



# ELSENHAM ECO-TOWN

## INTERIM WATER DEMAND AND SUPPLY ASSESSMENT: BENCHMARKS AND OPTIONS CONSIDERATION

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## 1 EXECUTIVE SUMMARY

The need to value water, thus reducing reliance on mains water to a minimum and working towards a goal of water neutrality, will be a fundamental part of making Elsenham an exemplar of sustainable development.

The intention of the water strategy is to reduce the use of mains water. This is both a climate change mitigation response, to reduce CO<sub>2</sub> emissions from the energy needed to treat and pump the water supplied and disposed of, and an adaptation response, because there are regional water availability issues that may be further affected according to climate change predictions.

This proposed interim water assessment is a response to the Supplement to PPS1 and the Draft PPS on Eco-towns consultation document from CLG.

The aspiration to reduce the need for mains water has always been rewarded in sustainable development rating methods such as Eco-homes and the Code for Sustainable Homes and is now proposed to be incorporated in the Building Regulations. Currently proposed amendments to Part G: Hygiene states that households are to have a design maximum 'wholesome' or potable water use requirement of 125litres per person per day (l/p/d), which is likely to come in to effect in 2009.

The recently released draft PPS for Eco-towns has outlined how these towns will be expected to reduce water consumption through incorporating measures to reduce water demand, improving water quality, and make use of Sustainable Urban Drainage features. Those towns, such as Elsenham, that are in areas of 'serious' water stress are expected to aspire to water neutrality, and as a minimum meet the water consumption targets (WAT1) from Level 5 of the Code for Sustainable Homes (the Code). This Level stipulates a maximum mains water use per person per day of 80 litres, which is achievable only with reduced water consumption coupled with an alternative water source, as efficiency measures alone are not capable of reaching this target.

Potable water demand reduction measures would be applied to all dwellings and non-domestic buildings within the Elsenham Eco-town development. These would be in the form of water efficient fittings coupled with ongoing and continuous occupant behaviour education to reinforce the advantages of a low water use lifestyle. The use of alternative water supplies for local or district distribution will also be considered, as will how wastewater treatment could be most efficiently addressed.

The application of water efficiency and alternative supply options in line with the domestic Code Level 5 water target (80l/p/d), coupled with best practice industry standards for non-domestic buildings, could produce an overall mains water saving at Elsenham Eco town of around 300MI/yr, which is a reduction of 50% compared to the average present water use in the Three Valleys.

Alternative supply sources of water for consideration in the move towards water neutrality include: treated rainwater and greywater (wastewater from non-foul sources), or re-use of treated water from sewage treatment.

Harvesting rainwater from the roofs of the development has the potential to yield around 177MI/yr (adjusted for predicted climate change variation) which is equivalent to 69% of the total annual demand (see Section 4.2.1).

Greywater harvesting from the whole Elsenham development has the potential to yield around a further 164MI/yr which is equivalent to 64% of the total annual demand, based on collection from wash basins, showers and baths in both domestic and non-domestic buildings, (see Section 4.2.2),

There is sufficient critical mass to provide an opportunity to make use of a combination of greywater reuse in addition to the rainwater collection to meet the total annual water demand. It would be a prerequisite that one or both of these sources of water are treated to a potable standard in order to potentially provide a water neutral solution.

Further design development will consider how water efficient features would be applied in the Elsenham Eco-town and the most appropriate methods of harvesting alternative water sources and treating these to a potable standard. For example, the potential for rainwater harvesting from roofs and paved areas for high level treatment to potable standards and/or greywater, treated to a lower standard, considered for the flushing of toilets. This may also include treating greywater and/or wastewater to a potable water standard, but this will be considered against issues such as costs and perception. Precedent from other countries, including Australia and Japan, where such water recycling systems are currently applied will be referred to as the strategy is developed.

## 2 INTRODUCTION

The Government has recently released several reports and guidance documents in support of increasing water security and demand reduction. Defra's Future Water Strategy (2008) states that "wasting water means wasting a resource on which we are dependent and which is limited in its seasonal and regional availability. It means wasting the energy required to supply, treat and distribute the water to where it is used, and to remove and treat wastewater."

The draft Planning Policy Statement for Eco-towns has outlined how these towns will be expected to reduce water consumption through incorporating measures to reduce water demand, improving water quality, and using SUDS. Towns in areas of serious water stress, such as Elsenham, are expected to aspire to water neutrality, and as a minimum meet the water consumption targets (WAT1) from Level 5 of the Code for Sustainable Homes.

In addition, it is the Government's intention to reduce the total water use of the average UK person to 120-130litres per person per day (l/p/d) by 2030, with the introduction of more efficient water fittings and technologies (Water Strategy – Future Water, Defra February 2008). This is compared to the present UK average daily water use of approximately 150l/p/d.

Proposed changes by the Government to the Building Regulations, Part G: Hygiene state that new dwellings will have a design maximum 'wholesome' water use requirement of 125l/p/d of water supply as of 2009 [CLG, Water Efficiency in New Building, 2007].

In addition to the use of wholesome water, the Part G consultation document seeks to recommend where alternative water sources (e.g. rainwater or greywater) can be used; the consultation specifies where 'wholesome' water must be supplied to (i.e. kitchens, drinking water, washing). It also outlines the manner for which non-wholesome water should be supplied and stored.

Designing to meet a wholesome water demand of 105l/p/d (as required by Code for Sustainable Homes levels 3 &4) is possible, in theory, through the use of more efficient water fittings and appliances, together with occupant education. However, Code for Sustainable Homes levels 5 & 6 (and the aspiration to water neutrality) will require further efficiencies in fittings and appliances as well as alternative supply sources of water such as rainwater harvesting and greywater reuse.

This report discusses issues regarding:

1. The predicted water demand for the proposed Elsenham Eco-town development;
2. Considerations of water efficiency measures;
3. Scenario options for alternative water source harvesting and distribution at the household and community scale;
4. Onsite wastewater treatment; and,
5. Operational and management considerations for an onsite water management scheme.

The design strategy applied to the water supply network serving all dwellings and non-domestic buildings within the Elsenham Eco-town development in order to move towards the aspiration of water neutrality will be focused on demand side reduction in water use and supply side provision of alternate water supplies.

In the Three Valleys Water (TVW) supply zone the average 'wholesome'<sup>1</sup> (or potable) drinking water monitored use is presently approximately 174l/p/d (195l/p/d for unmetered and 153l/p/d for metered supply usage, from OfWat – Security of Supply, leakage and water efficiency: 2006-07 Report). TVW have supplied an initial view on the new off-site supply reinforcement infrastructure required to service Elsenham at circa 5,000 residential units with 'normal' levels of mains water supply. The initial dialogue has indicated that in order to provide sufficient mains water to the development, approximately 5,800m of new distribution pipework would be required, together with additional off-site main pump booster stations and additional reservoir capacity. It should be noted, however, that this figure does not take into account the proposed water efficiency measures or alternative water sources.

These off-site infrastructure reinforcements will be charged to the development at cost price, to which will be added the additional water supply infrastructure charge (flat rate charge per dwelling), to give the off-site cost of a traditional approach to water supply. There will also be an equivalent off-site infrastructure reinforcement cost for providing necessary drainage infrastructure. Thus any cost increase from the provision of lower water using infrastructure for water supply and treatment should be considered against the possible reinforcement charge cost offsets, as they will reduce the cost burden.

Educating the final users on good practice and the safe use of alternative water sources is fundamental; education measures would be provided as guidelines in Home Information Packs (HIPs) and as a part of community support bodies.

Common **alternative sources** of water include: water abstracted from wells, springs, boreholes or watercourses; rainwater; reclaimed greywater; and reclaimed industrial process water. The approach to supplying alternative sources of water at potable water standard is dependent on: the availability of these sources (e.g. rainfall rates coupled with collection efficiencies, abstraction rates, local water resources); the desired 'mains' water use reduction and the sustainability target (i.e. Eco-town target of 80l/p/d as a maximum, with the aspiration of water neutrality); and the cost of filtering, cleaning, storing and distributing the supply.

Alternative sources of water will be investigated for Elsenham and considered for how best the water may be collected, stored and distributed at varying scales (i.e. individual dwellings, block by block, or site-wide networks). The above issues of standards, availability and cost will influence the application and scale of an alternative water system.

**Wastewater treatment** is the remediation of sewage or 'blackwater' to a standard that is safe to release into the natural environment, either via existing watercourse or land area of sufficient ability to absorb and oxygenate the treated water. If high

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<sup>1</sup> 'Wholesome' water refers to water complying with the requirements of regulations under section 67 Standards of wholesomeness of the Water Industry Act of 1991. 'Wholesome' water, in this report, will also be referred to as 'potable'.

level treatment of the wastewater is not required to achieve water neutrality, traditional or mains wastewater facilities would collect the sewage to a centralised community plant that would filter and treat to a point whereby the water can safely be released into the environment.

Alternatively, if an onsite treatment option is chosen, small packaged sewage treatment plant with an option for tertiary treatment reedbeds may be an option, pending further investigation. Such onsite treatment plant must be licensed by the Environment agency to treat discharged water to a maximum Biological Oxygen Demand (BOD) of less than 20mg/l before discharging to a local water course or leachfield. If detailed evaluation shows that there is a viable water neutrality option requiring high grade wastewater treatment, further constructed wetland treatment can provide a compliant non-wholesome standard for use in site irrigation systems.

It is possible to treat wastewater to potable water standard utilising reverse osmosis treatment methods, which is an option that could help achieve 'water neutrality' option and may be considered at a later more detailed design stage, along with centralised rainwater harvesting and full treatment to potable standard.

Discussions with the EA, local water and sewage undertakers will be required to obtain any required consents.

A detailed option appraisal process will be carried out at detailed design stage in order to assess the feasibility and commercial viability of all water collection/reuse and final disposal options in relation to the outcomes required. The requirements, at present, are that domestic water use should be designed to 80l/p/d plus equivalent exemplary non-domestic use, and a full SUDS rainwater design. In addition to these requirements is an aspiration of achieve 'water neutrality'. All options will utilise the maximum feasible level of water demand reduction measures.

### 3.1 WATER BENCHMARKS

The following benchmarks and water use breakdown provides a prediction of the water demand expected within Elsenham Eco-town. Against this demand, water efficiency measures can be optimised to minimise potable water use and determine where alternative water sources can provide part or all of the wholesome water (i.e. potable), or whether a better option would be to provide a non-wholesome water supply network (as per proposed Part G of the Building Regulations).

The water requirement for the following types of building within Elsenham Eco-town development have been calculated:

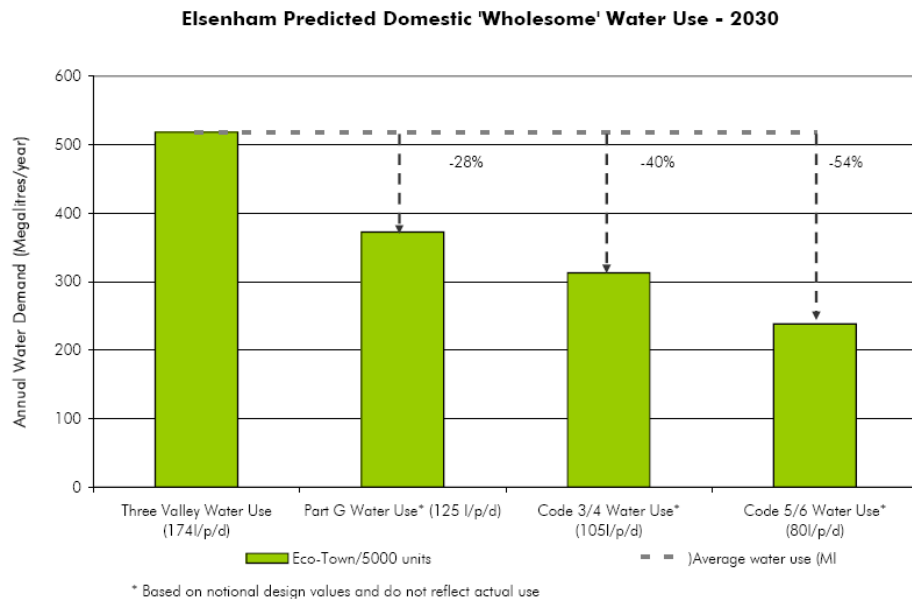
- Domestic
- Non domestic
  - Offices
  - Education
  - Health
  - Hotel
  - Retail
  - Industrial

The benchmark figures used in this report are generic and do not take into account the detailed characteristics of buildings that might affect performance,

such as the actual use patterns within the building or occupant numbers. Additionally the benchmarks do not consider the demand for irrigation.

Figure 1 shows published target options for the domestic buildings, namely:

- Local current use (Three Valleys water use)
- Building Regulation Standards (Part G)
- 'Best Practice' Standard (Code level 3/4 – Efficient supply and demand)
- 'Exemplary Practice' Standard – Eco-town (Code level 5/6 – Efficient supply and demand + alternative water sources)

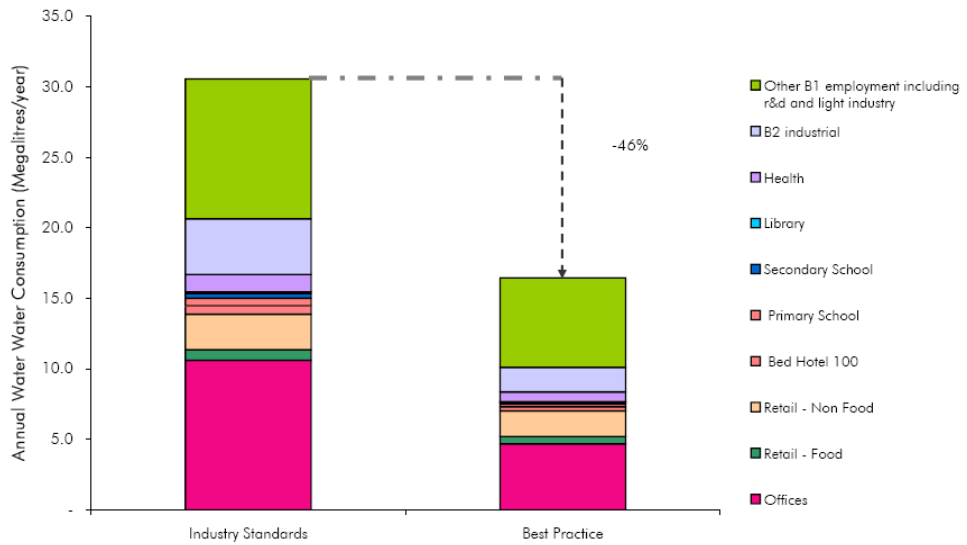


**Figure 1 - Elsenham Predicted 'Wholesome' Water Use**

Figure 2 shows target options for water use in non-domestic buildings:

- Industry Standards (Typical benchmark)
- Best Practice (Efficient supply and demand)

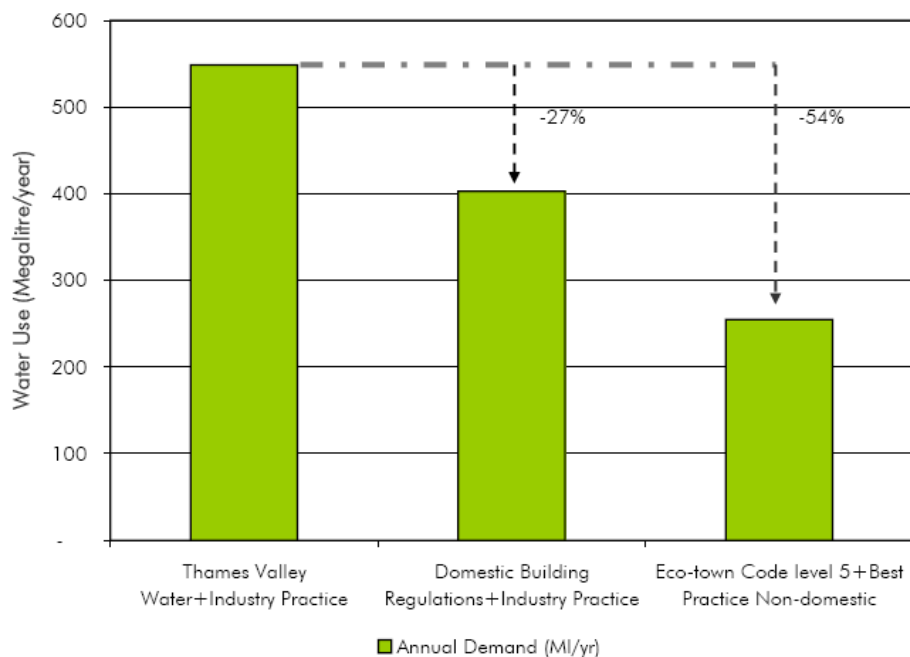
**Elsenham Predicted Non-Domestic 'Wholesome' Water Use - 2030**



**Figure 2 - Water Elsenham Predicted Non-Domestic 'Wholesome' Water Use – 2030**

The Eco-town PPS states that towns in areas of serious water stress should meet the water consumption requirements of Code for Sustainable Homes level 5 (i.e. 80l/p/d) and similar high standards for non-domestic buildings. Therefore, from Figure 1 and Figure 2, the 'Exemplary Practice' Standard for dwellings and 'Best Practice' Standard for non-domestic buildings are the targeted water demand levels for the Elsenham Eco-town. These levels would achieve a 54% reduction in water demand from a 'Local Current Use' and 'Industry Standard' practice baseline (see Figure 3).

**Elsenham Eco-town - Total Predicted Water Use Reduction from Baseline**



**Figure 3 - Reduction in Water Use from Standard Baseline**

Standards Applied	Annual 'Wholesome' Water Use* (MI/yr)	Reduction from TVW Average and Industry Practice (%)
'Best practice Code 5' + 'best practice non-domestic'	255MI/yr	54%
'Building Regulations' + 'industry standard practice'	403MI/yr	27%
'TVW average' + 'industry standard practice'	549MI/yr	0%
* The domestic water use represents 86% of the predicted water use within the Eco-town.		

**Table 1 - Predicted water demand and % reductions from standard practice**

### 3.2 WATER USE BREAKDOWN

Figure 4 and Figure 5 below provide a typical breakdown in water use within domestic buildings and offices, which are likely to be the predominant building types developed in Elsenham Eco-town. These figures indicate where water resources are used within the building and enable identification of where water use saving measures can be applied to high water uses and also where alternative water sources can be applied.

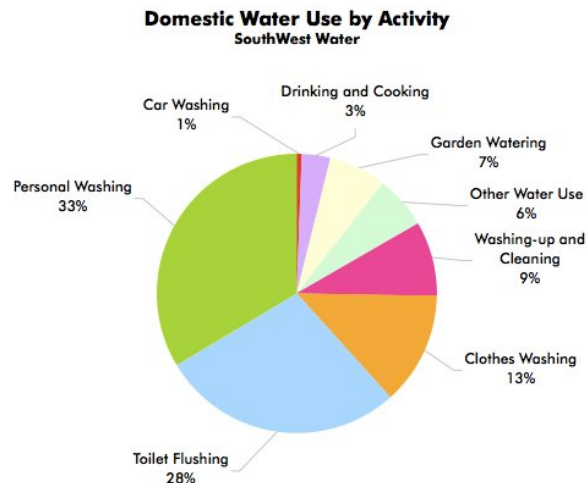


Figure 4 - Water use breakdown in a dwelling by Activity (as per Southwest Water)

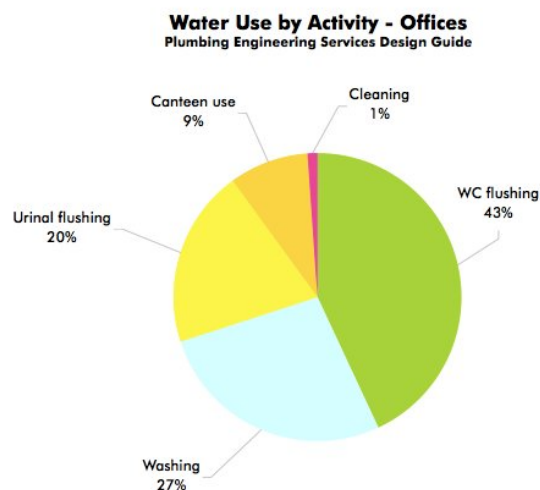


Figure 5 - Water use breakdown in offices by Activity<sup>2</sup> (Source: Plumbing Engineering Services Design Guide)

The upcoming revision of Building Regulations Part G: Hygiene differentiates between those activities that are appropriate for 'wholesome' or potable water use and those that could make use of 'non-wholesome' sources of water (e.g.

<sup>2</sup> This breakdown does not consider that water which is used in any air conditioning units

rainwater of greywater)<sup>3</sup>. For more information see Appendix B: Proposed Part G Consultation Changes.

It is estimated from the above breakdown and proposed Part G guidance that approximately 49% of a dwelling's water demand and 63% of an office's water demand may be supplied by non-wholesome water sources. Use of alternative water sources for these elements is a step towards water neutrality.

## 4 WATER USE REDUCTION DESCRIPTION

### 4.1 WATER EFFICIENCY

Use of efficient water fittings and appliances can help to reduce the potable and non-potable water required for domestic services (e.g. WC flushing, hygiene, cleaning, drinking). However, these must be supported with a change in occupant behaviour.

To support the achievement of exemplary water efficiency, the design of individual dwellings should include the following water efficient appliances:

- WCs, 4/2 litre dual flush
- Flow control fittings to all basins and taps, such as flow restrictors or aerators
- Proximity detection to non-domestic basins, taps and urinals
- Low volume or ergonomic baths
- All domestic appliances installed to be best-practice with respect to water use
- Inclusion of water meters to make consumers more aware of their water use and potentially accountable for the amount they use.
- Careful plant species selection to minimise water requirements for irrigation, including potential drought hardy indigenous landscaping.

There are also a number of improvements that can be made to reduce water consumption in commercial buildings. BREEAM Offices provides credits based on water consumption, measured in m<sup>3</sup>/person/year. Other versions of BREEAM such as Retail award credits based on water fitting specifications rather than consumption benchmarks. Water use is dependent on building type, building use, staff numbers, and fittings.

In order to reduce unnecessary use of potable or wholesome water for irrigation purposes around the Eco-town the plants selected for the landscape design would be based on a selection of native species and specification of drought-resistant plants. Rainwater collection and storage facilities would be used to supply water to the planting arrangements and play fields, either as a network of smaller supply points or as several larger ones. Greywater would also be considered for use in the plantings and play fields. Special consideration as to the use of water in market gardens and allotments will be given, with efficient irrigations systems put

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<sup>3</sup> 'Wholesome' water is often considered as 'mains' water, but may be any water supply that is of suitable drinking standard (as defined by the Water Act, 1991). 'Non-wholesome' water is water that is not treated to as high a standard as the 'wholesome' or potable standard.

in place using drip or trickle irrigation for shrubs and trees (this is more efficient than using overhead sprinklers) along with effective timing of irrigation to avoid watering during the day (when evaporation rates are highest).

## 4.2 ALTERNATIVE WATER SOURCES

### 4.2.1 Rainwater collection

Rainwater harvesting would typically use run-off from roofs, but could also use water from hard-standing areas around the site, with water from this surface collection stored in tanks and/or surface water bodies. Table 2 provides a breakdown of rainwater collection possibilities and considerations.

Supply Source & Considerations	
Individual building rooftops	Collect rainwater from rooftops as this is a clean source of water, and can be used directly for WC's and washing with only macro filtering applied (i.e. to remove debris) or conveyed to central plant for Reverse Osmosis/UV/chemical shock treatment to potable standard for water neutrality.
Surface water runoff	Surface water runoff may be collected from rooftops, permeable paving, underground pipes or channels, vegetated swales, bio-retention cells and filter strips. These would lead to collection pipes, which in turn would re-direct to local collection tanks or to central plant for treatment to potable standard.

**Table 2 - Rainwater collection sources**

Rainwater harvested from local collection tanks could be treated using cyclone filtration to remove particles and distributed for various non-wholesome water usages such as irrigation, landscaping, car washing and toilet flushing. Accidental cross connection between main water supply and reclaimed water would be avoided by following good practice guidance.

An evaluation of the likely storage volume of a local storage rainwater harvesting system to meet non potable water supply requirements has been carried out. Other rainwater harvesting options including treatment to full potable standard will be evaluated at detailed design stage.

The evaluation has been based on the following:

1. Rainwater is collected from roofs only.
2. The harvested water would be used for WC flushing, irrigation and other non-potable usage such as car washing etc.
3. The non potable water usage has been assessed to be 57 litres per person per day, which equates to 37% of the assumed daily water demand of 125 litres per person per day (i.e. B.Reg's Pt G requirements). Non-domestic 'non-wholesome' water demand is ~63% of total demand.
4. An allowance of 5 litres per person per day has been made for irrigation.
5. Residential occupancy is based on 2.3 persons per dwelling.
6. Occupancies of buildings have been averaged over the year, with residential occupancy being 96% of the year (allowing 2 weeks annual leave), offices 64% of the year (allowing annual leave and not working

weekends) and schools 54% of the year (allowing school holiday and weekends).

The evaluation outcome suggests that:

1. Based on an AR/D value of 0.81 (the ratio of the catchment area multiplied by the annual rainfall divided by the annual demand - CIRIA C539), the maximum efficiency is 68%. This equates to a storage period of 10 days of demand, which is equal to 4861 m<sup>3</sup>.
2. The rule of thumb method, assuming the storage volume is equal to 5% of the annual yield, gives a storage volume equal to 8 days of demand, which is equal to 4834 m<sup>3</sup>.

The storage tank selection will be a balance between the available rainwater, the water volume to be stored as determined by the number of days of use, the site conditions and location of the tank, and the cost of the tank.

Harvesting rainwater, using the above assumptions, has the potential to yield 177MI/yr, based on a complete use of 4861m<sup>3</sup> storage every 10 days, which is equivalent to 69% of the total annual demand.

#### 4.2.2 Greywater collection

Reclaimed grey-water can be collected from basins, baths and showers for non wholesome water usage. It would be filtered, disinfected and redistributed for toilet flushing or outdoor use (e.g. car washing, landscape irrigation).

Greywater collection from personal washing (i.e. showers) and clothes washing can be applied at an individual housing scale with small collection, filtering and distribution systems for use in WC's and washing machines. However such individual systems can be problematic in operation for the following reasons:

- They require frequent maintenance to check that filters are not blocked. If blocked they revert to backup potable water supplies and as users often prefer the back up water quality they do not insist on regular maintenance and little potable water is saved.
- The colourant and disinfectant used is commonly bromine. This is the next heaviest halogen to chlorine, it is persistent in the environment and can damage wastewater treatment plant by killing the bacteria responsible for treatment.
- A separate low level collection, filtration, disinfection and pumping tank is required to the high level storage header tank and such tanks can be expensive to provide and difficult to accommodate. In addition separate greywater drainage systems are needed, leading to increased costs and spatial requirements.

Greywater collection could also be applied at a neighbourhood or site-wide scale and it is likely that such systems would be preferable to small scale. Options for such communal scale systems that could be further evaluated are:

1. A separate greywater drainage system involving a pipe network collecting greywater to feed into a central plant with filtration / UV treatment, for re-distribution to meet non wholesome water requirements.
2. A network of constructed wetland trenches known as Gravel Bed Hydroponic (GBH) wetland networks. These are effectively a network of collection trenches

filled with gravel and planted with reeds and other water loving species. The constructed wetlands are the most efficient of the vertical reedbed treatment systems, requiring only approximately one quarter of the area of horizontal constructed wetland for the same treatment standard. GBH trench networks also replace the need for a separate greywater collection drainage network system, provide wildlife corridors and habitats and can provide high levels of nitrate removal from anoxic bacteria. These bacteria inhabit the gravel at depths below 500mm and can metabolise nitrate for its oxygen content, releasing simple nitrogen.

Table 3 illustrates the potential available greywater that could be collected for re-use across the Elsenham development.

Sector	Source	Yield (MI/yr)
Domestic	Efficient Wash Basins + Shower + Bath = 36.7l/p/d for 5,000 homes	147MI/yr
Non-Domestic	Efficient Wash Basins = 12.7l/p/d for ~ 6,200 persons	17MI/yr

**Table 3 - Greywater collection source and predicted yield**

Using the above assumptions, the harvesting of greywater is predicted to have the potential to yield 164MI/yr, based on collection from wash basins, showers and baths in both domestic and non-domestic buildings. This is equivalent to 64% of the total annual demand.

As greywater is more expensive to treat to potable standard than rainwater, with higher energy costs and CO<sub>2</sub> emissions, it is likely that greywater would be treated to meet non potable water use and supplied via a separate non wholesome water pipe network. Harvested rainwater would then be treated to potable standard and used in a separate potable water pipe supply network.

It has been predicted that in principle there is sufficient collectable greywater and rainwater, treated to potable and non-potable standards, to make a water neutral solution to be achievable. However an exhaustive options appraisal of the construction and operational costs and issues such as user acceptance has to take place at detailed design stage in order to compare with a solution that relies on mains water use in accordance with the Eco-towns water use targets and demand reduction measures, with grey/rainwater harvesting to meet non wholesome water needs.

#### 4.2.3 Supply Scenario examples for compliance with Eco-towns water use standards if water neutrality is not feasible

A range of efficient fittings and appliances will be considered for the dwellings of Elsenham, along with the supply of alternative water sources for appropriate uses. Table 4 provides an illustration of potential measures.

Option	Features	Equivalent Code Level
Option 1 – Efficient Fittings n.b. this option does not meet the eco-towns target	Dual Flush 4/2L WC + Low Flow Basins and Shower + Ergonomic Bath + Efficient Washer and Dishwasher	3/4
Option 2 – Efficient Fittings + Rainwater harvesting (individual)	Option 1 + Individual Rainwater Collection for WC + Washer	5/6
Option 3 – Efficient Fittings + Rainwater harvesting (community)	Option 1 + Community Rainwater Collection for WC + Washer	5/6
Option 4 – Efficient Fittings + Greywater harvesting (no washer connection)	Option 1 + Individual Greywater Collection for WC + Washer	5/6

**Table 4 - Efficient water fittings and alternative sources of water and equivalent Code level**

### 4.3 WASTEWATER

The process of treating wastewater is done in four stages. The first, preliminary treatment, provides grit removal and screening of large solids. Second, primary settlement removes heavy solids, grease and scum whilst also providing flow balancing and some biological treatment. Thirdly, a secondary treatment introduces aeration to break down organic material. The final stage is the tertiary treatment that allow for final polishing prior to integrating into water courses or land.

The Water Cycle Scoping Study has indicated that drainage for Elsenham lies on an operational boundary between Anglian Water (AW) and Thames Water (TW) service areas. This operational boundary line appears to broadly follow Elsenham High Street with AW's region to the north and TW's region to the south. Improvement of the existing Stansted Mountfitchet sewage treatment works and associated infrastructure will most likely be required to receive the increased flows from the development.

Ultimately the Water Cycle Study for Elsenham will assess the options available for sewage treatment and identify the most sustainable and feasible solution. This will require further consultation with sewerage undertakers and the EA to ensure the solution complies with the necessary consent criteria. Initial consultation with Anglian Water and Thames Water has identified four options for the disposal of foul water:

1. Foul drainage to drain into the existing system, with upgrades to enable it to be pumped to the sewage treatment works at Stansted Mountfitchet;
2. A new sewage treatment works to the north of the development draining into the River Cam;
3. A new sewage treatment works at the south of the site draining into Stansted Brook;
4. A new sewage treatment works to be located at a suitable location discharging clean flows into the ground.

The potential to use small onsite packaged sewage treatment plants, incorporating wetlands / reed beds, will also be investigated as these low-impact treatment techniques have the potential to add a further degree of water security and sustainability.

#### Conventional Techniques

Conventional wastewater treatment essentially involves initial screening of larger objects followed by primary sedimentation treatment of suspended solids and secondary treatment which pumps air into wastewater or uses trickle filters. This process stimulates the proliferation of bacteria, which assimilate the nutrients in much the same way as a natural system, reducing the biological oxygen demand to compliance levels suitable for discharge of the treated water.

Modern conventional methods are often energy intensive but have the major advantage of requiring a much reduced land area compared with a wetland system.

#### Low impact techniques

Modern design of constructed wetlands (e.g. reedbeds) generally attempts to achieve the element of tertiary treatment, beyond minimum discharge treatment standards and being nutrient reclamation and carbon fixing, in as small an area as possible whilst allowing for passive measures to minimise energy input into the process (as described above for Gravel Bed Hydroponic systems). The design of a constructed wetland will be unique to the climate, topography and soil characteristics of the locality.

The solids produced in the primary sedimentation process can be treated by composting, or by pressing/drying/digesting to provide a fuel for energy production. All treatments serve to chemically stabilise the solids and reduce pathogens. The end product of composting is soil with a high organic content that is suitable for growing plants, although it cannot be used on edible crops for 3 months prior to harvesting. However, considerable CO<sub>2</sub> is emitted during composting without the benefit of producing renewable energy and therefore other treatment methods that achieve onsite treatment of site organic waste coupled with the production useable renewable energy will be considered preferentially first. The end product of drying is a fibrous 'brick' that can be used as a fuel. The end products of anaerobic digesting are a gas that can be used to generate power, liquor that can be used as a liquid fertiliser, plus a fibrous solid that can be used to improve the water holding capacity of a soil or burnt as a fuel.

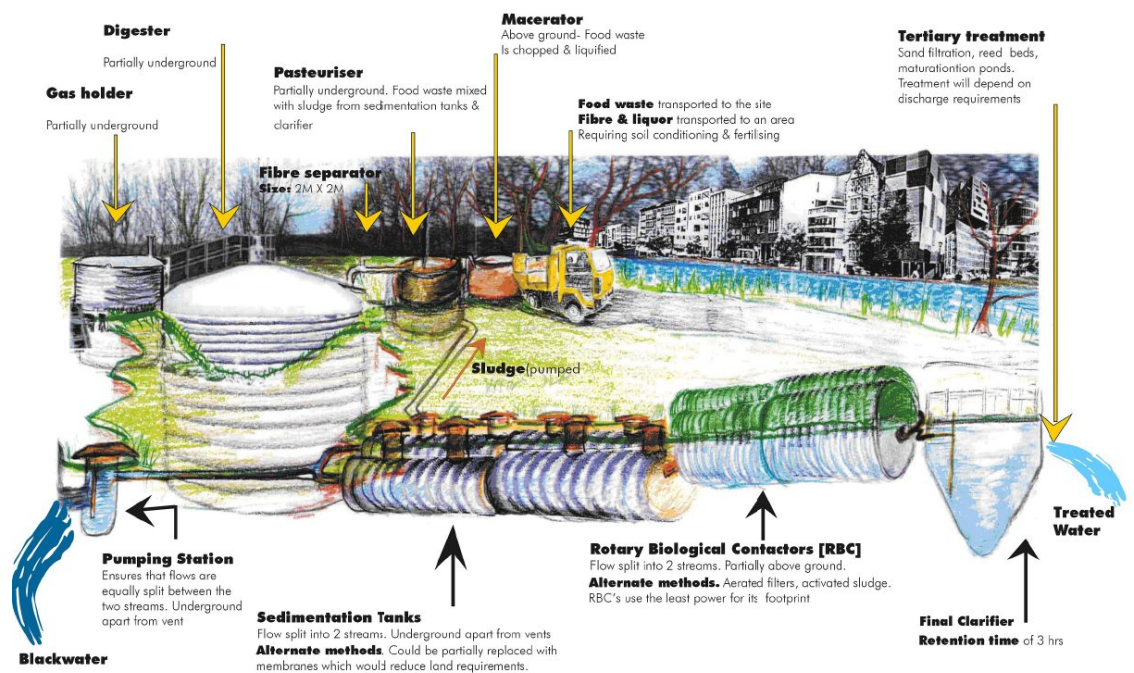


Figure 6 - Example onsite wastewater treatment

#### 4.4 WATER NEUTRALITY

The concept of water neutrality, as defined in the Eco-town PPS, is “where the total water used after a new development is no more than the total water used before the development.’

The above predictions and water collection techniques provide an indication as to how water neutrality might be achieved for the Elsenham Eco-town. The harvesting of rainwater, being the first and preferred choice of alternative water supply, may be able to yield 177MI/yr or 69% of the total predicted demand. In addition, greywater harvesting could also yield 164MI/yr or 64% of the total predicted demand. The combined effect of using these alternative sources of water treated to both a potable and non-potable standard would help to achieve water neutrality.

It is worth noting that there are cost and potential health and safety issues when considering water distribution networks carrying different treatment grades of water. Therefore, although it will be considered as a strategy in design development as it will reduce the overall embodied CO<sub>2</sub> emissions of the water provided, commercial and health risk issues will also be taken into account which could result in all alternative water supplies being treated to potable standard to enable a single pipe distribution network.

Water neutrality is likely to be most suitably achieved by consideration of reclamation in the following order:

- harvested rainwater from roofs treated to potable supply standards followed by rainwater harvesting from paved areas for high level treatment
- should further potable water supply be required greywater could be treated to a lower standard to, for example, flush toilets

- greywater and wastewater can be treated to potable water standard but costs can be high and there may be user resistance issues so this should only be considered as a last resort.

These options are subject to further investigation into technical, environmental, legislative and economic viability. Proposals to meet the Eco-town water targets and further consideration of the aspiration of water neutrality will be provided for outline planning.

#### 4.5 CLIMATE CHANGE

Predictions for a changing climate, whereby water stress is increased due to altered rainfall patterns and increased temperatures, identify that the East of England will be significantly affected as it is currently the driest region in the UK and likely to face increasing frequency of drought conditions. Summers are predicted to continue to get drier, thus exacerbating current drought risk, and winters are due to experience more frequent precipitation events (UKCIP02, 2002).

The water strategy for the Elsenham Eco-town will consider the risks posed due to climate change, and development of any rainwater collection storage and treatment proposals as outlined above would consider the effect of future precipitation levels on the ability of rainwater harvesting to meet water demand.

#### 4.6 GOVERNANCE

Further investigations will be made into the potential for a centralised management body to undertake the operation, maintenance and billing of a complete (or partial) water supply and disposal system. This body could be a component of the Elsenham Cooperative Limited (ECL), who could either act directly as the operating body or work in a licensing partnership with a water undertaker. The integration of energy supply under the ECL in addition to other services would be part of a multi utility or MUSCo approach.. Operation, management and billing costs under the ECL of MUSCo become more efficient with an increasing number of utilities/services supplied to a single community. The involvement of an water operating partner could relate to the infrastructure investment phase (e.g. expressing a preference for a technology or distribution type) or the billing and maintenance considerations. The level of involvement is likely to be based on the preference of a particular undertaker and the influence of their financial model.

There is potential of supporting the cost of management and maintenance of rainwater and greywater systems via a significant reduction in mains water brought into the development. The net water imported to the development could be close to nothing if water neutrality is worked towards, with the site operator receiving a percentage of a consumers cost savings compared to costs from the local incumbent utility supplier.

All potential technology/finance/partnering options will be further appraised as the water strategy is developed leading up to outline planning, including those focusing on the local incumbent utility suppliers and those involving a more independent focused approach.

## 5 FURTHER PROPOSAL INVESTIGATIONS

This water benchmarking study provides a prediction of the likely demand for an Eco-town development at Elsenham. During the lead up to outline planning, a full water strategy will be developed, drawing from the Water Cycle study and discussions with the appropriate water and wastewater suppliers, Environment Agency, and other key stakeholders.

## APPENDIX A: ANNUAL WATER DEMAND ASSUMPTIONS

### Domestic Water Demand Values

Elsenham Predicted 'Wholesome' Water Use		
	Water Demand (Megalitre)	Percentage of reduction from TVW Baseline (Megalitre)
Eco-Town with 5000 units		
Three Valley Water Use (174l/p/d)	518	0%
Part G Water Use* (125 l/p/d)	372	-28%
Code 3/4 Water Use* (105l/p/d)	313	-40%
Code 5/6 Water Use* (80l/p/d)	238	-54%
* Based on notional design values and do not reflect actual use		

**Table 5 - Domestic water benchmarks and annual water demand**

## Non-Domestic Water Demand Values

Elsenham Eco-Town			Water Benchmarks				Use Coefficient	Annual Water Demand (MI/yr)	
Type	Total Area (m <sup>2</sup> )	Population	Industry Standards	Units	Best Practice	Units	%	Industry Standards	Best Practice (l/yr)
Offices	11,400	1,140	9,300	(l/p/yr)	6,400	(l/p/yr)	64%	10.60	4.67
Retail - Food	1,850	370	400	(l/m <sup>2</sup> /yr)	300	(l/m <sup>2</sup> /yr)	96%	0.74	0.53
Retail - Non Food	6,300	1,260	400	(l/m <sup>2</sup> /yr)	300	(l/m <sup>2</sup> /yr)	96%	2.52	1.81
100 Bed Hotel	1,000	200	3,000	(l/bedspace/yr)	1,500	(l/bedspace/yr)	96%	0.60	0.29
Primary School	1,500	143	3,800	(l/p/yr)	2,700	(l/p/yr)	54%	0.54	0.21
Secondary School	1,000	83	3,900	(l/p/yr)	2,700	(l/p/yr)	54%	0.33	0.12
Library	575	57.5	203	(l/m <sup>2</sup> /yr)	128	(l/m <sup>2</sup> /yr)	54%	0.12	0.04
Health	790	79	1,560	(l/m <sup>2</sup> /yr)	900	(l/m <sup>2</sup> /yr)	96%	1.23	0.68
B2 industrial	10,600	424	9,300	(l/p/yr)	6,400	(l/p/yr)	64%	3.94	1.74
Other B1 employment w R&D and light industry	31,000	1,550	9,300	(l/p/yr)	6,400	(l/p/yr)	0.64	9.92	6.35

**Table 6 - Non-domestic water benchmarks and annual water demand**

Assumed population and water demands: OFFICE	
Population	CIBSE Guide A – Environmental Design One person per 10 m <sup>2</sup>
Water benchmarks	OGC - Final Watermark Project Report, May 2003 – Industry Standards: 9,300 l/p/yr – Best Practice: 6,400 l/p/yr
Assumed population and water demands: RETAIL – FOOD	
Population	CIBSE Guide A – Environmental Design One person per 5 m <sup>2</sup>
Water benchmarks	Estimation: – Industry Standards: 400 l/m <sup>2</sup> /yr – Best Practice: 300 l/m <sup>2</sup> /yr
Assumed population and water demands: RETAIL – NON-FOOD	
Population	CIBSE Guide A – Environmental Design One person per 5 m <sup>2</sup>
Water benchmarks	Estimation: – Industry Standards: 400 l/m <sup>2</sup> /yr – Best Practice: 300 l/m <sup>2</sup> /yr
Assumed population and water demands: HOTEL	
Population	Estimation: Two people per bedroom
Water benchmarks	CIRIA C657: Water key performance indicators and benchmarks for offices and hotels – Industry Standards: 3000 l/ bedspace/yr – Best Practice: 1500 l/bedspace/yr
Assumed population and water demands: PRIMARY SCHOOL	
Population	Estimation: 500m <sup>2</sup> effective area: 1 pupil each 3.5 m <sup>2</sup>
Water benchmarks	DfES (Oct. 2002) Energy and Water Benchmarks for Maintained Schools in England 2000-01 – Industry Standards: 3,800 l/p/yr – Best Practice: 2,700 l/p/yr
Assumed population and water demands: SECONDARY SCHOOL	
Population	Estimation: 333m <sup>2</sup> effective area: 1 pupil each 4 m <sup>2</sup>
Water benchmarks	DfES (Oct. 2002) Energy and Water Benchmarks for Maintained Schools in England 2000-01 – Industry Standards: 3,900 l/p/yr – Best Practice: 2,700 l/p/yr
Assumed population and water demands: LIBRARY	
Population	Estimation: One person per 10 m <sup>2</sup>
Water benchmarks	OGC - Final Watermark Project Report, May 2003 – Industry Standards: 9,300 l/m <sup>2</sup> /yr – Best Practice: 6,400 l/m <sup>2</sup> /yr
Assumed population and water demands: HEALTH	
Population	CIBSE Guide A – Environmental Design One person per 10 m <sup>2</sup>
Water benchmarks	OGC - Final Watermark Project Report, May 2003 – Industry Standards: 1,560 l/m <sup>2</sup> /yr

	– Best Practice: 900 l/m <sup>2</sup> /yr
Assumed population and water demands: B2 INDUSTRIAL	
Population	Estimation: One person per 25 m <sup>2</sup>
Water benchmarks	OGC - Final Watermark Project Report, May 2003 – Industry Standards: 9,300 l/p/yr – Best Practice: 6,400 l/p/yr
Assumed population and water demands: OTHER B1 EMPLOYMENT INCLUDING R&D AND LIGHT INDUSTRY	
Population	Estimation: One person per 25 m <sup>2</sup>
Water benchmarks	OGC - Final Watermark Project Report, May 2003 – Industry Standards: 9,300 l/p/yr – Best Practice: 6,400 l/p/yr

## APPENDIX B: PROPOSED PART G CONSULTATION CHANGES

### 5.1 PROVISION OF COLD WATER SUPPLY

G1 (1) There shall be a suitable installation for the provision of wholesome water to –

- a) any place where drinking water is drawn off;
- b) any sanitary appliance used for washing provided in accordance with G4 and G5; and
- c) any sink provided in accordance with G6 and in a place kitchenware and utensils are washed.

(2) There shall be a suitable installation for the provision of water of suitable quality to any WC or urinal fitted with a flushing device.

(3) In this Part “wholesome water” has the same meaning as Section 67 (Standards of wholesomeness) of the Water Industry Act 1991.

### 5.2 WHOLESOME WATER (ALL BUILDINGS)

1.1 Water supplied to the building by a statutory water undertaker or a licensed water supplier through an installation complying with the requirements of the Water Supply (Water Fittings) Regulations 1999 (SI 1999/1148 as amended) may be assumed to be wholesome water.

1.2 Attention is drawn to the requirements of the Water Supply (Water Fittings) Regulations 1999 (SI 1999/1148 as amended) which make provision for preventing contamination, waste, misuse, undue consumption and erroneous measurement of water supplied by a water undertaker or licensed water supplier.

1.3 Where a building is supplied with water from a source other than a water undertaker or licensed water supplier, the water shall be considered to be wholesome if it meets the criteria set out in the Private Water Supplies Regulations 1991 (SI 1991/2790 as amended).

### 5.3 NON-WHOLESOME WATER (ALL BUILDINGS)

1.4 Water treated to the high standards of wholesome water is not essential for all of the uses that water is put to in buildings, e.g. toilet flushing, irrigation. A variety of alternative sources are available for water. These include –

- a) Water abstracted from wells, springs, bore-holes or water courses;
- b) Captured rainwater;
- c) Reclaimed grey water; and
- d) Reclaimed industrial process water.

Note: Guidance on the marking of pipework conveying water from non-wholesome sources can be found in the WRAS Information & Guidance Note No. 9-02-05 Marking and identification of pipework for reclaimed (grey water) systems.

1.5 Water from non-wholesome sources not treated to wholesome water standards might contain particulate contaminants. Such water should be filtered prior to storage.

1.6 Water from non-wholesome sources that does not need treatment other than filtration should be stored prior to transfer to the point of use or a cistern either –

- (a) Underground; or
- (b) Above ground at a temperature not exceeding 25°C.

1.7 Where storage is above ground and the water is intended for use inside the building, the systems should be designed to minimise the retention time of the stored water. Systems should incorporate a mechanism that allows for (a) the automatic dumping of stagnant water (b) discharge of water to facilitate maintenance. Where practical, this should be an automatic system.

	WCs and Urinals	Laundry	Outdoors Use
Well, spring, borehole or water course	Yes with satisfactory risk assessment taking account of changing conditions	Yes with satisfactory risk assessment taking account of changing conditions	Yes
Rainwater	Yes	Yes	Yes
Reclaimed grey water	Yes with satisfactory risk assessment	Yes with satisfactory risk assessment	Yes with satisfactory risk assessment

**Table 7 - Examples of appropriate uses of non-wholesome water in dwellings (source: Part G Consultation, CLG 2008)**

	WCs and Urinals	Laundry	Outdoors Use
Rainwater	Yes	Yes	Yes
Wells, springs, bore-holes or water courses	Yes with satisfactory risk assessment taking account of changing conditions	Yes with satisfactory risk assessment taking account of changing conditions	Yes
Air-conditioning condensate	Yes	Yes	Yes
Reclaimed grey water	Yes with satisfactory risk assessment	Yes with satisfactory risk assessment	Yes with satisfactory risk assessment
Effluent (reclaimed industrial process water)	Yes with satisfactory risk assessment	Not normally practical	Not normally practical

**Table 8 - Examples of appropriate uses of non-wholesome water in buildings other than dwellings (source: Part G Consultation, CLG 2008)**

## APPENDIX C: CODE FOR SUSTAINABLE HOMES WATER CALCULATOR

### 5.4 THE CODE WATER CALCULATION EXAMPLES

The following provide an example of how the different Code levels can be achieved using the Code Water Calculator.

The Code for Sustainable Homes Level 6 water use requires a design level of 80l/p/d, based on the CSH water calculator. The comparison with average water use of 173l/p/d presents a great opportunity reduce water demand in the East, which is identified by the EA as an area of 'serious' water stress. The following Options provide an assessment of those fittings that are able to meet this water target.

Where,

Option 1 – Efficient Fittings

Option 3 – Efficient Fittings + Rainwater harvesting (community)

Option 2 – Efficient Fittings + Rainwater harvesting (individual)

Option 4 – Efficient Fittings + Greywater harvesting (no washer connection)

	CSH 5/6 Option1	CSH 5/6 Option2	CSH 5/6 Option3	CSH 5/6 Option4
WC - Dual Flush	4/2.6 (litres) 2.8	4/2.6 (litres)	4/2.6 (litres)	4/2.6 (litres)
Wash Basin	(litres/min)	3 (litres/min)	3 (litres/min)	4 (litres/min)
Shower	7 (litres/min)	8 (litres/min)	8 (litres/min)	8 (litres/min)
Bath	100 (litres) 2.8	110 (litres)	110 (litres) 2.8	100 (litres)
Kitchen Sink	(litres/min)	3 (litres/min)	(litres/min)	2.8 (litres/min)
Washing Machine	39 (l/p/d)	39 (l/p/d)	39 (l/p/d)	39 (l/p/d)
Dishwasher	12 (l/p/d)	12 (l/p/d)	12 (l/p/d)	12 (l/p/d)
Net Dwelling Water Use	98.22	104.94	103.88	107.57
Rainwater Collection	0	27.98	27.98	0
Greywater Recycling	0	0	0	27.98
Gross Dwelling Water Use	98.22	76.96	75.9	79.56
Code Level	Code 6 Not Possible	5/6	5/6	5/6

Meeting the 80L/person/d target requires a balance to be achieved against consumer perception and comfort vs. water savings.

One of the main things to note with meeting this target is that is should be ensured that consumer comfort is maintained to reduces the likelihood of consumers retro-fitting sanitary fittings post-occupation. Whilst this cannot be prevented, it can to an extent be mitigated against through the installation of fittings that still offer consumer satisfaction.

## Schedule of Revisions

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