# 7.0 Water Conservation and Sustainable Drainage

## 7.1 Introduction

7.1.1 Climate change projections indicate that in the future Wales is likely to experience hotter, drier summers and warmer, wetter winters. Extreme weather events – both heavy rainfall and heat waves – are also likely to be more common. Less rainfall in the summer and prolonged periods of hot, dry weather will lead to pressure on water resources, while more rainfall in the winter and extreme rainfall events will increase the likelihood of flooding and challenge the capacity of our existing sewerage systems.

7.1.2 There is therefore a need to adapt to climatic changes by adopting more effective methods of managing our water resource and dealing with the flood risk posed to our communities. The following sections consider a number of sustainable water conservation and sustainable drainage methods which can be integrated within new developments.

## 7.2 Water Conservation

7.2.1 Whilst South East Wales is in a relatively strong position on water resources, it does not have an abundant public water supply that can be taken for granted. There is a need to value our water resources much more than in the past, particularly with future challenges to our water supply resulting from predicted impacts of climate change and reduced water abstraction from the Wye and Usk rivers.

7.2.2 There are two main approaches to reducing the consumption of mains drinking water: the use of water efficient fittings and appliances; and the use of water (rainwater and greywater) recycling systems. Both of these can be incorporated into new developments and can contribute to the sustainability rating awarded under Code for Sustainable Homes and BREEAM standards.

### *Water saving measures*

Water saving measures should be considered in the first instance as these can provide significant benefits at a relatively low cost. The following measures can be incorporated into new developments to minimise water consumption:

- The volume of water used to flush toilets can be reduced by installing dual flush, interruptible flush, variable flush and cistern displacement devices. Delayed action water inlet valves can also be used ensure that the refill of the system does not begin until the flush has stopped.
- Showers can be fitted with simple flow regulators or 'water saver shower heads' to the limit the maximum flow rate. 'Water saver shower heads' usually work by creating finer drops or by incorporating air into the flow.
- The volume and shape of a bath will determine how much water is used. Tapered or peanut shaped baths may provide more space for bathing with less water. Insulating

a bath also minimises heat loss reducing the need to top up the bath with hot water.

- Spray taps can save approximately 80% of the water and energy used for hand washing. Tap inserts, such as Tapmagic, can be used to allow the full flow of water for the filling of the basin where necessary.
- The use of small bore pipes and short distances to the most frequently used appliances will reduce the volume of water wasted while waiting for the tap/shower to run hot.
- Commercial and public buildings should install flush control or waterless urinals and sensor or timed turn off taps to prevent water wastage.

## Water Recycling Systems

7.2.4 Water recycling systems can provide an alternative source of water to mains water supply, but do not reduce overall water consumption. They are also often more expensive than simple water efficiency devices and can have other trade-offs, such as energy costs and carbon emissions. Consequently, water recycling systems should only be considered once all feasible water efficiency measures have been incorporated into the development. Two common methods of water recycling, namely rainwater harvesting and greywater recycling, are discussed below. In both cases, important considerations include: the amount of water needed to meet anticipated demand; design specifics and cost of system; and maintenance requirements.

## Rainwater harvesting

7.2.5 Rainwater harvesting is the collection of rainwater directly from the surface it falls on. It is most often collected from the roof of a property; however, other hard surfaces, such as a permeable paving, can be used to increase the yield. Once collected the water can be stored and subsequently used for non-drinking purposes, such as toilet flushing, garden watering and clothes washing. The use in clothes washing is however dependent on the quality of the water collected.

7.2.6 Rainwater harvesting has a number of benefits, including reducing the demand for mains water, reducing the risk of flooding and pollution and creating financial savings for customers with water meters. Savings are particularly noticeable for commercial/industrial buildings and schools as they tend to have large roof areas and a high demand for non-drinking water.

7.2.7 The Environment Agency estimates that using rainwater to flush the toilet alone could potentially reduce the demand for mains water by approximately 39 litres of water per day (26%)[10]. Using rainwater to supply the washing machine and water the garden would further increase the saving of main water for non-drinking uses.

7.2.8 The volume of water collected from a rainwater harvesting system will depend on a number of factors, including the amount of rainfall in the region, the roof and/or hard-standing surface area, tank storage capacity and needs of the user. Further information on the method of calculating the amount of rainwater you can collect is available in the Environment Agency's guidance entitled "Harvesting rainwater for domestic uses: an information guide".

7.2.9 The most basic form of rainwater harvesting is the use of a garden rainwater butt which collects water from the roof's guttering system (see Figure 7.1). Here, the rainwater does not require any treatment or mains backup and can be used directly to water the garden and wash the car. Rainwater harvesting systems can however be much more sophisticated and typically include components which:

- collect, filter and store water;
- distribute water to points of use;
- provide a mains water backup when rainwater levels run low; and
- control the mains backup and monitor water levels.

10 *Environment Agency. 2010. Harvesting Rainwater for Domestic Uses: An Information Guide (Bristol, EA).*

**_Figure 7.1 A garden rainwater butt._**

7.2.10 Rainwater harvesting systems range in scale from individual domestic installations to large scale commercial schemes. There are two general types which transfer water to points of use in the following ways:

- Direct pumped systems which pump the water directly to the point of use as and when required; and
- Gravity fed (header tank) systems which pipe the water to a header storage tank and then deliver it to the point of use using gravity.

7.2.11 Each system type has its advantages and disadvantages in terms of energy efficiency and installation and maintenance requirements. A schematic diagram of a typical rainwater harvesting system is shown in Figure 7.2.

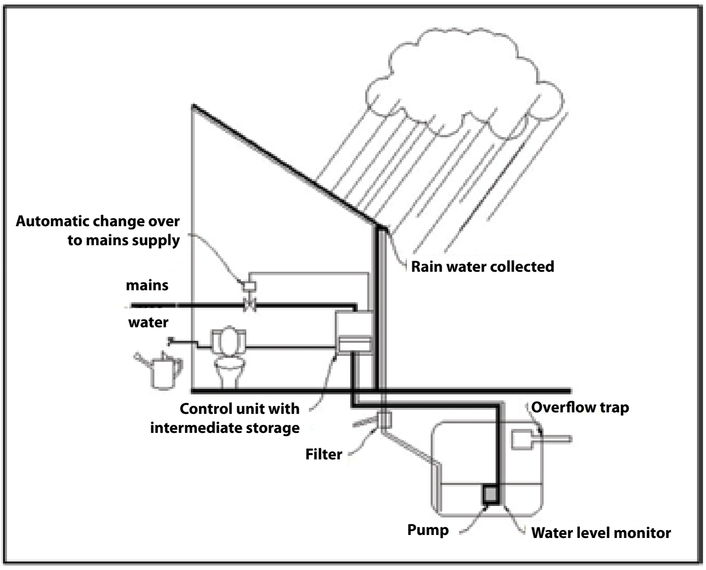


**_Figure 7.2 A rainwater harvesting system._**

## Greywater recycling

7.2.12 Greywater recycling involves the collection, treatment and re-use of waste water for purposes that do not require drinking water quality, such as toilet flushing and garden watering. The waste water is typically sourced from showers, baths and hand basins.

7.2.13 The use of greywater recycling to flush the toilet can potentially save a third of the mains water used in the home[11]. Other benefits include better reliability of supply over rainwater harvesting systems, financial savings for consumers with water meters and reduced pressure on the sewerage system. It is worth noting that cost savings tend to be more reliable with larger communal systems.

7.2.14 Greywater systems can operate on a single dwelling scale or on a development wide scale and vary significantly in their complexity. They do, however, tend to have the following common features:

- a tank for storing treated water;
- a pump;
- a distribution system for transporting water to the point of use; and
- a method of treatment which prevents a deterioration in the quality of water.

11 *Environment Agency. 2011. Greywater for Domestic Users: An Information Guide (Bristol, EA).*

7.2.15 There are a variety of grey-water systems available which can be categorised based on the method of treatment they use. They include the following:

- Direct reuse systems which require no storage or treatment;
- Short retention systems which provide a basic standard of treatment and ensure that the greywater is not stored for too long;
- Basic physical and chemical systems which filter out debris and treat stored grey-water with chemical disinfectants to prevent bacterial growth;
- Biological systems which use bacterial cultures in aerated environments to remove organic matter from wastewater; and
- Bio-mechanical systems which use a combination of biological and physical treatment including bacterial cultures, filtration and ultraviolet disinfection.

7.2.16 Further information on each of these systems can be found in the Environment Agency's guidance entitled "Greywater for domestic users: an information guide".

## 7.3 Sustainable Drainage

### *Benefits of Sustainable Drainage*

7.3.1 Our traditional drainage system is based on the collection of rain water in gutters and gullies and its conveyance through underground pipes (drains and sewers). Whilst this drainage system is designed to cope with large rainstorms, it can be overwhelmed by intense events with the potential for pollution and flooding. Further pressure will be placed on the existing system as a result of additional urbanisation and more common extremes in heavy rainfall caused by climate change.

7.3.2 Sustainable drainage systems (SuDS) are a more natural way of managing rainwater runoff on site. In controlling runoff as near to its source as possible and mimicking natural drainage processes, SuDS can reduce the effect of development on both the quality and quantity of surface water runoff. Water quality improvements arise from the reduction in sediments and contaminants from runoff either through settlement or biological breakdown of pollutants. The quantity of runoff can be reduced by allowing water to infiltrate into the ground, slowing down water before it enters the watercourse and providing areas for water storage in the natural contours of the land. In doing so, the impact of urbanisation on flooding can be mitigated.

7.3.3 SuDS have a number of additional environmental advantages over conventional drainage systems, including water resource, amenity and biodiversity benefits. Water resource benefits relate to SuDS' ability to assist natural groundwater recharge and enable water conservation. In respect of amenity and biodiversity benefits, SuDS can be integrated with green infrastructure to create habitats and encourage biodiversity whilst also providing attractive public open spaces (see Chapter 10 for more details).

7.3.4 SuDS can also offer benefits to developers, including providing savings on the overall cost of construction and maintenance of drainage schemes, and increasing house values by 10%-20% through the use of SuDS which improve the visual attractiveness of a development[12].

7.3.5 The extent to which all the benefits of sustainable drainage can be realised will depend on the opportunities and constraints of the development site.

### *SuDS Techniques*

7.3.6 There are a variety of SuDS techniques available which deal with surface water in three different ways: they allow water to infiltrate into the ground; they convey water into a watercourse; or they provide storage on site and attenuate the flows of water. A SuDS scheme will often use of a combination of techniques to allow each of these processes to occur.

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12 *Dickie, S., McKay, G., Ions, L. and Shaffer, P. 2010. Planning for SuDS – Making It Happen, C687, (London, CIRIA).*

7.3.7 The different types of SuDS technique[13] are broadly summarised below:

- **Preventive Measures** - good site design and housekeeping measures and rainwater recycling.
- **Filter Strips and Swales** – vegetated landscape features with smooth surfaces and gently sloping gradients that drain water evenly off impermeable surfaces (see Figure 7.3).

***Figure 7.3 A swale incorporated into the design of a business park.***

- **Filter Drains and Pervious Pavements** – permeable surfaces that allow rainwater and runoff to infiltrate into the underlying ground for storage prior to discharge.
- **Infiltration Devices** – below ground or surface structures that drain water directly into the ground. These structures can act as source, site or regional control measures. Examples include soakaways, infiltration trenches, swales with infiltration and infiltration basins (see Figure 7.4).

***Figure 7.4 An infiltration trench incorporated into open space within the grounds of a hospital.***

- **Basins and Ponds** – structures designed to hold water when it rains. These range from basins that are free from water to water filled depressions that have spare capacity to take in additional water. Examples include detention basins, ponds and wetlands (see Figure 7.5).

***Figure 7.5 A pond incorporated into the design of a business park.***

7.3.8 SuDS techniques have different spatial requirements which makes some more suited to a particular development setting than others. For instance, higher density developments tend to have less space available for the use of SuDS, making larger scale site and regional measures, such as detention basins and ponds, unsuitable. Source control measures, such as green roofs and rainwater harvesting, are however suitable for all scales of development and will also minimise the amount of land needed for other SuDS components. In general, the following SuDS techniques are suited to high, medium and low density developments.

7.3.9 <u>High density developments</u>

- Green roofs and rain water harvesting can be integrated into the design of the building.
- Permeable paving can be located in the streetscape or the public realm and combined with underground storage systems, such as modular geo-cellular storage.
- Bio-retention components can be located along road-sides.
- Micro-wetlands and bio-retention components can be integrated with squares, courtyards or hard paved spaces.

13 *For more detailed information on individual SuDS techniques, see Woods-Ballard, B., Kellagher, R., Martin, P., Jeffries, C., Bray, R. and Shaffer, P. 2007. The SUDS Manual, C697 (London, CIRIA).*

- Channels and rills can be used in curtilage or open space settings.

7.3.10 Medium density developments

- Green roofs and rain water harvesting can be integrated into the design of the building.
- Water butts or rain gardens can be incorporated within residential curtilages.
- Permeable paving and filter strips can be incorporated into the streetscape.
- Bio-retention components and swales can be located along road-sides.
- Micro-wetlands and bio-retention components can be integrated with squares, courtyards or hard paved spaces.
- Ponds and wetlands can be integrated with open space.

7.3.11 Low density developments

- Green roofs and rain water harvesting can be integrated into the design of the building.
- Water butts or rain gardens can be incorporated within residential curtilages.
- Bio-retention and swales can be located along road-sides.
- Permeable paving can be incorporated into the streetscape.
- Swales, ponds and wetlands can be integrated with open space.

## *Design Approach to SuDS*

7.3.12 The preferred method of managing surface water runoff is through the use of SuDS. Alternative methods should only be used where there are practical and/or environmental reasons for doing so. Examples of the latter include inadequate infiltration rates, shallow water tables and unacceptable risks relating to ground stability and land contamination. The following methods of managing surface water should be considered in order of preference.

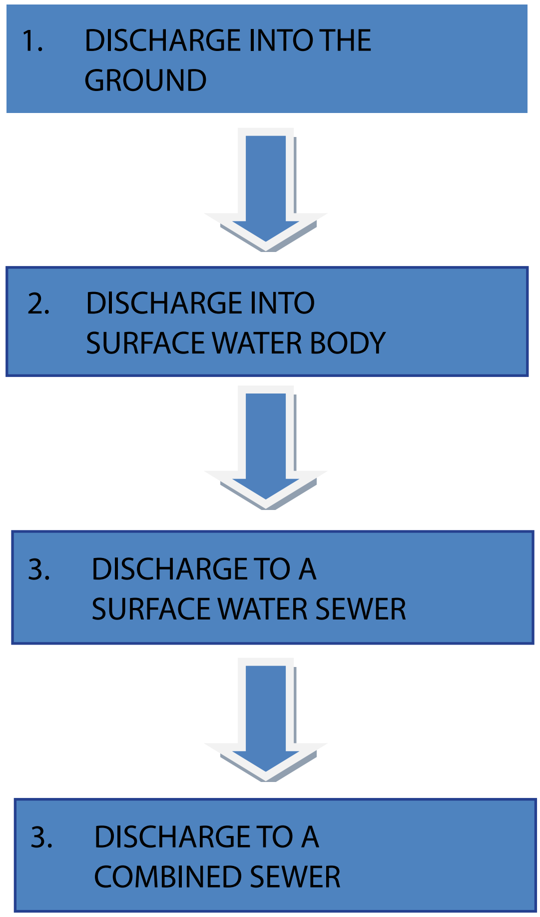


***Figure 7.6 Order of preference of methods of managing surface water runoff.***

7.3.13 Sustainable drainage needs to be considered at the beginning of the site design process if it is to be delivered successfully. Retrofitting drainage solutions into a pre-determined development layout may increase costs and limit the multiple benefits that SuDS can provide.

7.3.14 A good SuDS scheme is based on an understanding of the site conditions and the range of design requirements relevant to the development proposed. The suitability of a particular SuDS technique will depend on the characteristics of the site and it is important to identify opportunities and constraints at early stage in the design process. The aim should be to create design solutions which integrate chosen SuDS components with other urban design features. In doing so, communities and stakeholders are more likely to approve, operate and maintain SuDS as part of the development as a whole.

7.3.15 The following factors should be considered as part of the design process:

- The need to respond to natural drainage systems and processes, including natural flow paths, existing water bodies and potential infiltration areas;
- Land use and density requirements and their effect on water treatment and storage capacity;
- The potential mix of permeable and impermeable surfaces;
- The likely space requirements for site and regional control SuDS;
- The integration of SuDS components with open space, landscape and streetscape features;
- The potential for enhancing biodiversity interests; and
- Long term maintenance and management requirements.

7.3.16 In terms of controlling surface water runoff from a development site, the SuDs scheme will need to be designed so that the volume and rate of surface water runoff from the site does not exceed those experienced under the undeveloped situation. For re-development, the SuDS scheme should reduce runoff where possible. An allowance for the increase in future rainfall intensities will need to be taken into account based on the predicted effects of climate change.

7.3.17 Early consultation with Natural Resources Wales[14] and the Council's Drainage Engineer is recommended in order to identify local surface water issues and establish design standards and performance parameters. A technical appraisal of the proposed SuDS scheme demonstrating how it will meet the agreed criteria will be required in support of the planning application.

## *Adoption and Maintenance*

7.3.18 Sustainable drainage systems require appropriate inspection and maintenance in order to maintain their effectiveness and prevent failure. The maintenance of specific SuDS components should be considered as part of the design process and a management plan should accompany development proposals. The latter should include an overview of the design concepts of the SuDS scheme and a maintenance schedule that includes both initial and on-going maintenance of the SuDS components.

7.3.19 The nature of the maintenance requirements can be categorised as regular, occasional and remedial, and will vary depending on the type of SuDS scheme and components involved. A number of SuDS techniques are on or near the surface and most can be easily managed by standard landscape practice. For example, vegetated SuDS require routine maintenance to control growth, ranging from regular (swales and filter strips) to annual (basins) grass cutting. Balancing ponds require both longer term management of vegetation and periodic de-silting to maintain storm water capacity. Below-ground SuDS, such as modular geocellular storage, will require maintenance in accordance with manufacturer or designer specifications.

7.3.20 The Council, in its role as Lead Local Flood Authority, is likely to be become the SuDS Approval and Adopting Body[15] in the near future. In this role, the Council will be responsible for both approving the original design of the SuDS and adopting and maintaining the finished system. Before handover the SuDS will need to be inspected to ensure it has been constructed and functions in accordance with the approved scheme. Any remedial works identified will need to be completed by the developer. For the time being a Section 106 Agreement will be required for the transfer of the SuDS to the Council, along with the management plan and appropriate commuted sum for future maintenance and management responsibilities.

14 *It should be noted that an Environment Permit to Discharge may be required from Natural Resources Wales for a SuDS to discharge to a surface water body.*

15 *See Schedule 3 of the Flood and Water Management Act 2010.*

# 8.0 Materials

## 8.1 Introduction

8.1.1 Developments can improve their environmental performance by using building and construction materials that have a lower environmental impact over their life cycle. There are a range of factors that need to be taken into account in choosing the most appropriate materials for a development and it is recommended that consideration is given to this early in the design process. Some of the key factors for consideration are identified below.

## 8.2 Low-Impact Materials

8.2.1 Re-used and recycled materials should be used in preference to virgin materials. Materials from renewable sources, such as timber, should also be chosen ahead of those from non-renewable sources, such as plastics, where possible.

8.2.2 Another important consideration is the embodied energy of a material. This is typically described as the energy used in the extraction, production and transportation of that material. There is considerable variation in the embodied energy of materials. For instance, aluminium, concrete, glass and plastics require energy intensive production processes, while timber and straw bales come from low energy, natural sources that have the added advantage of storing carbon.

8.2.3 In general, developments should limit the use of high embodied energy materials as much as possible. There can however be instances where the use of high embodied energy materials is integral to the design of the scheme, such as the use of concrete in building designs which seek to maximise solar gain. Here it is possible for the energy saved over the operational life of the development to offset the high levels of energy embodied in the building material.

## 8.3 Responsible Sourcing

8.3.1 Materials should be selected from a sustainably managed source. In particular, any timber used should carry Forest Stewardship Council (FSC) certification in order to have the confidence that the development is not contributing to the destruction of the world's forests. FSC is an international, non-governmental organisation dedicated to managing the world's forests to the highest environmental, social and economic standards. Harvested trees are replanted or allowed to regenerate naturally and due respect is given to the wildlife and the people who live and work in them.

## 8.4 Local Materials

8.4.1 The transportation of materials can have a number of environmental impacts, including the consumption of non-renewable energy and the emission of greenhouse gases. These impacts can be reduced by sourcing materials from as close to a site as possible (see Figure 8.1).

***Figure 8.1 Pembrokeshire larch cladding used on the Larch House, the Works Site, Ebbw Vale.***

8.4.2 Local materials have traditionally contributed to the distinctiveness and sense of place of an area. The use of local materials can therefore contribute to preserving local character as well as helping support the local economy.