OXERA

OXFORD ECONOMIC RESEARCH ASSOCIATES

ENVIRONMENT AGENCY

APPENDICES TO:

PERIODIC REVIEW OF PRICES 2004: HYPOTHETICAL SCENARIO MODELLING

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Appendix 1: OXERA Water Industry Financial Model

The OXERA water industry financial model is primarily an illustrative tool, designed to demonstrate how allowed revenues in the water sector are built up from their various constituent components. The model enables a number of high-level scenarios to be considered for PR 04. The model was constructed by OXERA in 2002, with the results presented to the Environment Agency in September 2002.

The model is presented at the aggregate industry level, combining both the water and sewerage services. In contrast, Ofwat models the industry at the company level, and disaggregated by service. While a number of the features of Ofwat's financial modelling methodology are included within the framework—for example, OPEX efficiency, depreciation treatment, outperformance allowances, etc—some other areas are not modelled in detail. In particular, the tariff basket mechanism and the impact of meter switching are not included in the framework. In addition, financial indicators (eg, interest cover and dividend cover) are not modelled explicitly. A simplified approach is also taken to the issue of taxation. As a result of these factors combined, the model is likely to understate the K factor to a degree. Appendix 2 describes in more detail the differences between the OXERA financial model and the more detailed company-specific modelling undertaken by Ofwat.

The model also only uses publicly available information and, where this is not available, certain assumptions have needed to be made. As such, it is important to emphasise that the model is not intended to mimic exactly how Ofwat sets allowed revenues; rather, it retains the core elements of Ofwat's methodology, while being user-friendly and facilitating the examination of several potential options. This simplification makes the model ideal for the purpose of gaining an understanding of how the building blocks of allowed revenues fit together in the water sector.

The OXERA financial model enables three stages to be modelled, as follows:

- **stage 1: PR 99**—using publicly available data, and adopting appropriate assumptions where such data is unavailable, the make-up of allowed revenues at PR 99 is modelled.[1] This is necessary because it is important to obtain an appropriate 'starting point' for allowed revenues at PR 04 (for example, with regard to OPEX in 2005). The base-case scenario adopts assumptions that give rise to a level of allowed revenues similar to that allowed for at the 1999 review;

[1] Data sources used to populate the model include Ofwat (1999), 'Future Water and Sewerage Charges 2000–05: Final Determinations'; Competition Commission (2000), 'Mid Kent Water Plc: A Report on the References under Sections 12 and 14 of the Water Industry Act 1991'; Ofwat (2002), 'RD 05/02: The Approach to Depreciation for the Periodic Review 2004, March; Ofwat (2002), 'RD 08/02: Regulatory Capital Values 2001–05', March; Ofwat (2001) 'Financial Performance and Expenditure of the Water Companies in England and Wales: 2000–2001 report', July; Ofwat (2001) 'June Returns for the Water Industry in England and Wales' CD Rom, December.

- **stage 2: outperformance against PR 99**—potential outperformance against the 1999 OPEX and CAPEX efficiency assumptions is then also modelled. These savings are assumed to be passed onto customers, although the speed at which this occurs depends on the profiling of outperformance assumed over the AMP3 period. In the base case, zero net outperformance is assumed;

- **stage 3: PR 04**—given the above information, and adopting certain assumptions regarding OPEX, CAPEX, etc, going forward, it is then possible to model PR 04. In the base case, assumptions similar to those adopted at PR 99 are adopted (for example, with regard to efficiency savings, the level and profile of CAPEX, etc).

When allowed revenues are determined in stages 1 and 3, it is possible to re-profile the K factors in order to arrive at a desired profile of prices that gives the same NPV of allowed revenues as that obtained before re-profiling. In practice, however, some profiles will be preferable to others due to cash-flow reasons. This feature is not captured explicitly within the model, as financial indicators are not included explicitly in the framework.

In what follows, each of the stages of the model are described in more detail. All expenditure data included in the model is presented in £m and is expressed in 2000/01 prices.

A1.2 Stage 1: PR 99

In stage 1, OXERA has attempted to mirror Ofwat's PR 99 settlement. The assumptions made on the building blocks in stage 1 (and on outperformance in stage 2) feed into the modelling of stage 3. Within the framework, the modelling of PR 04 allowed revenues in stage 3 is otherwise similar to the modelling of allowed revenues in stage 1.

Each of the components is discussed below. Figure A1.1 provides a useful summary of how these elements fit together. It is recommended that reference be made to this figure when reading the text below—particularly in respect of depreciation.

A1.2.1 OPEX

For PR 99, the first component modelled is OPEX before efficiencies. This expenditure is split between that incurred to maintain a base level of service (the vast majority of OPEX), quality, supply–demand balance (excluding new development expenditure), and enhanced service levels (a very small component of allowed OPEX in practice). These profiles are projected for each of the five years from 2000–01 to 2004–05. In addition, efficiency targets are applied to each of these four classifications of OPEX. Broadly speaking, a 'catch-up target' is first applied. This is based on an assumed efficiency gap between the most efficient and average companies in the industry, and a catch-up rate for closing this gap (eg, 60% over the five years). In addition, a 'frontier target' is applied, based on extra efficiencies that can be expected across the water industry—even by the most efficient companies. In general, higher overall targets are assumed for enhancement expenditure (ie, quality, supply–demand balance and enhanced service levels) than for base OPEX.

The OPEX profiles, after efficiencies, assumed for 2000–01 to 2004–05 then feed directly into the price control as a revenue requirement.

A1.2.2 CAPEX

The CAPEX allowance for PR 99, as an input to the financial model, is calculated in a similar way to that for OPEX, although, as discussed in sections A1.2.3 and A1.2.4, the way in which this is remunerated in price limits is different to that of OPEX.

First, CAPEX for each of the five years from 2000–01 to 2004–05 is entered into the model. This is split between capital maintenance (infrastructure), capital maintenance (non-infrastructure), quality enhancement, supply–demand balance enhancement, and enhanced service levels. New development is excluded from supply–demand balance expenditure, since this is assumed by Ofwat to be self-financing (this is a simplified approach compared with that used by Ofwat).

Although the model has the capability to apply efficiency assumptions to this expenditure, for the purposes of PR 99, the CAPEX included in the model is expressed net of efficiencies. This is because there is more readily usable publicly available information on the net CAPEX allowed for in price limits for each of the five years than on CAPEX before efficiencies are applied. In contrast, the modelling of PR 04 explicitly incorporates CAPEX before efficiencies and the efficiency assumptions separately (see section A1.4.2).

In order to prepare the net CAPEX included in the model for its depreciation treatment (see section A1.2.3), an assumption is then made on the proportion of enhancement CAPEX that is infrastructure and that which is non-infrastructure.

Combining all the above assumptions leads to four lines of (net) new CAPEX included in the model, for 2000–01 to 2004–05, as follows:

- capital maintenance infrastructure;
- capital maintenance non-infrastructure;
- capital enhancement infrastructure; and
- capital enhancement non-infrastructure.

For the depreciable elements of this expenditure (capital maintenance non-infrastructure and capital enhancement non-infrastructure), assumptions are then made on the standard industry asset lives of this expenditure. This is explained in more detail, below.

A1.2.3 Depreciation

Capital expenditure is not fed into price limits in the same way as OPEX. This is because CAPEX can be lumpy, and such expenditure can be on assets with very long lives. Therefore, to reflect CAPEX incurred in each year straight into the price control would result in highly volatile prices from year to year. It would also raise concerns regarding intergenerational equity (ie, the extent to which current or future customers should pay for CAPEX incurred over the five-year period).

A large portion of CAPEX included in the model is reflected through the ‘traditional’ remuneration approach used across many utility sectors. One interpretation of this is as follows:

- the CAPEX assumed is added to the RCV of the company;

- it is assumed that, in order to invest, the company needs to borrow money. In each year, the 'principal' borrowed is remunerated in price limits through depreciation. For example, if it assumed that the amount of CAPEX 'borrowed' in year 1 is £100m, and that this should be depreciated over 20 years, then the depreciation assumed for this piece of investment in each year will be £5m, until the asset involved is fully depreciated. The depreciation is subtracted from the RCV;

- in order to repay investors for the money lent to pay for the CAPEX, investors require a 'return on capital'. This is the assumed cost of capital (in %) multiplied by the total RCV of the company (the RCV and cost of capital components of the modelling are described in more detail in section A1.2.4).

However, regarding depreciation, not all investment is treated by Ofwat in the above fashion. This varies according to the *type* of investment, both in terms of *whether* this is added to the RCV and, for expenditure that *is* added to the RCV, the way in which this is depreciated.

A summary of how Ofwat treats the various elements of expenditure, and the way in which these feed into the OXERA financial model, is shown in Table A1.1. For new CAPEX, the four categories of expenditure correspond to those described at the end of section A1.2.2 above.

Table A1.1: Depreciation treatment of assets and expenditure in the OXERA financial model

Expenditure area and treatment	Added to RCV?	Depreciated?
(1) Existing non-infrastructure assets Based on a valuation of the asset base (eg, in March 1998), an assumption is made regarding the cumulative CCD on existing assets, to reimburse the principal for past investment. CCD on existing assets should decline over time. In the OXERA financial model, an assumption needs to be made in the model of the fall-off rate for CCD on existing assets.	n/a	Yes
(2) Maintenance infrastructure Since the underground network is regarded by Ofwat as a contiguous whole, infrastructure maintenance CAPEX is deemed a continuous activity that should be remunerated as such. Therefore, infrastructure maintenance expenditure is not added to the RCV, and is not depreciated. Instead, it is allowed for through an IRC calculated as an average of expenditure requirements over a 15-year period. The difference between infrastructure maintenance spend and the IRC is, however, added to the RCV in each year. The model requires assumptions regarding pre-2000 expenditure and net projections for 2005 and beyond	No, but see comment (left)	No
(3) Maintenance non-infrastructure This CAPEX is added to the RCV. Using certain standard industry assumptions on the proportion of CAPEX falling into various asset lives, this expenditure is depreciated using straight-line CCD. The model requires as inputs these asset-life assumptions.	Yes	Yes
(4) Enhancement non-infrastructure This CAPEX is added to the RCV. Using certain standard industry assumptions on the proportion of CAPEX falling into various asset lives, this expenditure is depreciated using straight-line CCD. A higher proportion of CAPEX is assumed to fall into longer asset-life categories for enhancement compared with maintenance expenditure (see 3). The model requires as inputs these asset-life assumptions.	Yes	Yes
(5) Enhancement infrastructure This CAPEX is added to the RCV. However, it is not depreciated, and remains in the RCV, earning a return on capital employed in perpetuity.	Yes	No

Source: OXERA analysis of Ofwat approach.

Using Table A1.1 as a reference, the total CCD (in £m) included in the revenue requirement is then the sum of:

- (1) CCD on existing assets;
- (3) maintenance non-infrastructure CCD; and
- (4) enhancement non-infrastructure CCD.

In addition, in the model, a broad-equivalence adjustment may be applied to total CCD. Ofwat's approach in PR 99 was premised on the idea that, in 'steady state', the increase in cumulative CCD accounted for by new non-infrastructure maintenance spend (3) should be offset by the decline in CCD on existing assets over the review period (1), so that total 'base' CCD remains broadly constant in each year. The model incorporates this adjustment, as an exogenous assumption.

Furthermore, a positive 'work in progress' adjustment may be added to the CCD to account for enhancement expenditure undertaken between 1998–99 and 2000–01. The

total IRC included in the revenue requirement may also be adjusted in the model for 'wind-out' of past 'pre-payments' or 'accruals'.

The total revenue requirement is then net total CCD (in £m) plus net total IRC (in £m).

A1.2.4 RCV, return and tax

The RCV is a crucial benchmark for investors, since it is on this that investors are assumed to earn a return on capital employed.

In the model, an opening RCV for 2000–01 needs to be assumed. The development of the RCV by the end of the year may then be thought of as operating in a similar way to a 'bank account'. Here, the increase in the RCV will be the (depreciable) CAPEX that has gone *into* the business for that year (section A1.2.2), less the depreciation (section A1.2.3) that has come *out*. In effect, the latter represents the principal that has been repaid to investors.

Within the framework, the RCV for the first year of the price control (2000–01) is calculated systematically as follows:

closing RCV (2000–01)

= opening RCV (2000–01)
+ non-infrastructure capital maintenance
+ infrastructure capital enhancement
+ non-infrastructure capital enhancement
– total CCD
+ (infrastructure capital maintenance – IRC)
+ rolling outperformance (previous review).

The last of these items is described in more detail in section A1.3. For PR 99, the outperformance adjustments made are based on published Ofwat figures, and relate to outperformance against the assumptions underpinning the 1994 review. The closing RCV for 2000–01 then forms the opening RCV for 2001–02. Subsequent RCV calculations are then conducted on the same basis as that described above.

Investors earn a return on the *entirety* of the RCV. To calculate this allowed return, a cost of capital (in %) needs to be assumed in the model, expressed on a *post-tax equity, pre-tax* debt basis. This recognises that, in water, tax is treated in the financial modelling as a cost to the business (see below). It is then assumed that the return on capital employed is earned on the *average* RCV for each year (ie, the average of the opening and closing RCVs). The cost of capital assumption (in %) is multiplied by this average RCV, to give the return on capital revenue requirement for each year (in £m).

As noted above, tax is added straight into the framework as an additional revenue requirement (in £m) for each year, in line with Ofwat's approach in PR 99. The model assumes that this is a given percentage (eg, 15%) of the operating profit for the industry. A simple macro is used to calculate this. This abstracts from reality, since Ofwat's treatment of taxation is more complex than this, and is applied according to the investment programme of the company concerned (see Appendix 2).

A1.2.5 Allowed revenues

Within the model, the revenue requirement for each year is calculated as follows:

Revenue requirement

= total OPEX
+ CCD
+ IRC
+ return on RCV
+ taxation
– non-tariff basket revenues.

Non-tariff basket revenues are those associated with large users, and are assumed to offset the revenue requirement to be recouped from domestic customers. The model assumes that large-user revenues fall over time by some fixed percentage per year.

To calculate the impact on customer bills of the above revenue requirement, it is necessary in the model to make an assumption on the number of domestic (water *and* sewerage) households, over which the revenue requirement can be spread. The model assumes that the number of domestic customers grows by a fixed percentage per year. This assumption results in a notional average combined water and sewerage bill for each year. This treatment of the revenue requirement—bill relationship abstracts from reality. In practice, the tariff basket mechanism is used to allocate the revenue requirement over different customer types (eg, measured, unmeasured, water sewerage, etc). In addition, the model does not take account of the revenue losses associated with meter switching (see Appendix 2).

Within the modelling framework, it has been assumed that the K factor will be offset by customer growth of 0.8% per annum. In other words, any increases in required revenues will be offset, to a degree, by spreading revenues across a wider customer base. The tariff basket, and its interaction with the K factor, does not work exactly along these lines. In this report, the K factor should be interpreted as an average percentage annual notional *bill* change, rather than as a *price change* (see Appendix 2). The *level* of the notional bills should not be interpreted.

For 2000–01, this notional bill may be compared with that assumed by Ofwat in the 1994 review for 1999–2000, to provide the initial P_0 price change (in % per annum). Subsequent K factors may then be calculated on the basis of the required increase in bills (in % per annum) for the four following years up to 2004–05. The result is a complete K profile for 2000–01 to 2004–05. This profile will be associated with a certain NPV of allowed revenues over the five-year period.

However, it is also possible in the model to re-profile the K factors to a desired profile of prices, while maintaining the same NPV of allowed revenues. In the base-case case in the model, the K factors have been re-profiled in order to provide a price profile similar to that assumed by Ofwat for PR 99.

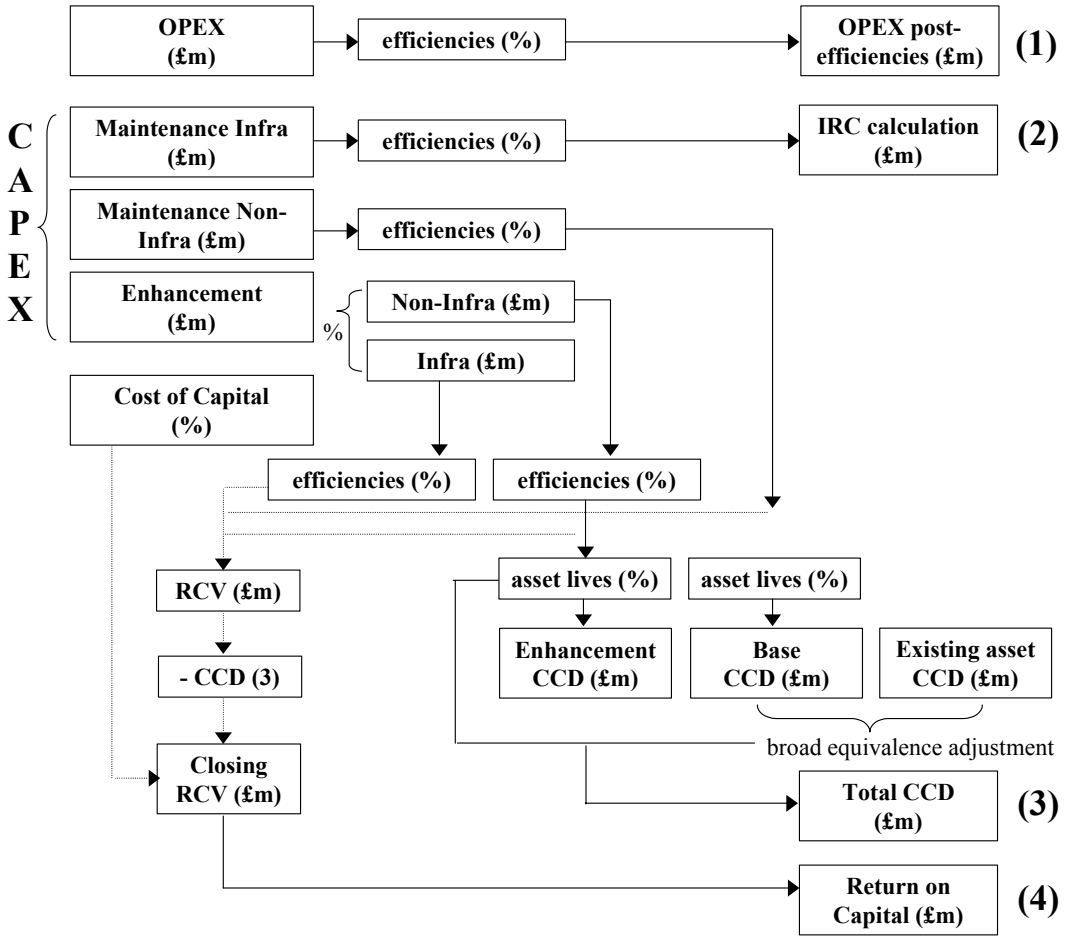
The model does not explicitly examine *ex post* financial indicators once revenues have been set, such as interest cover (how many times ‘profits before tax and interest’ cover ‘interest payments’) or dividend cover (how many times ‘profits after tax’ cover ‘dividend payments’). Ofwat undertakes a test on these sorts of indicator for each

company, and adjusts allowed revenues in its model if, for the company concerned, these are not sufficient in *every* year to maintain a satisfactory level and/or trend in these indicators. Such adjustments increase the assumed rate of return for companies, and are notionally equivalent to increasing the cost of capital in the model. Companies with particularly large and lumpy investment programmes may need such adjustments. For many years, several companies in the water industry have been cash-flow negative, which means that, from year to year, the revenues received by the companies have been less than their outflows (including OPEX, CAPEX, interest and dividends). This also exerts pressure on financial indicators.

These kinds of test are company-specific, and are therefore excluded from the OXERA model. However, by assuming a higher cost of capital in scenarios with high investment, OXERA has to some extent captured the financeability constraints that tend to be associated with larger investment programmes.

Figure A1.1 provides a summary of how allowed revenues are constructed in the OXERA financial model, using the above methodology. The figure concentrates on the aspects of how the OPEX (1), IRC (2), CCD (3) and return on capital (4) components are constructed.

Figure A1.1: Summary of OXERA financial model key components



Source: OXERA.

A1.3 Stage 2: outperformance against PR 99

Section A1.2 focused on the assumptions and calculations used in the model underlying PR 99. However, in practice, companies may under- or outperform these assumptions. In this respect, the model incorporates Ofwat's 'rolling mechanisms' for OPEX and CAPEX outperformance, as used during PR 99. These seek to ensure that companies retain the benefits of outperformance for five years, regardless of when the savings were made. The mechanisms seek to ensure that companies have as much incentive to achieve efficiencies towards the end of a review period as they do at the beginning. The alternative—passing on *all* of these benefits to customers at the start of each review period via the P_0 adjustment (before re-profiling)—would distort these incentives.

A1.3.1CAPEX outperformance

In the model, CAPEX outperformance is captured through an adjustment to the RCV. Without the rolling mechanism in place, the opening RCV for 2005–06 would simply be adjusted downwards to reflect all of the outperformance in PR 99. However, with the rolling mechanism in place, if outperformance occurs in 2002–03, the downward adjustment to the RCV associated with this year is not made until five years later (ie, 2007–08). In general, for each year of PR 04, there will be a *downward* or *zero* adjustment to the RCV.

The profiling of these adjustments depends on the profiling of CAPEX efficiencies over PR 99. These may be set by the user. No adjustments are made if companies do not, over the entirety of PR 99, outperform against Ofwat's PR 99 assumptions.

A1.3.2 OPEX outperformance

The OPEX rolling mechanism operates differently. Without the rolling mechanism in place, the opening base OPEX for 2005–06 would simply be adjusted downwards to reflect the base OPEX for 2003–04 (or, possibly, 2004–05). However, with the rolling mechanism in place, outperformance at the end year of AMP2 is compared against the level of outperformance in each of the pervious years, to derive an 'incentive allowance' for each year of PR 04. For example, to derive an 'incentive allowance' for 2005–06, outperformance in 2004–05 is compared against outperformance in 2000–01. To derive an 'incentive allowance' for 2006-07, outperformance in 2004–05 is compared against outperformance in 2001–02.

For PR 04, each year's incentive allowance is *added* to the OPEX revenue requirement after efficiencies. The incentive allowance cannot be negative in any year. If OPEX outperformance is assumed in the model to be front-loaded in PR 99, no incentive allowance is made. The profiling of outperformance may be set by the user.

A1.4 Stage 3: PR 04

The structure of the model for the PR 04 review is almost identical to that in stage 1, although the assumptions underlying stage 1, and the outperformance assumed in stage 2, feed into stage 3.

Where different to stage 1, the components for modelling stage 3 are discussed below.

A1.4.1 OPEX

The modelling of OPEX for PR 04 is similar to that for PR 99, with respect to the categories of OPEX included before efficiencies, and the way in which overall efficiency targets are derived.

The user can define a reference year from PR 99 to use as a starting point for the base OPEX assumption for 2005–06. The enhancement categories of expenditure are automatically informed by out-turns for 2004–05, although the user may change these amounts, if required.

In addition, the incentive allowance described in section A1.3.2 is, for each year, added to the (post-efficiency) OPEX revenue requirement.

A1.4.2 CAPEX

The categories of expenditure relating to CAPEX are the same in PR 04 as for PR 99. The user is free to set whatever level and profile of pre-efficiency CAPEX is to be included in price limits.

The model does, however, have some built-in options for setting CAPEX. For example, for maintenance expenditure, it is possible to set the required CAPEX using the 'serviceability' methodology—here, the CAPEX included in price limits for 2005–06 onwards is, for each year, an average of that incurred over the previous five years.

An alternative built-in option is to set CAPEX on the basis of some ratio of that incurred in PR 99 (eg, 1.3×), while maintaining the same profile of expenditure included in PR 99. This is an option for both maintenance and enhancement expenditure. This built-in option is informed by CAPEX out-turns for 2004–05, since it is assumed that (average) historical unit costs of undertaking work are taken into account in projecting future (pre-efficiency) CAPEX requirements.

Efficiency assumptions can then also be applied to this assumed expenditure, on the basis of both catch-up and frontier targets. The user is also free to front- or back-load the catch-up efficiency assumptions (Ofwat assumed in PR 99 that, for CAPEX, catch-up occurred in the first year of the price-control period).

The other assumptions for CAPEX (eg, non-infrastructure/infrastructure split, asset apportionments) are incorporated into the model in the same way as described in section A1.2.2.

A1.4.3 Depreciation

Depreciation for PR 04 feeds into the model in much the same way as that described in section A1.2.3 (eg, in terms of the differing treatment of expenditure categories).

In terms of differences in the way in which the model operates compared with PR 99, the CCD on existing assets for PR 04 also includes the remaining depreciation on base and enhancement expenditure incurred in PR 99. Because of the way the model works, no work-in-progress adjustment needs to be applied to enhancement expenditure for PR 04.

The user is free to apply broad-equivalence adjustments to CCD, and adjustments for wind-out/accruals on the IRC, in much the same way as described in section A1.2.3.

A1.4.4 RCV, return and tax

The RCV for PR 04 is calculated in exactly the same way as that described in section A1.2.4. In the model, the opening RCV for 2005–06 is automatically the closing RCV for 2004–05. The rolling CAPEX outperformance adjustment, described in section A1.3, is subtracted from the closing RCV in each year.

The (post-tax equity, pre-tax debt) cost of capital assumed feeds into the model in exactly the same way as described in section A1.2.4, and the revenue requirement (£m) is calculated by applying the cost of capital (%) to the *average* RCV for each year.

Tax is added straight into the framework as an additional revenue requirement (in £m) for each year (as per section A1.2.4). Again, the model assumes that this is a given percentage (eg, 15%) of the operating profit for the industry. A simple macro is used to calculate this.

A1.4.5 Allowed revenues

Within the model, the revenue requirement for each year is calculated in the same way as that described in section A1.2.5.

For 2005–06, the notional bill is compared to that derived (after K factor re-profiling) for 2004–05. Subsequent K factors are then calculated on the basis of the required increase in bills (in %) for the four following years up to 2009–10. Again, it is possible in the model to re-profile the K factors to a desired profile of prices, while maintaining the same NPV of allowed revenues.

Appendix 2: Differences Between the OXERA Water Industry Financial Model and Ofwat's Financial Modelling

In early 2003, the Environment Agency asked OXERA to explore the differences between OXERA's financial model and the framework used by Ofwat. The new financial model developed for Ofwat for the forthcoming review is Aquarius 3. Ofwat published a rulebook to accompany the first release of the model in November 2002.[2] More recently, the model has been updated, taking into account feedback from companies. An updated rulebook was published in May 2003.[3]

As noted in section 3, the OXERA model is presented at the aggregate industry level, combining both the water and sewerage services. In contrast, Ofwat models the industry at the company level, and disaggregated by service.

This section, based on the work undertaken for the Environment Agency, considers why the values provided by OXERA's modelling might *underestimate* the K factors that would result from Ofwat's modelling of required revenues at PR 04. This may occur for a number of reasons:

- the calculation of financeability checks is not explicitly taken into account in OXERA's model;
- the taxation allowance may be lower than that resulting from Ofwat's calculations;
- the tariff basket, and revenue effects of meter switching, are not modelled.

There is likely to be underestimation of the K factor in respect of financial indicators and tariff basket effects. Whether OXERA's treatment of tax results in underestimation of the K factor is less clear.

These issues are discussed, in turn, below.

A2.1 Exogeneity of financeability calculations

OXERA's model, unlike Aquarius 3, does not treat the financeability calculations (entering into the cost of capital adjustments) as endogenous to the model.

For scenarios that included a large capital programme (such as scenarios 3 and 4, described in section 3), an assumption of a higher cost of capital (in part, to account for financeability) was taken into account. However, this was an *ad hoc* adjustment, rather than forming part of the model. In Aquarius 3, by contrast, the financeability checks—based on the values of financial indicators resulting from the inputs into the model—form a part of the model, and are hence endogenous to the revenue requirements that result.

[2] Ofwat (2002), 'Aquarius 3 Financial Model Rule Book—November 2002 Version', November.
[3] Ofwat (2003), 'Aquarius 3 Financial Model Rule Book—May 2003 Version', May.

Within the working of Aquarius 3, the impact of financeability checks might be higher than the increases in the cost of capital assumed by OXERA. In particular, larger increases in adjustments to the K factor might take place for *some* companies. This is most likely to affect those companies with the largest CAPEX programmes.

A2.2 Calculations of taxation

Aquarius 3 calculates the tax requirement for companies on an individual basis, and takes account of the various elements of the taxation regime. A more simplified approach is taken in OXERA's model.

In addition, in Ofwat's model, tax is applied to the taxable profit/loss. Figure A2.1 shows the elements taken into account in calculating that profit or loss.

Figure A2.1: Ofwat's calculation of taxable profit/loss

Taxable profit/loss
= historic-cost operating profit
+ (depreciation + IRC – capital allowances)
– CAPEX allowable as deduction from profits
– finance lease depreciation
– interest payable
+ interest receivable
+ revenue expenditure not allowable
+ change in general provision
– profit/income not taxed as trading income
+ exceptional income
± profit/loss adjustments for tax
+ other investment income
+ chargeable gain
± loss relief

Source: OXERA analysis of Ofwat (2002), 'Aquarius 3 Financial Model Rule Book', November.

While it is unclear what impacts might occur on the additions/reductions in taxable trading profit as a result of the calculation shown in Figure A2.1, it is of note that Ofwat's starting point is the *historic-cost* account profit.

In OXERA's model, by contrast, taxation is assumed to be a proportion of the *current-cost operating profit*, which tends to be lower than the historic-cost figure as a result of adjustments to the latter made for depreciation, asset disposals and working capital adjustments. In 2001–02, for the industry as a whole, the historic-cost operating profit

was £2,506m, 26% higher than the current-cost operating profit for the industry (£1,995m).

However, some adjustments to the historic-cost operating profit in Ofwat's framework (shown in Figure A2.1) are likely to be sizeable—particularly the interest payments on debt. These will be even more considerable for highly geared companies with higher interest repayments. Indeed, aggregate tax payments for the industry may have fallen as a result of the financial restructurings.

As a result, while the OXERA model does diverge from the *calculation* of taxes that companies may pay to Aquarius 3, Ofwat's methodology is likely to produce varying results for individual companies. It is therefore unclear what *overall* levels of taxation should be assumed.

As a check on OXERA's assumption of a 15% tax rate on current-cost operating profit, past data on taxation paid by companies as a proportion of their profits can be used. Looking at the results for the industry for 1997–98 to 2001–02, shown in Table A2.1, suggests that the assumption of 15%—based on past data alone—is a reasonable approximation. It should be noted, however, that this does not no account is taken of any potential changes to the tax regime going forward.

Table A2.1: Taxation payments as a proportion of current-cost operating profit, industry aggregate, 1997/98 to 2001/02

Financial year	Current-cost operating profit (£m)	Taxation paid (£m)	Taxation payments as a proportion of the current-cost operating profit (%)
1997/98	2,310.07	196.82	8.52
1998/99	2,439.14	440.70	18.07
1999/00	2,530.81	448.31	17.71
2000/01	1,942.23	373.74	19.24
2001/02	1,995.58	149.54	7.49
1997/98 to 2001/02	11,271.83	1609.11	14.34

Source: OXERA analysis of Ofwat (2002), 'June Returns 2001–02', November.

A2.3 The tariff basket

OXERA's model, unlike Aquarius 3, does not model the tariff basket. The tariff basket incorporates five separate calculations, and governs annual allowed increases for five basket items: unmeasured water, measured water, unmeasured sewerage, measured sewerage and trade effluent.

This means that the K factor emerging from OXERA's model does not take into account increases or decreases in price that may result from the composition of the tariff basket. The effect of this *in general* is difficult to predict, and is likely to be company-specific, depending on the make-up of a company's customer base and tariff structures.

However, the revenue effect of *meter switching* is likely to play a role in the level of companies' required revenues, and this is not taken into account in OXERA's model.

When unmeasured customers switch to a free meter, there are two impacts on companies' revenues: the *cost* of installing a free meter and the *revenue* effect of meter switching. The revenue effect is linked to the fact that customers with an incentive to switch to a meter are those who use less than the average unmeasured amount of water, and/or live in a higher than average rateable value property. Switching is therefore likely to result in lower charges for these customers, and these have to be recovered from unmeasured customers. Ofwat's setting of the K factor also has to take into account the assumptions on the degree to which the 'average' customer bill will rise due to the revenue loss, and the consequent tariff rebalancing between measured and unmeasured customers.

While OXERA's model does take into account the costs of installing free meters, it does not take account of the need to increase revenues as a result of switching. Though the degree to which the K factor is underestimated would be company-specific, depending on Ofwat's assumptions about the number of unmeasured customers who would switch to a meter, some systematic underestimation of the K factor might be expected in the OXERA model in this regard.

Appendix 3: Alternative Price Profiles

Alternative price profiles, which generate the same NPV of allowed revenues to the scenarios presented in section 3, are shown below.

Table A3.1: Baseline scenario alternative price profiles (%)

2006 (P_0)	2007	2008	2009	2010	Average K factor
–1.5	–0.3	–0.3	–0.4	–0.5	–0.6
–0.7	–0.7	–0.7	–0.7	–0.7	–0.7
–2.1	0.0	0.0	0.0	0.0	–0.4
–2.6	0.0	0.0	1.0	1.0	–0.1
–3.9	1.0	1.0	1.0	1.0	0.0
–1.2	–0.5	–0.5	–0.5	–0.5	–0.6
–0.9	–0.5	–0.5	–1.0	–1.0	–0.8
NPV:	27,167				

Table A3.2: Scenario 1 alternative price profiles (%)

2006 (P_0)	2007	2008	2009	2010	Average K factor
4.0	0.5	0.5	0.4	0.3	1.1
1.7	1.7	1.7	1.7	1.7	1.7
4.9	0.0	0.0	0.0	0.0	1.0
4.4	0.0	0.0	1.0	1.0	1.3
3.0	1.0	1.0	1.0	1.0	1.4
2.4	1.0	1.0	2.0	2.0	1.7
1.0	2.0	2.0	2.0	2.0	1.8
NPV:	28,333				

Table A3.3: Scenario 2 alternative price profiles (%)

2006 (P_0)	2007	2008	2009	2010	Average K factor
–11.6	–1.0	–1.0	–1.1	–1.2	–3.3
–4.9	–4.9	–4.9	–4.9	–4.9	–4.9
–9.9	–2.0	–2.0	–2.0	–2.0	–3.6
–9.0	–2.0	–2.0	–4.0	–4.0	–4.2
–6.5	–4.0	–4.0	–4.0	–4.0	–4.5
–5.2	–5.0	–5.0	–4.0	–4.0	–4.6
–4.7	–5.0	–5.0	–5.0	–5.0	–4.9
NPV:	24,055				

Table A3.4: Scenario 3 alternative price profiles (%)

2006 (P_0)	2007	2008	2009	2010	Average K factor
8.3	3.7	3.4	3.0	2.5	4.1
5.0	5.0	5.0	5.0	5.0	5.0
6.9	4.0	4.0	4.0	4.0	4.6
6.3	4.0	4.0	5.0	5.0	4.9
4.9	5.0	5.0	5.0	5.0	5.0
7.9	5.0	5.0	0.0	0.0	3.5
12.2	0.0	0.0	5.0	5.0	4.3
NPV:	30,965				

Table A3.5: Scenario 4 alternative price profiles (%)

2006	2007	2008	2009	2010	Average K factor
–3.6	1.6	1.6	1.3	1.0	0.4
–0.3	–0.3	–0.3	–0.3	–0.3	–0.3
–4.5	2.0	2.0	2.0	2.0	0.7
–0.8	0.0	0.0	0.0	0.0	–0.2
–2.2	1.0	1.0	0.0	0.0	0.0
–2.7	1.0	1.0	1.0	1.0	0.3
–3.2	1.0	1.0	2.0	2.0	0.5
NPV:	27,144				

Appendix 4: Financial Modelling Excluding the CAPEX Programme

Using the OXERA water industry financial model, OXERA undertook further scenario modelling for the Environment Agency, to consider the possible impact on price limits if no quality programme were undertaken *at all* during the next price-control period. This assumption is entirely unrealistic, but it provides an indication of the impact of the enhancement programme on price limits (at least using the building block approach alone). This further modelling was undertaken in January 2003.

Expenditure (both in terms of OPEX and CAPEX) in the water industry falls into one of four categories:

- to maintain existing levels of service (base service levels, including capital maintenance);
- to improve water quality or make environmental improvements (collectively referred to as 'quality');
- to enhance the supply–demand balance; and
- to improve customer-service levels.

The last three expenditure categories are collectively referred to as 'enhancement'.

Two sets of modelling are discussed in this appendix:

- the impact of no OPEX or CAPEX relating to 'quality' being undertaken, while assuming that supply–demand balance expenditure still takes place; and
- the impact of removing the OPEX and CAPEX relating to both the quality programme and expenditure on maintaining the supply–demand balance.

In both cases, any expenditure, either in terms of OPEX or CAPEX, on improving customer-service levels is assumed to be included in the next price-control review—in the latter scenario, this is the only new enhancement expenditure to be allowed for in PR 04.

The remainder of this appendix, which outlines the additional modelling work conducted by OXERA, considers the impact on prices, on the base case and the four additional scenarios, when the quality programme is removed. The format is as follows:

- results following the removal of expenditure on the quality programme;
- results following the removal of the expenditure on the quality programme *and* on maintaining the supply–demand balance.

A4.1 Impact on the base-case scenario

The results from (the unaltered) base-case scenario were presented in Table 3.4 in section 3.

A4.1.1 Baseline scenario—excluding the expenditure on the quality programme

While keeping all remaining assumptions the same, OXERA modelled the base-case scenario excluding the £7.8 billion CAPEX on the quality programme (or OPEX associated with the new quality programme, of £164m per annum).

Given these changes, the modelling results are provided in Table A4.1.

Table A4.1: PR 04 base-case scenario excluding OPEX and CAPEX on the quality programme

	2006	2007	2008	2009	2010
Base OPEX	2,390	2,334	2,280	2,227	2,175
Enhancement OPEX	*29*	*28*	*27*	*26*	*25*
Total OPEX	2,418	2,362	2,306	2,252	2,200
CCD	1,324	1,320	1,315	1,309	1,304
IRC	384	384	384	384	384
Return on RCV	1,889	1,871	1,853	1,834	1,813
Taxation	283	281	278	275	272
Total required revenues	**6,298**	**6,217**	**6,136**	**6,055**	**5,973**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,128	6,054	5,979	5,904	5,828
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	144.62	141.74	138.89	136.05	133.23
P_0	**–5.0%**				
K		**–2.0%**	**–2.0%**	**–2.0%**	**–2.1%**
Average annual price change					**–2.6%**

As can be seen, the exclusion of the total quality programme, given the remaining assumptions in the base-case scenario, would imply significant reductions in prices compared with the original base-case scenario, and a reduction in the NPV of required revenues between 2006 and 2010, of £1,810m, to **£25,357**m.

A4.1.2 Baseline scenario—excluding the expenditure on the quality programme and on the supply–demand balance

Further exclusions of expenditures on maintaining the supply–demand balance do not significantly alter the results shown in Table A4.1, as the values for both OPEX and CAPEX in this category tend to be small compared with those for the quality programme:[4]

- CAPEX on maintaining the supply–demand balance of £768m; and
- OPEX on maintaining the supply–demand balance of £30m per annum.

[4] The OXERA financial model excludes new development from the expenditure on supply–demand balance, since Ofwat reports that new development has not *net* impact on price limits. The approach adopted by OXERA would be expected to have a similar effect to including the expenditure on new development and then netting off grants and contributions.

When it is assumed that no expenditure is allowed on either the quality programme or on the supply–demand balance, the modelling results that emerge are shown in Table A4.2.

Table A4.2: PR 04 base-case scenario—excluding OPEX and CAPEX on the quality programme and the supply–demand balance expenditures

	2006	2007	2008	2009	2010
Base OPEX	2,390	2,334	2,280	2,227	2,175
Enhancement OPEX	*0*	*0*	*0*	*0*	*0*
Total OPEX	2,390	2,334	2,280	2,227	2,175
CCD	1,321	1,315	1,308	1,301	1,293
IRC	384	384	384	384	384
Return on RCV	1,885	1,860	1,834	1,807	1,780
Taxation	283	279	275	271	267
Total required revenues	**6,263**	**6,172**	**6,081**	**5,989**	**5,898**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,092	6,008	5,924	5,838	5,753
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	143.79	140.68	137.60	134.54	131.53
P_0	**–5.6%**				
K		**–2.2%**	**–2.2%**	**–2.2%**	**–2.2%**
Average annual price change					**–2.9%**

A4.2 Impact on Scenario 1

The results from (the unaltered) Scenario 1 were presented in Table 3.6 in section 3.

A4.2.1 Scenario 1—excluding the expenditure on the quality programme

Excluding the CAPEX on the quality programme of £7.7 billion, as well as the OPEX on the quality programme of £156m per annum, gives rise to the results shown in Table A4.3.

Table A4.3: Scenario 1—excluding OPEX and CAPEX on the quality programme

	2006	2007	2008	2009	2010
Base OPEX	2,351	2,328	2,305	2,282	2,260
Enhancement OPEX	*28*	*27*	*27*	*27*	*26*
Total OPEX	2,379	2,355	2,332	2,309	2,286
CCD	1,326	1,324	1,322	1,320	1,318
IRC	398	398	398	398	398
Return on RCV	2,213	2,191	2,169	2,147	2,123
Taxation	332	329	325	322	318
Total required revenues	**6,648**	**6,597**	**6,546**	**6,495**	**6,443**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,477	6,433	6,389	6,344	6,298
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	152.87	150.63	148.41	146.19	143.99
P_0	**0.4%**				
K		**–1.5%**	**–1.5%**	**–1.5%**	**–1.5%**
Average annual price change					**–1.1%**

The price limits are again significantly lower than had been assumed in the unaltered Scenario 1. However, while a similar magnitude of the quality programme on OPEX and CAPEX has been removed, the NPV of revenues, of **£26,359m** for PR 04, is nonetheless higher than in the amended base-case scenario, of **£25,357m**. This is a result of the assumptions on the cost of capital, efficiency and outperformance used in Scenario 1.

However, Scenario 1 assumes a relatively high cost of capital (compared to the base case), of 6.8%, which is unlikely to be consistent with a small capital programme. This is because less pressure would be expected on companies' financeability (although macroeconomic factors may inflate the cost of capital).

Even though the size of the quality programme taken out of the price-control setting is *smaller* in Scenario 1 than in the base case, the *reduction* in the NPV of required revenues is *higher* in Scenario 1 than in the base case—7% rather than of 6.7%. This is likely to be due to a high cost of capital in Scenario 1. As a higher cost of capital assumption was applied in Scenario 1 than in the base case, it resulted in a greater reduction to the required revenues than if the cost of capital assumption had been lower (and, hence, led to lower required revenues for a given amount of CAPEX relating to the quality programme).

In practice, removing the quality programme in Scenario 1 would result in a fall in the required cost of capital, for financeability reasons, and so the reduction in required revenues in Scenario 1 would be even greater than that presented in Table A4.3.

A4.2.2 Scenario 1—excluding the expenditure on the quality programme and on the supply–demand balance

If PR 04 were to further exclude the expenditure on maintaining the supply–demand balance from Scenario 1 (which equates to £28.2m per annum in OPEX and £144m for CAPEX), the NPV of revenues for PR 04 would, according to the OXERA model, be

£26,114m. This is not significantly different to the result suggested by the model, were those expenditures to be allowed into PR 04.

This would translate into the price limits shown in Table A4.4.

Table A4.4: Scenario 1—excluding OPEX and CAPEX on the quality programme and on the supply–demand balance

	2006	2007	2008	2009	2010
Base OPEX	2,351	2,328	2,305	2,282	2,260
Enhancement OPEX	*0*	*0*	*0*	*0*	*0*
Total OPEX	2,351	2,328	2,305	2,282	2,260
CCD	1,323	1,319	1,315	1,310	1,306
IRC	398	398	398	398	398
Return on RCV	2,209	2,177	2,146	2,114	2,082
Taxation	331	327	322	317	312
Total required revenues	**6,612**	**6,549**	**6,485**	**6,421**	**6,358**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,442	6,385	6,328	6,270	6,213
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	152.03	149.50	146.99	144.49	142.03
P_0	**–0.2%**				
K		**–1.7%**	**–1.7%**	**–1.7%**	**–1.7%**
Average annual price change					**–1.4%**

A4.3 Impact on Scenario 2

The results from (the unaltered) Scenario 2 were presented in Table 3.7 in section 3.

A4.3.1 Scenario 2—excluding the expenditure on the quality programme

In this case, excluding the effects of the quality programme—of £7 billion on CAPEX and £131m per annum on OPEX—does lead to significant price cuts, as can be seen in Table A4.5. In this case, the NPV of revenues has fallen by £1,548m (or 6.4%) from £24,055m.

Moreover, even lower prices might be expected in this scenario, as a removal of a significant CAPEX quality programme (and somewhat lower increases in OPEX) may also be associated with a reduction in the cost of capital.

However, the fall in prices (and allowed revenues) is smaller than in the previous two scenarios. This is partly due to a lower quality programme being taken out of allowed revenues, and partly to the fact that higher efficiencies had been applied to the OPEX relating to the quality programme in Scenario 2. Hence, the expenditure on quality that fed into price limits in Scenario 2 was lower still than in the base case or in Scenario 1.

Table A4.5: Scenario 2—excluding OPEX and CAPEX on the quality programme

	2006	2007	2008	2009	2010
Base OPEX	1,893	1,832	1,772	1,714	1,658
Enhancement OPEX	*23*	*22*	*21*	*20*	*19*
Total OPEX	1,916	1,853	1,792	1,733	1,677
CCD	1,268	1,259	1,249	1,238	1,228
IRC	342	342	342	342	342
Return on RCV	1,879	1,842	1,804	1,766	1,728
Taxation	282	276	271	265	259
Total required revenues	**5,687**	**5,573**	**5,458**	**5,345**	**5,233**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	5,517	5,409	5,301	5,194	5,088
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	130.21	126.65	123.14	119.69	116.33
P_0	**–14.5%**				
K		**–2.7%**	**–2.8%**	**–2.8%**	**–2.8%**
Average annual price change					**–5.2%**

A4.3.2 Scenario 2—excluding the expenditure on the quality programme and on the supply–demand balance

As in the other scenarios, the exclusion of additional expenditure on maintaining the supply–demand balance makes little difference to the impact on price compared with the scenario when it is just the expenditure on the quality programme that is excluded, of –0.3% of average annual price change, as is shown in Table A4.6.

Table A4.6: Scenario 2—excluding OPEX and CAPEX on the quality programme and on the supply–demand balance

	2006	2007	2008	2009	2010
Base OPEX	1,893	1,832	1,772	1,714	1,658
Enhancement OPEX	*0*	*0*	*0*	*0*	*0*
Total OPEX	1,893	1,832	1,772	1,714	1,658
CCD	1,266	1,255	1,243	1,230	1,218
IRC	342	342	342	342	342
Return on RCV	1,875	1,831	1,787	1,742	1,698
Taxation	281	275	268	261	255
Total required revenues	**5,659**	**5,535**	**5,412**	**5,290**	**5,170**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	5,488	5,371	5,255	5,139	5,025
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	129.53	125.76	122.06	118.42	114.89
P_0	**–15.0%**				
K		**–2.9%**	**–2.9%**	**–3.0%**	**–3.0%**
Average annual price change					**–5.5%**

A4.4 Impact on Scenario 3

The results from (the unaltered) Scenario 3 were presented in Table 3.9 in section 3.

A4.4.1 Scenario 3—excluding the expenditure on the quality programme

Overall, this scenario still predicts a price increase in PR 04. However, the effect of taking out the quality programme has a greater impact on prices than is the case for other scenarios. As such, the fall in the NPV of revenues is of 10.8%, to **£27,608m**. This is likely to be due to the magnitude of the CAPEX programme on quality that has been taken out of the price limits, as well the high cost of capital that had been applied to it.

The result for prices is shown in Table A4.7. Moreover, the reduction in revenues might be expected to be even greater, as the cost of capital assumption (of 7%) might be unrealistic given a significant cut to the CAPEX programme.

Table A4.7: Scenario 3—excluding OPEX and CAPEX on the quality programme

	2006	2007	2008	2009	2010
Base OPEX	2,301	2,279	2,256	2,234	2,212
Enhancement OPEX	*28*	*27*	*27*	*27*	*26*
Total OPEX	2,329	2,306	2,283	2,261	2,238
CCD	1,389	1,450	1,510	1,570	1,630
IRC	483	483	483	483	483
Return on RCV	2,290	2,289	2,282	2,271	2,254
Taxation	344	343	342	341	338
Total required revenues	**6,835**	**6,871**	**6,902**	**6,926**	**6,944**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,664	6,707	6,744	6,775	6,799
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	157.29	157.05	156.66	156.12	155.43
P_0	**3.3%**				
K		**–0.2%**	**–0.2%**	**–0.3%**	**–0.4%**
Average annual price change					**0.4%**

A4.4.2 Scenario 3—excluding OPEX and CAPEX on the quality programme and on the supply–demand balance

The CAPEX associated with the supply–demand balance in this scenario is sizeable (although OPEX associated with this does not differ significantly from the other scenarios). However, given the size of the CAPEX programme as a whole in Scenario 3 (in particular, the size of the quality programme), the additional exclusion of the supply–demand balance expenditure does not result in a significant change in prices, taking a further £258m of the NPV of the unaltered Scenario 3. The resulting prices can be seen in Table A4.8.

Table A4.8: Scenario 3—excluding OPEX and CAPEX on the quality programme and on supply/ demand balance

	2006	2007	2008	2009	2010
Base OPEX	2,301	2,279	2,256	2,234	2,212
Enhancement OPEX	*0*	*0*	*0*	*0*	*0*
Total OPEX	2,301	2,279	2,256	2,234	2,212
CCD	1,385	1,443	1,500	1,556	1,612
IRC	483	483	483	483	483
Return on RCV	2,285	2,274	2,258	2,238	2,213
Taxation	343	341	339	336	332
Total required revenues	**6,798**	**6,820**	**6,836**	**6,847**	**6,852**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,627	6,656	6,679	6,696	6,707
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	156.42	155.85	155.14	154.29	153.34
P_0	**2.7%**				
K		**–0.4%**	**–0.5%**	**–0.5%**	**–0.6%**
Average annual price change					**0.1%**

A4.5 Impact on Scenario 4

The results from (the unaltered) Scenario 4 were presented in Table 3.10 in section 3.

A4.5.1 Scenario 4—excluding the expenditure on the quality programme

Excluding the sizeable expenditure on the quality programme, both for OPEX and CAPEX, implies a significant reduction in the required revenues for PR 04 under the assumptions outlined in Scenario 4. The reduction in the NPV of revenues, to **£24,427m,** amounts to £2,717m, and gives rise to prices shown in Table A4.9.

Table A4.9: Scenario 4—excluding OPEX and CAPEX on the quality programme

	2006	2007	2008	2009	2010
Base OPEX	2,012	1,946	1,882	1,821	1,761
Enhancement OPEX	*24*	*23*	*22*	*21*	*20*
Total OPEX	2,036	1,969	1,904	1,842	1,781
CCD	1,287	1,296	1,305	1,312	1,319
IRC	439	439	439	439	439
Return on RCV	2,058	2,052	2,043	2,032	2,019
Taxation	309	308	306	305	303
Total required revenues	**6,129**	**6,064**	**5,998**	**5,930**	**5,861**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	5,959	5,900	5,841	5,779	5,716
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	140.64	138.15	135.67	133.17	130.69
P_0	**–7.7%**				
K		**–1.8%**	**–1.8%**	**–1.8%**	**–1.9%**
Average annual price change					**–3.0%**

However, as the depreciation profile is less front-loaded than in Scenario 3, and the cost of capital is lower, the impact on the price reductions of removing the quality programme also has less of an effect.

A4.5.2 Scenario 4—excluding OPEX and CAPEX on the quality programme and on the supply–demand balance

Further exclusions of the supply–demand balance expenditures have little effect on the overall price limits, as with all the other scenarios. The results are shown in Table A4.10.

Table A4.10: Scenario 4—excluding OPEX and CAPEX on the quality programme and on supply–demand balance

	2006	2007	2008	2009	2010
Base OPEX	2,012	1,946	1,882	1,821	1,761
Enhancement OPEX	*0*	*0*	*0*	*0*	*0*
Total OPEX	2,012	1,946	1,882	1,821	1,761
CCD	1,285	1,292	1,298	1,303	1,308
IRC	439	439	439	439	439
Return on RCV	2,054	2,040	2,023	2,005	1,985
Taxation	308	306	303	301	298
Total required revenues	**6,098**	**6,023**	**5,946**	**5,869**	**5,792**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	5,928	5,859	5,789	5,718	5,647
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Average water/sewerage bill	139.91	137.19	134.48	131.77	129.09
P_0	**–8.1%**				
K		**–1.9%**	**–2.0%**	**–2.0%**	**–2.0%**
Average annual price change					**–3.3%**

A4.6 Summary of modelling results

A4.11: Summary of modelling results

Scenario	Unchanged		Without the quality programme		Change from 'unchanged'		Without the quality programme or supply–demand balance		Change from 'unchanged'	
	Average annual price change (%)	NPV of required revenues	Average annual price change (%)	NPV of required revenues	Difference in price change (K)	% Difference in NPV change	Average annual price change (%)	NPV of required revenues	Difference in price change (K)	% Difference in NPV change
Base case	–0.6	27,167	–2.6	25,357	–2	–6.66	–2.9	25,127	–2.3	–7.51
Scenario 1	1.1	28,333	–1.1	26,359	–2.2	–6.97	–1.4	26,114	–2.5	–7.83
Scenario 2	–3.3	24,055	–5.2	22,507	–1.9	–6.44	–5.5	22,315	–2.2	–7.23
Scenario 3	4.1	30,965	0.4	27,608	–3.7	–10.84	0.1	27,350	–4	–11.67
Scenario 4	0.4	27,144	–3.0	24,427	–3.4	–10.01	–3.3	24,220	–3.7	–10.77

As Table A4.11 shows, in all of the scenarios, taking out the quality programme does have a significant effect on the K factor. The price change tends to be reduced by 2% in lower CAPEX scenarios and by 3.5–4% in high CAPEX scenarios. Additional exclusions of the expenditure on maintaining the supply–demand balance thereafter tend to be marginal, in each case taking a further 0.3 percentage points off the average annual change assumed in the original scenarios.

In practice, removing the CAPEX programme in high CAPEX scenarios (eg, Scenario 3) might be expected to reduce the cost of capital, for financeability reasons, and so the reduction in required revenues associated with removing parts of the capital programme may be expected to be even greater.

Appendix 5: Sensitivity of Results to Changes in the Assumed Cost of Capital

The tables below illustrate how the results of the modelling change when the assumed cost of capital is changed. Sensitivities are provided for Scenarios 1, 2, 3 and 4. The impact on the unadjusted K profile, and on the smoothed K equivalent profile (ie, that which generates the same NPV of allowed revenues, but assumes a constant year-on-year change in prices), is shown in each case.

Table A5.1: Scenario 1 sensitivity of the price profile to the cost of capital (%)

Cost of capital (%)	2006 (P_0)	2007	2008	2009	2010	Average K factor	Smoothed K factor
6.8	4.0	0.5	0.5	0.4	0.3	1.1	1.7
6.3	1.0	0.5	0.5	0.4	0.2	0.5	0.6
5.8	–1.9	0.4	0.4	0.3	0.2	–0.1	–0.4
7.3	6.9	0.6	0.6	0.5	0.3	1.7	2.7
7.8	9.9	0.6	0.6	0.5	0.3	2.3	3.7

Table A5.2: Scenario 2 sensitivity of the price profile to the cost of capital (%)

Cost of capital	2006 (P_0)	2007	2008	2009	2010	Average K	Smoothed K
5.8	–11.6	–1.0	–1.0	–1.1	–1.2	–3.3	–4.9
5.3	–14.6	–1.1	–1.1	–1.1	–1.2	–4.0	–6.1
4.8	–17.5	–1.1	–1.1	–1.2	–1.3	–4.7	–7.3
6.3	–8.7	–0.9	–0.9	–1.0	–1.1	–2.6	–3.7
6.8	–5.7	–0.9	–0.9	–0.9	–1.1	–1.9	–2.6

Table A5.3: Scenario 3 sensitivity of the price profile to the cost of capital (%)

Cost of capital	2006 (P_0)	2007	2008	2009	2010	Average K	Smoothed K
7	8.3	3.7	3.4	3.0	2.5	4.1	5.0
6.5	5.2	3.6	3.3	2.9	2.5	3.5	3.9
6	2.2	3.5	3.2	2.9	2.4	2.8	2.9
7.5	11.3	3.7	3.5	3.1	2.5	4.8	6.0
8	14.3	3.8	3.5	3.1	2.6	5.4	7.0

Table A5.4: Scenario 4 sensitivity of the price profile to the cost of capital (%)

Cost of capital	2006 (P_0)	2007	2008	2009	2010	Average K	Smoothed K
6.3	–3.6	1.6	1.6	1.3	1.0	0.4	–0.3
5.8	–6.6	1.5	1.4	1.2	0.9	–0.4	–1.5
5.3	–9.6	1.3	1.3	1.1	0.8	–1.1	–2.7
6.8	–0.6	1.8	1.7	1.4	1.1	1.1	0.9
7.3	2.5	1.9	1.8	1.5	1.2	1.8	2.0