

Guidance on Implementing Cost Effectiveness of Measures in the Context of the Water Framework Directive

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Table of Contents

TABLE OF CONTENTS	1
1. INTRODUCTION.....	3
1.1 Background	3
1.2 Layout of the Guidance	3
2. ECONOMIC ANALYSIS AND THE WATER FRAMEWORK DIRECTIVE.....	4
2.1 Introduction	4
2.2 Objectives of the Water Framework Directive.....	4
2.3 Measures.....	4
2.4 Water Status Levels.....	5
2.5 Economic Analysis Requirements of the WFD	6
2.6 Overall Process of Integrating Economic Analysis.....	7
2.7 Feasibility of Measures	8
3. PURPOSE AND SCOPE OF THE COST EFFECTIVENESS ANALYSIS.....	10
3.1 Introduction	10
3.2 Setting a Target Status Date	10
3.3 Establishing the Good Status Gap and Need for Additional Measures.....	10
3.4 Maintaining Good Status.....	10
3.5 Focusing on Additional Uncommitted Measures.....	10
3.6 Focusing on Feasible Uncommitted Measures.....	11
3.7 Undertaking CEA at the Appropriate Geographic Unit of Analysis.....	11
3.8 Applying CEA to Measures aimed at each of the Quality Elements	11
3.9 Identifying Candidate Measures.....	11
3.10 Sifting and Screening of Measures.....	12
3.11 Making Use of Generic Cost Effectiveness Analyses.....	12
3.12 Including Supplementary National Level Measures	12
3.13 Developing Strategies	13
4. STRUCTURE OF THE COST EFFECTIVENESS ANALYSIS.....	15
4.1 Introduction	15
4.2 Defining Outputs	15
4.3 Measuring Outputs	15
4.4 Assessing the Timing and Duration of Outputs	16
4.5 Discounting of Outputs	17
4.6 Using a Present Value Year of 2010	17
4.7 Estimating the Cost Effectiveness Decision Criterion	19
4.8 Dealing with Uncertainty	19
4.9 Reviewing for Measure-specific Impacts and Non-Monetisable Costs	20
4.10 Auditing the Process.....	20
5. DEFINING AND ESTIMATING COSTS	21

5.1	Introduction	21
5.2	Defining Costs.....	21
5.3	Deciding the Level of Detail of Cost Estimates	22
5.4	Treating Initial and Recurring Costs	22
5.5	Prices	22
5.6	Quantification of Costs.....	22
6.	SUMMARY OF STEPS IN THE CEA.....	24
	APPENDIX 1: DISCOUNT FACTORS	26
	APPENDIX 2: CASE STUDIES	27
	Case Study A: Fake River - Hydromorphological Pressures	27
	Case Study B: Fake River - Point Source Pressures.....	39

1. Introduction

1.1 Background

The purpose of this document is to provide guidance on the application of cost effectiveness analysis to measures aimed at achieving the objectives of the Water Framework Directive (WFD). The Water Framework Directive was transposed into national legislation via the European Communities (Water Policy) Regulations (S.I. No. 722 of 2003). The purpose of the Directive is to establish a framework for the protection of inland surface waters, coastal waters and ground waters.

Under Article 4(3) of the Water Policy Regulations, 2003, the Minister for the Environment, Heritage and Local Government may issue guidance and general policy directions in relation to the implementation of the Regulations. The purpose of this document is to issue that guidance in respect of the cost effectiveness analysis of measures. While the guidance is not binding, the relevant public authorities shall have regard to it in implementing the river basin management planning process, including the preparation of river basin management plans.

The guidance is thus aimed at the public authorities, including the local authorities and the Environmental Protection Agency, that are involved in the river basin management planning process.

1.2 Layout of the Guidance

The Guidance is laid out as follows. Section 2 outlines the role of economic analysis in the context of the Water Framework Directive. The purpose and scope of the cost effectiveness analysis is considered in Section 3. The overall approach to cost effectiveness analysis is explored in Section 4. Section 5 sets out the methodology for defining and estimating costs. Finally, in Section 6, the steps to be undertaken in completing a cost effectiveness analysis are set out.

2. Economic Analysis and the Water Framework Directive

2.1 Introduction

This Section of the Paper provides an overview of the Water Framework Directive (WFD) and identifies the role of economics in its implementation.

2.2 Objectives of the Water Framework Directive

The Water Framework Directive (WFD) came into effect on 22 December 2000 and sets a framework for comprehensive management of water resources in the European Community, within a common approach and with common objectives, principles and basic measures. It addresses inland surface waters, estuarine and coastal waters and groundwater. Member States have to ensure that co-ordinated approach is adopted for the achievement of the objectives of the WFD and for the implementation of programmes of measures for this purpose. The objectives of the WFD are:

- To protect and enhance the status of aquatic ecosystems (and terrestrial ecosystems and wetlands directly dependent on aquatic ecosystems);
- To protect high quality waters where they exist, to prevent any further deterioration of water status and to achieve at least “good status” (as defined) in surface waters and ground waters by 2015;
- To promote sustainable water use based on long-term protection of available water resources;
- To provide for sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use;
- To provide for enhanced protection and improvement of the aquatic environment by reducing / phasing out of discharges, emissions and losses of priority substances;
- To mitigate the effects of flood and droughts;
- To protect territorial and marine waters
- To establish a register of “protected areas” e.g. areas designated for protection of habitats or species

2.3 Measures

Each Member State is required to adopt a programme of measures to achieve the objectives of the Directive, including the achievement of good status objectives and the prevention of deterioration of status. These measures comprise basic measures and supplementary measures. Basic measures are minimum requirements and include but are not confined to measures aimed at compliance

with the Community legislation already in place.¹ Supplementary measures are measures to be applied in addition to basic measures with the aim of achieving the objectives of the Directive.

Under certain conditions, the deadline of 2015 may be extended for two further periods of six years. In such circumstances, the measures to bring the water body to the required status by the extended deadline(s) must be put in place (Article 4.4).

Under more stringent conditions, where water bodies are so affected by human activity or their natural condition is such that the achievement of the objectives would be infeasible or disproportionately expensive, then less stringent environmental standards may be set. However, this only on the condition that environmental and socioeconomic needs served by such human activity cannot be achieved by other means which are a significantly better option not involving disproportionate costs (Article 4.5).

2.4 Water Status Levels

The Directive aims to achieve good status or prevent a deterioration in the status of water bodies. Status is defined by reference to:

- Ecological status, or in the case of artificial or heavily modified water bodies, ecological potential; and
- Chemical status.

Ecological status assigns water bodies to one of five ecological classes: High, Good, Moderate, Poor, and Bad.

Four quality elements need to be considered in order to assess a water body's ecological status viz.:

- Biological quality elements
- Physico-chemical conditions;
- Relevant specific synthetic or non-synthetic pollutants; and
- Hydromorphological elements.

¹ This legislation includes existing Community legislation such as that on Integrated Pollution Prevention and Control (96/61EC), Urban Waste Water Treatment (91/271/EEC), and the Protection of Waters against Pollution Caused by Nitrates from Agricultural Sources (91/676/EEC). The Water Framework Directive also requires implementation of additional new basic measures including Measures to Protect Drinking Water Sources and Controls on Point Source and Diffuse Source Discharges. For further information consult the Department of Environment, Heritage and Local Government's publication entitled "River Basin Management Planning: A Practical Guide for Public Authorities."

Biological quality assessment uses numeric measures of communities of animals and plants. Physico-chemical assessment looks at elements, such as levels of nutrients, which support the biology. The chemical assessment within the ecological classification refers to polluting substances that could adversely affect ecology. The hydromorphological assessment examines water flow and physical habitat.

The overall ecological status of the water body is defined by the lowest level of status achieved across the four quality elements. This means, for example, that if one of the elements is assessed as Poor and all other elements are Good, then the overall ecological status of the water body is Poor.

Chemical status refers to a list of priority hazardous substances for which standards are expected to be adopted in 2008. Good status in respect of chemical elements will be defined by achieving the standards set.

Regulations have been proposed that will give legal status to the criteria and standards to be used for classifying surface waters in accordance with the ecological objectives approach of the Water Framework Directive.²

2.5 Economic Analysis Requirements of the WFD

The Directive includes a number of references and or provisions in relation to matters involving economic aspects. The most significant provisions are:

- Article 5 requires a Member State to carry out an economic analysis of water use by 2004; this analysis has been completed.
- Article 9, requires a Member State to have in place by 2010 water-pricing policies which provide adequate incentives to promote efficient use of water resources and which take account of the principle of recovery of the costs of water services;
- Article 11 and Annex III, provide that the programme of measures adopted by a Member State to achieve the relevant environmental objectives must comprise the most cost-effective combination of measures;
- As indicated above, Article 4(4) allows a Member State to adopt a longer timeframe (i.e. beyond 2015) for achievement of the objective of Good status for a water body in certain circumstance where completing the improvements within the original timescale would be disproportionately expensive; and

² Draft European Communities Environmental Objectives (Surface Waters) Regulations 2008.

- Article 4(5) allows a Member State to adopt less stringent objectives for a specific water body where achievement of full objective would be disproportionately expensive (costly).

2.6 Overall Process of Integrating Economic Analysis

Figure 1 depicts an overall approach to the integration of economic analysis which fits with the requirements of the Directive. The first issue to be resolved relates to the extent to which Cost Effectiveness Analysis (CEA) must be applied to basic measures. Appendix III indicates that CEA is to be applied to the measures contained in Article 11. As that article refers to both basic and supplementary measures, in principle, CEA must be applied to basic measures. This view must be qualified by two factors:

- Government has already largely initiated these measures: for example, a National Action Programme under the Nitrates Directive is in place; and
- The Community Legislation that underpins the requirements for basic measures usually sets actions that Member States must take, and therefore does not give rise to the possibility of choice of measures.

Where Government has already put in place measures aimed at meeting the requirements of Community legislation, it makes sense that only new or additional i.e. uncommitted basic measures should be subject to CEA.³ Such uncommitted measures have the potential to arise only where goals rather than actions have been identified in the legislation.

However, it must be recognised that there may not be a need for such additional measures, so that CEA of basic measures may not be required. In terms of Figure 1, this would mean that the first four steps in the process would become redundant.

CEA must be applied to supplementary strategies so that identification of the 2015 good status or reduced status gap is a requisite first step. This is the gap that remains after all basic measures have been implemented. There is then a need to identify measures or combinations of measures (strategies) to meet that gap. These measures must be both technically feasible and operationally feasible in the sense of capable of implementation by 2015. CEA is then applied to supplementary measures/strategies that are feasible to determine the most cost effective approach.

³ For example, the WFD identifies controls over abstractions of fresh surface water and ground water as a basic measure. CEA is required to choose between alternative measures aimed at achieving such control.

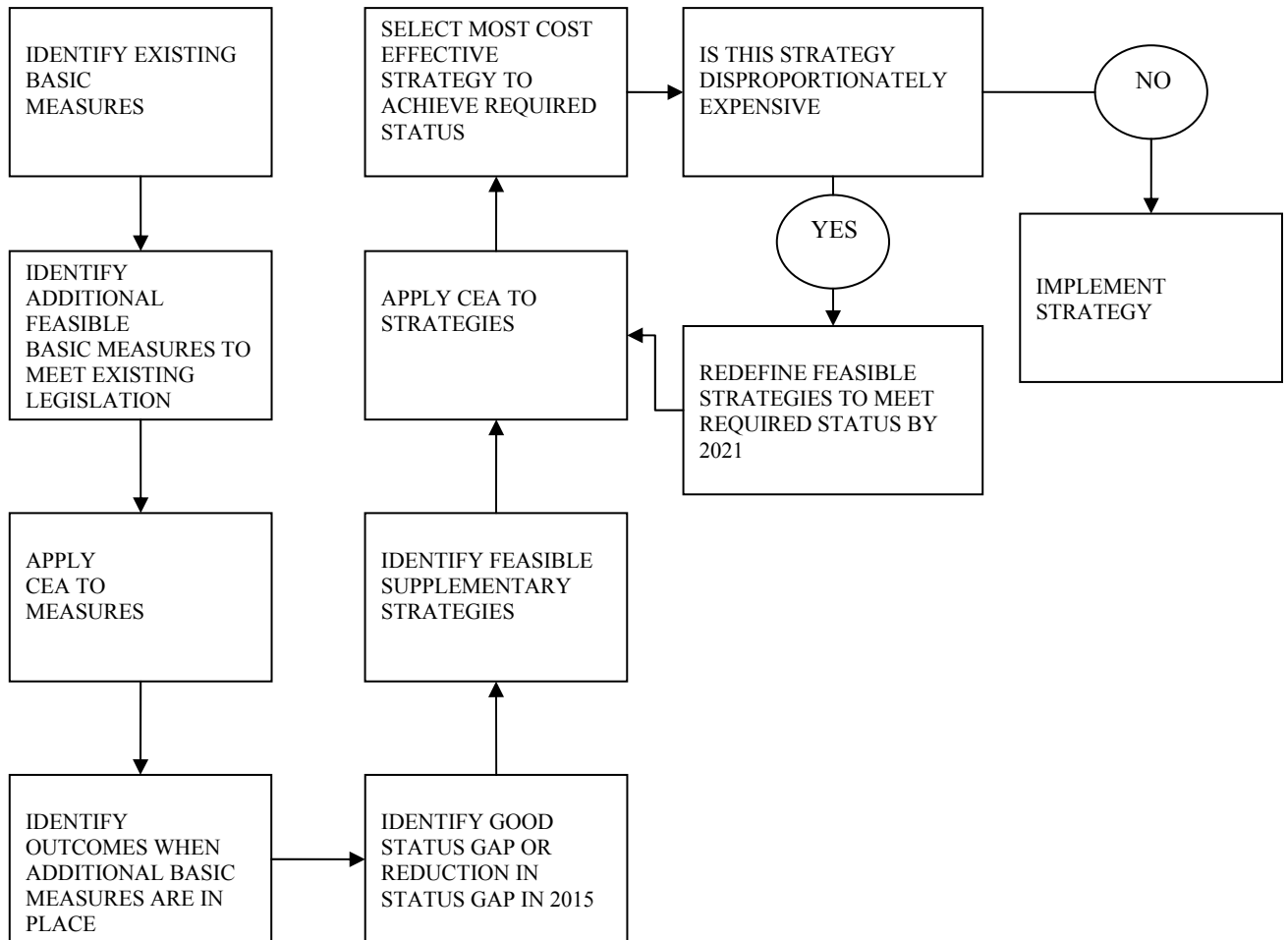
The final step in the process is to determine that the most cost-effective strategy is not disproportionately expensive. If it is not disproportionately expensive, then implementation can proceed. If it is disproportionately expensive, then achievement of good status can be postponed to 2021 and a similar appraisal process is then applied. Ultimately, if no affordable strategy can be found to deliver good status by 2027, then adoption of less stringent environmental objectives can be considered.

2.7 Feasibility of Measures

A central consideration in the above process is the establishment of measures that are feasible. Article 4.4 indicates that deferral of deadlines can be justified on grounds of technical infeasibility. This should be interpreted as dealing with situations where measures that provide a technical solution to an environmental problem are not available. However, measures may also fail to be feasible for other reasons e.g. where they are practically incapable of implementation by the deadline – operational feasibility.

It is clear that neither type of feasibility should be based on cost or budget grounds. Financial issues cannot be relied on to exclude measures from CEA a priori and without the appropriate level of analysis.

Figure 1: CEA Process



3. Purpose and Scope of the Cost Effectiveness Analysis

3.1 Introduction

This Section of the Guidance identifies the measures to which cost-effectiveness analysis (CEA) should be applied.

3.2 Setting a Target Status Date

The objective, in the first instance, should be to achieve Good status by 2015. Where this is not possible on either feasibility or disproportionate costs grounds, a revised Target Status Date of 2021 should be considered. Again, if this is not possible, a revised Target Status Date of 2027 should be set.

3.3 Establishing the Good Status Gap and Need for Supplementary Measures

The first step in the process is to consider whether supplementary measures are required to achieve Good Status by the Target Status Date. This will require the description of a Reference Scenario. This scenario depicts the water quality status that will be achieved by the Target Status Date when current trends in pressures and the effect of current policies, including basic measures already committed, are taken into account.

Where the predicted Reference Status is less than Good Status a Good Status Gap is present. Additional basic measures and or supplementary measures are those currently uncommitted measures that would be needed to close this Good Status Gap.

3.4 Maintaining Good Status

The above process depicts the situation where the water body is currently below Good Status. However, some water bodies may be assessed as being already at or above Good Status. The Directive requires that the status of these water bodies should not deteriorate. This again requires a prediction of the Reference Status of the water body by 2015, if all basic measures have been implemented. If that predicted Reference Status is less than the current status, then there is a Reduced Status Gap additional basic and or supplementary measures are required.

3.5 Focusing on Additional Uncommitted Measures

Where Government has already put in place basic measures aimed at meeting the requirements of Community legislation, these should not be subjected to Cost Effectiveness Analysis. The only basin measures that should be included in Cost

Effectiveness Analysis are any additional, uncommitted basic measures. Supplementary measures are uncommitted measures to be applied in addition to basic measures with the aim of achieving the objectives of the Directive. These supplementary measures should be selected on the basis of Cost Effectiveness Analysis.

3.6 Focusing on Feasible Supplementary Measures

Additional uncommitted measures must be both technically feasible and operationally feasible in the sense of capable of implementation by the Target Status Date. CEA is then to be applied to measures/strategies that are feasible to determine the most cost effective approach.

3.7 Undertaking CEA at the Appropriate Geographic Unit of Analysis

The first step in the identification of feasible measures will be an assessment of the appropriate geographic unit of analysis. Where water bodies are interconnected, and where the pressures identified for one water body are leading to good status gaps in other water bodies, then the level of analysis should be the aggregate of these water bodies or the river basin as a whole.

3.8 Applying CEA to Measures aimed at each of the Quality Elements

In practice, river basin planners will aim to address pressures that impact negatively on four of the five elements viz.

- Physico-chemical conditions;
- Relevant specific synthetic or non-synthetic pollutants;
- Hydromorphological elements; and
- Chemical status elements.

Achieving good status in respect of biological quality elements will normally be an outcome of good status achievement for the other four quality elements.

As good status must be achieved across all elements, this means that CEA must be applied to alternative measures to achieve good status for each of the four quality elements identified above.

3.9 Identifying Candidate Measures

Annex VI Part B of the Directive provides a sample list of supplementary measures that may be considered. It is important to note that these measures include administrative and legal standards and controls, economic and fiscal instruments, and management measures as well as capital works. Care should be

taken to consider low cost measures from this list, as well as more expensive capital projects.

3.10 Sifting and Screening of Measures

If there is only one feasible measure available for achieving good status in respect of a quality element, then CEA need not be applied, as a choice between measures does not arise.

Alternatively, there may be on occasion a large number of measures available to address a specific quality element. In order to reduce the workload, river basin planners may:

- Identify and exclude measures that are dominated by others, in sense of being obviously less cost effective, and or
- Screen measures by excluding some measures from further analysis.

In arriving at a reduced number of measures to be evaluated, planners should take care to include very different measures for analysis, so as to ensure that trade-offs between costs and effectiveness are highlighted by the process. In this context, screening of measures could take the form of taking one measure to represent a family of similar measures.

Where sifting and screening of measures takes place, it is important to document the decisions made and, in particular, why measures have been excluded from further analysis.

3.11 Making Use of Generic Cost Effectiveness Analyses

As the same pressures may be identified for a number of River Basins, it may make sense to consider the cost effectiveness of measures for some pressures in an abstract manner, or alternatively, to transfer CEA analyses from one River Basin to another. This generic approach could both save time and reduce costs. This approach is acceptable provided that the CEA is rigorously applied at the generic level and the relevance of the measures and the CEA for the water body in question is confirmed.

3.12 Including Supplementary National Level Measures

Inclusion of national level measures in a management plan presents issues as such measures have to be subject of a policy decision and or legislation at central government level. There is currently a structural problem with regard to the incorporation of such measures at the river basin planning level, in that full planning at the river basin level requires national policy context.

The need for such measures will become evident from the river basin planning process itself and there will be a need to assess the requirement for such measures based on the analyses of all river basins. This can be done at two stages. If generic CEAs are carried out, then national level measures can be identified at this stage. If these measures are agreed in principle, then they can be included subsequently in the river basin level CEAs of measures and confirmed through that process. Alternatively, if they are not considered at the generic level, then they will need to be considered at river basin level. Some greater co-ordination of the approach to this issue across river basins will then be required.

3.13 Developing Strategies

This Guidance envisages that CEA will be applied to measures aimed at achieving good status in relation to each quality element. However, some measures may impact on more than one quality element. In this context, there may be a need to evaluate combinations of measures or strategies.⁴ Similarly, no one measure may achieve good status on its own, so that there may be a need to consider packages of measures or strategies.

In this context, the better options arising at the measure level should then be combined to develop strategies. These strategies would then be subject to a CEA that recognises any synergies between them e.g. that morphological measures to improve ecological status may also improve chemical status.⁵

In developing strategies, consideration should be given to:

- Including measures in a package to address the four quality elements identified above;
- Including complementary measures in a package; complementary measures are those where the inclusion of one measure increases the effectiveness or reduces the cost of another measure;
- Avoiding substitutable measures in a package, where measures are aimed at the same quality element; substitutable measures are those where the inclusion of one measure reduces the benefits or increases the costs of another measure.

Where options for analysis comprise alternative packages of measures, these packages should be formed so as to present substantially different approaches to meeting the project's objectives. For example, there might be a point discharge

⁴ It is also recognised that an individual measure or measures may be sufficient to achieve good status.

⁵ It is recognised that in practice, there may be a limited number of feasible measures and strategies.

strategy that would be compared to a diffuse discharge strategy. This would illustrate relative effectiveness leading to a combined preferred strategy that combines elements of both.

4. Structure of the Cost Effectiveness Analysis

4.1 Introduction

This Section of the Report sets out the overall structure of the CEA. Cost effectiveness analysis is a technique aimed at identifying the most cost effective method of achieving a set target. There is, thus, a need to define the output precisely, establish how the achievement of that output will be quantified and set out a cost effectiveness analysis decision criterion, which may be used to assess the relative merits of alternative measures.

4.2 Defining Outputs

The output of measures/strategies is measured by the extent to which status is improved from the Reference Status. Thus, a measure should be regarded as contributing to effectiveness, only when good status is achieved. Improvements in water quality that fall short of good status should not be regarded as effective in the sense of achieving an output.

As was indicated in Section 2, status is defined via a five-fold hierarchy from bad to poor to moderate to good to high. Only movements from a level below good status to a level of good status or above should be regarded as effective. This means that improvements in status that fall short of good status should not be accorded any weight in the decision-making process and the focus should be on considering fully effective measures.

4.3 Measuring Outputs

A numeric scoring system should be used to encapsulate incremental changes, with one incremental unit being awarded for a one step move in status and two for a two step move, and so on. So for example, the outputs arising from a sample of different transitions between water status levels is as follows:

Table 4.1: Output and Water Status Transitions

Water Status Transition	Incremental Units
Bad to Good	3
Poor to Good	2
Moderate to Good	1
Moderate to High	2

4.4 Assessing the Timing and Duration of Outputs

Some measures may achieve good status earlier than others. Although feasible effective measures are those that can be both implemented and achieve the desired outputs by the target year (2015, in the context of the first river basin plan), the impacts of these measures may extend over a much longer period. Similarly, the impact of a measure may attenuate, so that the improvement in status does not persist. In order to ensure that such analyses are implemented in a consistent fashion and take full accounts the impacts wherever they occur, they should be evaluated over a 30-year period to take account of the long life of capital projects. A shorter evaluation period may be adopted where capital measures are not involved. In such cases, the effective lifetime of the most long lasting measure should be adopted as the evaluation period.

Non Water Outputs

In addition to raising the status of water bodies, measures may also contribute some non-water positive or negative impacts. A key question to be answered is the degree to which these other impacts should be included in the measure of effectiveness. Non water impacts would appear to emanate from two sources.

Firstly, the improvement in status of a water body could give rise to positive economic benefits in terms of, say, tourism. Such effects do not need to be considered in the CEA as the latter is aimed at achieving good status, and only measures that achieve that status are considered. Thus, in respect of a given water body, the non-water benefits arising from good status are identical, no matter what measures are applied.

Secondly, non-water benefits could arise from the nature of the measure itself. For example, measures to control the rate of afforestation could impact on carbon sinks and increase Ireland's contribution to global warming. Rather than develop a methodology that attempts to encompass these effects, it is proposed to adopt achievement of good status as the indicator of effectiveness, rank measures on this basis and then consider the scale of measure-specific non water impacts and whether the cost-effectiveness ranking would be altered by including such impacts.

4.5 Discounting of Outputs

Some measures may achieve outputs sooner than others, and the CEA should, other things being equal, favour those measures. Table 4.2 depicts a hypothetical situation where the water body is at moderate status and two alternative measures are being assessed to achieve good status by 2021.⁶

The first measure achieves good status by 2016, and thus has 24 years over which it is providing output in terms of meeting good status requirements. The second measure achieves good status in 2020 and has only 20 years of output.

A discounted factor is applied to each output for each year and a sum of discounted status increment years is calculated. Thus output or effectiveness is measured as

$$\text{Output} = \sum^n \frac{\text{Status Increment Years}_n}{(1+R)^n}$$

Where R is the Rate of Discount.

In the example of Table 4.2, output is measured at 12.53 for the first measure and 9.55 for second, reflecting the fact that good status is achieved earlier for the first measure.

The discount factor applied is 4 per cent, which is the factor mandated by the Department of Finance. A table of discount factors is presented in Appendix 1.

4.6 Using a Present Value Year of 2010

As river basin management plans are to be completed by end 2009, some measures contained within the plan may be commenced in 2010. The year 2010 should be used as the present value year, i.e. the year to which all outputs are discounted. As an evaluation period of 30 years is proposed, this means that measures should be assessed for each year from 2010 to 2039, as in the example given.

⁶ It is assumed that there are no feasible measures that would achieve good status by 2015

Table 4.2: Example of Discounting Procedure

Year	Measure 1		Measure 2	
	Status Increments	Discounted Status Increments	Status Increments	Discounted Status Increments
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	1	0.79	0	0
2017	1	0.76	0	0
2018	1	0.73	0	0
2019	1	0.70	0	0
2020	1	0.68	1	0.68
2021	1	0.65	1	0.65
2022	1	0.62	1	0.62
2023	1	0.60	1	0.60
2024	1	0.58	1	0.58
2025	1	0.56	1	0.56
2026	1	0.53	1	0.53
2027	1	0.51	1	0.51
2028	1	0.49	1	0.49
2029	1	0.47	1	0.47
2030	1	0.46	1	0.46
2031	1	0.44	1	0.44
2032	1	0.42	1	0.42
2033	1	0.41	1	0.41
2034	1	0.39	1	0.39
2035	1	0.38	1	0.38
2036	1	0.36	1	0.36
2037	1	0.35	1	0.35
2038	1	0.33	1	0.33
2039	1	0.32	1	0.32
Sum of Discounted Status Increments		12.53		9.55

4.7 Estimating the Cost Effectiveness Decision Criterion

To estimate cost effectiveness, the outputs of a measure or strategy must be compared to the costs. The proposed measure for this is the output achieved per €1m spent on the measure or strategy in question.

Costs should therefore be discounted in a similar manner to yield a Present Value of Costs

$$\text{Present Value of Costs (PVC)} = \sum^n \frac{C_n}{(1+R)^n}$$

The cost effectiveness of the measure is thus calculated as:

$$\text{Output per €1m spent on measure} = \frac{\text{Output} * 1\text{m}}{\text{PVC}}$$

The measure or strategy with the highest output per €1m of spending is to be preferred. The next section discusses the estimation of costs, while Appendix 2 provides a two worked examples of CEA for a hypothetical water body.

4.8 Dealing with Uncertainty

Assessing the cost effectiveness of measures or strategies requires estimates of costs and outputs. There may be a degree of uncertainty about both of these estimates. The method of choosing the most cost effective measure or strategy described here, is based on selecting the method which has the best ratio of output to cost relative to the other methods available. Therefore the results of the exercise will remain valid in a range of situations where the actual costs and outputs of the measures in question prove to be different to the estimates used in the assessment. This feature of the method contributes to the robustness of the results that it gives.

In addition, this method of assessing cost effectiveness should produce valid results even when the effects of a measure are not exactly the same as those estimated. There may be uncertainty as to the exact effect of a measure on water quality, and the actual effect may be different from that estimated during the cost effectiveness analysis. However, over a wide range of outcomes, predictions that the measure will, say, improve water quality from moderate to good, will remain valid. Even where a measure does not reach the output anticipated this may simply amount to a delay in achieving good status. This would have a relatively small effect on the output measures used in this approach to measuring cost effectiveness. Provided that the cost effectiveness analysis would not lead to the

choice of a different measure if the output varied by a number of units, then the method is robust with respect to this risk.

This method of assessing cost effectiveness may be vulnerable to uncertainty in predicting the costs of measures or strategies. To the extent that unforeseen circumstances would affect the costs of all possible measures, they should not affect the relative ranking of measures produced by this method. To this extent, the method is robust with respect to certain sources of uncertainty about costs.

However, it is possible that the method may identify the wrong measure as being the most cost effective. This will arise if the costs of the measure in question turn out to be higher than estimate by a significant margin, while the rejected measures would have had actual costs closer to their estimated costs. This risk can be addressed by applying sensitivity analysis to the cost estimates. This technique for addressing forecasting risks investigates whether the result of the cost effectiveness analysis would be different if the costs of the measure in question were higher than the estimates used in the cost effectiveness analysis. There are two main approaches to carrying out this type of sensitivity analysis:

- Add a percentage “contingency” amount to the estimated costs of the measure, and verify that this does not affect the outcome of the cost effectiveness analysis; or,
- Analyse the cost estimate, identify areas where the costs could be higher than anticipated and prepare an alternative “worst case” estimate of the costs of the measures. Verify that using this “worst case” estimate would not change the result of the cost effectiveness analysis.

4.9 Reviewing for Measure-specific Impacts and Non-Monetisable Costs

The above methodology assumes that all measure costs are known as well as the value of measure specific impacts. With regard to the costs of measures, it is imperative that all Exchequer costs and resource costs are measured. However, environmental costs may not be measurable. Similarly, the value of measure-specific impacts may not be easily gauged. Where these unknowns are present, the analyst should consider whether the scale of these non-monetisable effects is likely to be such as to alter the relative cost effectiveness of measures.

4.10 Auditing the Process

The CEA process should be recorded in detail, with each step being recorded even where it does not impinge on the final outcome. For example, where measures are screened out, the reason for doing so should be set out; where no measure is possible for technical or operational reasons, the rationale should be made clear.

5. Defining and Estimating Costs

5.1 Introduction

This Section of the Guidance discusses the definition and measurement of costs.

5.2 Defining Costs

The costs to be assessed in the CEA should be economic costs. Economic costs go beyond public sector financial costs in that they assess the costs to society as a whole, rather than simply the financial cost to the Exchequer.

Measures may thus give rise to a number of categories of costs:

- **Public Implementation Costs:** these are costs for the public sector arising from implementation of the measure. These costs may be initial, recurring or both. They include the costs of infrastructure, management initiatives, legislation and control measures. Where the measure imposes additional taxes or charges, these should be netted off the public implementation costs.
- **Industry Implementation Costs:** These are compliance costs imposed on industry.⁷ Again they may be initial or recurring or both. They include the costs of additional treatment and restraints on production
- **Consumer Implementation Costs:** These are costs arising from implementation of measures that are imposed directly on consumers of water or water related activities. They include additional taxes, access charges and the reduction in consumer welfare from restraints on access to water-based recreation.⁸
- **External Costs:** these are costs for society at large that arise because of implementation of the measure by the public sector or industry. These are most likely to arise where infrastructure development gives rise to external environmental costs such as air pollution or visual intrusion.

It should be noted that in respect of both public and industry implementation costs, it is important to consider costs that arise indirectly, where these are important. For example, a restraint imposed on ground water abstraction may give

⁷ “Industry” is used throughout the report to refer to all private sector productive activities, including agriculture and services.

⁸ In most cases, some or all of the costs imposed on industry will be passed on to consumers. In order to avoid double counting, these costs should be ignored and the costs should be reckoned as if they were fully met by industry. As a result, consumer implementation costs refer only to those costs directly imposed on consumers.

rise to costs associated with the supply of water from more distant water bodies. Similarly, a reduction in marine dredging activities may have an impact on port economics.

5.3 Deciding the Level of Detail of Cost Estimates

In order to assess the cost-effectiveness of measures, they must be described in sufficient detail to enable costs to be measured. It is a matter of judgment as to the degree to which measures should be designed. However, by analogy with capital projects, it is suggested that a feasibility design and cost be established. This design and cost estimate is indicative and falls considerably short of detailed design and costing.

5.4 Treating Initial and Recurring Costs

The costs of a measure will typically comprise initial and recurring costs. There is a need to combine these costs to arrive at an estimate of the overall cost of the measure. As recurring costs occur some time in the future, a simple aggregation of cost will not suffice.

The discounting process which was described in Section 4.7 should be used. This process allocates costs to the year in which they occur and discounts them to a present value year.

5.5 Prices

All costs should be estimated at constant prices. That is, general inflationary effects should be excluded. As cost analyses will be completed in 2009, it is recommended that costs be measured at constant 2009 prices.

5.6 Quantification of Costs

In principle, public and private sector implementation costs and taxes and charges imposed on consumers are readily amenable to quantification. Quantification is more difficult or impossible in relation to consumer welfare impacts or external costs, because a set of robust values for these impacts is not available. It is recommended that the measurement of cost-effectiveness should proceed on the basis of costs that are readily quantifiable and significant non-quantifiable cost impacts should be noted for consideration in the appraisal process.

Treatment of Taxes and Subsidies

Where a measure requires inputs that are taxed, then the true cost of the measure is overstated. This is because while such taxes are a cost to the entities implementing the measure, they represent a benefit to other taxpayers through State expenditures or transfers. Thus, tax costs are not economic costs and should be excluded. Similarly, if some input costs are subsidised, the true costs are understated, as more resources are used up than would be indicated by the subsidised prices.

The implication is that costs should be measure net of taxation but gross of subsidies. A practical step in addressing this issue would be to exclude VAT on construction and other inputs and where impacts on agricultural production are being measured, to estimate such impacts at agricultural prices gross of subsidies.

6. Summary of Steps in the CEA

Step Number	Description	Comment
	Overall	
1.	Determine the current status of the water bodies in the catchment	
2.	Predict the 2015 status assuming based on the Reference Scenario	Take account of the impact of pressures up to 2015 and those measures and actions that are already committed by Government under existing legislation
3.	Identify water bodies that have either a good status gap or a reduced status gap by 2015,	Reduced status gap is where the status is good or above in 2008 but falls by 2015
4.	Determine the geographic unit of analysis	Where the pressures identified for one water body are leading to good status gaps in other water bodies, then the level of analysis should be the aggregate of these water bodies or the river basin as a whole.
	For Each Status Deficient Water Body	
5.	Determine whether additional measures are available to help close gap by 2015	Include technical and operationally feasible measures only
6.	Sift and screen measures as appropriate	Where a large number of measures are available, reduce their number to reflect the principal alternative approaches available

7.	Develop alternative measures and or strategies capable of closing the gap	Make sure the alternatives to be considered represent substantially different approaches
8.	Measure outputs of alternative measures or strategies	Make sure to discount and aggregate the outputs
9.	Measure costs of alternative measures or strategies	Include all relevant public implementation, industry, consumer and external costs. Include initial and recurring costs. Make sure to discount and aggregate the costs
10.	Calculate cost-effectiveness ratio for all alternative measures or strategies and rank them	
11.	Choose most cost-effective measure or strategy	In doing so, consider whether non water outputs and non-monetisable costs are large enough to alter the ranking of measures based on the cost-effectiveness ratio.
12.	Determine whether the most cost effective measures is disproportionately expensive	Refer to Guidance on Disproportionate Cost Analysis
13.	If not disproportionately expensive, include measure or strategy in river basin plan	If measure disproportionate set status target for 2021 and start the CEA with this target date

Appendix 1: Discount Factors

The Table of Discount Factors is based on a discount rate of 4 per cent.

Year	Discount Factor
1	1.0000
2	0.9615
3	0.9246
4	0.8890
5	0.8548
6	0.8219
7	0.7903
8	0.7599
9	0.7307
10	0.7026
11	0.6756
12	0.6496
13	0.6246
14	0.6006
15	0.5775
16	0.5553
17	0.5339
18	0.5134
19	0.4936
20	0.4746
21	0.4564
22	0.4388
23	0.4220
24	0.4057
25	0.3901
26	0.3751
27	0.3607
28	0.3468
29	0.3335
30	0.3207

Appendix 2: Case Studies

Case Study A: Fake River - Hydromorphological Pressures

A1 Background

Fake River contains a ten kilometre stretch with no pollution pressures, but with morphological pressures that impact on the river biology. These morphological pressures consist of overgrazing and channelisation. These pressures are impacting on the ecology of the River, so that measures aimed at addressing morphological pressures are required if good status is to be achieved.

A2 Identifying the Pressures

There are two pressures. The first is that overgrazing of animals is occurring leading to destruction of the riparian zone and occasional incursion of animals into the river. These are in turn leading to a reduction in water quality and disturbance to spawning grounds. The second pressure is that river dredging has occurred leading to channelisation. This has altered river flow and spawning grounds, with adverse effects on fish life.

A3 Establishing the Current and Year 2015 Status

Currently, the morphological pressures are such that the ecological status of the River is Moderate. This status will not be raised by 2015 unless additional uncommitted measures are taken.

A4 Establishing the Good Status Gap

Additional measures are needed to bring the status from Moderate up to Good.

A5 Identification of Feasible Alternative Measures: Overgrazing

With regard to the overgrazing pressure, planners have identified two options:

- Natural recovery; and
- Assisted recovery.

Natural recovery is often termed “benign neglect” by river morphologists and involves removal of the pressure, and leaving the river alone to recover naturally. Overgrazing has been a problem in the west of Ireland. However it is widely accepted that the process of natural recovery is already occurring in Ireland since

farming practices have changed and there is no longer a high intensity of farming in upland areas i.e. the pressure has been removed. However, this process will take a long time to achieve the desired result.

Assisted recovery is the application of soft engineering enhancement measures to boost the river's recovery potential. Irish experts foresee these measures as being the most relevant to address morphology issues. In the context of Fake River, this takes the form of:

- Bank stabilisation using log tree revetments and willow spiling; and
- Fencing off to allow recovery of riparian zone (preventing livestock).

Recovery of the riparian zone will take 6 years to achieve from the date of the capital works (2011), so that good status would be achieved in 2017, in the period of the second river basin plan.

Natural recovery is not a measure in the context of the WFD. No action is required on the part of Government to achieve this outcome. Either it is happening naturally because of changes in the socio-economic environment, or it is occurring due to past and committed Government initiatives. Natural recovery is in fact the Reference Scenario. It would be different if additional policies to restrict stocking rates were being contemplated.

As a result, there is only one option being considered. If there are no other realistic options, then there is no need to apply cost effectiveness analysis.

However, the issue of disproportionate costs could arise, in that assisted recovery could be deemed to be disproportionately expensive. Assisted recovery costs have been estimated at an initial capital cost of €2m with recurring annual maintenance costs of €7,500.⁹

This might be the case if natural recovery were to occur soon after 2021, say 2023. This would mean that the assisted recovery spend would provide benefits for a limited period of 6 years. A disproportionate cost analysis, which compares a reference scenario (natural recovery) with the assisted recovery scenario, would be needed to make the case.

A6 Identification of Feasible Alternative Measures: Channelisation

With regard to the channelisation pressure, three measures were again identified:

- Natural recovery;

⁹ Note: all the costs in this case study are real costs derived from a number of sources but, principally, the POMS Morphology Report.

- Assisted recovery – enhancement scheme; and
- Large scale restoration scheme.

Natural recovery in this context is the cessation of watercourse maintenance activities. Good status would be achieved within ten years – 2020. It should be noted, that unlike the overgrazing example, natural recovery **is** a measure in the context of the WFD. This is because it requires an additional action on the part of Government viz. cessation of maintenance activities. Thus, “natural recovery” is a misnomer.

Assisted recovery is a lower cost option comprising:

- Recreation of pools;
- Fencing off;
- Narrowing of channels; and
- Substrate Enhancement.

Good status would be achieved within 7 years, i.e. by 2017.

Large scale restoration involves remeandering of the river and raising bed levels in addition to the actions under assisted recovery. Good status would be achieved by 2014.

A7 Sifting and Screening of Measures

As only three measures have been identified, no sifting or screening is required.

A8 Developing a Strategy

As all three measures are capable of achieving good status, there is no need to consider combining measures into a strategy.

A9 Setting a Target Status Date

Only one of the measures – large scale restoration - achieves good status prior to 2015. Therefore, no CEA is required and this measure should be proceeded with, unless it can be shown to be disproportionately expensive. If it is disproportionately expensive, then the CEA analysis of the three options would need to be undertaken in the context of a 2021 target date.

A10 Defining and Measuring Outputs

As all of the alternative measures are aimed at achieving good status, the output is one incremental unit. This will be achieved at different dates according to the following table.

Measure	Incremental Output	Year Output is Achieved
Natural recovery	1	2020
Assisted recovery	1	2017
Large scale restoration	1	2014

A11 Calculation of Outputs

The calculation of the Discounted Sum of the Increment Years is presented in Table A1 and summarised below:

Measure	Output in Discounted Increment Years
Natural recovery	9.55
Assisted recovery	11.74
Large scale restoration	14.21

At 14.21 units, the output from the large scale restoration measure is 49 per cent above Natural recovery and 21 per cent above Assisted recovery.

A12 Defining and Estimating Costs

Public Implementation Costs

The following are the public implementation costs. These relate to the initial capital costs of works and recurring maintenance costs. Cessation of maintenance activities gives rise to no direct public implementation costs.

Measure	Initial Costs (€m)	Recurring Costs (€000)
Natural recovery	0.0	0.0
Assisted recovery	2.5	7,500
Large scale restoration	6.5	15,000

Industry Implementation Costs

As dredging of the river will be discontinued, it may be expected that with the Natural and Assisted recovery Measures, there will be a seasonal loss of productive farming land, as the river will breach its banks in certain places in periods of high rainfall. With regard to large scale restoration, remeandering of the river will give rise to further land take. This will reduce the farmer's consumer surplus as measured by the costs of the land take. This is a once-off capital item.

Three stretches of river to an aggregate of 1,000 metres in length and 50 metres wide will be flooded. This will result in the loss of 5 hectares of land for five months of the year. Assuming a price €25,000 per hectare and assuming a loss of value proportionate to the duration of flooding, this is a once off cost of €0.052m (€25,000 x 5 hectares x 5/12).

With regard to meandering, a further 1,000 metres in length will be affected, with an average width of 150 metres. This amounts to a land loss of 15 hectares at a cost of €0.375m. The once-off industry costs of the measure are therefore as follows:

Measure	Costs (€m)
Natural recovery	0.052
Assisted recovery	0.052
Large scale restoration	0.427

Consumer Implementation Costs

Prior to dredging of Fake River, periodic flooding occurred. Channelisation was partly prompted by the fact that, in a number of flooding events, some houses had come under threat, although no ingress of water had taken place.

Flood risk modelling revealed that two properties would be affected in a 50 year flood and six properties in the 100 year flood. In the 100 year flood, three properties would be flooded to above floor level, which is a key determinant of damage to property and contents.

The costs incurred by damage at these intervals were calculated using Flood Hazard Research Centre (FHRC) FLAIR data.¹⁰ The FHRC approach calculates the damage inflicted by flooding of different depths and durations and distinguishes between the impact of flooding on the building fabric and on its contents. The costs arising from flood effects on a variety of property types are provided in the FHRC FLAIR report.¹¹ Using the above damage costs, the expected value of the damage cost for any one year can be estimated, taking account of the probability of a flood occurring and the costs imposed when it does occur. This was estimated at €3,300 per annum.

Intangible benefits such as those impacting on the health of wellbeing of residents are normally taken to be equivalent to the damage costs, so that the annual expected costs of flooding of residences was estimated at €6,600 per annum.

Because the flood heights reached even in the 100 year flood were not sufficient to result in a major ingress of water above floor, dredging was found to be a sufficient response.

¹⁰ FLAIR 1990, Flood Hazard Research Centre, Middlesex Polytechnic 1990.

¹¹ They are given in January 1990 prices in pounds sterling. These figures were converted revised by converting them into Irish Euro at the 1990 exchange rate and the increasing them according to Irish inflation rates for the intervening period.

It was considered that all of these flood relief benefits (€6,600 per annum) would be lost under the Natural recovery and Assisted recovery measures. These would thus represent a consumer implementation cost.

With regard to Large scale restoration, re-meandering of the river would increase the flood plain and reduce the severity of the flooding to some extent. In this case, the expected damage would be reduced by one quarter compared with no protection, so the flood relief benefits lost would be €4,950 (0.75 X €6,600).

For all measures, these costs would start to arise once good status is restored.

The annual consumer costs of the measure are therefore as follows

Measure	Costs (€m)
Natural recovery	0.007
Assisted recovery	0.007
Large scale restoration	0.005

External Costs

There are no external costs arising.

A13 Cost Effectiveness

The Table below summarises the cost-effectiveness of the alternative measures. The natural recovery measure has a cost effectiveness ratio of 97.4 units of output per €1m of spending. This is by far the highest cost effectiveness score. Large scale restoration only scores 2 on this scale, while assisted recovery scores 4.4. Tables A.1 to A.3 summarise the calculations.

Measure	Output in Discounted Increment Years	Discounted Costs (€m)	Effectiveness Ratio (units of output per €m)
Natural recovery	9.55	0.098	97.4
Assisted recovery	11.74	2.646	4.4
Large scale restoration	14.21	6.926	2.0

The natural recovery measure is so superior in cost-effectiveness terms that it is likely to hold true across a range of water bodies, especially those outside urban areas. For water bodies with substantial residential or commercial dwellings in their catchments, it is possible that natural recovery would give rise to increased consumer costs in the form of higher risks of flood damage. In this context, large scale restoration might become a more cost-effective option, as remeandering of the river could reduce the flood risk to property.

Table A2.1: Measurement of Costs: Natural Recovery

Year	Natural Recovery Costs (€000)					
	Public Implementation	Industry	Consumer	Total	Discounted	
2010	0.0				0.0	0.000
2011	0.0				0.0	0.000
2012	0.0				0.0	0.000
2013	0.0				0.0	0.000
2014	0.0				0.0	0.000
2015	0.0				0.0	0.000
2016	0.0				0.0	0.000
2017	0.0				0.0	0.000
2018	0.0				0.0	0.000
2019	0.0				0.0	0.000
2020	0.0	52	6.6	58.6	39.588	
2021	0.0		6.6	6.6	4.287	
2022	0.0		6.6	6.6	4.122	
2023	0.0		6.6	6.6	3.964	
2024	0.0		6.6	6.6	3.811	
2025	0.0		6.6	6.6	3.665	
2026	0.0		6.6	6.6	3.524	
2027	0.0		6.6	6.6	3.388	
2028	0.0		6.6	6.6	3.258	
2029	0.0		6.6	6.6	3.133	
2030	0.0		6.6	6.6	3.012	
2031	0.0		6.6	6.6	2.896	
2032	0.0		6.6	6.6	2.785	
2033	0.0		6.6	6.6	2.678	
2034	0.0		6.6	6.6	2.575	
2035	0.0		6.6	6.6	2.476	
2036	0.0		6.6	6.6	2.381	
2037	0.0		6.6	6.6	2.289	
2038	0.0		6.6	6.6	2.201	
2039	0.0		6.6	6.6	2.116	

PVC

98

Table A2.2: Measurement of Costs: Assisted Recovery

Year	Assisted Recovery Costs (€000)				
	Public Implementation	Industry	Consumer	Total	Discounted
2010	0.0			0.0	0.000
2011	2500.0			2500.0	2403.846
2012	7.5			7.5	6.934
2013	7.5			7.5	6.667
2014	7.5			7.5	6.411
2015	7.5			7.5	6.164
2016	7.5			7.5	5.927
2017	7.5	52	6.6	66.1	50.231
2018	7.5		6.6	14.1	10.303
2019	7.5		6.6	14.1	9.906
2020	7.5		6.6	14.1	9.525
2021	7.5		6.6	14.1	9.159
2022	7.5		6.6	14.1	8.807
2023	7.5		6.6	14.1	8.468
2024	7.5		6.6	14.1	8.142
2025	7.5		6.6	14.1	7.829
2026	7.5		6.6	14.1	7.528
2027	7.5		6.6	14.1	7.239
2028	7.5		6.6	14.1	6.960
2029	7.5		6.6	14.1	6.692
2030	7.5		6.6	14.1	6.435
2031	7.5		6.6	14.1	6.188
2032	7.5		6.6	14.1	5.950
2033	7.5		6.6	14.1	5.721
2034	7.5		6.6	14.1	5.501
2035	7.5		6.6	14.1	5.289
2036	7.5		6.6	14.1	5.086
2037	7.5		6.6	14.1	4.890
2038	7.5		6.6	14.1	4.702
2039	7.5		6.6	14.1	4.521
PVC					2641

Table A2.3. Measurement of Costs: Large Scale Restoration

Year	Large Scale Restoration Costs (€000)				
	Public Implementation	Industry	Consumer	Total	Discounted
2010	0.0				0.0
2011	6500.0			6500.0	6250.000
2012	15.0			15.0	13.868
2013	15.0			15.0	13.335
2014	15.0	427	4.95	447.0	382.055
2015	15.0		4.95	20.0	16.397
2016	15.0		4.95	20.0	15.767
2017	15.0		4.95	20.0	15.160
2018	15.0		4.95	20.0	14.577
2019	15.0		4.95	20.0	14.017
2020	15.0		4.95	20.0	13.478
2021	15.0		4.95	20.0	12.959
2022	15.0		4.95	20.0	12.461
2023	15.0		4.95	20.0	11.981
2024	15.0		4.95	20.0	11.521
2025	15.0		4.95	20.0	11.078
2026	15.0		4.95	20.0	10.651
2027	15.0		4.95	20.0	10.242
2028	15.0		4.95	20.0	9.848
2029	15.0		4.95	20.0	9.469
2030	15.0		4.95	20.0	9.105
2031	15.0		4.95	20.0	8.755
2032	15.0		4.95	20.0	8.418
2033	15.0		4.95	20.0	8.094
2034	15.0		4.95	20.0	7.783
2035	15.0		4.95	20.0	7.484
2036	15.0		4.95	20.0	7.196
2037	15.0		4.95	20.0	6.919
2038	15.0		4.95	20.0	6.653
2039	15.0		4.95	20.0	6.397
PVC					6926

Case Study B: Fake River - Point Source Pressures

B1 Background

Fake River contains a ten kilometre stretch which faces pressure from three point sources of pollution. These point sources are affecting the BOD and nutrient load of the river, and reducing the biological quality of the river. Measures will be required to address this pressure in order to achieve good status for this water body by 2015.

B2 Identifying the Pressures

There are three point sources which discharge into this water body. They are:

- A municipal waste water treatment plant serving a population equivalent of less than 2,000 (“the small MWWTP”);
- A municipal waste water treatment plant serving a population equivalent of between 2,000 and 10,000 (“the medium MWWTP”); and,
- An industrial plant discharging waste water into the river under an Integrated Pollution Prevention Control (“IPPC”) licence from the EPA (“the Industrial Discharge”).

The assimilative capacity at the point on the river where the small WWTP discharges is such that the river currently shows an excessive BOD load, at this point. Population projections for the community using the small MWWTP indicate that this pressure will persist, and even worsen, by 2015 in the absence of corrective measures. This excessive BOD load is enough to limit water quality to Moderate on this water body.

The assimilative capacity at the point where the medium MWWTP discharges is currently sufficient to ensure that this plant is not causing water quality to fall below Good. However, the future output of the medium MWWTP has been estimated, based on projected population in 2015. By 2012, the medium MWWTP will be causing an excessive nutrient load in the river. This excessive nutrient load will limit water quality to Moderate on this water body from 2012 on.

The industrial plant has adequate capacity to treat its waste water, and the river has adequate assimilative capacity at the point where the waste water is discharged. Despite this, it is causing deterioration in the biological quality of the receiving waters. This deterioration is enough to limit water quality to Moderate on this water body.

B3 Establishing the Current and Year 2015 Status

If the Fake River is to reach Good status by 2015, all of the water bodies on the river must meet the relevant standards for: biological quality; physico-chemical conditions, pollutants and hydromorphological elements.

As described in Section B2 above, the Fake River currently faces pressure from the small MWWTP and the Industrial Discharge. The effect of these will be to keep the river at Moderate rather than Good status. Both of these pressures would have to be addressed to bring the river to Good status.

By 2015, the pressure from the medium MWWTP will have increased to the point where it also would prevent the river from reaching Good status.

B4 Establishing the Good Status Gap

To reach Good status by 2015 measures are needed to address the pressure from all three point sources.

B5 Identification of Feasible Alternative Measures: Small MWWTP

With regard to the pressure from the small MWWTP, planners have identified two options:

- Upgrading the plant; or,
- Relocating the point at which the plant discharges into the river.

The proposed upgrade to the small MWWTP would increase the extent to which sewage is processed before being discharged into the river. It would increase the level of tertiary treatment from a BOD25 to a BOD10 standard. The upgrade would be completed, and would take full effect, by 2012, at a one off capital cost of €200,000. There would be no additional ongoing costs from this upgrade.

Relocating the discharge point for the small MWWTP would be completed and take full effect by 2014. This work would have a one off cost of €500,000. There would be no additional ongoing costs from this upgrade.

B6 Identification of Feasible Alternative Measures: Medium MWWTP

With regard to the point pressure from the medium MWWTP, two potential measures were identified:

- Planning and Development controls; or,
- An upgrade to the medium MWWTP.

The medium MWWTP currently has sufficient capacity to deal with the waste water from its catchment area. It does not currently place pressure on water quality that would prevent the Fake River from reaching good status. However, current planning would allow the town served by the medium MWWTP to grow, and it is anticipated that this growth will take place. Once this growth takes place, the MWWTP will no longer be able to treat waste water from the town to a standard where it does not put pressure on water quality in the Fake River. If the relevant area plans were changed to prevent this town from growing any more, this pressure would be removed.

This measure would have no costs for the local authority. However it would impose costs on the private sector. The usefulness of this measure comes from the fact that it prevents developers from building additional residential and commercial property in the medium sized town. This leads to there being fewer residents and businesses in the town by 2015, than would otherwise have been the case. If the revised planning rules have an effect on development, there must be people and firms for whom this medium-sized town was the preferred location for their home or business premises, and the new planning rules must be making them locate in an alternative, “second best” location. The tighter planning controls must, therefore, be imposing some cost on businesses and residents. These costs could take the form of extra construction costs imposed by the “second best” locations, or the premises and homes in these “second best” locations being considered less valuable by the businesses and residents affected. These costs represent an economic cost of this measure, and must be taken into account in assessing cost effectiveness. The process of estimating such costs is discussed below.

The alternative measure that will alleviate pressure from the medium MWWTP is an upgrade of the plant to increase the level of nutrient removal. This upgrade would have a one off capital cost of €300,000 and would be completed by 2012.

B7 Identification of Feasible Alternative Measures: Industrial Discharge

The only technically feasible solution to remove the pressure from the Industrial Discharge is for the firm in question to invest more in waste water treatment in its

plant to increase the quality of the water it discharges into the Fake River. This work would have a one off cost of €1m for the firm in question. The proposed measure is that this investment by the firm should be made a condition of its IPPC licence. This would be implemented by 2012 and would prevent this point source from affecting the quality of the water in the Fake River. As there is only one technically feasible measure to address this pressure and so allow the Fake River to reach good status by 2015, no further cost effectiveness analysis is required for this measure. This measure should be included in the River Basin Management Plan for the Fake River, and implemented, unless it can be demonstrated that the measure is disproportionately costly.

B8 Sifting and Screening of Measures

Cost effectiveness analysis is only required for two point source pressures. Only two technically feasible measures have been examined for each point source. No sifting or screening is required.

B9 Developing a Strategy

For each of the two point sources, there is a choice of two measures, either of which will allow the Fake River to reach good status. None of the measures affects more than one point source. Therefore, there is no need to combine measures into strategies. The Cost Effectiveness Analysis should consist of identifying the most cost effective measure for each of the two point sources of pressure.

B10 Setting a Target Status Date

For each point source of pressure there is a choice of measures which will deal with the pressure by 2015. It will therefore be possible to pick a pair of measures that will lead to good status for the Fake River by 2015. CEA should be used to pick the most cost effective pair of measures to achieve good status by 2015. These measures should be included in the River Basin management plan and implemented unless they can be shown to be disproportionately expensive.

B11 Defining and Measuring Outputs

Small MWWTP

Both measures for the small MWWTP will allow the Fake River to move from Moderate to Good status (provided the other pressure is dealt with). The output

from each measure is, therefore, one incremental unit of status. This will be achieved at different dates according to the following table.

Measure	Incremental Output	Year Output is Achieved
Plant Upgrade	1	2012
Relocate the discharge point	1	2014

Medium MWWTP

Similarly, both measures for the medium MWWTP have an output of one incremental unit of status. For both measures this output will be achieved by 2012.

B12 Calculation of Outputs

The calculation of the Discounted Sum of the Increment Years is presented in Table B1 and summarised below:

Small MWWTP

Measure	Output in Discounted Increment Years
Plant Upgrade	16.02
Relocate the discharge point	14.21

Plant upgrade has an output some 13 per cent greater than relocating the discharge point, due to earlier results.

Medium MWWTP

Measure	Output in Discounted Increment Years
Planning and Development Controls	16.02
Plant Upgrade	16.02

Both of the technically feasible measures for the medium MWWTP address the pressure, and so allow good status, by 2012. Therefore, they deliver the same output.

B13 Defining and Estimating Costs

Public Implementation Costs

The following are the public implementation costs. These relate to the initial capital costs of works and recurring maintenance costs.

Small MWWTP

Measure	Initial Costs (€'000)	Recurring Costs (€000)
Plant Upgrade	200	0
Relocate the discharge point	500	0

Medium MWWTP

Measure	Initial Costs (€'000)	Recurring Costs (€000)
Planning and Development Controls	0	0
Plant Upgrade	300	0

Industry Implementation Costs

None of the measures being considered for the small MWWTP and the medium MWWTP would impose extra costs on industry. The measure that will be implemented for the Industrial Discharge will impose costs on industry. These costs would have to be taken into account if this measure was being compared with another technically feasible measure in a CEA.

Consumer Implementation Costs

As discussed above one of the measures being considered for the medium MWWTP, the tightening of planning and development controls, could impose costs on developers.

In principle, the tightening of planning and development controls will prevent developers from building on their first choice of site. Developers will be building on a “second best” site. This will impose extra economic costs on the builder if these second best sites:

- Will impose extra building costs on the developer; or,
- Will lead to the developed property being valued less highly by the eventual user,

These costs will be passed on the eventual user of the buildings, in the form of higher prices or in buildings that are less valuable to the user. In other words, the imposition of tighter planning controls could lead to an economic cost being imposed on consumers.

However, these costs will not be material if equivalent development land is available elsewhere in the general area. This type of cost will only arise if there is a general shortage of development land in the area.

Placing a value on this cost will be difficult. It will be some proportion of the development value of the lands affected by the tighter planning controls. For this measure, this cost has been estimated as a one off cost of €268,000 arising in 2012 when the new planning controls are introduced. Details of this estimate are set out in Table B3 below.

External Costs

There are no external costs arising.

B14 Cost Effectiveness

The Tables below summarises the cost-effectiveness of the alternative measures. Details of the calculation of Discounted Costs are set out in Table B2 below.

Small MWWTP

Measure	Output in Discounted Increment Years	Discounted Costs (€'000)	Effectiveness Ratio (units of output per €m)
Plant Upgrade	16.02	185	86.6
Relocate the Discharge Point	14.21	427	33.3

The plant upgrade is clearly the most cost effective way to address the pressure on water quality from the small MWWTP. Spending on the plant upgrade is almost three times as cost effective as spending on relocating the discharge point. This arises from the fact that the plant upgrade is cheaper than relocating the discharge point, and delivers the necessary quality improvement sooner.

Medium MWWTP

Measure	Output in Discounted Increment Years	Discounted Costs (€'000)	Effectiveness Ratio (units of output per €m)
Planning and Development Controls	16.02	248	64.6
Plant Upgrade	16.02	277	57.8

For the medium MWWTP, implementing planning and development controls seems marginally more cost effective than upgrading the plant. Both measures achieve the necessary improvement in quality at the same time, so have the same output in terms of improving water quality. However the cost of the planning and development controls, as estimated for this exercise, is lower than the cost of a plant upgrade. However the cost of the planning and development controls is an economic cost imposed on consumers due to a decrease in the choice of

development land available. This cost can only be estimated, and this result is sensitive to the accuracy of the estimate used. If there was a significant risk that the actual cost to consumers of the planning controls would be greater than estimated, the most cost effective strategy might be to opt for the plant upgrade.

Table B1.1: Measurement of Output, Small MWWTP

Year	Upgrade Plant		Relocate Discharge	
	Increment Years	Discounted Increment Years	Increment Years	Discounted Increment Years
2010	0	0.00	0	0.00
2011	0	0.00	0	0.00
2012	1	0.92	0	0.00
2013	1	0.89	0	0.00
2014	1	0.85	1	0.85
2015	1	0.82	1	0.82
2016	1	0.79	1	0.79
2017	1	0.76	1	0.76
2018	1	0.73	1	0.73
2019	1	0.70	1	0.70
2020	1	0.68	1	0.68
2021	1	0.65	1	0.65
2022	1	0.62	1	0.62
2023	1	0.60	1	0.60
2024	1	0.58	1	0.58
2025	1	0.56	1	0.56
2026	1	0.53	1	0.53
2027	1	0.51	1	0.51
2028	1	0.49	1	0.49
2029	1	0.47	1	0.47
2030	1	0.46	1	0.46
2031	1	0.44	1	0.44
2032	1	0.42	1	0.42
2033	1	0.41	1	0.41
2034	1	0.39	1	0.39
2035	1	0.38	1	0.38
2036	1	0.36	1	0.36
2037	1	0.35	1	0.35
2038	1	0.33	1	0.33
2039	1	0.32	1	0.32
		16.02		14.21

Table B1.2: Measurement of Output, Medium MWWTP

Year	Planning and Development Controls		Plant Upgrade	
	Increment Years	Discounted Increment Years	Increment Years	Discounted Increment Years
2010	0	0.00	0	0.00
2011	0	0.00	0	0.00
2012	1	0.92	1	0.92
2013	1	0.89	1	0.89
2014	1	0.85	1	0.85
2015	1	0.82	1	0.82
2016	1	0.79	1	0.79
2017	1	0.76	1	0.76
2018	1	0.73	1	0.73
2019	1	0.70	1	0.70
2020	1	0.68	1	0.68
2021	1	0.65	1	0.65
2022	1	0.62	1	0.62
2023	1	0.60	1	0.60
2024	1	0.58	1	0.58
2025	1	0.56	1	0.56
2026	1	0.53	1	0.53
2027	1	0.51	1	0.51
2028	1	0.49	1	0.49
2029	1	0.47	1	0.47
2030	1	0.46	1	0.46
2031	1	0.44	1	0.44
2032	1	0.42	1	0.42
2033	1	0.41	1	0.41
2034	1	0.39	1	0.39
2035	1	0.38	1	0.38
2036	1	0.36	1	0.36
2037	1	0.35	1	0.35
2038	1	0.33	1	0.33
2039	1	0.32	1	0.32
		16.02		16.02

Table B2.1: Measurement of Costs: Small MWWTP: Plant Upgrade

Year	Costs (€000)			
	Public Implementation	Industry	Total	Discounted
2010	0	0	0	0
2011	0	0	0	0
2012	200	0	200	185
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
2022	0	0	0	0
2023	0	0	0	0
2024	0	0	0	0
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
2028	0	0	0	0
2029	0	0	0	0
2030	0	0	0	0
2031	0	0	0	0
2032	0	0	0	0
2033	0	0	0	0
2034	0	0	0	0
2035	0	0	0	0
2036	0	0	0	0
2037	0	0	0	0
2038	0	0	0	0
2039	0	0	0	0
Present Value of Costs				185

Table B2.2: Measurement of Costs: Small MWWTP: Relocate Discharge Point

Year	Costs (€000)			
	Public Implementation	Industry	Total	Discounted
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	500	0	500	427
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
2022	0	0	0	0
2023	0	0	0	0
2024	0	0	0	0
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
2028	0	0	0	0
2029	0	0	0	0
2030	0	0	0	0
2031	0	0	0	0
2032	0	0	0	0
2033	0	0	0	0
2034	0	0	0	0
2035	0	0	0	0
2036	0	0	0	0
2037	0	0	0	0
2038	0	0	0	0
2039	0	0	0	0
Present Value of Costs				427

Table B2.3: Measurement of Costs: Medium MWWTP: Planning Controls

Year	Costs (€000)			
	Public Implementation	Consumers	Total	Discounted
2010	0	0	0	0
2011	0	0	0	0
2012	0	268	268	248
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
2022	0	0	0	0
2023	0	0	0	0
2024	0	0	0	0
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
2028	0	0	0	0
2029	0	0	0	0
2030	0	0	0	0
2031	0	0	0	0
2032	0	0	0	0
2033	0	0	0	0
2034	0	0	0	0
2035	0	0	0	0
2036	0	0	0	0
2037	0	0	0	0
2038	0	0	0	0
2039	0	0	0	0
Present Value of Costs				248

Table B2.4: Measurement of Costs: Medium MWWTP: Plant Upgrade

Year	Costs (€m)			
	Public Implementation	Consumers	Total	Discounted
2010	0	0	0	0
2011	0	0	0	0
2012	300	0	0	277
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
2022	0	0	0	0
2023	0	0	0	0
2024	0	0	0	0
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
2028	0	0	0	0
2029	0	0	0	0
2030	0	0	0	0
2031	0	0	0	0
2032	0	0	0	0
2033	0	0	0	0
2034	0	0	0	0
2035	0	0	0	0
2036	0	0	0	0
2037	0	0	0	0
2038	0	0	0	0
2039	0	0	0	0
Present Value of Costs				277

Table B3: Estimating the Consumer Costs of Planning and Development Controls

Projected Populations Equivalents using the medium MWWTP by 2015 if no controls in place	12,000
Maximum Capacity of the MWWTP	10,000
Number of Population Equivalents that the Planning Controls must prevent from using the MWWTP	2,000
Average Household Size	3
Number of housing units that must be prevented from being developed	667
Average plot size in acres for a residential unit in this town (acres)	0.1
Amount of land to lose development status (acres)	67
Value of this land per acre when development possible (€)	200,000
Development Value of land affected by the new Planning Controls (€m)	13.4
Percentage of this value that is "lost" to the economy due to the change in planning controls, i.e. cannot be replaced by using alternative lands	2%
Cost to consumers of the new planning and development controls (€)	<u>268,000</u>