UNITED UTILITIES

UNITED UTILITIES HOME AUDIT PROJECT

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SUMMARY

I OBJECTIVES

1. Determine the practicality of fitting and promoting a range of water saving devices;
2. Gain a better understanding of the likely costs of fitting these devices;
3. Determine associated savings of these devices through property and DMA metering.

II REASONS

United Utilities (UU) is in a position of low water stress however over the next 25 years the company will have to invest in small to medium scale supply-demand schemes. WRMP methodologies require that all potential supply-demand schemes be compared on a like for like cost/benefit basis. Therefore UU has conducted a study into the effectiveness of domestic water efficiency devices. The project has been designed to investigate the potential costs involved in conducting an efficient large-scale scheme, as opposed to a project aimed to maximise water savings at any cost.

III CONCLUSIONS

The key results of the study regarding number of audits and devices fitted are shown in Table 1. The percentage of each device fitted indicates the proportion of households where at least one of these devices was installed.

Table 1 Uptake rate and devices fitted

Offers to take part in water efficiency study	4,642
Household Audits undertaken	393
Successful response rate	8%
Showerheads fitted	212 (48%)
Eco-beta dual flush retrofits fitted	193 (34%)
Save-a-flush bags fitted	384 (58%)

A simple regression model, built to disaggregate the measured property savings into savings for each device gives the results in Table 2:

Table 2 Estimated water savings per device

	Water savings		
	l/prop/day	**l/prop/year**	**m^3/year**
Savings from participating in survey (constant)[1]	47	17,039	6713
Estimated dual flush savings	2	804	108
Estimated Save-a-flush savings	10	3,653	825
Estimated showerhead savings	37	13,441	2,554

An average incremental cost (AIC) and an average incremental social cost (AISC) have been calculated for this water efficiency scheme. A water efficiency scheme's AIC measures how much it has cost, on average, to save one unit of water. The AISC incorporates external social and environmental costs and benefits. AICs and AISCs have been expressed as pence per cubic metre of water saved. Headline results are given in Table 3.

Table 3 Scheme AIC and AISC Results

NPV Scheme Costs (£)	55,775
NPV Opex Savings (£)	913
NPV water Savings (m3)	45,628
AIC (p/m3)	**120.2**
NPV Net Carbon Costs	-6,179
NPV Net Other Social and Environmental Costs	189
AISC (p/m3)	**107.1**

The results show that it cost 107.1 pence to save 1 cubic meter of water from the trial. The AISC result is lower than the AIC, and this is mainly due to the carbon benefit of saving hot water from using efficient showerheads.

IV RECOMMENDATIONS

The context of the results from this trial should be considered carefully before extrapolation to represent a larger scale trial. The sensitivity analysis indicates that the 'constant' water savings (thought to be associated with behaviour change immediately after having an audit carried out) are a key factor in determining the AISC of the trial. In addition, the results from the eco-beta should be considered in relation to the target properties of the trial – which being newer would have a smaller than average proportion of toilets suitable for retrofit.

[1] Note, these savings have been adjusted to take account of approximately 12 l/prop/day of 'background' savings which are external to the trial. See section 3.3.2.

1. INTRODUCTION

Over the last few years the profile of demand management and water efficiency promotion has moved up the regulatory and political agenda. Following the 2006 droughts in South East England and the continuing pressures on the available supplies in the region there has been increased activity by government and regulators looking at possible mechanisms for encouraging water efficient behaviour. In particular there are clear expectations from Ofwat and the Environment Agency (EA) that water efficiency measures should form part of all company's Water Resource Management Plans (WRMP). Ofwat are currently consulting on the introduction of mandatory water efficiency targets for water companies.

United Utilities (UU) is in a position of low water stress however over the next 25 years the company will have to invest in small to medium scale supply-demand schemes. WRMP methodologies require that all potential supply-demand schemes be compared on a like for like cost/benefit basis. The EA have been urging water companies to adopt a more environmentally focussed agenda that places greater emphasis on encouraging water efficiency schemes.

United Utilities believes that supply-demand investment should be made on a cost/benefit basis. Water efficiency schemes can be effectively costed, however there is a lack of detailed region specific information about the benefits that are achievable through these schemes. Therefore UU has conducted a study into the effectiveness of domestic water efficiency devices. The project has been designed to realistically represent what the costs of conducting an efficient large-scale scheme would be, as opposed to a project aimed to maximise savings at any cost.

1.1 The location of the trial

United Utilities owns and operates the water network in North West England. It provides water and wastewater services to 2.9 million homes and over 200,000 non-household customers across the region. The company supplies 1,900 million litres of water every day via a network of over 40,000 kilometres of water mains, and over 100 water treatment works.

A total of 4,642 customers living in two DMAs in the Great Sankey area of Warrington were invited to participate in the trial. In total 393 audits were successfully completed, from a pool of 509 households that originally volunteered to take part.

1.2 Aims and objectives

The study was aimed at investigating the effectiveness of domestic water efficiency devices. Specifically it was designed to:

1. Determine the practicality of fitting and promoting a range of water saving devices;

2. Gain a better understanding of the likely costs of fitting these devices;

3. Determine associated savings of these devices through property and DMA metering.

2. METHODOLOGY

2.1 Recruitment

An invitation to take part in a study into the effectiveness of water saving devices was sent to 4,642 domestic properties in the Greater Sankey area of Warrington (across two DMAs). Customers had to respond via an enclosed form to confirm they would be willing to take part in the trial. The invitation letter and application form distributed via post can be found in Appendix A.

The target population can be described as financially stable, living in homes predominantly built since 1990 (and therefore have a water meter). The area was specifically targeted as previous studies have indicated that the customers most likely to engage in water efficiency promotions are financially well off and living in a metered property. Over 95% of the target properties were in ACORN category 1 (Wealthy achievers) or 2 (Comfortably off). The population targeted by the study is therefore not representative of the UU customer base; however there are a large number of similar areas within the UU region.

Following receipt of the completed application form indicating willingness to take part in the trial, customers were contacted by telephone to arrange a suitable time for a qualified plumber to visit the property and have water efficient devices installed. UU offered only a limited number of Saturday appointments for audits, and it is thought this could have contributed to the drop-out rate seen between agreeing to participate and actually having an audit carried out. Overall 23% of the customers who agreed to participate ultimately dropped out of the trial. This is discussed further in Section 3.1. When customers were unsuccessful in having an audit carried out, a letter was sent offering a water savers pack (containing a shower timer). An example letter of this type can be found in Appendix B.

2.2 Measurement type

Of the 393 customers who underwent an audit, 313 were metered customers and 80 were unmetered

For metered customers, several meter readings were taken during the course of the trial. Initially the customers were asked to provide a meter reading when they responded to the invitation to take part in the trial. Subsequently meter readings were also taken when the water audit was carried out, and at one month intervals for three months following the trial. The post-installation meter readings have been used to calculate a post-trial average daily consumption for each household.

Meter readings from the UU billing database from before the trial began have also been collated (from as early as December 2006) and used to calculate a pre-trial average daily consumption for each household.

2.3 Water efficient devices

All customers who had a water audit carried out were given a 'water savers pack' which included a basic shower timer and information on saving water. Further devices were installed where appropriate including:

- Low flow shower heads (Challis aerated showerheads).
- Dual flush retrofit (EcoBeta Dual Flush devices).
- Save-a-flush cistern device.

Customers were given the option of requesting the removal or repair of water efficient devices for up to three months after they were fitted.

Devices were installed by 3 qualified plumbers, who each completed up to five appointments per day during the installation window.

During the water audit, information was gathered on the types and number of water using appliances installed in the home, and behaviour on water use. In addition information on occupancy was confirmed. Where shower heads were installed, pre-installation and post-installation flow rate readings were measured using a 'shower bag'. An example audit form can be found in Appendix C.

3. RESULTS

Both qualitative and quantitative analysis has been undertaken on the results of the trial. To reflect this, the following sections have been included within this results section:

- Participation rates
- Appliance installations and removals
- Water Savings
- Customer attitudes

Cost benefit analysis has also been undertaken for this trial, the results of this can be found in Section 4.

3.1 Participation

The invitation to take part in a study into the effectiveness of water saving devices was sent to 4,642 domestic properties in the Greater Sankey area of Warrington (across two DMAs). A total of 509 customers (11.0%) responded via the enclosed form to confirm they would be willing to take part in the trial. 393 customers (77% of those who volunteered) ultimately had an audit undertaken. Overall therefore, the uptake rate for the trial was 8.5%.

Before the audits took place, of the 393 customers who underwent a water audit:

- 5 had a negative attitude to water efficiency (1.3%) whilst 387 had a positive attitude (98.5%).
- 34 believed they did not behave in a water efficient manner (8.7%) whilst 356 believed they did behave in a water efficient manner (90.6%).
- 61 people thought their appliances were not water efficient (15.5%) whilst 319 thought appliances were water efficient (81.2%).
- 147 thought they would not change their behaviour (37.4%) whilst 241 thought they would (61.3%).

For some customers who volunteered to take part but did not ultimately undergo a water audit, reasons for dropping out were given. UU indicated that most customers probably left the study due to difficulties in arranging suitable appointments, as there were only a limited number of Saturday appointments available. Other reasons provided by customers included customer changing their mind, illness and a different customer being present at the address to the one who volunteered to take part.

313 of the 393 customers taking part in the audits were metered, with the remaining 80 customers being on unmeasured tariffs. Details of audit participation are given in Table 3.1. Table 3.2 shows the proportions of invited metered and unmeasured customers that completed an audit.

Table 3.1 Audit participation

Households invited to take part in audit	4,642
Households accepted invite	509
Households completed audit process	393
% participating households metered	77.1%
% participating households unmeasured	22.9%

Table 3.2 Uptake of metered and unmeasured customers

Customer type	% Uptake rate
Metered	10.4%
Unmeasured	4.9%

The uptake rate for metered customers was higher than for the unmeasured customers.

3.2 Appliance installations and removals

Although 393 customers underwent a home water audit, 57 of these customers did not have a shower head, save a flush or eco-beta dual flush retrofit device installed. However, all of the customers taking part in the trial were given a water savers pack including water efficiency information and a shower timer.

Table 3.3 shows the number of each device fitted in metered and unmeasured households. The percentage of households where at least one water efficiency device was fitted is also shown for measured and unmeasured households.

Table 3.3 Devices fitted in metered and unmeasured households

	Metered households	**Unmetered households**
Eco-beta dual flush retrofit device fitted	165	28
Save-a-flush cistern displacement device fitted	316	68
Water efficient shower head fitted	178	34
% households with devices fitted	87%	80%

Feedback questionnaires from approximately 3 months after the water audits occurred were returned by 243 of the customers. Information regarding device removal was included within the information on these surveys, and this is also reported within this section.

3.2.1 Water efficient shower heads

Only one property out of the 393 audited did not have a shower installed.

In total 212 shower heads were fitted across 190 households. 48.3% of homes that were audited therefore had at least one water efficient shower head fitted.

Shower heads were not offered to customers where the shower type was not suitable, for instance most electric showers. In addition to this, many customers declined the offer of an efficient showerhead, because they didn't want the head, or the existing head was ornamental etc. In a few cases (2 reported) the shower head did not fit the existing shower.

Of the customers who returned a feedback survey, 136 had originally had a shower head installed, and 100 indicated that they were still using the efficient shower head supplied. Therefore, within the first 3 months of an audit, 26.5% of customers are likely to remove an efficient shower head. UU did not ask for the showerhead to be returned in the event of it being removed. In addition no customers requested that the plumber return to remove a showerhead.

3.2.2 Eco-beta dual flush retrofit devices

Eco-beta dual flush retrofit devices were installed on toilets where the cistern volume was greater than 6 litres.

In total 325 toilets across 191 houses were suitable for eco-beta devices to be installed. Of these, 134 homes had at least one eco-beta installed, and a total of 193 toilets were converted to dual flush. Of the homes that were audited, 34.1% had at least one eco-beta device fitted. Due to the nature of the sample (fairly modern housing, with new toilets fitted), the number of toilets which were suitable for a dual flush retrofit is likely to be lower than the regional average.

Of the customers who returned a feedback survey, 99 had at least one eco-beta installed. 88 customers reported that they were still using the device. Plumbers were called back to 2 homes to remove eco-beta devices, and plumbers had to adjust the installation of a further 4 devices in 3 homes. This evidence suggests that, within the first 3 months of an audit, 11.1% of customers are likely to remove an eco-beta device – a process which can require plumbing expertise.

3.2.3 Save-a-flush cistern displacement devices

Save-a-flush cistern displacement devices were to be installed in toilets with cisterns of greater than 6 litres in volume where a dual flush retrofit could not take place, and in single flush toilets with 6 litre cisterns.

In total 570 toilets, across 291 houses were suitable for save-a-flush devices to be installed. Of these 226 homes had at least one save-a-flush installed, and a total of 384 devices were

installed. Of the homes that were audited, 57.5% had at least one save-a-flush installed. Due to the nature of the sample (fairly modern housing, with new toilets fitted), the number of toilets which were suitable for a save-a-flush cistern displacement devices is likely to be lower than the regional average.

Of the customers who returned a feedback survey, 128 had at least one save-a-flush installed, and 28 reported that they had removed at least one of those installed. This evidence therefore suggests that within the first 3 months of an audit, 21.9% of customers are likely to remove a save-a-flush device.

3.3 Water savings

Of the 393 customers who underwent a home audit, 313 were metered, and 80 were unmeasured.

3.3.1 Metered customers

Meter readings for each household were gathered from the UU billing database dating back to December 2006. Readings between December 2006 and the date of the water audit were used to estimate an average daily water consumption for each property pre-audit. Meters were read at the time of the water audit, and 3 monthly readings were taken post-audit. These readings have been used to estimate an average daily water consumption for each property post-audit.

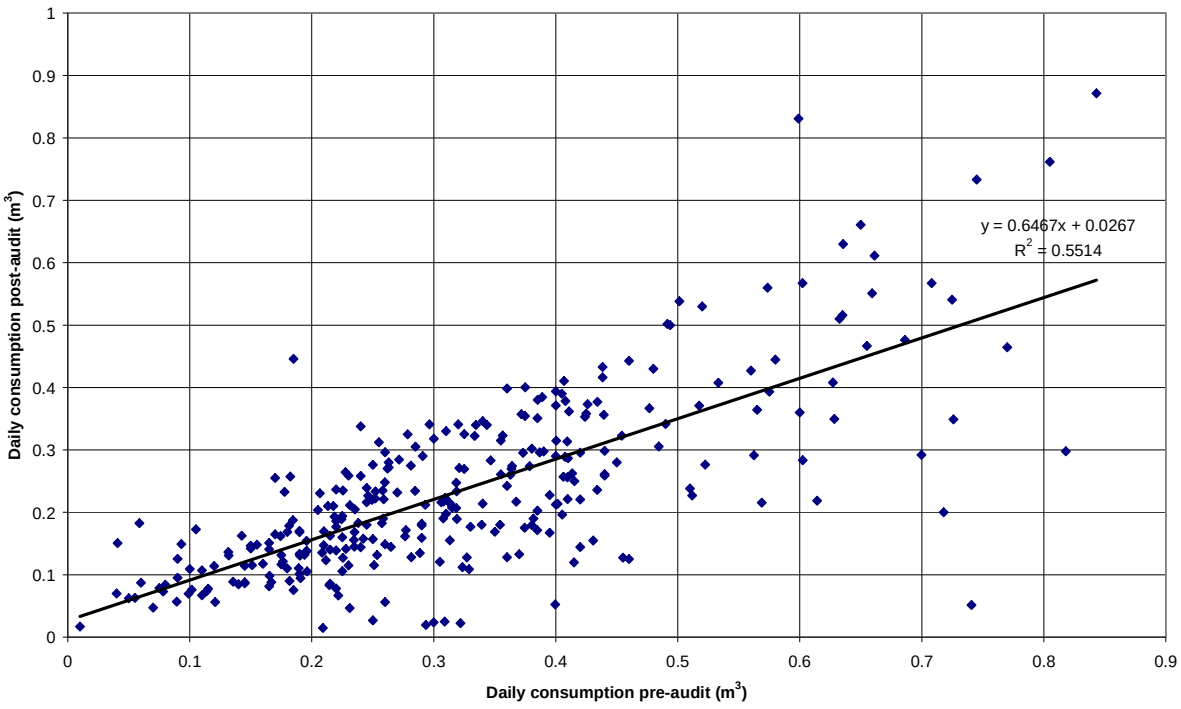


Figure 3.1 Pre-audit versus post-audit water consumption by property

The difference between pre- and post- audit water consumption by property is shown in Figure 3.1. It is clear that post-audit consumption is lower than pre-audit consumption in the majority of cases.

For ten metered properties, the results of the daily consumption analysis were unable to be used as the meter readings appeared to indicate negative consumption – this is probably due to a mixture of customers' own reads, estimated and actual reads being used for the calculation. These ten properties were therefore treated as unmeasured for the purposes of the analysis, leaving 303 metered customers.

The average water saving, calculated from pre- and post- audit daily consumption figures per household, for measured customers was 85 litres. The 90% confidence level for this saving is calculated at +/- 10 litres. A histogram of water savings, indicating the spread of results is given in Figure 3.2. Total measured water savings per day over the post-audit monitoring period are shown in Table 3.4.

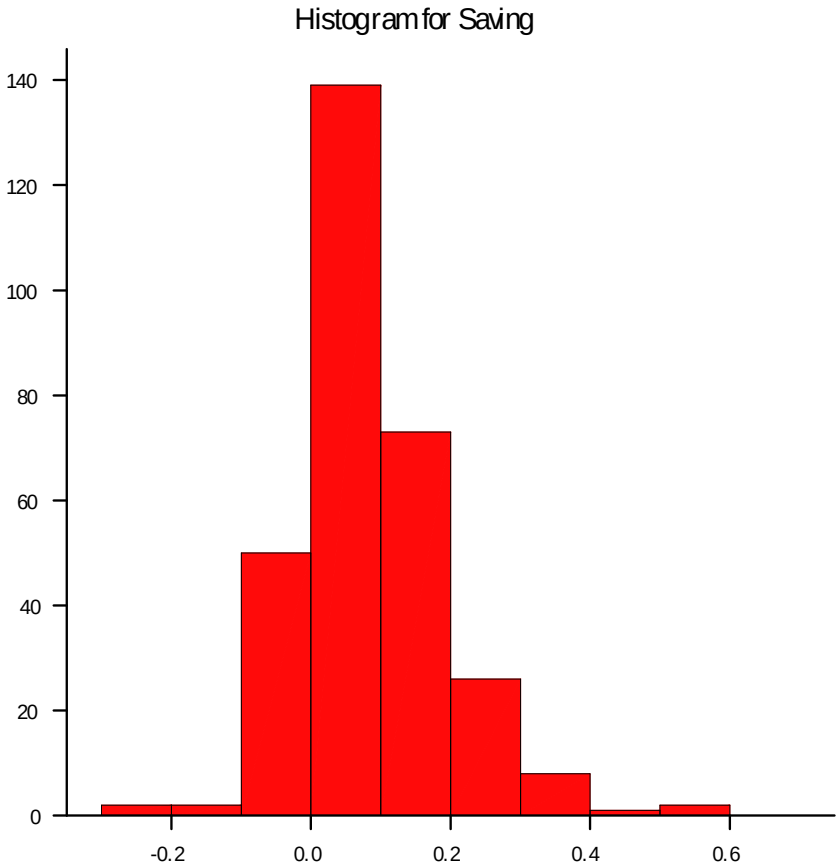


Figure 3.2 Histogram of measured customer savings

Table 3.4 Total measured water savings[2]

Number measured properties	303
Average daily saving (l/day)	73
Total daily savings (Ml/day)	0.022

3.3.2 'Background' water savings

The average daily consumption of a control group of properties from the same DMAs, where no audits were carried out, has been determined for pre-audit and post-audit monitoring periods. Daily water consumption in this control group was, on average, 12.4 litres lower during the post-audit period than the pre-audit period. This indicates that a proportion of the measured water savings from the audit are in fact 'background' savings that are due to factors external to the project. A saving of approximately 12 litres per person per day due to seasonal variation is not exceptional, therefore this 'background' saving seems reasonable.

3.3.3 Disaggregation of savings

For each measured household, a total household water savings volume is known, along with which devices each household had installed during the audit. This information enables a simple regression model to be built to disaggregate the results of the trial and provide a water saving per device value. An uncertainty is also associated with each value.

In order to reduce uncertainty surrounding the frequency of use of devices, and of different facilities within the home (for instance where a home has three WCs, the frequency of use of each of the WCs will be different), the regression has been based upon whether or not at least one of each device was installed in the home. For instance, no differentiation was made between homes that had 2 shower heads installed and homes that only had one.

The regression analysis produced the results given in Table 3.5.

Table 3.5 Regression analysis to disaggregate savings between devices

Parameter	Estimated savings (litres/property/day)	Confidence
Constant	47	<.001
Eco-beta fitted	2.2	0.861
Save-a-flush fitted	10	0.413
Shower head fitted	36.8	0.002

[2] Adjusted to exclude background changes in water consumption based on control group.

The 'Constant' saving associated with the process of visiting customers' homes, providing literature on efficient water use and a shower timer, and undertaking a water audit are large. The savings seen as a result of this activity should be considered a consequence of behavioural changes. Little research is available on typical savings for this form of activity.

The savings associated with fitted showerheads are in line with other studies into the effectiveness of aerated showerheads. The joint Liverpool John Moore's University and United Utilities study 'Water Efficient Showerheads' (2007) indicated that savings in the region of 38.7 l/prop/day could be expected. The results of this study further support these findings.

The estimated savings associated with Save-a-flush are also consistent with existing research and assumptions. A save-a-flush should save 1 litre per flush once installed, with the average household flushing the toilet approximately 5 to 6 times per person per day. Therefore a saving of 10 litres per day would indicate approx 10 flushes per day, which is reasonable.

The estimated savings for the Eco-beta device are significantly different from savings seen elsewhere. Typically savings are estimated saving 2 litres per large flush, with an average ratio of 1 large to 1 small flush. Other studies have shown however that actual savings seen from an ecobeta could be higher, at between 20 and 30 l/prop/day[3]. Possible reasons for the low savings seen as part of this study include:-

- The study area has a high percentage of new properties. The toilets in these properties have smaller cisterns than average, reducing the benefits of moving to dual flush.
- No record was kept of whether the toilet fitted with the Eco-beta was the primary toilet for the property, or a secondary toilet that is used less frequently.
- No literature was given to the customer explaining how the new Eco-beta device works, possibly resulting in it being used incorrectly.
- Plumbers were given limited training on the fitting of the Eco-beta. It is possible that 'low flush' volumes were set higher than necessary, reducing the water saving potential of the Eco-beta.

Results can be deemed statistically significant where the confidence value is less than 0.05. Therefore Table 3.5 indicates that the result for the shower head – at 36.8 litres – and the result for the 'constant' are statistically significant.

The results of the regression analysis have interesting implications. Whilst the saving associated with shower heads is statistically significant, the savings associated with the toilet intervention devices (10 litres for save-a-flush and 2 litres for eco-beta) are not statistically significant. This could be due to a number of reasons including high variation in savings seen at houses where these devices were installed, or small samples.

Unmeasured customers

In the absence of meter readings for the unmeasured customers (including 10 customers where meter readings were not able to be used), the results of the regression analysis have

[3] Evidence from Waterwise (2008) *Evidence base for large scale water efficiency* Interim report July 2008 :

been used to estimate savings that would have been seen during the trial, based on the devices installed in properties.

The average saving for the unmeasured customers participating in the scheme is therefore estimated to be 66 litres (+/- 3.2 litres for 90% confidence interval) based on the disaggregated savings from measured customers.

3.3.4 Comparison of regression analysis with 'Waterwise' disaggregation method

The Waterwise Evidence Base for Large Scale Water Efficiency has extracted information on costs and benefits (water saved) from UK and international water efficiency pilots and programmes. Many of these programmes have reported only the total volume of water saved by a basket of water efficiency devices. In order to estimate the water savings associated with each individual device, Waterwise have disaggregated the yield using assumptions derived from micro-component data[4]. The methodology developed by Waterwise has been used to disaggregate the total measured water savings from this United Utilities project into estimated savings from each device; the results of the disaggregation by this method are shown in Table 3.6.

Table 3.6 Results of disaggregation by 'Waterwise method'

Water Efficiency device	Savings estimated using Microcomponent analysis data (l/prop/day)	Adjusted savings[5] (l/prop/day)
Low flow showerhead	6.25	7.11
Save-a-flush	11.52	13.11
Ecobeta Dual flush	11.52	13.11

Total water saving calculated from microcomponent data	20.21
Total water saving (measured) as recorded in report	23

Note, the savings have excluded the 47 litres per household per day that are thought to be associated with background changes in water consumption, and the impact of having an audit carried out (irrespective of devices installed). The 'Waterwise method' currently has no assumptions regarding the water savings associated with literature.

The distribution of the total water savings amongst the individual devices resulting from this method of disaggregation differs from the distribution suggested by the regression analysis. However, since the regression results for shower heads are statistically significant, and the

[4] For more information see Waterwise (2008) *Evidence base for large-scale water efficiency – Interim Report*

[5] Note, savings estimated using Microcomponent analysis data were adjusted using the ratio of measured water savings to water savings calculated from microcomponent data. Water savings are only estimated to have occurred in houses where at least one device was installed.

results are based on actual measurements as opposed to generic assumptions, the results from the 'Waterwise method' disaggregation have not been used in the AIC and AISC calculations for each individual water efficiency device (see Section 4).

The Waterwise method was developed to disaggregate device specific water savings where robust data on individual property consumption and audit histories was not available. It is a less reliable method than the approach adopted within this study. Therefore the regression analysis results have been used in preference to the Waterwise methodology as the basis of reported headline and device specific savings.

3.3.5 Comparison of shower head savings with recorded pre- and post-installation flow rate measurements taken by plumbers

Shower bags were used to estimate the flow rate of showers both before and after the installation of the water efficient shower heads. Figure 3.3 shows how flow rate was reduced in the properties following the installation of a water efficient shower head. The average flow saving achieved was 3.26 litres/minute.

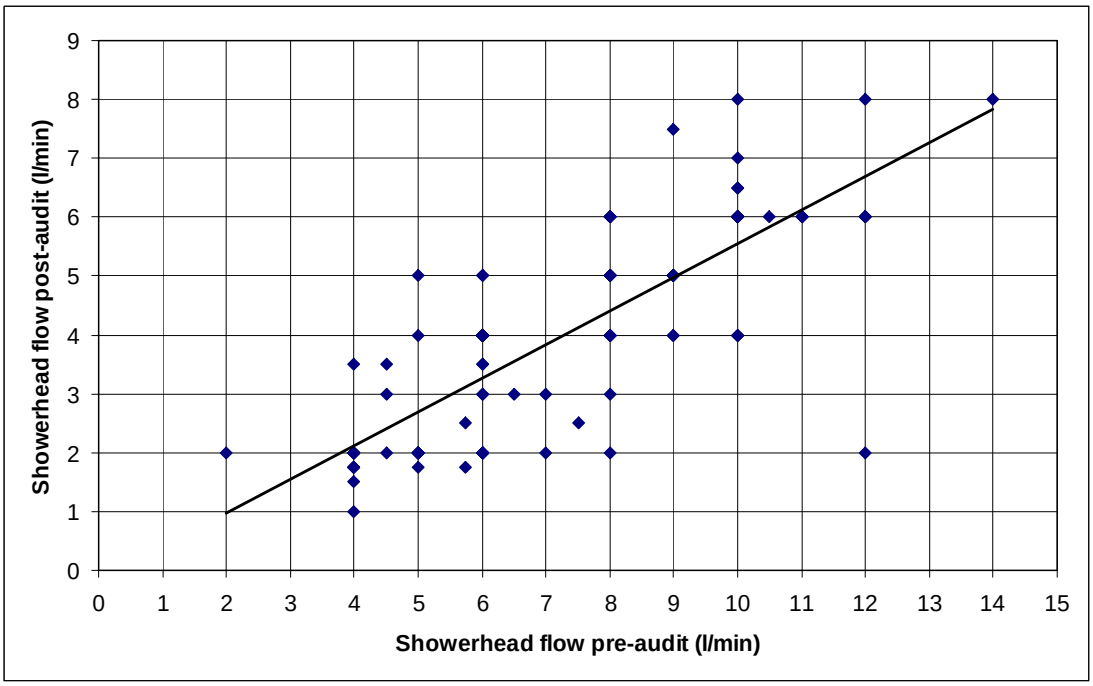


Figure 3.3 Shower flow rates pre- and post-installation of efficient shower head

The regression analysis used indicated that a water efficient shower head saved 36.8 litres of water per property per day (see Section 3.3.2.). This suggests that an average household, with an occupancy of 2.9[6], showers for 11 minutes in total per day; this seems a reasonable length of time for shower use per property, and therefore supports the flow rate reductions measured by the shower bags.

[6] This is the average occupancy of the households that participated in the scheme.

3.3.6 Comparison pre- and post-audit at DMA level

The households participating in this scheme resided in two District Metered Areas (DMAs). For each of these DMAs, estimated per capita consumption (PCC) pre- and post-audit was compared to evaluate the effect of the scheme at DMA level.

The mean PCC for the time period April 2007 to June 2007 was compared against the mean PCC for April 2008 to June 2008 in both DMAs (see Table 3.7).

Table 3.7 DMA level water savings

DMA	DMA 1	DMA 2
1st Period	April '07 - June '07	April '07 - June '07
2nd Period	April '08 - June '08	April '08 - June '08
1st Period Mean PCC	145.54	167.59
2nd Period Mean PCC	142.78	169.63
2 tail t-test probability	0.147	0.431
Significant at 95% Level	No	No
1 tail t-test probability	0.294	0.215
Significant at 95% Level	No	No

The average PCC did decrease in DMA 1 between the time periods. However, in DMA 2 the average PCC actually increased from April 2007-June 2007 to April 2008-June 2008. Statistical analysis reveals that there is no significant difference between the mean PCCs in either DMA. This demonstrates that water savings from the scheme were insignificant at the DMA level despite almost all properties in each DMA being given the opportunity to take part in the study.

3.4 Customer attitudes

Following the trial, participants were sent a survey by post to complete regarding:

- Personal details, address and occupancy of property.
- Whether their property was metered.
- Number of showers and toilets in the property (also garden).
- Which devices were fitted and if these are still used or have been removed.
- Whether participants perceive their water usage to have changed since the trial.
- Whether participants perceive themselves as water efficient.
- Participants experience of the study.

See Appendix E for the follow-up survey.

3.4.1 Experience of trial

Of the 243 households that responded, most found the trial to be a positive experience, with very few classing their experience of the study as 'poor' or 'very poor' (see Table 3.8).

Table 3.8 Customer's experience of study

Experience of study (responses)			
Very good	Good	Poor	Very Poor
86	134	15	7

Whilst the vast majority of customers had a positive experience a small number did not. Customers were dissatisfied with the trial for a variety of reasons including:-

- UU missing pre arranged appointments.
- Perceived long delays between customer sending off an application and receiving an audit.
- UU refusing to fix some leaks as the original invitation to take part indicated that small leaks would be repaired. (typically unprepared leaks would have cost in excesses of £100 to repair).

3.4.2 Change of behaviour

144 of the 243 respondents (59%) indicated that they had changed their water use since the trial. Interestingly, the average water savings for metered respondents claiming to have changed their water use was higher than the average savings achieved by those who felt their usage had not changed (see Table 3.9).

Table 3.9 Water savings against customer perception of use

Changed use?	Average Water Savings[7] (m^3/day)
Yes	0.086
No	0.065

Following the audit, 224 of the 243 respondents (92.2%) believed that they behaved in a water efficient manner.

[7] Excluding 'background' savings

3.4.3 Continued use of devices

At the time of the follow-up survey, most households were still using the devices that had been fitted or provided by UU:

- Of 137 shower heads fitted for survey respondents 101 were still being used (74%).
- Of 100 eco-beta dual flushes fitted for survey respondents 89 were still being used (89%).
- Of 129 Save-a-flushes fitted for survey respondents 100 were still being used (78%)
- Of 141 shower timers issued to survey respondents 95 were still being used (67%).

This suggests that the majority of households were happy with the water efficiency devices provided by the trial, but that even if a company fits a water saving device there is no guarantee of water savings.

3.4.4 Leaks

During the household visits, leaking taps or overflows were identified in 45 properties. Where appropriate, the customer was offered a remedial visit to repair the leak. Leaks were repaired in 10 of these properties.

Water savings from leak repairs were excluded from the regression analysis due to a lack of information. However, it is interesting to note that the average saving in households where leaks have been fixed is 86.9 litres compared with overall average savings of 72 litres. This suggests that offering leak repairs does offer some savings for individual households. However, overall, repairing leaks does not offer a significant opportunity to save water.

4. COST BENEFIT ANALYSIS

4.1 Costs

The total costs of the study are broken down by activity in Table 4.1.

Table 4.1 Costs of water efficiency trial

	Cost
Project management and administration	£28,469
Household audits, including installation of devices	£18,588
Communication	£3,273
Collection of meter data	£5,340
Purchase of water efficiency devices	£5,444

Project management

The project management costs covered fees for a project manager, a programme manager, a graduate engineer and a full time administrator. In addition, there were administration costs associated with setting up the project database and establishing a telephone number for the scheme.

Total cost of household audits

Selected volunteers had a home visit from a qualified plumber. These householders had water efficient devices of their choice installed, an assisted water use survey, and were given a tailored water savers pack. During the water audit, if leaking taps were found these were usually fixed. Although customers were given the option to request the removal of the water efficiency devices by a plumber, customers were able to remove the devices themselves and during this 3 month period plumbers were only requested to remove dual flush retrofit devices. Costs associated with household visits are shown in Table 4.2.

Table 4.2 Cost of home visits

Activity	Cost
Home audits	£9,515
Abortive home visits	£1,138
Water savers pack	£983
Dual flush retrofit fittings	£2,486
Save-a-flush cistern device fittings	£1,978
Low flow showerhead fittings	£1,365
Fixed tap or overflow fixes	£431
Dual flush retrofit removals	£232
Extra cost of Saturday visits	£433

Communication

The target audience, 4,642 properties, were sent letters inviting them to participate in the study. Following the study, a further 393 letters were sent out; these letters thanked the study participants and asked them to complete a follow-up questionnaire. The total cost of these communications was £3,273.

Collection of meter data

Metered properties participating in the study had a series of three monthly meter readings taken by United Utilities. The total cost of these meter readings was £5,340.

Cost of water efficiency devices

Table 4.3 presents the unit cost of purchasing and fitting each device, the number of each device fitted under the scheme and the total cost of purchasing and fitting these devices.

Table 4.3 Cost of water efficiency devices

Device	Unit cost for purchase and installation	Number fitted	Total cost
Eco-beta dual flush retrofit	£21.38	193	£4,126
Save-a-flush cistern device	£5.67	384	£2,177
Water efficient shower head	£23.44	212	£4,969

4.2 Water savings

The results of the regression analysis, described in Section 3.3.2 are provided for reference in Table 4.4, including the equivalent annual saving in m^3 per year.

Table 4.4 Estimated water savings per device

	Water savings		
	l/prop/day	**l/prop/year**	**m^3/year**
Savings from participating in survey (constant)[8]	47	17,039	6713
Estimated dual flush savings	2	804	108
Estimated Save-a-flush savings	10	3,653	825
Estimated showerhead savings	37	13,441	2,554

These savings are multiplied for each house that had at least one of the particular device installed – installing two of the device in any home does not double the savings. This methodology has been used in accordance with the regression analysis, which aimed to reduce uncertainty in the results (see Section 3.3.2).

The total water savings thought to be associated with the trial in year 1, are given in Table 4.5.

Table 4.5 Water savings from trial, year 1

Type of household	**Average Water Savings (l/prop/day)**
Measured	72
Unmeasured	66
Weighted average of all households	71

Total water savings in year 1 (m^3)	**10,190**

4.2.1 Water savings over time

For consistency, the methodology used by the Waterwise Evidence Base for Large Scale Water Efficiency for projecting water savings forward in time has been adopted in this economic analysis. This approach models water savings as decaying according to a half-life profile. The half-life of the scheme is the time (in years) over which the water savings due to the scheme have decayed such that that they are 50% of the original figure. The Waterwise

[8] Note, these savings have been adjusted to take account of approximately 12 l/prop/day of 'background' savings which are external to the trial. See section 3.3.2.

methodology assigns half-life values based on the asset life of the devices installed. The "most likely" half-life is equal to half the asset life. It has been assumed that the water efficiency devices fitted under this scheme all have an asset life of ten years; therefore the most likely half-life of the scheme is 5 years.

The regression analysis indicated that a proportion of the water savings could not be attributed to any of the water efficiency devices installed (see section 3.3.2). The cause of these 'constant' savings is unknown, but it is likely that at least some of the water was saved in response to the water savers pack.

The Waterwise methodology does not assign a half life to water savings associated with water efficiency promotional material. It is likely that study participants will make a greater effort to conserve water in the period immediately following the trial, but that these efforts will decrease over time. For this study, an assumption has been made that the "most likely" scenario for depreciation is that water savings resulting from behavioural change will decay at twice the rate of savings made by water efficiency devices; hence, a half life of 2.5 years has been assigned to 'constant' water savings. There is a clear need for more evidence of water savings associated with promotional material.

As there is high uncertainty associated with water savings in the future, sensitivity tests have been undertaken. Assuming that the 'constant' water savings decay with a half-life of 2.5 years, additional AICs and AISCs have been calculated for a "best case" scenario, where savings associated with water efficiency devices have a half-life of 20 years, and a "worst case" scenario, where water savings associated with water efficiency devices have a half-life of 2.5 years. Further scenarios have tested the AIC's/AISC's sensitivity to 'constant' water savings over time by assuming that water savings associated with devices have a half-life of 5 years whilst 'constant' water savings have a half-life of 6 months ("worst case") or 5 years ("best case"). The results of these sensitivity tests can be found in Appendix E.

Figure 4.1 depicts the 'constant' water savings predicted over time for three scenarios which form the sensitivity analysis for the constant savings. These indicate the best case, most likely case and worst case scenarios used in the sensitivity analysis for decline in water savings associated with customer behaviour changes due to audits.

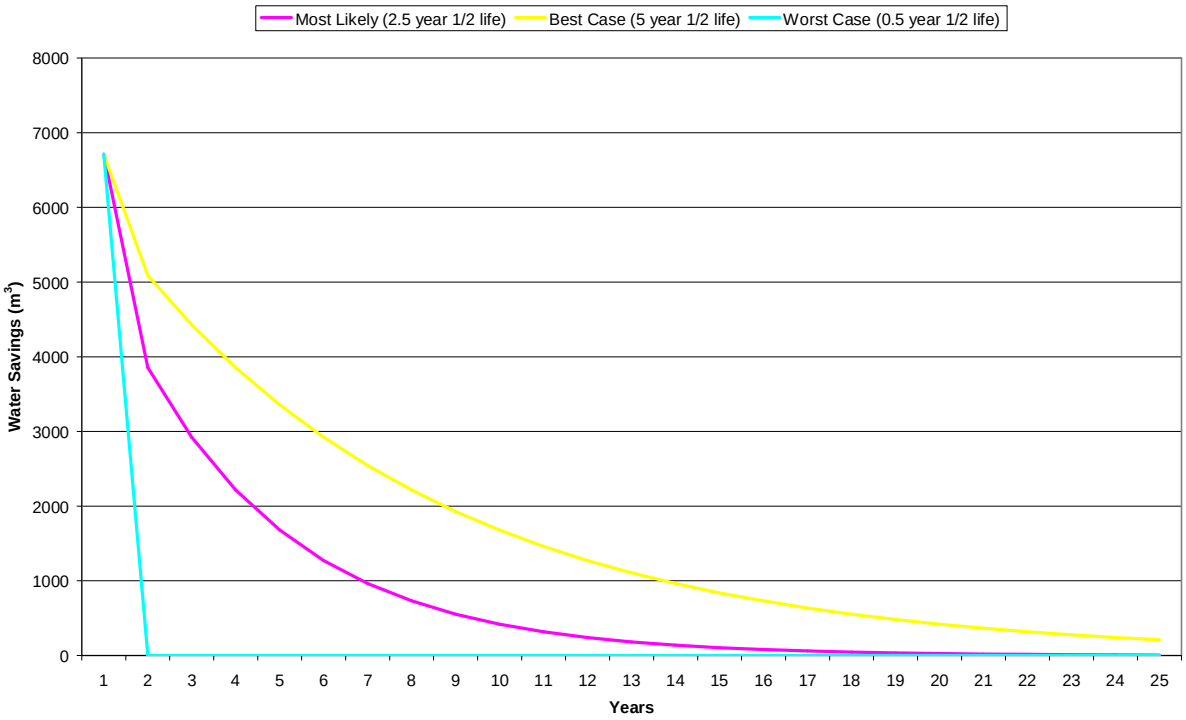


Figure 4.1 Assumed 'constant' water savings over time

Figure 4.2 shows the projected water savings over time made by the water efficiency devices for three scenarios. These indicate the best case, most likely case and worst case scenarios used in the sensitivity analysis for decline in water savings associated with the water saving devices.

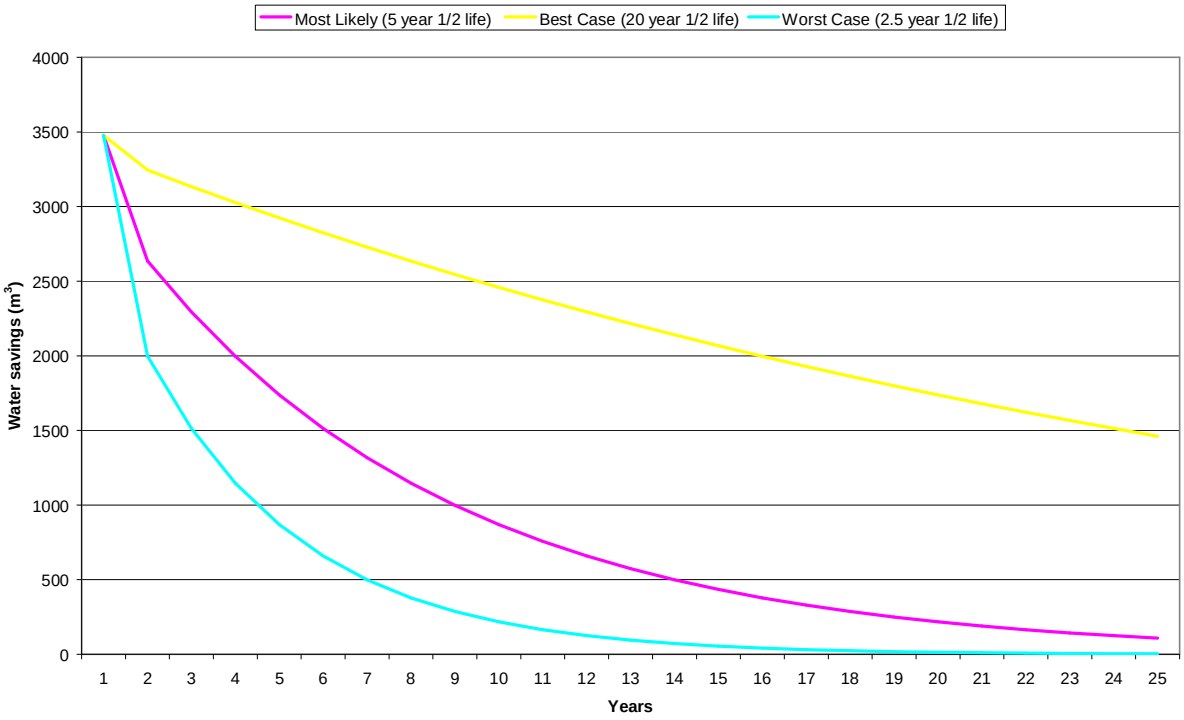


Figure 4.2 Assumed water savings over time from devices

4.3 Economic analysis

An average incremental cost (AIC) and an average incremental social cost (AISC) have been calculated for this water efficiency scheme. Additional AICs and AISCs have been calculated for each individual water efficiency device.

A water efficiency scheme's AIC measures how much it has cost, on average, to save one unit of water. The AISC incorporates external social and environmental costs and benefits. AICs and AISCs have been expressed as pence per cubic metre of water saved.

4.3.1 Methodology

The AIC was calculated using the following equation:

$$AIC = \frac{C + O - OS}{W}$$

Where:
C = net present value (NPV[9]) of the capital expenditure (Capex)

[9] The NPV is the sum of a discounted stream of costs/benefits. Discounting converts future values into present values since money/water saved now is worth more now than money/water saved in the future.

O = NPV of the operating expenditure (Opex)

OS = NPV of the Opex saving to the company; this is the money saved by not producing the extra units of water that have been saved by the scheme.

W = NPV of the total water saved

To incorporate social and environmental costs and benefits, the AISC was calculated as set out in the following equation:

$$\textbf{AISC} = \frac{\textbf{C + O + E – OS}}{\textbf{W}}$$

Where:

C = net present value (NPV[10]) of the capital expenditure (Capex)

O = NPV of the operating expenditure (Opex)

E = NPV of the social and environmental cost/benefit of the scheme

OS = NPV of the Opex saving to the company

W = NPV of the total water saved

This methodology for calculating AISCs is consistent with the approach set out in WR25B (A Framework for valuing the options for managing water demand)[11], Economics of Balancing Supply and Demand and the Water Resource Planning Guidelines[12].

A discount rate of 4.5% was applied to both the AIC and the AISC calculations, in line with EA Water Resource Planning Guidelines. All AICs and AISCs are calculated over a 25 year time horizon.

Project costs

In this analysis, all scheme costs were modelled as operating expenditure (Opex). It is reasonable to consider the purchase of the water efficiency devices as Opex since these assets were not retained by United Utilities, but were given away to customers (Waterwise); this approach is consistent with latest government guidance. Meter reading costs were excluded from the economic analysis since these are scheme-specific costs which would not occur if the scheme was implemented on a greater scale.

[10] The NPV is the sum of a discounted stream of costs/benefits. Discounting converts future values into present values since money/water saved now is worth more now than money/water saved in the future.

[11] UKWIR (2008): A Framework for valuing the options for managing water demand'

[12] NERA (2002): 'The Economics of Balancing Supply and Demand'

Carbon Savings

The amount of embodied carbon in the water efficiency devices[13] and the savers pack is shown in Table 4.6.

Table 4.6 Embodied carbon in water efficiency devices

Device	Kg CO_2 per item	Number of items	Tonnes of CO_2
Eco beta dual flush retrofit	0.63	192	0.12
Water efficient shower head	1.90	212	0.40
Water savers pack	0.34	394	0.13

Although there is carbon embodied in the water efficiency devices, the scheme reduces the amount of energy (and hence carbon) used for treatment and for domestic water heating.

The electricity used to treat each megalitre of water for use in a toilet or a shower is shown in table 4.7[14]. Each megalitre of water saved by an eco-beta, a save-a-flush device or a water efficient shower head was estimated to save 0.34 tonnes of CO_2.

Water efficient shower heads will save an additional 13.7 tonnes of CO_2 per megalitre of water since the amount of gas and electricity used to heat water will be reduced. The scheme's estimated electricity savings (in kWh) were converted into Kilograms of carbon dioxide using Defra's long-term marginal electricity conversion factor[15]. The gas savings were converted into CO_2 savings using the equivalent conversion factor for natural gas. The "most likely" profile of water savings over time was used to estimate the total amount of CO_2 saved, as reported in Table 4.7,

Table 4.7 Carbon savings associated with water efficiency devices

	Energy saved (kWh/Ml water)	tCO_2 /Ml water	tCO_2 saved
Water treatment - electricity saved	789	0.34	15,510
Domestic water heating - electricity saved	16,321	7.02	119,085
Domestic water heating - gas saved	32,587	6.71	113,908

[13] Excluding save-a-flush for which no data was available

[14] For details of values and assumptions used to calculate energy savings see "MTP 2007 - DEFRA Energy Enquiry" and "Water and Energy Efficient Showers: Project Report 2007"

[15] Guidelines to Defra's GHG conversion factors for company reporting Annexes updated June 2007, available at http://www.defra.gov.uk/environment/business/envrp/pdf/conversion-factors.pdf

The amount of carbon embodied in the materials used in the scheme is tiny in comparison with the carbon savings achieved by the scheme. Hence, overall the scheme saved carbon. Clearly, the biggest carbon savings resulted from decreased water heating in the home.

For the cost benefit analysis, the carbon savings were converted into a monetary value, in accordance with the latest Defra guidance, using the shadow price of carbon[16].

Social and Environmental Costs

The social and environmental costs and benefits that have been included in the AISC calculation are as follows:

- Cost of traffic disruption as a result of water audits.
- Cost of embodied carbon in the water efficiency devices[17] and the savers pack.
- Energy savings associated with using the devices:
    - Carbon savings associated with reduced treatment energy.
    - Carbon savings associated with home energy savings.

4.3.2 Results of economic analysis

AIC and AISC values are sensitive to total water savings over the lifetime of the analysis. There is a high degree of uncertainty associated with future water savings; this gives rise to a range of possible AICs and AISCs. The results of the "most likely" case, where water savings from devices decay according to a 5 year half life and 'constant' water savings decay according to a 2.5 year half life, should be taken as central estimates for the AIC and AISC; these results are presented in Table 4.8. AIC and AISC values calculated according to each of the scenarios for water savings over time are tabulated in Appendix C.

Table 4.8 Scheme AIC and AISC Results

NPV Scheme Costs (£)	55,775
NPV Opex Savings (£)	913
NPV water Savings (m3)	45,628
AIC (p/m3)	**120.2**
NPV Net Carbon Costs	-6,179
NPV Net Other Social and Environmental Costs	189
AISC (p/m3)	**107.1**

16 Defra (2007): How to use Shadow Price of Carbon in policy appraisal, available at: http://www.defra.gov.uk/Environment/climatechange/research/carboncost/index.htm

17 Excluding save-a-flush for which no data was available

4.3.3 Projecting to 10,000 households

As many of the project management costs are fixed, one off costs, further efficiencies could be realised by increasing the scale of the study. The potential cost of undertaking 10,000 audits has been estimated. It has been assumed that the same 8% uptake rate will apply, i.e. a target audience of about 118,100 households will need to be invited to take part in the study in order to get 10,000 audit participants. For this exercise, it has been assumed that, excluding the cost associated with the administrator, other project management costs will be one off costs. All other costs associated with the scheme have been increased proportionally (see Table 4.9). Assuming the effectiveness of the water efficiency scheme would increase proportionally, the water that could be saved in the first year of the scheme is shown in Table 4.10.

The AIC and AISC of conducting this scheme in 10,000 households is shown in Table 4.11. Water savings over time have been modelled using the "most likely" scenario (see Section 4.2.1). The AIC and AISC values reported in Table 4.11 are lower than their counterparts in Table 4.8; this demonstrates how rolling out the scheme on a greater scale could reduced the average cost of saving a unit of water.

Table 4.9 Projected costs of water efficiency project with 10,000 households

	Cost
Project management and administration	£321,125
Household audits, including installation of devices	£446,783
Communication	£83,081
Purchase of water efficiency devices	£230,482

Table 4.10 Potential water savings from 10,000 household audits

Potential water savings in year 1 (m^3)	258,632

Table 4.11 Results for 10,000 household projection

NPV Water Savings (m^3)	1,158,066
NPV Net Carbon Savings (tonnes)	6,307,170
AIC (p/m^3)	93.1
AISC (p/m^3)	79.9

4.3.4 Economic analysis of individual water efficiency devices

AICs and AISCs have been calculated for each of the individual water efficiency devices used in this scheme (Table 4.12). These analyses have used the "most likely" scenario for water

savings over time (see Section 4.2.1). The water savings used to calculate the AIC and AISCs in Table 4.12 were estimated by regression analysis (see Section 3.3.2). Since the showerhead was the only device with statistically significant water savings, there is less uncertainty around the AIC and AISC of the showerhead than there is around the AICs and AISCs of the other devices.

The AICs and AISCs for the individual devices are high relative to the AIC and AISC of the overall scheme. This is because the scheme costs used in these analyses represent, in effect, a worst case scenario: the cost benefit analysis for each device was carried out as if only that device was offered by the scheme and the entire project overhead costs (cost of project management, audits, water savers pack and communications) applied. The 'constant' water savings and the water savings attributed to each particular device by the regression analysis were used in the calculations of each device's AIC and AISC.

Table 4.12 Results of economic analyses of individual devices

	Eco-beta dual flush retrofit	**Save-a-flush cistern displacement device**	**Water efficient shower head**
NPV Scheme Costs (£)	48,197	46,016	48,808
NPV Opex Savings (£)	465	560	789
NPV Water Savings (m3/year)	23,301	28,058	39,512
AIC (p/m3)	**204.8**	**162.0**	**121.5**
NPV Net Carbon Cost (£)	**-191**	**-234**	**-13,859**
NPV Other Social and Environmental Costs (£)	189	189	189
AISC (p/m3)	**204.8**	**161.8**	**86.9**

The water efficient shower head has the lowest AIC and the lowest AISC, indicating that it is the most cost-effective of the water efficiency devices installed during this trial. The addition of environmental and social costs has dramatically lowered the average incremental cost of the showerhead. This is due to the large carbon savings associated with reduced consumption of hot water in the home (hence less energy used to heat water).

Although smaller, there is also an environmental and social benefit associated with installing both the save-a-flush and the dual flush devices. Thus, the inclusion of these impacts has reduced the average cost of each device.

5. CONCLUSION

The United Utilities study in the Great Sankey area of Warrington was designed to gather evidence on the effectiveness of domestic water efficiency devices. The study aimed to gain a better understanding of the likely costs of fitting a range of water efficiency devices and the water savings associated with the installation of these devices. Thus, the primary purpose of the scheme was not to maximise savings, but to gain understanding of the most cost-effective methods of achieving water savings. The findings from this study will inform the design of future schemes that may be rolled out on a larger scale.

The key results of the study regarding number of audits and devices fitted are shown in Table 5.1. The percentage of each device fitted indicates the proportion of households where at least one of these devices was installed.

Table 5.1 Uptake rate and devices fitted

Offers to take part in water efficiency study	4,642
Household Audits undertaken	393
Successful response rate	8%
Showerheads fitted	212 (48%)
Eco-beta dual flush retrofits fitted	193 (34%)
Save-a-flush bags fitted	384 (58%)

303 of the 393 households that participated in the study (77%) were metered[18]. An average water saving was calculated for each of these properties using pre- and post-audit daily consumption figures estimated from meter readings.

A simple regression model was built to disaggregate the total estimated water savings from each measured household; the model produced an estimate of water saving per device with an associated uncertainty. The savings estimated for both of the toilet intervention devices were not statistically significant. Therefore, there is high uncertainty around quoted water savings from the eco-beta dual flush retrofit device and the save-a-flush cistern displacement device.

The results of this regression analysis were used to estimate the water savings in the unmeasured households during the trial, based on the devices installed in these properties.

[18] A further 10 properties were metered, but were considered as unmeasured since their meter readings showed negative consumption.

Table 5.2 Headline results of 'Home Audits' study

Cost of Scheme (£)	55,747
Estimated Carbon Savings (tonnes)	193,026
Estimated Water Savings (m^3)	45,628
AIC (p/m^3)	120.2
AISC (p/m^3)	107.0

Table 5.2 summarises the costs and benefits[19], and presents the "most likely" AIC and AISC of the study[20]. AIC and AISC values are sensitive to the estimation of water savings in the future, but there is uncertainty surrounding these savings. To allow for this, a range of scenarios for future water savings were developed. AICs ranged from 68.1 p/m^3 (where 'constant' water savings decayed with a 2.5 year half life and savings from devices decayed with a 20 year half life) to 185.4 p/m^3 (where 'constant' savings decayed with a 0.5 year half life and savings from devices decayed with a 5 year half life). Corresponding AISCs ranged from 49.4 p/m^3 to 165.7 p/m^3. In all of the scenarios, the average cost of the study was reduced when social and environmental costs were included.

Table 5.3 AICs and AISCs of individual devices

Device	**AIC (p/m3)**	**AISC (p/m3)**
Eco-beta dual flush retrofit device	204.7	204.7
Save-a-flush cistern displacement device	161.9	161.7
Water efficient shower head	121.5	86.9

AICs and AISCs were also calculated for individual devices (see Table 5.3). The water efficient shower head has the lowest AIC and the lowest AISC, indicating that it is the most cost-effective of the water efficiency devices. The shower head is particularly cost-effective when environmental and social costs are considered, due to the carbon savings associated with reduced hot water use. Reduced use of hot water accounted for approximately 92% of the carbon savings achieved by the entire scheme. Hence, shower heads achieved the bulk of the carbon savings.

If this scheme was rolled out on a greater scale (assuming uptake rates and effectiveness were directly proportional) then it would become more cost effective. A projection of a 10,000 property 'household audits' project found that the AIC would be reduced to 93.1 p/m^3 and the

[19] Costs and water savings are discounted

17. Assumes that 'constant' water savings decay with a half life of 2.5 years and water savings from water efficiency devices decay with a half life of 5 years (see Section 4.2.1).

AISC to 79.9 p/m^3. The results of this study could be used to design a more cost-effective scheme that could be rolled out on a larger scale.

The water savings seen from these audits need to be considered in context of the type and location of the properties targeted. 'Constant' savings as a result of undertaking the household audit, and providing customers with water saving tips are likely to decay faster than savings associated with physical devices.

The savings associated with fitted showerheads are in line with other studies into the effectiveness of aerated showerheads. The joint Liverpool John Moore's University and United Utilities study 'Water Efficient Showerheads' (2007) indicated that savings in the region of 38.7 l/prop/day could be expected. The results of this study further support these findings. The estimated savings associated with Save-a-flush are also consistent with existing research and assumptions, saving around 1 litre per toilet flush.

The estimated savings for the Eco-beta device are significantly different from savings seen elsewhere. Possible reasons for the low savings seen as part of this study include:-

- The study area has a high percentage of new properties. The toilets in these properties have smaller cisterns than average, reducing the benefits of moving to dual flush.

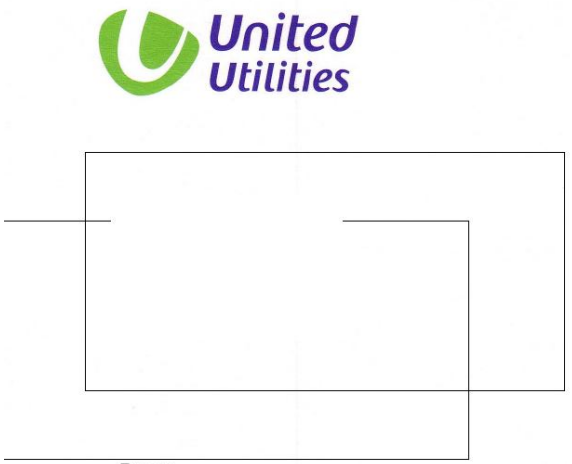
- No record was kept of whether the toilet fitted with the Eco-beta was the primary toilet for the property, or a secondary toilet that is used less frequently.

- No literature was given to the customer explaining how the new Eco-beta device works, possibly resulting in it being used incorrectly.

- Plumbers were given limited training on the fitting of the Eco-beta. It is possible that 'low flush' volumes were set higher than necessary, reducing the water saving potential of the Eco-beta.

It is important to note that any interaction with a large number of customers will result in some complaints being raised. This may have implications for customer satisfaction indices.

APPENDIX A CUSTOMER RECRUITMENT LITERATURE



United Utilities North West
Lingley Mere Business Park
Lingley Green Avenue
Great Sankey
Warrington WA5 3LP

Telephone 01925 234000
www.unitedutilities.com

Dear

Help us to protect future water resources

When you consider that United Utilities provides seven million people in the North West with the equivalent of 93,000 glasses of water every second, you can begin to understand the amount of resources that are required to collect, treat, and transport drinking water to your home every day.

In the last 30 years our demand for water has increased by an incredible 70%. Every person now consumes an average of 150 litres of water a day, and with only 1% of the water we supply actually being drunk, you can see why we all need to consider new and efficient ways to use water in the home.

We would like to ask you to take part in a major research project we are undertaking in Warrington. We are looking for 500 volunteers to get involved in a six-month study to measure the effectiveness of a range of water efficient products.

As part of the study we would fit water saving products **free of charge** in your home. You would be welcome to keep these products at the end of the study at no cost to you.

The products we would fit in your home will depend upon your current plumbing arrangements but could include water efficient showerheads and toilet flush devices. These products not only save water but if you are on a meter could help to reduce your water bill too.

Once these items have been fitted we will measure their effectiveness by taking regular meter readings (rest assured that your existing billing arrangements will not be affected in any way). At the end of the study we will also ask you about your experiences in using these products. If at the end of the study you wish to have the products removed we will do so **free of charge**.

As an added extra we'll also try to repair any dripping taps and other small leaks that we may find.

continued over...

United Utilities Water PLC
Registered in England & Wales No. 2366678
Registered office: Dawson House, Great Sankey
Warrington WA5 3LW

9/4496-3/05

24612/C1/0000001

The findings of the study will help to give United Utilities a clear understanding of what effect these devices have on helping to reduce overall water demand and our impact on the local environment.

If you would like to take part, please complete the attached application form and return it to us in the pre-paid envelope. We will then contact you in the next few weeks to confirm if you have been chosen for the study and arrange for our surveyors to visit your home to fit the water saving devices. The study will be taking place between now and the end of November.

If you require any further information about this research programme please email me at waterwise@uuplc.co.uk or alternatively write to me at the following address:

Ben Nadel
United Utilities
Thirlmere House
Lingley Mere Business Park
Warrington
WA5 3LP

Thank you for your time.

Yours sincerely,

Ben Nadel
Water Resources Strategy Manager

Enc.
Questionnaire
Pre-paid envelope

Application Form – United Utilities Water Effciencey Study

To apply to take part in this study simply fill in this form and return it to:

Ben Nadel, United Utilities, Thirlmere House, Lingley Mere Business Park, Warrington, WA5 3LP

1. Your details

Mr/Mrs/Miss/Ms _____

Surname _____

First Name _____

Other Initials ____

Tel. Home: _____ Tel. Mobile: _____

Address _____

_____

_____

Postcode _____

Your United Utilities customer account number (if you know it) ☐☐☐☐☐☐☐☐☐☐☐☐☐

2. Your home

On average how many people will be living in your home between September 2007 and March 2008?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6+ ☐

How many toilets does your home have?

1 ☐ 2 ☐ 3 ☐ 4+ ☐

How many showers does your home have?

1 ☐ 2 ☐ 3 ☐ 4+ ☐

Do you have a garden? Yes ☐ No ☐

Do you have a water meter? Yes ☐ No ☐

I would like the surveyor to provide a personalised password when they visit my home ☐

3. Your meter reading (To be completed by customers with water meters only)

To help us understand how much water you have saved throughout the study we need to know your meter reading. (Rest assured your normal bill paying arrangements will not be affected in any way.)

Please record the black & white numbers on your meter only.

Meter reading ☐☐☐☐☐

I have a water meter but need assistance to read it ☐

I wish to apply to take part in the United Utilities Water Efficiency Study (all information will remain confidential to this trial and will not be passed to third parties).

Signature _____ **Date** ___/___/_____

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APPENDIX B UNSUCCESSFUL PARTICIPANT LETTER

waterwise@uuplc.co.uk

20-Jun-08

Dear

Water Saving Research Project

Thank you for volunteering to take part in our research project looking at the effectiveness of water efficiency devices. Unfortunately we have been unable to contact you to arrange a suitable time to visit your home and the study has now come to an end.

If you would like to receive a free 'Water Savers Pack' please ring our leaflet request line on 0845 303 7711 or visit our website, www.unitedutilities.com.

If you require any further information about this research programme please email me at waterwise@uuplc.co.uk or alternatively write to me at the following address:

Ben Nadel
United Utilities
Thirlmere House
Lingley Mere Business Park
Warrington
WA5 3LP

Yours sincerely,

Ben Nadel
Water Resources Strategy Manager

APPENDIX C CUSTOMER WATER AUDIT FORM

Jobs For _____

United Utilities

PropRef:	House number:
Title:	APT num/name:
First name:	House name:
Surname:	Street:
Phone number:	Sub street:
Phone number2:	Town:
Auditor name: _____	Village/District:
Date:	Postcode:
Time:	Password:

House type Detached/Semi-detached/Terrace/Bungalow/Flat

Number of occupants in house between September and March: _____

Number of occupants in house under 12: _____

Age of property: _____

House is metered?: Yes / No Comments: _____

Meter reading: _____

Type of plumbing in home Mains Fed/Gravity Fed/Combi-boiler

No. baths in property _____ No. taken per week _____

No. bidets in property _____ Frequency of use _____

No. washing machines _____	No. dishwashers _____
Approx age washing machines _____	Approx age dishwashers _____
Make and model _____	Make and Model _____
No. washes Per week _____	No. washes per week _____

No. of Outside taps _____ Water softener Yes / No

Fixed pool? Yes / No Inflatable pool/ very large paddling pool? Yes / No

Pond? Yes / No

Water butt Yes / No Frequency of use in warm weather _____

Hose Pipe Yes / No Frequency of use in warm weather _____

Sprinkler Yes / No Frequency of use in warm weather _____

Use timer with sprinkler? _____

Watering can Yes / No Frequency of use in warm weather _____

No. times washes car a month _____ Method Hose/Bucket/Car wash

Jobs For

United Utilities

No. toilets _____	Toilet 1	Toilet 2	Toilet 3	Toilet 4
Cistern size				
Suitable for Ecobeta	Yes / No	Yes / No	Yes / No	Yes / No
Suitable for Save-A-Flush	Yes / No	Yes / No	Yes / No	Yes / No
EcoBeta offered	Yes / No	Yes / No	Yes / No	Yes / No
Save-A-Flush offered	Yes / No	Yes / No	Yes / No	Yes / No
Reason not offered				
EcoBeta fitted	Yes / No	Yes / No	Yes / No	Yes / No
Save-A-Flush fitted	Yes / No	Yes / No	Yes / No	Yes / No
Reason not fitted				

No. showers _____ No. showers per week _____

	Shower 1	Shower 2	Shower 3	Shower 4
Electric shower	Yes / No	Yes / No	Yes / No	Yes / No
Mixer (un-pumped)	Yes / No	Yes / No	Yes / No	Yes / No
Mixer (pumped)	Yes / No	Yes / No	Yes / No	Yes / No
Shower head offered	Yes / No	Yes / No	Yes / No	Yes / No
Shower time/flow rate				
Reason not offered				
Shower head fitted	Yes / No	Yes / No	Yes / No	Yes / No
Flow rate after fitted				
Reason not fitted				

Any leaking taps/over flows? Yes / No Leaks fixed? Yes / No

Description of any internal leaks _____

Any supply leaks? Yes / No

Description of any internal leaks _____

Completed certificate of installation and Water Saver Pack given to customer? Yes / No

Customer Opinions

Customer opinions towards water efficiency? Positive/Negative/Unconcerned

Customer see their behaviour as water efficient? Yes / No

Customer believe the appliances in their home are water efficient? Yes / No

Customer believe they will change behaviour as a result of audit? Yes / No

Customers signature _____

Date of signature _____

Technician signature _____

Date of signature _____

APPENDIX D AIC AND AISC SENSITIVITY TESTING

A set of scenarios were developed to show the range of water savings that could occur in the future. The principal factors determining the rate at which the water savings attributable to water efficiency devices will decay over time are the functional lifetime of the device and the rate of bathroom replacements. 'Constant' water savings will decay over time according to behavioural use of water. These changes are harder to predict.

1) Devices sensitivity testing: 'constant' water savings decay according to a 2.5 year ½ life profile for these scenarios

Scenario/half life of water savings from devices	**"Most Likely": devices 5 year 1/2 life**	**"Best Case": devices 20 year 1/2 life**	**"Worst Case": devices 2.5 year 1/2 life**
NPV scheme costs (£)	55,775	55,775	55,747
NPV Opex savings (£)	913	1,586	685
NPV water savings (m3/year)	45,628	79,582	34,285
AIC (p/m3)	**120.2**	**68.1**	**160.7**
NPV net Carbon Costs (£)	-6,179	-15,027	-3,224
NPV other Social and Environmental costs (£)	189	189	189
AISC (p/m3)	**107.1**	**49.4**	**151.8**

'Constant' sensitivity testing: water savings attributed to devices decay according to a 5 year 1/2life profile for these scenarios

Scenario/ half life of 'constant' water savings	**"Most Likely": 2.5 year 1/2 life**	**"Best Case": 5 year 1/2 life**	**"Worst Case": 0.5 year 1/2 life**
NPV Scheme Costs (£)	55,775	55,775	55,747
NPV Opex Savings (£)	911	1,347	594
NPV Water Savings (m3/year)	45,628	67,530	29,754
AIC (p/m3)	**120.2**	**80.6**	**185.5**
NPV Net Carbon Costs (£)	-6,179	-6,364	-6,045
NPV Other Social and Environmental Costs (£)	189	189	189
AISC (p/m3)	**107.1**	**71.5**	**165.8**

Clearly, AIC and AISC values are sensitive to projected water savings: variations in both 'constant' savings and savings from devices bring about large changes in the AIC/AISC.

APPENDIX E FOLLOW-UP QUESTIONNAIRE

Questionnaire – United Utilities Water Efficiency Study

Please complete this simple questionnaire and return it in the pre-paid envelope provided to
Waterwise Team, United Utilities, Sales & Marketing Dept, Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

1. Your details

Mr/Mrs/Miss/Ms _____ First name or initials _____

Surname _____

Tel. Home: _____ Tel. Evening: _____

Address _____

_____

_____ Postcode _____

2. Water efficient fittings

During your home visit did you have a water efficient showerhead fitted? Yes ☐ No ☐

If you had a showerhead fitted are you still using the showerhead? Yes ☐ No ☐

If not, why did you decide to remove it?

_____

_____

During your home visit did you have a dual flush conversion fitted to your toilet? Yes ☐ No ☐

If you had a dual flush conversion fitted are you still using it? Yes ☐ No ☐

If not, why did you decide to remove it?

_____

_____

During your home visit did you have any save-a-flush bags fitted to your toilet/s? Yes ☐ No ☐

If you had save-a-flush bags fitted have you removed any? Yes ☐ No ☐

If so, how many and why did you decide to remove them?

_____

_____

If you were given a shower timer (small egg timer) are you using it? Yes ☐ No ☐

If you received an information pack on saving water did you read it? Yes ☐ No ☐

If you had any leaks repaired has the problem reappeared? Yes ☐ No ☐

Please turn over >

3. Water saving showerhead

If you had a showerhead fitted and are using it please answer the questions below.

How satisfied are you with the appearance of the new showerhead compared with your previous showerhead?

Better ☐ Similar ☐ Poorer ☐

How well does the water flow cover your body compared with your previous showerhead?

Better ☐ Similar ☐ Poorer ☐

How satisfied are you with the water flow for washing your hair compared with your previous showerhead?

Better ☐ Similar ☐ Poorer ☐

How satisfied are you with the water and air temperature in your shower compared with your previous showerhead?

Warmer ☐ Same ☐ Cooler ☐

How does the water feel on you skin?

Too forceful ☐ Just Right ☐ Too Gentle ☐

Overall, how satisfied were you with the water efficient showerhead?

Very satisfied ☐ Satisfied ☐ Dissatisfied ☐ Very dissatisfied ☐

What is most appealing to you about the showerhead?

☐ Appearance
☐ Better for the environment - water efficient
☐ Better for the environment - energy efficient
☐ Money Saving
☐ Performance
☐ Nothing
☐ Other _____

Will you continue to use the showerhead?

Yes ☐ No ☐

Any comments on the showerhead: _____

4. Your experience

Was booking your home visit? Quick and easy ☐ Long and complicated ☐

During your home visit/s was the plumber courteous, friendly, and professional?

Definitely ☐ Some what ☐ Not at all ☐

Do you think being water efficient is important?

Definitely ☐ Some what ☐ Not at all ☐

Do you consider yourself to be water efficient? Yes ☐ No ☐

Have you changed the way you use water as a result of the home visit? Yes ☐ No ☐

Overall how have you found the experience of taking part in this study?

Very Good ☐ Good ☐ Poor ☐ Very Poor ☐

Do you have any general comments about this water efficiency study?

_____

_____

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