OXERA

OXFORD ECONOMIC RESEARCH ASSOCIATES

ENVIRONMENT AGENCY

PERIODIC REVIEW OF PRICES 2004: HYPOTHETICAL SCENARIO MODELLING

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Executive Summary

In March 2002, the Environment Agency commissioned OXERA to build a financial model of the water industry, in order to augment the Agency's understanding of economic regulation in the water sector. The result—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 various constituent components.

As part of the exercise, OXERA modelled a number of scenarios for the setting of prices at the 2004 periodic review (PR 04). These prices will cover the period April 1st 2005 to March 31st 2010. While all the scenarios used are clearly hypothetical, the starting point, or base-case scenario, seeks to mimic broadly the assumptions used by Ofwat at the 1999 periodic review (PR 99). However, this does not mean that this represents a 'most likely' or 'central' scenario.

Following input from the Environment Agency, OXERA then considered a range of alternative scenarios involving combinations of 'higher' and 'lower' assumptions on key variables. The purpose of these exercises was not to develop scenarios that might be regarded as 'most realistic', nor to attach probabilities to each particular scenario. Rather, the aim was to illustrate how different assumptions on the building blocks might lead to different outcomes for prices. The results were presented to the Agency in September 2002.

The OXERA model aims to capture the principal aspects of Ofwat's approach, but the modelling was undertaken at the aggregate industry level, combining the water and sewerage services. In contrast, Ofwat models the industry at the company level, and disaggregated by service. The OXERA model is also based on publicly information available at the time, and, where this was not available, certain assumptions had to be made.

Furthermore, while a number of the features of Ofwat's financial modelling methodology were included within the framework (eg, operating expenditure (OPEX) efficiency, depreciation treatment, outperformance allowances, etc), some other areas were not modelled in detail (eg, the tariff basket mechanism and the impact of meter switching). In addition, *pro-forma* financial indicators (eg, interest cover and dividend cover) were not modelled explicitly.[1] A simplified approach was also taken to the issue of taxation. As a result of these factors combined, the model is likely to understate, to a certain extent, the profile of bills—the K factor.

[1] Ofwat applies an *ex post* 'financeability check' to its modelling results. Indicators tested include interest cover and dividend cover. In the past, Ofwat has undertaken this on a *pro-forma* basis (for example, in relation to the interest cover test, Ofwat's assumed *pro-forma* gearing level has been adopted in calculating interest payments, rather than the company's actual gearing level). Where such indicators are breached, Ofwat has increased the allowed revenues in the model, thereby increasing the allowed rate of return. This is conceptually equivalent to increasing the cost of capital in the model.

The price limits that Ofwat might set at PR 04 will be determined by the regulator's decisions on the amount of revenue that companies should be allowed to finance their functions over the period from 2005–06 to 2009–10. In the water sector, four main building blocks are added together to determine these allowed revenues:

- OPEX;
- current-cost depreciation (CCD) and infrastructure renewals charges (IRC);
- a return on capital employed; and
- taxation.

OPEX feeds into the price control *directly*—it is an annual allowance based on predicting future costs. Here, assessment is required of the future scope for operating efficiencies. In contrast, the allowances for CAPEX are calculated in a *less direct* way. This is because CAPEX is typically 'lumpy', and such expenditure can be on assets with very long lives. Therefore, to recover the CAPEX in each year of the price control, as it is spent, would result in highly volatile prices from year to year. It would also raise concerns regarding intergenerational equity. Hence, a large proportion of CAPEX in the water industry is fed into the price control using a 'traditional' remuneration approach used in many utility sectors. Expenditure on overground (non-infrastructure) assets, in respect of both capital maintenance and enhancement, is treated in the following manner:

- *regulatory capital value* (RCV)—this is added to over time through net new CAPEX;

- *depreciation*—in order to invest, companies need to borrow money, through either debt or equity. The 'principal' borrowed is remunerated in price limits through an allowance for depreciation (this also reflects the 'use' of the assets over time). In each year, the depreciation allowance is subtracted from the RCV;

- *return on capital*—in order to repay investors for the money supplied to fund the CAPEX, investors require a 'return on capital'. This is the assumed 'cost of capital' (in %) multiplied by the total RCV of the company.

However, maintenance on underground (or 'infrastructure') assets is not treated in the way illustrated above. This expenditure is not added to the RCV, and, by the same token, is not depreciated. Rather, it is remunerated through an IRC allowance in each year of the price control, akin in some ways to a 'pay-as-you-go' approach to remuneration (ie, an approach that resembles that adopted for OPEX).[2]

[2] Infrastructure enhancement expenditure *is* added to the RCV, but this remains in the RCV in perpetuity (ie, it is not depreciated).

In practice, a number of factors determine the four main building blocks. When OXERA developed the hypothetical base case, and other scenarios, for PR 04, considerations included the following.

- *The degree to which companies might outperform Ofwat's PR 99 assumptions*, as regards the OPEX and CAPEX efficiency assumptions in price limits. In the base-case scenario for PR 04, OXERA assumed zero net outperformance. Other scenarios considered higher levels of outperformance.

- *The scope for future OPEX and CAPEX efficiencies*—considerations here include the methodology for assessing frontier shift, the comparative-efficiency models that Ofwat proposes to use, and the assumed rate of catch-up. In the base-case scenario, OXERA considered efficiency targets similar to those adopted in PR 99. Other scenarios considered both less, and more, demanding overall targets. Potential increases in base OPEX (pre-efficiencies) were limited to one scenario, and no increases in enhancement OPEX (pre-efficiencies) were assumed in any of the scenarios modelled.

- *Future CAPEX requirements*—at the last review, there was much controversy on the appropriate approach for assessing future capital maintenance requirements. In PR 99, Ofwat used a *top-down* 'serviceability' approach. Companies have since been developing a *bottom-up* economic approach to assessing maintenance needs. OXERA's base-case scenario for PR 04 assumed a serviceability approach similar to that used in PR 99. Other scenarios considered the possibility of greater capital maintenance allowances. In respect of the water and environmental quality programme, OXERA considered a base-case scenario that reflected the level of activity assumed by Ofwat in PR 99, with both positive and negative deviations around this in other scenarios. In some scenarios, increased allowances for sewer flooding were also considered.

- *Depreciation*—at the last review, Ofwat applied a downward adjustment to most companies' depreciation allowances. Such adjustments were also incorporated into OXERA's modelling, although these were not based on detailed bottom-up calculations.

- *The cost of capital*—or the return required by investors to invest in the water industry, rather than in other investments. In its base-case PR 04 assumption, OXERA adopted a cost of capital assumption similar to that adopted by Ofwat in PR 99. Around this, hypothetical scenarios regarding macroeconomic trends were considered, which placed upward or downward pressure on the cost of capital.

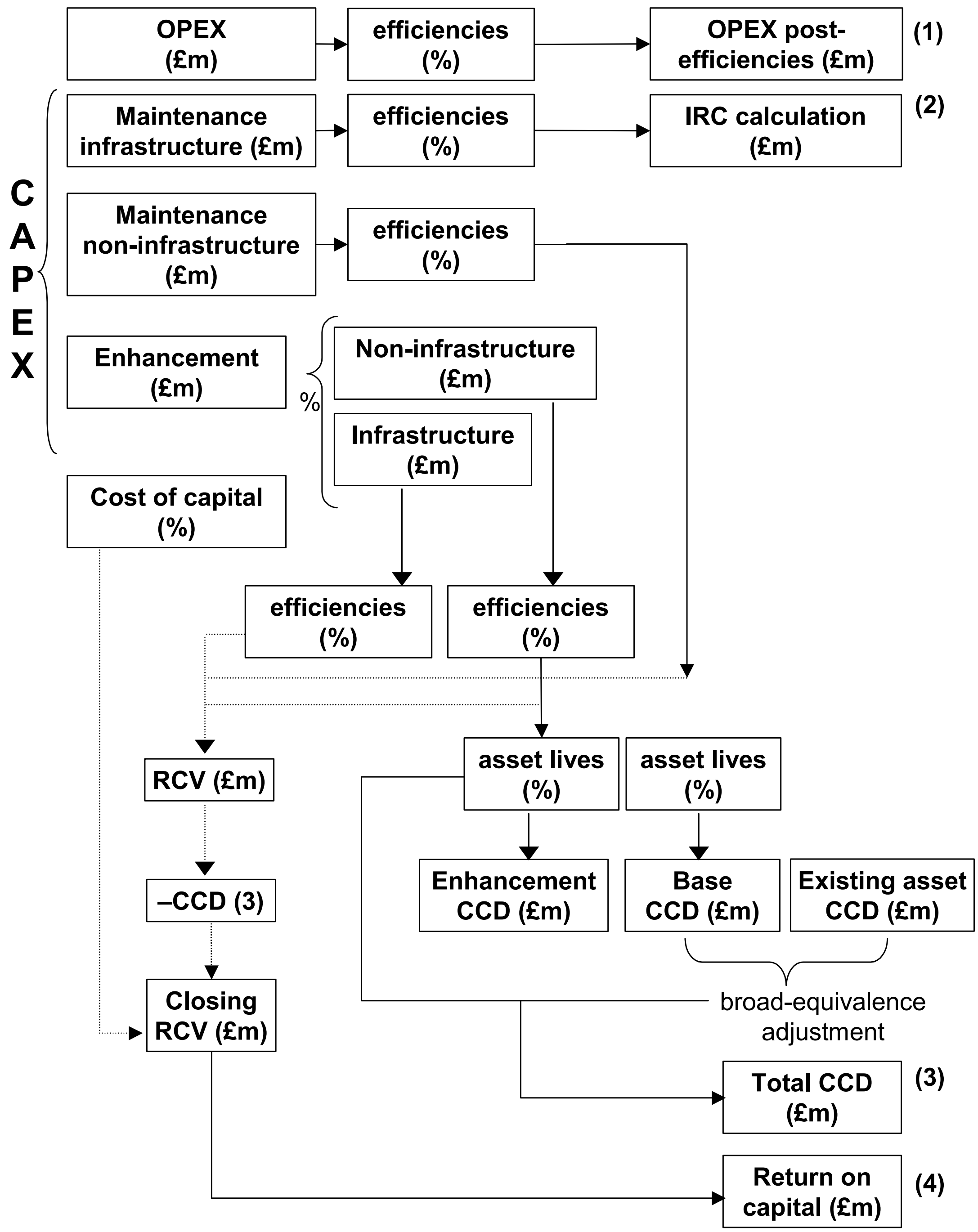
- *Taxation*—Ofwat treats tax as a revenue line to be remunerated, rather than including it within the cost of capital through a 'tax wedge'. Tax was an important issue, given the emergence of highly geared companies in the water sector (ie, those with high levels of debt relative to equity in their balance sheets), and that such companies might, in practice, pay little tax.

- *Financeability considerations*—although OXERA's modelling did not explicitly capture (*pro-forma*) financial indicators, such as interest cover and dividend cover, in some higher CAPEX scenarios, the allowed return was increased to reflect a notional impact on financeability. This was undertaken by increasing the assumed cost of capital in the model in some scenarios.

The above shows that there were many uncertainties in undertaking the modelling. It is also of note that a number of regulatory developments have occurred since the modelling was undertaken—most notably the publication by Ofwat of its PR 04 framework methodology papers, the revised lists of key environmental programme drivers published by the Environment Agency, the guidance issued by the Drinking Water Inspectorate on the water quality programme, and ministerial guidance on these programmes.

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

Figure 1: Summary of OXERA financial model key components



Source: OXERA.

In order to populate the PR 04 base-case scenario, it was first necessary to model an approximation of the PR 99 settlement. The assumptions that fed into OXERA's modelling of the base-case scenario, as compared with the PR 99 settlement, are shown in Table 1. As stated above, the baseline scenario sought to mimic broadly the assumptions used by Ofwat at PR 99.

Table 1: PR 99 base case versus PR 04 base case

PR 99	PR 04
OPEX efficiencies of 2.3% per annum base, 3.3% per annum enhancement	OPEX efficiencies of 2.3% per annum base, 3.3% per annum enhancement
OPEX (pre-efficiencies) of £2,918m in 2000–01	OPEX of £2,641m (pre-efficiencies) in 2005–06
CAPEX programme of £15.5 billion (post-efficiencies) over five years	CAPEX programme of £15.5 billion (pre-efficiencies) over five years
CCD of £1,345m by 2004–05	CAPEX efficiency targets as per PR 99
IRC of £400m per annum	CCD of £1,415m by 2009–10
Opening RCV of £28.4 billion in 2000–01	IRC of 385m per annum
Cost of capital of 5.8%	Opening RCV of £32.7 billion in 2005–06
Average and effective tax rate of 15%	Cost of capital of 5.8%
	Average and effective tax rate of 15%

The base-case PR 04 price limits produced from the above assumptions are summarised in Table 2. The results reveal a small initial reduction in prices of 1.5%, followed by even smaller subsequent reductions. Here, reductions in OPEX are counterbalanced to a degree by the increases in CCD and in return on capital (as the RCV grows). The price profile shown above can, however, be adjusted to provide an alternative K factor profile that is consistent with the same net present value (NPV) of revenues. For example, a 'smoothed' K factor of –0.7% per annum, maintained over the five years of the price control, would result in the same NPV of allowed revenues.

Table 2: PR 04 base-case scenario K factors

Scenario	2006 (P_0)	2007	2008	2009	2010	Average K factor	Smoothed K factor
Baseline	–1.5	–0.3	–0.3	–0.4	–0.5	–0.6	–0.7

However, some profiles might not prove satisfactory if these result in cash shortfalls in any year with regard to maintaining financial indicators, such as interest cover and dividend cover. Notably, the water sector has been, and continues to be, cash-flow negative. This means that, from year to year, the revenues received from companies have been less than the outflows (including OPEX, CAPEX, interest and dividends) from the companies. Higher K factors might therefore be required in practice to maintain key financial indicators.

Other scenarios were then developed, which considered different CAPEX programmes (relative to the base case). Crucially, the CAPEX programme that may be financed within any given price envelope will depend on the assumptions made on the other building blocks of allowed revenues. As such, four key hypothetical scenarios were developed around the PR 04 base case, as follows:

Scenario 1 lower CAPEX (than the base case) but higher prices;

Scenario 2 lower CAPEX and lower prices;

Scenario 3 higher CAPEX but higher prices; and

Scenario 4 higher CAPEX and lower prices.

The inputs to these scenarios, and their impact on the building blocks, are summarised in Table 3.

Table 3: Four scenarios for PR 04

	Lower CAPEX	Higher CAPEX
Lower prices	**Scenario 2**	**Scenario 4**
	Key assumptions	**Key assumptions**
	High outperformance of 20% OPEX, 10% CAPEX	High outperformance of 15% OPEX, 5% CAPEX
	High OPEX efficiencies of 3.3% per annum base, 4.5% per annum enhancement	High OPEX efficiencies of 3.3% per annum base, 4.5% per annum enhancement
	OPEX (pre-efficiencies) of £2,113m in 2005–06	OPEX (pre-efficiencies) of £2,245m in 2005–06
	CAPEX programme of £14 billion (pre-efficiencies) over five years	CAPEX programme of £23.7 billion (pre-efficiencies) over five years
	CAPEX efficiency targets as per base case/PR 99	CAPEX efficiency targets as per base case/PR 99
	Resulting building block	**Resulting building blocks**
	CCD of £1,330 by 2009–10	CCD of £1,520 by 2009–10
	IRC of £340m per annum	IRC of £440 per annum
	Opening RCV of £32.7 billion in 2005–06	Opening RCV of 32.7 billion in 2005–06
	Cost of capital as per base case	Cost of capital of 6.3%
	Tax rate as per base case	Tax rate as per base case
Higher prices	**Scenario 1**	**Scenario 3**
	Key assumptions	**Key assumptions**
	Low outperformance of 5% OPEX, 2% CAPEX	Low outperformance of 5% OPEX, 2% CAPEX
	OPEX (pre-efficiencies) of £2,559m in 2005–06 (including rates increase)	OPEX (pre-efficiencies) of £2,509m in 2005–06
	Low OPEX efficiencies of 1% per annum base, 1.4% per annum enhancement	Low OPEX efficiencies of 1% per annum base, 1.4% per annum enhancement
	CAPEX programme of £15.2 billion (pre-efficiencies) over five years	CAPEX programme of £24 billion (pre-efficiencies) over five years
	Lower CAPEX efficiency targets than in PR 99/base case	Lower CAPEX efficiency targets than in PR 99/base case
	Resulting building blocks	**Resulting building blocks**
	CCD of £1,435 by 2009–10	CCD of £1,960 by 2009–10
	IRC of £400m per annum	IRC of £480m per annum
	Opening RCV of £32.7 billion in 2005–06	Opening RCV of £32.7 billion in 2005–06
	Cost of capital of 6.8%	Cost of capital of 7%
	Tax rate as per base case	Tax rate as per base case

The price profiles resulting from each of the above scenarios are summarised in Table 4. As for the base case, the K factors can be smoothed while providing the same NPV of allowed revenues. Furthermore, the tables illustrate how the effective smoothed K factor profiles change when the assumed cost of capital is increased or decreased by one percentage point.

Table 4: K factors for the four scenarios

	Cost of capital (%)	2006 (P_0)	2007	2008	2009	2010	Average K factor	Smoothed K factor	Smoothed K with a –1/+1% change in the cost of capital	
									–1%	**+1%**
1	6.8	4.0	0.5	0.5	0.4	0.3	1.1	1.7	–0.4	3.7
2	5.8	–11.6	–1.0	–1.0	–1.1	–1.2	–3.3	–4.9	–7.3	–2.6
3	7.0	8.3	3.7	3.4	3.0	2.5	4.1	5.0	2.9	7.0
4	6.3	–3.6	1.6	1.6	1.3	1.0	0.4	–0.3	–2.7	2.0

The scenarios modelled illustrate that, depending on the inputs, a range of prices could be generated in aggregate across the industry. Scenario 2 considered a case where high OPEX and CAPEX outperformance against PR 99, high future OPEX efficiencies, and low future CAPEX requirements might result in prices falling by around 3.5–5% per annum. Scenario 3 considered how a higher CAPEX programme, together with low outperformance, lower future efficiencies, a higher cost of capital and (to some extent) front-loading of depreciation, could lead to annual price rises of between 4 and 5%. The two other scenarios modelled considered some cases in between.

One finding of the modelling was that, using the building-block approach alone, increases in CAPEX have a more muted effect on prices than might first be expected. This is because the impact of CAPEX on required revenues depends as much on the assumed cost of capital, depreciation and the IRC, as on the level of CAPEX. In particular, within Ofwat's framework, there is a significant 'back-loading' of depreciation, particularly for enhancement expenditure.[3] Hence, abstracting from the requirement for companies to maintain certain financial indicators, it would at first seem that significantly large CAPEX programmes could be accompanied by relative low increases in prices. However, this picture is somewhat illusory.

First, this entails a back-loading of funding for CAPEX onto future generations of water customers.[4] The impact on future customers, and the limitations placed on facilitating future CAPEX in future price limits by including a given level of CAPEX in a current settlement, should always be taken into account.

[3] Ofwat's asset apportionments, for assessing CCD on new investment, effectively assume an average asset life of 27 years for maintenance expenditure and 43 years for enhancement expenditure. This means that, in each year, consumers pay for only around 1/27th of the allowed non-infrastructure maintenance expenditure and 1/43rd of the non-infrastructure enhancement expenditure.

[4] Future customers will continue to be paying for this expenditure for years to come until it becomes fully depreciated. A return on capital will also continue to be earned on the part of the expenditure left in the RCV.

Second, in practice, financial indicators may be stretched when CAPEX is increased. Here, the building-block approach alone may not be sufficient to ensure that companies have enough allowed revenues. In such situations, the allowed rate of return may need to be increased. The size of the adjustment required will, in part, be a function of the magnitude of CAPEX included within price limits.

The sensitivity of the results to the cost of capital, as shown in the last two columns of Table 4, illustrates the importance when setting price limits, not only of the cost of capital assumption, but also potential adjustments to the assumed rate of return to reflect financeability considerations.

Contents

1. Introduction

In March 2002, the Environment Agency commissioned OXERA to build a financial model of the water industry. The aim of this was to augment the Agency's understanding of economic regulation in the water sector. The result—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 considers the industry at the aggregate industry level, combining the water and sewerage services. In contrast, Ofwat models the industry at the company level, and disaggregated by service. While many of the features of Ofwat's financial modelling methodology are included within the framework, a number of other areas are not modelled in detail.[5]

As part of the exercise, OXERA modelled a number of hypothetical scenarios for when Ofwat sets prices at the 2004 periodic review (PR 04). These prices will cover the period April 1st 2005 to March 31st 2010. As a starting point, a base-case scenario, developed by OXERA, sought to mimic broadly the assumptions used by Ofwat at the 1999 review (PR 99). Following input from the Environment Agency, OXERA then considered deviations around this base-case scenario. The results were presented to the Agency in September 2002.

Although the scenarios developed with the Environment Agency were hypothetical, before the modelling was conducted, it was clear that the large reductions in prices experienced at the last review—comprised of an initial reduction in prices of 12.3%, followed by broadly stable prices[6]—were unlikely to be repeated in PR 04.

First, the 12.3% 'P_0' reduction at PR 99 reflected significant outperformance by companies, in terms of the efficiency savings they had been able to achieve against the regulator's 1994 price-limit assumptions. Given that the PR 99 settlement was somewhat 'tighter' than PR 94, the scale of this outperformance seemed unlikely to be repeated.

Second, and perhaps even more importantly, the PR 99 P_0 reduction was influenced by a re-setting of the cost of capital. This step change occurred because Ofwat's cost of capital assessment was based largely on (then) current market data and forward-looking evidence, and interest rates at PR 99 were significantly below those prevailing at PR 94. Looking towards PR 04, the magnitude of this stepped reduction in interest rates, which occurred over the 1990s, may not be repeated.

In order to model PR 04 settlement, it was also necessary to look forward, and, in this regard, there were many uncertainties. As mentioned above, the base-case scenario

[5] Section 3 discusses these issues in more detail.

[6] In PR 99, Ofwat assumed the following real price profile across the industry, in each year, from 2000–01 to 2004–05: –12.3%, –0.4%, 0.1%, 1.1% and 1.5%. See Ofwat (1999), 'Final Determinations: Future Water and Sewerage Charges 2000–05', November.

developed by OXERA incorporated assumptions based on a 'repeat' of PR 99. This did not mean that this represented a 'most likely' or 'central' scenario—more appropriately, this was a starting point. The range of alternative scenarios developed then considered combinations of 'higher' and 'lower' assumptions on key variables. The purpose of these exercises was not to develop scenarios that might be regarded as 'most realistic', nor to attach probabilities to each particular scenario. Rather, the aim was to illustrate how different assumptions on the building blocks might lead to different outcomes for prices.

In developing these scenarios, important considerations included the following:

- the degree of operating expenditure (OPEX) and capital expenditure (CAPEX) outperformance that might be assumed against the PR 99 settlement;
- the extent of ongoing (Asset Management Plan 3, or AMP3)[7] and new environmental improvements, the way in which future capital maintenance needs might assessed, and the degree to which other areas of investment (eg, sewer flooding) might be allowed for;
- the future scope for efficiencies;
- the extent to which Ofwat would seek to apply an adjustment to companies' depreciation profiles, as was the case for most companies in PR 99;
- Ofwat's approach to setting the cost of capital; and
- the financeability of the overall package, and the effect of this on the required rate of return.

In these respects, it is important to emphasise that the financial modelling (discussed in detail in section 3) was undertaken just as the PR 04 process was getting under way. In particular, it was undertaken prior to Ofwat issuing its consultation on, or reaching decisions on, its overall approach to PR 04. The modelling used the information available at the time it was undertaken, and considered some potential scenarios against this background.

In respect of prospective prices for PR 04, subsequent developments that have occurred include the following:

- since September 2002, Ofwat has published its consultation on the methodology for PR 04 (October 2002), the conclusions to this consultation (March 2003), and

[7] The water industry regulatory periods are referred to as Asset Management Plan periods, or AMPs.

the standardised assumptions on key inputs that Ofwat wants companies to include in the 'reference plan' element of their business plans (May 2003);[8]

- the Environment Agency has published revised guidance on environmental drivers for PR 04,[9] and the Drinking Water Inspectorate (DWI) has also published its views on what the major water quality investment drivers are for PR 04; [10]
- Defra has issued a high-level paper, and more detailed guidance, on the quality and environmental investment programme. The former was published in November 2002, with ministerial guidance to Ofwat published in January 2003;[11]
- the OXERA report on capital structure, produced for Ofwat, has been published;[12]
- Ofwat's new financial model, Aquarius 3, has been released (and updated) since September 2002;[13]
- a number of statements on the prospective financeability of the water sector have been made in the City and by Ofwat;
- Ofwat has also issued supporting documents on specific issues relating to PR 04.

Some caution therefore needs to be adopted in interpreting the results from the scenarios presented in section 3.[14] While these recent developments do not affect the structure or the workings of the model, they could be of importance in as far as they could have an impact on the assumptions made regarding these inputs. New scenarios, and permutations of assumptions that could plausibly be modelled, are continually emerging. In summary, therefore, the results presented in this paper represent some illustrative hypothetical outcomes.

[8] Ofwat (2002), 'Setting the Price Limits for 2005–10: Framework and Approach—A Consultation Paper', October; Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March; Ofwat (2003), 'RD 18/03: Reference Plan Packages A & B', May.

[9] See Environment Agency (2002), 'Environmental Drivers for the 2004 Periodic Review: Version 2', August; and (2003), 'Environmental Drivers for AMP4: Version 3', April. The earlier list of potential drivers was published in Environment Agency (2002), 'Environmental Drivers for the 2004 Periodic Review: Version 1.0', March.

[10] See Drinking Water Inspectorate (2002), 'DWI Information Letter 13/2002: The 2004 Periodic Review of Prices and AMP4—Initial Guidance', September; (2002), 'DWI Information Letter 14/2002: The 2004 Periodic Review of Prices and AMP4—Confirmation of Initial Guidance', October; and (2003), 'DWI Information Letter 4/2003: The 2004 Periodic Review of Prices and AMP4—Further Guidance', May.

[11] Defra (2002), 'Directing the Flow—Priorities for Future Water Policy', November; and (2003), 'Water Industry: The 2004 Periodic Review of Water Price Limits—Initial Guidance from the Secretary of State to the Director-General of Water Services', January.

[12] OXERA (2002), 'Capital Structure of Water Companies', final report to Ofwat, October.

[13] Aquarius 3 was first released by Ofwat in November 2002, and, following refinements to the model, was re-released in May 2003—see Ofwat (2003), 'RD 19/03: Aquarius 3 Financial Model'.

[14] In addition, there are certain areas that are not captured in the model—see section 3 and Appendix 2.

Furthermore, as emphasised throughout the paper, certain aspects of Ofwat's financial modelling have not been incorporated into the approach used here. In particular, because the modelling has been undertaken at the industry level of aggregation, the maintenance of financial indicators has not been modelled explicitly by OXERA.

In summary, the scenarios modelled in this paper do *not* reflect OXERA's assessment of what the inputs that will feed into price limits at PR 04 *should* be. The purpose of the modelling exercise was to illustrate how different assumptions on the building blocks might lead to different outcomes for prices.

The remainder of this paper is structured as follows:

- section 2 introduces the building-block approach to setting price limits in water, and discusses the key issues for PR 04;
- section 3 describes the OXERA water sector financial model, and the results of the modelling of PR 04 undertaken by OXERA in 2002 for the Environment Agency;
- on the basis of the modelling conducted, section 4 presents some conclusions.

2. Ofwat's Approach to Setting Price Limits and Key PR 04 Issues

This section discusses the 'building blocks' for setting price limits in the water industry, the assessments that are made to determine these in practice, and what the main issues are for PR 04. The section begins with a basic exposition of the building-block approach to assessing allowed revenues, and is followed by an examination of some of the main determinants of the following building blocks:

- OPEX and efficiency;
- CAPEX and depreciation; and
- the cost of capital.

Finally, the issue of the overall 'financeability' of the price-limit package, once the building blocks have been fitted together, is also discussed.

In each case, the important issues for PR 04 are drawn out. This includes a discussion of the main considerations in determining the input assumptions at the time when the modelling (described in section 3) was undertaken by OXERA. Information that has become available since the modelling was conducted, and its possible impact on the assumed inputs, is also discussed.

2.1 The basic 'building-block' approach

The Director General of Water Services (DGWS) has a duty to ensure that companies can *finance their functions,* while promoting *efficiency and economy*. As a result, the methodology for setting price limits is based on forecasting the necessary revenues for water companies to fulfil the functions that are required of them, while making assumptions on achievable levels of efficiency in the industry.

In water, as in many other utility sectors in which price limits are set, there are three basic building block (or cost) elements for which the regulator aims to provide an overall *revenue allowance*:[15]

- OPEX;
- return on capital, to remunerate investors; and
- depreciation, to remunerate the company for its outlays on capital investment (and investors for the outlays of principal).

The second and third building blocks are concerned with remunerating CAPEX. As will be discussed later in this paper, the approach outlined above represents a broad simplification of the approach in practice, which is more complex in the water sector due to the varying treatments of different forms of investment.

[15] In practice, as discussed later in this paper, remuneration for taxation is also required.

What the above shows is that OPEX and CAPEX enter into a price control in very different ways. OPEX feeds *directly* into the price control—the OPEX allowance for each year is based on predicted operating costs (taking into account estimated future efficiencies).

In contrast, the allowances for CAPEX are calculated in a less direct way. This is because CAPEX is typically 'lumpy', and such expenditure can be on assets with very long lives. Therefore, to recover the CAPEX in each year of the price control, as it is spent, would result in highly volatile prices from year to year. It would also raise concerns regarding intergenerational equity.

Hence, a large proportion of CAPEX in the water industry is fed into the price control using a 'traditional' remuneration approach used in many utility sectors:

- *regulatory capital value* (RCV)—water companies comprise capital assets, including treatment plants, pumping stations, etc. The asset base of the company, for price-setting purposes, is measured by the RCV. The assets of the company, and hence the RCV, are added to over time through net new CAPEX;

- *depreciation*—it is assumed that, in order to invest, the company needs to borrow money, through either debt or equity. In each year, the 'principal' borrowed is remunerated in price limits through an allowance for depreciation, until the investment concerned is fully depreciated. An alternative perspective is that the capital outlay needs to be recovered by the company, and the depreciation allowance spreads the cost of the asset over its useful life, as the asset is 'consumed'. Investors require this asset consumption to be remunerated by customers. In either interpretation, in each year, the depreciation allowance is subtracted from the RCV;

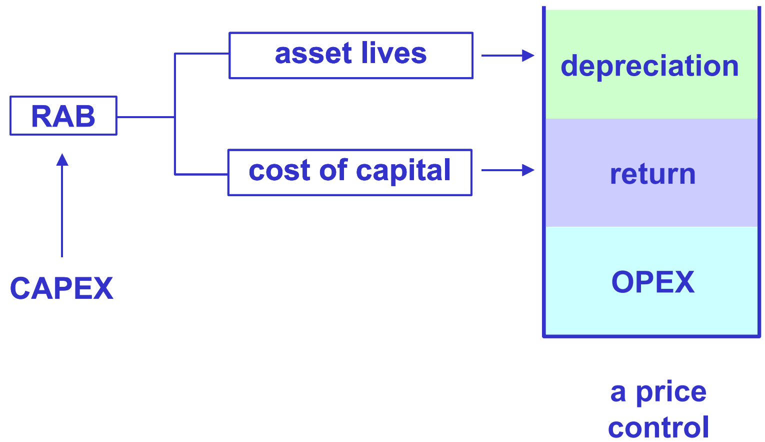
- *return on capital*—in addition to ensuring that capital outlays made by investors (the 'principal') are remunerated through depreciation charges, prices must be set to enable these investors to receive a return commensurate with the risks inherent in their investments. Without this, investors would have no reason to provide funds for the water sector as opposed to other possible investments. Hence, in order to repay investors for the money supplied to fund the CAPEX, investors require a 'return on capital'. This is the assumed 'cost of capital' (in %) multiplied by the total RCV of the company.

However, as discussed in section 2.4, not all CAPEX in water is treated in the above way.

With regard to debt versus equity financing, since privatisation in 1989, most financing in the water industry for new investment has been in the form of debt, except where takeovers have involved new injections of equity. As such, gearing, measured for example by the ratio of debt to debt plus equity, increased steadily over the 1990s. Since 2000, a number of companies have refinanced their *existing* balance sheets, thereby taking on an even higher proportion of debt.

A simple representation of the three-pronged 'building-block' approach is shown in Figure 2.1.

Figure 2.1: Periodic-review building blocks



The revenue allowances for each year are then converted into a price cap. In the water industry, this is expressed as RPI + K, where the K factor is the real year-on-year percentage increase in prices. Rather than limiting prices, the formula limits the allowed increase in a 'weighted basket' of tariffs (comprised of charges for unmeasured, measured and trade-effluent customers). Taken together, prices can then rise by a maximum of RPI + K,[16] where RPI (the retail price index) represents economy-wide inflation.

In practice, the K factor will be positive if upward pressures on prices—due, for example, to additional CAPEX and OPEX requirements—outweigh the prospective efficiencies that might be achieved going forward.

For the interested reader, a more detailed exposition of how the various building-block elements discussed above fit together in the water industry is provided in Appendix 1, which describes the workings of the OXERA water sector financial model.

Against the above background, in what follows, the main inputs to the building blocks, and the key issues for PR 04, are discussed.

2.2 Operating expenditure

2.2.1 Framework for assessing OPEX

OPEX refers to the day-to-day costs incurred by a company to deliver ongoing service to customers. A company's OPEX allowance is set on an annual basis, and is comprised of two main elements:

[16] The K factor is set so that when applied to the tariff basket—and taking account of projected measured consumption, the number of customers, and the rateable values of properties (for unmeasured tariffs)—the resulting revenues do not exceed the estimated allowed revenues for the company over the price-control period.

- the starting level of operating costs (plus any future increases); and
- the potential for future efficiency, as determined by the regulator.

The vast majority of operating costs (over 90%) are associated with maintaining existing service levels to customers ('base' OPEX). Potential increases in rates might, for example, put upward pressure on this OPEX. In addition, 'enhancement' OPEX, associated with delivering the quality programme, improving the supply–demand balance or improving service levels, needs to be funded.

While potential changes in base OPEX are important, so is the scope for future efficiencies. In the water industry, efficiency targets are set with reference to two broad parameters:

- *a frontier shift*—the efficiency achievements achievable by the most efficient company, or the technological improvements expected for the industry as a whole;
- *a catch-up target*—which depends on how far each individual company is from the frontier company, and the rate by which they can catch up to the (current) frontier.

Under the RPI + K framework, once prices have been set, companies have an incentive to beat the regulator's targets, in so far as they can retain any benefits of outperformance. This incentive was enhanced by Ofwat in PR 99 through the introduction of a rolling incentive mechanism for OPEX, which means that companies can retain the benefits of outperformance for five years, regardless of the year in which the efficiencies were made.[17] Since OXERA conducted its modelling, Ofwat has been considering introducing further incentives for efficiency for the companies at the frontier.[18] However, these changes will not affect price limits in 2005–09.[19]

The methodology for setting efficiency targets is discussed below.

2.2.2 Frontier targets

In PR 99, Ofwat based its assessment of the potential for frontier shift on a study that examined past and potential overall future productivity improvements in water relative to other sectors. Ofwat assumed that 50% of the future expected improvement could be made at the frontier. The resulting target was applied to the industry as a whole. For example, at PR 99, Ofwat assumed a 1.4% per annum frontier efficiency improvement for base water and sewerage OPEX (2.1% for enhancement).

[17] A mechanism for retaining CAPEX outperformance was already in place at the time of the 1999 review. This involved delaying the adjustments to the RCV so that the benefits of outperformance were kept for five years regardless of when the outperformance had occurred in the previous review cycle

[18] For details, see Ofwat (2003), 'Periodic Review 2004—A Further Consultation on Incentive Mechanisms: Rewarding Out-performance and Handling Under-performance of Regulatory Expectations', a consultation paper, June.

[19] The proposed new mechanisms affect the (potential) price limits from 2010 onwards only.

Ofwat's approach assumes that, while the RPI element of the price cap should broadly capture expected economy-wide efficiency savings, the frontier target is based on the degree to which the water industry is expected to have greater or lesser potential for productivity growth than the rest of the economy. If the water industry were expected to achieve identical productivity growth to the UK economy as a whole, the frontier target would be zero. Some regulators have, in fact, assumed this to be the case. Ofgem, for example, in setting OPEX efficiency targets for the electricity distribution companies in 1999, decided 'not to tighten the efficiency frontier from 1998/99 onwards'.[20]

2.2.3 Catch-up targets

Catch-up targets are company-specific. To set these, it is first necessary to assess the relative efficiency of each company; in turn, this enables:

- the most efficient (or 'frontier') company (or companies) to be identified; and
- the efficiency gap between the frontier and each remaining company to be established.

At PR 99, Ofwat relied predominantly on econometric modelling to assess companies' relative OPEX efficiency. (The regulator also econometrics to assess capital maintenance efficiency, see below.) Separate models, and targets, were adopted for the water and sewerage services. The models were used to establish the size of the efficiency gap between each company and the industry frontier.

Having made an assessment of companies' claims for 'special factors' (local factors not captured by the models), Ofwat derived catch-up targets for companies by assuming that a certain amount of that gap could be closed within a given period. At PR 99, for base water OPEX, Ofwat assumed the proportion to be 60%.

2.2.4 OXERA's PR 04 modelling

When OXERA undertook the financial modelling, discussed in section 3, one scenario considered a small increase in base OPEX (pre-efficiencies), to reflect a notional increase in business rates. The potential for increases in (pre-efficiency) base OPEX, over the 2006-10 period, was not modelled in any of the other scenarios. In addition, no increases in (pre-efficiency) enhancement OPEX were included in the scenarios. All the scenarios involved an overall reduction in OPEX over the 2006-10 period, once the efficiency assumptions were incorporated. The degree to which this is a valid assumption in practice will depend on whether future OPEX efficiencies will be sufficient to outweigh any upward pressures on OPEX.

On efficiencies specifically, at the time when OXERA undertook the financial modelling, it was unclear what the scope for future gains might be, although Ofwat had already

[20] Ofgem (1999), 'Reviews of Public Electricity Suppliers 1998 to 2000: Distribution Price Control Review—Final Proposals', December.

accepted that the easy efficiencies were already likely to have been made.[21] Key issues concern the methodology for assessing frontier shift, the comparative efficiency models that Ofwat proposes to use, and the rate of catch-up. At the time, these issues had yet to be clarified by Ofwat, as part of the PR 04 process, and, as discussed in section 2.2.5, they are still being clarified.

In the modelling conducted, OXERA therefore considered scenarios that, taking the frontier targets and catch-up targets together, involved the same, less demanding, or more demanding targets than at PR 99. Less (more) demanding catch-up targets for the industry as a whole might, for example, result if the spread of efficiency across companies were assessed by Ofwat to be small (large).

2.2.5 Developments since the modelling was conducted

With regard to the underlying OPEX base, since the hypothetical modelling was undertaken by OXERA, potential increases in non-domestic rates and pensions costs have emerged as important issues in the industry. [22]

Also, Ofwat has issued some details on how it intends to derive the *overall* scope for future efficiency. Ofwat has suggested that the principal basis for calculating and applying the catch-up targets for PR 04 will remain largely unchanged, although the regulator is still considering how to develop its existing efficiency models, and appears willing to consider alternative comparative-efficiency techniques.[23] The regulator is due to publish its revised OPEX (and capital maintenance) econometric models in December 2003.[24]

Ofwat has suggested two key changes to the calculation and application of efficiency targets in the water industry.[25] Whether the industry agrees with the approach remains to be seen.

First, as at the previous review, Ofwat has commissioned consultants to estimate the overall scope for future efficiency in the water sector. However, the main difference is the way in which Ofwat intends to translate this overall scope to derive the frontier shift. At PR 99, Ofwat derived the frontier shift of 1.4% for base OPEX by assuming that 50% of the overall scope for future efficiency could be attributed to frontier shift. As such, the

[21] 'I accept that many of the easy efficiency gains may have been made. Managers are having to work harder to drive out further efficiency savings. But there is no sign yet that the scope is exhausted' (Fletcher, P., 2002, 'Regulation, Competition and Sustainability', speech delivered at IWO Conference, York, April.)

[22] These issues are, for example, discussed in Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March.

[23] See, for example, Ofwat (2002), 'Water and Sewerage Service Unit Costs and Relative Efficiency: 2001–2002 Report', December, Chapter 7; and (2003), 'Ofwat Forward Programme 2003–04 to 2005–06', March, Chapter 4.

[24] See 'Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March, Chapter 3.

[25] Ofwat has also suggested amendments to how it intends to take into account of OPEX and CAPEX trade offs, and to assess the frontier for each service. See Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March.

derived frontier target was a *fixed* number. By contrast, for PR 04, the regulator has said that the frontier shift will be calculated as the overall scope for efficiency, less whatever is estimated to be the average scope for catch-up across the industry. The frontier shift is therefore now a *variable*, dependent on the efficiency gap that emerges from the econometric models. In practice, this means that, if companies are deemed to be close together (far apart) in terms of their relative efficiency, the frontier-shift assumption will be quite large (small).

The work commissioned by Ofwat,[26] which has also been published since OXERA undertook its modelling, has identified an overall rate of improvement in water services' OPEX and capital maintenance of between 1.5% and 3% per year for the 2005–10 period. This suggests a slightly lower scope for improvements going forward than at the previous review. For water OPEX only, this translates into a range of 2–4%. In both cases, the range for sewerage services is 0.25 percentage points higher.

Second, in developing the framework and approach to PR 04, the regulator has attempted to improve the incentives on frontier companies to make further efficiency savings. At PR 99, the whole of the frontier-efficiency assumption was converted into a frontier target, applied to the industry. For PR 04, Ofwat has said that it will change the balance between 'sticks' and 'carrots' for the frontier shift, whereby the 'stick' represents the amount of the overall scope for frontier shift feeding into price limits, and the 'carrot' the residual proportion (which, if the efficiency targets are achieved, the company would retain for five years). In the previous review, only the catch-up factor was divided in this way into stick and carrot elements, through a 60% catch-up rate.[27] For the frontier-shift element, the balance between the stick and carrot elements remains to be decided.

The last change in the methodology implies, other things being equal, lower frontier targets than under the methodology assumed in PR 99. However, the overall impact of the two changes described above is difficult to ascertain, since it is dependent on future data (for example, regarding the overall efficiency gap in the industry). Nonetheless, Ofwat has put forward some reference plan assumptions for companies to take into account in their business plans.[28] For base OPEX, Ofwat has proposed a frontier-shift assumption of 0.6% per annum, with a catch-up assumption ranging from 0% to 4% (2% for a company of average efficiency), which implies a target for a company of average efficiency of 2.6% per annum. Again, these reference assumptions have been published since OXERA undertook the modelling presented in this paper.

[26] Europe Economics (2003), 'PR04—Scope for Efficiency Improvement in the Water and Sewerage Industries', report for Ofwat, March.
[27] This 'carrot' also captured modelling errors, and was not merely an incentive to outperform.
[28] Ofwat has, however, made clear that these, alongside other reference plan assumptions, are 'plausible assumptions to use in the reference plans. They are not decisions, and are likely to change through the course of the periodic review'. See Ofwat (2003), 'RD 18/03: Reference Plan Packages A & B', May.

2.3 Capital expenditure

This section considers the various forms of CAPEX in the water industry, and the main points to highlight for PR 04.

2.3.1 The level of capital expenditure

The four drivers of CAPEX in the water industry are:

- capital maintenance requirements (base CAPEX, or maintenance);
- the size of the environmental programme (particularly on waste water) and the drinking water quality programme (quality);
- expenditure aimed at maintaining the supply–demand balance; and
- expenditure to deliver enhanced service levels.

The major areas of expenditure allowed for in PR 99 were for maintenance and the quality programme, as demonstrated in Table 2.1. Investment in supply–demand balance and enhanced service levels had a relatively minor impact on price limits, at the industry level, and it is of note that, in PR 99, Ofwat regarded around four-fifths of total industry supply–demand balance expenditure as 'self-financing'.

Table 2.1: Ofwat's PR 99 CAPEX projections (£m), 2000–05

Five-year industry CAPEX projection	Water	Sewerage	Total
Base service (comprising infrastructure renewals expenditure and non-infrastructure capital maintenance)	3,390	3,020	6,410
Quality enhancements	2,260	5,120	7,380
Supply/demand balance[1]	1,129	556	1,685
Enhanced service levels	1	137	138

Note: Ofwat noted that only £315m of CAPEX for balancing supply and demand had an impact on price limits since the remaining expenditure was regarded by the regulator as self-financing.
Source: Ofwat (1999), 'Future Water and Sewerage Charges 2000–05: Final Determinations', November.

The quality programme largely originates from EU Directives, which have been (or will be) transposed into UK legislation. Ministers, following advice from the Environment Agency and the DWI, decide on the overall scope and timescale for environmental and drinking water improvements. As part of this framework, the Agency and DWI identify the main drivers for ministers to consider, and work with companies to discuss how compliance might best be achieved (including approval of schemes).

One major area of controversy at the last periodic review was Ofwat's approach to assessing capital maintenance requirements. In PR 99, using top-down serviceability indicators, it assessed whether companies had been able to maintain service to customers over the previous five years. Where this had been the case, the regulator in general used the historical average of past maintenance expenditure to project future expenditure requirements.[29]

This top-down, backward-looking, approach received criticism from both the Environmental Audit Committee (EAC) and the Competition Commission. The EAC cited problems with the serviceability indicators used, and noted that the approach was purely reactive (it constituted a 'no deterioration' approach).[30] In addition, the Competition Commission stated that the relationship between service-delivery performance indicators and asset condition was neither simple nor well understood, and that Ofwat's approach did not predict an optimal level of maintenance.[31]

However, the Commission also stated that the industry had not developed a robust means of assessing the required level of capital maintenance expenditure. This point had been made clear by Ofwat in a letter to water companies during the 2000 Competition Commission cases. In particular, the water companies had not demonstrated in any great detail what would happen to service to customers if a certain portion of their maintenance bid had not been funded.[32]

In terms of capital efficiency assessments, Ofwat sets targets for the frontier shift in a similar way to that used for OPEX. For assessing comparative efficiency, however, it uses two approaches for CAPEX:

- econometric modelling (regression) for capital maintenance; and
- the cost-base approach—for assessing both capital maintenance and capital enhancement efficiency.[33]

In setting the catch-up targets for capital maintenance at PR 99, Ofwat apportioned a 50/50 weighting to the cost base and the econometric approaches, respectively. The Competition Commission instead applied a 75% weighting to the methodology generating the lower efficiency target, noting that Ofwat's modelling of CAPEX efficiency, in respect of both the econometrics and the cost base, was likely to be less robust than its modelling of OPEX efficiency.[34]

[29] To restore serviceability to customers, Ofwat did permit some increases in funding. Dwr Cymru was allowed a 10% rise in sewerage infrastructure maintenance; Southern Water a 10% increase in sewerage maintenance; and Wessex Water an increase of 10% in water and sewerage infrastructure maintenance activity. See Ofwat (1999), 'Final Determinations: Future Water and Sewerage Charges 2000–05', November.

[30] Environmental Audit Committee (2000), 'Seventh Report: Water Prices And The Environment', November.

[31] Competition Commission (2000), 'Mid Kent Water Plc: A Report on the References under Sections 12 and 14 of the Water Industry Act 1991', August.

[32] Ofwat (2000), 'MD 161: Maintaining Serviceability To Customers', April.

[33] The cost base approach used by Ofwat involves estimating the relative capital efficiency of water companies by comparing their estimates of capital works unit costs for a range of standardised capital projects.

[34] Competition Commission (2000), 'Mid Kent Water Plc: A Report on the References under Sections 12 and 14 of the Water Industry Act 1991', August.

2.3.2 OXERA's PR 04 modelling

At the time OXERA undertook its financial modelling, the scope of the PR 04 quality programme was very unclear. The Environment Agency had published an initial draft list of potential environmental drivers for the periodic review[35] (which has subsequently been revised). At this early stage in the process, the DWI had yet to confirm its initial guidance. Furthermore, ministerial guidance had yet to be issued. It was also unclear whether the Water Framework Directive (WFD) would have a prospective impact on CAPEX in PR 04. Nonetheless, what was evident was that a number of European Directives needed to be complied with, including the Urban Waste Water Treatment Directive and the Freshwater Fish Directive.

With regard to capital maintenance, when OXERA undertook its financial modelling, Ofwat had consulted on its intended approach.[36] This prioritised the serviceability approach as the prime basis for assessing capital maintenance budgets, although Ofwat suggested ways of improving its serviceability assessments. Furthermore, the regulator had undertaken research with the Environment Agency and DWI to improve the serviceability indicators.[37] In tandem, the industry had been developing a 'Common Framework' for assessing future maintenance requirements, using an economic, risk-based approach.[38]

In the absence of further detail, OXERA considered hypothetical scenarios for quality expenditure broadly in line with that assumed at PR 99, with deviations around this. In addition, OXERA considered hypothetical scenarios that would allow for a greater capital maintenance expenditure than that suggested by a serviceability approach alone.

Another area considered by OXERA in its modelling was sewer flooding. This was becoming a controversial area, following a high-profile court case.[39] Some scenarios run by OXERA considered increased allowances for sewer flooding, compared with that allowed in PR 99.

In respect of CAPEX efficiency, OXERA assumed efficiency targets that were similar to, or lower than, those assumed by Ofwat in PR 99.

[35] Environment Agency (2002), 'Environmental Drivers for the 2004 Periodic Review: Version 1.0', March.

[36] See Ofwat (2002), 'RD 14/02: Maintaining Water And Sewerage Systems in England And Wales: Our Proposed Approach for the 2004 Periodic Review', May

[37] See Ewan Associates/Mott MacDonald (2001), 'Development of Enhanced Serviceability Indicators for Sewerage Assets: Final Report' for Ofwat and the Environment Agency, October; WS Atkins (2001), 'DWI/Ofwat Joint Serviceability Study: Review of Drinking Water Quality Aspects Relating to Infrastructure and Non-infrastructure Assets', May; and Ofwat (2002), 'RD 15/02: Maintaining Serviceability to Customers in England and Wales—An Update on Serviceability Indicators and Measures', May.

[38] See UKWIR (2002), 'Capital Maintenance Planning: A Common Framework', May.

[39] *Peter Marcic v Thames Water Utilities Ltd* (2002 EWCA CIV65).

2.3.3 Developments since the modelling was conducted

While there is some information now available in the public domain regarding the CAPEX programme that is likely to emerge in PR 04, much still needs to be resolved.

The Environment Agency has published revised drafts of its list of potential environmental drivers,[40] and the DWI has published its initial and subsequent further guidance on water quality requirements.[41]

Defra's initial guidance on the capital programme was limited to qualitative statements only.[42] At this stage in the process, its latest guidance, published in January 2003, is more detailed, but remains largely qualitative.[43] The final guidance, which should set out the work programme to be undertaken by the water industry in PR 04, is not due until January 2004. Hence, there has been relatively little issued in the public domain at this stage by way of quantification of the impact of the quality programme. What has become clearer, however, is that there is now relatively less for companies to do to improve drinking water quality, given the strides that have been made since privatisation.

In respect of the WFD, Defra has noted that most capital investment to comply with this is not required until after the 2005–10 period, although planning (for example, by the Environment Agency) is required before this.[44] The Agency has more recently noted that a start on some schemes may be required before 2010, but that, in other cases, it may be sensible to take account of future requirements within the generality of schemes for PR 04 to avoid costly alterations at a later stage.[45]

Some important environmental drivers for PR 04, as discussed in both the EA guidance and by Defra to date, and for which, according to Defra, there is 'an essential and clear case',[46] include:

- the Urban Waste Water Treatment Directive;
- Groundwater Directive;
- Freshwater Fish Directive;

[40] Environment Agency (2002), 'Environmental Drivers for the 2004 Periodic Review: Version 2', August; and (2003), 'Environmental Drivers for AMP4: Version 3', April.

[41] Drinking Water Inspectorate (2002), 'DWI Information Letter 13/2002: The 2004 Periodic Review of Prices and AMP4—Initial Guidance', September; (2002), 'DWI Information Letter 14/2002: The 2004 Periodic Review of Prices and AMP4—Confirmation of Initial Guidance', October; and (2003), 'DWI Information Letter 4/2003: The 2004 Periodic Review of Prices and AMP4—Further Guidance', May.

[42] Defra (2002), 'Directing the Flow—Priorities for Future Water Policy', November.

[43] Defra (2003), 'Water Industry: The 2004 Periodic Review of Water Price Limits—Initial Guidance from the Secretary of State to the Director-General of Water Services', January.

[44] Defra (2003), 'Water Industry: The 2004 Periodic Review of Water Price Limits—Initial Guidance from the Secretary of State to the Director-General of Water Services', January.

[45] Environment Agency (2002), 'Environmental Drivers for the 2004 Periodic Review: Version 2', August; and (2003), 'Environmental Drivers for AMP4: Version 3', April.

[46] Defra (2003), 'Water Industry: The 2004 Periodic Review of Water Price Limits—Initial Guidance from the Secretary of State to the Director-General of Water Services', January.

- Bathing Water Directive;
- Shellfish Waters Directive;
- nature conservation and biodiversity; and
- Sites of Special Scientific Interest (SSSIs).

A number of other drivers fall into Defra's 'essential when clarified' and 'choices will be made' categories.

The government's January guidance also states that greater attention will be paid to asset maintenance, leakage and sewer flooding in the forthcoming review. At the same time, Defra has emphasised that schemes should include cost–benefit analysis and consideration of cost-effectiveness. In its consultation on the framework and approach for the periodic review, Ofwat also placed emphasis on cost–benefit analysis and the importance of assessing cost-effectiveness.[47]

Ofwat's position on capital maintenance to date is that implementing in full the Common Framework developed by industry may not be practical at this stage, owing to data limitations. However, the regulator has added a stage to its framework, which asks: 'how is the future different?' Here, the onus is on companies to demonstrate why more funding is required, by applying as best as possible the Common Framework approach, using judgements where required. It may be the case, however, that some companies have to date developed more robust (data-oriented) methodologies than others.

On efficiency target setting, as for OPEX, developments to the models are still being considered by Ofwat. In respect of the 'cost base' approach for maintenance and enhancement projects, Ofwat has proposed to amend the coverage of standardised projects. It does not intend to change the 50/50 weighting between the cost base and econometric approaches.

In summary, much remains to be resolved at this stage in the periodic-review process as to the likely magnitude of quality and maintenance expenditure in PR 04. That said, Ofwat has indicated that it will phase in catch-up targets for capital maintenance over three years (rather than as a first-year reduction), and has published reference plan assumptions. Here, the assumptions involve a catch-up target for an average company of 6% over three years, with a frontier-efficiency assumption of 0.5% per annum.[48]

[47] Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March.

[48] However, Ofwat has made clear that these, alongside other reference plan assumptions, are 'plausible assumptions to use in the reference plans. They are not decisions, and are likely to change through the course of the periodic review'. See Ofwat (2003), 'RD 18/03: Reference Plan Packages A & B', May.

2.4 Remunerating CAPEX

2.4.1 Differing treatments of expenditure

As noted in section 2.1, remuneration of CAPEX is more complex than for OPEX. Moreover, the 'traditional' depreciation approach is not used for all areas of CAPEX. The treatment concerned is split according to whether the expenditure is infrastructure or non-infrastructure, and whether it is maintenance or enhancement.

The basic methods for remunerating the different forms of CAPEX are shown in Table 2.2.

For infrastructure maintenance expenditure (or infrastructure renewals expenditure, IRE), Ofwat does not use the 'traditional' depreciation approach. Rather, the underground network is regarded by Ofwat as a contiguous whole, with repairs and replacements to the (very long-lived) assets taking place on a continual basis. As such, IRE is not added to the RCV, and is not depreciated. Instead, it is funded through an infrastructure renewals charge (IRC), calculated as an average of actual and required expenditure over a 15-year period. For the interested reader, a more in-depth discussion of the differing accounting treatments of CAPEX is provided in Appendix 1 (see A1.2.2 and A1.2.3), which describes OXERA's financial model.

Table 2.2: CAPEX remuneration

	Infrastructure	**Non-infrastructure**
Maintenance	IRC set for 15 years	CAPEX added to the RCV
	Difference between expenditure per year and IRC accounted for in the RCV	Current-cost depreciation deducted, depending on asset-life assumptions
	RCV not depreciated	
Enhancement	Added to the RCV in perpetuity	CAPEX added to the RCV
	Not depreciated	Current-cost depreciation deducted, depending on asset-life assumptions

2.4.2 OXERA's PR 04 modelling

One area of uncertainty at the time OXERA undertook its financial modelling was Ofwat's potential application of a 'broad equivalence' test for the depreciation of maintenance expenditure on non-infrastructure assets. This test aims to check that, for a certain group of assets, the expenditure being undertaken by companies is broadly in line with the depreciation allowance. When it was introduced at PR 99, it was met with criticism from the companies, and from the Competition Commission during its inquiries into Mid Kent Water and Sutton and East Surrey Water.

Although the Commission recognised the theoretical justification for a broad-equivalence test, it expressed concern regarding Ofwat's application of the methodology. In particular, while Ofwat had introduced broad equivalence as a 'check' on current-cost depreciation (CCD), rather than a means of setting depreciation values, the Commission felt that the regulator had used the test too mechanistically, having changed depreciation charges on the basis of broad equivalence for 21 out of the 23 companies.

As a result, in March 2002, Ofwat published a consultation concerning the methodology it intends to use to calculate the depreciation allowance at PR 04. The regulator's initial opinion was that it should:

> keep the comparison of CCD and MNI [maintenance non-infrastructure] expenditure to provide a check on the overall level of CCD allowed in price limits for PR 04.[49]

The regulator did accept the Commission's view that greater transparency in applying broad equivalence is required, and has reconsidered areas of its application that were criticised by the industry. However, Ofwat's position seemed to be that an improvement of the technicalities of the approach could give the regulator a better justification for making an adjustment, whereas the message from the Commission seemed to be that broad equivalence should only be a 'check' on the CCD.

OXERA therefore included notional broad-equivalence adjustments in its financial modelling, although these were somewhat arbitrary and were not based on detailed bottom-up calculations.

The asset apportionments used to calculate depreciation on non-infrastructure maintenance and enhancement expenditure (see Table 2.2) reflected those used by Ofwat in PR 99, as set out by Ofwat in March 2002.[50]

2.4.3 Developments since the modelling was conducted

It is still not clear what impact a check on CCD might have across the industry in PR 04. However, in July 2003, Ofwat reaffirmed that, in its view, the level of CCD should be consistent with the level of MNI expenditure, and that companies should provide robust explanations for any differences between CCD and non-infrastructure maintenance expenditure.[51] The approach that companies will take to this issue remains to be seen.

2.5 Return on capital and financeability

2.5.1 Framework for assessing the return on capital

The allowance for a return on capital is designed to remunerate investors in the industry. It is earned on the entirety of the RCV, and its value is therefore determined by:

- the size of a company's RCV; and
- Ofwat's cost of capital assumptions, set so as to ensure that investors earn a 'reasonable' return on their capital.

In the past, Ofwat has set a single cost of capital for the industry, and it will again for PR 04.

In calculating the cost of capital, most UK regulators (including Ofwat) have used a broad three-step approach:

- calculate the cost of equity in the industry;

[49] Ofwat (2002), 'The Approach to Depreciation for the Periodic Review 2002', a consultation paper, March.
[50] Ofwat (2002), 'The Approach to Depreciation for the Periodic Review 2002', a consultation paper, March.
[51] See Ofwat (2003), 'RD 27/03: Periodic Review 2004—Overall Check on the Level of Depreciation', July.

- calculate the cost of debt in the industry;
- assume a debt-to-equity ratio in companies' financing to deduce the weighted average cost of capital (WACC).

The standard framework used to calculate these elements has been the capital asset pricing model (CAPM). Inputs within this framework for estimating the cost of equity include components such as the risk-free rate (the rate payable on government bonds), the equity risk premium (the additional return required by investors to hold stocks rather than government bonds), and the beta (the degree to which water industry stocks move up and down with the market as a whole). A key input for estimating the cost of debt is the debt premium.

In terms of the mixture of equity and debt, at PR 99, Ofwat assumed a gearing level, expressed on a debt-to-debt-plus-equity basis of 45–55% (ie, around 50%). In contrast to some other regulators, Ofwat uses a post-tax equity, pre-tax debt cost of capital in its financial modelling, treating tax as a cost to the business.[52]

In addition, at PR 99, Ofwat made company-specific allowances for small companies, in the form of a small-company premium, and an allowance for companies with fixed-rate embedded debt in their balance sheets.

2.5.2 OXERA's PR 04 modelling

It was clear, when OXERA undertook its financial modelling, that one of the central issues with regard to setting the cost of capital at PR 04 was the emergence of new financial structures in the industry since the last periodic review. A number of water companies in England and Wales have chosen to increase significantly the amount of debt on their balance sheets, in an attempt to reduce the cost of capital, and therefore beat predictions set by the DGWS at PR 04.

The assumption made in the modelling, for the base-case scenario, implicitly assumed the gearing levels adopted by Ofwat at PR 99. This was in line with the regulator's statements at the time. The DGWS had suggested that he would wish to apply a single cost of capital estimate for the industry as a whole, but that he would not be guided by the highly geared companies in setting his allowed rate of return, as it could not be assumed that the current market conditions—in which some companies considered it advantageous to increase the ratio of debt to equity—would persist indefinitely. He said that, in Ofwat's opinion:

> Efficiency is not only a matter of lowering cost, it is also about diversifying risk.[53]

At the same time, OXERA's assumptions on the tax rate (to be applied to industry aggregate figures) took some (notional) account of the tax savings that might be available

[52] In the water sector, tax is a company-specific revenue line, additional to OPEX, CCD, IRC and return on capital employed.
[53] Fletcher, P. (2002), 'The Periodic Review in Context', speech given at Water UK City Conference 2002, January.

to those companies that have adopted highly leveraged structures. In practice, highly geared structure may pay very little tax. Ofwat's approach—of treating tax as a cost to the business—may imply that companies that have geared up significantly might not expect to benefit significantly from the associated tax advantages. However, no potential changes to the tax regime itself were incorporated into the modelling.

In its base-case PR 04 scenario, OXERA adopted an assumption on the cost of capital similar to that assumed by Ofwat in PR 99. OXERA also included a small-company premium and embedded-debt elements in its cost of capital assumptions. Around this, hypothetical scenarios regarding macroeconomic trends (which would lead, for example, to notional changes in the risk-free rate and equity risk premium) were considered.

Ofwat also applies a 'financeability check' to its modelling results. This is because the building-block approach alone may not result in a particular company having enough cash flow in each year to finance its functions. Here, an *ex post* check is made on the main financial indicators, such as interest cover and dividend cover. In the past, Ofwat has undertaken these tests on a *pro-forma* basis. For example, in relation to the interest cover test, Ofwat has adopted a *pro-forma* assumption on the level of gearing, rather than calculating interest payments on the basis of the company's actual gearing level. Where such indicators have been breached by certain companies, Ofwat has increased the allowed revenues in the model. In turn, this increases the allowed rate of return for the company. The approach is, therefore, conceptually equivalent to increasing the assumed cost of capital in the model.

OXERA's financial model does not explicitly consider financial indicators, but, in some higher CAPEX scenarios, the cost of capital was increased to reflect a notional impact on financeability. As noted below, however, to the extent that financeability is an important issue for some companies, this will not be sufficiently reflected in the industry-level results presented here.

2.5.3 Developments since the modelling was conducted

Since OXERA's modelling was undertaken, it has become clear that the financeability of the capital programme has emerged as a crucial consideration for PR 04. While Ofwat has indicated that it is too early to say what level of financial indicators might be used at PR 04, the regulator has also cited that there is some evidence to indicate that companies will need to have better financial ratios now than in PR 99 to achieve a comparable credit quality.[54]

Notably, the water sector has been, and continues to be cash-flow negative. This means that, from year to year, the revenues received from companies have been less than the outflows (including OPEX, CAPEX, interest and dividends) from the companies. This cash outflow has been financed through borrowing and retained earnings. Concerns have

[54] See Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March, p. 119.

emerged (in particular, from City analysts) regarding the ability of companies to maintain investment-grade credit ratings. As for PR 99, Ofwat will, for PR 04, target credit ratings that lie comfortably within the investment-grade category, through the use of a range of financial indicators.[55]

Ofwat also seems to be bearing in mind that further equity may need to be attracted into the water industry. When it outlined its framework and approach to PR 04, the regulator was keen to stress that it would 'take account of' the levels of return required by equity investors so that the industry remains attractive to them.[56] As yet, Ofwat has not elaborated on the exact mechanism through which equity formation might be encouraged.

Nonetheless, the importance of financeability, and of equity formation in particular, may, other things being equal, suggest higher price limits compared with the base-case scenario presented here.

As regards other developments, the OXERA report on capital structure, prepared for Ofwat,[57] highlighted that, while there is some evidence that highly leveraged structures have achieved outperformance on the cost of capital against the regulator's PR 99 assumptions, there may also be potential future social and private costs to take into account. Such costs might materialise if there were a 'systemic failure' among highly leveraged companies. Given that it was difficult to assess where the balance of argument lies in this regard, there did not appear to be a strong case for Ofwat to move away from its 50% gearing assumption.

In terms of other elements of the cost of capital, a report commissioned jointly by a number of regulators cited that little weight should be placed on recent beta estimates, which are rather low.[58] This is because the low beta estimates were more likely to reflect increases in stock-market volatility, rather than a reduction in risk in the sector. As such, although Ofwat has stated that the CAPM will form the main basis for assessing the cost of equity in the water sector, it may also use evidence outside of the framework (for example, by considering overall market returns, rather than calculating the equity risk premium and beta separately).[59]

[55] See Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March, p. 117.
[56] Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March.
[57] OXERA (2002), 'Capital Structure of Water Companies', final report to Ofwat, October.
[58] Smithers & Co Ltd (2003), 'A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the UK' February.
[59] This is valid if it can be assumed *ex ante* that the beta for water stocks is equal to 1.

Although Ofwat intends to retain a small-company premium adjustment, where relevant it is less inclined to make adjustments for embedded debt, arguing that the circumstances at the current review are different to those in PR 99.[60]

For water and sewerage companies (WASCs), Ofwat's reference plan assumption for the cost of capital is to assume 50% gearing, with a cost of capital of 5.7% on existing assets, including the PR 99 allowance for embedded debt, and 5.4% on new assets. For the smallest water-only companies, Ofwat's reference plan assumption is to assume 50% gearing, with a cost of capital of 6.7% on existing assets, including the PR 99 allowance for embedded debt, and 6.3% on new assets. For small companies, Ofwat has allowed a small-company premium 'in line with past practice'. These figures are expressed on a post-tax equity, pre-tax debt basis.[61]

[60] See Ofwat (2003), 'Setting Water and Sewerage Price Limits for 2005–10: Framework and Approach', March, pp. 114–7.
[61] Ofwat has, however, made clear that these, alongside other reference plan assumptions, are 'plausible assumptions to use in the reference plans. They are not decisions, and are likely to change through the course of the periodic review'. See Ofwat (2003), 'RD 18/03: Reference Plan Packages A & B', May.

3. OXERA Financial Model and Potential PR 04 Scenarios

3.1 The 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. In what follows, the basic mechanics of the model are discussed. A comprehensive description of the model is presented in Appendix 1. In addition to facilitating an understanding of the model itself, the appendix is useful for readers who wish to understand in more detail the building blocks of regulation in the water industry.

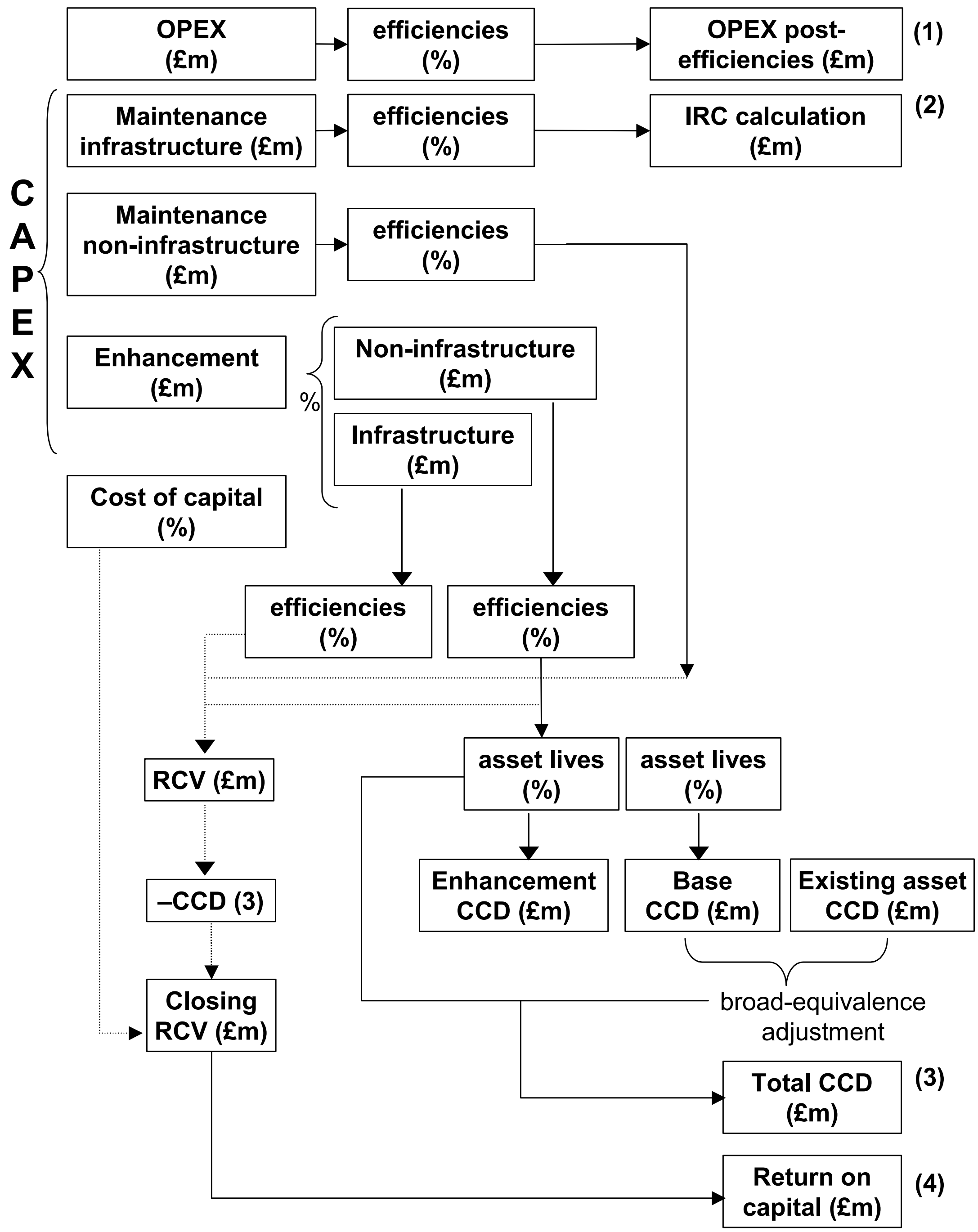
The OXERA model enables a number of higher-level scenarios to be considered for PR 04. It was constructed by OXERA in 2002, with the results presented to the Environment Agency in September 2002. The modelling presented later in this section was therefore conducted prior to the publication of a number of papers, which provide more detail on the approach that might be followed in setting prices in PR 04. These developments were discussed in section 2.

The OXERA model is presented at the aggregate industry level, combining 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 key 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.

Figure 3.1 provides a summary of how allowed revenues are constructed in the OXERA financial model. The figure concentrates on how the OPEX (1), IRC (2), CCD (3) and return on capital (4) components are constructed. Appendix 1 presents more detail on how these building blocks are calculated.

Figure 3.1: Summary of OXERA financial model key components



Source: OXERA.

The OXERA financial model then enables three key stages to be modelled, as follows.

Stage 1: PR 99
Using publicly available data, and adopting appropriate assumptions where such data is unavailable, the composition of allowed revenues at PR 99 is modelled.[62] 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 case adopts assumptions that give rise to a level of allowed revenues similar to that allowed for at the 1999 review.

Stage 2: outperformance against PR 99
Potential outperformance against the 1999 OPEX and CAPEX efficiency assumptions is then also modelled. It is assumed that these savings are passed on to 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 possible to model PR 04. In the base case, assumptions similar to those adopted at PR 99 are adopted (eg, 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 net present value of allowed revenues as that obtained before re-profiling. However, in practice, 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.

3.2 The 1999 price review

In stage 1 of the process outlined above, OXERA has sought to model the PR 99 settlement. For the 1999 review, the following assumptions have been adopted in the modelling (all expenditure data included in the model is presented in £m and is expressed in 2000/01 prices):

- a base OPEX of £2,689m in 2000/01 before efficiencies plus around £230m of enhancement (a total of £2,918m pre-efficiencies). Efficiencies of 2.3% per annum for base OPEX, and higher efficiencies for enhancement, are applied. The

[62] 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.

assumptions are informed by information from Ofwat's reports on 'Financial Performance and Expenditure' and the 1999 'Final Determinations';

- a CAPEX programme of £15.5 billion over the five-year period (*after* efficiencies), including a quality programme of £7.8 billion, maintenance expenditure of £6.8 billion, and supply–demand balance expenditure (excluding new development) of £766m, based on information from the 'Final Determinations' and 'RD 05/02'. The profile of this spend is an inverted U-shape, based on numbers presented in 'RD 05/02';

- an assumption for cumulative CCD on 'pre-AMP3 existing assets' for 2001 of £1.1 billion, with a fall-off of £55m per annum thereafter on information from the 'June Returns' and from the 'Final Determinations'. The fall-off rate is extended to proxy the expiry of accounting lives of certain assets existing prior to 2000, which would have been valued using modern equivalent asset valuation (see Table 3.1);

- asset apportionments for the CCD treatment of new (maintenance and enhancement) non-infrastructure expenditure as outlined by Ofwat in RD 05/02, plus an assumed 'pre-AMP3 work-in progress' adjustment to cumulative enhancement CCD of +£100m per annum;

- a broad-equivalence adjustment to the combined cumulative 'pre-AMP3 existing asset' CCD and new maintenance CCD of –£80m per annum;

- an IRC, based on a straight average of assumed infrastructure maintenance expenditure from 1995/96 to 2013/14 of around £450m per annum, reduced to around £400m per annum, assuming wind-out of accrual;

- an opening RCV for 2000/01 of £28.4 billion, based on information from the 'Final Determinations';

- rolling CAPEX outperformance against the assumptions underlying the 1994 review, based on information from RD 05/02;

- an assumed post-tax equity, pre-tax debt real cost of capital of 5.8%, based on OXERA calculations derived from Ofwat's published post-tax equity, post-tax debt figure of 4.75% with adjustments, which include premia for embedded debt and higher financing costs for small companies (see section 2.3);

- an assumption that the average and effective tax rate (which is treated as a cost to the business) on operating profits is 15%;

- an assumption of 1999/2000 tariff basket revenues of around £7 billion, based on the 'Final Determinations', with the number of households increasing by 0.8% per annum (based on 'June Return' information) and large-user revenues falling by around 4% per annum (based on the 'Final Determinations').

The results of this exercise, in terms of the assumed build-up of allowed revenues, and the impact on the initial P_0 price cut for 2000/01 and subsequent K factors, are outlined in Table 3.1. A simplified approach is taken to determining average water bills in this modelling. The absolute level of these 'notional' bills should not be interpreted in this scenario, or in any other scenario presented in this paper. What is of greater import is the path of bills over time—ie, the K profile.

Table 3.1: PR 1999 scenario

	2001	2002	2003	2004	2005
Base OPEX	2,626	2,565	2,505	2,447	2,390
Enhancement OPEX	*222*	*214*	*207*	*200*	*194*
Total OPEX	2,848	2,779	2,712	2,647	2,584
CCD	1,230	1,262	1,296	1,324	1,345
IRC	402	402	402	402	402
Return on RCV	1,663	1,694	1,740	1,808	1,871
Taxation	249	254	261	271	281
Total required revenues	**6,393**	**6,391**	**6,411**	**6,452**	**6,482**
Less non-tariff basket revenues	208.86	200.54	192.55	184.89	177.54
Total net required revenues	6,184	6,191	6,218	6,267	6,304
Number of domestic billed (W+S)	41.041	41.369	41.700	42.034	42.370
Notional average water/sewerage bill	150.67	149.65	149.12	149.09	148.79
P_0	**–11.8%**				
K		**–0.7%**	**–0.4%**	**0.0%**	**–0.2%**
Average annual price change					**–2.7%**

Table 3.1 presents a scenario in which there is an initial price cut in 2000/01 of 11.8%, followed by a small reduction in prices. In the assumed cost of capital of 5.8%, the scenario gives rise to an NPV of allowed revenues for the industry of £26.4 billion over the five-year period. However, it is possible to set the K factors for 2000–01 to 2004–05 at the amounts assumed by Ofwat in its 'Final Determinations', and then recalculate the required P_0 to give the same NPV of allowed revenues. The revised price profile is provided in Table 3.2.

Table 3.2: Final PR 1999 price profile (%)

	2001	2002	2003	2004	2005
P_0	–12.8				
K		–0.4	0.1	1.1	1.5
Average annual price change					–2.3

The price profile described in Table 3.2 compares with a P_0 assumed in the 'Final Determinations' of –12.3%. OXERA's modelling generates a closing revenue for 2004–05 of £6,450m.

3.3 Baseline scenario for PR 04

For PR 04, the following assumptions were used in the base case:

- no outperformance against the PR 99 assumptions on OPEX (which would otherwise lower the opening base OPEX for PR 04), nor on CAPEX (which would otherwise result in reductions to the RCV for each year of PR 04);

- a base OPEX for 2005/06 based on the 2003/04 base OPEX figure of £2,447m, before efficiencies, plus enhancement OPEX of £194m per annum before efficiencies (in total, £2,641m before efficiencies). No increases in (pre-efficiency) base or enhancement OPEX are assumed;

- percentage efficiency targets for both OPEX and CAPEX that are broadly the same as those for PR 99 (with CAPEX efficiencies being explicitly modelled for each CAPEX category);

- a CAPEX programme (*before* efficiencies) of £15.5 billion—amounting to £13.6 billion after efficiencies—comprising a gross quality programme of £7.8 billion, capital maintenance expenditure (based on a 'serviceability' approach using a historical average of past expenditure) of £6.8 billion, and £768m for supply–demand balance (excluding new development);

- asset apportionments for new non-infrastructure investment as per PR 99, with a lower broad-equivalence adjustment to base CCD of –£30m per annum;

- an IRC, based on the same methodology as PR 99, of £384m per annum (after efficiencies);

- an opening RCV for 2005/06 of £32.7 billion;

- a cost of capital of 5.8% (post-tax equity, pre-tax debt) and taxation assumptions as per PR 99.

These assumptions are summarised in Table 3.3.

Table 3.3: PR 99 base case versus PR 04 base case

PR 99	PR 04
OPEX efficiencies of 2.3% per annum base, 3.3% per annum enhancement	OPEX efficiencies of 2.3% per annum base, 3.3% per annum enhancement
OPEX (pre efficiencies) of £2,918m in 2000–01	OPEX (pre efficiencies) of £2,641m in 2005–06
CAPEX programme of £15.5 billion (post-efficiencies) over five years	CAPEX programme of £15.5 billion (pre-efficiencies) over five years
CCD of £1,345m by 2004–05	CAPEX efficiency targets as per PR 99
IRC of £400m per annum	CCD of £1,415m by 2009–10
Opening RCV of £28.4 billion in 2000–01	IRC of 385m per annum
Cost of capital of 5.8%	Opening RCV of £32.7 billion in 2005–06
Average and effective tax rate of 15%	Cost of capital of 5.8%
	Average and effective tax rate of 15%

The results from the modelling, given the above assumptions, are presented in Table 3.4.

Table 3.4: PR 04 base-case scenario (‘repeat of PR 99’)

	2006	2007	2008	2009	2010
Base OPEX	2,390	2,334	2,280	2,227	2,175
Enhancement OPEX	*188*	*181*	*176*	*170*	*164*
Total OPEX	2,577	2,515	2,455	2,396	2,339
CCD	1,346	1,365	1,384	1,400	1,414
IRC	384	384	384	384	384
Return on RCV	1,929	1,990	2,050	2,106	2,153
Taxation	289	298	307	316	323
Total required revenues	**6,526**	**6,553**	**6,580**	**6,602**	**6,613**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,355	6,390	6,423	6,451	6,468
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Notional average water/sewerage bill	149.99	149.61	149.20	148.66	147.88
P_o	**–1.5%**				
K		**–0.3%**	**–0.3%**	**–0.4%**	**–0.5%**
Average annual price change					**–0.6%**

The results reveal a small initial reduction in prices of 1.5%, followed by even smaller subsequent reductions. The results show how the reductions in OPEX are counterbalanced to a degree by the increases in CCD and in return on capital (as the RCV grows). The reductions in prices shown here should be interpreted as a change in bill for a notional customer, and do not consider the potential effects of tariff basket rebalancing.

The price profile shown above can, however, be adjusted to provide an alternative K profile that is consistent with the same NPV of revenues. For example, a ‘smoothed’ K of –0.7% per annum, maintained over the five years of the price control, would result in the same NPV of allowed revenues. Other profiles are shown in Appendix 3. Some profiles might not prove satisfactory if these result in cash shortfalls in any year with regard to maintaining financial indicators, such as interest cover and dividend cover. Notably, the water sector has been, and continues to be, cash-flow negative, and so higher K factors might be required in practice to maintain key financial indicators.

Appendix 4 also demonstrates the impact on the base-case scenario if, hypothetically, the quality programme were to be removed. (Removing the supply–demand balance programme is also discussed). While this is an unrealistic assumption, it does enable the impact of the capital programme on prices to be examined. Compared with the results presented in Table 3.4, removing the quality programme reduces the average K factor to –2.6% per annum. This is associated with an NPV of allowed revenues of £25,357m.

3.4 Alternative scenarios for PR 04

In this section, consideration is given to the potential impact on price limits if different assumptions are made on certain parameters: future CAPEX requirements, prospective efficiencies, cost of capital, asset-life assumptions.

The following four scenarios are modelled (relative to the base case). Crucially, the CAPEX programme that may be financed within any given price envelope will depend on the assumptions made on the other building blocks of allowed revenues.

Scenario 1 lower CAPEX but higher prices;

Scenario 2 lower CAPEX and lower prices;

Scenario 3 higher CAPEX but higher prices; and

Scenario 4 higher CAPEX and lower prices.

These are summarised in Table 3.5 and are discussed in turn below.

Table 3.5: Four scenarios for PR 04

	Lower CAPEX	Higher CAPEX
Lower prices	**Scenario 2**	**Scenario 4**
	Key assumptions	**Key assumptions**
	High outperformance of 20% OPEX, 10% CAPEX	High outperformance of 15% OPEX, 5% CAPEX
	High OPEX efficiencies of 3.3% per annum base, 4.5% per annum enhancement	High OPEX efficiencies of 3.3% per annum base, 4.5% per annum enhancement
	OPEX (pre-efficiencies) of £2,113m in 2005–06	OPEX (pre-efficiencies) of £2,245m in 2005–06
	CAPEX programme of £14 billion (pre-efficiencies) over five years	CAPEX programme of £23.7 billion (pre-efficiencies) over five years
	CAPEX efficiency targets as per base case/PR 99	CAPEX efficiency targets as per base case/PR 99
	Resulting building blocks	**Resulting building blocks**
	CCD of £1,330 by 2009–10	CCD of £1,520 by 2009–10
	IRC of £340m per annum	IRC of £440 per annum
	Opening RCV of £32.7 billion in 2005–06	Opening RCV of 32.7 billion in 2005–06
	Cost of capital as per base case	Cost of capital of 6.3%
	Tax rate as per base case	Tax rate as per base case
Higher prices	**Scenario 1**	**Scenario 3**
	Key assumptions	**Key assumptions**
	Low outperformance of 5% OPEX, 2% CAPEX	Low outperformance of 5% OPEX, 2% CAPEX
	OPEX (pre-efficiencies) of £2,559m in 2005–06 (including rates increase)	OPEX (pre-efficiencies) of £2,509m in 2005–06
	Low OPEX efficiencies of 1% per annum base, 1.4% per annum enhancement	Low OPEX efficiencies of 1% per annum base, 1.4% per annum enhancement
	CAPEX programme of £15.2 billion (pre-efficiencies) over five years	CAPEX programme of £24 billion (pre-efficiencies) over five years
	Lower CAPEX efficiency targets than in PR 99/base case	Lower CAPEX efficiency targets than in PR 99/base case
	Resulting building blocks	**Resulting building blocks**
	CCD of £1,435 by 2009–10	CCD of £1,960 by 2009–10
	IRC of £400m per annum	IRC of £480m per annum
	Opening RCV of £32.7 billion in 2005–06	Opening RCV of £32.7 billion in 2005–06
	Cost of capital of 6.8%	Cost of capital of 7%
	Tax rate as per base case	Tax rate as per base case

3.4.1 Scenario 1—lower CAPEX but higher prices

Within this scenario, the following assumptions have been made. A number of these assumptions (eg, starting OPEX, starting RCV) feed in automatically as a consequence of other assumptions (eg, outperformance):

- average outperformance across the industry on OPEX of 5% over the five years[63] of AMP3, and outperformance on CAPEX of 2%, relative to Ofwat's projections;
- less scope for OPEX efficiencies going forward due to a narrower gap between the most and least efficient companies, and a reduced frontier target. For base OPEX, this results in efficiency targets of 1% per annum;
- an increase in rates (affecting base OPEX) of £50m (pre-efficiency) in 2005/06;
- CAPEX requirements (*before* future efficiencies) are based on the same methodologies as for the base case, but take account of average improvements in efficiency across the industry. A quality programme of £7.7 billion is assumed, plus capital maintenance (employing the serviceability methodology) of £6.6 billion. £752m is allowed for supply–demand expenditure (excluding new development). Total CAPEX of £15.2 billion is allowed *before* efficiencies—which equates to post-efficiencies CAPEX allowance of £14.4 billion;
- lower CAPEX efficiency targets are assumed compared with the base case;
- due to assumed increases in macroeconomic factors (eg, the risk-free rate, and the equity risk premium), the cost of capital is assumed to rise to 6.8%.

All other assumptions are as for the base case (except where changes feed through automatically as a consequence of other assumptions).

The results from Scenario 1 are presented in Table 3.6. This illustrates that the combination of low outperformance against PR 99, low future prospective efficiencies and a higher cost of capital results in an average increase in prices (before re-profiling) of 1.1% in real terms, even though the CAPEX programme has not been increased relative to the base case.[64]

[63] Outperformance of 5% in a particular year means that, for that year, OPEX is 5% below that projected by Ofwat. Hence, outperformance of 5% in the first year (2006) followed by outperformance of 5% in the remaining years implies front-loading of efficiency savings. If companies spend/invest evenly over the five-year period, this would translate into 5% outperformance *per annum*.

[64] Note also that the base case assumed zero outperformance.

Table 3.6: PR 04 Scenario 1

	2006	2007	2008	2009	2010
Base OPEX	2,351	2,328	2,305	2,282	2,260
Enhancement OPEX	*182*	*179*	*177*	*174*	*172*
Total OPEX	2,533	2,507	2,482	2,457	2,432
CCD	1,349	1,371	1,394	1,415	1,435
IRC	398	398	398	398	398
Return on RCV	2,262	2,336	2,411	2,483	2,547
Taxation	339	350	362	372	382
Total required revenues	**6,881**	**6,963**	**7,047**	**7,125**	**7,193**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,710	6,799	6,890	6,974	7,048
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Notional average water/sewerage bill	158.37	159.21	160.04	160.72	161.14
P_0	**4.0%**				
K		**0.5%**	**0.5%**	**0.4%**	**0.3%**
Average annual price change					**1.1%**

The above price profile may be adjusted while providing the same NPV of allowed revenues. A smoothed K factor of 1.7% per annum, maintained over the five years of the price control, would result in the same NPV of allowed revenues. Alternative price profiles are shown in Appendix 3.

Appendix 4 demonstrates the impact on the scenario if, hypothetically, the quality programme were to be removed. Compared with the results presented in Table 3.6, this reduces the K factor to –1.1% on average per annum. This is associated with an NPV of allowed revenues of £26,359m. However, in practice, the effective cost of capital might fall in the face of a lower CAPEX requirement, for financeability reasons. Hence the fall in the K factor could be greater in practice.

Appendix 5 considers the sensitivity of the model results to changes in the assumed cost of capital. As noted above, Scenario 1 assumed a cost of capital of 6.8%. Appendix 5 shows that, if the cost of capital were instead 5.8%, the smoothed K factor profile would be –0.4% per annum, rather than 1.7% per annum. If, however, the cost of capital were 7.8%, the smoothed K factor would be 3.7% per annum. The sensitivity of these results illustrates just how important the cost of capital assumption, and potential adjustments to the assumed rate of return to reflect financeability considerations, are in setting price limits.

3.4.2 Scenario 2—lower CAPEX and lower prices

The second scenario modelled adopts the following assumptions:

- high OPEX and CAPEX outperformance against the PR 99 assumptions, of 20% and 10% respectively;
- higher efficiency targets for OPEX (eg, 3.3% per annum in total for base OPEX, comprised of a catch-up rate of 1.9% and a frontier shift of 1.4%), due to some

companies in the industry outperforming others by a wide margin. In practice, however, the efficiency targets set will depend on the exact methodologies used by Ofwat;

- a (pre-efficiency) CAPEX programme based on the same methodologies as the base case, but taking into account the past outperformance against PR 99. Here, a total investment programme of £14 billion is assumed before efficiencies, including £7 billion of quality spend, £6.1 billion of maintenance and £691m of supply–demand expenditure. The size of the CAPEX programme *after* efficiencies is £12.3 billion;
- CAPEX efficiencies similar to those assumed in the base case;
- a broad-equivalence adjustment to base CCD of –£80m per annum; and
- a cost of capital as in the base case.

All other assumptions are as for the base case (except where changes feed through automatically as a consequence of other assumptions).

The results from Scenario 2 are presented in Table 3.7. The scenario demonstrates how, in particular, marked outperformance on OPEX (combined with tough future efficiency targets) reduces the revenue requirement. To a lesser extent, the outperformance on CAPEX and its effect on the pre-efficiency CAPEX forecasts, and the separate effect of how outperformance feeds through to adjustments in the RCV in each year, also reduce the return on capital component.

However, it is unclear whether companies will be able to outperform by as much as that outlined above. Given that, by PR 04, the easy efficiencies will have already been made in the industry, it is questionable whether Ofwat would set tougher targets than those assumed in PR 99.

Table 3.7: PR 04 Scenario 2

	2006	2007	2008	2009	2010
Base OPEX	1,893	1,832	1,772	1,714	1,658
Enhancement OPEX	*148*	*142*	*135*	*129*	*124*
Total OPEX	2,042	1,973	1,907	1,843	1,781
CCD	1,289	1,300	1,311	1,320	1,327
IRC	342	342	342	342	342
Return on RCV	1,915	1,949	1,982	2,011	2,034
Taxation	287	292	297	302	305
Total required revenues	**5,875**	**5,856**	**5,839**	**5,817**	**5,789**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	5,704	5,693	5,682	5,667	5,644
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Notional average water/sewerage bill	134.63	133.29	131.98	130.58	129.04
P_0	**–11.6%**				
K		**–1.0%**	**–1.0%**	**–1.1%**	**–1.2%**
Average annual price change					**–3.3%**

The above price profile may be re-profiled, while maintaining the same NPV of allowed revenues. A smoothed K factor of –4.9% per annum, maintained over the five years of the price control, would result in the same NPV of allowed revenues. Alternative profiles are shown in Appendix 3.

Appendix 4 demonstrates the impact on the scenario if, hypothetically, the quality programme were to be removed. Compared with the results presented in Table 3.7, this reduces the average K factor to –5.2% per annum. This is associated with an NPV of allowed revenues of £22,507m.

Appendix 5 considers the sensitivity of the model results to changes in the assumed cost of capital. As noted above, Scenario 2 assumed a cost of capital of 5.8%. Appendix 5 shows that, if the cost of capital were instead 4.8%, the smoothed K profile would be –7.3% per annum, rather than –4.9% per annum. If, however, the cost of capital were 6.8%, the smoothed K factor would be –2.6% per annum. The sensitivity of these results again illustrates how important the cost of capital assumption and financeability considerations are in setting price limits.

3.4.3 Scenario 3—higher CAPEX but higher prices

Scenario 3 adopts the following assumptions:

- outperformance of 5% on OPEX and 2% on CAPEX, as per Scenario 1;
- a total CAPEX programme of £24 billion before efficiencies, comprised of £14 billion of quality expenditure, £8.6 billion of maintenance (based on serviceability plus a 30% mark-up), £752m of supply–demand CAPEX, and an additional £100m per annum in enhanced service level expenditure (the smallest component of total CAPEX) for sewer flooding. After efficiencies, the CAPEX programme amounts to £22.7 billion;

- OPEX and CAPEX efficiency targets similar to Scenario 1;
- front-loading of the depreciation profiles for both 'new' maintenance and enhancement expenditure, to reflect a revised assessment of whether current or future customers should meet the bill for CAPEX, given the stepped-up CAPEX programme (although Ofwat's methodology to date has been based purely on *standardised asset lives*). This is shown in Table 3.8;
- an increase in the assumed cost of capital to 7%, to reflect a combination of macroeconomic movements and a mark-up to enable companies to maintain key financial indicators (in light of the stepped-up CAPEX programme).

All other assumptions are as for the base case (except where changes feed through automatically as a consequence of other assumptions).

Table 3.8: Asset-life assumptions, Scenario 3

	Asset life category	Asset life (Y)	Baseline scenario (%)			Scenario3: front-loading (%)		
			Water	Sewerage	Water and sewerage	Water	Sewerage	Water and sewerage
Base (MNI) CAPEX	Very short	5	8	5	7	20	20	20
	Short	10	22	20	21	45	45	45
	Medium	20	42	50	46	30	25	28
	Medium long	40	3	5	4	5	10	8
	Long	60	25	20	23	0	0	0
	Land	100	0	0	0	0	0	0
Enhancement CAPEX	Very short	5	0	0	0	5	0	0
	Short	10	5	5	5	10	20	20
	Medium	20	30	38	34	20	45	50
	Medium long	40	5	10	8	40	10	10
	Long	60	60	45	53	60	25	20
	Land	100	0	2	1	100	0	0

Ofwat's methodology to date has been based purely on standardised asset lives. Whether the regulator would, in practice, front-load depreciation in the manner described above in Table 3.8 is open to debate. Nonetheless, the impact of front-loading the depreciation profiles is to increase CCD in each year of the price control. There are a number of other ways in which CCD might increase, including some combination of:

- a reduction in the broad-equivalence adjustment to CCD (on existing assets);
- Ofwat taking account of company-specific, rather than standard, asset-life assumptions for some companies; and

- reclassification of non-infrastructure expenditure between maintenance and enhancement.

More generally, there may be upward pressure on prices if more maintenance infrastructure than non-infrastructure expenditure were required, or if expenditure on non-infrastructure assets were reclassified as infrastructure expenditure. This is because, as discussed in section 2.4, outlays on infrastructure assets are, through the IRC, remunerated over a 15-year period. This is shorter than the average asset lives assumed for non-infrastructure expenditure.

The results from Scenario 3 are presented in Table 3.9. A significant consequence of the increased CAPEX is its effect on the required return (as a result of additions to the RCV), multiplied by the effect of a higher cost of capital. Total CCD also rises, but it is the cost of capital effect that dominates. One reason for this is that the vast majority of CCD relates to that on existing assets (existing at the time of the review), not on ‘new’ maintenance and enhancement expenditure. In addition, the cost of capital applies to the whole RCV, not just to the increase in RCV resulting from new asset additions.

Prior to any K factor re-profiling, while the increase in the cost of capital affects only the initial P_0 increase, the increase in CCD affects both the P_0 and the profile of K factors thereafter. In combination with low outperformance and low future efficiencies, the result is that prices increase by 4.1% per annum in real terms.

Table 3.9: PR 04 Scenario 3

	2006	**2007**	**2008**	**2009**	**2010**
Base OPEX	2,301	2,279	2,256	2,234	2,212
Enhancement OPEX	*182*	*179*	*177*	*174*	*172*
Total OPEX	2,483	2,458	2,433	2,408	2,384
CCD	1,454	1,582	1,712	1,837	1,957
IRC	483	483	483	483	483
Return on RCV	2,380	2,558	2,730	2,890	3,029
Taxation	357	384	409	433	454
Total required revenues	**7,158**	**7,464**	**7,766**	**8,051**	**8,307**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,987	7,301	7,609	7,900	8,162
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Notional average water/sewerage bill	164.91	170.94	176.75	182.05	186.60
P_0	**8.3%**				
K		**3.7%**	**3.4%**	**3.0%**	**2.5%**
Average annual price change					**4.1%**

The above price profile can be re-profiled while maintaining the same NPV of allowed revenues. A smoothed K of 5% per annum, maintained over the five years of the price control, would result in the same NPV of allowed revenues. Alternative profiles are shown in Appendix 3. However, owing to concerns regarding financial indicators, in practice, some profiles may be more desirable than others.

Appendix 4 demonstrates the impact on the scenario if, hypothetically, the quality programme were to be removed. Compared with the results presented in Table 3.9, this reduces the average K factor across the industry to 0.4% per annum. This is associated with an NPV of allowed revenues of £27,608m. However, in practice, it would be expected that the cost of capital would fall in the face of a lower CAPEX requirement, for financeability reasons. Hence, the fall in the K factor might be greater in practice.

Appendix 5 considers the sensitivity of the model results to changes in the assumed cost of capital. Scenario 3 assumed a cost of capital of 7%. Appendix 5 shows that, if this 6% instead, the smoothed K factor profile would be 2.9% per annum, rather than 5% per annum. If, however, the cost of capital were 8%, the smoothed K factor would be 7% per annum. The sensitivity of these results demonstrates once more how important the cost of capital assumption and financeability considerations are in setting allowed revenues.

3.4.4 Scenario 4—higher CAPEX and lower prices

In the final scenario, the following assumptions are made:

- OPEX outperformance of 15%, and CAPEX outperformance of 5% against the PR 99 assumptions;
- a total (pre-efficiency) CAPEX programme of £23.7 billion, comprised of £14 billion in quality expenditure, £8.4 billion in maintenance spend (based on serviceability plus a 30% mark-up), £729m of supply–demand CAPEX, and an additional £100m per annum in enhanced service level expenditure (the smallest component of total CAPEX) for sewer flooding. The post-efficiency CAPEX allowance is £20.8 billion;
- high OPEX efficiency targets, as per Scenario 2, and CAPEX efficiency targets as per Scenario 2 (the latter reflect the base-case assumptions for PR 04);
- a broad-equivalence adjustment to base CCD of –£80m per annum, as per Scenario 2; and
- an increase in cost of capital, but only to 6.3% (reflecting more favourable macroeconomic conditions than Scenario 3).

All other assumptions are as for the base case (except where changes feed through automatically as a consequence of other assumptions).

The results from this scenario are presented in Table 3.10. The table shows that, although the total CAPEX assumed is similar to that outlined in Scenario 3, the impact on prices is more muted. This is due to longer asset-life assumptions producing lower depreciation charges, a lower cost of capital assumption, an expectation of greater outperformance up to 2004, and more demanding efficiency targets thereafter. As a result, the average increase in prices is contained to +0.4% per annum.

Table 3.10: PR 04 Scenario 4

	2006	2007	2008	2009	2010
Base OPEX	2,012	1,946	1,882	1,821	1,761
Enhancement OPEX	*158*	*150*	*144*	*137*	*131*
Total OPEX	2,169	2,096	2,026	1,958	1,893
CCD	1,328	1,378	1,427	1,473	1,516
IRC	439	439	439	439	439
Return on RCV	2,135	2,282	2,425	2,560	2,680
Taxation	320	342	364	384	402
Total required revenues	**6,392**	**6,538**	**6,682**	**6,815**	**6,929**
Less non-tariff basket revenues	170.47	163.69	157.17	150.92	144.91
Total net required revenues	6,222	6,374	6,525	6,664	6,784
Number of domestic billed (W+S)	42.370	42.709	43.050	43.395	43.742
Notional average water/sewerage bill	146.84	149.25	151.57	153.57	155.10
P_0	**–3.6%**				
K		**1.6%**	**1.6%**	**1.3%**	**1.0%**
Average annual price change					**0.4%**

The above prices may be re-profiled while maintaining the same NPV of allowed revenues. A smoothed K of –0.3% per annum, maintained over the five years of the price control, would result in the same NPV of allowed revenues. Other profiles are provided in Appendix 3.

The above scenario demonstrates that it is the way in which CAPEX feeds into the price control, as much as the level of CAPEX assumed, that determines the price limits for the five-year period. Contrasting scenarios 3 and 4 illustrates how similar ‘high CAPEX’ scenarios result in very different outcomes for consumers over the AMP4 period.

Appendix 4 demonstrates the impact on the scenario if, hypothetically, the quality programme were to be removed. Compared with the results presented in Table 3.10, this reduces the average K factor across the industry to –3% per annum. This is associated with an NPV of allowed revenues of £24,427m.

Appendix 5 considers the sensitivity of the model results to changes in the assumed cost of capital. Scenario 4 assumed a cost of capital of 6.3%. Appendix 5 shows that, if it were 5.3% instead, the smoothed K factor profile would be –2.7% per annum, rather than –0.3% per annum. If, however, the cost of capital were 7.3%, the smoothed K factor would be 2% per annum. The sensitivity of these results further demonstrates how important the cost of capital assumption and financeability considerations are in setting prices.

4. Conclusions

The results presented in section 3 demonstrate that there is a wide range of possible price limits that might be set at the next review. The scenarios developed took a 'repeat' of PR 99 as a starting point for PR 04.

As emphasised in the introduction, the analyses and numbers provided in this report are for illustration only. The base-case scenario should not be regarded as a 'central' scenario, and the purpose of modelling deviations around this was not to develop scenarios that might be regarded as 'most realistic', or to attach probabilities to these scenarios.

In addition, the analyses and numbers presented are subject to the limitations of the modelling. In particular, the model does not explicitly take account of potential impacts on financial indicators, or the effects of free metering on revenues. In these respects, the model is likely to understate the K factor.

The scenarios modelled in this paper therefore do *not* reflect OXERA's assessment of what the inputs that will feed into price limits at PR 04 *should* be. The purpose of the modelling exercise was to illustrate how different assumptions on the key building blocks might lead to different outcomes for prices.

The scenarios discussed in section 3 highlighted the following:

- as shown in the **base-case scenario**, assuming no outperformance on the AMP3 settlement, and efficiency target and cost of capital assumptions similar to AMP3, a similar level of CAPEX to AMP3 (£15 billion before efficiencies) might be accommodated within prices that are slightly falling to broadly stable;

- as illustrated in **Scenario 1**, assuming some outperformance on AMP3 (5% on OPEX, 2% on CAPEX over five years), but also reduced efficiency assumptions going forward (eg, half the rate assumed for AMP3 in respect of OPEX efficiencies), and a higher cost of capital (one percentage point higher than assumed in AMP3), £15 billion of CAPEX might result in an average annual price increase of around 1–2%;

- **Scenario 2** showed how, relative to the base-case scenario, high OPEX and CAPEX outperformance (20% and 10%, respectively), high future OPEX efficiencies (3.3% per annum for base OPEX), and low future CAPEX requirements (of £14 billion) could result in falling prices, of around –3.5% to –5% per annum;

- **Scenario 3** illustrated how, under assumptions on outperformance and efficiencies similar to Scenario 1, higher CAPEX aspirations could generate more significant price increases. Here, a combination of a higher CAPEX programme (of £24 billion), a higher cost of capital (just over one percentage point more than assumed in AMP3), and (to some extent) front-loading of depreciation, could lead to an annual increase in prices of around 4–5% per annum;

- relative to Scenario 3, **Scenario 4** showed how more bullish assumptions on outperformance (15% OPEX and 5% CAPEX) and future efficiencies (3.3% per annum for base OPEX), and a lower cost of capital, might allow around £24 billion of CAPEX to be accommodated within broadly stable prices.

One interesting finding of the modelling was that, using the building-block approach alone, increases in CAPEX have a more muted effect on prices than might first be expected. This is because the impact of CAPEX on required revenues depends as much on the assumed cost of capital, depreciation and the IRC, as on the level of CAPEX. In particular, within Ofwat's framework, there is a significant 'back-loading' of depreciation, particularly for enhancement expenditure.[65] Hence, abstracting from the requirement for companies to maintain certain financial indicators, it would at first seem that significantly large CAPEX programmes could be accompanied by relative low increases in prices. But this picture is somewhat illusory.

First, this entails a back-loading of funding for CAPEX onto future generations of water customers.[66] The impact on future customers, and the limitations placed on facilitating future CAPEX in future price limits by including a given level of CAPEX in a current settlement, should always be taken into account.

Second, in practice, financial indicators may be stretched when CAPEX is increased. Here, the building-block approach alone may not be sufficient to ensure that companies have enough allowed revenues. In such situations, the allowed rate of return may need to be increased. The size of the adjustment required will, in part, be a function of the magnitude of CAPEX included within price limits.

The results from the scenarios presented in section 3 were particularly sensitive to the assumptions made on the cost of capital. The sensitivity of these results demonstrates just how important the cost of capital, and adjustments to the assumed rate of return to reflect potential financeability considerations, are in setting price limits. Going forward, the model could be refined in order to capture financial indicators, and the effect of these on price limits, more explicitly within the modelling framework.

[65] Ofwat's asset apportionments, for assessing CCD on new investment, effectively assume an average asset life of 27 years for maintenance expenditure and 43 years for enhancement expenditure. This means that, in each year, consumers pay for only around 1/27th of the allowed non-infrastructure maintenance expenditure and 1/43rd of the non-infrastructure enhancement expenditure.

[66] Future customers will continue to be paying for this expenditure for years to come until it becomes fully depreciated. A return on capital will also continue to be earned on the part of the expenditure left in the RCV.