a rainwater harvesting system (see additional guidance on water butts below.)

- Run-off from roofs is directed to a local soakaway or other holding facility such as tanks, ponds, swales etc.
 - Green roofs. Note: For soil based grass roofs, calculation should be made on the basis of the infiltration, moisture retention and depth of soil. For sedum roofs, infiltration data should be provided by the manufacturer/installer.
6. External hard surfaces.
- These include:
- all drives and other surfaces with vehicular access
 - communal car parking
 - patio areas, pathways and other hard surfaces.
- These do NOT include:
- site distribution roads and associated pavements
 - footpaths less than 1.5m wide that have free drainage to soft landscaping areas on both sides.
7. The assessor should check that the calculations for the attenuation device, provided by the design team, comply with the requirements i.e. if the attenuation device will be able to attenuate (hold) 50, 75 or 100% of a peak flow (see *Supplementary Guidance A: Establishment of Storage Volume*). Information provided by the developer/ design team should include the following:
- Type and specification for holding facilities/ soakaways.
 - The area of hard surfaces and roofs.
 - Design storm and/ or flooding frequency (refer to BS EN 752-4, Section 11- Table 1 or statutory body requirements if they require a more onerous design flooding frequency.). The frequency is depending on the size of the development and the area.
 - The design rainfall for the site (calculated for prescribed storm and/ or flooding frequency for 60 min peak rainfalls, unless otherwise required by a statutory body).
 - For soakaways the soil infiltration rate and the method of measurement and/ or calculation.
 - Calculations for the peak flow (run-off) rates (refer to BS EN 752-4 for hard surfaces and BS EN 12056-3 for roof run-off).
 - Calculations for the storage volume of the holding facility/ soakaway. The storage volume of the soak-away must be at least 50, 75 or 100% - depending on flood risk area - of the volume of a peak storm (rainfall) with a duration of 60 minutes (unless otherwise required by a statutory body).
 - Where soakaways or other such systems are proposed, the developer must provide evidence that advice and approval has been obtained from the relevant statutory body. Local geological or hydrological conditions can dictate the type(s) of system that may be used. See *Supplementary Guidance B*.
 - Planned maintenance which will depend on selected event frequency.
8. Note that the assessor is not required to perform any calculation as this should be provided by the design team. However, BS EN 752-4 and BS EN 12056-3 contain

guidance on calculating the peak flow rate and determining the design flooding frequency should this information be required.

9. To ensure effective operation of the water run-off attenuation measures, the facilities must discharge half their volume within 24-48 hours (unless advised otherwise by a statutory body) of the storm event in readiness for any subsequent storm inflow. Most soakaways are designed for a 24 hours half discharge.
10. If all run off is discharged directly from the site to either the sea, estuaries covered by a shoreline management plan or designated wildlife/SSSI areas (as part of habitat management), then the credit may be awarded without the need to specify additional attenuation measures.
11. Where the drainage system already discharges all surface runoff to a properly designed soakaway system (for example to BRE Digest 365, See *References*) for the appropriate design storms then the credit may be awarded without the need to specify additional attenuation measures. Soakaway design calculations must be supplied and verified.
12. Run-off from roofs to water butts **does not** automatically comply with the requirements of this credit, as water use is dependent on the occupier and excess water is normally discharged direct to drainage systems. Where such excess is then stored in such a manner as to meet the requirements, this credit can be awarded.
13. None of the credits can be awarded where the assessed development has proceeded against the recommendation of the relevant Flood Defence Agency on the basis that the flooding implications are too great.

Flats

14. There is no specific guidance for flats/apartments. The standard approach should be followed.

Refurbishment

15. There is no specific guidance for refurbishment. The standard approach should be followed.

Special Cases

There are currently none for this issue.

Supplementary Guidance

A: Establishment of Storage Volume

The assessor should first establish if soakaways, porous surfaces to car parking and road/pedestrian circulation areas, or water run-off holding facilities such as tanks and ponds have been specified, or are present on the site.

In cases where such facilities are specified, the Design Team will have carried out their own sizing calculations. The Assessor should ask for a copy of these to determine whether the target of 50%, 75% or 100% reduction of peak run-off will be achieved.

When determining whether the specified facilities meet the required target, the Assessor should establish the potential impermeable surface area (m^2) for the site (i.e. building area and 'hard' surfaces areas such as car parking and paths). Using the design rainfall for the site and the surface areas, the storage volumes should be

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checked. When storage facilities contain gravel or other fill materials then evidence of how the available void space was determined should be supplied.

The storage volume of the soakaway must be 50, 75 or 100% or more of the volume of the rainfall for peak rainfall levels and duration.

B: Soakaway design

Local geological or hydrological conditions can prevent soakaways or other such systems relying on natural ground absorption from working (for further information see BRE Digest 365, see *References*). There needs to be a geo-textile wrap around soakaways and land drains to prevent clogging with mobile sediment and reduce the resulting possibility of localised flooding, which may kill the surrounding planting. The backfill needs to be inert and unlikely to affect soil-water chemistry that can harm planting (e.g. no limestone).

Further Information

The Met Office (incl. figures for UK rainfall)
www.met-office.gov.uk

British Standards Online
<http://bsonline.techindex.co.uk/>

The Environment Agency
www.environment-agency.gov.uk/

Scottish Environment Protection Agency
www.sepa.org.uk

Rivers Agency – Northern Ireland
www.riversagencyni.gov.uk

CIRIA
Source control using constructed pervious surfaces (CIRIA publication C582)

Defra
www.defra.gov.uk

Background

Around 5 million people, (i.e. 2 million properties), live in flood risk areas in England and Wales. Excessive surface run-off can cause significant flash flooding problems to natural watercourses, rivers and municipal systems. The need to cater for such peak run-off means that systems are sized accordingly and are oversized for most of the year.

On many sites it should be possible to include holding facilities to delay the release of storm water from the site and statutory authorities may require this in certain sensitive areas, usually where natural watercourses are affected.

The main intention of this credit is to reduce the overall surface run-off of rainwater from hard landscaped surfaces and roofs within the development. In housing developments this can be done either by specifying porous paving for all hard surfaces in the development, or by the adoption of soakaways or other systems (including green roofs) that reduce peak run-off loads.

Porous paving will allow water to soak through the paving into natural water tables rather than direct collected rainwater into public sewers and watercourses. Care needs to be taken to ensure that the local conditions will permit a soakaway to function adequately, and advice should be sought from the relevant statutory body to confirm this. Conventional hard landscaping can be specified in conjunction with systems that direct all collected rainwater into holding ponds or tanks. Some porous paving systems specifically designed for parking areas, collect the water and pass it through an interceptor or constructed wetland before it is returned to the natural drainage system.

References

CIRIA. – *C523 – Sustainable urban drainage systems – best practice manual for England, Scotland, Wales and Northern Ireland* (2001)

BS EN 752-4 – *Drain and sewer systems outside buildings – Hydraulic design and environmental considerations* (1998)

BS EN 12056-3 – *Gravity drainage inside buildings – Roof drainage, layout and calculations* (2000)

BRE Digest 365 - *Soakaway design* (1991)

Photographs



Barrow Brook, Clitheroe Views Downstream of Whalley Road