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Water neutrality: an economic assessment for the Thames Gateway development

Resource Efficiency science programme
Science report: SC080033/SR3

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Steve Killeen

Steve Killeen

Head of Science

Executive summary

The Thames Gateway study published by the Environment Agency in 2007 provides detailed cost estimates for a number of scenarios which would be likely to achieve water neutrality. This project builds on this work by developing estimates of the benefits of achieving water neutrality and using these in a cost benefit analysis.

Demand side measures

Two water efficiency measures scenarios were used as set out in the earlier report:

- The **water neutrality scenario** sets out how water neutrality can be achieved within the period over which the Thames Gateway is being developed. The assumptions made represent the preferred combination of measures considered necessary to deliver water neutrality rather than an assessment of what is realistically achievable.

- The **progressive scenario** is based on the upper limit of what might be achieved within current and potential future regulatory frameworks.

Both scenarios envisage an annual rate of meter penetration 5 per cent higher than allowed for by the water companies in their Water Resource Management Plans (WRMPs). This rollout would be accompanied by the introduction of marginal charging for water using ‘rising block’ tariffs. Both scenarios would also see extensive deployment of water-saving appliances in existing and new homes. Many of the proposed water efficiency measures will also reduce energy consumption due to the reduced need to heat water as well as greater use of more efficient white goods. The close similarity between the hot water saved in the two scenarios highlights the fact that the scenarios were developed focusing on water rather than energy savings. Estimates of the corresponding public benefit from the reduction in carbon dioxide (CO_2) emissions were also made based on the carbon intensity of gas and electricity.

Supply side benefits

The analysis was undertaken to develop a representative mix of water sources which would be displaced (i.e. would no longer be required to be developed) if water was to be saved. This was done with reference to the relevant planned developments within the Thames, Essex & Suffolk and South East Water water resource management plans, but not Southern Water’s water resource management plans. The costs and benefits of displacing water usage from the Southern Water area have been represented by the mix of developments planned elsewhere within the Thames Gateway. It is not believed that this approximation has had a significant impact on the overall finding. The supply zone model ensures that whichever source is assumed, the costs and the benefits of that source are captured. A preferred list of options was developed for each supply zone that would meet the remaining gap in supplies if implemented. These options were used to estimate the benefits from water savings under the two scenarios on the basis of the following principles and assumptions:

- The options with the highest Average Incremental Social Costs (AISCs) are displaced in preference.

- The volume of water displaced from any one source is limited to the capacity as set out in the 2007 report.

- Any investment already made (e.g. the CAPEX associated with the building of the Beckton desalination plant) is not included.

- Supply options were taken as discrete projects that cannot be resized. In a number of cases, however, there are opportunities to transfer the displaced supplies into other supply zones and displace costs elsewhere.
- Where there is an unmet deficit (e.g. the years leading up to the beginning of the WRMP period), the savings were valued based on a weighted mean of the other supply options.

These combinations of displaced supplies were used to value the financial and environmental benefits of the water savings by using the cost assumptions as set out in the draft WRMPs, including social valuations of the options. The value of displaced greenhouse gas emissions were estimated by combining differential emission factors and the Shadow Price of Carbon (SPC).

Results

The benefits of proceeding with either scenario were found to outweigh the costs of implementing the necessary measures (see the table below). Although the benefits are dominated by the financial savings, the domestic energy savings are considerable – particularly for the progressive scenario. The financial savings associated with the reduced need to build infrastructure are far greater than the benefits from the reduction in environmental impact, including lower greenhouse gas emissions.

Summary of the results of the cost–benefit analysis (£ million).

	Discounted totals (2008 £ million)	
	Neutrality	**Progressive**
Total cost of measures	£165	£91
Total domestic energy savings	£111	£103
Financial benefits of displaced supply	£106	£42
Environmental benefits	£1	£0
Supply CO_2 benefits	£12	£4
Total supply benefits	£120	£46
Total net benefit	£65	£58
Benefit to cost ratio	**1.39**	**1.64**

Sensitivity analysis shows that:

- where a 4.5 per cent rate of discount is applied, benefit to cost ratios of 1.28 and 1.47 respectively for the two scenarios are generated;
- where an assessment period of 25 (rather than 60 years) is applied, benefit to cost ratios of 1.05 and 1.16 respectively are generated;
- where all benefits associated with the energy savings are excluded, benefit to cost ratios of 0.72 and 0.50 respectively are generated;
- where wholesale gas and electricity prices are used, benefit to cost ratios of 1.18 and 1.27 respectively are generated.

Unintended consequences

The following five areas have potentially unintended consequences relating to water companies:

- the potential incentive for water companies to opt for demand side measures in preference to supply side resource developments;
- water efficiency targets as set by Ofwat are displaced outside the Thames Gateway area;
- existing metering programmes are distorted;
- an improvement in the water company's trading position under the Carbon Reduction Commitment (CRC);
- potential benefits to energy suppliers in the event that they are involved with the rollout of measures.

With the exception of the CRC, it is believed that these potential unintended consequences can be successfully mitigated, although co-ordinated efforts will be required by the regulatory bodies during detailed planning of the delivery mechanisms.

Conclusions

The analyses suggest that the benefits would outweigh the costs for both the water neutrality and progressive scenarios. While the net present benefit of proceeding with the water neutrality scenario is slightly greater than the progressive scenario, the progressive scenario returns a greater benefit to cost ratio and therefore represents a better return on the investment.

These net benefits are based on water efficiency scenarios developed to save water, not energy. If water neutrality was adopted in the Thames Gateway development, additional net benefits are likely if the adopted measures are chosen based on an assessment that captures the energy benefits associated with the water savings.

The sensitivity analysis demonstrates that the positive net present benefits are dependent on the savings associated with reduced domestic energy consumption. If a conservative wholesale value of gas and electricity is assumed, the benefits remain greater than the costs for both scenarios. Where more conservative economic parameters are applied (4.5 per cent rate of discount and 25 years rather than 3.5 per cent/3.0 per cent and 60 years), both scenarios still provide total net present benefits.

A high level assessment of the likely winners and losers from water neutrality suggests that the only potential losers in the event of the measures being implemented are those who pay water bills to a water company that operates within the Thames Gateway development area but who opt not to adopt any of the proposed measures. Such a distributional implication can be dealt with if funds are made available to the water companies. There are likely be considerable cost savings available for Thames Gateway residents moving into new properties.

Previous experience of promoting such measures suggests that the uptake rates assumed in the water neutrality scenario would be challenging to achieve. Further analysis of the demographics profile of the Thames Gateway population suggests that concerted engagement would be required to achieve the required levels of uptake. The estimated administrative costs (undiscounted) of implementing the water efficiency measures (based on data from Waterwise) are about £7.8 million for the water neutrality scenario and £5.6 million for the progressive scenario.

Overall, the water neutrality provides a slightly higher net present value (NPV) but lower benefit to cost ratio than the progressive scenario. The progressive scenario therefore represents the risk adverse scenario. However, the objective behind the water neutrality scenario would be likely to help with the concerted action required to deliver water neutrality, as well as providing a valuable example for other development areas to follow.

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Contents

List of Tables

List of Figures

1 Introduction

This report was prepared by Metroeconomica Limited on behalf of the Environment Agency and the Department for Communities and Local Government (CLG). It presents the findings of work package 2 of the project, 'Delivering Water Neutrality in the Thames Gateway' (Science Project Code: SC080033). The objectives and main tasks of this project are broken down into three areas:

- Work package 1: to identify and assess options relating to the implementation and financing of water neutrality, particularly relating to 'off-setting' new water use by retrofitting existing homes, buildings and non-domestic water use.
- Work package 2: to undertake a cost–benefit analysis of water neutrality (using the preferred scenario) as outlined in an earlier Thames Gateway study (Environment Agency 2007a).
- Work package 3: to support the development of generic guidance that will enable the Environment Agency and the organisations with which it works to estimate the feasibility of reaching water neutrality in significant new developments (e.g. eco-towns and growth areas).

The findings of work packages 1 and 3, which were undertaken by Artesia Consulting Limited, are available in separate reports.

1.1 Context of the study

The Thames Gateway is a major growth area that will help deliver the Government's aim to provide more housing. It straddles the lower estuary of the River Thames and lies in an area where the water resources are envisaged to be under stress. The significant scale of development in the area was seen as presenting an opportunity to make it a showcase for best practice sustainable development with respect to water efficiency, energy efficiency and renewable energy.

In November 2007, the Environment Agency together with the Department for Environment, Food and Rural Affairs (Defra) and CLG published a major report, *Towards Water Neutrality in the Thames Gateway* (Environment Agency 2007a), which looked at whether it was feasible to develop the Thames Gateway development area into a water neutral zone. The research was undertaken in conjunction with the water supply companies, regulators, developers, house builders and selected residents in the Thames Gateway.

1.2 Relationship to previous assessments

This study aims to build on the earlier study (Environment Agency 2007a) to explore and analyse the delivery options for water neutrality in the Thames Gateway. The work also relates to a project being undertaken by ENTEC to refine the definition of water neutrality and assess how to monitor the performance of eco-towns with respect to water issues. These reports are expected to help develop a broader understanding of water neutrality and how to achieve it. Consequently, it is hoped that water neutrality will become a useful concept for the Environment Agency and others to apply operationally – in areas outside of the Thames Gateway as well as in the Thames Gateway itself.

The Thames Gateway study (Environment Agency 2007a) provides detailed cost estimates for a number of scenarios that would be likely to achieve water neutrality. However, it did not consider:

- the cost of the reduced energy consumption in the home due to water efficiency measures;
- the administrative and promotional costs of implementing water neutrality;
- any potential economic, social or environmental benefits of achieving water neutrality.

This project set out to estimate these missing costs and benefits in order to make a complete assessment of the costs and benefits.

The earlier study also made high level estimates of the likely contribution that industry could make to water neutrality, though it was not able to provide cost estimates for these savings. Therefore, these savings have been removed from the estimates.

The earlier study assessed costs based on the majority of the measures being initiated from 2007. This project assessed costs and benefits based on a delay in implementation of the planned efficiency measures (and water savings) of two years, so most of the measures do not now start until 2009/10 and end in 2018/19.

This project made use of the spreadsheets developed by ENTEC to prepare the earlier report (Environment Agency 2007a). The information in these spreadsheets was used within this project without further verification of its robustness. This report should therefore be read in conjunction with the earlier study and the limitations presented within it.

2 Methodology

The approach taken in this assessment is cost–benefit analysis (CBA). The Treasury's guidance on economic assessment – often referred to as the 'Green Book' (HM Treasury 2003) defines CBA as:

> 'Analysis which quantifies in monetary terms as many of the costs and benefits of a proposal as feasible, including items for which the market does not provide a satisfactory measure of economic value'.

Cost–benefit analysis is typically used by governments to evaluate the desirability of a given intervention. The aim is to gauge the efficiency of the intervention relative to the status quo or Business As Usual (BAU) scenario. The costs and benefits of the impacts of an intervention are typically evaluated in terms of the public's willingness to pay for them (benefits) or willingness to pay to avoid them (costs). All costs and benefits are monetised and then discounted to represent net present values (NPVs).[1]

Environment Agency (2007a) presents two water efficiency scenarios that can be compared against a BAU, or counter-factual, scenario.

- **The water neutrality scenario** sets out how water neutrality can be achieved within the period that the Thames Gateway is being developed.
- **The progressive scenario** explores the upper limit of what might be achieved within current and potential future regulatory frameworks.

The costs and benefits of both scenarios were assessed in the new study in order to judge the different merits and relative cost-effectiveness.

2.1 Main economic variables used

Environment Agency (2007a) assesses costs over a 60-year period and discounted to a present value (PV), using a 4.5 per cent discounting rate as indicated in the Environment Agency's water resources planning guidelines current at the time (Environment Agency 2007b).

A more recent version of the water resources planning guidelines published in November 2008 (Environment Agency 2008a) proposes a 60-year valuation period as the most relevant timeframe to assess the costs (and benefits) of water infrastructure. But when undertaking cost–benefit analyses in the UK, the discount rate that should be applied in public sector appraisals is that set by *The Green Book* (HM Treasury 2003). This advises the use of a discount rate that declines over time as shown in Table 2.1.

Therefore the discount rate applied in this assessment is 3.5 per cent for the first 30 years and 3.0 per cent for the remaining 30 years. The year 2008/09 is taken as year of valuation which represents present values.

[1] NPV value represents the discounted net flows of cash throughout the period of a project. Therefore the net cash flow position is calculated for each year and discounted to represent the present valuation of the future flow of net cost and benefits. The sum of these discounted net flows indicates the net worth to proceeding with the project.

Table 2.1 Discount rates (as advised in *The Green Book*).

Year(s)	Discount rate (discount factor)
1–30	3.50%
31–75	3.00%
30	(0.3563)
40	(0.2651)
50	(0.1973)
60	(0.1468)

Source: HM Treasury (2003)

2.2 Approach to valuing water savings

Implementing water efficiency measures will lead to a reduced need to supply water.

When developing water supplies, economic theory suggests that the cheaper options will be developed in preference to the more expensive ones. However, an important part of the Water Resource Management Plan (WRMP) process (see, for example, Thames Water 2008a–d) is to:

- capture environmental and social values within the cost estimates;
- consult on public opinion as to how to manage water resources.

Therefore, the preferred options as set out in the WRMP represent the social preference order in which infrastructural developments will be built to meet demand in coming years. Therefore this is the order in which they would be displaced in the event that demand for water is less than anticipated during the WRMP process.

3 Assessment of demand side measures

3.1 Water efficiency measures

Environment Agency (2007a) provides detailed cost estimates for a number of water efficiency scenarios including non-domestic measures. These scenarios are summarised in Table 3.1.

Table 3.1 Summary of delivery scenarios as presented in the 2007 study. [1]

Scenario	Progress towards water neutrality	Water saving [2,3] (ML/d in 2016)	NPV of measures [4] (2006 £m)
Progressive	32%	13	£75.8
Neutrality 1a: High retrofit	100%	42	£156.6
Neutrality 1b: High retrofit including variable tariffs	100%	42	£173.0
Neutrality 2a: Ambitious CSH [5]	100%	42	£181.1
Neutrality 2b: Ambitious CSH including variable tariffs	100%	42	£126.7
Neutrality 3: Intermediate scenario with variable tariffs	100%	42	£139.8
Beyond neutrality	120%	51	£282.7

Notes:
[1] Source: Environment Agency (2007a), Tables 7.1 and 7.5.
[2] Relative to an estimated BAU scenario.
[3] The 2007 study used a different rate of discount and timeframe for the rollout of measures. The figures also include the savings from non-domestic measures but do not capture the costs.
[4] NPV = net present value
[5] CSH = Code for Sustainable Homes (CLG 2006a).

Although not the cheapest, the water neutrality intermediate scenario (based on scenario 3) was identified in the 2007 report as the preferred scenario due to its overall perceived benefits. This scenario would see extensive deployment of water-saving appliances in existing and new homes as well as the introduction of variable tariffs based on the rollout of water meters throughout much of the Thames Gateway.

In addition, a scenario that delivered savings less than water neutrality (called the 'progressive scenario') was modelled to explore the upper limit of what might be achieved within current and potential future regulatory framework. Specifically, the progressive scenario assumed limited retrofit and took a cautious approach to uptake of Code for Sustainable Homes (CSH) (see Environment Agency 2007a and CLG 2006a).

The standards achieved under the all scenarios are summarised in Table 3.2 for new homes and the measures assumed for existing homes in Table 3.3. The measures are described in more detailed in Appendix I.

Table 3.2 Efficiency standards for new homes. [1,2]

	Totals	2008/9	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Water neutrality scenario											
Number of standard new homes built	32,577	10,863	13,878	7,835	0	0	0	0	0	0	0
CSH 1/2–120 l/h/d [3]	18,109	1,917	2,449	6,084	7,660	0	0	0	0	0	0
CSH 3/4–105 l/h/d	60,783	0	0	4,517	8,902	14,887	10,372	8,628	6,693	4,439	2,343
PCC 95 –95 l/h/d [4]	10,815	0	0	0	0	509	775	1,400	1,883	2,825	3,423
CSH 5/6–80 l/h/d	10,815	0	0	0	0	509	775	1,400	1,883	2,825	3,423
	133,098	**12,781**	**16,327**	**18,435**	**16,561**	**15,905**	**11,922**	**11,428**	**10,458**	**10,089**	**9,190**
Progressive scenario											
Number of standard new homes built	24,742	10,863	13,878	0	0	0	0	0	0	0	0
CSH 1/2–120 l/h/d	26,826	1,917	2,449	12,007	10,452	0	0	0	0	0	0
CSH 3/4–105 l/h/d	74,386	0	0	5,784	5,341	14,986	11,097	10,506	9,495	9,044	8,133
PCC 95 –95 l/h/d	7,145	0	0	644	768	920	826	922	963	1,045	1,057
CSH 5/6–80 l/h/d	0										
	133,098	**12,781**	**16,327**	**18,435**	**16,561**	**15,905**	**11,922**	**11,428**	**10,458**	**10,089**	**9,190**

Notes:
[1] *Generated from spreadsheets provided during personal correspondence with Chris Tattersall, Entec UK Ltd.*
[2] *See Environment Agency (2007a) for details of standards.*
[3] *l/h/d = litres per head per day.*
[4] *PCC = per capita consumption (i.e. per person).*

Table 3.3 Uptake of measures in existing households. [1]

Measure	Feasible	Progressive scenario				Neutrality scenario		
		Uptake rate [2]		Installed			Installed	
		Metered households	Unmetered households	% Installed [3]	Households	Uptake rate	% Installed	Households
Variable flush retrofit device	70%	25%	15%	15%	91,472	55%	38.5%	236,158
Ultra low flush WC replacement	100%	0%	0%	0%	–	10%	10.0%	61,340
Low flow showerhead	43%	25%	15%	9%	56,190	50%	21.5%	131,881
Low flow taps	100%	25%	15%	21%	130,647	50%	50%	306,669

Notes: [1] *Taken from Environment Agency (2007a) Table 6.6 and spreadsheets provided during personal correspondence with Chris Tattersall, Entec UK Ltd.*
[2] *The uptake rate refers to the probability that the measure will be adopted in homes where the measure is feasible.*
[3] *'% Installed' refers to the proportion of households actually adopting the measure.*

The number of new homes built under the progressive and water neutrality scenarios are the same in any one year but there are differences in the proportion of homes achieving the various standards and hence the differing levels of water savings (Table 3.2). In particular, the water neutrality scenario relies on more homes achieving the more efficient standards including use of 80, 95 and 105 litres per person per day. The progressive scenario also differs notably in the mix of standards in that no standard new homes are built in 2010/11, though 7,835 are still built under the water neutrality scenario.

Measures were also envisaged for non-residential properties that would deliver savings of 40 per cent from offices and 10 per cent from other non-households (Environment Agency 2007a). The detailed measures and costs intended to deliver these water savings were not developed within the earlier report (Environment Agency 2007a) and so were excluded from this economic assessment.

The uptake of common residential retrofit devices as set out in Table 3.3 is limited by:

- the proportion of homes that the device can feasibly be installed in;
- the rate at which people are willing to uptake the measure being offered or proposed.

In the case of the progressive scenario, the rate of uptake is considered to depend on whether a water meter is installed.

3.1.1 Feasibility of uptake rates assumed in the water neutrality scenario

The assumptions set out in Environment Agency (2007a) represent the preferred combination of measures considered necessary to deliver water neutrality rather than an assessment of what is realistically achievable. Previous experience of promoting such measures would suggest that the uptake rates in Table 3.3 for the water neutrality scenario would be challenging to achieve.

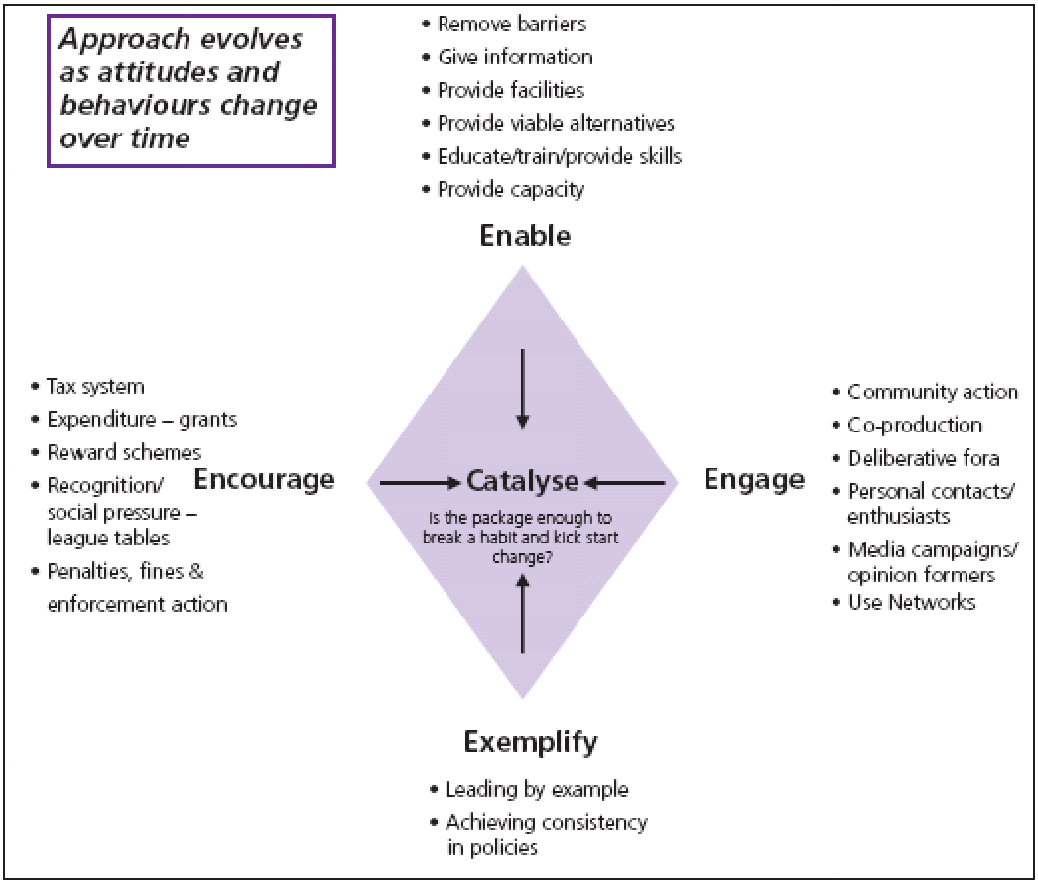
Scenario 2 of the Waterwise evidence base report (Waterwise 2008) considered a retrofit of a basket of measures within a single resource zone. These rates were:

- **lower** uptake example of 13 per cent uptake based on Thames Water's experience;
- **medium** uptake example of 25 per cent uptake based on Essex & Suffolk Water's home surveys in Brentwood and Romford;
- **high** uptake example of 35 per cent uptake based on Essex & Suffolk Water's home surveys in Witham.

The rate of uptake depends on the measures promoted; less focused efforts have been known to achieve uptake rates as low as 2–5 per cent. It will therefore be necessary to adopt best practice in promotional and engagement techniques if the rates assumed in the neutrality scenario are to be achieved. Research in this area centres on the implementation of the '4 Es' model as outlined in Figure 3.1:

- enable via the removal of barriers to action;
- encourage via incentives;
- exemplify by leading by example;
- engage.

Figure 3.1 The 4 'Es' model of behavioural change.



Source: Defra (2008a)

Defra (2008a) explores the issues in more depth and considers behavioural attitudes and actions via a model that segments the English population into seven behavioural segments. This model can be used to identify any gaps between attitudes and action, and therefore potential for greater action. The relevant behavioural policy goal (more responsible use of water) was found to be highly or moderately acceptable to four out of the seven segments. These segments represent about 58 per cent of the English population and therefore the uptake proposed in Table 3.3 should be achievable by engaging people in a way which ensures that their behaviour matches their attitudes.

However, the demographic profile of the Thames Gateway population (see, for example, CLG 2006b) suggests that a greater proportion of the Thames Gateway population would be in the segments less inclined to find the goal of using water more responsibly acceptable, and therefore would be unlikely be to interested in adopting these measures on environmental grounds. A key segment to engage would be Segment 5 – characterised by their cautious willingness to participant. For those in this segment to act, they need to see action by others and a sense of following social norms. Beyond this, the most resistant segments (those in Segment 6 who face the barrier of an often hectic lifestyle and those in Segment 7 who are said to be honestly disengaged) are generally less likely to be open to voluntary engagement or exemplification by others. Behavioural change in these groups would call for interventions that enable and encourage (e.g. choice editing, that is removing the option of buying the undesired product) or regulation. However, such interventions are not particularly feasible within the Thames Gateway. Therefore, the rates of uptake proposed in Environment Agency (2007a) for existing households seem very challenging within the population in question and are likely require initiatives which either compel people to act or seek to alter their underlying attitudes.

The rate of meter penetration was assumed to be 5 per cent higher than that assumed in the water companies' current Water Resource Management Plans. This is close to the rate of metering that some companies indicated would be possible on change of occupancy, and would result in 70 per cent of domestic properties in the Thames Gateway being metered by 2018 (Environment Agency 2007a). Requiring the installation of a water meter at the point of change of occupancy represents a suitable approach in behavioural terms, as the new resident is adaptable to a new context. It therefore seems sensible to consider this approach as way of ensuring that the rate of meter penetration is achieved.

3.2 Costs of water efficiency measures

The additional costs of the various measures assessed in the 2007 study include:

- installation costs that are additional to a standard development;
- costs of installing and maintaining water meters;
- costs of administering variable rate tariffs.

The additional costs and the water consumption of the most important appliances are given in Table 3.4.

Table 3.4 Additional costs and consumption per use of water efficient appliances. [1]

	New households						
	Level of water consumption						
	Standard	120 l/p/d [2]		105 l/p/d [2]		80 l/p/d [2]	
Appliance	Volume (L)	Volume (L)	Cost [3]	Volume (L)	Cost*	Volume (L)	Cost [3]
WC	6.0	4.5	–	3.0	£100.00	0.4	– [4]
Basin	1.9	1.2	£4.79	1.2	£4.79	1.2	£4.79
Shower	48.7	36.0	£5.00	30.0	£5.00	24.0	£5.00
Bath	88.0	80.0	–	80.0	–	60.0	–
Kitchen sink	2.1	2.1	–	2.0	£4.79	2.0	£4.79
Washing machine	55.0	45.0	–	45.0	–	45.0	–
Dishwasher	17.0	12.0	–	12.0	–	12.0	–

Existing households		
Retrofit device	Cost	Saving (l/household/day)
Variable flush retrofit device	£8	24
Ultra low flush WC replacement	£140	53
Low flow showerhead	£15	13
Low flow taps	£5	2.7

Notes: [1] Taken from a spreadsheet provided during personal correspondence with Chris Tattersall, Entec UK Ltd.
[2] l/hh/d = litres per household per day
[3] Cost per household.
[4] Replaced with recycled water.

3.3 Water meters and variable tariffs

The 2007 study (Environment Agency 2007a) considered a move to compulsory metering in existing households[2] for both the water neutrality and progressive scenarios. However, the reductions in water use from switching from an unmetered to a metered supply are complicated by the potential impact of other measures such as those mentioned above. Environment Agency (2007a) quoted savings of 10–15 per cent of average annual demand, but assumed that compulsory metering would result in a 10 per cent reduction in annual average demand (per capita).

For both scenarios, Environment Agency (2007a) assumed an annual rate of meter penetration 5 per cent higher than allowed for by the water companies in their WRMPs and close to the rate some companies indicated for metering on change of occupancy. Metering at this rate would result in 70 per cent of domestic properties in the Thames Gateway being metered by the point that water neutrality is achieved in 2018. All meters were assumed to be standard rather than ‘smart’ meters.

When calculating the costs of additional meters, it was assumed that:

- 35 per cent of households have a boundary box in place (meter installation cost of £71 per water meter);
- 65 per cent of households have no boundary box (meter installation cost of £250 per water meter);
- it costs £10 per meter per year to maintain and operate meters;
- meters need replacing every 10 years.

Variable tariffs can increase water savings by increasing the economic incentive to reduce demand. Environment Agency (2007a) assumed a ‘rising block’ tariff (i.e. a tariff with higher unit rates for each unit of water above a certain threshold) for all new metered households and existing households where meters are installed from 2010/11 onwards. Variable tariffs of this type are not used at present in the UK for household customers.

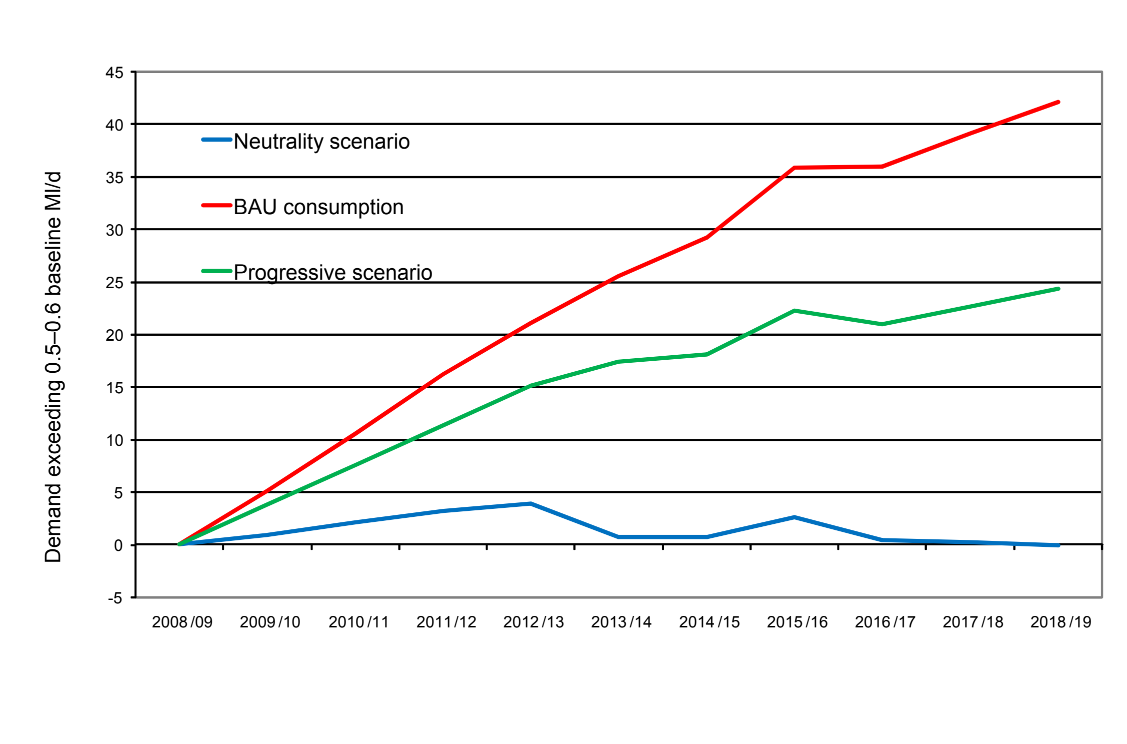
A rising block tariff can be implemented using a standard mechanical water meter that is read manually once or twice a year. Environment Agency (2007a) assumed variable tariffs to provide an additional 5 per cent reduction in annual average demand on top of the 10 per cent reduction that metering alone would provide. Variable tariffs were applied to both new and homes with water meters. It was assumed that the variable tariffs would incur an additional operating cost of £5 per meter per year.

[2] As part of the BAU scenario, it was assumed that water meters were installed in all new homes.

3.4 Water savings due to household water efficiency measures

All the neutrality scenarios reduce the water demand to the baseline level. However, the water-saving measures would not keep up with the BAU increase in demand for water throughout the period of development. Figure 3.2 shows the level of water consumption under the two scenarios against the BAU level of consumption. The preferred water neutrality scenario falls some 4 million litres per day (Ml/d) short of neutrality in 20012/13, largely due to constraints on the rollout of variable tariffs. This shortfall will reduce the water savings in the years leading up to the achievement of water neutrality.

Figure 3.2 Scenarios for the level of water consumption. [1,2,3]



Notes: [1] *Generated from spreadsheets provided during personal correspondence with Chris Tattersall, Entec UK Ltd.*
[2] *2005/06 baseline consumption = 365 Ml/d.*
[3] *Excludes non-domestic water savings based on proportions as provide in Environment Agency (2007a) Figure 7.2.*

Table 3.5 shows the corresponding water savings due to the household water efficiency measures under the two scenarios. These are the savings used in the assessment of benefits.

Table 3.5 Water savings from domestic properties (Ml/d). [1,2,3]

Scenario	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Water neutrality	3	5	8	11	17	19	22	24	27	29	29
Progressive	0	1	2	3	4	6	8	9	10	11	11

Notes: [1] *Spreadsheet provided during personal correspondence with Chris Tattersall, Entec UK Ltd.*
[2] *Based on an average of upper and lower estimates.*
[3] *Excludes non-domestic water savings based on proportions as provided in Environment Agency (2007a), Figure 7.2.*

3.5 Domestic energy savings

Many of the proposed water efficiency measures will also reduce energy consumption within the home. This will result from a reduced need to heat water, as well as the increased use of more efficient white goods (e.g. dishwashers and washing machines). The energy savings associated with the more efficient devices were not considered during the 2007 study. Relevant measures (see Table 3.4) include:

- taps, showers and baths that provide water at reduced flow rates;
- more water-efficient washing machines and dishwashers.

3.5.1 Energy savings from 'non-white goods'

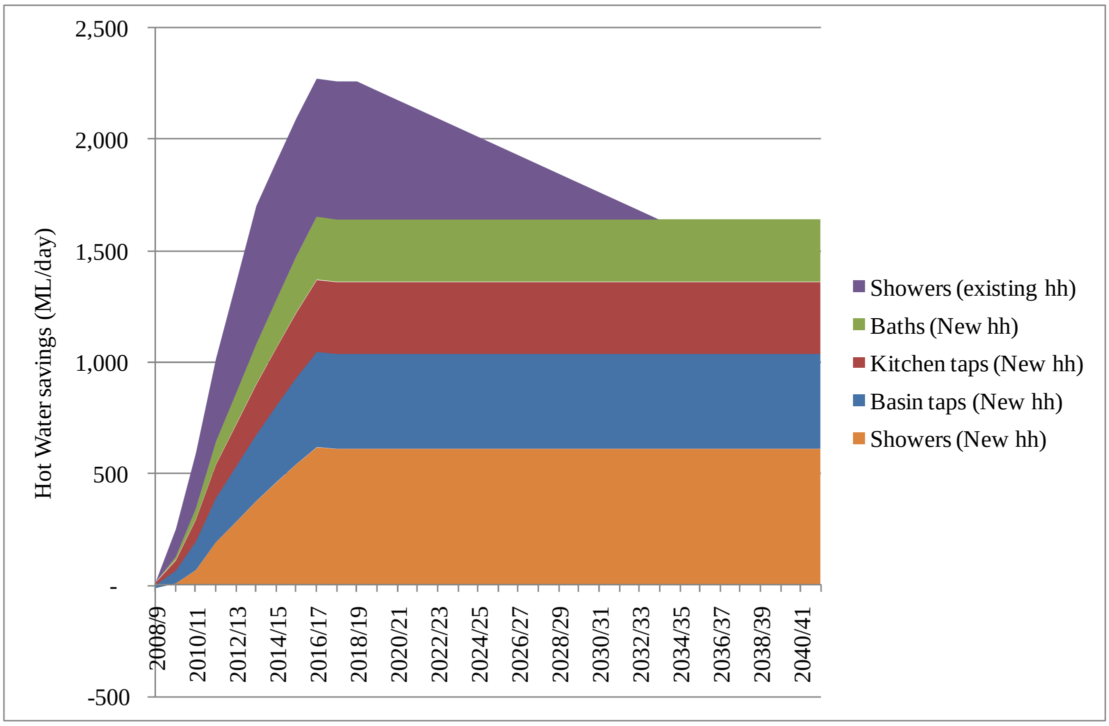
It can reasonably be assumed that shower water will be heated. However, some of the water from kitchen and bathroom taps will be used for rinsing and other cold uses, and will not be heated. It was assumed that:

- 75 per cent of all water from kitchen taps and 50 per cent from bathroom basin taps will be used cold and therefore will not be heated;
- the water for these devices is heated by a domestic gas boiler with an efficiency of 70 per cent – the typical efficiency as discussed in BRE (2005).

The lifespan of many of these appliances will be somewhat less than the 60-year assessment period. However, the assessment of cost required for Environment Agency (2007a) made allowances for the periodic re-installation of appliances as required. The water and energy savings were assumed to be maintained throughout the assessment period. This is not the case for devices installed retrospectively in existing homes, which have an assumed lifespan of 15 years. The profiles of the water saved by the additional[3] devices installed are shown for the two scenarios in Figures 3.3 and 3.4.

[3] This represents the savings net of that installed under the BAU scenario.

Figure 3.3 Hot water savings in new and existing homes (neutrality scenario)[1,2]

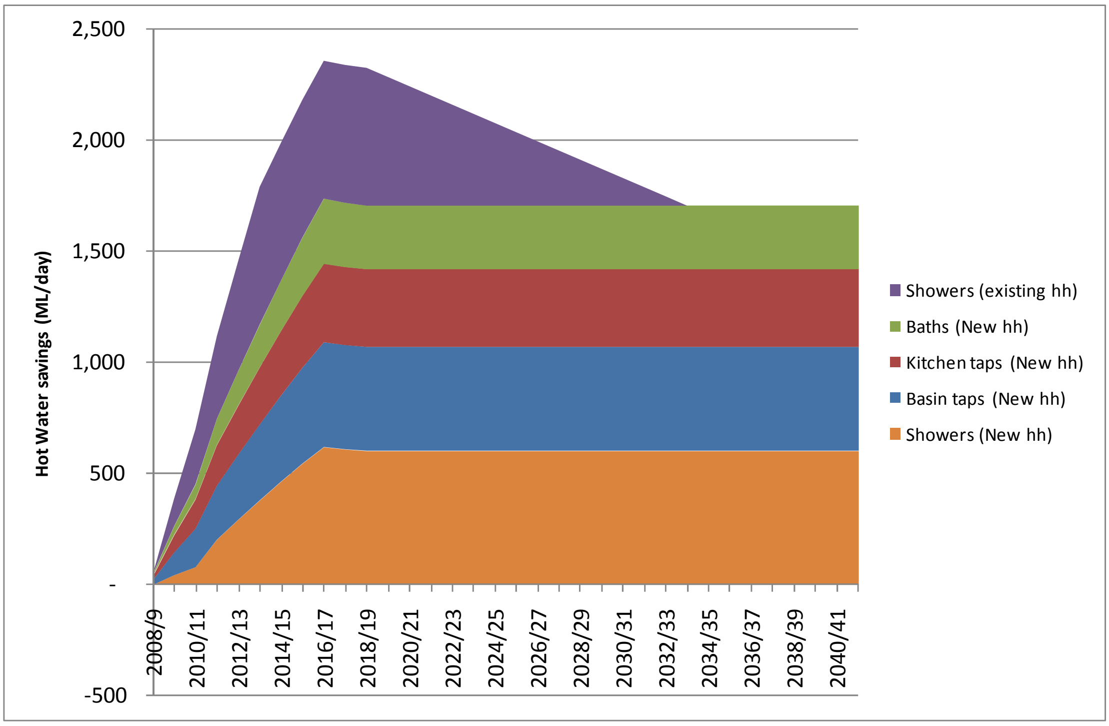


Notes

[1] Generated from spreadsheets provided during personal correspondence with Chris Tattersall, Entec UK Ltd.

[2] Savings continue in a steady state.

Figure 3.4 Hot water savings in new and existing homes (progressive scenario)[1,2]



Notes

[1] Generated from spreadsheets provided during personal correspondence with Chris Tattersall, Entec UK Ltd.

[2] Savings continue in a steady state.

A notable outcome from comparing Figure 3.3 with Figure 3.4 is the close similarity between the hot water saved in the two scenarios.

The difference between the two scenarios is the mix of standards that new homes are built to (Table 3.2); the progressive scenario has slightly more non-standard homes built but to a generally lower standard. However, assumptions on water savings set out in Table 3.6 show that the savings from the different hot water installations do not vary greatly between these standards. Therefore the two scenarios have similar volumes of hot water savings. Those water devices that differentiate the higher standards tend to deliver cold water savings such as rain water harvesting.

Table 3.6 Water saving assumptions for hot water devices installed in new homes. [1,2]

	New households		
	Level of household water consumption		
	120 l/p/d	105 l/p/d	80 l/p/d
Appliance	**Saving (l/hh/d)**	**Saving (l/hh/d)**	**Saving (l/hh/d)**
Basin	12.7	12.7	12.7
Shower	–	25.2	25.2
Bath	3.1	10.8	10.8
Kitchen sink	9.3	9.3	9.3

Notes [1] *Generated from spreadsheets provided during personal correspondence with Chris Tattersall, Entec UK Ltd.*
[2] *See Environment Agency (2007a) for details of standards.*

The assumptions and derived calculations made to estimate the energy savings associated with heating hot water in the home are shown in Table 3.7. The calculations assume that all hot water is heated by a domestic gas boiler.

Table 3.7 Energy efficiency assumptions relating to domestic hot water use.

Assumption	Value	Unit	Source
Specific heat of capacity – water	4.18	GJ/Ml/°C	-
	1.2	MWh/Ml/°C	-
Domestic gas tariff	0.039	£/kWh	British Gas tier 2
	39	£/MWh	-
Temperature of tap water (assumed to be ground temperature)	10.5	°C	www.earthenergy.co.uk/ technology.asp
Temperate of water delivered by showers	40	°C	-
Efficiency of boiler	70	%	BRE (2005)
Delivered energy required per Ml of hot water	48.9	MWh/Ml saved	-
Gas savings	**£1,895**	**£/Ml hot water**	**-**

3.5.2 Energy savings from 'white goods'

Environment Agency (2007a) also assumed that more water-efficient washing machines and dishwashers will be used to deliver the water savings within new homes. In this study it was assumed (Table 3.4) that:

- the water consumption of standard washing machines and dishwashers would be 55 and 17 litres per use respectively;
- all non-standard washing machines and dishwashers would use 45 and 12 litres per use respectively.

The energy efficiency of such appliances will be strongly associated with the level of water efficiency, as the heating of water represents a significant proportion of their overall energy requirement. The savings were therefore based on the energy required to heat the volumes of saved water (10 and 5 litres respectively). It was assumed that:

- washing machines would be used on a 40°C cycle;
- dishwashers would be used on a 65°C cycle;[4]
- energy savings of white goods only lasted nine years.[5]

The electricity saving would be the same for all new households complying with the standard of 120 l/p/day or better.

Based on the number of households meeting these standards (Table 3.2), the electricity savings under the progressive scenario would be slightly greater than under the water neutrality scenario. The various assumptions used to calculate the domestic energy savings for the use of more efficient white goods are shown in Table 3.8.

Table 3.8 Energy saving assumptions for more efficient 'white goods'. [1]

Assumption	Value	Unit	Source
Persons per household	2.4	person	Environment Agency (2007a)
Cost of electricity in IG11 postcode (Barking and Dagenham)	£0.12	£/kWh	British Gas
Energy saving on water heating (40°C cycle)	0.34	kWh/use	-
Energy saving due to more efficient washing machine	90	kWh/year	-
Savings from more efficient washing machine	**£10**	**£/hh/year**	**-**
Energy saving on water heating (40°C cycle)	0	kWh/year	-
Energy saving due to more efficient dishwasher	83	kWh/year	-
Saving from efficient dishwasher	**£10**	**£/hh/year**	**-**

Notes [1] *See Table 3.4 for use assumptions.*

[4] See normal load at: http://www.currys.co.uk/martprd/editorial/guide_dishwashers

[5] See http://www.mtprog.com/spm/download/document/id/598

3.5.3 Benefits of associated CO_2 emissions

There will be a corresponding public benefit from the CO_2 reduction associated with such domestic energy savings. The various assumptions used to calculate the CO_2 savings associated with domestic energy savings are shown in Table 3.9.

Table 3.9 Assumptions used for the calculation of domestic CO_2 savings. [1]

Assumption	Value	Unit	Source
CO_2 emissions of natural gas	185	t/GWh	Defra (2004)
CO_2 emitted to heat domestic hot water	0.54	t/Ml	-
CO_2 savings from an efficient washing machine	0.069	t/hh/year	-
CO_2 savings from an efficient dishwasher	0.092	t/hh/year	-
CO_2 emissions factor for grid electricity	0.537	kgCO_2/kWh	Defra (2008b)
Shadow Price of Carbon (2008) [2]	£26.0	£/tCO_2	Defra (2007a,b)

Notes: [1] *See Tables 3.7 and 3.8 for proceeding assumptions.*
[2] *This figure is increased by 2 per cent per a year as proposed within Defra (2007a).*

3.6 Administrative cost of measures

Environment Agency (2007a) captured the costs of installing water efficiency devices, but did not include the administrative and promotional costs of implementing water neutrality. These costs have been estimated based on Waterwise's *Evidence Base for Large-scale Water Efficiency in Homes* (Waterwise 2008). This report represents an authoritative source of data on the administrative costs of implementing water-saving measures in existing homes.

The costs represent costs of applying a basket of demand management measures across a whole water resource zone in line with what would be required to deliver water neutrality. The costs are estimates based on typical costs taken from several company projects.

The costs are broken down into two headings:

- **Administration costs** including procurement overheads, but excluding the cost of the device themselves;
- **Recruitment costs and project management,** i.e. letters, press, etc. and project management.

The costs are presented on a costs per household basis for two groups of properties in the area targeted for demand management:

- households where the measure is taken up and some devices are installed (i.e. adopting households);
- households where the measure is promoted but not taken up (i.e. declining households).

Therefore, customer recruitment costs were captured for all households whether the measures are adopted or not. These costs are summarised in Table 3.10.

Table 3.10 Administrative costs of promoting a basket of demand management measures in existing homes.

Cost heading	Cost (£ per property)		
	Most likely	Best case	Worst case
Costs where the measure(s) is taken up			
Recruitment costs and project management	£17.00	£10.00	£20.00
Administration costs	£3.00	£2.00	£4.00
Costs where the measure(s) is not taken up			
Recruitment costs and project management	–	–	–
Administration costs	£1.50	£1.00	2.00

These cost estimates were used to develop total cost estimates for the administrative costs of implementing the measures as set out for existing homes in Environment Agency (2007a). To do this, it was necessary to make approximations for:

- the number of adopting households – assumed to be the uptake of the retrofitting device with the greatest uptake;
- the number of households where the promotional effort fails to lead to the adoption of measures (i.e. declining households). This was calculated by subtracting the number of households where the promotional effort is successful from the number of households who would be the subject of promotional effort. This later figure was assumed to be total existing households divided by the number of years that the devices are installed.

This process is shown in Tables 3.11 and 3.12 for the neutrality and progressive scenarios respectively.

The resulting administrative costs estimates (undiscounted) are about £7.8 million for the water neutrality scenario (Table 3.11) and £5.6 million for the progressive scenario (Table 3.12).

Table 3.11 Estimated administrative costs – neutrality scenario. [1]

	All years: 2009/10 – 2013/14	All years: 2014/15 – 2018/19
Number of existing households	613,398	613,398
Rate of promotional rollout	122,680	–
Variable flush retrofit device installed	67,474	–
Ultra low flush WC replacement installed [2]	6,134	6,134
Low flow showerhead installed	61,340	–
Low flow taps installed	61,340	–
Number of adopting households	67,474	6,134
Administrative cost: adopting households	£20	£20
Administrative costs: adopting households	**£1,349,476**	**£122,680**
Number of declining households	55,206	–
Administrative cost: declining households	£1.50	–
Administrative costs: declining households	**£82,809**	**–**
Total annual administrative costs	**£1,432,284**	**£122,680**

Notes: [1] *The rate of uptake is more concentrated over five years for the water neutrality scenario (as opposed to 10 years for the progressive scenario).*
[2] *In the case of ultra low WC replacement, there is a small residual level of uptake after the other devices. It has been assumed that this will occur after the promotional effort has ceased.*

Table 3.12 Estimated administrative costs – progressive scenario.

	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Number of existing households	613,398	613,398	613,398	613,398	613,398	613,398	613,398	613,398	613,398	613,398
Promotional effort (households)	122,680	122,680	122,680	122,680	122,680	122,680	122,680	122,680	122,680	122,680
Number of adopting households	21,710	22,134	22,550	22,951	26,333	3,590	3,284	2,991	2,723	2,409
Administrative cost: adopting households	£20.00	£20.00	£20.00	£20.00	£20.00	£20.00	£20.00	£20.00	£20.00	£20.00
Administrative costs: adopting households	**£434,191**	**£442,684**	**£450,995**	**£459,023**	**£526,652**	**£71,792**	**£65,671**	**£59,823**	**£54,465**	**£48,181**
Number of declining households	39,630	39,206	38,790	38,389	35,007	57,750	58,056	58,349	58,617	58,931
Administrative cost: declining households	£1.50	£2.50	£3.50	£4.50	£5.50	£6.50	£7.50	£8.50	£9.50	£10.50
Administrative costs: declining households	**£59,445**	**£98,014**	**£135,765**	**£172,749**	**£192,539**	**£375,376**	**£435,422**	**£495,964**	**£556,857**	**£618,773**
Total administrative costs	**£493,636**	**£540,698**	**£586,760**	**£631,772**	**£719,192**	**£447,169**	**£501,093**	**£555,786**	**£611,322**	**£666,954**

4 Assessment of supply side benefits

One of the main reasons for developing the Thames Gateway in a water neutral way is the financial and environmental benefits associated with supplying less water. The water saved under the water neutrality and progressive scenarios would be 29 Ml/d and 11 Ml/d respectively by 2018/19 (Table 3.5). The benefits of this reduction in the amount of water consumed depend, in part, on whether there is a shortfall in supply within the area. The Thames Gateway already experiences low rainfall and high water use related to a densely populated area and lies in an area considered to be 'seriously' water stressed. However, the degree to which water can be transferred freely around the Thames Gateway area is limited so it is possible that some supply zones will experience surpluses while others suffer deficits in supplies.

All water companies have an obligation to consult on their Water Resource Management Plans (see Thames Water 2008a, Essex & Suffolk Water 2008, South East Water 2008). The WRMP process first seeks to manage future demand and then propose supply side schemes if required. The analyses within Water Resource Management Plans sub-divide the supply areas into supply zones – typically characterised by limitations in the transferability of supplies between the zones. The analysis was undertaken to develop a representative mix of water sources which would be displaced (i.e. would no longer be required to be developed) if water was to be saved. This was done with reference to the relevant planned developments within the Thames, Essex & Suffolk and South East Water water resource management plans, but not Southern Water's water resource management plans. The costs and benefits of displacing water usage from the Southern Water area have been represented by the mix of developments planned elsewhere within the Thames Gateway. It is not believed that this approximation has had a significant impact on the overall finding. The supply zone model ensures that whichever source is assumed, the costs and the benefits of that source are captured. Table 4.1 shows the estimated split in supplies between these companies by 2016[6]

Table 4.1 Estimated split in supplies between the main water supply companies in 2016. [1,2]

Company	Supply zone	2016 (Ml/d)	2016 (%)
Thames Water	London	220	43%
Essex & Suffolk Water	Essex	158	31%
South East Water	Zone 8	128	25%

Notes: [1] *Data obtained from Environment Agency (2007a).*
[2] *Two other companies supply very limited volumes of water to the Thames Gateway. It was assumed that the supply options of these three companies are representative of the whole Thames Gateway.*

[6] This is the year that the 2007 report anticipated that the measures would achieved water neutrality.

For the purposes of the analysis, it was assumed that the water savings will occur in proportion to these levels of supplies. By combining the information in Table 3.5 and Table 4.1, it is possible to develop a segmented view of water savings for the two scenarios (Table 4.2).

Table 4.2 Assumed split of water savings between water company supply zones (Ml/d). [1]

	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Thames Water (London zone)	1.1	2.2	3.5	4.6	7.4	8.4	9.6	10.6	11.7	12.7
Essex & Suffolk (Essex zone)	0.8	1.6	2.5	3.3	5.3	6.1	6.9	7.6	8.4	9.1
South East Water (Zone 8)	0.7	1.3	2.0	2.7	4.3	4.9	5.6	6.2	6.8	7.4
Total neutrality scenario	**2.6**	**5.2**	**8.0**	**10.6**	**16.9**	**19.4**	**22.2**	**24.5**	**26.9**	**29.2**
Thames Water (London zone)	0.2	0.6	1.0	1.1	1.8	2.8	3.4	4.0	4.4	4.8
Essex & Suffolk (Essex zone)	0.1	0.4	0.7	0.8	1.3	2.0	2.5	2.9	3.2	3.4
South East Water (Zone 8)	0.1	0.3	0.6	0.7	1.0	1.6	2.0	2.3	2.6	2.8
Total progressive scenario	**0.4**	**1.3**	**2.3**	**2.6**	**4.1**	**6.5**	**7.9**	**9.3**	**10.2**	**11.0**

Notes [1] *In line with Environment Agency (2007a), it is assumed that the measures act over 60 years and so the volumes of saved water remain constant beyond the years shown here.*

Analysis at this supply zone level confirms ongoing scarcity of water supplies in the London and Essex zones in the coming years. It also reveals a short-term surplus in supply in the case of Kent, followed by an ongoing deficit. The draft Water Management Resource Plans set out the options proposed by the companies to fill any deficit in supplies. These plans include supply options as well as demand side measures intended to reduce the demand for water. These demand side measures include leakage reduction as well as efficiency measures similar to those intended to deliver water neutrality. Therefore there is the potential for the water companies to be incentivised to reduce their demand side effort as the least cost solution. This is discussed further in Section 7.4 on potential intended consequence. However, the following analysis assumes that there will be the appropriate intervention intended to tackle this and ensure that it is supply side options that are displaced.

The following summarises the situation in these three supply zones and the supply side solutions proposed:

- **Thames Water's** draft WRMP proposes demand management measures as the preferred programme for the London supply zone from 2010–2020 (Thames Water 2009). There is then a requirement for groundwater and artificial recharge schemes. A 100 Mm^3 reservoir providing a yield of 178 Ml/d is planned for 2026. This forms part of the Upper Thames Major Resource Development (UTMRD), of which the Abingdon Reservoir forms the central component.
- **Essex & Suffolk Water's** draft WRMP suggests a growing shortfall in supplies throughout the planning period up to 2035 (Essex & Suffolk Water 2008). The plan proposes to fill this deficit by raising the existing Abberton reservoir in 2014.
- **South East Water's** draft WRMP reports that existing infrastructure will deliver a surplus in the relevant Kent areas up to 2016 (South East Water 2008). This deficit will be filled by new groundwater sources (one at Hoplands Farm, Thurnham, and one in zone 7) in the first instance and then a reservoir scheme from 2024.

4.1 Estimating the benefits of water savings

The supply model developed for this analysis seeks to estimate the benefits due to a reduced need to build additional infrastructure in line with the savings as set out in Table 4.2. This was performed with reference to the proposed supply side plans set out in the respective water company's draft Water Resource Management Plan.

Water companies use a methodology agreed with the industry regulators for water resource planning. This approach involves calculating the financial costs of schemes in terms of capital and operating expenditure. These costs are discounted over a 60-year valuation period at an industry standard rate of discount of 4.5 per cent to derive an Average Incremental Cost (AIC). AICs therefore reflect the cost that society is required to pay for water provided by the regulated water industry.

A key part of the WRMP process is to incorporate and consult on public values related to the management of water resources. To do this, certain environmental and social costs are added to the AIC calculation to give an Average Incremental Social Cost (AISC). The environmental and social costs are environmental and social impacts expressed in monetary terms based on willingness-to-pay or benefits transfer studies.

In this way, a 'least cost' solution can be found which includes consideration of environmental and social impacts. Risk, or reliability, in terms of being able to maintain a secure supply of water to customers is also captured in AISCs. Using AISCs, water companies propose the socially optimum combination of supply options to meet any residual deficit after demand side measures have been considered.

Although not definitive, the options as set out in the three draft WRMPs do represent a clear picture of what would very likely be built to meet demand in the event that water neutrality is not achieved in the Thames Gateway.

4.2 Supply side preferred options

The three draft WRMPs identify a number of water resource schemes as feasible options to respond to any identified deficits. These include a range of traditional schemes such as groundwater development through to innovative schemes such as aquifer storage and recovery (ASR), desalination and effluent reuse (in London, where treated effluent is discharged to the Tideway).

From these lists, a preferred list of options was developed for each supply zone which, if implemented, would meet the remaining gap in supplies. These options provide a pool of possible candidate options which might not be built if demand for water was to be reduced. These preferred options were as follows:

For the **London zone** within the Thames Water supply area:

- **ELRED groundwater** – a groundwater scheme in east London, which would provide 1.0 Ml/d from 2011/12;
- **Northern New River 1** – a groundwater well option, which would provide 1.8 Ml/d from 2013/14;
- **UTMRD (Abingdon Reservoir)** – a proposed large reservoir in the Abingdon area far to the west of London, which would provide about 267 Ml/d by 2026.[7] The relevant part of the scheme would provide 178 Ml/d. This will rely on transfer capacity to the Thames Gateway, which is believed to be available.
- **Kidbrooke artificial recharge scheme** – a scheme involving the addition of surface water to a groundwater reservoir, which would provide the equivalent of 5.0 Ml/d by 2013/14;
- **Beckton desalination –** This plant will produce freshwater from the brackish saltwater of the Thames Estuary from a site on the north bank of the Thames Beckton, east London. The plant would deliver up to 140 Ml/d from the second half of 2009. It does not form part of the draft WRMP as Thames Water has begun construction.[8] Suitable cost estimates were not available for this plant, so its costs are represented by another desalination plant ('Estuary South Desalination') quoted in Thames Water's draft Water Resource Management Plan.[9]

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[7] This was intended for completion by 2020/21 in the Thames Water plan, but has since been put off until 2026.

[8] See http://www.water-technology.net/projects/water-desalination/

[9] Thames Water (2006d), Table WRP2: Feasible list of water management options

In the **Essex zone** within the Essex & Suffolk Water supply zone:

- **Abberton** is an existing pumped storage reservoir (south of Colchester in Essex). The overall scheme proposes to increase the capacity (effectively 'raising') of the reservoir to that it can deliver an additional 64 Ml/d by 2014. This will also require increased abstraction from the River Ely/Ouse near Denver and provision for increased conveyance of water from Denver to Abberton through enhancement of the capacity.

Within **zones 6–8** of the former Mid Kent Water supply zone:

- **Broad Oak** is a winter storage reservoir scheme which includes building a treatment works and further extensive mains infrastructure reinforcement to all the principal urban demand points across the zone. The reservoir will deliver 27.6 Ml/d on average, rising to 55.4 Ml/d during peak summer periods.

- **Thurnham groundwater** source is planned to supply water from the greensand aquifer in zone 6 from 2016. This will deliver 3.6 Ml/d on average, increasing to 6 Ml/d during peak summer periods.

- **Zone 7 groundwater** from 2018, providing 2 Ml/d on average.

- **Hoplands Farm** is a new groundwater scheme being developed at Hoplands Farm, near Canterbury. It will provide 4.5 Ml/d on average and 6.8 Ml/d during peak periods.

Table 4.3 shows the capacity and the year that the option will be operational, alongside a number of cost values associated with the options including the AIC, AISC and the resulting social cost (SC) (i.e. AIC minus AISC).

Table 4.3 Preferred supply options in the Thames Gateway supply zones. [1,2,3]

Option	Capacity Ml/d	Capacity Ml/year	Commissioning year	AIC £/Ml	AISC £/Ml	SC £/Ml	SC-C 3[4] £/Ml
TW: Northern New River 1	1.8	657	2013/14	£146	£149	£3	£0.89
TW: ELRED groundwater	1	365	2011/12	£104	£113	£9	£8.09
TW: Kidbrooke aquifer recharge	5	1,826	2013/14	£406	£411	£5	£2.29
TW: Abingdon Reservoir 3	267	97,522	2026/27	£281	£276	-£5	-£6.11
TW: Desalination [4]	140	51,135	2010/11	**£279**	**£351**	**£72**	**£19.49** [5]
E&S: Abberton Reservoir	64	23,376	2014/15	£511	£516	£5.0	£8.11
SEW: Thurnham groundwater	3.6	1,315	2016	£500	**£509**	**£9**	**£8**
SEW: Zone 7 groundwater	2	731	2018	£790	**£799**	**£9**	**£8**
SEW: Hoplands Farm groundwater	4.5	1,644	2019/20	£826	**£835**	**£9**	**£8**
SEW: Broad Oak reservoir	27.6	10,081	2020/24	£1,031	**£1,036**	**£5**	**£2**
E&S: Existing Essex [6]		–	–	**£358**	**£376**	**£18**	**£16**
SEW: Existing surplus Kent		–	–	**£358**	**£376**	**£18**	**£16**

Notes:

[1] Data sourced from Thames Water (2006a), Thames Water (2008a,d), Essex& Suffolk Water 2008 and South East Water (2008).
[2] The values in red and bold have been derived from costs of other similar schemes.
[3] The non-CO_2 social costs (SC-C) have been calculated based on figures shown in Table 4.5.
[4] The CAPEX for the Beckton desalination plant has been removed to reflect the sunken nature of the investment.
[5] The non-greenhouse gas CO_2 emissions social cost is largely due to the air emissions associated with the energy used in the desalination process (based on data in Table 25.2 of Thames Water 2008c).
[6] Existing Essex are based on weighted (by capacity) averages of all the other options.

The options set out in Table 4.3 were used in the supply model to estimate the benefits from water savings under the two scenarios on the basis of the following principles and assumptions:

- The options with the highest AISCs are displaced in preference. This effectively runs the least cost solution process in reverse and reflects the tendency to maximise available benefits when faced with expected reduced demand. The rational for using AISCs rather than AICs is that the draft WRMPs were developed on this basis and it can be assumed that any substantial changes in demand would require further consideration on the basis of social values.
- The volume of water displaced from any one source is limited to the capacity as set out in Table 4.3. As the draft WRMPs set out more capacity than will be saved by water neutrality, not all sources will be displaced.
- Any cost that has already been spent (e.g. the CAPEX associated with the building of the Beckton desalination plant) is not considered.
- Supply options were taken to be discrete projects that cannot be resized. However, the water displaced can vary year-by-year for some options. This would not generally be the case in a truly closed supply system but, in a number of cases, there are opportunities to transfer the displaced supplies into other supply zones and displace costs elsewhere. The approach adopted here is therefore an approximation of a much more complex system of larger supply configurations. It also accepts water supply companies are able to engage in supply solutions across their boundaries, and agree on least cost solutions and make the necessary financial arrangements to reflect this. Cases where variations in supply are possible include:
    - UTMRD (Abingdon Reservoir) scheme: the water has already been transferred across several supply zones and could reasonably go to displace supplies in other water supply zones;
    - Abberton reservoir in Essex: limited by existing imports into the water supply zone from Thames Water at Chigwell (20 Ml/day);
    - Beckton desalination plant: the capital investment has already been made and the displaced costs are represented only by the operational costs. Displacements from this plant can therefore be varied freely.[10]
- Where there is an unmet deficit (e.g. the years leading up to the beginning the WRMP period), the savings were valued based on a average weighted mean of the other supply options.

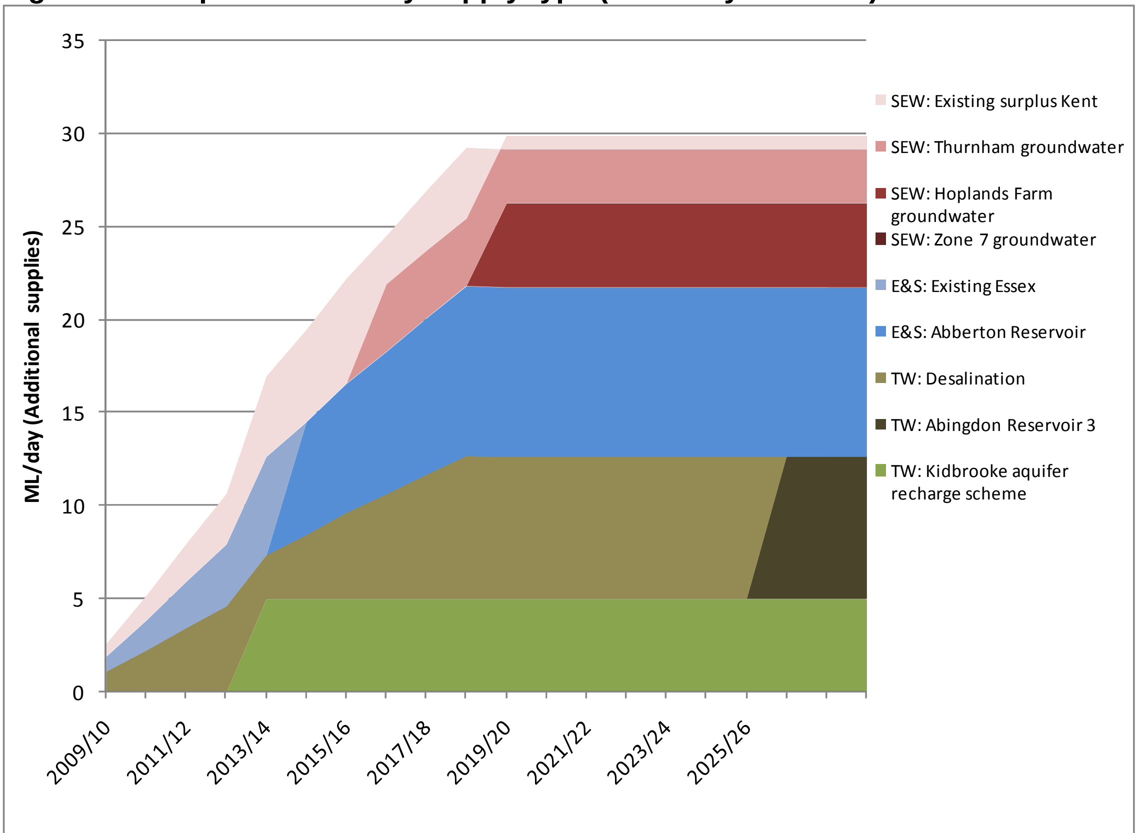
[10] This plant was also used to fill small short-term local deficits caused by the displacement of discrete projects.

4.3 Displaced water supplies

The mix of options that would be displaced on this basis for the water neutrality scenario is shown in Figure 4.1. If the efficiency measures as assumed under the water neutrality scenario are adopted in the Thames Gateway, the following would result:

- In the **London** supply zone, the Kidbrooke aquifer recharge scheme investment would be displaced. In addition, output from desalination would be displaced up to 2026 when the Abingdon Reservoir (UTMRD) becomes available, when there would be displaced demand on this scheme leading to displacements elsewhere.
- In the **Essex** supply zone, existing reserves available for trading would be greater than anticipated. After 2014, this would lead to a reduced demand for supplies from the Abberton reservoir.
- In the **Kent** supply zones 6-8, three groundwater supplies at Thurnham and Hoplands farm would no longer be required. This would leave small surpluses and deficits (valued using average values).

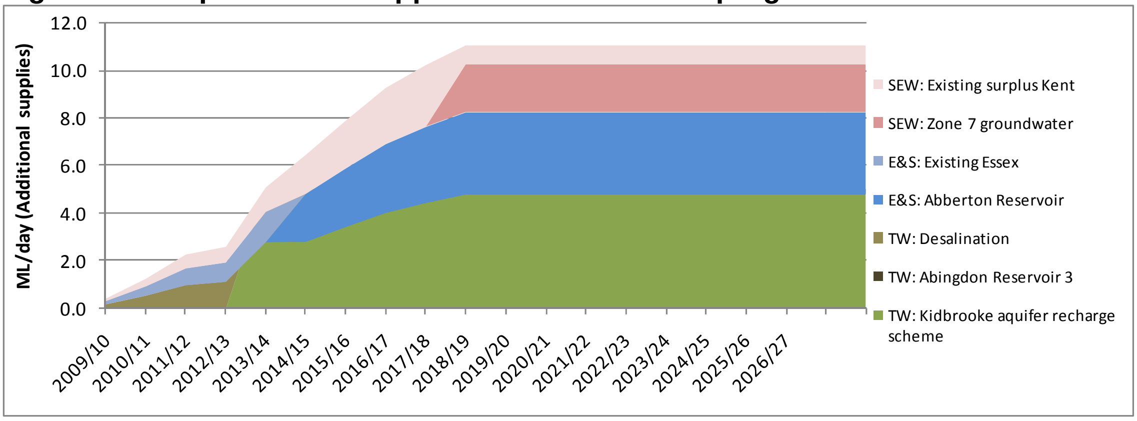
Figure 4.1 Displaced water by supply type (neutrality scenario). [1,2,3]



Notes [1] *Based on the preferred supply options presented in Thames Water (2008a), Essex & Suffolk Water 2008) and South East Water (2008)*
[2] *The values are additional to the 2005/06 baseline demand for water and therefore represent the required supplies without water neutrality.*
[3] *The supply mix shown continues for the reminder of the 60-year planning period.*

A slightly different picture emerges when this approach is used for the progressive scenario (Figure 4.2). A notable difference is the reduced volumes of desalination and water from the Abingdon Reservoir, which is displaced due to the preferential displacement of the Kidbrooke aquifer recharge scheme.

Figure 4.2 Displaced and supplied water under the progressive scenario.



Notes: [1] *Based on the preferred supply options presented in Thames Water (2008a), Essex & Suffolk Water (2008) and South East Water (2008).*
[2] *The values are additional to the 2005/06 baseline demand for water and therefore represent the required supplies without additional progressive measures.*
[3] *The supply mix shown continues for the reminder of the 60-year planning period.*
[4] *The discrete nature of the project displacement in the Kent area led to a slight under-displacement of supplies and therefore a slight surplus.*

4.4 Displaced greenhouse gas emissions

The greenhouse gas (GHG) implications of future water resources options are explored in an Environment Agency briefing note (Environment Agency 2008b). This found that most (89 per cent) of the seven tonnes of carbon dioxide equivalent (CO_2e) emitted per Ml of water supplied can be attributed to water use in the home (Table 4.1) – most noticeably in the heating of water. Savings in such emissions have already been calculated based on the particular appliances being proposed and are therefore excluded from the calculations here. Of the remaining 11 per cent:

- 2 per cent is due to the treatment of supplied water;
- 7 per cent is due to the treatment of waste water;
- 1.6 per cent is due to the distribution of water;
- 0.4 per cent is due to the abstracting and conveying of water.

Table 4.4 Greenhouse gas emissions from the water system in the UK. [1]

Source	Percentage
Domestic emissions	89.0
Water treatment	2.0
Water distribution	1.6
Wastewater treatment	7.0
Production	0.4

Notes [1] *Data from Environment Agency (2008b).*

Environment Agency (2008b) also provides differentiated carbon emissions and costs depending on the type of water supply option. These data were used to estimate the non-domestic GHG emissions for each Ml of water proposed by the various options assumed in the supply model (Table 4.5).

Table 4.5 Full chain greenhouse gas emissions by source. [1,2]

Source	Incl. home	Excl. home	Incl. home	Excl. home
	$kgCO_2e$/day/hh		tCO_2e/Ml	
River intake	2.48	0.32	*7.14*	*0.91*
Groundwater abstraction	2.46	0.30	*7.09*	*0.86*
Reservoir	2.61	0.45	*7.52*	*1.29*
Aquifer recharge scheme	2.47	0.31	*7.12*	*0.89*
Desalination (brackish water)	2.91	0.75	*8.38*	*2.15*
Current water 'full chain; supply	2.43	0.27	7.00	0.77

Notes [1] *Calculated from Environment Agency (2008b).*
[2] *The figures in italics are derived from other figures in Environment Agency (2008b).*

Based on the emission factors shown in Table 4.5 and the displaced supplies shown in Figure 4.1 and Figure 4.2, the GHG emissions associated with the delivery and treatment of water can be calculated (Table 4.6). Also shown are the CO_2 emissions associated with domestic energy use as calculated in Section 3.5.

Table 4.6 Total GHG emissions (tonnes CO_2e throughout assessment period).

Scenario	In home (energy)	Water sector	Total
Water neutrality	1,023,677	683,879	**1,707,556**
Progressive	992,017	215,962	**1,207,979**

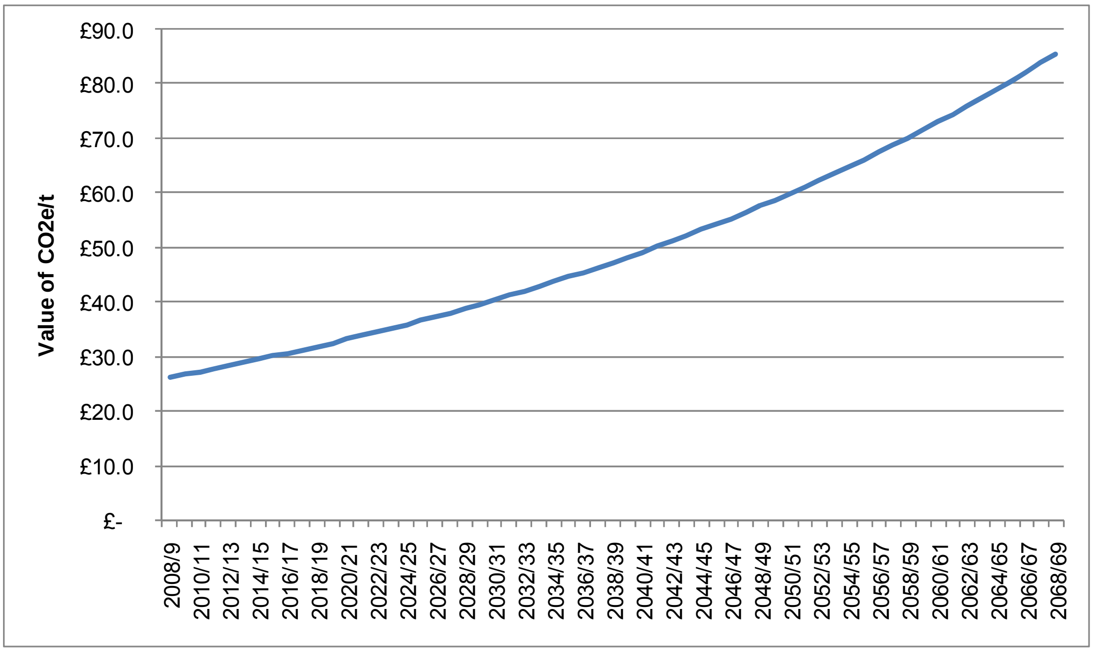
4.4.1 Value of displaced greenhouse gas emissions

Defra guidance on how to value greenhouse gas emissions in government appraisals (Defra 2007a,b) is for use in all policy and project appraisals across government with significant effects on carbon emissions. The guidance adopts the concept of the Shadow Price of Carbon (SPC) as the basis for incorporating carbon emissions in cost–benefit analysis and impact assessments.

The Shadow Price of Carbon is used to value the expected increase or decrease in emissions of greenhouse gas emissions resulting from a proposed policy. Put simply, the SPC reflects the damage costs of climate change caused by each additional tonne of greenhouse gas emitted – converted into carbon dioxide equivalent (CO_2e) for ease of comparison. The SPC is different from the previously used Social Cost of Carbon (SCC) in that it takes more account of uncertainty and is based on a greenhouse gas emission stabilisation trajectory.

The SPC in 2008 was £26/tCO_2e; in valuing emission changes in subsequent years, this figure needs to be increased by 2 per cent per year. The results of this calculation are shown in Figure 4.3. They were also used in relation to the domestic energy savings identified in Section 3.5.

Figure 4.3 Shadow Price of Carbon over time. [1]



Notes: [1] *Based on Defra (2007a)*

4.5 Environmental benefits from displaced supplies

Various studies have considered the external values of the production options in question. For example, Environment Agency (2007c) sets out the scope of benefits provided by groundwater provides and how these can be monetised if impaired or lost. There have also been a number of valuation studies on the value of reservoirs.[11] Less evidence is available for newer supply options such as desalination and artificial recharge schemes. Where the environmental impacts of desalination are considered, however, it is often found that its climate impacts are greatest as desalination is a relatively energy-intensive way of producing water.

A number of methodological concerns arise when applying non-market valuation techniques. Monetisation approaches emphasise those environmental and social impacts that can be ascribed a monetary value. With any such approach, a number of impacts are non-monetisable and are thus excluded from the assessment. Furthermore, all valuations have a social context as they are based on a relevant population's willingness to pay where their income constraint is a key component. A further limitation relates to the techniques required to 'transfer' findings from the original valuation study site to the policy site.

[11] Such studies additionally capture the wildlife and recreational benefits associated with reservoirs such as their use for water sports, thus offering the potential to provide a net benefit to society.

This transfer can be made with or without adjustments for, for example:

- income;
- function transfer of the benefit function;
- meta analysis.

If the benefit is being transferred without adjustment, it is important to ensure that the function and the social context of those who use and value the benefit are similar.

This project responded to these challenges by linking the values used to the WRMP process. The draft Water Resource Management Plans covering the Thames Gateway (i.e. Thames Water 2008a, Essex & Suffolk Water 2008 and South East Water 2008) provide estimates of the external (i.e. social and environmental) costs associated with the case study options. Although this will not eliminate the methodological limitations, the values used in the WRMP process will have been subject to review and comment and therefore relate well to the case study options in question.

Table 4.3 provides estimates of AICs and AISCs that capture these values. AISCs include temporary and permanent environmental and social costs of producing water from a particular source, including the costs of carbon emissions. Therefore, the social cost (or benefit) of using a particular supply option is shown by subtracting the AIC from the AISC, as shown in final column of Table 4.3. However, the social cost includes an estimate of the greenhouse gas emissions associated with production and therefore would lead to double counting if used unadjusted. Crucially however, both the AISC estimates within the draft WRMPs and the carbon costs estimated in the Environment Agency's briefing note are based on the same approach and set of economic assumptions (i.e. 4.5 per cent rate of discount and 60 years). Therefore, the greenhouse gas component can be effectively subtracted from the social cost values by using the split in emissions as shown in Table 4.4. The results are shown in Table 4.7.

Table 4.7 Subtraction of greenhouse gas damage costs from social costs. [1]

	AIC(C)			SC	
	Incl. domestic	**Excl. domestic**	**Just production**	**Incl. GHG**	**Excl. GHG**
Name	**£/Ml**	**£/Ml**	**£/Ml**	**£/Ml**	**£/Ml**
River intake	£30	£5.08	£2.11	£3.00	£0.89
Groundwater abstraction	£29	£4.08	£1.11	£9.20	£8.09
Reservoir	£31	£6.08	£3.11	-£5.00	-£8.11
Aquifer recharge scheme	£29	£4.08	£1.11	£5.40	£4.29
Desalination (brackish water)			£52.69 [2]	£72.18	£19.49
Current water 'full chain; supply	£28	£3.08	£0.11	£16.96	£16.84

Notes: [1] *Values from Environment Agency (2008b), Thames Water (2008a), Essex & Suffolk Water (2008) and South East Water (2008).*
[2] *This value was calculated based on specific GHG cost estimates provided in the relevant Strategic Environmental Assessment (SEA) (Thames Water 2008b). This source suggests that both GHG and air emissions remain significantly adverse even after mitigation measures are considered. The GHG emissions are estimated to equate to 73 per cent of the social costs.*

5 Results

This section brings together the costs of the domestic measures as provided by the 2007 study (Environment Agency 2007a) with the benefits estimated for the purposes of this project. These have been discounted in line with the guidance provided by HM Treasury (2003) to provide an overall estimate of the present value of proceeding with the water efficiency measures.

5.1 Discounted costs of the measures

The cumulative discounted costs of the measures are shown in Figures 5.1 and 5.2 for the water neutrality and progressive scenarios respectively. Thus, the full net present costs are shown by the end of the period in 2068/69.

Figure 5.1 Cumulative discounted costs of measures – water neutrality scenario.

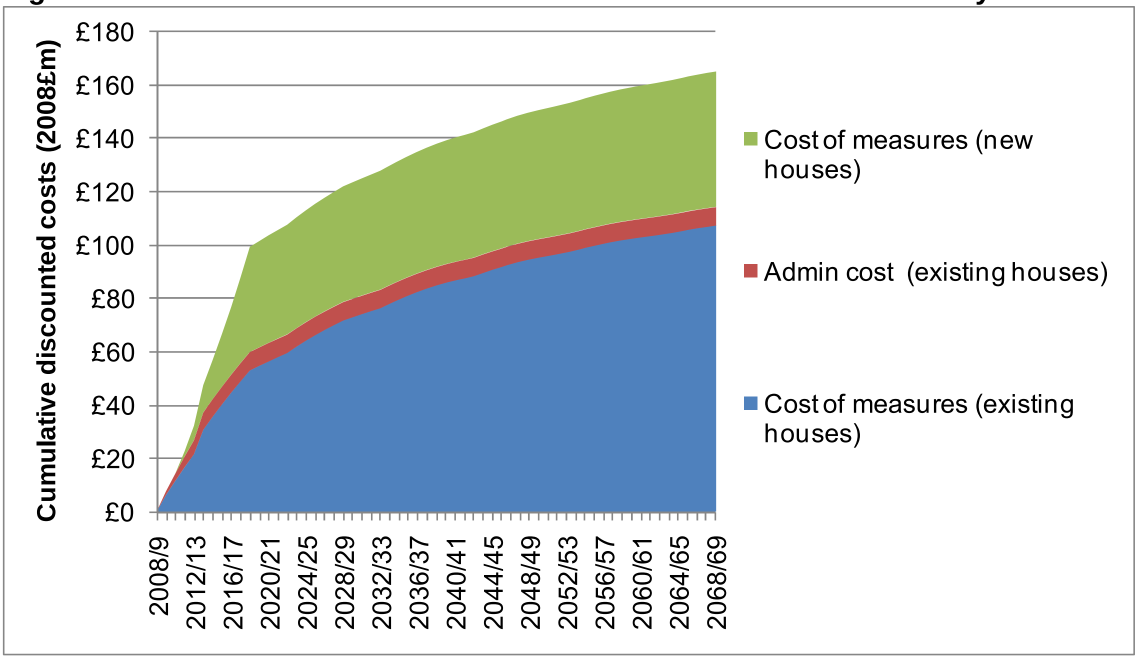
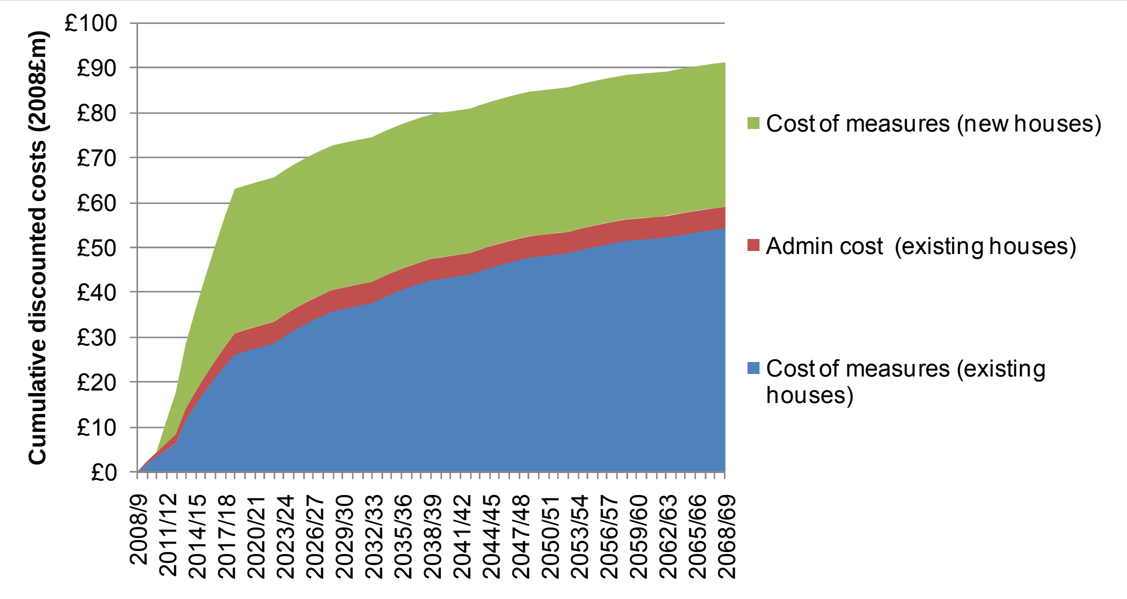


Figure 5.2 Discounted costs of measures – progressive scenario.



The costs of implementing the measures in existing homes under the water neutrality scenario are more than in new homes (Figure 5.1). This is also the case (but to a lesser degree) in the progressive scenario (Figure 5.2), where the cost of implementing measures in existing homes is considerably less. In both scenarios, the administrative costs of implementing measures in existing homes forms a small proportion of total discounted costs.

5.2 Discounted benefits of displaced supplies

The savings of requiring less water include:

- financial savings from reduced need to supply water;
- reduced CO_2 emissions associated with these supplies;
- reduced environmental impacts from supply infrastructure;
- reduced energy bills for households which implement many of the water efficiency measures, as well as the associated reduction in CO_2 emissions.

The cumulative discounted savings in these three areas are shown in Figure 5.3 and Figure 5.4 for the water neutrality scenario and progressive scenario respectively.

Figure 5.3 Cumulative discounted benefits of displaced supplies (water neutrality scenario).

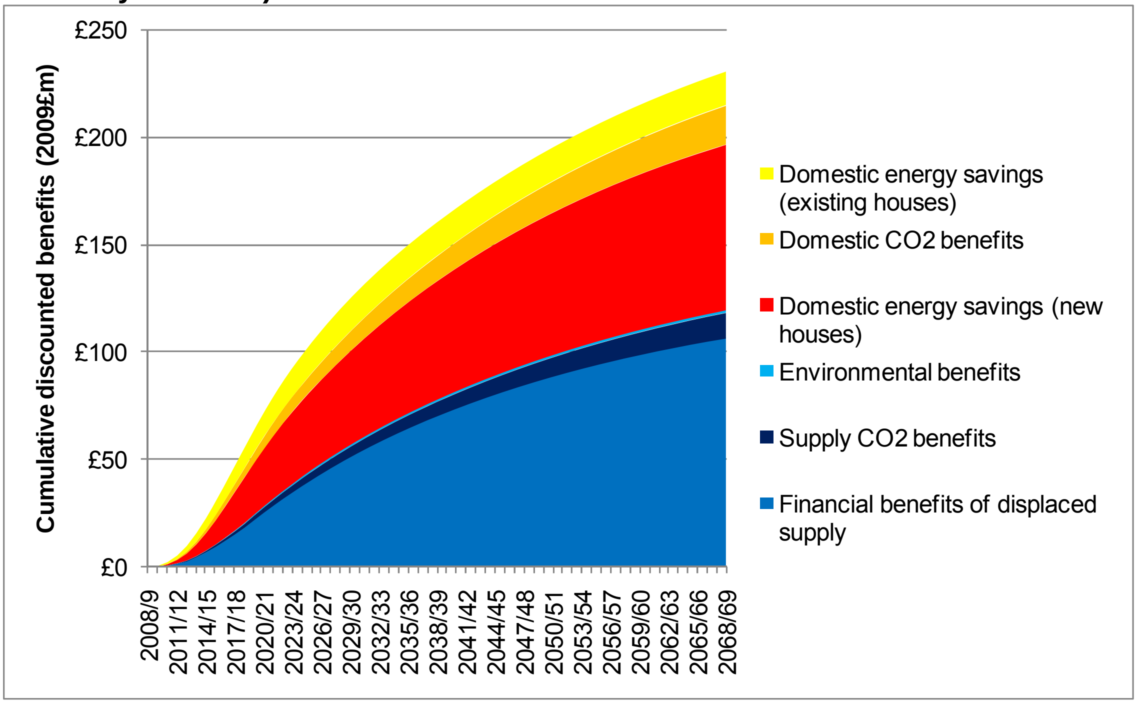
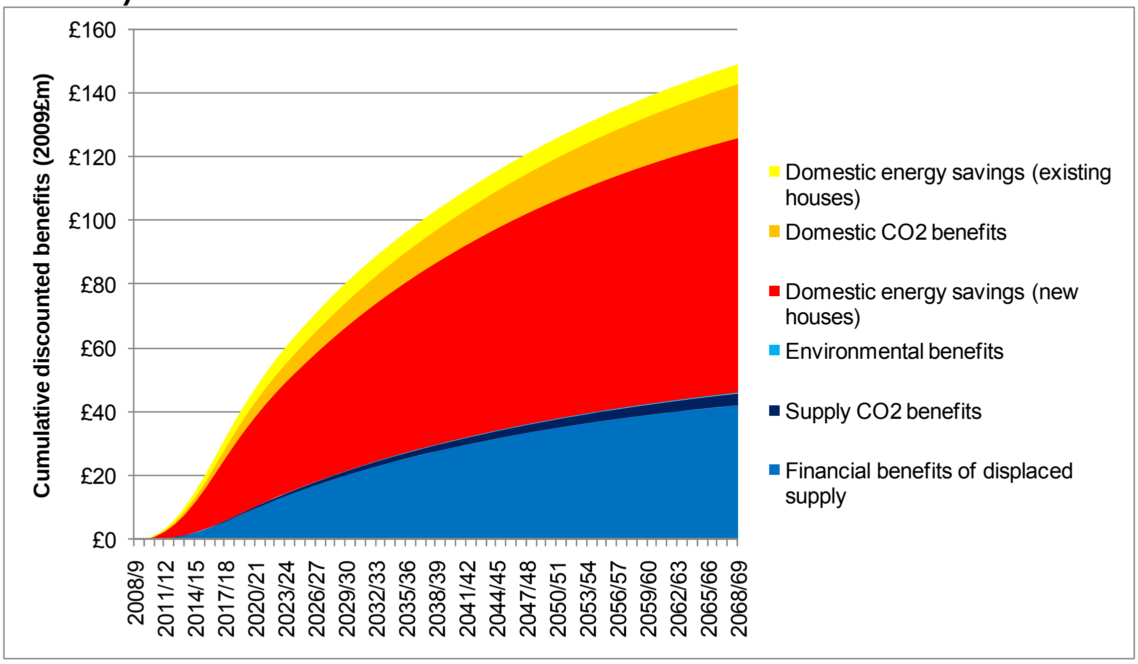


Figure 5.4 Cumulative discounted benefits of displaced supplies (progressive scenario).



The benefits associated with the water neutrality scenario are greater than the progressive scenario. The difference is greatest with the savings associated with supplies of water in the water neutrality scenario. Within this, the financial savings associated with the reduced need to build infrastructure are greater, by far, than the non-financial environmental and greenhouse gas emissions reduction benefits. This is the case in both scenarios.

The energy savings form a notable proportion of the benefits, particularly for the progressive scenario. The energy savings are broadly similar in absolute terms between the two scenarios, but the supply side benefits from a greater proportion of the total benefits in the water neutrality scenario.

Within the saved energy benefits, it is the savings associated with new homes' domestic bills which form the greatest proportion, with savings in energy bills in existing homes forming a far less proportion of the benefits in both scenarios. The benefits in terms of CO_2 also form a small proportion of the savings in relation to the energy savings in new homes.

5.3 Cost–benefit analysis

Comparing the discounted costs and benefits provides an indication of the net present value (NPV) of proceeding with the proposed scenarios and therefore an indication of whether the benefits outweigh the cost. If absolute certainty can be placed on all values in a cost–benefit analysis, then all that would be required to make a decision would be the NPV of the proposals. But as highlighted in Section 6, there will always be some uncertainty in the assumptions and values used in any assessment. Furthermore, the distribution of costs and benefits is relevant in decision-making terms – both in terms of fairness of allocation as well as concerns about regressivity and affordability of certain vulnerable sub-groups. The results of the cost–benefit analysis are given in Table 5.1.

Table 5.1 Results of the cost–benefit analysis.

	Undiscounted totals (£ million)		Discounted totals (2008 £ million)	
	Neutrality	**Progressive**	**Neutrality**	**Progressive**
Cost of measures				
Cost of measures (existing homes)	£225	£117	£107	£54
Admin cost (existing homes)	£8	£6	£7	£5
Cost of measures (new homes)	£84	£40	£51	£32
Total cost of measures	**£317**	**£162**	**£165**	**£91**
Domestic energy savings				
Domestic energy savings (existing homes)	£22	£9	£16	£6
Domestic energy savings (new homes)	£187	£193	£77	£80
Domestic CO_2 benefits	£49	£48	£18	£17
Total domestic energy savings	**£257**	**£250**	**£111**	**£103**
Other benefits	**£318**	**£124**	**£120**	**£46**
Financial benefits of displaced supply	£280	£111	£106	£42
Environmental benefits	£3	£1	£1	£0
Supply CO_2 benefits	£35	£11	£12	£4
Total other benefits	**£318**	**£124**	**£120**	**£46**
Total costs			£165	£91
Total benefits			£230	£149
Total net benefit			**£65**	**£58**
Benefit to cost ratio			**1.39**	**1.64**

The benefits of proceeding with water neutrality outweigh the costs of implementing the necessary measures by a factor of 1.39 (costs = £165 million; benefits = £230 million) (Table 5.1). On this basis, the net benefits in present (2008) terms would be £65 million. The benefits are dominated by the financial savings from displaced need to develop supply infrastructure (£120 million), though the savings associated with domestic energy are almost as great (£111 million).

The results for the progressive scenario suggest that the benefits of proceeding with the scenario would outweigh the costs of implementing the necessary measures by a similar factor of 1.64 (costs = £91 million; benefits = £149 million) (Table 5.1). On this basis, the net benefits in present (2008) terms would be £58 million. The benefits are dominated by the savings associated with domestic energy (£103 million), with the financial savings from displaced need to develop supply infrastructure (£46 million) being somewhat less dominant than was the case in the water neutrality scenario.

6 Sensitivities and uncertainties

This section explores a number of areas of uncertainty associated with the assumptions used and tests how sensitive the results are to plausible changes in these assumptions.

Sensitivity analysis was undertaken in the following areas:

- the economic parameters including the rate of discount and the length of time that the costs and benefits are being considered;
- uncertainties in the assumptions made relating to the assumed price of energy.

In all cases, only one change was made at a time with all other assumptions remaining the same as those used in Section 5.

6.1 Sensitivity analysis of economic parameters

The water industry is regulated based on a rate of return on water company investments of 4.5 per cent. It is also assumed that investments in the sector have a life of 60 years. Indeed AIC are calculated using these two assumptions. This report uses a rate of discount of 3.5 per cent for the first 30 years and 3 per cent for the second 30 years based on HM Treasury Green Book guidance (HM Treasury 2003). However, 60 years is a relatively long period of time to assess costs and benefits. A more typical assessment period used in cost–benefit analysis is 25 years.

Therefore sensitivity analysis was undertaken using:

- a discount rate of 4.5 per cent rather than the rate proposed in the Green book;
- an assessment period of 25 years rather than 60 years.

The outcome of these analyses is shown in Table 6.1. As expected, Table 6.1 shows that the ratio of benefit to cost decreases when the rate of discount is increased and the period of assessment is decreased. However, the benefits outweigh costs for all the sensitivities tested.

Table 6.1 Sensitivity analysis of key economic parameters.

	r = 4.5% [1]		t = 25 years [1]	
	Discounted totals (2008 £ million)		Discounted totals (2008 £ million)	
Cost of measures	**Neutrality**	**Progressive**	**Neutrality**	**Progressive**
Cost of measures (existing homes)	£91	£45	£72	£35
Admin cost (existing homes)	£7	£5	£7	£5
Cost of measures (new homes)	£45	£30	£41	£30
Total cost of measures	**£143**	**£80**	**£120**	**£70**
Domestic energy savings				
Domestic energy savings (existing homes)	£14	£6	£14	£6
Domestic energy savings (new homes)	£62	£64	£44	£45
Domestic CO_2 benefits	£14	£13	£9	£8
Total domestic energy savings	**£90**	**£83**	**£67**	**£59**
Other benefits	**£93**	**£36**	**£59**	**£22**
Financial benefits of displaced supply	£83	£33	£53	£21
Environmental benefits	£1	£0	£1	£0
Supply CO_2 benefits	£9	£3	£5	£1
Total other benefits	**£93**	**£36**	**£59**	**£22**
Total costs	£143	£80	£120	£70
Total benefits	£182	£118	£126	£81
Total net benefit	**£40**	**£38**	**£6**	**£11**
Benefit to cost ratio	**1.28**	**1.47**	**1.05**	**1.16**

Notes: *r = discount rate and t = assessment period*

6.2 Sensitivity analyses of energy assumptions

The energy savings form an important part of the benefits. There is the possibility that other economic assessments of the Thames Gateway development could capture the energy savings associated with it, risking the double counting of benefits if the outcomes of these assessments were added up. Therefore the energy savings have been removed to give the results reproduced in Table 6.2.

The cost of gas and electricity were assumed to be based on the prices faced by domestic consumers within the Thames Gateway area. But if the impact of the water efficiency measures is captured fully in the power system planning process, the savings would be based on the wholesale values of the energy. Wholesale values were taken from Ofgem (2009); the value of electricity is now £0.065/kWh (rather than £0.12/kWh) and the value of gas is £0.024/kWh (rather than £0.039/kWh). These sensitivities are explored in Table 6.2.

Table 6.2 Sensitivity analyses of energy assumptions. [1]

	Energy = £0		Energy = wholesale	
	Discounted totals (2008 £ million)		Discounted totals (2008 £ million)	
Cost of measures	**Neutrality**	**Progressive**	**Neutrality**	**Progressive**
Cost of measures (existing homes)	£107	£54	£107	£54
Admin cost (existing homes)	£7	£5	£7	£5
Cost of measures (new homes)	£51	£32	£51	£32
Total cost of measures	**£165**	**£91**	**£165**	**£91**
Domestic energy savings				
Domestic energy savings (existing homes)	£0	£0	£10	£4
Domestic energy savings (new homes)	£0	£0	£47	£49
Domestic CO_2 benefits	£0	£0	£18	£17
Total domestic energy savings	**£0**	**£0**	**£75**	**£70**
Other benefits	**£120**	**£46**	**£120**	**£46**
Financial benefits of displaced supply	£106	£42	£106	£42
Environmental benefits	£1	£0	£1	£0
Supply CO_2 benefits	£12	£4	£12	£4
Total other benefits	**£120**	**£46**	**£120**	**£46**
Total costs	£165	£91	£165	£91
Total benefits	£120	£46	£194	£116
Total net benefit	**-£46**	**-£45**	**£29**	**£25**
Benefit to cost ratio	**0.72**	**0.50**	**1.18**	**1.27**

Notes: [1] *Where the energy costs are removed, the CO_2 benefits of domestic energy savings have also been removed.*

The results shown in Table 6.2 highlight the impact that the energy savings have on the outcome of the cost–benefit analysis as presented in Section 5:

- Where the energy savings have been removed all together, the benefits no longer outweigh the costs in either scenario.
- Where the more conservative wholesale energy prices are assumed, the benefit to cost ratio falls notably – particularly in the case of the progressive scenario, where the ratio reduces from 1.64 (Table 5.1) to 1.27 (Table 6.2).

It follows from the assumptions used in Environment Agency (2007a) that there are similar volumes of hot water savings in both the progressive and water neutrality scenarios (Section 3.5.1). The water neutrality scenario therefore delivers the extra savings via measures which save more cold water such as water metering and rain water harvesting.

7 Analysis of consequences and impacts

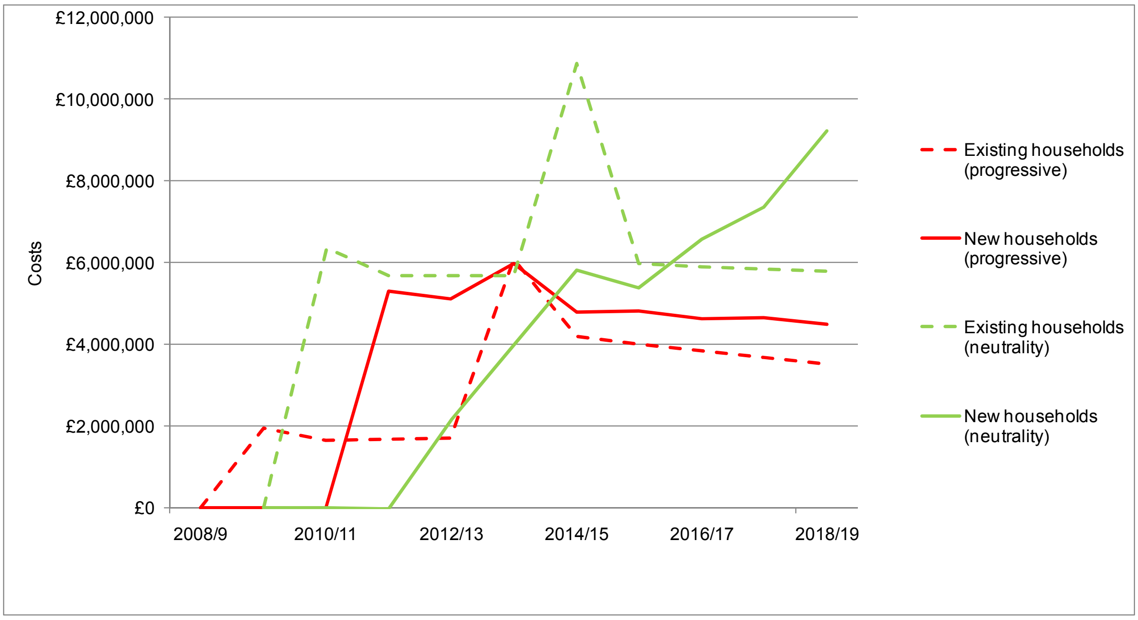
The CBA methodology seeks to find whether a proposed measure provides net benefits at a macro level. It is assumed that any negative impact can be either successfully mitigated or compensated for. This section:

- maps out the important winners and losses from the measures;
- explores the consequences of the scenarios;
- examines how the negative impacts and unintended consequences can be managed.

7.1 Cost of the measures

Figure 7.1 shows the total costs for all measures in new and existing households across the Thames Gateway.

Figure 7.1 Net costs of water efficiency measures (undiscounted). [1]



Notes: [1] *Based on the costs of preferred supply options presented in Thames Water (2006a).*

The costs of measures in existing households are greater under the water neutrality scenario (green dashed line in Figure 7.1) than the progressive scenario (red dashed line), as would be expected to deliver greater water savings.

For new households under the two scenarios, the profiles of costs are quite different, with the costs of the progressive scenario (solid red line in Figure 7.1) exceeding that of the water neutrality scenario (solid green line) in the years leading up to 2013/14. This is reversed after 2013/14 where the costs of measures under the water neutrality scenario exceed that of the progressive scenario. This is important as the costs will be delayed under the water neutrality scenario, and have therefore been valued differently within the CBA methodology. It also highlights the different underlying assumptions made for new homes under these scenarios.

In terms of who pays, under the progressive scenario (i.e. the red lines in Figure 7.1), new homes pay more in most years. However, the water neutrality scenario (shown by the green lines) is required to place a greater proportion of the burden on existing homes rather than new build homes.

7.2 Economic benefits of the Thames Gateway development

Although wider economic benefits cannot[12] be captured within cost–benefit analyses, it is worth exploring what is at stake with the wider development. The Thames Gateway is considered essential to the future growth and competitiveness of London and the greater South East.

The vision for the Thames Gateway (EEDA 2007) is:

> '... growth within the global economy based on high value inward investment, stimulating and capturing innovation, the creation of vibrant, creative and stimulating places, demanding high quality in design and development achieving environmental sustainability and growing existing businesses to achieve:
>
> - a Gateway to international trade and investment between the UK, Europe and the world;
> - development of the London city-region to ensure that the global city and its region can grow and compete on the global stage;
> - enabling communities in Kent and Essex to benefit from, and contribute to, the London success story.'

[12] The methodology requires that there is the freedom not to proceed with the proposed measures. It is only valid to attribute any such benefits to water neutrality if (a) the impacts of further water use is considered unacceptable (i.e. it is not appropriate to put a value on the environmental impacts) and (b) the delivery of water neutrality is considered essential to the wider development proceeding.

The economic investment plan (EEDA 2007) estimates that, if the ambitions for growth in the Thames Gateway are achieved, it will add around £12 billion gross value added (GVA) per year to the UK economy. This relies on closing the productivity gap between the Thames Gateway and the rest of the South East region and achieving the target of 180,000 additional jobs by 2016. The plan sets out the strategy to bridge the productivity gap. This will involve:

- strengthening the fundamentals that underpin internationally competitive places – notably the skills base, transport and connectivity, high levels of economic participation and social capital, the quality of the environment, housing and civic spaces;
- developing a culture of innovation and creativity, and the networks, skills and institutions that enable knowledge-based growth;
- increasing business start-up and growth rates, and in particular to increase the number of businesses active in national and international markets;
- targeting investment in those sectors or clusters where the Thames Gateway can genuinely maintain or develop globally-leading competitive specialisms;
- strong leadership and governance.

7.3 Impact on vulnerable customers

There are notable vulnerability and deprivation issues within the existing Thames Gateway population; 12.3 per cent of its present residents claim income support, which is well above the London average rate of 7.4 per cent.[13] Furthermore, skill levels among the resident population of the Thames Gateway remain low with qualification levels below the national average in almost all areas.[13]

The work undertaken in 2007 (Environment Agency 2007a) supports the need for water metering to achieve the environmental objectives behind water neutrality in water-stressed areas such as the Thames Gateway. There are also concerns about disproportionate costs for low income households (i.e. it is regressive). However, an international comparison of water charging (see Ekins and Dresner 2004) found that the existing system of relatively low levels of water metering in England is more regressive and more burdensome on low income households than in any other industrial country examined. Therefore water metering is not, per se, more regressive than the existing arrangement for water charging in non-metered households, which is linked to rateable value.

In work supported by the Joseph Rowntree Foundation, Ekins and Dresner (2004) investigated the distributional effect of 11 alternative tariffs on low income households, including the standard metered tariff structures offered by Anglian Water and Seven Tent Water. Many of the tariffs incorporated measures intended to mitigate regressivity issues. The findings from this analysis were as follows:

- All the metered tariffs investigated were less regressive than the present tariffs. Therefore, on average, those in the lowest income group would be better off.
- All but one of the investigated options was also progressive (i.e. better) for the next income group (those with incomes of £10,000–20,000).

[13] http://www.londonmet.ac.uk/services/london-office/the-thames-gateway/key-issues/skills.cfm

Therefore, it was concluded that there is no basis for supposing that switching to metering will, on average, make low income households worse off (Ekins and Dresner 2004).

7.4 Potential unintended consequences

Five areas were identified in this study as potentially having unintended consequences relating to water companies. These areas are:

- the potential incentive for water companies to displace demand side measures in preference to supply side resource developments;
- water efficiency targets as determined by Ofwat;
- existing programmes of metering;
- any improvement in the trading positions of the water companies under the Carbon Reduction Commitment (CRC);
- the potential benefits to energy suppliers in the event that they are involved with the rollout of measures.

It is believed that, apart from the CRC, these potential unintended consequences can be successfully managed, although co-ordinated effort will be required by the respective regulatory bodies during the detailed planning of the delivery mechanisms. The five areas are discussed below.

7.4.1 Displacement of demand side measures

The analysis within this report valued the benefits of water neutrality based on displacing supply side infrastructure such as reservoirs. But there may be some cases where, if a water company was to follow purely a least social costs planning process, the reduced demand associated with water neutrality might lead to the displacement of demand side measures (e.g. reducing leaks, replacing mains, installing water meters, etc). Therefore, there is the potential for the outcome of water neutrality to be effectively a concentrating of measures in the Thames Gateway area which is offset by a reduced efficiency effort in the area surrounding it. In comparison:

- Mains replacement within the Thames Water area has an average AISC of about £1,469/Ml saved (Thames Water 2008d). A supply curve[14] shown in Table 32 of Thames Water (2008a) shows that this can vary from -£430/Ml (i.e. a saving) to a cost of £3,300/Ml.
- The AISC of leak control measures within the Thames Water region vary from £758/Ml to £4,712/Ml.
- The AISC of the UTMRD (Abingdon Reservoir) scheme is only £276/Ml.

These figures highlight the fact that the WRMP process is a complex consultative process which does not always follow a least cost solution. There is a requirement to consult on the draft WRMP plan and make revisions based on the outcome (compare, for example, the difference in the preferred programme between Thames Water 2008a and Thames Water 2009).

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[14] That is, the increasing costs per unit of water saved as the more leaky and cheaper to replace mains are replaced in preference.

A major influence on this process is the desire to reduce leaks, particularly in the context that costumers are faced with conservation measures.[15] It may well therefore be possible to intervene and endure that this unintended consequence does not occur. This would require early engagement with the relevant water companies, perhaps in consultation with the water regulator Ofwat.

7.4.2 Water efficiency targets

In November 2008, Ofwat published its *Water Supply and Demand Policy* (Ofwat 2008). This policy covered the areas of water efficiency, leakage, metering and climate change. Of particular relevance to the water neutrality study are the water efficiency targets. These form a basis for quantifying water companies' performance on water efficiency activities and highlighting the work they do to help consumers to use water more wisely. Since 1996, each water company has had a duty under section 93A of the Water Industry Act 1991 to promote water efficiency to its customers. Since 2005, this duty has also applied to licensed water suppliers.

The base service water efficiency (BSWE) is the minimum level of activity that Ofwat expects all water companies to achieve under their duty to promote water efficiency. The target is an activity-based target that Ofwat has set for water savings of one litre of water per property per day through water efficiency activity for the period 2010/11 to 2014/15. Because Ofwat believes that the BSWE target represents the level of activity that companies should be achieving, it does not propose to provide additional funding to meet it.

In the event that the measures required to achieve water neutrality are implemented by bodies other than the water companies, there is a risk that the costs of meeting this target will be captured by the water neutrality effort. This would therefore represent an unintended benefit to the water companies.

It is important, therefore, that the activities of the water companies in meeting this target are co-ordinated with the additional activities targeted at the water neutrality area. There should be synergies in the messages and measures, and double-counting of water savings should be avoided.

7.4.3 Metering

All companies have a meter optant policy in place (i.e. a policy that allows householders to opt to have a meter fitted at their property). However, there are unlikely to be sufficient people selecting to switch to a metered account to make this policy work for water neutrality.

An alternative approach being adopted by a growing number of water companies is to install meters under a policy which installs meters on change of occupancy. This relies on sufficient movement in the house buying and rental market, and the co-operation of home-owners and tenants. This option also tends to be more expensive.

The third option is to use compulsory metering powers (Environment Agency 2007a). This requires that the area lies within an area of high water stress. Under this option, the water company can meter all the properties in a specific area, potentially leading to economies of scale for the cost of meter installation in the order of 10–20 per cent.

The planned metering activity set out in the water company's draft Water Resource Management Plan will already be funded through the WRMP and water company business plan. If left to the water companies to implement, there is an incentive to

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[15] See, for example, http://nnet-server.com/server/common/eafloods20.htm

increase the number of meters deployed in the water neutrality area and to reduce meter deployment in areas outside the water neutrality area. If this results in no net increase in water meter deployment over the whole water company area, then the funds may already exist within the water company to target metering in the water neutrality area. However, this outcome would represent an unintended consequence contrary to the sustainable development objectives behind the water neutrality concept. There is also a chance that, if additional funds were made available to water companies to deliver this part of the water neutrality plan, they would be an unintended benefit for the water companies. It is therefore important that any such agreement is made in a way which controls for such a 'halo' effect.

7.4.4 Carbon Reduction Commitment

The Carbon Reduction Commitment (CRC) is a new mandatory emissions trading scheme that aims to improve energy efficiency and reduce the amount of carbon dioxide (CO_2) emitted in the UK. CRC will affect large organisations in both the public and private sector.

The water industry will meet the qualification criteria as presently being proposed in guidance published by Defra in March 2009 (Defra 2009);[16] water companies will have to monitor their emissions and purchase allowances, sold by Government, for each tonne of CO_2 they emit.

The performance of an organisation in terms of reducing its emissions will affect its standing in the annual performance league table showing the comparative performance of all participants. An organisation's position in this league will be the basis of the recycling of revenues raised from selling allowances back to participants.

The potential consequence of this relates to the relative contraction of the water company's business associated with water neutrality and the potential improvement in their ranking in the performance league, and therefore the relative proportion of recycled revenue received. Water neutrality will therefore likely represent a benefit in this regard.

The draft Defra guidance (Defra 2009) contains two relevant metrics used to assess performance and assign the position within the league:

- An **absolute metric** which simply reflects the relative change in an organisation's CRC emissions.
- A **growth metric** which takes into account the fact that a growing organisation may have an increase in its absolute emissions by measuring change in emissions intensity. This metric therefore gives credit to organisations that are expanding in an energy-efficient way.

Organisations are only legally required to provide information for the absolute metric. However, all metrics will be taken into account when working out league position and failure to disclose information for the growth metric will lead to no league table points. However, based on the assumption that the demand for water is growing for the relevant water companies, it seems likely that they will have more incentive to disclose information on their growth and will need to factor in water neutrality in the Thames Gateway within their disclosures. Therefore, the benefit to the sector will be limited to the impact that water neutrality will have on assessment on the absolute metric.

[16] This guidance was based on the draft legislation at that time (subject to a consultation that ended on 4 June 2009).

A number of factors impact on the benefit that water neutrality will have on the water sector. These include:

- **Weighting placed on the absolute metric in any one year**. This is 60 per cent in 2011 and 2012 rising to 75 per cent for future phases.
- **Length of time of the CRC**. Defra (2009) sets the policy out until 2015 and makes the design subject to review after this date. It is reasonable to assume that some sort of emissions incentive policy will remain into the future; in the absence of knowledge as to what form this might take, it is assumed that the CRC will be extended indefinitely.
- **Value of allowances**. The Government will sell allowances annually at the start of each compliance year at a fixed price of £12/allowance. There is an opportunity to 'buy-out' allowances at the EU scheme rate in the event that EU permits become worth less than £12/tonne CO_2. The figure of £12/tonne therefore represents an upper price ceiling.
- **Degree that revenues are recycled by the scheme administrator.** The degree of recycling will be based on the organisation's share of baseline emissions in 2010 and its performance within the league. The degree of bonus or penalty will be limited as shown in Table 7.1.

Table 7.1 Bonus/penalty rates for the top and bottom placed participants in the league table. [1]

Phase	Year of CRC	Level of recycling
Introductory phase	2010	+/-10%
Introductory phase	2011	+/-20%
First capped phase	2012	+/-30%
First capped phase	2013	+/-40%
First capped phase	2014	+/-50%
Subsequent phases	2015 +	For review

Notes: [1] *Taken from Defra (2009).*

The relationship between reduced emissions is therefore complex. However, it is driven by the degree of impact of the absolute metric, the value of emissions and the degree to which the performance league can act as a bonus or a penalty. These factors have been combined to generate an indicative calculation of the possible benefit of water neutrality in the Thames Gateway in relation to the CRC (Table 7.2). It is assumed that:

- the CRC will act throughout the assessment period;
- the water industry will value future costs and benefits at a rate of 4.5 per cent.

Table 7.2 Indicative calculation of benefit to the water industry in relation to the CRC.

	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Discount factor (4.5%)	0.876	0.839	0.802	0.768	0.735	0.703
Water Neutrality scenario						
Tonnes CO_2 reduced	5,777	7,713	10,707	14,184	16,405	18,269
Value of credit	£12.00	£12.00	£12.00	£12.00	£12.00	£12.00
Bonus rate	60%	60%	75%	75%	75%	75%
Impact of absolute metric	20%	30%	40%	50%	50%	50%
Estimated benefit of CRC	£8,319	£16,659	£38,545	£63,827	£73,823	£82,212
NPV of benefit	£7,290	£13,970	£30,931	£49,013	£54,247	£57,810
Total NPV (up to 2068)	**£1,691,282**					
Progressive scenario						
Tonnes CO_2 reduced	1,359	1,553	1,758	3,251	3,973	4,662
Value of credit	£12.00	£12.00	£12.00	£12.00	£12.00	£12.00
Bonus rate	60%	60%	75%	75%	75%	75%
Impact of absolute metric	20%	30%	40%	50%	50%	50%
Estimated benefit of CRC	£1,957	£3,355	£6,328	£14,628	£17,880	£20,980
NPV of benefit	£1,715	£2,814	£5,078	£11,233	£13,139	£14,753
Total NPV (up to 2068)	**£441,997**					

Notes: [1] *Assumptions are taken from Defra (2009).*
[2] *The benefit has been evaluated over the full assessment period that the Thames Gateway water neutrality measures are assumed to act.*

The indicative benefits that the relevant water companies might gain due to the CRC are in the region of £1.7 million (under the water neutrality scenario) and £0.4 million under the progressive scenario (Table 7.2). These are indicative as the impact of any single change in emissions on a company's position in the performance league table and the corresponding revenues recycled are based on a ranking and are not therefore necessarily linear.

7.4.5 Carbon Emissions Reduction Target (CERT)

The Electricity and Gas (Carbon Emissions Reduction) Order 2008[17] placed an obligation on electricity and gas suppliers to meet an overall target for reduction in carbon emissions in the household sector. The Order requires the energy regulator Ofgem to determine the carbon emissions reduction obligation for each supplier. Ofgem is also tasked with determining whether measures proposed by suppliers can be used to meet their targets and what reductions in carbon emissions should be attributed to them.

The Order requires that a supplier must achieve its carbon emissions reduction obligation by promotion of measures for the following purposes:

- achieving improvements in energy efficiency;
- increasing the amount of electricity generated or heat produced by microgeneration;
- increasing the amount of heat produced by any plant that relies wholly or mainly on wood;
- reducing energy consumption.

Many of the measures intended to deliver water neutrality would qualify under the CERT obligation. However, domestic energy suppliers would only benefit if:

- they are involved with the delivery of the measures; and
- Ofgem considers that the reduction was due to their actions.

Therefore, any negotiation with energy suppliers to rollout the measures required for water neutrality will need to include discussions on issues related to CERT. A crucial early issue to be resolved would be to gain clarification from Ofgem as to whether a particular delivery mechanism is eligible to contribute towards the supplier's obligation. Such a process may seek to design the mechanism, in consultation with Ofgem, to ensure that the rollout mechanism does qualify. The negotiated arrangements with the suppliers should seek to reflect to the degree that this can be achieved to avoid the benefit being captured by the supplier in an unintended way.

[17] http://www.opsi.gov.uk/si/si2008/draft/ukdsi_9780110805306_en_1

7.5 Likely winners and losers

Only a high level assessment of the likely winners and losers from the measures was possible at this stage. The following assumptions were made to give the assessment of likely winners and losers as shown in Table 7.3:

- The additional costs of measures in new homes will be borne by developers and therefore ultimately by those purchasing new homes within the Thames Gateway.
- The retrofit effort within existing homes will be led by the relevant water companies – probably supported by a number of public sector bodies.
- Efforts to prevent the unintended consequences are successful where feasible.

Table 7.3 Assessment of likely winners and losers.

	Financial	Environment	Security of supply
New Thames Gateway residents (including vulnerable)	+++	+	+
Existing Thames Gateway residents who adopt measures	++		
Water bill payers within relevant water company areas	– ?		

Key:
+++ = considerable net benefit
++ = notable net benefit
+ = small net benefit
– = small net cost
? = notable uncertainty associated with assessment.

The assessment of winners and losers suggests that there is only one group who could lose in the event of the measures being implemented (Table 7.3).

- Residents who live in new homes would make considerable financial savings; there are sufficient water and energy savings associated with the proposed packages of measures to offset the additional costs of the measures.
- To a lesser degree this would also be the case for existing residents who adopt the proposed retrofit measures. These residents will typically face additional investment costs as they are replacing existing infrastructure, rather than making an additional investment. Not all existing residents will have a water meter installed but these people would still make the energy savings. However, it can be assumed that most of the existing residents who adopt the measures will either already have, or intend to have, a water meter installed.
- Those who pay water bills to one of the water companies that operate within the Thames Gateway could also see a small decrease in their bill as a result of water neutrality due to the unintended consequences. However, with the exception of the limited impact on the company's trading position

within the CRC, the unintended consequences of water neutrality can be successfully managed. More significant would be any additional cost of implementing measures in existing homes that is borne by the water companies and not met by grants or other funds. It is possible that the costs would be passed onto all water bill payers but the benefits of the measures would only be reflected in the adopting homes water bills via reduced measured consumption.

- The environmental benefits of water neutrality are positive for all residents in and around the Thames Gateway. The potential loss of use value associated with the loss of reservoirs would unlikely to occur as the proposed reservoir projects are considerable in size and not easy to resize. Therefore, it is likely that any water surplus as a result of the measures would be traded.
- The security of water supplies (and therefore the probability that use restrictions would not be required) would also improve for all relevant residents in the years leading up to the time when the larger reservoir projects come on stream. The relevant Kent reservoir is due to be commissioned by early as 2014/15. However, Thames Water's Abingdon reservoir is not due for completion until 2026/27.

8 Conclusions

The results of the analyses suggest that the benefits would outweigh the costs for both the water neutrality and progressive scenarios. While the net present benefit of proceeding with the water neutrality scenario is slightly greater than the progressive scenario (£65 million as opposed to £58 million), the progressive scenario returns a greater benefit to cost ratio (1.64 as opposed to 1.39) and therefore represents a better return on the investment.

These net benefits are based on water efficiency scenarios developed to save water, not energy. If water neutrality was to be adopted in the Thames Gateway development, there are likely to be additional net benefits if the adopted measures are chosen based on an assessment that captures the energy benefits associated with water savings.

The sensitivity analysis demonstrates that the positive net present benefits are dependent on the savings associated with reduced domestic energy consumption. However, if a conservative wholesale value of gas and electricity is assumed, the benefits remain greater than the costs for both scenarios.

Where more conservative economic parameters are applied (4.5 per cent rate of discount and 25 years rather than 3.5 per cent/3.0 per cent and 60 years), both scenarios still provide total net present benefits, i.e. 1.28 and 1.47 for a 4.5 per cent discount rate and 1.05 and 1.16 for an assessment period of 25 years for the water neutrality and progressive scenarios respectively.

A high level assessment of the likely winners and losers from water neutrality suggests that the only potential losers in the event of the measures being implemented are those who pay water bills to a water company that operates within the Thames Gateway development area but who opts not to adopt any of the proposed measures. Such a distributional implication can be dealt with if funds are made available to the water companies. There would likely be considerable financial savings available for Thames Gateway residents moving into new properties.

Previous experience of promoting such measures would suggest that the uptake rates assumed in the water neutrality scenario would be challenging to achieve. Further analysis of the demographics profile of the Thames Gateway population in the context of the Defra's pro-environmental behaviours segmentation model (Defra 2008a) would suggest that concerted engagement would be required to ensure the required levels of uptake. This may well require innovative initiatives that engage residents and propose the measures as a default or social norm, as well as providing a level of incentive for action.

Overall the water neutrality provides a slightly higher NPV but lower benefit to cost ratio than the progressive scenario. The progressive scenario therefore represents the risk adverse scenario. However, the coherent objective behind the water neutrality scenario is likely to help the concerted action required to deliver water neutrality, as well as providing a valuable example for other development areas to follow.

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List of abbreviations

AIC	Average Incremental Cost
AISC	Average Incremental Social Cost
ASR	aquifer storage and recovery
BAU	Business As Usual
BSWR	base service water efficiency
CBA	cost–benefit analysis
CERT	Carbon Emissions Reduction Target
CLG	Department for Communities and Local Government
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CRC	Carbon Reduction Commitment
CSH	Code for Sustainable Homes
Defra	Department for Environment, Food and Rural Affairs
EEDA	East of England Development Agency
GHG	greenhouse gas
GVA	gross value added
JRF	Joseph Rowntree Foundation
l/h/d	litres per head per day
l/hh/d	litres per household per day
l/p/d	litres per person per day
ML/d	million litres per day
NPV	net present value
pcc	per capita consumption
PV	present value
SC	social cost
SC-C	non-CO_2 social cost
SPC	Shadow Price of Carbon
UTMRD	Upper Thames Major Resource Development
WRMP	Water Resource Management Plans

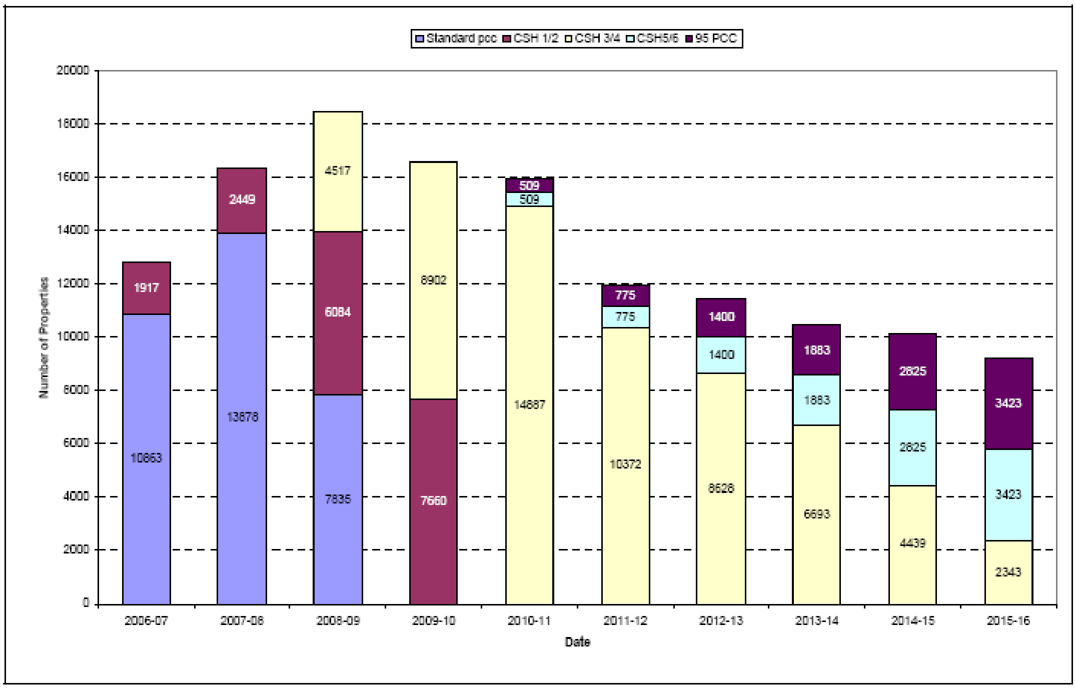
Appendix I Details of efficiency measures

Water neutrality scenario measures

Measures

- New homes: all new households (public and private) will achieve a minimum standard of CSH Level 3/4 from 2009/10 (see Figure A1).
- Existing homes:
  - By 2011/12, 10 per cent of public sector homes and 2 per cent of private sector homes achieve CSH Level 5/6.
  - By 2011/12, 10 per cent of public sector homes and 2 per cent of private sector homes achieve a per capital consumption (pcc) of 95 litres per person per day (l/p/d).
  - By 2015/16, 35 per cent of private sector homes achieve CSH Level 5/6 and 35 per cent achieve a pcc of 95 l/p/d.
  - Compulsory metering was assumed to result in a 10 per cent reduction in annual average demand (per capita).
  - Rising-block tariffs (i.e. higher unit rates for each unit of water above a certain threshold) were assumed to provide an additional 5 per cent reduction in annual average demand. It was assumed that the variable tariffs would incur an operating cost of £5 per meter.
- Non-household: 40 per cent savings from offices and 10 per cent from other non-households.

Figure A1 New households by CSH consumption level (neutrality scenario).



Assumed uptake

- An annual rate of meter penetration 5 per cent higher than the water companies allowed for in their current draft WRMPs was assumed for the Thames Gateway study. This is close to the rate some companies indicated for metering on change of occupancy. Metering at this rate would result in 70 per cent of domestic properties in the Thames Gateway being metered by 2016.
- Variable tariffs were applied to both existing metered households and new metered households from 2010/11 onwards.
- The rate of retrofitted existing homes was assumed to be evenly spread across the period.
- Assumed house-building rates were not equal for every year – with rates tapering off after 2011/12.

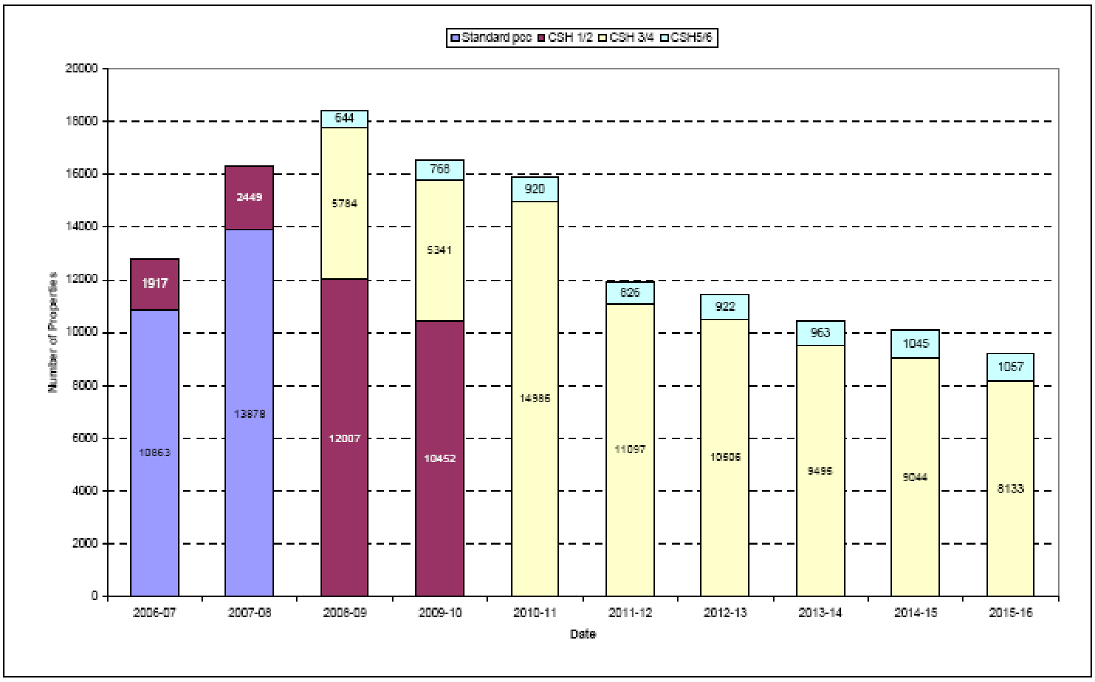
Progressive scenario

Figure A2 illustrates the CSH glide path for the progressive scenario with the following assumptions:

- All public sector homes are currently built to CSH Level 1/2, moving to Level 3/4 as a minimum from 2008/09, with homes built to Level 5/6 increasing from 11 per cent in 2008/09 to 20 per cent in 2015/16.
- All private sector homes are built to a minimum of CSH Level 3/4 from 2010/11.
- Some 10 per cent of private sector homes achieve CSH Level 5/6 in 2015/16.

Table 3.3 shows that the assumed uptake rate of retrofit measures is the least ambitious of all the scenarios. With an estimated 21 per cent of existing homes to be retrofitted with low flow taps, it still presents a considerable challenge. In the non-households, only water savings from offices were assumed.

Figure A2 Annual new households by CSH consumption level (progressive scenario).



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