Department for the Environment, Food and Rural Affairs

Costing of the Revision to the Bathing Water Directive: Phase 3 Studies

Final Report

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Executive Summary

ES1 Introduction

This report was commissioned by the UK Department for Environment, Food and Rural Affairs (DEFRA) to assess the costs of implementing a revised Bathing Water Directive (76/160/EEC). The analysis uses data generated for bathing waters in England and Wales.

ES2 Potential Microbiological Thresholds

The assessment takes as a basis the microbiological assessment categories presented in the draft WHO methodology as potential thresholds for a revision to the Directive (WHO, 2001). The potential thresholds are given in the table below.

WHO Microbiological Assessment Category	Faecal Streptococci Threshold (/100ml, 95%ile)
Class A	less than 40
Class B	40 to 200
Class C	201 to 500
Class D	over 500

No threshold(s) for revision to the Directive have been published. Three potential microbiological thresholds equating to Class A, B and C were therefore tested, of 40, 200 and 500 faecal streptococci per 100ml at 95%ile respectively, to reflect the range of potential compliance scenarios.

ES3 Identification of Bathing Water Categorisation After Existing Infrastructure Commitments Are Installed by 2005

An assumption has been taken that compliance with the Guideline standard of the existing Directive is approximately the same as draft WHO methodology Class B and existing Mandatory equates to Class C. It is then possible to predict the future categorisation after the England and Wales water company 2000 to 2005 asset management and investment period. As expected, the main shift from 2000 to 2005 is for a greater number of Class B sites, with only 3 bathing waters likely to remain in the lowest Class D category, as detailed in the table below.

WHO Microbiological Assessment Category	Number of Bathing Waters in England and Wales by 2005
Class A	54
Class B	287
Class C	126
Class D	3

ES4 Assessment of Measures Needed to Meet Revised Standards

The main sources of faecal pollution for bathing waters in England and Wales are identified in the table below. Other less significant sources may have been identified on a site-specific basis.

Source	Range of Inputs
Continuous discharges	Wastewater treatment works Industrial discharges Cross connections to surface water outfalls
Intermittent discharges	Direct combined sewer overflows Storm-water overflows
Diffuse discharges	Riverine wastewater treatment works Riverine combined sewer overflows Unspecified urban diffuse sources Agricultural drainage and run-off Septic tanks
Mammals and birds	Seal and bird colonies, dogs, donkeys
Harbours and marinas	Unsewered wastewater from boats

Identification of the measures to improve microbiological quality at each bathing water to the three regulatory scenario thresholds was undertaken primarily during regional discussions with the Environment Agency and water company personnel. At the meetings the participants were requested to assess for each bathing water the measures necessary by 2005 to achieve consistent Class C, approximating to the existing Mandatory standard; to Class B approximating to the existing Guideline standard; and to a Class A threshold significantly more stringent than the existing Guideline standard.

The participants in the risk assessments were uncomfortable with the requirement to identify all sources and specify remediation measures for many of the bathing waters being considered, particularly for the most stringent regulatory scenario, as they felt that insufficient data were available to be unequivocal in many cases. This was particularly relevant when discussing the magnitude and extent of diffuse faecal contamination and its remediation. Where necessary a qualified opinion was given. A database containing a consolidated matrix of bathing waters, microbiological data and potential faecal sources was used as the basis of the assessment.

ES5 Assumptions and Limitations

An important component of the costing exercise has been the drive to maintain an open and auditable costing system. Many of the costs and measures have been determined on the basis of qualified judgement, and in some cases heroic estimates. The project team has therefore sought to identify where improvements in the prediction of measures and the consequent costs could be strengthened and confidence added. It is hoped that in this way any future studies could build on these initial findings to arrive at focused cost estimates based on updated best available data.

ES6 Costing Assumptions for the Compliance Scenarios

ES6.1 Wastewater Sources

Approximately 99% of the wastewater treatment works over 15,000 population equivalent have already been upgraded to provide a minimum of secondary treatment to comply with the Urban Wastewater Treatment Directive. A significant number of the coastal treatment works also have UV disinfection installed to comply with the requirements of the Mandatory and in many cases Guideline standards of the existing Bathing Water Directive. There are also a number of additional UV disinfection systems planned for installation prior to 2005 with similar aims.

There are however a number of wastewater treatment works more distant from the bathing waters that may need to be upgraded to meet more stringent standards. There also remain a reasonably large number of CSOs that are not designed to the 3 spills policy that may contribute to indirect coastal or riverine microbiological loads during rainfall events. These have been identified where appropriate and upgrades specified..

For the bathing waters that require additional measures the costs were derived from data held by the Office of Water Services (Ofwat) and the water companies.

ES 6.2 Agricultural Sources

Faecal pollution from direct and diffuse agricultural sources has been identified as a potentially significant source of faecal contamination for a large number of bathing water at the more stringent thresholds.

There are relatively few studies that have sought to identify the microbiological budgets and the consequent influence of diffuse agricultural contamination. Furthermore, to our knowledge there is only one research study in the UK by the Scottish Agricultural College and CREH, in Irvine Bay, Ayrshire on the west coast of Scotland, which has sought to develop costs for remediation of faecal contamination due to agricultural activities. These data have been used by WRc as the basis for their report to the European Commission on costs for the revision of the Bathing Water Directive (WRc, 2001). A recent review by Cascade Consulting in association with Professor Hanley (Cascade Consulting, 2002c) has concluded that these costings are based on unsupported assumptions and do not incorporate sound economic analysis to establish least cost solutions. In the absence of more robust data, the transfer of the existing study outcomes to catchments in England and Wales has been made in recognition of these shortcomings.

With this in mind, the assumptions and outcomes in agricultural costs must be treated with great caution and policy should not be dictated by these findings. However, the general findings of the shift from urban wastewater treatment towards agriculture-derived faecal pollution control and the consequent change in focus of remediation costs over the longer term is of significance and can be considered reasonable. It is the scale of the costs that remains open to question.

A number of measures have been identified that have the potential to reduce agricultural diffuse pollution, shown as Steps 1 to 6 in the WRc report. These are:

Step 1:	Prevent animal access to watercourses
Step 2:	and eliminate dairy farmyard losses
Step 3:	and eliminate leaks from storage

Step 4: and eliminate waste spreading during bathing season by extra storage

Step 5: and 10m grazing exclusion zone

Step 6: and no grazing on fields with medium and high slopes.

There was also a Step 7 in the WRc report that suggested various sizes of network storage. This measure has not been used in the present analysis as the consensus view indicates that the measure is untested and potentially unworkable.

In reality the Ayrshire catchment is likely to have more acute problems than many in England and Wales, given that there have been recognised faecal contamination events at the coastal bathing water sites. Extrapolation of the data from this site, where there are a high number of rainfall events, is more likely to overestimate the actual costs for agricultural diffuse pollution abatement and should be viewed as an additional reason for the conservative assessment.

Other minor sources of faecal pollution and their abatement measures have been costed on the basis of existing data where available.

ES6.3 Costing Conventions Used

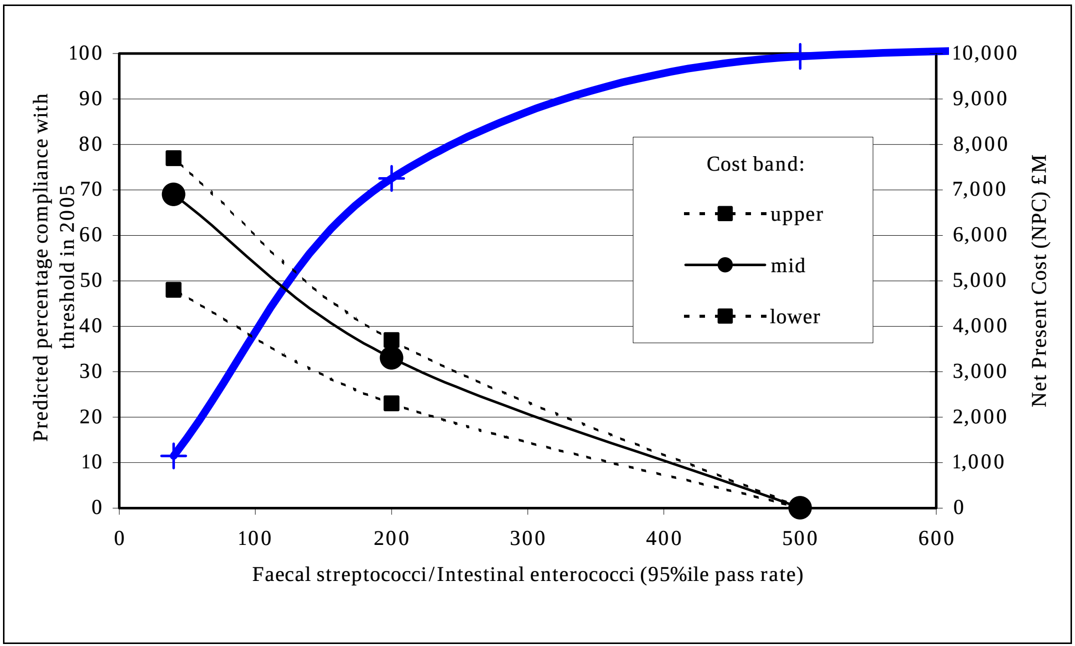
Given the variable confidence in the remediation measures and their likely costs for the range of catchments under investigation, it has been necessary to develop a range of costs for each measure in three bandings that represent a lower, central and upper estimate. Details of the assumptions of each are given in the main report.

Capital costs are taken as occurring fully at the beginning of year one. Recurring costs are expected to be accrued over the lifetime of the asset, equating to approximately 25 years. It is reasonable to assume that diffuse pollution controls for agriculture should also be discounted over this period as they will tend to be ongoing and hence recurring costs. A net present cost (NPC) has therefore been calculated to enable comparison of capital and recurring costs agricultural costs, a 25 year discounting period has been calculated, at a 6% discount rate, similar to that for major wastewater infrastructure. This elevates the costs of the agricultural measures as they are likely to be based on annual subsidy payments that over time can accrue significantly. This is a major factor in the apparently disproportionately high costs for agricultural pollution control measures.

ES7 Estimated Costs for the Compliance Scenarios

The estimated net present costs for a move to a Class C threshold of 500/100ml faecal streptococci at 95%ile is relatively modest at £9.7 million reflecting the view that most bathing waters in the UK will have achieved similar Mandatory compliance by 2005. The striking feature is for the predicted significant increase in costs for improvement to Class B, with a net present cost for a central estimate of some £3.5 billion, and particularly to Class A, where the net present costs are estimated to increase to £7.3 billion. The variance between upper and lower cost estimates should also be considered to give an idea of the confidence that can be ascribed. For example, to achieve Class B the difference between the upper and lower cost estimate is £2.5 to 3.9 billion.

A central trend is shown in the figure below, within the upper and lower bands, together with the likely rate of compliance based on 2005 bathing water quality data (without the additional expenditure identified here).



Inspection of the capital and recurring costs demonstrate a significant change in the cost allocation from previous studies. Comparison of central estimates shows an approximate rise in capital costs from £2.9 million (Class C) to £280 million (Class B) and £590 million for Class A compliance. Such levels of expenditure on traditional wastewater and some agricultural diffuse infrastructure are considered reasonable. These costs are in the same order of magnitude when compared to the AMP3 spend to achieve Mandatory and a significant percentage of Guideline compliance (by 2005) for the existing Directive

These costs are however relatively modest when considered against the NPC recurring cost of approximately £6.8 million, £3.2 billion and £6.7 billion for central cost estimates for Class C to A respectively. The majority of the recurring costs are due to the abatement of agricultural diffuse pollution, largely as a result of the need to provide subsidies to farmers to alter livestock grazing practices. These costs should be viewed with great caution at this time, as there remain severe doubts about the validity of the cost effectiveness and efficiency of the recurring pollution control measures. This total is likely to represent a significant over-estimate of the actual costs to the farming community, although data to substantiate a reduction in the figure are currently unavailable. Given the emphasis on agricultural controls that these costs infer, and the recognition that the existing costs are based on only one study in Scotland, a strong recommendation for additional studies to provide increased confidence in this element of the cost estimate is suggested.

A further limitation of the present study is that no costs are currently allocated to upgrade CSOs to 1 spill per bathing season. This measure would be required to achieve Class A and may be required to achieve Class B in certain circumstances, dependant on the level of acceptance of occasional "statistical" failures. No data are currently available to assess these costs although water industry contacts have indicated that a doubling of all CSO spend to date and planned would not be unreasonable.

The balance of costs for the measures identified would be spread across a number of industries. Wastewater treatment and sewerage costs would typically be costs to the water industry, which would in turn be passed on to the public. A small proportion would be borne by local authorities. By far the most significant burden would be targeted at diffuse agricultural source abatement costs that would be the responsibility of the farming community. The mechanism of farming support, if available, for implementation of these measures has not been considered as part of this study.

Monitoring and beach management costs for the revision are estimated to be approximately £3.5 million per annum, which is relatively insignificant in relation to the other costs described earlier.

ES8 Discounting

The draft WHO methodology assumes the integration of discounting into beach management. The theory is that if the beach manager can demonstrate prior knowledge of potential faecal contamination incidents, such as CSO spills or diffuse pollution from an adjacent river, and that reasonable steps have been taken to restrict the occurrence of such incidents, it is appropriate for the beach manager to inform the public, with the aim of discouraging bathing during such incidents. If this procedure is adopted and human contact is prevented, any failures of the bathing water microbiological standard during that period can be discounted or waived.

The key areas of cost outlined in the studies have been agricultural diffuse pollution and upgrading to CSO systems. Discounting could preclude the need, for example, to undertake such wide ranging agricultural diffuse pollution abatement measures, and the number of CSO spills could remain at the existing policy level (3 spills on average).

Extrapolating from the costs and compliance figure given earlier, and incorporating a number of broad assumptions, it is possible to estimate that approximately 20% of the costs could be saved if one discounted event is permitted and 50% with 3 discounted events. It must be stressed that these figures are very approximate, and based on largely unsubstantiated agricultural costs. However, they do give some feel to the very significant cost saving that could be afforded, whilst maintaining protection to public health.

ES9 Conclusions and Recommendations

a) The range of improvement measures required are dominated by relatively few key actions:

- Installation of UV disinfection systems
- Upgrading of CSOs to reduce spill frequency
- Reduction in agricultural point and diffuse pollution

A significant limitation of the study is the ability to predict the geographical extent of improvement measures in the absence of site specific source-pathway-receptor risk assessment studies.

b) Unit costs for the water industry infrastructure are developed from water company returns during the periodic review of prices, co-ordinated by Ofwat, enhanced where possible through discussions with both water companies and Ofwat. Confidence in the unit costs is relatively high.

c) Unit costs for the control of agricultural pollution are taken from research studies by the Scottish Agricultural College and CREH, synthesised into a report by WRc for the European Commission. Costs are based on a study of two catchments in Scotland.

d) Confidence in the cost estimates for agricultural diffuse pollution abatement is low. The costs are based on a single study and the transferability of the data is not known. Furthermore, there are reported difficulties with the technical and economic basis of the measures and their associated cost base that have yet to be resolved. The data are used in this report in the absence of any better information and should be treated with great caution. Policy direction must not be decided on the basis of these data alone and will require detailed substantiation. It is likely that the cost data for agricultural controls are a conservative over-estimate. Further work on this issue is strongly recommended.

e) Central cost estimates (calculated to net present cost) to achieve Class C, B and A are £9.7 million, £3.5 billion and £7.3 billion respectively. The overwhelming majority of the costs (in excess of 95%) to achieve Class B and A are attributed to improvement measures to reduce agricultural diffuse pollution, including provision of wastewater storage and farming subsidies. The costs for agricultural diffuse pollution controls must be viewed with caution and are likely to overestimate the true cost at this time.

f) Discounting, if adopted, has the potential to reduce the costs for achieving the more stringent thresholds by a significant margin, whilst retaining the safeguards to public health. There remain a number of key issues relating to the advantages and disadvantages of discounting that would need to be resolved prior to such a system being incorporated into the revision.

g) If a very stringent microbiological threshold such as Class A (40 faecal streptococci/100ml, 95%ile) is chosen by the European Commission, there will be bathing waters in England and Wales that may not be able to consistently comply, even with implementation of all suitable improvement measures. There is also likely to be a significant number that randomly fall in and out of compliance annually leading to a less consistent compliance baseline.

h) A number of studies are recommended to increase confidence in the predicted costs. The most pressing need is for greater clarity in the measures necessary to control agricultural pollution and the least-cost method of implementation. Costs for upgrading CSO infrastructure to 1 spill per bathing season are also required. Validation of wastewater and agricultural improvement measures is recommended to add confidence to the assessment. Finally, the integration of measures to fulfil the requirements of the water-related European Commission Directives should be considered, together with the environmental and economic benefits of such an integrated catchment planning approach.

Glossary

Bathing season	Designated annual period over which the BWD applies, in England and Wales 1 May to 30 September.
Bathing water	Specific area designated under the existing BWD.
Capital cost	Lump sum cost of constructing infrastructure.
Combined sewer overflow	Water in excess of the design capacity of the sewerage system that spills from a specifically designed overflow point. The discharge will contain surface water (rainfall) and diluted wastewater (domestic and industrial effluent). The wastewater does not receive treatment at a WwTW and is typically associated with storm events.
Faecal bacteria	Bacteria derived from faecal sources including, in this context, human and livestock excreta.
Faecal coliforms	Group of faecal indicator bacteria with mandatory and guideline standards under the existing BWD.
Faecal streptococci	Group of faecal indicator bacteria with guideline standards only under the existing BWD.
Guideline	Recommended, but legally binding, compliance standards under the existing BWD.
Intestinal enterococci	Group of faecal bacteria (similar to faecal streptococci) under consideration for compliance standards in the revised BWD.
Mandatory	Legally bound compliance standards under the existing BWD.
Net present cost	Accounting method to calculate the overall project capital and recurring costs of a scheme over a period of time as a single value in current costs.
Outfall	Typically a pipeline through which a discharge occurs, in this context discharges from WwTW, CSOs and storm water overflows.
Recurring cost	Operational and maintenance costs and subsidies incurred on a regular basis, eg annual.

Percent of (%-of)	Percentages are commonly used in the testing of scenarios. The percentage is dependent on the number of samples taken. 95%-of compliance from say, 20 samples allows for one sample in 20 to exceed the threshold value, eg in the existing BWD.
Percentile (%ile)	A specified percentile is representative of that number of observations as a proportion of the whole, for example a 95%ile value will reflect the value of the 95^{th} sample of 100 observations. The normal distribution is used to identify the percentile and its value. Commonly used as threshold values in limit setting, eg in the WHO classification.
Water company	Regional, private companies providing fresh water supply and in certain cases sewerage services.

Acronyms

AMP2/3	water company periodic Asset Management Plan: AMP2 1995-2000, AMP3 2000-2005
BWD	Bathing Water Directive (76/160/EEC)
CREH	Centre for Research into Environment and Health
CSO	Combined Sewer Overflow
DEFRA	UK Department for Environment, Food and Rural Affairs
FS	faecal streptococci
GIS	Geographical Information System
£k	thousand pounds Sterling
NPC	Net Present Cost
Ofwat	UK Office of Water Services (water industry regulator)
pe	population equivalent
SAC	Scottish Agricultural College
SEPA	Scottish Environment Protection Agency
SIC	Sanitary Inspection Category
USEPA	US Environment Protection Agency
UV	Ultraviolet light (in this context a wastewater disinfection technique)
WHO	World Health Organisation
WRc	Water Research Centre
WwTW	Wastewater Treatment Works

1 Introduction

1.1 Background

This report was commissioned by the UK Department for Environment, Food and Rural Affairs (DEFRA) to determine an initial cost estimate for a proposed revision by the European Commission of the Bathing Water Directive (76/160/EEC). The analysis uses data generated for bathing waters in England and Wales.

The report is the third of the series. The two previous reports are:

- Revision of the Bathing Water Directive: Summary of Phase 1 and 2
- Revision of the Bathing Water Directive: Evaluation of the Draft WHO Beach Classification Methodology.

1.2 Study Objective

The objective of the study as stated in the Terms of Reference is "to assess the cost implications of implementing a revised bathing water Directive".

The full Terms of Reference for the study are given in Appendix 1.

1.3 Report Contents

The report is divided into six Sections and two Appendices, as follows:

Section 1	Introduction
Section 2	Study Methodology
Section 3	Development of Unit Costs
Section 4	Cost Estimate for the Revision to the Bathing Water Directive

2 Study Methodology

2.1 Introduction

The study has been divided into 3 phases. Phases 1 and 2 involved desk based analysis and classification of the 474 bathing waters in England and Wales according to the draft World Health Organisation document "***Bathing Water Quality and Human Health***" (Ref: WHO/SDE/WSH/01.2). The draft WHO methodology has two elements:

- Microbiological assessment
- Sanitary inspection (risk assessment)

Each of these elements was tested for England and Wales using existing datasets and through regional meetings with water industry personnel. The outcome of Phases 1 and 2 was therefore a database containing the microbiological categorisation for each bathing water, combined with a risk assessment of all potential faecal contamination sources. The findings of these phases was reported in *Revision of the Bathing Water Directive: Summary of Phase 1 and 2* (Cascade Consulting, 2002a)

In advance of the draft revision from the European Commission with specific regulatory standards (likely to emerge in mid-2002) Phase 3 has sought to identify the most useful elements of the draft WHO methodology determined from Phases 1 and 2, together with a synthesis of the most promising approaches suggested by the European Commission and Member States to arrive at a potential set of regulatory compliance scenarios. Each element of the study process and the resultant potential compliance scenarios are described below.

2.2 Microbiological Categorisation

The microbiological assessment category is based on the draft WHO methodology that suggests the use of faecal streptococci concentrations in the bathing water. The categories are determined according to the thresholds given in Table 2.1.

Table 2.1 Draft WHO Microbiological Assessment Category (WHO, 2001)

WHO Microbiological Assessment Category	Faecal streptococci threshold (/100ml, 95%ile)
Class A	less than 40
Class B	40 to 200
Class C	201 to 500
Class D	over 500

The revised Directive may include standards for intestinal enterococci, for which few data are currently available for UK bathing waters. However for the purposes of this assessment it is reasonable to assume that the concentration of intestinal enterococci is equivalent to faecal streptococci, and therefore data on the latter are appropriate for this review.

Microbiological assessment categorisation data were supplied by the Environment Agency, based on actual microbiological bathing water monitoring data (faecal streptococci) from England and Wales in 2000. The total numbers of bathing waters in each category are shown in Table 2.2.

Table 2.2 Categorisation of Bathing Waters in England and Wales According to the Draft WHO Methodology using Year 2000 Data

WHO Microbiological Assessment Category	Number of Bathing Waters in England and Wales
Class A	57
Class B	221
Class C	118
Class D	75

Note: 3 bathing waters not sampled

However, in order to analyse the implications of the revised Directive it has been necessary to determine the effects of planned bathing water quality improvements contained in the 2000 to 2005 water industry investment cycle (Asset Management Plan 3 (AMP3)). Significant expenditure has been agreed through AMP3 to improve bathing waters to consistent Mandatory and in many cases Guideline compliance by 2005.

The cost assessment of the revision therefore uses a 2005 baseline and includes only costs for post-AMP3 improvements. The prediction of the 2005 microbiological categories have been developed based on 2000 and 2001 microbiological data and Environment Agency predictions post-AMP3. In summary, the actual microbiological water quality categorisation for each bathing water has been determined for 2000 and 2001, and weighed against the predicted Environment Agency categorisation contained in the draft *Bathing Water Stewardship* report (Environment Agency, 2002).

The Environment Agency has allotted a category, ranging from 1 to 8, for each bathing water based on the risk of failure of the Mandatory and Guideline standards of the existing Directive. Category 1 bathing waters are expected to meet the Guideline standard every year whereas category 8 would imply regular failure of the Mandatory standard. No bathing waters will be in category 8 by 2005. Of interest to this study, bathing waters that are expected to consistently reach the Guideline standard are shown as category 1 to 3.

Using the assumption that Guideline compliance is approximately the same as draft WHO methodology Class B (see following Section 2.3) and Mandatory equates to Class C it is then possible to predict the future categorisation after the AMP3 investments to 2005, as shown in Table 2.3. As expected, the main shift from 2000 to 2005 is for a greater number of Class B sites, with only 3 bathing waters likely to remain in the lowest Class D category.

Table 2.3 Categorisation of Bathing Waters in England and Wales According to the Draft WHO Methodology for 2005.

WHO Microbiological Assessment Category	Number of Bathing Waters in England and Wales
Class A	54
Class B	287
Class C	126
Class D	3

Note: 4 bathing waters de-designated

Having developed an understanding of the categorisation for each bathing water by 2005, it is then possible to determine for each potential regulatory scenario the measures required to comply, as described in the following sub-sections.

2.3 Determination of Potential Compliance Scenarios

The European Commission is due to produce a draft for the revision to the Bathing Water Directive in the near future. At present there is no specific regulatory compliance standard against which to test existing and future performance of bathing waters in England and Wales. There have however been a number of suggested approaches based on the draft WHO methodology and other studies in the European Union that have been used as the basis for the suggested approach.

The following potential compliance scenarios are based on a range of microbiological threshold values for faecal streptococci. Faecal streptococci are chosen as they have been proven to have a causative link to health effects in bathers (see NRA, 1994; Wiedenmann et al, 2002). The potential compliance scenarios are:

- < 40 faecal streptococci per 100ml, 95%ile (Class A)
- 200 faecal streptococci per 100ml, 95%ile (Class B)
- 500 faecal streptococci per 100ml, 95%ile (Class C)

Furthermore, the range of faecal streptococci concentrations chosen (40 to 500) and the 95%ile compliance statistic should provide a sufficiently wide envelope that if a different threshold or compliance rate is specified, it is likely to fall within the boundaries of the present cost assessment. Table 2.4 provides a rough guide to the "equivalence" of the range of bathing water standards that are used for regulatory purposes. Given the different statistical basis of the standards in the figure the relationships are at best representative and should be taken as indicative only. Recent communication with the Environment Agency suggests that in the UK statistical assessment using a 95%ile standard would be similar to using a 95%-of samples compliance rate because of the relatively high (typically 20) number of samples taken per bathing season.

Table 2.4 Different Regulatory Standards in Relation to the Three Regulatory Scenarios

Existing Regulatory Standards		Three Regulatory Scenarios	
BWD Mandatory	2000 FC/100ml	Class C	500 FS/100ml
USEPA geomean	~400-500 EC/100ml #		
BWD Guideline	100 FS/100ml (90%-of)	Class B	200 FS/100ml
		Class A	40 FS/100ml

Notes: All thresholds are at 95%-of unless specified otherwise
FC faecal coliforms; EC *E. coli*; FS Faecal streptococci
this value is calculated from estimations of log normality and is a relatively crude approximation.

2.4 Assumptions for Testing of Potential Regulatory Scenarios

One of the most challenging parts of the study has been to identify the likely measures to comply with the three potential regulatory scenarios. There are few if any studies available that have sought to identify all of the potential continuous, intermittent and diffuse sources of faecal contamination for such a diverse range of bathing waters. The present study has often therefore had to rely on assumptions and the application of qualified judgement to arrive at reasonable estimates of the sources and pathways of faecal contamination. The following sub-section describes the key assumptions used to frame the scenario testing. A number of working assumptions have also been required when deriving the costs for individual and collective improvement measures, which are discussed in Section 3.

2.4.1 Assumptions to Improve from Class D to C

A limited number of bathing waters may still periodically fall in to the Class D (>500 FS/100ml, 95%ile) category by 2005, according to the predictions from the studies undertaken (see Table 2.3). When assessing the requirement to improve from Class D to Class C (below 500 FS/100ml, 95%ile) it is useful to assume that the Class C microbiological threshold is roughly equivalent to the existing Mandatory standard for the Bathing Water Directive.

The difficulty with this assumption is that the existing Mandatory standard does not include faecal streptococci, being couched in terms of total and faecal coliforms (10,000 and 2,000 per 100ml @ 95%-of respectively). However, there are rule of thumb estimates that suggest a ratio of 1 faecal streptococci to 4 faecal coliforms in many bathing waters. There is considerable scatter in the data that underpin this relationship, depending for example on prevailing environmental conditions and the specific faecal sources. However for the purposes of this assessment it is considered a reasonable approximation. The influence of this assumption on the overall cost is likely to be minimal as relatively few bathing waters will fall into this bracket.

2.4.2 Assumptions to Improve from Class C to B

The Class B microbiological threshold of 200 faecal streptococci/100ml, 95%ile has been taken as equivalent to the Guideline standard for the existing Bathing Water Directive. This assumption has been based on a number of studies, including the work of WRc (Julian Ellis, *pers comm.*) and the Federal Environment Agency, Berlin (Lopez-Pila, 2002). The Guideline standard of 100 faecal streptococci/100ml @ 90%-of samples can be converted, using the assumption that the concentrations are log-normally distributed, to arrive at an approximate equivalence of 180 to 200 faecal streptococci/100ml, 95%ile (ie. ~Class B).

A significant number of bathing waters in England and Wales are planned to improve to meet the existing Guideline standard by 2005, following AMP3. These bathing waters are also assumed to meet the Class B scenario after 2005. The list of these bathing waters has been provided by the Environment Agency. Any bathing waters that meet the Class B scenario in 2000, from the microbiological category data provided by the Environment Agency, have also been assumed to meet Class B after 2005, assuming no deterioration in water quality. It is recognised that bathing water schemes are designed on the basis of statistical compliance with Bathing Water Directive standards and that this factors in some “statistical” fluctuation in compliance over the longer term. For example, the 1 in 20 year risk of inadvertent failure accepted by DEFRA for the purposes of CSO design and spill frequency calculation. These risks have not been considered in the costing exercise, as they would provide additional complication and reduced clarity within an existing imprecise framework.

An additional source of corroboration is the bathing water categorisation process undertaken by the Environment Agency and reported in the Stewardship report. Each bathing water is allocated a score ranging from 1 (very high quality) to 8 (very poor) depending on their performance against the existing Mandatory and Guideline standards. Predictions of the categorisation have been undertaken for 2005, after the AMP3 investment period. The data have been used to support the Class B predictions, assuming that any bathing water that achieves a category 1, 2 or 3 with the Environment Agency classification has had measures put in place to comply with Guideline and therefore Class B by 2005 (Keith Davies, *pers comm*.).

The Environment Agency categorisation is potentially conservative, as compliance results from the 2001 bathing season showed somewhat better compliance than the 1 to 8 categorisation would suggest. The categorisation process is risk based, with some potential for random intermittent failure of the standards built in to the predictive approach (eg Category 3 complies with Guideline standards in 2 to 3 out of every 5 years). This combined with the relatively benign weather in 2001 may have accounted for the conservative outcome. With these caveats in mind, the Environment Agency categorisation data have therefore been used to support and corroborate rather than drive the predictive approach.

2.4.3 Assumptions to Improve from Class B to A

For the purposes of the costing exercise all bathing waters that achieved Class A status in 2000 will remain Class A for the 2005 baseline, except for three identified by the Environment Agency with Guideline compliance difficulties. There are no data on which to re-classify bathing waters from Class B to A within the intervening period, although in reality some may improve to this level with the planned infrastructure during AMP3.

The greatest difficulty when trying to predict future compliance at such a stringent standard (40 faecal streptococci/100ml, 95%ile) is the variability created by the sampling and analysis regimes, together with the environmental fluctuations in microorganism concentrations. The result is that bathing water microorganism concentrations are likely to vary considerably around the standard threshold, with breaches of the threshold potentially placing bathing waters above the compliance limits relatively randomly.

This is demonstrated by comparing the bathing water data for 2000 and 2001. Fifty four bathing waters achieved Class A in 2000, while 28 bathing waters reverted to Class B in 2001 and one became Class C. Inspection of these data suggest that 10 of the bathing waters have identified AMP3 investments which should improve consistency of classification. Of the remaining 18, four are likely to improve through work to adjacent bathing waters with the other 14 likely to remain subject to fluctuation around the microbiological threshold.

The assumption that all year 2000 Class A bathing waters remain in the same category may therefore underestimate the costs associated with maintenance of their status.

Microbiological load and budget studies, potentially with modelling would be required for each bathing water to increase the level of confidence in prediction of consistent achievement of the Class A threshold.

2.5 Beach Management and Discounting

Beach management is viewed by the European Commission and Member States as integral to the revision of the Bathing Water Directive. Where there may be risks to human health from contact with faecally contaminated waters there should be intervention action from the appropriate authority to either prevent contact or provide advice to lower the potential for human health effects. A suite of beach management actions are envisaged to promote the safe and sustainable use of bathing waters into the future.

One element of the beach management debate has been the use of “discounting”. The draft WHO methodology assumes the integration of discounting into beach management. The theory is that if the beach manager can demonstrate prior knowledge of potential faecal contamination incidents, such as CSO spills or diffuse pollution from an adjacent river, and that reasonable steps have been taken to restrict the occurrence of such incidents, it is appropriate for the beach manager to inform the public, with the aim of discouraging bathing during such incidents. If this procedure is adopted and human contact is prevented, any failures of the bathing water microbiological standard during that period can be discounted or waived. The implication of such an approach is that very costly investment to contain unusual or extreme events (usually through heavy rainfall) either from point or diffuse sources may be averted whilst allowing a similar level of health protection.

There are however potential difficulties with such an approach, including for example the accountability of such a system and the ability to consistently predict the contamination events that would be required to implement the beach management actions.

Discounting has the potential to afford significant cost advantages for infrastructure and diffuse pollution controls. It may however have a negative connotation if beach management actions and advisories are used too frequently or inappropriately, with the potential to negatively influence tourist preferences. The political and technical drivers for discounting are still being debated by the European Commission and Member States. Discounting is therefore considered in the context of potential effects on the cost base later in the study (see Section 4.5), but has not been used as an integral part of the initial data gathering and assessment framework.

2.6 Sanitary Inspection Category

A sanitary inspection categorisation (SIC) process has also been undertaken according to the guidelines in the draft WHO methodology. The initial SIC classification was undertaken as a desk based exercise using information provided in the Environment Agency draft Stewardship report. The Stewardship report collates microbiological, infrastructure and investigative data for each bathing water in England and Wales. The SICs were determined taking into account the location and design of wastewater infrastructure (wastewater treatment works, CSOs, sewerage etc.) and other faecal sources on a case-by-case basis.

Phase 2 of the study involved a series of regional meetings with Environment Agency and Water Company personnel to verify the initial SIC, based on more detailed local knowledge. A total of 6 regional meetings were held for this purpose. The regional meetings assessed the initial analysis and iterated the classification dependant on local knowledge of the wastewater and diffuse pollution sources.

Data generated by the risk assessment on potential sources of faecal contamination have been used as the basis for the prediction of future intervention measures that may be required to meet any new microbiological threshold.

A key conclusion from Phase 2 of the study was the recommendation that the SIC should not be used as a primary compliance assessment tool as suggested by the draft WHO methodology (see Cascade Consulting, 2002b). The principal reason relates to the fact that many bathing water managers had difficulty consistently assessing the appropriate SIC category with the guidance contained in the draft WHO document. This could lead to inconsistent application of the methodology. Although the risk assessment is considered central to the emerging beach management methodology, it is seen as supporting definition and implementation of beach management actions rather than for compliance testing. The SIC categorisations are not therefore considered further in this report.

2.7 Identification of Point and Diffuse Sources of Faecal Contamination

The data derived from the Stewardship report and the subsequent meetings with Environment Agency and water company experts forms the basis of the costing exercise. The data include details of all known significant sources of faecal microorganisms for each bathing water. The main sources are identified in Table 2.4 below. Other less significant sources may have been identified on a site-specific basis.

Table 2.5 Main Potential Sources of Faecal Microorganisms for Bathing Waters in England and Wales

Source	Range of Inputs
Continuous discharges	Wastewater treatment works Industrial discharges Cross connections to surface water outfalls
Intermittent discharges	Direct combined sewer overflows Storm-water overflows
Diffuse discharges	Riverine wastewater treatment works Riverine combined sewer overflows Agricultural drainage and run-off Septic tanks
Mammals and birds	Seal and bird colonies, dogs, donkeys
Harbours and marinas	Unsewered wastewater from boats

Existing (year 2000) and planned wastewater treatment and sewerage infrastructure (post AMP3 in 2005) are detailed together with all other potential continuous, intermittent and diffuse sources in Appendix 2. The matrix assimilates all data provided by the Environment Agency and the water companies. It should be noted that these data have not been subject to verification by either the Agency or the water companies and may be subject to some discrepancy. This study has taken the data presented at face value and has not assess their reliability or accuracy. Additional confidence in the defined measures could be provided through validation of the dataset by the relevant Agency regions and water companies.

This stage has established a baseline of existing and proposed wastewater infrastructure and identified the range of other possible faecal contamination sources for each bathing water. The next stage is to undertake a risk assessment for each of the regulatory scenarios to establish for the progressively more stringent microbiological thresholds the necessary range of pollution abatement measures. To undertake the risk assessment a number of assumptions have had to be made, as described below.

2.8 Identification of Measures to Comply with Regulatory Scenarios

Identification of the measures to improve microbiological quality at each bathing water in England and Wales to the three regulatory scenario thresholds was undertaken primarily during the regional discussions with the Environment Agency and water company personnel. At the meetings the participants were requested to assess for each bathing water the measures necessary by 2005 to achieve consistent Class C, approximating to the existing Mandatory standard; to Class B approximating to the existing Guideline standard; and to a Class A threshold significantly more stringent than the existing Guideline standard.

In all cases there were already specified data on the requirements to attain consistent Class C status, as befits the equivalence of Mandatory compliance with the existing Directive. A significant proportion of the bathing waters (70 to 80%) are also subject to infrastructure upgrading works as part of the AMP3 investment cycle to meet the Guideline compliance standard, and are likely as a consequence to attain Class B status (there remains some doubt that attaining Guideline would guarantee consistent compliance with Class B as the statistical basis of each regime is different, with Guideline allowing greater flexibility in terms of risk of failure than Class B). Measures and costs (only agglomerated) for the Mandatory and Guideline compliance schemes are available from the Office of Water Services (Ofwat) and have been factored into the final cost estimates.

For the remaining schemes required to meet Class B and for all schemes when considering Class A compliance, the most significant sources of potential faecal contamination have been identified where possible and the measures to reduce or alleviate the risks have been specified. All of the summary data describing the proposed measures to attain Classes C to A for each bathing water in England and Wales are contained in Appendix 2.

The participants in the risk assessments were uncomfortable with the requirement to identify all sources and specify remediation measures for many of the bathing waters being considered, particularly for the most stringent regulatory scenario, as they felt that insufficient data were available to be unequivocal in many cases. This was particularly relevant when discussing the magnitude and extent of diffuse faecal contamination and its remediation.

However, the nature of the study is to develop a strategic view of the likely costs of the revision to the Directive. The project team therefore encouraged the participants to make quantified assessments where possible, and to arrive at qualified statements of the most likely sources and pathways where there were a lack of quantified data to rely upon.

Having identified the potential sources and remediation measures it has then been necessary to ascribe unit costs for the various measures to achieve each of the regulatory scenarios, as described in the following Section.

3 Development of Unit Costs

3.1 Collation of Cost Data

A wide variety and scale of measures have been identified for remediation of the potential sources of faecal contamination. These range from continuous and intermittent wastewater discharges to diffuse urban and agricultural run-off. The breadth of measures has required collation of cost data from a similarly diverse set of regulators, water companies, research and academic institutions. The following organisations have played a key role in the provision of cost data for these studies:

- Department for Environment, Food and Rural Affairs (DEFRA)
- Scottish Executive
- Environment Agency
- Scottish Environment Protection Agency (SEPA)
- UK water companies
- Office of Water Services (Ofwat)
- Scottish Agricultural College (SAC)
- Water Research Centre (WRc)
- Centre for Research into Environment and Health (CREH)

The following Section describes a number of working assumptions for each of the main remediation measures that have been required to arrive at a satisfactory cost allocation. Given the strategic nature of the studies and the lack of definition for many of the measures required it has been necessary to develop cost estimates based on lower, central and upper cost bands. The cost bands and the reasons for the variance are discussed for each measure.

This section also describes how unit costs have been developed, the assumptions made and the potential for additional studies that could be carried forward if required to increase the levels of confidence in the costs developed.

An important component of the costing exercise has been the drive to maintain an open and auditable costing system. Many of the costs and measures have been determined on the basis of qualified judgement, and in some cases heroic estimations. The project team has therefore sought to identify where improvements in the prediction of measures and the consequent costs could be strengthened and confidence added. It is hoped that in this way any future studies could build on these initial findings to arrive at focused cost estimates based on updated best available data.

The costs allocated for each measure are summarised in Table 4.1 and the full dataset is contained in Appendix 2.

3.2 Continuous Wastewater Discharges

Approximately 99% of the sewage treatment works over 15,000 population equivalent have already been upgraded to provide a minimum of secondary treatment to comply with the Urban Wastewater Treatment Directive. A significant number of the coastal WwTWs also have UV disinfection installed to comply with the requirements of the Mandatory and in many cases Guideline standards of the existing Bathing Water Directive. There are also a number of additional UV disinfection systems planned for installation prior to 2005 with similar aims.

However, although many of the coastal wastewater discharges direct to or immediately adjacent to bathing waters are subject to UV disinfection, and the high level of microbiological protection that these systems confer, there are a number of more distant or riverine WwTWs that may have to provide wastewater disinfection to meet the potential regulatory scenarios.

Capital costs for WwTW improvement to provide UV treatment have been based on cost figures provided by Ofwat with limited corroboration from a number of water companies. Ofwat has developed a graphical relationship between UV system size, based on the population equivalent (pe) that has to be treated, against the capital cost for installation. The relationship is linear with relatively little variance. A unit cost of £6/pe has been used as a central cost estimate with +/- 10% (£6.60/pe and £5.40/pe) for an upper and lower cost bands, due to variability in survey and construction costs.

Operational costs for UV treatment have been based on the broad assumption that operational costs are approximately 10% of capital costs. Although efforts were made to corroborate this assumption with the water companies, no data were made available within the study timescale.

A different approach has been taken for a small number of WwTWs where an improvement to the outfall has been identified as the most appropriate measure. Two bathing water sites already receive UV treatment but are currently deemed insufficient to achieve secure compliance with the existing Directive. The need for outfall improvement has been identified for both sites. Costs for outfall construction are very scheme-specific (depending on outfall location, geology of the area etc.) but specific information on costs is not available.

Costs for two types of outfall have therefore been used to develop the cost estimates, based on a small and a larger pipeline extension. The cost of construction for the small outfall is shown as £500k by Ofwat, with an estimated length of ~0.5km, giving a unit cost of £1 million/km. This value has been used as a lower band unit cost. The larger outfall extension of 2.4 km was costed at ~£10 million, giving an upper band cost of £4 million/km. A central cost estimate is intermediate at £2 million/km.

No data are available on the outfall lengths required for the proposed schemes. The range of potential length of outfalls are assumed to be 0.5km, 1km or 2km therefore giving unit costs of £0.5, £2 and £8 million for lower, central and upper cost estimates.

The costs for wastewater treatment are relatively well documented, having benefited from the periodic review and AMP planning process. Reasonable confidence can therefore be ascribed to the unit cost estimates developed here. However there are still likely to be geographical (eg weather patterns) and site specific influences (eg ground conditions) that may influence individual scheme costs. Variance in the cost estimates is more likely to centre on the spatial extent of measures, for example how far up a river catchment to provide WwTW UV disinfection, rather than any site specific differential between UV installation costs. Additional confidence in these costs could be achieved by site-specific studies for each of the potential WwTW upgrades.

3.3 Combined Sewer Overflow Discharges

The provision of suitable combined sewer overflow (CSO) facilities in the sewerage system has been and continues to be a costly exercise for water companies in AMP2 and 3. The regulatory policy for CSO provision to meet the existing Mandatory and Guideline standards is based on a statistical confidence that the bathing water will comply with the Bathing Water Directive for 98.2% of the time (see *Environment Agency Water Quality Consenting Standard: CSO Discharges Affecting Bathing Waters*). This equates to a requirement that CSO discharging directly into bathing waters should be designed to spill no more than 3 times per bathing season (on average). All the direct coastal CSOs impacting on bathing waters are expected to achieve this requirement after the 2005 AMP3 period.

However, there remain a reasonably large number of more remote CSOs that are not designed to the 3 spills policy that contribute to indirect riverine microbiological loads during rainfall events, and could prejudice compliance with more stringent bathing water standards. The following sub-sections describe what upgrading is required to achieve the regulatory scenarios.

3.3.1 Improvement to Class B

Studies have been undertaken by the Environment Agency to assess whether the 3 spills policy would be adequate to allow compliance with the Class B regulatory scenario. Adopting the same statistic approach as for the existing Directive the results would suggest that the 3 spills policy would be adequate to maintain compliance with the Class B scenario, but that the percentage probability of failing the threshold would increase from approximately 5% (1 in 20) with the existing Guideline to an estimated 15 to 20% (1 in 5) for Class B. This is a reflection of the tighter percentile standard (95%ile rather than 90%-of) which allows for fewer peaks. To achieve a similar "risk of non-compliance" as the existing Guideline, CSO spill frequency may have to be reduced to 1 spill per season. The decision for which level of risk is acceptable in terms of compliance is political and would need to be agreed with DEFRA and the Environment Agency. For the purposes of this study it has been assumed that 3 spills per season are adequate to comply with the Class B scenario, on the assumption that the risk of non-compliance is relatively modest compared to the other wastewater assumptions taken. A rough approximation of the costs to move to a 1 spill per season strategy is discussed in the Class A scenario, as discussed later in this sub-section.

The costs for CSO upgrading to 3 spills policy depends to a large extent on the geographical location and existing sewerage infrastructure. CSO spill frequency is very weather dependant, which in turn is influenced by the catchment location and rainfall patterns. The sewerage network may also be old or lack sufficient storage. All of these issues can influence the costs for upgrading CSOs, particularly with reference to the storage requirements, the ground conditions during construction and the availability of sufficient area for the storage tank(s).

The large number of CSOs within the AMP2 and 3 programme have enabled Ofwat to arrive at a unit cost for CSO installation (Ofwat, 2000). For a medium-size storage tank (750m^3) to a combined sewer overflow the range of costs is from £200k to £380k, with a benchmark of £340k. These costs have been used for lower, upper and central unit costs respectively. To arrive at a higher level of confidence for CSO costs it would be necessary to undertake site specific studies to determine rainfall return periods and consequent run-off characteristics, existing and future storage volume requirements, identification of suitable areas for location of storage and local ground conditions that may influence construction activities.

For CSOs direct to the beach/bathing water, the costs has been developed on the basis of a single storm tank, with the volume dictated by the 3 spills per season policy. For indirect storm discharges, in many cases it is uncertain how many upstream CSOs would impact on the bathing water, particularly for compliance with the Class A threshold. Costs have only been allocated for the immediate inland CSOs considered to impact on the bathing water (as identified from the Phase 2 meetings). Microbiological budget and modelling studies would be required to accurately determine the number and upstream limit of riverine CSOs requiring an upgrade.

For the majority of direct CSOs it is assumed they are designed to 3 spills per bathing season. It is not clear where (if any) CSOs designed to 1 spill every 5 years (direct to beach) are in place.

It is assumed that there are no significant operational costs for CSOs.

3.3.2 Improvement to Class A

For improvements to the highest Class A threshold of 40 FS/100ml, 95%ile, the Environment Agency calculations identify the requirement to reduce all direct CSO spill frequencies to 1 spill or less per bathing season. This is likely to have a significant cost implication for all existing CSOs plus the remaining direct and indirect CSOs identified in this study. At this stage it has not been possible to develop unit costs for 1 spill per season CSO improvements. No such data are available from Ofwat and the water companies are reluctant to release any data, as they tend to be site specific and may not reflect the national situation.

It would be possible for the water companies to produce indicative costs for a range of rainfall and catchment scenarios, as many of the water companies have the hydraulic CSOs models set up. This would allow additional storage volumes to be calculated for CSO spill frequencies of 1 spill or fewer per bathing season and hence the costs for construction. A recent study has been let by UKWIR to assess the potential engineering requirements for wastewater upgrades resulting from the revision to the Directive. This may include assessment of 1 spill scenarios should the cost information be deemed significant.

3.4 Contaminated Surface Water Outfalls /Sewer Misconnections

There are a number of catchments where surface water outfalls have been identified as sources of faecal contamination. The main source of such problems is usually misconnections from sewerage systems or from new housing/industrial developments that have inadvertently connected to the wrong outfall system.

Ofwat has allocated £10.6million to a water and sewerage company for resolution of 193 surface water outfall problem locations from 2000-2005. A unit cost for individual surface water outfall/misconnection problem has been allocated as £55k, including studies and remediation costs. This has been used as a central cost estimate, with +/-10% for upper and lower cost bands.

3.5 New Connections to Sewerage System

Where septic tanks have been identified as a potential source of pollution, the assumption has been that the solution would be to connect to the sewerage system. Unit costs have been based on data provided by Ofwat for properties connected to existing sewerage systems. A central unit cost of £277k and upper and lower cost bands of £350k and £230k respectively have been used.

Costs will vary based on the number of properties involved and the length of pipeline required. No data were available on either of these factors for the catchments where the requirement for new connections was identified. To gain greater confidence in the associated costs, the numbers of properties to be connected and distances to existing sewerage would be required. The same costs have been used for caravan parks identified as being a potential source of pollution. For greater accuracy in costing, the population equivalent of the caravan parks in question together with distance to existing sewerage system would be required.

3.6 Marinas and Harbours

A number of marinas and harbours were identified as potential sources of faecal contamination, primarily through lack of pump-out facilities or potentially because the facilities were not being used. Cost for provision of pump-out systems and sewerage to the main sewer system were provided by marina owners. A suitable facility for a 400 berth marina (usual size for tourist areas) was deemed to be in the region of £20k to £30k. These have been used as upper and lower cost bands, with a central cost estimate of £25k. Operational costs have not been developed but are likely to be relatively insignificant.

3.7 Diffuse Pollution Remediation

3.7.1 Urban Diffuse Contamination

Discussions with the water industry have identified diffuse urban pollution as a potential source of faecal contamination. Few data are available on the magnitude and significance of potential sources, what the sources may be and what remedial action may be necessary. No costs allocation has been developed. For the most stringent thresholds more studies may be needed to identify the sources and pathways for urban diffuse pollution.

3.7.2 Bird Populations

Several bathing waters are known to have a problem with bird populations that contribute to diffuse faecal pollution. These include for example bathing waters close to internationally recognised breeding bird colonies. The majority of these are sites have internationally recognised habitat status (Special Area of Conservation and/or Special Protected Area). It is unlikely that much could be done in these circumstances to ameliorate the faecal pollution sources and as a result several bathing waters would be unlikely to achieve the more stringent thresholds. It may be appropriate in these circumstances where consistent compliance with a more stringent standard cannot be guaranteed, to review the designation of the bathing water in question. No costing has been allocated, as it has not been deemed possible to develop such costs.

3.7.3 Agricultural Diffuse Contamination

General Principles

Agricultural diffuse pollution has been identified as a potentially significant source of faecal contamination for a large number of bathing water at the more stringent thresholds. Identification of agricultural diffuse contamination of bathing waters has only emerged in the past five to 10 years as a significant factor, since the reduction in the majority of the urban wastewater sources brought about by initiatives under the Urban Waste Water and Bathing Water Directives. There are relatively few studies that have sought to identify the microbiological budgets and the consequent influence of diffuse agricultural contamination (eg Wyer *et al*, 1998). Furthermore, to our knowledge there is only one research study in the UK, in Irvine Bay, Ayrshire on the west coast of Scotland, which has sought to develop costs for remediation of faecal contamination due to agricultural activities.

The research group formed to investigate the Ayrshire bathing waters has included CREH and SAC, who together have been assessing the sources, loads and events that contribute to bathing water quality. Preliminary findings from these studies are available (Aitken et al, 2001; Wyer et al, 2001) and are used as a basis for the cost estimates presented here. The same research data have been used by WRc in their report for the European Commission Economic Evaluation of the Bathing Water Directive (76/160) and of its Revision. The WRc study is based on additional model predictions and farm studies in the Ayrshire catchment, which have produced a table of specific farm management methods to reduce the likely inputs of faecal indicator organisms to the River Irvine. Associated costs for compliance with 3 regulatory scenarios were presented, which are the same thresholds as Classes A to C used in the present study. The report states that there are large uncertainties in the model predictions and the unit costs, and that the results can only be taken as indicative of the levels of investment likely to be required.

An independent audit of the SAC and WRc reports undertaken by Cascade Consulting in association with Professor Nick Hanley (Cascade Consulting, 2002c) suggests that the basic assumptions on which the agricultural faecal pollution abatement measures are based may not be based on sound scientific evidence and that the economic evaluation of the costs for the various measures does not conform to usual economic principles. For example, not all possible abatement measures have been identified, such as reduction in livestock densities, and some of the basic assumptions appear to be unsupported. In addition, no attention has been given to seeking the least-cost solution to achieving a given reduction in loads, which may well have led to significant over-estimation of the costs for faecal load reductions.

In summary, great care must be taken when using or transferring the data, and this should only be undertaken where no other data are available, noting the deficiencies in the cost analysis. With this in mind, the following assumptions on agricultural costs must be treated with great caution and policy should not be dictated by these findings. However, the general findings of the shift from urban wastewater treatment towards agriculture-derived faecal pollution control and the consequent change in focus of remediation costs over the longer term is of significance and can be considered reasonable. It is the scale of the costs that remains open to question. Recommendations are presented in Section 5.2 for studies to better determine the pollution abatement measures and associated costs for future input to this costing process.

In the absence of more robust data, the transfer of the existing study outcomes to catchments in England and Wales must be made in recognition of the assumptions used in the original work. The variables identified in the characterisation of the Ayrshire catchment include:

- live-stocking densities of 2.3/ha
- farm sizes and practices (dairy/beef/sheep)
- farm waste management practices
- relative number/proportion of farms in a catchment
- rainfall (20ml/day for high flow in river)

- percentage high (10% gradient) and medium (7% gradient) slopes in the catchment
- same cost for agricultural land (£1,500/ha for lowland, £700/ha for upland)
- hydrology of soil type

In reality the Ayrshire catchment is likely to have more acute problems than many in England and Wales, given that there have been recognised faecal contamination events at the coastal bathing water sites. Extrapolation of the data from this site, where there are a high number of rainfall events, is more likely to overestimate the actual costs for agricultural diffuse pollution abatement and should be viewed as a conservative assessment.

A number of measures have been identified that have the potential to reduce agricultural diffuse pollution, shown as Steps 1 to 6 in the WRc report. These are:

Step 1: Prevent animal access to watercourses
Step 2: and eliminate dairy farmyard losses
Step 3: and eliminate leaks from storage
Step 4: and eliminate waste spreading during bathing season by extra storage
Step 5: and 10m grazing exclusion zone
Step 6: and no grazing on fields with medium and high slopes.

There was also a Step 7 in the WRc report that suggested various sizes of network storage. This measure has not been used in the present analysis as the consensus view indicates that the measure is untested and potentially unworkable.

Of particular importance in the context of the English and Welsh catchments is an appropriate extrapolation of Step 6, the “high and medium slopes” measure, within a given catchment. This is the most significant driver for agricultural recurring costs in the Ayrshire work as it requires the annual remuneration of farmers for restricting livestock access to steeply sloping (and hence susceptible) grazing land. Information on the percentage of high and medium sloping fields in the relevant English and Welsh catchments was not available but could greatly enhance the development of these costs (if this measure proves to be sustainable and cost effective).

The costs from the Ayrshire study were developed on a 'per-farm' basis. Costs (capital and recurring) for catchments in England and Wales have been calculated on an area basis (hectares) as no information on the number of farms in each catchment could be obtained in the study timescale. Sizes of the contributing catchments (in hectares) have been obtained, and it has been assumed that in each case the whole catchment has to be addressed for diffuse pollution remediation (with the exception of a lower cost band for improvements to B, see below). Where a stream has been identified as the contributing source an assumption of catchment size of 500, 200, or 50 hectares based on map observation has been used, as in the original Ayrshire case study.

The costs for the Ayrshire catchment were divided by 70,600 (size of Ayrshire catchment in hectares) to get a unit cost per hectare, and then multiplied by the catchment size for the relevant bathing water.

A conservative assumption has been taken that a full suite of diffuse pollution mitigation is required for each of the bathing waters identified as having agricultural diffuse pollution problems. Further detailed catchment-based studies would be required to determine with confidence the most appropriate balance of measures for individual bathing waters. This issue is covered in greater detail in a recent report by Cascade Consulting to the Scottish Executive (Cascade Consulting, 2002c).

The final cost for agricultural diffuse control at each bathing water is then calculated on the basis of the total catchment size and unit costs for pollution abatement, depending on the threshold and cost banding. At issue is the principle of applying costs to the whole catchment, or whether there is merit in costing only for the lower catchment. Discussions with CREH would suggest that during storm events when the majority of agricultural contamination occurs there is little attenuation within the catchment and any faecal microorganisms entering the watercourses are likely to be transported to the river or estuary mouth and present a possible risk. This would suggest that the whole catchment should be considered when costing abatements, as has been adopted for the present study.

One problem with this approach is where to delimit actions for the larger catchments in England and Wales, including the Rivers Tyne, Tees, Humber, Thames, Solent and Severn. Using the catchment areas for each of these would substantially increase the cost base but may not reflect the true costs for compliance. For the purposes of the present study the catchment areas for contributing systems have been applied for local rather than regional rivers and no upper catchment costs have been allocated for the rivers identified above. This assumption can be defended when considering that the time of travel from the upper catchments for the larger rivers may be in the order of several days, and a level of microbiological attenuation will be likely.

There is also the possibility of double counting the costs for catchment-based measures, where improvements in one system may positively influence other bathing waters. For this reason all diffuse pollution costs are catchment-based rather than specifically to one or a number of bathing waters, so that any improvements can be shared.

Improvement from D to C

There are no bathing waters where diffuse pollution measures are deemed to be required for improvement to Class C. One exception is the Lim catchment, although the improvements will move the bathing waters to Class B. Costs have therefore been allocated to the Class B improvements.

Improvement from C to B

It is assumed for a central cost estimate that measures to reduce agricultural diffuse pollution on each farm will include the six steps identified earlier, incorporating prevention of animal access to watercourses through to restriction of grazing on steeply sloping fields. For the upper cost band it has been assumed there are higher livestock densities of 4 per hectare, as in the Ribble Catchment (WRc, 2002). A multiplication factor of 1.7 has therefore been used (4/2.3), but only for steps 2, 3 and 4 of the farm waste management measures. This is because the livestock density will not have a significant influence on steps 1, 5 and 6. For steps 2, 3 and 4 livestock density will be a significant factor as the measures are concerned with the storage of faecal waste. A higher livestock density will mean greater volume of waste and therefore higher storage costs.

For the lower cost band it has been assumed that 25% of farms in the catchment already apply good farm management practices, including these farm management measures. This is costed on the basis that these farms occupy 25% of the catchment area.

Improvement from B to A

Due to the lack of reliable data, cost estimates for improvements from B to A have not been developed. The methodology used in the WRc Ayrshire report, i.e. steps 7a, 7b and 7c has not been used due to difficulties with the reliability of this approach. Further study would be required to validate the assumptions used in applying this method, to determine whether this would effectively reduce faecal loads and whether the associated costs developed are representative.

Where catchments have been identified as requiring improvement directly to A, the same costs as improvement to B have been used, again on a catchment-specific basis. It should be noted that these measures will not necessarily improve the associated bathing water(s) to achieve the A standard. The most effective method for achieving significant reductions in agricultural faecal loads and therefore achieving the A standard may be to reduce the livestock densities in the relevant catchments, although costs for this measure are not available at this time.

A notable point is that where significant diffuse agricultural problems have been identified, there are generally high livestock densities (data taken from the DEFRA/MAFF 2000 farm census data). It is often difficult to calculate costs for reduction of livestock densities and other agricultural measures where confounding factors such as European Union Common Agricultural Policy subsidies, livestock grants and other potential agri-environmental and cross-cutting grant aid schemes are operated. It is recommended that further work be undertaken to calculate the most cost effective and efficient stock reduction strategy, together with the actual cost to the farming community and the consequent improvements through reduction in faecal load to the bathing waters.

Several bathing waters were identified where the source of agricultural diffuse pollution was from adjacent marshland used for grazing. Areas of marshland were estimated from map observations. Costs have been based on the Fylde coast study undertaken by WRc (WRc, 2002). The report states that there are large uncertainties in prediction of loads from saltmarshes and that costs should only be used as indicative of levels of investment likely to be required. For achieving Class B it has been assumed that 75% of the area of marshland used for grazing must have animals removed. For achieving Class A it has been assumed that the whole of the area must have animals removed.

Costs were developed using the same compensation rate as in the WRc report (£1,500/hectare/year) with upper and lower bands of +/- 10%. This cost may be disproportionately high, as grazing marsh of this type is often of relatively low value and may only warrant land prices of £2.5 to 5k per hectare. Due to lack of data on marshland impacting on 3 bathing waters in Morecambe, area of marshland was assumed to be the same as that for the Ribble Estuary (2100 hectares). In order to increase the levels of confidence that removal of livestock would achieve compliance with the scenarios, information on livestock densities and agricultural activities on the marshland would be required, together with research findings on the actual contribution of marshland faeces to the faecal loading into the receiving waters (for a range of tidal conditions) along with detailed modelling of the impacts of the loads on the bathing water.

Costs developed assume that diffuse pollution abatement measures and their associated costs are not concurrent with associated directives such as the Water Framework, Urban Waste Water Treatment, Nitrates and Shellfish Directives. In reality actions will be necessary to reduce the influence of agricultural diffuse pollution on water quality parameters for each of these directives with consequent beneficial effects in reduction of faecal contamination. As an example, fencing of watercourses to control erosion in catchments to protect salmonid spawning habitat may be required under the Water Framework that could have a beneficial affect on faecal contamination as well, as would the potential for changes to agricultural practices required under the Nitrates Directive. These associated measures and costs are not factored in here, but could reduce the total diffuse pollution abatement costs for the revision of the Bathing Water Directive. Insufficient data are available to determine the marginal costs for this study. It is recommended that further studies be undertaken to differentiate the costs for each of these drivers

Increased confidence is required in the diffuse agricultural costs. The main factors affecting the requirement for measures are the stocking densities and distributions, livestock type, rainfall event patterns, run-off characteristics, land use characteristics, farming practices and farm infrastructure (drainage, hardstanding areas etc.). Much of this data may already be available through the farm census, GIS databases (eg Centre for Ecology and Hydrology) and existing research studies that could be usefully collated. However, the routes of transmission into the farm drainage and watercourses, and subsequently to receiving waters requires further study for a variety of catchment types, and are currently less well understood (see Cascade Consulting, 2000c).

Given the variety of prevailing weather conditions (eg East Anglia compared to Wales), the farming practices and land use (predominantly arable to mainly sheep farming on hills) and farm infrastructures, it is likely that the diffuse control costs will in reality vary considerably. The costs allocated in the present study should be viewed in this context. Only a low level of confidence can be placed on the agricultural diffuse control costs at this time. As this represents by far the most significant cost driver (see Section 4) it is recommended that additional studies are targeted at increasing the knowledge base for these issues. A key to this process is likely to be the catchment-based diffuse microbiological budget and modelling approach being developed by a number of research and academic institutions.

4 Cost Estimate for the Revision to the Bathing Water Directive

4.1 Cost Matrices for the Improvement Measures

The cost matrices have been developed through the process discussed in Section 3. The costs must be read in conjunction with the explanation of the assumptions and limitations of the costing exercise described previously, particularly where they relate to agricultural sources and remediation measures. Table 4.1 overleaf summarises the findings for the unit cost estimates that are used in the costing exercise.

4.2 Calculation of Final Cost Estimates

The costs have been applied to the measures identified for each bathing water to arrive at an agglomerated cost for each of the three potential regulatory scenarios (Class C, B and A). The costs are reported on a regional basis, using the consolidated data presented in Appendix 2.

There are two components to the cost calculation. Capital costs are taken as occurring fully in year one. Recurring (or operational) costs are expected to be accrued over the lifetime of the asset, equating to approximately 25 years when considering water industry infrastructure. It is reasonable to assume that diffuse pollution controls for agriculture should also be discounted over this period as they will tend to be ongoing and hence recurring costs.

A net present cost (NPC) has therefore been calculated to enable comparison of capital and recurring costs, using the capital cost at the beginning of year one and the same value for recurring costs in year one and each of the next 24 years. This has been discounted to 2002 monetary values using the Treasury discount rate of 6% recommended for capital projects for the 25 year discount period.

Table 4.1 Unit Costs for Faecal Contamination Improvement Measures

Measures	Unit	Upper Cost	Central Cost Estimate	Lower Cost
Continuous Wastewater Treatment				
UV Disinfection capital costs (Calculated by mutiplying by pe of WwTW)	Cost / population equivalent (pe)	£6.60	£6	£5.40
UV Disinfection (recurring costs)	10% of capital cost	central cost +10%	10% of capital cost	central cost -10%
Intermittent Wastewater Treatment				
CSOs - tank only - increase in storage (for 3 spills per bathing season)	750m^3 storage for single tank	£380,000	£340,000	£200,000
Surface water outfall/sewer misconnections	misconnection investigations and resolution	£61,000	£55,000	£50,000
Diffuse Source Abatement				
Agricultural - capital costs	Costs/hectare	£330	£250	£180
Agricultural - recurring costs	Cost / hectare / year	£260	£240	£160
Agricultural - grazing on marshland - recurring costs	Cost / hectare / year	£1,700	£1,500	£1,400
Septic tanks connection to sewerage system (first time rural sewerage)	10-16 properties (average)	£350,000	£280,000	£230,000
Boats/marinas sewerage - pumping facilities and treatment.	cost per facility	£30,000	£25,000	£20,000
Diffuse urban		NO COSTS DEVELOPED		
Diffuse - bird populations		NO COSTS DEVELOPED		

The NPC represents the overall costs for each of the three potential regulatory scenarios in terms of total cost over the 25 year period in 2002 monetary values.

Of importance for the agricultural costs, a 25 year discounting period has been calculated, similar to that for major wastewater infrastructure. This elevates the costs of the agricultural measures as they are likely to be based on annual subsidy payments that over time can accrue significantly. This is a major factor in the apparently disproportionately high costs for agricultural pollution control measures.

4.3 Cost Estimates for the Regulatory Scenarios

Cost estimates for the three regulatory scenarios are given in Table 4.2. Costs demonstrate a number of trends, primarily related to the relative stringency of the microbiological threshold from Class C to A. The most striking feature is the predicted significant increase in costs from C to B, with a net present cost for the central estimate of some £3.5 billion, and particularly from B to A, where the costs are predicted to increase to £7.3 billion. The variance between upper and lower cost estimates should also be considered to give an idea of the confidence that can be ascribed. For example, to achieve Class B the difference between the upper and lower cost estimate is £2.5 to 3.9 billion.

A central trend is shown in Figure 4.1, with the upper and lower bands, together with the likely rate of compliance based on 2005 bathing water quality data (without the additional expenditure identified here).

Inspection of the capital and recurring costs demonstrate a significant change in the cost allocation from previous studies. Comparison of central estimates shows an approximate rise in **capital** costs from £2.9 million (Class C) to £280 million (Class B) and £590 million for Class A compliance. Such levels of expenditure on traditional wastewater and some agricultural diffuse infrastructure are considered reasonable. These costs are in the same order of magnitude when compared to the AMP3 spend to achieve Mandatory and a significant percentage of Guideline compliance (by 2005) for the existing Directive

These costs are however relatively modest when considered against the NPC **recurring** cost of approximately £6.8 million, £3.2 billion and £6.7 billion for central cost estimates for Class C to A respectively. The majority of the recurring costs are due to the abatement of agricultural diffuse pollution, largely as a result of the need to provide subsidies to farmers to alter livestock grazing practices. These costs should be viewed with great caution at this time, as there remain severe doubts about the validity of the cost effectiveness and efficiency of the on-going pollution control measures(see Section 3.7.3). This total is likely to represent a significant over-estimate of the actual costs to the farming community, although data to substantiate this statement are not currently available.

To illustrate this point, Table 4.3 shows the estimated costs for wastewater and other infrastructure measures *without* the agricultural diffuse pollution costs. To achieve Class B would cost in the region of £73 to 120 million and Class A would require £130 to 200 million. The majority of these costs would be targeted at wastewater treatment and sewerage through water industry investment. The table is instructive when compared to Table 4.2, as it demonstrates that to achieve the more stringent thresholds (Class B or A) the emphasis for costs is likely to shift from the water industry to the agricultural sector. Given the emphasis on agricultural controls that these costs infer, and the recognition that the existing costs are based on only one study in Scotland, a strong recommendation for additional studies to provide increased confidence in this element of the cost estimate is suggested in Section 5.

Table 4.2 Summary of Total Costs in England and Wales

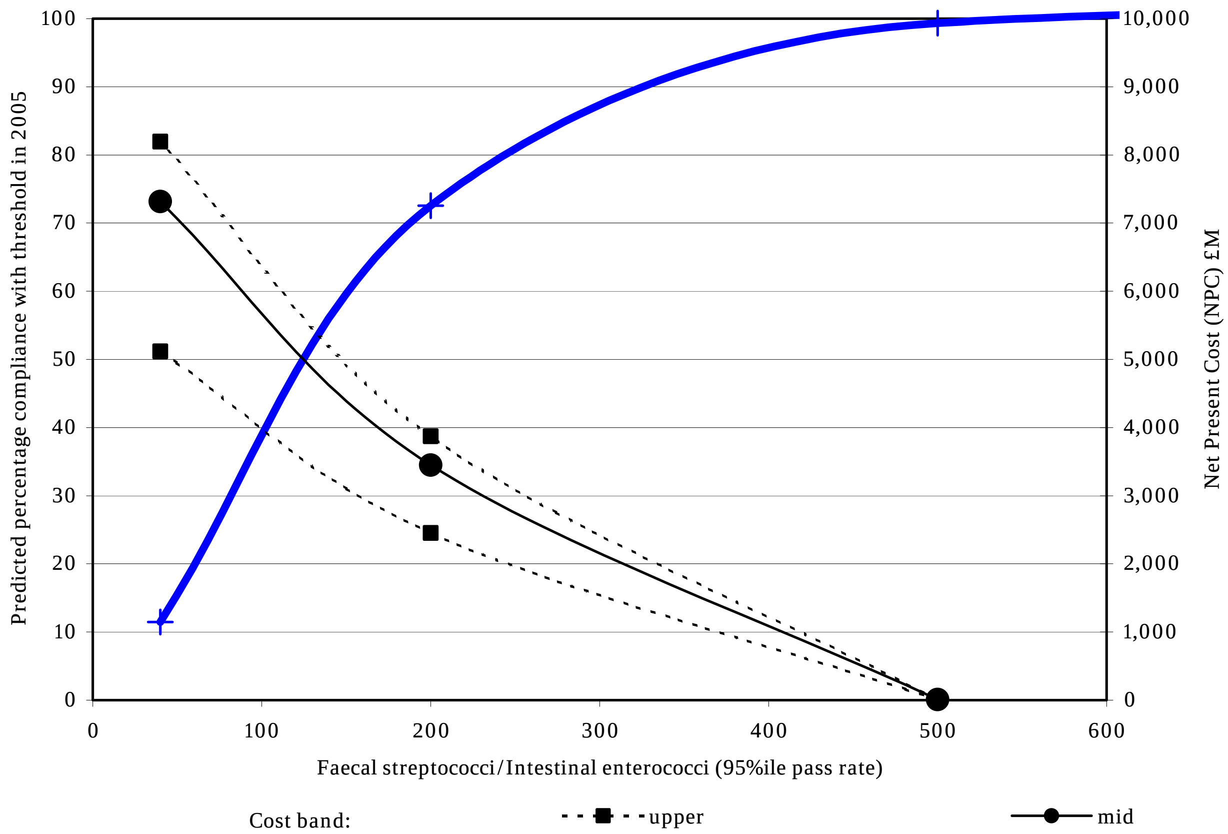
	Improvement to C (500FS/100ml, 95%ile)			Improvement to B (200FS/100ml, 95%ile)			Improvement to A (40FS/100ml, 95%ile)		
	Upper	**Central**	Lower	Upper	**Central**	Lower	Upper	**Central**	Lower
Capital costs (£ million)	3.4	2.9	1.8	370	280	210	780	590	440
Annual recurring costs (£ million/year)	0.60	0.50	0.40	260	230	170	550	500	350
NPC of recurring costs (£ million)	8.1	6.8	5.4	3,500	3,200	2,200	7,400	6,700	4,700
Total NPC (over 25 years)	12	9.7	7.2	3,900	3,500	2,500	8,200	7,300	5,100

Table 4.3 Summary of Total Costs in England and Wales – Without Agricultural Diffuse Pollution

	Improvement to C (500FS/100ml, 95%ile)			Improvement to B (200FS/100ml, 95%ile)			Improvement to A (40FS/100ml, 95%ile)		
	Upper	**Central**	Lower	Upper	**Central**	Lower	Upper	**Central**	Lower
Capital costs (£ million)	2.7	2.4	1.4	93	73	49	150	120	86
Annual recurring costs (£ million/year)	0	0	0	2.2	2.0	1.8	3.8	3.5	3.1
NPC of recurring costs (£ million)	0	0	0	30	27	24	52	47	42
Total NPC (over 25 years)	2.7	2.4	1.4	120	100	73	200	170	130

Note: Costs included to 2 significant figures

Figure 4.1 Cost estimates (low, central and high) for Measures to Comply with Three Potential Regulatory Scenarios for the Revision to the Bathing Water Directive



A further limitation of the present study is that no costs are currently allocated to upgrade CSOs to 1 spill per bathing season. This measure would be required to achieve Class A and may be required to achieve Class B in certain circumstances, dependant on the level of acceptance of occasional "statistical" failures. No data are currently available to assess the costs to improve to 1 spill a season, although these could be developed relatively quickly through modelling studies with the co-operation of the water industry. From discussions with water industry representatives, indicative costs for 1 spill per bathing season CSO upgrades are likely to be in the region of twice the cost for upgrade to 3 spill per bathing season CSOs, i.e. twice the cost for the CSO improvements identified in this study, plus twice the cost for CSO improvements identified in AMP3

The balance of costs for the measures identified would be spread across a number of industries. Wastewater treatment and sewerage costs would typically be costs to the water industry, which would in turn be passed on to the public. A small proportion would be borne by local authorities. By far the most significant burden would be targeted at diffuse agricultural source abatement costs that would be the responsibility of the farming community. The mechanism of farming support, if available, for implementation of these measures has not been considered as part of this study.

4.4 Monitoring and Beach Management Costs

The marginal increase in monitoring and beach management costs for the revision to the Bathing Water Directive have been analysed for the European Commission by WRc (WRc 2002). Using the data presented in the report it is possible to develop a cost for the additional monitoring and basic beach management approach.

At present the report estimates the total cost (for the UK) of monitoring for the existing Directive to be in the region of £450,000. Having identified the revised monitoring requirements and new obligations for beach management actions the report calculates that there is unlikely to be any additional (marginal) cost [*the WRc report is unclear on this issue – further work needs to be undertaken to confirm this conclusion, see below*].

The actual activities that may be required by beach managers and the frequency of each activity are not currently known. In the absence of detailed itineraries and activities it is reasonable to assume that the majority of the bathing waters will in the future have improvement plans and measures that will ensure compliance with the revised Directive (this may be a statutory requirement). In this case it is reasonable to suggest that two officers in each relevant Environment Agency region would be sufficient to police their bathing waters and react to any unplanned incidents. Using a simple calculation based on employment and travel costs, 14 officers could be expected to cost in the region of £700,000 per annum (assuming a unit rate of £50,000 per person per annum).

It is likely that the local authorities will have a level of responsibility for the provision of information and potentially to maintain personnel on beaches to apply the management actions. No management regime has been identified for this process at present and costs cannot easily be established. However, an estimate based on the number of bathing waters (470) and an allocation of one member of local authority staff per 5 bathing waters at a cost of £25,000 per member of staff (including overheads) would arrive at a figure of some £2,400,000 per annum. In many cases this cost may be shared by existing job functions, including environmental health officers, lifeguards etc. and should be viewed as an upper estimate.

These costs are relatively insignificant in terms of the broader capital and recurring costs for implementation of the pollution abatement measures identified earlier.

4.5 Discounting

Much debate surrounds the practicality and utility of discounting data and faecal contamination events, providing that the bathing population is sufficiently well informed and can avoid contact with faecally contaminated waters. No studies have been published that establish the potential effects of discounting on bathing water compliance rates or the implications for bathing water compliance costs. The present study has focused on the potential costs for implementation of measures to achieve three regulatory scenarios and does not directly consider discounting.

However, there are assumptions that can be made that could illuminate the debate. For example, it may be possible to reduce the number of improvement measures for many bathing waters if discounting were to be adopted along the lines of the proposals in the draft WHO methodology.

The key areas of cost outlined in the studies have been agricultural diffuse pollution and upgrading to CSO systems. It may not be necessary, for example, to undertake such wide ranging agricultural diffuse pollution abatement measures, and the number of CSO spills could remain at the existing policy level (3 spills on average).

At present the 1 spill per bathing season costs are not factored in to the cost calculations, so the effect of removing this requirement cannot be identified. However, for the agricultural diffuse pollution abatement it may be possible to obviate the need for whole-scale improvements. Where rainfall run-off events leading to faecal contamination of the bathing waters occurs relatively infrequently it may be possible to argue that discounting during these events is acceptable. This pre-supposes that the events can be predicted with reasonable accuracy.

As a very rough approximation, the scale of cost saving to be made can be developed from the compliance and cost relationship shown in Figure 4.1. A suite of compliance rate data were generated by DEFRA for the European Commission on potential compliance rates with different statistical and microbiological thresholds. The data for 2001 showed compliance rates of 67%, 81% and 93% for UK bathing waters with a 200 IE threshold at 95, 90 and 80%ile respectively. Using these figures and assuming a central cost estimate, it is possible to save approximately 20% of the costs with one discounted event (equivalent to 90%ile compliance) and 50% with 3 discounted events (equivalent to 80%ile compliance). It must be stressed that these figures are very approximate, and based on unsubstantiated agricultural costs. However, they do give some feel to the very significant cost saving that could be afforded, whilst maintaining protection to public health.

There are a number of major provisos to discounting as an approach. Firstly it must be possible to predict the contamination event, which has proven difficult to date for many catchments. Also, it is reasonable to suggest that the bathing population would only accept a limited number of events, with the implication that any discounting is likely to be capped at a small number per bathing season. In this case, only catchments where the rainfall and hydrology dictate a limited number of significant rainfall run-off events would be open to such an approach.

Considering the above, there are potentially significant cost savings that could be attained through the use of discounting. The balance between potential cost savings, the needs of the local communities and the auditability of the discounting process requires further debate and definition.

4.6 Limits on Achieving the Class A regulatory scenario

As demonstrated by a number of smaller rural beaches in England and

Wales, there are occasions when a bathing water will fail the more stringent thresholds (eg. Guideline, Class B or Class A) when there is no obvious source of faecal contamination. This has been demonstrated for a number of bathing waters that achieved Class A in 2000 but were subsequently reduced to Class B in 2001, with no obvious reason for the reduced quality. In reality, at the most stringent of proposed scenarios, Class A, there could be many bathing waters that may still fail due to the low threshold and low but variable ambient microbiological water quality, despite measures to achieve the threshold of <40 faecal streptococci/100ml, 95%ile.

A corollary of this is that there are three bathing waters identified for which no additional measures can be identified to take the site from Class B to Class A. At present they maintain Class B status, but there are no obvious local sources of faecal contamination that could be alleviated to allow improvement to Class A. A further category is the bathing waters where their location would seem to preclude achieving Class A, which are likely to include bathing waters in areas subject to significant estuarine influences. These may include bathing waters on the Severn Estuary where there are no obvious sources of faecal contamination, but where the background levels in the highly turbid estuary water may limit any additional improvements and potentially some parts of the Lancashire coast. Thirty four such bathing waters were identified.

5 Conclusions and Recommendations

5.1 Conclusions

i) The studies are based on best available information from the Environment Agency and water companies on the sources and risks of faecal contamination to bathing waters in England and Wales.

ii) The improvement measures to meet the three regulatory scenarios (Class C, B and A) are based on information developed at six regional meetings. No verification of the improvement measures identified in Appendix 2 has been undertaken by water industry personnel at this time, but is recommended to increase confidence in the measures identified.

iii) The number of bathing waters requiring improvement measures after 2005 is based on bathing water quality data for 2000 and 2001, corroborated by Environment Agency predictions for post AMP3 compliance with Mandatory and Guideline compliance rates. The number of bathing waters requiring improvement measures to meet each of the three regulatory scenarios are predicted to be:

- To Class C 3 bathing waters
- To Class B 129 bathing water
- To Class A 416 bathing waters

iv) The range of improvement measures required are dominated by relatively few key actions:

- Installation of UV disinfection systems
- Upgrading of CSOs to reduce spill frequency
- Reduction in agricultural point and diffuse pollution

A significant limitation of the study is the ability to predict the geographical extent of improvement measures in the absence of site specific source-pathway-receptor risk assessment studies.

v) Unit costs for the water industry infrastructure are developed from water company returns during the periodic review of prices, co-ordinated by Ofwat, enhanced where possible through discussions with both water companies and Ofwat. Confidence in the unit costs is relatively high.

vi) Unit costs for the control of agricultural pollution are taken from research studies by SAC and CREH, together with a report by WRc for the European Commission. Costs are based on limited studies of two catchments in Scotland.

vii) Confidence in the cost estimates for agricultural diffuse pollution abatement is low. The costs are based on a single catchment study and the transferability of the data is not known. Furthermore, there are reported difficulties with the technical and economic basis of the measures and their associated cost base that have yet to be resolved. The data are used in this report in the absence of any other information and should be treated with great caution. Policy direction must not be decided on the basis of these data alone and will require detailed substantiation. It is likely that the cost data for agricultural controls are a conservative over-estimate. Further work on this issue is strongly recommended.

viii) Other actions to improve the confidence in improvement measure costings are included in the relevant Sections of the report.

ix) Central cost estimates (calculated to net present cost) to achieve Class C, B and A are £9.7 million, £3.5 billion and £7.3 billion respectively. The overwhelming majority of the costs (in excess of 95%) to achieve Class B and A are attributed to improvement measures to reduce agricultural diffuse pollution, including provision of wastewater storage and farming subsidies. The costs for agricultural diffuse pollution controls must be viewed with caution and are likely to overestimate the true cost at this time.

x) Monitoring and beach management costs are relatively insignificant in comparison to the capital and recurring costs for improvement measures.

xi) Discounting, if adopted, has the potential to reduce the costs for achieving the more stringent thresholds by a significant margin, whilst retaining the safeguards to public health. There remain a number of key issues relating to the advantages and disadvantages of discounting that would need to be resolved prior to such a system being incorporated into the revision.

xii) If a very stringent microbiological threshold such as Class A (40 faecal streptococci/100ml, 95%ile) is chosen by the European Commission, there will be bathing waters in England and Wales that may not be able to consistently comply, even with all suitable improvement measures. There is also likely to be a significant number that randomly fall in and out of compliance annually leading to a less consistent compliance baseline.

5.2 Recommendations

As noted at several points within the report text, there are a number of areas that could be usefully assessed to improve confidence in the cost estimate. In order of importance to the cost estimate, these include:

- Agricultural diffuse pollution controls:
  - Characterisation of catchment agricultural land use
  - Development of suitable faecal contamination run-off estimates

- Identification of all suitable faecal pollution abatement measures
- Confirmation of effectiveness of abatement measures for a variety of UK catchments
- Suitable transfer co-efficients for inter-catchment application
- Assessment of areas of catchments that contribute inputs
- Identification of marginal costs for agricultural diffuse pollution abatement through farming and land use practices
- Determination of the most cost effective and cost efficient faecal pollution abatement measures in line with sound economic principles.

- Calculation of CSO unit costs to upgrade to 1 spill per bathing season

- Verification of improvement measures in the cost matrices by water industry representatives

- Verification of CSO tank size and cost assumptions for a variety of catchment types

- Verification of wastewater UV disinfection operating costs

- Identification of other potential sources of faecal pollution in catchments, such as septic tanks and diffuse urban pollution that may contribute to bathing water failures at more stringent standards

- Verification of upstream limits for contributing indirect wastewater discharge and diffuse pollution measures

- Identification of the potential for cost sharing for diffuse pollution controls across a number of Directives (Water Framework, Nitrates etc.) in line with the new DEFRA approach to sustainable farming, outlined in *Farming and Food – A Sustainable Future* (Policy Commission on the Future of Farming and Food, 2002).

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APPENDIX 1

Department for the Environment, Food and Rural Affairs: Terms of Reference

Contract reference: WS 128/-/9/97

REVISION OF THE BATHING WATER DIRECTIVE 76/160/EEC: IMPLICATIONS OF THE WHO APPROACH TO BEACH CLASSIFICATION: PHASE 3 STUDIES

<u>Points agreed at meeting between DEFRA and Kieran Conlan, 10 January 2002</u>

Project tasks

Determination of required improvements at each bathing water

The 2000 microbiological monitoring database for England and Wales will be assessed, in order to ascertain the number of bathing waters meeting and failing under each regulatory scenario. The results will be compared with the 2001 microbiological monitoring database to ensure consistency.

Consideration will be given to whether the statistical basis for UK CSO policy still applies when microbiological standards are tightened and a different compliance statistic (i.e., 95%) is used. If this is the case then required improvements at tighter standards could include changes to CSO design.

In the case of bathing waters requiring measures to address diffuse pollution, previous studies on diffuse pollution (such as the Ayrshire coast study, the David Kay model, the Dutch RIZA methodology and Environment Agency studies on the south-west coast) will be used to establish the required improvements.

Costing of bathing water quality improvements

The costing of bathing water quality improvements should compare costs associated with sewage infrastructure improvements with those relating to beach management. The distinction between these costs is important, as it is possible that under a revised Directive beach management actions could be taken in certain cases instead of infrastructure improvements.

The costing of required sewerage infrastructure improvements at each bathing water will be carried out using information from the Environment Agency report "Achieving the Quality". This will enable the determination of costs of infrastructure to meet higher than mandatory bathing water standards. In the case of bathing waters for which the required data are not available, costings will be carried out through a detailed examination of the situation at each bathing water in question. For the most stringent regulatory scenario chosen (40 IE/100ml) it may need to be assumed that all improvement measures are required.

During the costing exercise discussions will be held with OFWAT to verify the accuracy of the matrix. Economic rules developed by OFWAT will be used throughout the costing procedure. The tenderer will perform spot checks of the matrix as necessary to enable further verification of the results.

The costing exercise will take into account the feasibility of predicting breaches of bathing water standards under each regulatory scenario, and thus how readily a discounting system using "pre-emptive" beach management actions could be applied to UK beaches. The effects of discounting on the costing of improvements required at each bathing water will be ascertained.

From the results of the costings for each regulatory scenario, a graph will be developed showing variation of cost with bathing water quality standard. The envelope of potential compliance standards will range from 40 to 2000 IE, using 95% compliance as a driver. If at a later date the Commission showed signs of adopting an alternative statistical approach to percentages, the calculations would be re-run on this basis. As well as showing the regulatory scenarios considered in the project, the cost curve will show the relative stringency of other notable standards (e.g., EPA, Commission test compliance protocol, WHO guideline values).

An examination of the impact of discounting on the magnitude and shape of the cost curve will also be carried out. It will then be possible to assess the impact of discounting on compliance, and how discounting can be handled in a bathing water classification scheme, such as that of the WHO's.

Project budget and timescale

The budget for the project (including the breakdown into individual tasks and travel and subsistence costs) remains exactly as stated in the December 2001 proposal from Cascade Consulting. The tenderer will sub-contract part of the work, if this becomes necessary, to meet the required timescales.

The timetable for the project is amended as follows:

Actual start date: 18 January 2002
Anticipated end date: 15 March 2002

Project outputs

The three milestones identified in the project specification will be modified thus:

Milestone 1: A <u>draft interim report</u> will be produced and sent to DEFRA by 5pm on 6 February 2002 at the latest. Electronic distribution is preferable. The draft interim report will discuss:

- Estimates of costs of required improvements for each regulatory scenario;
- The shape of the plot showing how costs of required improvements increase with tightening water quality standards;
- The ease with which discounting can be applied at more stringent water quality standards; and
- The effects of discounting on compliance and on the costs associated with each identified regulatory scenario.

The report will be used to inform the UK line to take for an Expert Working Group for the bathing water Directive and so should where possible give clear diagrammatic representations of its findings for ease of presentation to Commission and Member

State experts. The report should also briefly qualify any assumptions made in arriving at its conclusions, and should state any limitations of the results produced.

Milestone 2: Following completion of stage 2 of the project, a draft final report due on 6 March 2002.

Milestone 3: The output from this project in the form of a final report due on 15 March 2002.

Water Quality Division
DEFRA
14 January 2002

APPENDIX 2

Summary Matrices of Costs for the Three Regulatory Scenarios

Improvement Measures for Each Scenario - Region A

Improvement from D to C

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
1	380	340	200

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Additonal SWO improvements

SWO outfall impro	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower

Improvement from C to B

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
1	**2,300**	15	14	12	2	1	1

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
1	380	340	200

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
2	no costs at present	no costs at present	no costs at present

DIRECT Additonal SWO improvements

SWO outfall impro	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
1	**14,000**	92	84	76	9	8	8

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
5	1900	1700	1000

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
9	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
2	700	554	460

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
2	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**122,196**	**B**	40569	30060	22545	32015	29083	19612
Catchment	**21,607**	**B**	7174	5315	3986	5661	5142	3468
7 streams	**3,500**	**B**	1162	861	646	917	833	562

Improvement from B to A

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
2	**26,000**	172	156	140	17	16	14

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
4	1520	1360	800

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
27	no costs at present	no costs at present	no costs at present

DIRECT Additonal SWO improvements

SWO outfall impro	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
1	61	55	50

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
6	**442,200**	2919	2653	2388	292	265	239

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
6	2280	2040	1200

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
27	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
4	1400	1108	920

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	61	55	50

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
2	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
8	240	200	160

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**122,196**	**previously t**	-	-	-	-	-	-
Catchment	**21,607**	**previously t**	-	-	-	-	-	-
7 streams	**3,500**	**previously t**	-	-	-	-	-	-
Catchment	**35,816**	**A**	11891	8811	6608	9384	8524	5748
14 streams	**6,100**	**A**	2025	1501	1125	1598	1452	979
Catchment	**12,931**	**A**	4293	3181	2386	3388	3078	2075

Improvement Measures for Each Scenario - Region B

Improvement from C to B

DIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
5	**178,000**	1175	1068	961	117	107	96

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
2	760	680	400

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Additonal SwO improvements

SWO outfall impro	Total CAPEX £k		
Number of SV	Upper	Mid	Lower
2	122	110	100

INDIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
1	**58,000**	383	348	313	38	35	31

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
1	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
3	1050	831	690

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower

Improvement from B to A

DIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
7	**558,550**	3686	3351	3016	369	335	302

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
5	no costs at present	no costs at present	no costs at present

DIRECT Additonal SwO improvements

SWO outfall impro	Total CAPEX £k		
Number of SV	Upper	Mid	Lower
5	305	275	250

INDIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
5	**134,500**	888	807	726	89	81	73

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
30	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
2	700	554	460

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
9	549	495	450

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
2	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	30	25	20

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**19,801**	**A**	6574	4871	3653	5188	4713	3178
Catchment	**38,754**	**A**	12866	9533	7150	10154	9223	6220
Catchment	**8,530**	**A**	2832	2098	1574	2235	2030	1369
Catchment	**7,463**	**A**	2478	1836	1377	1955	1776	1198
Catchment	**45,825**	**A**	15214	11273	8455	12006	10906	7355
Catchment	**58,431**	**A**	19399	14374	10781	15309	13907	9378
2 streams	**1,000**	**A**	332	246	185	262	238	161
marshland	**500**	**A**	-	-	-	850	750	700
Runoff to l	**urban runof**	**A**	N/A	N/A	N/A	N/A	N/A	N/A

Improvement Measures for Each Scenario - Region C

Improvement from C to B

DIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
1	380	340	200

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Additonal SwO improvements

SWO outfall impro	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
1	**180,000**	1188	1080	972	119	108	97

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
0								

Improvement from B to A

DIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
6	no costs at present	no costs at present	no costs at present

DIRECT Additonal SwO improvements

SWO outfall impro	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
1	61	55	50

INDIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing W	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
0								

Improvement Measures for Each Scenario - Region D

Improvement from C to B

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
1	**188,000**	1241	1128	1015	124	113	102

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
2	760	680	400

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
5	no costs at present	no costs at present	no costs at present

DIRECT Additonal SWO improvements

SWO outfall improv	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
6	366	330	300

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
2	**554,000**	3656	3324	2992	366	332	299

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
5	1900	1700	1000

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
22	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
4	244	220	200

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
1 marshland	**22,000**	**B**	-	-	-	28050	24750	23100

Improvement from B to A

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
4	**301,000**	1987	1806	1625	199	181	163

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
15	5700	5100	3000

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
16	no costs at present	no costs at present	no costs at present

DIRECT Additonal SWO improvements

SWO outfall improv	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
15	915	825	750

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
13	**822,500**	5429	4935	4442	543	494	444

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
26	9880	8840	5200

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
78	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	350	277	230

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
8	488	440	400

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
1 marshland	**22,000**	**A (previously to B)**	-	-	-	9350	8250	7700
Catchment	**76,266**	**A**	25320	18761	14071	19982	18151	12241
2 marshland	**Costed in 1 marshland (above)**	**A**	N/A	N/A	N/A	N/A	N/A	N/A
8 streams	**4,000**	**A**	1328	984	738	1048	952	642

Improvement Measures for Each Scenario - Region E

Improvement from D to C

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
1	380	340	200

DIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
0	0	0	0

DIRECT Additonal SwO improvements

SWO outfall improv	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
5	1900	1700	1000

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**2,181**	**(cost as to**	724	537	402	571	519	350

Improvement from C to B

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
4	**24,600**	162	148	133	16	15	13

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
14	5320	4760	2800

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
0	0	0	0

DIRECT Additonal SwO improvements

SWO outfall improv	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
11	**149,950**	990	900	810	99	90	81

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
90	34200	30600	18000

INDIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
6	2100	1662	1380

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	61	55	50

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
2	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
4	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**6,315**	**B**	2097	1553	1165	1655	1503	1014
Catchment	**4,305**	**B**	1429	1059	794	1128	1025	691
Catchment	**10,018**	**B**	3326	2464	1848	2625	2384	1608
Catchment	**60,931**	**B**	20229	14989	11242	15964	14502	9779
Catchment	**18,260**	**B**	6062	4492	3369	4784	4346	2931
Catchment	**1,633**	**B**	542	402	301	428	389	262
Catchment	**6,010**	**B**	1995	1478	1109	1575	1430	965
2 Catchmen	**124,218**	**B**	41240	30558	22918	32545	29564	19937
12 streams	**6,400**	**B**	2125	1574	1181	1677	1523	1027

Improvement from B to A

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
8	**45,200**	298	271	244	30	27	24

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
1	380	340	200

DIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with d	Upper	Mid	Lower
40	no costs at present	no costs at present	no costs at present

DIRECT Additonal SwO improvements

SWO outfall improv	Total CAPEX £k		
Number of SW	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
11	**80,050**	528	480	432	53	48	43

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
15	5700	5100	3000

INDIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
43	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
20	7000	5540	4600

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
11	671	605	550

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
5	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
19	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**60,931**	**previous to**	-	-	-	-	-	-
Catchment	**6,315**	**previous to**	-	-	-	-	-	-
Catchment	**4,305**	**previous to**	-	-	-	-	-	-
Catchment	**10,018**	**previous to**	-	-	-	-	-	-
Catchment	**2,181**	**previous to**	-	-	-	-	-	-
Catchment	**6,010**	**previous to**	-	-	-	-	-	-
2 Catchmen	**124,218**	**previous to**	-	-	-	-	-	-
9 streams	**4,700**	**previous to**	-	-	-	-	-	-
49 streams	**18,300**	**A**	6076	4502	3376	4795	4355	2937
Catchment	**45,782**	**A**	15200	11262	8447	11995	10896	7348
Catchment	**6,380**	**A**	2118	1569	1177	1672	1518	1024
Catchment	**35,639**	**A**	11832	8767	6575	9337	8482	5720
Catchment	**47,819**	**A**	15876	11763	8823	12529	11381	7675
Catchment	**10,467**	**A**	3475	2575	1931	2742	2491	1680
Nature rese	**100**	**A**	33	25	18	26	24	16
Catchment	**26,073**	**A**	8656	6414	4810	6831	6205	4185
Catchment	**6,761**	**A**	2245	1663	1247	1771	1609	1085
Catchments	**53,046**	**A**	17611	13049	9787	13898	12625	8514
Catchment	**3,790**	**A**	1258	932	699	993	902	608
Catchment	**35,639**	**A**	11832	8767	6575	9337	8482	5720
Catchment	**27,687**	**A**	9192	6811	5108	7254	6590	4444
Catchment	**5,000**	**A**	1660	1230	923	1310	1190	803
Catchment	**12,467**	**A**	4139	3067	2300	3266	2967	2001

Improvement Measures for Each Scenario - Region F

Improvement from C to B

DIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
2	**152,000**	1003	912	821	100	91	82

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
1	380	340	200

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Additonal SwO improvements

SWO outfall impro	Total CAPEX £k		
Number of SV	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
2	**327,000**	2158	1962	1766	216	196	177

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
2	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	350	277	230

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	61	55	50

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricultural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**67,896**	**B**	22541	16702	12527	17789	16159	10897
Catchment	**23,200**	**B**	7702	5707	4280	6078	5522	3724
2 Catchme	**25,300**	**B**	8400	6224	4668	6629	6021	4061
Catchment	**27,800**	**B**	9230	6839	5129	7284	6616	4462
1 stream	**500**	**B**	166	123	92	131	119	80

Improvement from B to A

DIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
8	**39,556**	261	237	214	26	24	21

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
18	no costs at present	no costs at present	no costs at present

DIRECT Additonal SwO improvements

SWO outfall impro	Total CAPEX £k		
Number of SV	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwT		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
2	**20,000**	132	120	108	13	12	11

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
1	380	340	200

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
74	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	350	277	230

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
7	427	385	350

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
3	90	75	60

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Description	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
Catchment	**67,896**	**reviously t**	-	-	-	-	-	-
Catchment	**23,200**	**reviously t**	-	-	-	-	-	-
2 Catchme	**25,300**	**reviously t**	-	-	-	-	-	-
Catchment	**27,800**	**reviously t**	-	-	-	-	-	-
1 stream	**500**	**reviously t**	-	-	-	-	-	-
17 streams	**8,500**	**A**	2822	2091	1568	2227	2023	1364
Catchment	**12,750**	**A**	4233	3137	2352	3341	3035	2046
Catchment	**27,922**	**A**	9270	6869	5152	7316	6645	4481
Catchment	**2,000**	**A**	664	492	369	524	476	321
Catchment	**25,700**	**A**	8532	6322	4742	6733	6117	4125
Catchment	**14,000**	**A**	4648	3444	2583	3668	3332	2247
Catchment	**57,644**	**A**	19138	14180	10635	15103	13719	9252
Catchment	**129,078**	**A**	42854	31753	23815	33818	30721	20717
Catchment	**31,800**	**A**	10558	7823	5867	8332	7568	5104
2 Catchme	**32,800**	**A**	10890	8069	6052	8594	7806	5264

Improvement Measures for Each Scenario - Region G

Improvement from C to B

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
1	**282,000**	1861	1692	1523	186	169	152
2 outfall improvem ents	n/a	16000	4000	1000	n/a	n/a	n/a

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
4	1520	1360	800

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	no costs at present	no costs at present	no costs at present

DIRECT Additonal SwO improvements

SWO outfall improv	Total CAPEX £k		
Number of SV	Upper	Mid	Lower
0	0	0	0

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
3	**1,194,000**	7880	7164	6448	788	716	645

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
8	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	350	277	230

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
9	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Name	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
4 marshland	**3,600**	**B**	-	-	-	4590	4050	3780
Catchment	**30,100**	**B**	9993	7405	5553	7886	7164	4831
Catchment	**30,300**	**B**	10060	7454	5590	7939	7211	4863
Catchment	**16,600**	**B**	5511	4084	3063	4349	3951	2664
Catchment	**18,710**	**B**	6212	4603	3452	4902	4453	3003
2 Catchmen	**22,500**	**B**	7470	5535	4151	5895	5355	3611
Catchment	**51,290**	**B**	17028	12617	9463	13438	12207	8232
Catchments	**100,628**	**B**	33408	24754	18566	26365	23949	16151
Catchment	**38,728**	**B**	12858	9527	7145	10147	9217	6216
Catchment	**11,642**	**B**	3865	2864	2148	3050	2771	1869
3 streams	**500**	**B**	166	123	92	131	119	80

Improvement from B to A

DIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
0	**0**	0	0	0	0	0	0

DIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
0	0	0	0

DIRECT Decrease in CSO spill frequency (beyond current policy)

CSO storage tank i	Total CAPEX £k		
Number of BW with c	Upper	Mid	Lower
15	no costs at present	no costs at present	no costs at present

DIRECT Additonal SwO improvements

SWO outfall improv	Total CAPEX £k		
Number of SV	Upper	Mid	Lower
1	61	55	50

INDIRECT Additonal sewage treatment improvements

V disinfection at WwTV		Total CAPEX £k			Annual average OPEX £k		
Number of Ww	pprox total	Upper	Mid	Lower	Upper	Mid	Lower
4	**2,000**	13	12	11	1	1	1

INDIRECT Additonal CSO improvements

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
0	0	0	0

INDIRECT Decrease in CSO spill frequency (beyind current policy)

CSO storage tank i	Total CAPEX £k		
Number of CS	Upper	Mid	Lower
56	no costs at present	no costs at present	no costs at present

Diffuse pollution - New connections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
1	350	277	230

Diffuse pollution - Misconnections

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Birds Control

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
2	-	-	-

Diffuse pollution - Urban Runoff

Frequency	Total CAPEX £k		
0	Upper	Mid	Lower
	-	-	-

Diffuse pollution - Harbours/Marinas

Frequency	Total CAPEX £k		
No. Bathing Wa	Upper	Mid	Lower
0	0	0	0

Diffuse pollution - Agricutural

Catchment			Total CAPEX £k			Annual average OPEX £k		
Name	pprox area	ss improved	Upper	Mid	Lower	Upper	Mid	Lower
1 marshland	**1,500**	**previous to**	-	-	-	638	563	525
Catchment	**30,300**	**previous to**	-	-	-	-	-	-
Catchment	**18,710**	**previous to**	-	-	-	-	-	-
2 Catchmen	**22,500**	**previous to**	-	-	-	-	-	-
Catchment	**51,290**	**previous to**	-	-	-	-	-	-
Catchments	**100,628**	**previous to**	-	-	-	-	-	-
Catchment	**38,728**	**previous to**	-	-	-	-	-	-
Catchment	**11,642**	**previous to**	-	-	-	-	-	-
3 streams	**500**	**previous to**	-	-	-	-	-	-
2 streams	**1,000**	**A**	332	246	185	262	238	161
2 Catchmen	**63,139**	**A**	20962	15532	11649	16542	15027	10134