Towards water neutrality in the Thames Gateway

Peer reviews of Science report SC060100/SR1

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Environment Agency

HM Government
Thames Gateway

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Peer review 1

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1. Introduction

The Environment Agency commissioned Entec UK Ltd to produce a report for the study 'Towards water neutrality in the Thames Gateway' that explores the feasibility of what could be achieved through the management of demand for water in the Thames Gateway in the south-east of England. The study is intended to inform policy based around the concept of 'water neutrality'. The study also aims to inform the development of the relevant water companies' Water Resource Management Plans for 2009 and provide lessons for other significant housing growth proposals.

This report has been commissioned by the Agency to provide an objective and independent review of the modelling and costing work undertaken by Entec. In particular, an assessment is required of whether the approach to the modelling and costing is appropriate for a feasibility study, and whether the assumptions behind the modelling are appropriate and have been applied correctly. The Agency need to determine if the analysis is robust enough to meet the needs of the feasibility study, and/or whether it can be improved.

The approach adopted is to review each of the chapters of the report with an assessment of the validity of the methods, data and assumptions used. This is followed by a section of comment and discussion on the work. Finally, five formal questions are addressed.

No attempt has been made to check the arithmetical accuracy of the work as it is assumed a thorough internal review has been carried out of the spreadsheet modelling.

2. Review of document

2.1 Introduction (Chapter 1)

Chapter 1 provides an overall introduction to the study and summaries the context of the work. The concept of 'water neutrality' is defined here as:

"Water neutrality in the Thames Gateway would be achieved if the total water used after new development is equal to or less than the total water use in the Thames Gateway before the development."

This is an important definition as the concept is a new and there are no agreed definitions. The chapter could be improved by giving a little of the background to the derivation of the definition. It may also help to compare and contrast it with the better established (although still not categorically defined) concept of carbon neutrality. In effect this definition of neutrality necessitates offsetting the impact of new houses with savings made to existing properties, and this point could well be made.

2.2 Water use in the Thames Gateway (Chapter 2)

This chapter indicates the types of water use considered in the study and explains some the key data types used later in the study

2.3 Baseline water use (Chapter 3)

Chapter 3 is concerned with establishing water use in the Gateway in the baseline year of 2005/6. It draws particularly and appropriately from water company Water Resource Plans. As Water Resource Zones do not match the Gateway borders, data has been apportioned appropriately on a spatial basis using Royal Mail Address Point data. The one per cent deviation found between this approach and water company household data is acceptable.

The study incorporates the impact of leakage and its management in the Gateway. Significant reductions have been made by most companies to at or below the economic level of leakage (ELL). Thames Water is an exception to this but has in place a plan to reach the ELL over the next years. However, the study rightly argues that this gain should be ignored and only leakage reductions that go beyond the water company forecasts at the end of the study period should be counted towards water neutrality.

Calculating and apportioning non-household use is more challenging than household use due to its variability. The approach adopted by the study to address this (i.e. disaggregating this demand to a limited extent) is reasonable.

Baseline water use with leakage estimates at the beginning and end of the study period are calculated, tabulated and shown graphically.

2.4 Business as usual scenarios (Chapter 4)

In this chapter, the authors set out the basis for the (two) 'business as usual' scenarios to be used in the study.

DCLG housing projections have been used to forecast water use in new households, in preference with earlier estimates made by the water companies. As these figures relate to totals from 2001, some 32,500 houses are assumed to have already been built. Independent corroboration of this figure would enhance the accuracy of the results.

A sensitivity analysis of +/- 10 per cent is proposed 'to allow for uncertainty in the number of household completions'. However, it is not clear why this range has been chosen or how that range is then used later in the analysis. I note they are reproduced in Table 4.4 and Figure 4.3, but for what purpose? Clearly, there is uncertainty in the housing projections, as there is in all the other projections and forecasts used, so it is unclear as to why this has been singled out and what its use actually is.

The report defines two BAU scenarios; an upper and lower savings. The difference between the two amounts to assumptions made between the proportion of housing that is publicly funded, privately funded reaching CSH level 3 from 2008/9 and privately funded that will reach 120 l/h/d (internal use) from 2009/10. The assumed figures are clearly stated (15-30%), but appear arbitrary since it is argued that 'only very limited data has been forthcoming on the percentage of house in Thames Gateway that will be publicly funded or built on land owned by English Partnerships'. A more convincing justification for these figures is needed given the importance of this assumption in the later modelling work.

A similar criticism can be levelled at the assumptions made about forecast water use in new non-households. In particular, the assumption that all the new jobs will be office-based and that there will be no new demand for industrial processes needs explanation and justification.

In section 4.6.1 it is acknowledged that domestic demand is a product of per capita consumption, occupancy rate and population. In this case, household numbers replace population. It is also acknowledged that per capita consumption varies and that occupancy varies. However, it is not clear whether either of these variations is captured in the analysis.

I am concerned about the claim in section 4.7.1 that the BAU forecast 'takes account of the uncertainty in the delivery of housing numbers', particularly as there is no rational basis (given) at all for using of +/- 10 per cent for household. In fact there are other uncertainties, arguably of higher value, that are not included (some of which are identified in section 9.5.1).

2.5 Identification of demand management measures (Chapter 5)

Chapter 5 is concerned with the considering and prioritising the full range of demand management measures that may be applied in the Gateway. The approach adopted of building on previous relevant work on selection of options is generally accepted.

Of all the options considered, it is clear that compulsory metering is an extremely important potential demand management measure. The assumption made of assigning a 10% sustained demand reduction figure is supported by the balance of evidence, and is reasonable, albeit based on limited evidence. Uptake rates of meters at 5% above water company plans is also a reasonable assumption, given it is close to the rate some companies have indicated for metering on change of occupancy.

Section 5.6 considers measures that may be applied to new households at the development level. It is surprising that the Environment Agency report on *Water Related Infrastructure for Sustainable Communities. Technological Options and Scenarios for Infrastructure Systems* (Butler and Makropoulos, 2006) has not been referred to at this point as it reviews in detail options available at the development scale. A more complete summary of available development scale approaches (e.g. local abstraction - non-potable supply from groundwater) should be included in this report, with some justification for the techniques included for further analysis.

The analysis made of the potential contribution of rainwater harvesting (5.6.2) and table 5.4 is a simplistic one. The assumption made that all the rainfall captured on the roof will be stored and used is not necessarily valid but will depend on the detailed rainfall patterns and the volume of storage tank used (Leggett *et al*, 2001). Further, it assumed that the washing machine can be supplied by rainwater, which is quite controversial in a UK context. The outcome is that the assumption that 50 per cent of non-potable household demand can be met by rainwater harvesting has significant uncertainly. Oddly, this is qualified later (but not very explicitly) in section 5.7 where a 50 per cent reduction in toilet flushing demand only is used instead.

The general approach adopted in section 5.7 is valid in producing scenarios that first specify products that require minimal change to customer behaviour or perception before others that require more engagement.

Variable tariffs are addressed in section 5.8. As with basic metering, tariffs play an important part in the scenarios proposed, but the performance data used is minimal. One possibility to address this is to look at the impact of tariffs on consumption in other utilities, such as electricity. The value assumed of 5 per cent seems to be reasonable, but must have a significant uncertainty attached to it. Some indication of what such a tariff might be would also add credibility to the work.

The evidence base for existing non-household water consumption and saving is much sparser than for households. However, the 40 per cent savings assumption for offices may be over-optimistic. BSRIA(1998) investigated the potential impact of water conservation devices on various types of building in England & Wales, including offices. The results are difficult to interpret, but do indicate a wide range of potential savings depending on assumptions made. The 5 per cent figure used to represent the proportion of office use is reasonable.

The potential savings available to the remaining 95 percent of non-households is even more difficult to evaluate with any certainty, although the previously mentioned BSRIA report may be of some use. The figure of 10 per cent chosen must be conservative but is very uncertain.

2.6 Approach to costing (Chapter 6)

Chapter 6 outlines the approach adopted to the costing of the various scenarios and detail about the specific costs used. Expressing costs as average incremental costs (AICs) is industry standard and valid, with a useful clarification made concerning net present value and present value.

Costs for fixtures and fittings for new homes are based on the earlier WRc report, on which I cannot comment in detail. A general point that can be made is that some of these are likely to be higher than in practice over time. This is because there is currently no established or mass market to drive down costs. So the data used can perhaps be considered as conservative.

A significant assumption is made in Table 6.1 that 50 per cent of households are served by rainwater (greywater?) systems when specified in a particular scenario. Justification for this figure is required.

It would be helpful to recap in the text what the various CSH standards specified in table 6.2 actually are (especially 95 l/h/d). Additionally, explanation is needed on how each cost per property is built up (maybe in an appendix). In calculating the costs for each scenario using the 4.5 percent discount rate, it should be made clear over what period (60 years?). Proposals regarding replacement costs and maintenance costs are accepted.

Section 6.4 deals with costs for retrofitting extra homes. These costs are taken from a different source to the 'new homes' costs (earlier Entec report), on which I cannot comment in detail. It is quite hard to equate the appliances (and indeed costs) specified in Table 6.3 with those in Table 6.1. So for example, an ultra low flush WC replacement (excluding installation) costs £140. The same 'new home' appliance (assuming it is the 3.75 l toilet specified) costs £240. These differences need to be clarified.

An assumption is made that demand savings decline linearly to zero over 15 years. This seems to be a reasonable assumption, but justification is needed.

A very different approach has been taken to quantifying non-household costs, due to lack of data and the inherent variability in non-household types across the Gateway. It is understood that these costs will not be included in the final scenario comparisons, but that a simple sensitivity analysis on these costs will at least indicate the importance of this section of water demand in achieving water neutrality.

2.7 Definition of pathway scenarios (Chapter 7)

The use of scenarios is a common and accepted approach to thinking about the future (Butler, 2004). The Agency has produced excellent work in this area in the past and this should be mentioned here (Environment Agency, 2001), with some indication of why the alpha/beta/gamma/delta approach has not been used.

The scenarios and scale proposed are clearly argued. The concept of CSH 'glide paths, however, could be better explained. Table 7.1 is clear in setting out proposals that are 'progressive', 'neutrality' and 'beyond neutrality'.

By their very nature, the scenario definitions have many assumptions built in. Many of these are justified and many clearly identified in the tables in this chapter. However, other detailed assumptions are made along the way (e.g. in 7.3.3 11 per cent of new homes are assumed to achieve the water efficiency standards to CSH Level 5/6 in 208/9) in the text, and there is a danger that these are less clearly identified and justified.

The use of rainwater and/or greywater is specified in the 'beyond neutrality' scenario in section 7.9. In this section it is again suggested that washing machine demand could be met in this way. This contradicts what is written in section 5.7.

2.8 Results of pathway scenarios (Chapter 8)

In this chapter, the output from the various scenario model runs are presented and explained. In general terms, this is done very clearly. The key conclusions highlighted are the relatively poor performance of the progressive scenario, which many would argue to be a challenging future trajectory, and the impact of the Olympic games in 2012/13. The concept of 'neutrality deficit' is a useful one.

Similarly the scenario costs are clearly presented both in terms of present values and average incremental costs. Perhaps the most interesting result is the conclusion that the costs of achieving neutrality are approximately double the progressive scenario costs, and that the progressive scenario costs are substantially higher than the BAU costs.

Another important point that emerges, and is mentioned in the text in section 8.9, is that the retrofitting costs for new non-households could be of similar magnitude to the basic scenario costs mentioned above.

2.9 Further interpretation of results (Chapter 9)

The concept of retrofit and new property equivalence is a good one and will aid the relevance of the work to other areas and scales.

This chapter contains the very important topic of uncertainty. The authors clearly recognize and acknowledge the limitations of the results of their work, given the range of uncertainties in the data and elsewhere. The sensitivity analysis carried out on just one variable (assumed metering and variable tariff structures) shows both the utility of this approach and of the significant consequences of uncertainty in the input data on the study results.

2.10 Summary and conclusions (Chapter 10)

The conclusions presented in chapter 10 are thorough and represent reasonable and reasoned outcomes from the work. The key recommendation made, to develop and deliver a medium scale pilot scheme, is vital to decrease the uncertainty in the predictions made and increase the likelihood of actually achieving water neutrality in the Thames Gateway.

2.11 Carbon emissions ands costs

Rather than comment chapter by chapter on the carbon calculations, a brief discussion is included here. The carbon emission figures used are clearly referenced and represent best current understanding. As the report explains, these are very much average values and take no account of location or context. The results produced are therefore simple pro-rata calculations for each of the scenarios and can be considered as approximate at best.

3. Comments and discussion

There are broadly two approaches to water demand forecasting: top-down or bottom up. A range of forecasting techniques is available (Memon & Butler, 2006). This study is essentially top-down, driven by government policy on household growth, but contains elements of bottom-up (e.g. detailed water efficiency measures)!

A remarkably similar study has already been completed as part of the WaND project (Water Cycle Management for New Developments: www.wand.uk.net) by the University of Leeds (Parsons *et al*, 2007). The aim of the WaND study was to create forecasts of people, households and their water consumption to 2031 in the Thames

Gateway. It is suggested that methodology and results from the two studies are compared for the benefit of both.

Parsons *et al* incorporate a third housing category beyond 'existing' and 'new' that they refer to as 'replacement'. They argue the need for three categories because different policies (e.g. regulations, incentives, taxation) apply to each type. The need for this third category should be considered.

No mention is made in the report on the impact of climate change. Whilst it is understood this is not the focus of the work, Herrington (1996) has shown the potential impact on water demand (and resource) and this should be referred to in the introduction to the study.

Some of the scenarios used in the study rely on changing customer behaviour. A useful review on customer reactions to conservation policy instruments has been written by Jeffrey and Gearey (2006). Lessons can also be learnt from the energy sector (Schipper and Meyers, 1992).

It is recognised that assumptions are included in the text and some tables and key assumptions are highlighted in the text at the end of each chapter. Because there are so many of them, it is suggested that *all* the assumptions are further summarised (tabulated), perhaps in an appendix to improve clarity and comprehensiveness.

The report clearly recognises that all the assumptions are subject to uncertainty. It is unrealistic at this stage to try and *quantify* these uncertainties further. The appropriate 'health warning' in the text is therefore very welcome.

It should be noted that 'sensitivity analysis' does not quantify uncertainty, as implied in the report. Sensitivity analysis identifies those model parameters and variables that have the greatest impact on the results. The uncertainty in the results is obtained by quantifying (as far and as accurately as possible) the uncertainty in all the input data and propagating and combining that uncertainty into the output.

I suggest the report adds the following recommendations for further work:

- A thorough and comprehensive sensitivity analysis to identify key variables and priorities further research resources.
- A thorough and comprehensive uncertainty analysis to identify the potential accuracy of the results and the degree to which the various scenarios can in fact be distinguished. It would also establish the relative importance of the basic assumptions made against the assumptions made in the various scenarios.
- The need to collect additional data especially on the impact of metering and tariffs, and on the water saving potential of non-households.

4. Conclusions and recommendations

The following section directly answers the formal questions asked of the review, drawing on the response on the individual chapters. It should be considered a summary response.

4.1 Is the approach taken to modelling of demand for water in the baseline, business as usual and pathways scenarios sound and the most suitable given the available information, the time frame for the work (six months) and the issues being dealt with?

The approach taken to modelling demand is essentially top-down, based on government projections of household growth in the Thames Gateway. Consumption interventions are, however, bottom-up (especially households). The concept of having baseline consumption, a business as usual forecast and then a number of scenario pathways is a valid sand suitable approach.

The main components of demand are clearly identified (household (new and existing), non-household and leakage) and quantified as far as possible. However, two other components due to climate change and replacement housing have been omitted.

Similarly the main available demand management interventions have been identified. Most of these have come from earlier work. The emphasis of the study is mainly on in-house interventions. The impact of recycling (greywater and rainwater) is not accounted for in any detail, and only a limited number of development-scale interventions has been considered.

Uncertainty in the results, whilst being acknowledged in the text, is generally not well handled in presenting them graphically or in tabular form. There is an implicit confusion over sensitivity and uncertainty.

4.2 If yes, have appropriate input data been identified and used appropriately? If no, what are the limitations to the approach used, and what would be better and for what reasons?

Broadly speaking, the input data has been correctly identified and used appropriately.

The WaND Thames Gateway study (Parsons *et al*, 2007) has assembled a parallel data set, which may help with independent corroboration of some of the data used. Additionally, data on development-scale interventions is available in Butler and Makropoulos (2006), on greywater recycling and rainwater harvesting in Leggett *et al* (2001) and in BSRIA(1998) on non-household water demand and potential savings.

My main criticism is not about the data used, but in two other respects. Firstly, where data is not used directly, is interpreted or indeed just assumed, the basis for this is not particularly well justified. Secondly, little attempt is made to quantify the uncertainty levels of many of the inputs, and therefore the outputs. However, it is understood that this would be a significant undertaking and is outside the scope of this study.

4.3 Is the approach taken to the costing of the scenarios sound and the most suitable given the available information, the time frame for the work (six months) and the issues being dealt with?

The approach taken to the costing of the scenarios, using present value and average incremental cost comparisons is sound and reasonable. The concept of retrofit and new property equivalence is a good one and will aid the relevance of the work to other areas and scales.

The weakest part of the cost analysis is with respect to non-household costs, due to lack of data and the inherent variability in non-household types across the Gateway. This has been acknowledged in the study by omitting non-household costs in the overall analysis. The particular drawback, as identified in the report, is that these costs, if included, could have a significant influence on whether water neutrality can be achieved or not. Headline results should make it clear that the costs associated with non-households are not included.

4.4 If yes, have appropriate input data been identified and used appropriately? If no, what are the limitations to the approach used, and what would be better and for what reasons?

It is acknowledged that data on costs is particularly sparse and uncertain for many reasons. The approach taken by the study is to rely heavily on earlier studies. This is a reasonable. However, particular care needs to be taken to ensure that this data is compatible in terms of appliance types, dates of costs and the underlying assumptions that have been made in each study.

Some (but not much!) additional data is available in the studies referenced in section 4.2.

As in section 4.3, transparent and overt justification of assumptions made over costs and the inherent uncertainties in them is limited.

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Peer review 2

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Structure of Review

This peer review of the Entec water neutrality report will deal in turn with the three main areas of interest – the modelling of (**A**) demands and demand forecasts, (**B**) costs and costing, and (**C**) carbon emissions. (**D**) deals briefly with uncertainty and (**E**) concludes.

A. Modelling of Demand in Baseline, BAU and Pathway Scenarios

Introduction

1. In broad terms, the approaches used for the different categories of demand modelling appear to be *sound*. That is to say that I have no *major* concerns. In part, this arises because of the short time-frame for the study – apparently six months only. In a 1-2 year study I would have expected that the points about to be raised would have been dealt with explicitly and satisfactorily in the body of the report. I therefore presently classify these issues as *minor*. They should, however, certainly be picked up in future work on this type of issue.

2. These *minor concerns* relate to:
   i. Selection of baseline demand data (s. 3.2 and Appendix 1)
   ii. Occupancy rate and population forecasts used in BAU and Pathway scenarios (s. 4.2.1 and last para. of s. 4.3.1)
   iii. Choice of preferred metering and 'variable' tariff savings (s.5.4.3 & s.5.8)

   A few other points (term them *very minor* ?) will be also be raised.

Selection of Baseline Demand Data

3. Clearly this is important. In a real sense everything else follows from it. The reasoning offered in Appendix 1 for use of the 2005-06 dry year forecast from PR04 is unclear however. I can see why the 2005-06 dry year forecasts for the five zones in TG give, up to a point, a *consistent* set of data[1], and thus provide an attractive dataset. But why use a *dry year forecast* for a year when what is apparently required is *actual demand* in that year?

[1] Only up to a point because, of course, the methodologies used for demand forecasting by the three companies might differ very significantly, which the report acknowledges in Appendix 1.

4. In fact, both candidate sets of data seem to have drawbacks. The forecasts made for 2005-06 a year may simply be wrong (as predictions of the actuals), especially when for three of the water companies involved those forecasts must have been made at a time when the most recent 'actuals' available to each company were probably those for 2003-04, two years earlier (or, possibly, it was those for 2002-03; it depends how often the companies were able – and chose - to re-run their various models before the final submission to Ofwat)2. Furthermore, the forecast is a dry year one, when what is (presumably) usually required is an 'average climate' (or climate-standardised) year.3

5. The difficulty with the six-year *average actual* demand estimate considered by the report in Appendix 1 is that the usefulness of such a calculation as a guide to the actual demands of the *final year of the period* (2005-06) depends crucially on the behaviour of the time series – are there underlying trends (and, if so, up or down?) or are the series technically stationary? This surely is worthy of *some* mention and discussion in the report, however brief? For if the series is not 'stationary', the trend would normally mean that the average is a poor guide to the end-year value.

6. To tighten up the argument, therefore, there could have been, early on, an explicit statement of whether the intention was to work in drought (='dry') years or in (climatically) 'average' years, and only then should a decision have been made on what was the best guide to the 'dry' (or 'average'- whichever it is) actual demands – for separate WRZs and for separate components - for 2005-6. The latter would involve a brief examination of the behaviour of the various series over 2000-01 to 2005-06 and also noting how, qualitatively, the climate would have been expected to affect demands in each year (if at all). In this way, it could be ascertained in a rather more satisfactory fashion whether the 'other' set of data support the 'preferred' data set, as a guide to 2005-06 demands (either dry-year or climate-standardised, whichever was decided). Two candidate datasets (or for that matter methodologies) will always offer the prospect of one being used as a check on the other (preferred) candidate.

Occupancy Rates and Population Forecasts in BAU and Pathway Scenarios

7. The concern here stems from the reported difference, introduced in section 4 and briefly explored only much later in the report (in section 9.5.2), between the 2015-16 forecast household occupancy rates offered by (i) the Water Companies[4] (2.42) and (ii) the DCLG forecast drawn from the 2003-based household projections (2.23) [see section 4.2.1 and the end of section 4.3.1)]. The report describes the first figure as "slightly" higher than the second (see section 4.2.1), which in colloquial terms is no doubt a reasonable description of the difference. But these two numbers are multiplied up by large *other* numbers (dealing with pcc, and the number of households in an area) in order to gauge their effect on future water demands, so it is

[2] For Thames, a forecast made in 2006 would presumably have been relying on the last available *actual* demand data being for either 2005-06 or for 2004-05.

[3] Obviously, this depends on whether water neutrality is being sought with respect to *climate-standardised demands* or *dry-year demands* – perhaps there was discussion of this point.? Indeed, maybe the Steering Group made a decision on this issue? If it is the latter – *dry year demands* - then it follows that all other microcomponent data(O/F/V etc), metering savings etc., should logically also be geared to a *dry year*. Since such information about dry-year demands is much, much scarcer than that concerning average-year (the same as climate-standardised) demands, it is arguably easier to undertake the exercise using the latter.

[4] I assume the WCos. forecasts apply to the 5 WRZs which consitute the TG study area.

immediately clear that the overall impact of the difference would most certainly not be "slight".

8. Indeed, the difference (of about 0.2) is approximately equal to the (very significant) decline in average occupancy in south-east England that was, only a few years ago, being forecast in south-east England to occur over a future twenty year period. If the DCLG occupancy forecast had been used rather than the WCos.' forecasts, then – assuming for the moment unchanged pcc and household forecasts – household water demands in 2015-16 would have been about 8% lower than the report estimates. This result has been added to section 9.5.2 together with some reasoning for the report adopting the WCos.' occupancy forecasts (relating to the precautionary approach of the study).This is acceptable, but the issue is important and deserves more thorough attention.

9. For example, there should, of course, be a resulting effect on household pcc data if the assumed occupancy figure is altered, because numerous studies in the UK have shown that larger households realise certain economies of scale in water use. Work by NERA for UKWIR (*A Framework Methodology for Estimating the Impact of Household Metering on Consumption – Supplementary Information*, UKWIR Report 03/WR/01/5, London, 2003, pp. 91-96) suggests an elasticity of per capita water use with respect to household size of about
– 0.6 in both UM and M households, which tells us that a (small) *reduction* in occupancy of (say) 10% would be expected to be associated with an *increase* in pcc of about 6%.

10. Now it should be recognised that in a six-month report it is difficult to do justice to what are complex issues (and, no doubt, uncertain forecasts). However, other uncertainties are alluded to (and, in a sense, dealt with) later in the report (in section 9.5), and therefore it might have been appropriate to deal with this issue in more depth. Note that it could even have been argued that the occupancy difference makes no difference at all to the neutrality conclusions – since both the BAU and the Pathway scenario forecasts will then 'share' the lower occupancy forecast(s). However, it would most certainly affect the AIC estimates, since the denominator of this measure – the PV of water savings – would decline due to household demand (and thus household demand savings) being lower all along the glide-path to 2015-16.

Compulsory Metering and 'Variable Tariffs' Savings

11. There should be no objection to a 'precautionary' approach being adopted to the savings to be expected from compulsory metering and more sophisticated tariffs, although I would take issue with some of the text in s. 5.4.3 and s. 5.8.

12. First, it should be stated clearly that Ofwat ex post pcc data for M and UM households both *do not* and *cannot* "provide a reliable indication of the effect of metering on demand", because of the clear bias created by the self-selection of low-water-use households for optant metering (not, therefore, "is unlikely to", as stated at the end of the 3rd para. of 5.4.3).

13. Second, 10%-15% is the range experienced for compulsory metering savings in England & Wales (including the National Metering Trials) and continental Europe, so 10% is a reasonable precautionary estimate. The best 'point estimate' for the UK

remains as 12.5%. There is no reason to expect that this range would not be applicable to the TG; indeed, if attention was concentrated solely on the results of trials and studies covering the south-eastern half of England since 1988-89[5], it could be argued that it would probably be wise to put the range at 10% - 20%.

14. Third, the range of *additional* savings from more sophisticated tariffs – the term used in the report is 'variable tariffs', which is not found in the basic relevant literature – is, as the report makes clear, particularly difficult to estimate for the UK. Consider first the introduction of increasing block tariffs (IBTs), for which few local case studies are available, even for developed economies. The known evidence about IBTs has been recently set out at http://www.wwf.org.uk/filelibrary/pdf/water_tariffs_report01.pdf - see there Table 4 on p. 22, which covers six studies in the United States and one in Europe (Barcelona). Given the overlap in the case studies between the introduction of IBTs and the sometimes simultaneous introduction of (i) seasonal tariffs and/or (ii) general conservation campaigns, a range of savings of 5-10% is appropriate, with 5% being selected as a precautionary estimate.

15. The general evidence about the effects of the introduction of seasonal tariffs is both consistent and rather stronger (see, e.g., UKWIR study in 2006, section 3.3), although extremely limited in the UK (two studies in the National Metering Trials). Again, 5% in the Entec report is acceptable as a (possibly very) precautionary estimate.

Other Minor Issues

16. Section 4.2.1: there looks to be a large change of occupancy metering (COM) element in the London WRZ and hence COM is of some significance in the overall TG area; does the Thames WRP give any indication of the metering effect expected to be associated with COM?

17. Section 5.6.4: this appears to be saying that 'product selection' for a demand-management measure's entry into the various pathway scenarios depended upon:

- reliability
- extent of requirement for a change in customer behaviour or perception
- its complexity and whether it was 'technologically demanding',

to the exclusion of *economic attractiveness*. There need be no objection to this as long as the economic dimension is allowed to make an entry into the narrative later on, before optimal pathway selection is finalised. Clearly, it is desirable that economic criteria need to play some role, at some point, in deciding on option selection.

18. I appreciate this is a very difficult issue – nevertheless, it is one that at some point soon planners will have to confront – but the feasibility of jointly promoting CSH programmes <u>and</u> simultaneously introducing compulsory metering and/or more sophisticated tariffs is something that needs to be thought about much more, very probably in an enriched microcomponent framework. Perhaps the potential importance of this (in *reducing* possible overall demand savings) is still being under-rated?

[5] See the UKWIR metering effects report (2006), Table 1

B. The Costing of the Scenarios

Introduction

19. The approach taken to the costing of the scenarios is, granted the short time period for the study, sound and thus broadly satisfactory. There are, however, minor points to be raised (below) about (i) costing methodology, (ii) the costing of individual demand-management options and (iii) the allocation of costs to properties or households. Note that none of these undermine any of the work undertaken.

20. A lack of what could be referred to as an "embedded economic consciousness" in turn gives rise to (iv) the absence, as far as I could see, of any attempt to re-construct the neutrality scenarios taking account of the economic attractiveness (i.e. the economic cost-effectiveness) of the different demand-management options considered (a point anticipated in para. 17, above). This might turn out to be a more serious omission.

Costing Methodology

21. Discounting, at the EA's recommended rate of 4.5% per annum, has been, as far as I can see (without checking basic arithmetic, for which there is not the time), correctly undertaken[6].

22. The formula offered for Average Incremental Cost (AIC) in section 6.2 is at first sight odd, although not erroneous. The role of the "10" in the denominator is initially puzzling; but it turns out that 10 times W is necessary in the denominator, if an AIC in pence/m3 is required when the present values of costs (numerator) are in £ and those of water (denominator) are in megalitres.

23. Additionally an argument can be made that it is preferable for there to be no "–OS" factor present in the numerator, since the saving in water service system operating costs constitutes a *benefit* resulting from the demand-management measure and not a *cost*. Since this "OS" factor is common to (and of equal estimated monetary value for) all demand-management options, its inclusion will not affect their ranking; but it seems generally a more satisfactory procedure to omit from the demand-management cost calculation *all* those benefits which result from a Water Company consequently being able to operate the PWS and S&ST systems at a smaller scale and with lower 'output'. All such 'benefits' arising from the demand-management options would then go into an 'AIB' (= average incremental benefit) term, which can then be used to assist comparisons between the costs and benfits of various demand-management programmes.

Costing of Individual Demand-Management Options and Scenarios

24. I have no quarrel with the costing of individual demand-management options (save that for variable tariffs), but would have welcomed an additional row in Table 8.3 which set out the *overall* AIC of each of the seven scenarios listed[7]. This would

[7] Preferably with the AIC *excluding* the opex savings previously included.

have immediately identified the most cost-effective scenario overall, and, of most interest, the most cost-effective of the five neutrality scenarios.

25. The costing of 'variable' tariffs, as a simple £5/year for each household, seems arbitrary and therefore rather unsatisfactory. I would have thought it possible to obtain approximate estimates of the appropriate upgrade of a (i) large WCo's and (ii) small WCo's billing systems, plus any additional billing costs (covering e.g., the more complex presentation of consumption information on a bill). These have been undertaken for many years by various utilities abroad, and such information should be accessible, even if only on an order of magnitude basis. The spreading of such costs through discounting, over an appropriate time period and over all of that utility's customers, could then generate an appropriate order of magnitude for an additional annual cost.

Allocation of Costs to 'Homes' (probably a minor issue)

26. The purpose of section 9.2 is unclear to me, unless it be for promotional or political purposes. Costs per home or house, expressed in the way suggested, are really no guide to overall cost-effectiveness, and they also tell us little new about the cost-effectiveness of different scenarios. And I am unsure how identification of how many existing homes (on average) need to be retrofitted to offset the demand from a single new home in TG would be of help in other geographical areas. But perhaps I have missed something here? Certainly I am (of course) unaware of the detailed guidance given by the steering group during the course of the study.

Economic Criteria for Selection of the Optimum Scenario

27. By the end of section 8 of the report the apparently least costly of the neutrality scenarios (in PV £m. terms) *as they were originally constituted* can be identified; it appears to be *Neutrality 2b*. Whether that is also the most cost-effective (i.e., that neutrality scenario with the least overall AIC) is unclear, since the demand savings associated with 2b are significantly less than those associated with 1a and 2a, and we would need the additional figures for the AICs of each scenario (asked for in para. 28, above) to resolve that question.

28. Suppose 2b *was* the most cost-effective. An interesting economic question then becomes: is there any way, by altering the composition of 2b, that the costs may be lowered? And, if so, what would be the trade-off: would there be a reduction in reliability or an increase in reliance on customer behaviour, for example (see para. 20, above), as the price to be paid for a increase in cost-effectiveness? Low flow taps always look expensive, in every scenario, in AIC terms, so could they be replaced by more of some other more cost-effective measure? (the answer may well be no, but I feel that sort of question should at least be raised).

29. Note the same question can and should be asked of the authors' 'most favourable' scenario, no. 3: can the mix of measures be altered to reduce the overall cost, without an unacceptable price being paid in terms of changes in the other criteria by which measures are being judged?

C. Approach to Carbon Emissions Assessment

30. Carbon emissions for WCos. are estimated in the report as those arising in the provision of PWS and the treatment of sewage. There is also recognition that some of the demand-management measures proposed would have their own energy requirements (e.g., for pumping). However, it is unclear why no consideration is given to the energy required for the heating of pws supplies in the home, notwithstanding the 5th para. of s. 3.4.[8] Certainly carbon implications from the heating of water – either in a boiler or through in-appliance heating – would be expected to arise from both a BAU scenario and also the various pathway scenarios, due to the use of hot water in respect of:

Showering and baths
Use of basin and kitchen sink
Washing machines) since BAU and other scenarios considered imply different
and Dishwashers) take-up rates of these appliances in various CSH levels

31. They would also arise from (i) pws use (losses?) due to space heating via radiators in the home and (ii) use of both pws and direct abstractions by non-households for a multitude of purposes.

D. The Question of Uncertainty

32. Of course the uncertainties associated with many of the factors in this study – see the bullet points in section. 9.5.1, e.g. – are well appreciated. More than in most studies of water resource planning (broadly conceived), uncertainties riddle this type of exercise, and it is not easy to know how to deal with them in the absence of accepted confidence limits (90%, 95%, 99%, etc.) for most of the crucial numbers involved (household projections, O/F/V projections, etc.).

33. A crude approach would be either to go for the 'best estimate' for each factor or variable under consideration, or to select a 'safer', 'precautionary' estimate each time. That is, select an 'approach' to the uncertainty issue, and then stick to it through thick and thin. But a problem always emerges from such an approach when using other than a mean or 'best' estimate: e.g.,associating a *likely high* pcc with a *likely high* population gives a <u>*most*</u> *unlikely high* Ml/d. This is because they are linked in a multiplicative rather than an additive manner.

34. At times in the earlier part of the study I got the firm impression that a precautionary approach was being adopted – certainly in the discussion of metering savings that was being claimed, and I would agree with that position. But section 9.5.1 seems to tell a different story: indeed, a much more mixed one. The six bullet points listed there, and the immediately subsequent paragraph about retrofit costs, together comprise

- 3 precautionary assumptions (bullet points 1,3 and 6; for b/pt. 6, 10% and 5% are already precautionary);
- an 'inaccuracy claim' (b/pt. 2) the effect of which is arguably precautionary, since under price regulation WCos. continue to have a

[8] If logically they "should" have been included, but data requirements could not be met within the study period, then this could have been stated.

financial incentive to err on the high side in forecasting water consumption; and

- 3 other factors which are claimed to be over-optimistic (and thus are the opposite of precautionary)

35. t. The last paragraph of section 9.5.1 similarly provides a mixed narrative with "many of the assumptions" being "ambitious" while at the same time efforts were made throughout the study "to err towards the conservative end when estimating [certain] savings…." The result seems to be unsatisfactory: it *may be* that overall a precautionary balance has been obtained. But it does seem rather hit and miss. I conclude by wondering whether it would have been possible to have established a rather more consistent approach to the issue of uncertainty?

E. Overall Conclusion

36. Overall, however, this is a very valuable exercise, the like and ambition of which I have not previously encountered. It is basically sound, and the suggestions above may help *both* to complete and 'round out' the story *and* pursue the economic narrative further, even if they are (or rather were) clearly incapable of practical implementation in the time period available.

Tilton, 20th November 2007

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