www.water-efficient-buildings.org.uk

waterwise east

Water efficiency in new developments:

A best practice guide

EEDA East of England Development Agency

anglianwater

Environment Agency

Government Office for the East of England

Cambridge Water Company

waterwise

Essex & Suffolk Water

Acknowledgments

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Authorship

This guide was written by Clare Watters, Waterwise East Co-Ordinator and builds on previous work by her predecessor Andrew Pitt and the website project group. There was input from Jacob Tompkins, Managing Director of Waterwise and Victoria Higgins, Waterwise Communications Executive, who edited this guide.

About us

Waterwise is an independent, not-for-profit, nongovernmental organisation focused on decreasing water consumption in the UK, and on building the evidence base for large-scale water efficiency. Our aim is to reverse the upward trend in how much water we all use at home and at work. We are developing a framework supported by a robust social, economic and environmental evidence base to demonstrate the benefits of water efficiency. To achieve our aims we work with water companies, governments, manufacturers, retailers, non-governmental organisations, regulators, academics, agricultural groups, businesses, domestic consumers, the media and other stakeholders. We conduct our own research and also undertake work as consultants.

Waterwise East is the regional centre of excellence for water efficiency in the East of England. It aims to reduce water wastage in the region and is primarily focused on development and the built environment. We support the delivery water-efficient developments by working with developers, planners, housing associations, local authorities and other water stakeholders to improve their water efficiency knowledge and encourage sharing of best practice. We also work with other water stakeholders encouraging them to uptake and promote water efficiency.

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Contents

Introduction

In the past three years, over 10,000 new homes have already been built to improved water efficiency standards in the East of England with the support of Waterwise. This leaflet explains some of the considerations needed when building a water-efficient home or development.

Despite having a seemingly wet climate, parts of the UK are experiencing water shortages, with some areas in England having less water available per person than Sudan and Syria. Water efficiency is vital to accommodate new developments while protecting our rivers, wetlands, lakes and broads. Up until 2030 the overall picture in the UK is one of ever-increasing demand for an ever scarcer resource, and less water will need to go further.

The government is driving a sustainable development programme that mandates improved water efficiency in the built environment, including the Code for Sustainable Homes (Code) and Part G of the Building Regulations. In addition, improved water efficiency in new development will be supported through the planning system.

www.water-efficient-buildings.org.uk was launched by Waterwise East in June 2009. This contained "The Design Guide for Developers" which is useful for developers and housing associations building to any Code level with its associated water efficiency requirement. This leaflet summarises current best practice for those wishing to build new water-efficient developments.

www.water-efficient-buildings.org.uk provides a valuable source of information about costs and benefits of water-efficient new development, as well as advice on the specification and delivery of water-efficient developments. It is therefore relevant to policy and decision makers, for example helping deliver the government's Future Water ambition of 130 litres per person per day by 2030, and to make all homes zero carbon by 2050.

This guide will assist developers, facility managers and landlords to improve the water efficiency of new dwellings.

Disclaimer

Many elements of this guide are susceptible to change, particularly those depending on policy and regulation. This document uses information that was correct as of March 2010. All the information in this guide and more detailed, up-to-date information is available from www.waterefficientbuildings.org.uk

Regulation – government intentions and policy direction

Against a backdrop of climate change, energy supply security and the need for more housing, the government has outlined its strategy to improve the environmental performance of the built environment. In terms of new dwellings the following standards are driving water efficiency:

Part G of the Building Regulations

The government updated Part G of the Building Regulations in April 2010. This revision sets a whole-building standard of 125 litres per person per day for domestic dwellings, comprising internal water use of 120 litres per person per day (in line with Code levels 1 and 2), plus an allowance of five litres per person per day for outdoor water use. This is to be specified using the methodology set out in "The Water Efficiency Calculator for New Dwellings" also used for the Code (see pages 4 and 5 for more information on the calculation).

The Code for Sustainable Homes

The Code is the government's main tool for improving the environmental specification of new homes. All new homes are required to be assessed against the Code, with a Code or nil-rated certificate included in the Home Information Pack. All new homes built with public money must meet at least Code level 3 from April 2008. The Code is also the national standard most often used by the planning system to mandate water efficiency for new housing developments in their area.

There are seven Code levels ranging from level 0 (Building Regulations) to level 6 (zero carbon). To achieve the Code levels, points are awarded for achieving set standards in nine different aspects of development. Water consumption inside the home is one of the compulsory aspects of the Code and up to five credits are available for performance which reduces the amount of potable water used in the dwelling.

The water consumption specification for increasing Code levels are:

Table 1: Per capita daily water consumption specification of the Code for Sustainable Homes category WAT1 (CLG 2009)[1]

Water consumption (litres/person/day)	Credits	Mandatory Levels
≤120 l/p/day	1	Levels 1 and 2
≤110 l/p/day	2	
≤105 l/p/day	3	Levels 3 and 4
≤90 l/p/day	4	
≤80 l/p/day	5	Levels 5 and 6
Default Cases None		

Daily per capita consumption (PCC) of water is calculated using the Water Calculator (see overleaf)

The Technical Guide for the Code is available from www.water-efficient-buildings.org.uk

1 Communities and local government, "Code for Sustainable Homes Technical guide May 2009 Version 2", 2009, www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide.pdf

Water Efficiency Calculator

The Water Efficiency Calculator for New Dwellings (Water Calculator) is the government's national calculation method for the assessment of water efficiency in new dwellings. The calculator assesses the contribution that each internal water fitting (micro-component) has on whole-house water consumption.

The Water Calculator requires figures for water consumption, which should be provided in manufacturers' product details. Where product consumption is dependent on flow rates (for taps and showers), the flow rate should be measured at a standard 3 bar dynamic pressure (0.3MPa) unless low-pressure fittings are utilised, in which case it should be measured at 0.1 bar dynamic pressure (0.01MPa).

These water consumption figures are then multiplied by an assumed use factor to give each component's estimated water consumption per occupant. Table 3 shows how these figures are then used to determine the predicted water consumption of the property for the Code and Building Regulations.

The Code Technical Guidance is updated every six months. Each update so far has included changes to how water consumption has been calculated. This document is based on the September 2009 guidance.

www.water-efficient-buildings.org.uk links to an online, up-to-date water calculator which can be used to predict new building water consumption in accordance with the Water Efficiency Calculator for New Dwellings methodology.

Page 8 has examples of specifications that might be used to achieve different Code levels.

Multiple fittings

Where two or more of the same appliances are installed which have different water consumption rates, the average flow rate/volume should be calculated, along with a proportionate (also referred to as "weighted") average of the highest consuming fitting (proportionate average is calculated by taking the flow rate/volume and multiplying by 0.7). Where the proportionate average is higher than the average, the proportionate average must be used in the Water Calculator (see Table 2 for an example multiple fitting calculator for taps). This applies to all WCs, washbasin and kitchen taps, showers, baths, dishwashers and washing machines.

Water recycling

Under the Code and Part G of the Building Regulations, provision of recycled water for non-potable domestic use requires additional calculations prior to arriving at the final consumption figure for the dwelling. The calculation assumes that the total amount of non-potable water collected is less than the non-potable water demand (see page 12 for an example calculation). Recycling systems can be used to supply multiple dwellings, savings are apportioned over the number of dwellings supplied.

Table 2: Consumption calculator for multiple fittings for new dwellings[2]

2.1 Taps (excluding kitchen sink taps)

Tap fitting type	Flow rate (litres/min) (a)	Quantity (No.) (b)	Total per fitting type (c) = (a) x (b)
1			
2			
3			
4			
Total (sum of all quantities)	(d)		
Total (sum of all totals per fitting type)		(e)	
Average flow rate (litres/min)		(e)/(d)=	
Maximum flow rate (litres/min)		(f)	
Proportionate flow rate (litres/min)		[(f) x 0.7]=	

2 Communities and local government, "The Water Efficiency Calculator for new dwellings", 2009, www.planningportal.gov.uk/uploads/br/water_efficiency_calculator.pdf

Table 3: The water calculator for new dwellings[3]

Installation type	Unit of measure	Capacity/ flow rate (1)	Use factor (2)	Fixed use (litres/person/day) (3)	Litres/person/day = [(1) x (2)] + (3) (4)
WC (single flush)	Flush volume (litres)		4.42	0.00	
WC (dual flush)	Full flush volume (litres)		1.46	0.00	
	Part flush volume (litres)		2.96	0.00	
WCs (multiple fittings)	Average effective flushing volume (litres)		4.42	0.00	
Taps (excluding kitchen/ utility room taps)	Flow rate (litres/minute)		1.58	1.58	
Bath (where shower also present)	Capacity to overflow (litres)		0.11	0.00	
Shower (where bath also present)	Flow rate (litres/minute)		4.37	0.00	
Bath only	Capacity to overflow (litres)		0.50	0.00	
Shower only	Flow rate (litres/minute)		5.60	0.00	
Kitchen/utility room sink taps	Flow rate (litres/minute)		0.44	10.36	
Washing machine	Litres/kg dry load		2.1	0.00	
Dishwasher	Litres/place setting		3.6	0.00	
Waste disposal unit	Litres/use	If present = 1 If absent = 0	3.08	0.00	
Water softener	Litres/person/day		1.00	0.00	
	(5)	**Total calculated use (litres/person/day) = (Sum column 4)**			
	(6)	Contribution from greywater (litres/person/day) from separate greywater calculation			
	(7)	Contribution from rainwater (litres/person/day) from separate rainwater calculation			
	(8)	Normalisation factor			0.91
	(9)	Total water consumption (Code for Sustainable Homes) = [(5) – (6) – (7)] x (8) (litres/person/day)			
	(10)	External water use			5.0
	(11)	**Total water consumption (Building Regulation 17.K) = (9) + (10) (litres/person/day)**			

3 Communities and local government, "The Water Efficiency Calculator for new dwellings", 2009, www.planningportal.gov.uk/uploads/br/water_efficiency_calculator.pdf

The cost of achieving water efficiency

The price of water-efficient fittings and appliances has traditionally been more expensive than standard equivalents. Prices have started to decrease while performance relative to standard has improved and at this stage, achieving Code levels 3 and 4 specifications for water consumption is one of the cheaper aspects of the Code implementation.

Achieving Code levels 1 and 2

A specification of 120 litres per person per day, as per Part G of the Building Regulations, can be achieved through installing a combination of standard and efficient fittings and appliances (see Table 5 on page 8 for example specifications). Communities and Local Government (CLG) estimate that this will not add any cost to a new home (CLG, 2008[4]).

Achieving Code levels 3 and 4

A specification of 105 litres per person per day can be achieved by installation of efficient water using fittings (see Table 5 on page 8 for example specifications). CLG has estimated that under current supply-demand scenarios, achieving Code Level 3 will add between £200 to £240 to the cost of a new home (CLG, 2008).

Achieving Code levels 5 and 6

A specification of 80 litres per person per day will probably require some form of water recycling, although it is possible to use a fittings-based strategy, particularly if an efficient washing machine and/or dishwasher is specified (see Table 5 on page 8 for example specifications). Inclusion of a rainwater or greywater recycling system is relatively costly, although new models are becoming available that are much more cost-effective. CLG estimate that achieving Code level 5 or 6 would add between £1,750 to £4,500 to a new home.

The cost of meeting the Code will fall as demand increases as bulk supply of fittings will enable bathroom manufacturers to offer efficient products for much less than their current prices.

Contact Waterwise East for information on grants and subsidies available for water-efficient technologies.

Householder savings

Annual household (2.4 people) savings on water bills are estimated to range from around £100 to over £200.

Energy and carbon savings

Approximately 24 percent of domestic energy consumption in the UK goes to heating water (DTI 2002[5]). This excludes space heating. Savings on energy bills should be seen in homes where hot water requirements have been reduced. In general, hot water reductions will result in greater financial savings on energy bills than on water bills. Waterwise has estimated the energy and carbon emission savings per litre of saved water, given below in Table 4.

Table 4: Per-litre values for energy and direct and embedded carbon emissions saving for both gas and electricity hot water systems (Waterwise, 2010)[6]

For gas hot water systems

Litre type	Energy consumption (kWh)	Direct carbon emissions (Kg CO_2eq)	Indirect carbon emissions (Kg CO_2eq)
1 litre of hot water for taps and showers	0.039	0.0081	7.47×10^{-4}
1 litre of hot water for a bath	0.044	0.0097	7.47×10^{-4}
1 litre of cold water for indoor use	0.000	0.0000	7.47×10^{-4}
1 litre of cold water for outdoor use	0.000	0.0000	2.71×10^{-4}

For electrical hot water systems

Litre type	Energy consumption (kWh)	Direct carbon emissions (Kg CO_2eq)	Indirect carbon emissions (Kg CO_2eq)
1 litre of hot water for taps and showers	0.031	0.0171	7.47×10^{-4}
1 litre of hot water for a bath	0.034	0.0191	7.47×10^{-4}
1 litre of cold water for indoor use	0.000	0.0000	7.47×10^{-4}
1 litre of cold water for outdoor use	0.000	0.0000	2.71×10^{-4}

4 Communities and local government, "Code for Sustainable Homes: A Cost Review," 2008
5 Department of Trade and Industry, "Energy Consumption in the United Kingdom, 2002
6 Waterwise, "Evidence Base for Large-scale Water Efficiency in Homes, Phase II Interim Report," 2010, www.waterwise.org.uk/images/site/Policy/evidence_base/evidence%20base%20for%20large-scale%20water%20efficiency%20in%20homes%20-%20phase%20ii%20interim%20report.pdf

Home buyer and public attitudes to water efficiency

For developers, buyer demand for features is of prime importance when specifying a new home. Recent research suggests an increasing awareness and desire for 'eco' features amongst home buyers. Research by Nationwide Building Society (EDIE 2007)[7] for example found homeowners are concerned over how much energy (75 percent of respondents) and water (61 percent of respondents) they use and that home owners view sustainable homes as modern, attractive, hi-tech, fashionable and good value.

A summary of this report and other relevant research is available from www.water-efficient-buildings.org.uk

Waterwise East and Savills research, 2009[8]

Participants were given information on standard water-efficient fittings, and asked to indicate whether they would/do like, are neutral about, or would not like a having fitting of that type in their home. Figure 1 displays the results.

The results suggest that showers and dual-flush WCs have wider acceptability than the low-volume bath and taps options. The research also showed that most individuals that already had water-efficient fittings in their home liked them.

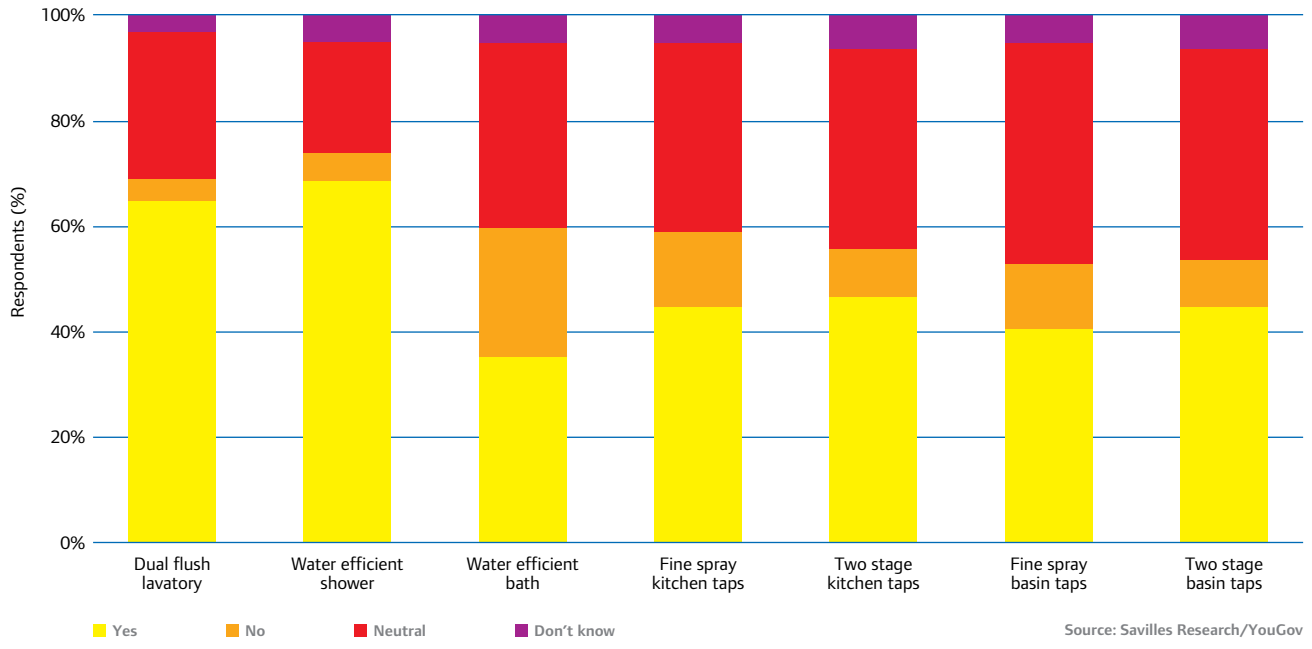
Attitudes to water recycling systems were also investigated. The results showed that people are generally receptive to the idea of using recycled water for WC flushing and rainwater for clothes washing. The idea of using greywater for clothes washing was markedly less popular.

The full research report is available from www.water-efficient-buildings.org.uk

Things to consider:

- "Eco" features such as water efficiency should be used as a selling point for new homes
- Potential financial savings on water and energy bills and environmental benefits associated with water-efficient fittings should be highlighted to homeowners
- Quality water-efficient fittings should be specified to ensure performance is acceptable to homeowners
- Detailed information on fittings and benefits should be included in an information pack for the home buyer
- Homeowners are most likely to welcome a dual-flush toilet and water-efficient shower and less likely to welcome a low-volume bath

Figure 1: Attitudes to various water efficient fittings



7 Sponge, "Eco Chic or Eco Geek? The Desirability of Sustainable Homes, Executive Summary", 2007, http://www.spongenet.org/library/Eco%20Chic%20Or%20Eco%20Geek%20Exec%20Summ.pdf
8 Waterwise East and Savills research, "Households' attitudes to water economy and water efficient appliances", 2009, www.water-efficient-buildings.org.uk/wp-content/uploads4TQ//2009/01/waterwisebriefingnotespring2009.pdf

Strategies for whole-building specification

Strategies for meeting water consumption targets can be broadly divided into fittings-based and recycling-based strategies. Example strategies to meet various target water consumption specifications are given below in Table 5.

When putting together a whole-building water specification, it is important to consider cost, the performance and sustainability of the fittings and appliances specified and the end-user attitudes to these fittings. Information on each of these factors is given throughout this guide.

www.water-effcient-buildings.org.uk is a good place to start when looking for whole-building specifications. The site links to an online Water Calculator that calculates whole-building water consumption and has a selection of water-efficient products from a drop-down menu to choose from.

Also the Association for Environmentally Conscious Builders (AECB) has created an alternative standard to the Code, which is based on performance requirements for individual water-using devices. These individual requirements provide a good starting point when specifying fittings and appliances.

Fittings-based strategies

Specifications up to and including Code level 3 and 4 can be met with water efficient fittings. Fittings strategies may add to the cost of a new home dependent on which fittings are chosen.

Recycling-based strategies

Recycling can be used in combination with water-efficient fittings to achieve the challenging water consumption target of Code levels 5 and 6. Recycling strategies will generally be more expensive than fittings strategies and therefore are not recommended as an option to lessen the need for water-efficient fittings at the lower levels of the Code.

When including recycled water in calculations, the amount that can be saved is limited to the consumption of the fittings where the recycled water is to be used.

Bathroom manufacturers

Bathroom manufacturers are increasingly looking to provide 'whole-building' solutions for developers, and as such, developers can approach product manufacturers with a desired specification or a water consumption target, particularly for larger developments. This works for either fittings-based or recycling-based strategies but for the latter, the company providing the recycling system should be included in the process at the earliest possible stage.

Table 5: Example scenarios meeting various Code levels

Strategy, Code level	SCENARIO 1 Fittings-based, Code level 1/2 (Building Regulations)	SCENARIO 2 Fittings-based, Code level 1/2 (Building Regulations)	SCENARIO 3 Fittings-based, Code level 3/4	SCENARIO 4 Fittings-based, Code level 3/4	SCENARIO 5 Fittings-based, Code level 5/6	SCENARIO 6 Recycling-based, Code level 5/6
WC	6 (single flush)	5/3 (dual flush)	5/3 (dual flush)	4 (single flush)	4/2.6 (dual flush)	6 (supplied by greywater)
Taps (excluding kitchen taps)	8	8	4	6	2	3
Bath	180	180	180	140	120	155
Shower	8	10	8	8	6	7
Kitchen sink taps	8	10	6	8	5	4
Washing machine	8.17 (not supplied)	8.17 (not supplied)	8.17 (not supplied)	8.17 (not supplied)	6.14 (supplied)	8.17 (not supplied)
Dishwasher	1.25 (not supplied)	1.25 (not supplied)	1.25 (not supplied)	1.25 (not supplied)	1.25 (not supplied)	1.25 (not supplied)
Water Recycling	0 (not supplied)	0 (not supplied)	0 (not supplied)	0 (not supplied)	0 (not supplied)	26.52 (greywater supplying toilet)
Predicted per capita consumption (Code)	119.24	118.59	103.28	104.32	79.76	79.84

Fittings and appliances

This section details the water-using fittings, appliances and water-efficient technologies that are normally used in dwellings. There is also information on the implications of water pressure and plumbing design.

Products include:

- WCs
- Showers
- Baths
- Taps
- Washing machines
- Dishwashers
- Water softeners and conditioners
- Waste disposal units
- Water recycling systems

The Water Calculator requires flows/capacities of installed products. This information should be available from the manufacturer.

When looking for water-efficient products, some good sources of information are:

Waterwise – for products that have been awarded the Waterwise Marque and for washing machine and dishwasher rankings. www.waterwise.org.uk

Bathroom Manufacturer's Association – for bathroom products awarded their Water Efficient Product Label. www.water-efficiency.org.uk

WCs

WCs are generally the largest water-users in the home, using around 30 percent of water in an average household (Waterwise, 2006)[9]. There are many WCs now available that have flush volumes less than six litres per flush (the maximum permitted under the Water Fittings Regulations.)

Things to consider:

- Specifying a low-volume and/or dual-flush WC can be a "quick win" when looking to reduce water consumption in a development
- Waterwise East research shows over 60 percent of homeowners would be happy with a dual-flush WC
- Newer style dual-flush WCs relying on drop valve mechanisms are susceptible to leaking whereas traditional siphonic flush valves are still common in single-flush WCs and rarely leak
- When matching separate WC pans with cisterns, it is important to ensure that the pan is designed to work at the flush volume of the cistern
- WCs can be supplied with recycled water
- The flushing mechanism of some WCs is pressure dependent, so installers should ensure that the WC manufacturer's requirements can be met particularly in low pressure

Showers

Showers are significant water-users in the home, using around 12 percent of water in an average household (Waterwise, 2006)[10]. To meet Building Regulations and increasing Code levels, developers will generally need to specify showers which operate at below ten litres per minute (l/min). However, higher flow showers can still be included in homes where it is offset against lower flow/capacity fittings elsewhere in the home.

Things to consider:

- Water-efficient showers that use technologies such as aeration increase the sensation of flow to improve user satisfaction
- Waterwise East research shows that over 60 percent of homeowners would be happy with a water-efficient shower
- Inability to offer home buyers "power showers" has been highlighted as a major concern for developers (NHBC Foundation 2008) but it is likely that perceptions of efficient showers are often outdated
- There are an increasing number of power showers that are limited to below 12 l/min
- Mains fed showers often have similar or higher flow rates than power showers
- It is possible to connect an efficient showerhead to most showers, including power showers, but we suggest caution in regard to electric showers and advise following manufacturers' instructions

9 Waterwise website, "Save water, At Home – Indoors", 2010, www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/save_water_at_home.html
10 Waterwise website, "Save water, At Home – Indoors", 2010, www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/save_water_at_home.html

Baths

A great variety of baths are available, many of which have large capacity maximum volumes.

Things to consider:

- Several baths are available that are shaped to reduce the overall volume while retaining sufficient depth for total immersion
- Some bath shapes may not lend themselves to the fitting of a shower above them
- Lowering the overflow allows the bath to look large but the reduced depth may be dissatisfying for some users
- Reducing the depth of the bath provides increased safety for some users but may be perceived as unsatisfactory for others
- Bath operational volume is measured to the bottom of the overflow with only water in the bath but some manufacturers provide different measurements

Taps

Taps are specified by flow rate. Calculations for kitchen and non-kitchen taps vary in the Water Calculator, but both take into account a usage factor and a fixed use factor. There is a great variety of taps on the market, which are efficient through design or through the addition of flow restrictors, regulators or aerators.

Things to consider:

- Aerated and spray-taps can increase user satisfaction by increasing the sensation of flow
- If flow limiters are fitted to the pipework supplying the tap, flow limiters will be required on both hot and cold supply pipework
- Taps with water-brakes, also known as 'click' or two stage taps, are not currently accommodated in the Water Calculator
- Click taps are generally only suitable for systems with pressure in excess of 1 bar
- The extra resistance imposed by the design of click taps can be a problem for people with arthritis or weak wrists

Washing machines

In the current Water Calculator, washing machine consumption is calculated on the basis of litres of water used per kilogram of dry load (figure given on the EU Energy Label). If a specific washing machine is not being provided, the default water consumption value specified must be used.

Things to consider:

- Machines with "eco" settings can make further water and energy savings
- Ensure the capacity of the machine is sufficient for the predicted occupation
- Rainwater or greywater can be used to supply washing machines:
  - Rainwater for washing clothes is more likely to be welcomed by homeowners than greywater
  - Ensure that the pressure and quality of the supply is adequate for the washing machine valve operation
  - Recycled water from a professionally installed system will not damage washing machines or reduce the efficiency of cleaning

Dishwashers

As with washing machines, the Water Calculator now calculates water consumption of dishwashers based on their consumption in litres per place setting derived from the figures quoted on the EU Energy Label. If a specific dishwasher is not being provided, the default water consumption value specified must be used. Innovation from manufacturers is driving increased efficiency in dishwasher performance.

Things to consider:

- Machines with "eco" settings can make further water and energy savings
- Ensure the number of place settings in the machine is sufficient for the predicted occupation

Water softeners and conditioners

The good practice benchmark for water consumption for water softeners or conditioners is four percent. This benchmark is derived from the total volume of water treated between regenerations, divided by the amount of water needed to carry out the regeneration cycle. The Water Calculator will only include the water consumption from a water softener or conditioner consumption is above this benchmark. An addition calculation is required if it is to be included in the Water Calculator (see Table 6 below).

Table 6: The water softener consumption calculation for new dwellings

Total capacity used per regeneration (%)	(a)	
Water consumed per regeneration (litres)	(b)	
Average number of regeneration cycles per day (No.)	(c)	
Number of occupants served by the system (No.)	(d)	
Water consumed beyond 4% (litres/day) [1-[4/(a)]] x [(b) x (c)] = (e)		
Water consumed beyond 4% (litres/person/day) [(e)/(d)] =		

Information on consumption can generally be obtained from the manufacturer or through the UK Water Trade Association (UKWTA): www.ukwta.org.uk

Things to consider:

- Water-efficient fittings often rely on small flow apertures and are prone to scaling and as such, water softeners and conditioners may become a more common inclusion in homes specified to high water-efficient standards in hard water areas
- Benefits include maximising efficiency and lifespan of various fittings including boilers
- Disadvantages include cost outlay, salt consumption, need for maintenance, energy consumption and the increased consumption of water during normal operation

It is recommended that where a water softener is to be installed, the supply of drinking water to the kitchen tap is from the mains and not softened.

Waste disposal units

The new Water Calculator includes waste disposal units calculations. Where present, a standard consumption of 3.08 litres per person per day must be assumed.

Installation and use of waste disposal units is discouraged. More information is available from www.water-efficient-buildings.org.uk

Water recycling systems

Water supplied by a recycling system requires additional calculations (see page 12 for the greywater and rainwater calculations required for the Water Calculator) and is deducted from the total calculated water consumption of a building. It is generally accepted that meeting the water targets for Code Levels 5 and 6 will require the inclusion of water recycling systems. It is not recommended that water recycling is used to meet lower Code levels.

Water recycling systems collect rainwater or greywater for the supply for non-potable uses such as WC flushing, clothes washing and various outdoor uses. Communal systems may be more financially viable than single-dwelling systems, although there may be some issues with consumer acceptance.

Things to consider:

- Fittings and appliances connected should be carefully selected / specified to ensure they are able to function under the expected water quality and pressure of the system
- The British Standards Institute has recently produced a Code of Practice for Rainwater Harvesting (BS 8515) and greywater reuse (BS 8525-1) and it is recommended that recycling systems are installed in accordance with these, requirements include clearly labelling pipework collecting and supplying recycled water

There are many companies operating in the UK that specialise in water recycling systems and there are systems available for, or that can be tailored to, practically any setting. It is recommended to engage a specialist water recycling company early in the development planning process.

Combined rainwater and greywater systems

Combined rain and greywater systems are suited to situations where the demand for non-potable water exceeds the supply from separate rain or greywater systems alone. The Water Calculator notes that where both rain and greywater are used the amount that can be saved is limited to the consumption of the fittings where the recycled water is to be used. Suppliers of recycling systems will be able to advise on the practicalities of combined systems. It is intended that guidance for combined systems will be added as an annex to BS 8525 in future.

Greywater recycling systems

Greywater systems collect and recycle some or all of the water used in the shower, bath and washbasin. To calculate the contribution of greywater, the amount of water available for recycling must be calculated (using the consumption figures in litres per person per day for the fitting(s) where water is to be supplied for recycling). The contribution of greywater entered into the Water Calculator must not exceed the non-potable water demand. Table 7 shows the calculations required for greywater demand for the Water Calculator.

Table 7: The greywater demand calculations for new dwellings[11]

WCs

Effective flushing volume (litres) (a)	Number of fittings present (b)	Quantity using greywater (c)	Greywater demand (d) = (a) x (c)
Total fittings consumption (e) = Sum of (b)		**Total Greywater demand** (f) = Sum of (d)	
Average greywater demand from WCs		= (f) / (e) x 4.42	

Washing machines

Litres per kg (a)	Number of fittings present (b)	Quantity using greywater (c)	Greywater demand (d) = (a) x (c)
Total fittings consumption (e) = Sum of (b)		**Total Greywater demand** (f) = Sum of (d)	
Average greywater demand from washing machines		= (f) / (e) x 4.42	

Things to consider:

- The key advantage of greywater systems is that demand is linked to supply, meaning that tank volumes can be smaller than a rainwater system supplying identical fittings
- Disadvantages compared to rainwater systems include the increased need for treatment and associated energy consumption and the system cost, maintenance and acceptability

Rainwater recycling systems

Rainwater recycling systems collect rainwater from surfaces, usually roofs, store it and supply it directly to fittings that do not require potable water. Table 8 shows the calculations required to assess the contribution of rainwater harvesting systems. The contribution of rainwater entered into the Water Calculator must not exceed the non-potable water demand (the same as the calculations given in Table 7 for greywater demand).

The UK Rainwater Harvesting Association is the trade body for the industry and lists suppliers on its website: www.ukrha.org

Table 8: The rainwater collection calculation for new dwellings – BS8515[12]

Intermediate approach

Collection area (m^2)	(a)	
Yield co-efficient and hydraulic filter efficiency e.g. 0.7	(b)	
Rainfall (average mm/year)	(c)	
Daily rainwater collection (litres)	[(a) x (b) x (c)]/365 = (d)	
Number of occupants	(e)	
Daily rainwater per person (litres)	(d) / (e) = (f)	

Detailed approach

Daily rainwater collection (litres)	(a)	
Number of occupants	(b)	
Daily rainwater per person (litres)	(a) / (b) = (c)	

Things to consider:

- Tailoring rainwater recycling systems to specific conditions/ developments/ dwellings is highly technical and as such specialist companies should be engaged
- Specialists should ensure that the system provides water of the required quality for the fittings it supplies and advise regarding required maintenance
- Rainwater system recycling maintenance should not be onerous for the end-user
- Rainwater harvesting can be utilised in conjunction with green roofs, but be aware that it may decrease the amount of rainwater that can be collected and may cause discolouration or water quality issues
- Space requirements for rainwater harvesting systems need to be considered at an early stage in the development planning process
- Rainwater storage can form a component of the surface water management strategy and can therefore contribute to achieving the requirements of Code Category 4: Surface Water Run-Off

Sustainable Drainage Systems (SuDS)

SuDS are an alternative to conventional piped means of managing surface water. SuDS aim to mimic the way rainfall drains in natural systems. SuDS are needed because urbanisation reduces the amount of rainfall that can soak into the ground and means that it has to be managed to prevent flooding.

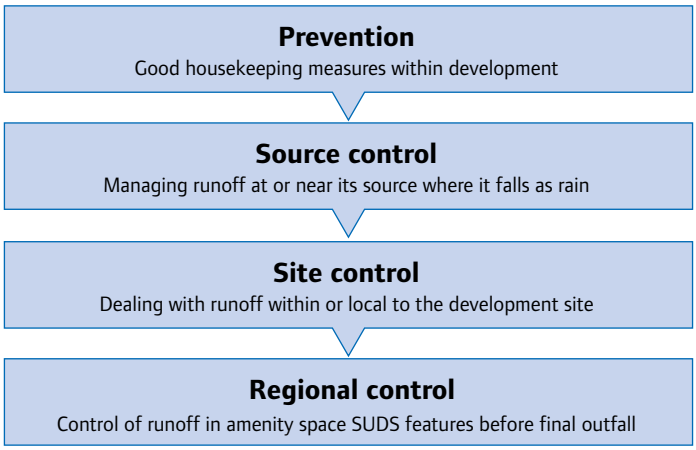
Traditionally this surface water has been combined with the foul sewerage system or more recently channeled through separate surface water sewers that discharge direct to local watercourses. As towns have spread and density has increased so too has the volume of the surface water that these piped systems must cope with. In the future, the pressure on urban drainage systems will increase both due to further development and also as a result of a changing climate where it is expected that more intense and/or prolonged storms will occur.

This means that a different approach to surface water management is needed. The prime function of SuDS, as with conventional drainage, is to provide effective flood risk protection over the long term both within and downstream of the development. However, SuDS approaches can bring wider benefits too; including adding amenity for the community, benefits to local biodiversity and treating the quality of surface water run-off.

Design and approach to SuDS

A central design concept is the SuDS "management train" to use a variety of drainage techniques in series to incrementally reduce pollution, flow rates, volumes and frequency of runoff (see Figure 2). A hierarchy of storage and flow management provides opportunities for day-to-day rainfall to be controlled at source, with larger infrequent volumes stored elsewhere in the development or in public open space where necessary or convenient.

Figure 2: The SUDS "management train"



Component SuDS features

Within a site design there will be a number of SuDS features to control runoff from development. Commonly used features include:

- Filter strips and swales
- Filter drains and permeable surfaces
- Green roofs and bio-retention areas
- Infiltration structures
- Basins, ponds and wetlands
- Underground storage

Barriers to use of SuDS

To date, the main barrier to SuDS schemes has related to issues of adoption and maintenance. Local authorities are being encouraged to move SuDS schemes forward but lack expertise and in many cases, incentives. Some of these issues are matters of national policy and work is being done at this level. However it may be that solutions can be found at a local level through effective joint working between developers, planners, water companies, the Environment Agency and other interested parties such as Internal Drainage Boards.

It is advisable to refer to the following for more information about SuDS:

The National SuDS Working Group, "The Interim Code of Practice for Sustainable Drainage Systems"

Environment Agency website, SuDS pages (outlines why SuDS offer a more sustainable option for drainage)

CLG, The Code for Sustainable Homes Technical Guidance (pages 97-111)

All these links are available from
www.water-efficient-buildings.org.uk

11 Communities and local government, "The Water Efficiency Calculator for new dwellings", 2009, www.planningportal.gov.uk/uploads/br/water_efficiency_calculator.pdf
12 Communities and local government, "The Water Efficiency Calculator for new dwellings", 2009, www.planningportal.gov.uk/uploads/br/water_efficiency_calculator.pdf

Outdoor water use

The revisions to Part G of the Building Regulations assume five litres per person per day for outdoor water use. The outdoor component is assumed rather than based on specification of criteria that affect outdoor water use.

However, outdoor potable water use can be minimised through specification of outdoor taps, appropriate landscaping, and provision of recycled water for irrigation using water butts.

Landscaping

Most dwellings with landscaped areas or garden space require an outdoor water source. Outdoor water demand can be reduced by specifying drought resistant lawn, turf and plants (although they are not always compatible with the need to maintain biodiversity), using mulch and bark in garden beds to reduce evaporation and the provision of information to the owner/occupier as to the watering requirements to maintain plant condition.

Installation of automatic irrigation systems is not recommended, but if installed it should be responsive to soil moisture or rainfall history.

Cambridge Water sponsored "dry garden" in the summer

Water butts

Water butts collect rainwater from surfaces and store it for non-potable uses, usually garden watering. The Code awards one credit if a system to collect rainwater for irrigation is supplied. This can be awarded if including a rainwater recycling system that supplies water in excess of the internal fittings demand. Water butts must be installed correctly, as per the Code Technical Guidance.

Pools

In order to obtain the one available credit for external water use under the Code, if a pool is to be included as part of the dwelling it must be wholly supplied by recycled water. Pool water quality requirements are more stringent than Bathing Water Directive requirements. However, at least part of this is dealt with by chlorine dosing of swimming pool water.

Professionally installed recycling systems with appropriate water treatment would be expected to provide water that meets Swimming Pool and Allied Trade Association water quality requirements.

Pool covers reduce evaporation and should always be supplied and their use encouraged.

Water pressure and design considerations

The focus of the Water Calculator approach is on end of pipe solutions. Yet good design of efficient dwellings requires an innovative approach that considers the whole plumbing system, including actual water pressures in the development and the design of the plumbing system.

Water pressure

Under the changes to Part G of the Building Regulations and the Code, flow rates of showers and taps are entered into the Water Calculator assuming a dynamic pressure of 3 bar (except for low-pressure systems, where they are entered at 0.1 bar.) Flow-rates should include any reductions achieved using flow restriction.

The normal range for water pressure in England is 1 – 5 bar, and pressure is influenced by instantaneous demand. To ensure a fitting's target water consumption is achieved, the fitting's flow rate can be controlled by either limiting the pressure or flow or a combination of both. The main control methods are:

Aerators – devices that have two functions. The first is to aerate the water to give it a softer feel and the second is to reduce the flow. A key benefit of the aerator is that it gives the appearance of a greater flow volume than actually delivered. Aerators can be combined with either flow restrictors or regulators so that the required flow rate can be delivered. Aerators require a minimum flow rate to function.

Flow regulators – simple or complex devices that not only restrict the bore of the fitting but also take account of the upstream pressure conditions. Flow regulators can control the flow rate accurately.

Flow restrictors – simple non-active devices that restrict the bore of the pipe or fitting to reduce the flow of water passing through it. They do not take account of the varying upstream supply pressures and so the control will be less accurate.

Pressure regulators – a device to limit the maximum pressure delivered into the system downstream. There will be an upper limit to the amount water that can flow through (flow rate) the regulator.

In simple terms, the greater the pressure the greater the flow that can be delivered, therefore the actual pressure in a development may be an important determinant on selection of fittings. Developers should discuss likely pressure patterns with the water supply company at the earliest possible stage and may want to measure pressure ranges themselves prior to installing fittings. Pressure within a building will also be influenced by the length and bore of the pipework linking the mains to the point of use. Pipework should be sized for peak demand.

Implications of boilers and water recycling on water pressure

Vented systems (i.e. water stored in a roof cistern) typically provide pressures of approximately 0.3 to 0.7 bar (static pressure). Un-vented systems, supplied direct from the mains, provide higher flow rates, although typically they are limited to a maximum of 3 bar for safety reasons.

Combination boilers supply water at mains pressure (anything from 1 to 5 bar under normal conditions). Some designs have limitations on the minimum flow rate required for the boiler to function correctly. They may also have an upper flow rate limit for the hot water, which can limit the number of appliances that can be served at any one time. Careful consideration is needed when specifying this type of system.

If water recycling systems are to be used, the fittings using this water should function under the expected pressure of the non-potable water system.

Plumbing system design – efficiency considerations

The length of pipework and relative location of fittings will influence the amount of water wasted via "dead-legs". A well designed system will maximise usability, hygiene and efficient use of water and energy.It is a requirement of the Water Fittings Regulations that hot water is delivered to a fitting within 30 seconds or less after opening the fitting.

Things to consider:

- Efficient fittings are often better served by pipes with bores narrower than the standard 15 mm
- The layout of the dwelling should be designed so that the water-using fittings are as close as possible to both the hot water storage and the mains entry point
- The largest water-using appliance should be installed last on a branch
- Minimised dead-leg plumbing should be considered, the AECB good practice water standard specifies dead-legs should be no more than 1.5 litres
- Pipework carrying hot water should be insulated (lagged) and this can save energy as well as water
- To meet Water Fittings Regulations, fittings that are a distance from the hot water source, may need to be served by 10 or 8 mm pipe, which often needs to be specially ordered and is often more expensive than 15 mm pipe

Developer interaction with water companies

Water supply and waste water services are supplied by water companies. In many areas, different companies provide water and waste water services. Developers need to be aware of the implications of development and the demands of water infrastructure and how it is managed by water companies.

There are requirements for developers to engage with both water supply and waste water service providers during the course of planning and building new developments. It is recommended that developers contact the water supply and waste water company(s) at the earliest possible stage in development planning.

Contact details

Anglian Water
www.anglianwater.co.uk

Bournemouth and West Hampshire Water
www.bwhwater.co.uk

Bristol Water
www.bristolwater.co.uk

Cambridge Water
www.cambridge-water.co.uk

Cholderton and District Water
www.choldertonwater.co.uk

Dee Valley Water
www.deevalleywater.co.uk

Essex and Suffolk Water
www.eswater.co.uk

Northern Ireland Water
www.niwater.com

Northumbrian Water
www.nwl.co.uk

Portsmouth Water
www.portsmouthwater.co.uk

Scottish Water
www.scottishwater.co.uk

Severn Trent Water
www.stwater.co.uk

South East Water
www.southeastwater.co.uk

South Staffordshire Water
www.south-staffs-water.co.uk

South West Water
www.southwestwater.co.uk

Southern Water
www.southernwater.co.uk

Sutton and East Surrey Water
www.waterplc.com

Thames Water
www.thameswater.co.uk

United Utilities
www.unitedutilities.com

Veolia Water Central
www.veoliawater.co.uk/central

Veolia Water East
www.veoliawater.co.uk/east

Veolia Water Southeast
www.veoliawater.co.uk/southeast

Welsh Water
www.dwrcymru.com

Wessex Water
www.wessexwater.co.uk

Yorkshire Water
www.yorkshirewater.com

Case studies

Savings on Tap: Highland Park development, Ashford, Kent

This development saw South East Water team up with Hillreed Homes, Kent County Council and the Environment Agency to trial the innovative Savings on Tap project to help households use water wisely.

Hillreed homes installed all homes on the Highland Park development with a variety of water-efficient appliances and fittings. Micro-component metering was also installed, and feedback on actual water consumption of appliances was recorded. The appliance specifications and feedback from metering is detailed below.

Water-saving taps

Variable flow rate taps were installed for main bathroom and kitchen taps. Downstairs bathrooms were fitted with spray or low water use taps limited to five l/min or less, but metering showed maximum flows of seven l/min.

Ultra low dual-flush toilets

Efficient dual-flush toilets were installed with either a four litre full flush and 2.5 litre half flush or four and three litre dual-flush. Metering showed some double-flushing occurred, and some residents stated that they did not use the half-flush, because it did not fully clear the pan.

High performance showers

Showers with a flow rate less than ten l/min were installed, using aeration where possible. A supply pressure of 5 bar meant that flow regulators had to be added to the showers to achieve the target flow rates. Metering showed that aerated showers achieved a maximum flow of 11 l/min, and that residents with aerated showers spent longer in the shower, meaning that the difference in volumes of water used by residents using aerated and non-aerated showers were negligible.

Water-efficient washing machines and dishwashers

Washing machines installed had a maximum water use of eight litres per kilogram of wash load and dishwashers a maximum water use of 1.2 litres per place setting.

Outdoor water use

Water butts were supplied to every property with a garden and outdoor taps restricted to a flow of ten l/min. Metering showed a maximum flow of 15 l/min. In 2009 high outdoor water consumption was seen in properties with a seasonal tariff.

Conclusions

The properties in the development averaged at around 120 litres per person per day, 30 litres less than the national average of 150 litres per person per day.

Hastoe Housing Association development, Upcher Close, Norfolk

12 properties were developed in February 2008 on behalf of Hastoe Housing Association. This scheme was designed and constructed to achieve an Ecohomes "Excellent" rating.

Water-efficient devices and a rainwater harvesting system were installed in each property to improve water efficiency. The predicted consumption for each property (using the Water Calculator) is less than 74 litres per person per day, achieving Code level 5 requirements.

Feedback received from occupiers of the dwellings was mixed, but the majority of occupiers gave the rainwater harvesting system a "satisfactory" review. They were pleased with the impact it had on their water bills and for this reason all occupiers said they would recommend the system.

The full case studies, along with others, which includes costs, advantages, disadvantages and problems, is available on www.water-efficient-buildings.org