

**Development of a Methodology to
Determine the Cost-Effectiveness of
Measures and Combinations of
Measures for the Water Framework
Directive (WFD)**

Part C: Costs

for

**The Collaborative Research Programme
on River Basin Management
Planning Economics**

***RPA* Consortium**

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***Developing Methodologies to Assess Costs and Economic Impacts
Even Handedly for the Main Types of Measures***

Final Report Part C:
Costs Methodology

prepared for

**The Collaborative Research Programme
on River Basin Management Planning Economics**

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1. INTRODUCTION

1.1 Assessment of Costs

The costs methodology has been developed to enable an assessment of the costs of measures from the local to the national level. It provides an approach to estimating the costs of combinations of measures, starting with the estimation of direct financial and economic costs, with only qualitative descriptions of non-water (indirect) costs and wider economic costs, and moving to the full monetary valuation of all costs and benefits (to the degree possible). The combinations to be costed are those identified in Step 5 of the effectiveness methodology, although initial costings of individual measures are also required to feed into earlier steps of the effectiveness methodology. This allows early screening of those measures that are more expensive and less effective, and ensures on-going iteration between the assessment of costs and effectiveness.

The costs methodology includes ten steps, nine of which relate to estimating the costs of measures, with the final step (Step 10) involving the identification of the most cost-effective combination(s) of measures (Step 10 is covered in Part D of this report). The methodology can be applied at different levels:

- each step within the assessment process can be applied at three different levels, with the level of analysis and detail required increasing from a ‘broad level’ to a ‘detailed level’ to an ‘in-depth level’. Simple sensitivity based decision rules are set out to help determine when more detail may be required; and
- the methodology has also been separated into a local/sub-regional component and a regional/national component. This reflects the fact that some types of impacts will not become significant until they occur at a larger geographic or economic scale than implied by a measure adopted only at a very local level. However, it is also recognised that it may be appropriate to group waterbodies for assessment purposes, thereby ensuring that any impacts that may arise across a large area or a large number of businesses/operators are identified as such and are addressed at the regional/national level as appropriate.

There are different levels within both the local/sub-regional and regional/national methodologies as the overall design follows a tiered approach. This means that each of the steps can be applied at one of three different levels, where the amount of detail required increases from level one (the ‘broad level’) to level two (the ‘detailed level’) and then to level three (the ‘in-depth level’). Thus, the amount of detail and quantification of impacts required and, hence, data to be collected increases from the broad to the in-depth level. However, each component is designed to be independent in that any one analysis can move to the appropriate level of detail. In this way, the assessment can be focused such that more time is spent on assessing those factors that are driving the decision and to addressing uncertainty within them. Figure 1.1, overleaf, shows how the three levels fit together and the conditions under which it may be necessary to go to a more detailed level.

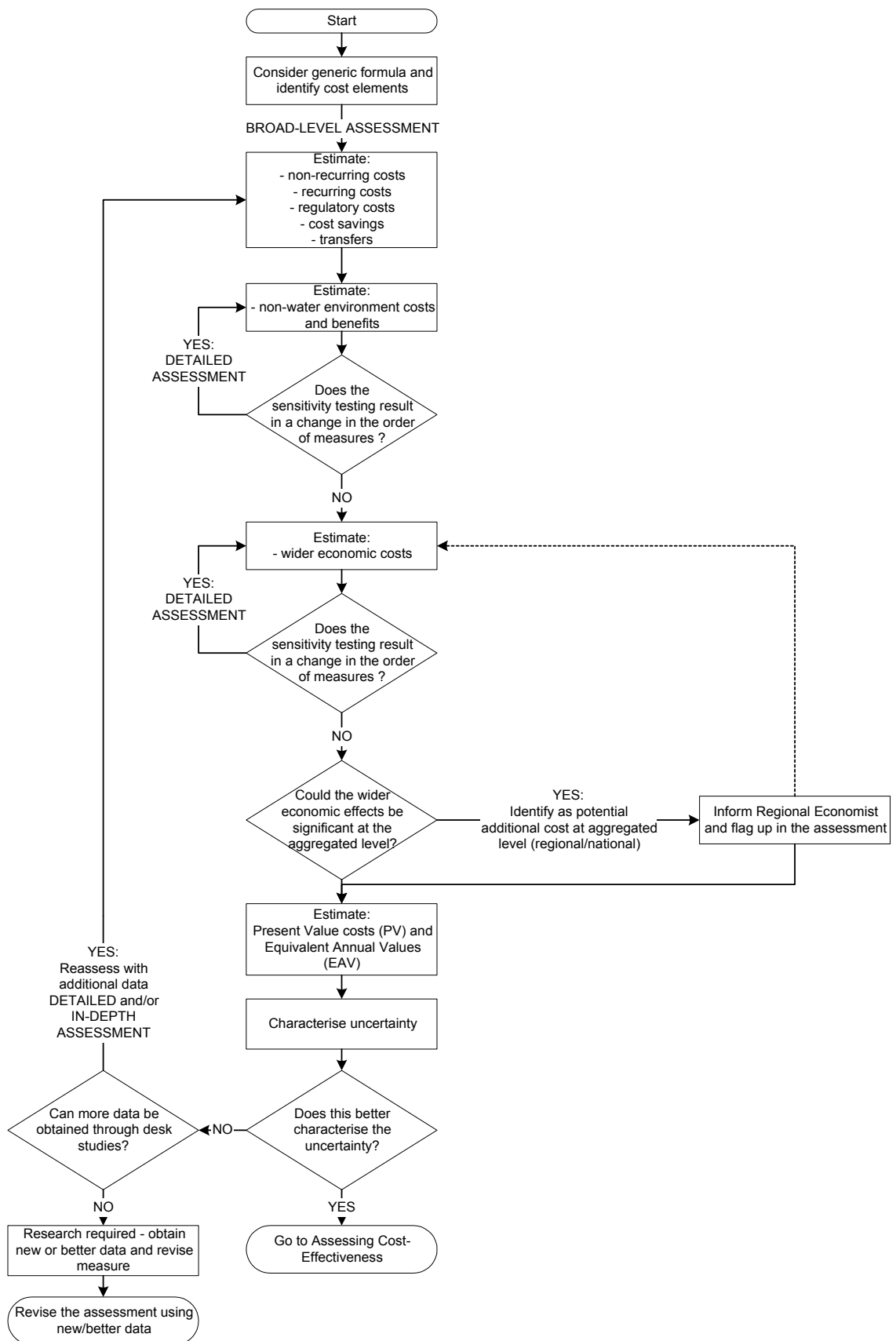


Figure 1.1: Overall Process for the Cost Assessment

1.2 Types of Costs that Need to be Assessed

The cost types that need to be brought together to estimate the total costs of a measure within the cost-effectiveness analysis are:

- non-recurring costs: these relate mainly to capital costs, but more generally are the additional one-off costs generated by a new measure/change in policy;
- recurring costs: these include changes in fixed costs (costs that do not vary across levels of production), in variable costs (costs that vary across levels of production or levels of activity) and in semi-variable costs (costs that have both a fixed and a variable component);
- non-recurring and recurring costs for regulators: regulator costs are associated with the set-up, administration, enforcement and monitoring of a new measure or a change in policy;
- cost savings: these may arise from the adoption or implementation of a measure and include savings in materials (inputs), reduced energy requirements, the recovery or sale of by-products, reduced maintenance costs, reduced manpower requirements, etc.;
- transfers: these are associated with the existence of taxes and subsidies and may result in estimates of the financial costs to businesses varying significantly from traditional measures of economic costs;
- non-water environment costs/benefits resulting from implementing the measure: they include changes in habitat, landscape, emissions to air, noise, etc. that may result from changes in land use (e.g. due to changes in agricultural practices or forestry), the construction of new treatment plants and pumping stations, and other types of works; and
- wider economic effects: any knock-on effects that are passed on or through to other sectors, organisations, etc. This includes the effects on producers and consumers in related markets that are not captured by the estimation of direct non-recurring and recurring costs.

1.3 Steps in the Costs Methodology

The cost assessment involves developing estimates for individual measures and then aggregating these for a proposed combination of measures. In the methodology, there are a series of steps to follow in assessing the cost of measures. The work required under each step is described, together with the key issues that may arise in each step. Flowcharts set out the process to be followed in each step and illustrate the linkages between the effectiveness and costs methodologies:

- **Steps 1 and 2** essentially involve pulling together key reference information such as the waterbody (or waterbodies) being assessed, geographic scale, measures being assessed and baseline assumptions from the effectiveness methodology;
- **Steps 3 and 4** set out the process to develop financial cost estimates (non-recurring, recurring costs and cost savings, to the organisation(s) implementing the measure and to regulators); low, medium and high estimates are to be developed and probabilities associated to the likelihood of these estimates being realised;
- in **Step 5**, financial costs are adjusted to reflect economic costs as required by removing the effect of transfers; again low, medium and high estimates are to be carried forward;
- **Step 6** involves the assessment of non-water environment costs and benefits, with these described in qualitative and quantitative terms first and then monetised where they may have an influence on the choice of measures. This is to ensure that the full costs (or benefits) of a measure are taken into account to reflect that impacts on the environment are not always accounted for in the costs to organisation(s) implementing the measure and/or to regulators; where quantitative estimates are developed, these should be in terms of low, medium and high figures, with their associated probabilities of occurrence;
- **Step 7** is used to determine whether wider economic impacts may be significant (where for example, the costs of the measure are large or where an activity would be forced to stop); if so, users are referred to the in-depth assessment and the assistance of regional or national economists;
- Once all of the cost elements making up each measure/combination of measures being considered have been estimated, it is necessary to estimate the discounted costs of individual measures. This is done in **Step 8**, which brings the cost estimates together to allow the Present Value (PV) and Equivalent Annual Value (EAV) costs to be estimated based on the low, medium and high assumptions; and
- **Step 9** is aimed at further characterising the level of uncertainty surrounding the cost estimates. The aim of this step is to guide the user on whether further data should be collected to reduce uncertainty.

Throughout Steps 3 to 6 (and 7 where wider economic effects are considered significant), users are to specify both the timing and duration of impacts. They are also to account for uncertainties in cost assumptions through the use of low, medium and high cost estimates. Probabilities should be assigned to the low, medium and high estimates to reflect uncertainty (where known this should be based on specified probabilities (e.g. the 10%, 50% and 90%iles); where probabilities are not known, then equal probabilities should be assigned to the low, medium and high estimates). All quantitative estimates are then converted to estimates of (net) present value costs and equivalent annual costs (in Step 9). Qualitative information is retained for non-valued impacts.

1.4 Direct Effects versus Wider Economic Effects

As discussed above, there are essentially two groups of problem types: those of a more local/sub-regional nature (Types 1 to 3 in the effectiveness methodology) and those of a more regional/national nature (Type 4 in the effectiveness methodology). Because the tools that one might apply in the cost assessment vary across these different scales, the assessment approach has been developed so as to allow consideration of direct effects first and then wider economic effects if these may be important; for example, wider economic effects may be important to Type 4 problems.

For measures that may have cost impacts at the regional/national level the assessment involves the following progression:

- Broad and detailed level: assessment of the direct costs of implementing the measure (in financial and economic terms), and starts with a qualitative description of non-water environment costs and benefits, and wider economic effects. This level of assessment applies to local/sub-regional scale issues, unless there is reason to believe that a more detailed analysis is required in particular of non-water environment costs and benefits and wider economic effects. This should be sufficient for most measures, particularly if they are implemented at the local level only.
- In-depth level: where the direct costs of implementing the measure (as estimated at the detailed level) cannot be relied upon to fully reflect the impacts on the organisation, sector, the national economy and society, then a further analysis is required to ensure that these are addressed. This analysis is more likely to be important and necessary for regional/national scale measures and/or where a number of local measures have been aggregated into an overall programme of measures.

The broad or detailed levels of assessment would be required for all measures/combinations of measures identified through the effectiveness assessment. The approach set out for these levels is essentially a ‘partial’ analysis in that it assumes that only those companies or operators directly affected by a measure are impacted. It therefore does not take into account any of the knock-on effects that may arise, for example, from one firm closing down an activity and another one starting up.

Where such knock-on effects or adjustments to product mix (e.g. in farming) may be significant, then the more in-depth level of assessment would be undertaken. In particular, this level of analysis is important where externalities and impacts on secondary markets are expected to be significant, or where there are significant market distortions or anomalies that need to be taken into account.

The need for a more in-depth assessment is likely to only apply to a subset of measures and sectors. It is likely to be more important for measures that are to be implemented at the national level, but may also be important in relation to some locally based measures which would have a significant effect on an industry sector.

For example, an in-depth assessment may be relevant to ‘local’ measures required at a port which may affect its ability to respond to changes in shipping demand and, as a result, impact not only the port’s long-term viability but also on those sectors servicing the port and on the regional and national economy more generally. It is also likely to be an essential component of the economic analysis for economic instruments and other forms of national restrictions (such as a product ban).

Table 1.1 sets out the level of quantification to be undertaken for the different levels of assessment (broad, detailed and in-depth) and the differences between what is considered in these. It is of note that the information developed during the broad and detailed assessments is a pre-requisite to preparing an in-depth assessment.

It should be noted that because impacts on secondary markets (knock-on effects) are not considered in the broad and detailed level of assessments, the final incidence of costs will be uncertain (with this having implications for the assessment of disproportionality). It is implicit however that, in not progressing to the in-depth level, the assumption is that the final incidence will not vary significantly from the initial incidence of costs.

Table 1.1: Approach to Cost Estimation at Different Levels of Assessment			
Scale of Assessment	Level of Assessment	Cost Types Subject to Quantification	Cost Types Subject to Qualitative Descriptions/Methods
Local/sub-regional Regional/National	Broad Level	Non-recurring costs Recurring costs Transfers	Any direct or hidden costs not readily quantified Non-water environment costs and benefits Wider economic effects
Local/sub-regional Regional/National	Detailed Level	Non-recurring costs Recurring costs Transfers Non-water environment costs and benefits	Any direct or hidden costs not readily quantified Any non-water environment costs and benefits not amenable to benefits transfer Wider economic effects
Local/sub-regional Regional/National	In-Depth Level	Non-recurring costs Recurring costs Transfers Non-water environment costs and benefits	Any direct or hidden costs not readily quantified Any non-water environment costs and benefits not amenable to benefits transfer
Regional/National and Local with exception	In-Depth Level	Wider economic effects on producers and consumer in related markets	Any wider economic effects not readily quantified using a resource cost based analysis or an expanded partial equilibrium analysis

1.5 Time Horizons

Costs may arise in a single period or may occur on an annual basis or recur periodically. They may also change over time due to changes in production or human resource capacity or due to knowledge constraints in the short term that are resolved in the medium to longer term. The potential for adaptation, technical innovation and

other capacity related activities to reduce costs over time should be borne in mind when developing cost estimates. For example, the costs of replacing particular types of assets over time may reduce due to innovation or technological change.

Some combinations of measures may involve the phasing of actions over time, with the aim of improving either the effectiveness of the measure or its associated costs through adaptation or by building on synergies across measures. Where this is the case, it will be important to ensure that any delays in the timing of measures are properly reflected in the cost assessment. Any cost savings that are assumed to occur as a result of delaying actions into the future must relate to having a longer time to implement the measure (from a clear starting point) and not as a result of unforeseen impacts or problems (which would probably relate to cost increases).

Where delaying action could result in a significant reduction in costs these should be examined. The most appropriate approach to doing this is to test the new 'delay' version of the combination of measures for both its relative effectiveness and costs. This will require iterations through both the effectiveness and costs aspects of the assessment, and may require the use of an approach such as decision analysis to properly capture the uncertainties surrounding the impacts of delay (in terms of both costs and effectiveness – see Section 11 on analysing uncertainty). This type of approach may also be important where costs would be higher in the first plan period due to capacity constraints, because measures would essentially be drawing resources away from invested or used in other potentially higher value uses.

This methodology requires that all future costs and benefits are converted into comparable units of value in present day terms, through the use of discounting. This allows the future stream of costs and benefits to be aggregated over time to give a total estimate of the net present value for a measure. Discounting, when applied to specific assets (machinery, etc.) provides a means of taking into account the opportunity costs of capital investments and is widely accepted and non-controversial. When applied to non-market goods and services, such as the non-water environment, discounting is used to reflect the social rate of time preference (individuals' placing more importance on impacts happening now than in the future).

For all government related assessments, the standard discount rate set by the Treasury should be used, with this being 3.5% (but reduces in year 31 to 3% and in year 76 to 2.5%). For the purposes of the financial analysis, it is proposed that the rates appropriate to the sector are used, these may be those applied under IPPC, or for the water companies the rates set by Ofwat, so as to reflect the time preference/opportunity costs of capital of the organisations incurring the costs.

The next issue is establishing the time period over which present value cost estimates should be developed. It is generally accepted that discounting should be linked to the life of the longest lived asset (asset in its widest sense not just machinery – any thing created which produces a flow of benefits). In the case of the water sector and traditional investments, this translates to a period of 20 to 30 years or longer, depending on the asset. In relation to flood and coastal protection (relevant to morphology), a period of 100 years is generally adopted.

For the purposes of the CEA, it is proposed that a fixed time period agreed across the main stakeholders is adopted to ensure that all measures, across all waterbodies and all river basins are assessed over the same period. All costs and benefits should also be expressed in a common price base. Costs should then be presented in terms of present values and equivalent annual values (EAVs); EAVs are particularly useful as they provide a means of dealing with the fact that different measures may give rise to costs over varying time horizons.

2. STEP 1: IDENTIFY APPROPRIATE SCALE OF ASSESSMENT

The first step in the cost assessment is to identify whether the assessment should be undertaken at the local/sub-regional or the regional/national scale. Step 1 of the effectiveness methodology involves defining the type of problem that is to be addressed by the effectiveness and, hence, cost assessment. Four problem types are set out:

- Type 1 problem: a local risk of impact caused by a single pressure;
- Type 2 problem: a local risk of impact caused by multiple pressures of the same type;
- Type 3 problem: local risk of impact caused by multiple pressures of different types; and
- Type 4 problem: similar risks of impact caused by single pressures across multiple water bodies.

These different types effectively correspond to problems that arise at the local (1,2 and 3) and at the higher regional or national level (4). There may be occasions when more than one measure could be proposed to reduce the risk associated with a pressure; similarly, for any given measure, it may be possible to apply it to a greater or lesser extent. This is reflected in the ‘effort’ attribute of the effectiveness methodology, which takes into account the different amount of ‘work’ (level or intensity of application) that has to be undertaken to reduce a pressure. Different levels of effort are assumed to be different measures.

There may be occasions when although the problem type identified for a waterbody may correspond to a Type 1, Type 2 or Type 3 problem, this same risk issue may be arising across numerous waterbodies within the river basin (with this then suggesting that the problem may be better characterised as a Type 4 problem). As a result, it may be appropriate to group these waterbodies for assessment purposes. This will help ensure that any impacts that may arise across a large area or a large number of businesses/operators are identified as such and are addressed at the regional/national level as appropriate.

The tasks involved in this step of the cost assessment are set out in Table 2.1.

Table 2.1: Summary of Tasks in Step 1
i) Feed general cost information into the screening of measures undertaken as part of the effectiveness assessment (there is likely to be readily available cost data at this stage);
ii) Review the combinations of measures from Step 4 of the effectiveness assessment and the identification of the appropriate scale for each measure from Step 2 of the effectiveness methodology;
iii) Determine whether the individual measures within the combination are best characterised as local or national (based on Types of pressure as defined in Step 1 of the effectiveness methodology);
iv) Check whether the local measures would only be applied to a small geographic scale or number of sites or businesses;
v) Make a decision whether to adopt the local or national scale of assessment for individual measures and/or the combination;
vi) Establish contact with relevant stakeholders to initiate the collection and validation of cost data.

The preliminary CEA to be carried out at the national level will decide for each pressure whether it should be addressed by local action, national action or a combination of both. The operational (local) assessment will then treat any measures that are to be undertaken at the national level as part of the baseline. Only measures that are required on top of these will then need to be assessed at the local level.

However, even at the local level, it will need to be determined whether the individual measures comprising any given combination would only be applied to a small set of local waterbodies, or whether it is likely that it would be applied to a large number of waterbodies (or to a large area), albeit at the local level. Where a measure would be applied cumulatively across a large number of waterbodies or a large area, then the impacts may be felt regionally (or nationally) rather than just locally.

Where the implications may be felt regionally (or nationally), then this may provide an early indication of the potential need to examine the wider economic effects that may arise from a combination of measures.

Note that stakeholder involvement in reviewing the combinations of measures and in developing the information necessary to cost them should start at this stage in the assessment. At the national level, trade and other sector organisations should be contacted and involved in developing costs as appropriate to reflect differences in the characteristics and activities undertaken by different companies with their sectors. At the local level, businesses should be involved in translating standard cost data to local conditions and their specific operations.

3. STEP 2: DEFINE REFERENCE INFORMATION

3.1 Overview

The aim of this step is to record details about the measures that are being proposed. These details are then linked to the different types of measures and the cost formula. By making these linkages, users of the methodology should be able to establish what types of costs should be considered within the assessment, to help ensure that a consistent approach is taken across measures and assessments. Note that there is no difference between the local and national level assessments for this Step.

Table 3.1: Summary of Tasks in Step 2

<ul style="list-style-type: none"> i) Recording of reference information for a given measure (from Step 2 of the effectiveness methodology) and/or combination of measures (from Step 4 of the effectiveness methodology). Consideration should also be given to the mechanisms by which the measures will be implemented; these are also identified in Step 2 of the effectiveness methodology; ii) Recording of the geographic scale (national, water body or an intermediate scale); iii) Identifying the types of measures under consideration and their classification, following Section 3.2 and using Table 3.1; iv) Setting out the baseline assumptions for each of the sectors affected by the measures (likely changes in production activities over time, planned changes in regulation, etc.) to be used as the counter-factual for estimating the additional costs arising from each of the measures; v) Identifying the cost formula for each type of measure from Table 3.3. The use of a specific cost formula by measure type will help ensure consistency across assessments, as well as enable screening out of those cost variables that are not relevant; and vi) Assessment of whether the cost function is likely to be linear or not.
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3.2 Types of Measures

Step 2 of the effectiveness methodology identifies measures that could be implemented to reduce or remove a pressure. To undertake the assessment of costs, it is necessary to have identified measures and/or combinations of measures that will reduce (or eliminate) the risk of failing to meet good status. It is not necessary to have completed all aspects of the assessment of effectiveness to assess the costs of the measures (although the level of effort required must be specified), but the measures identified in Step 2 should feed into the costs methodology at this point.

For the estimation of costs, there are 16 different types of measure that can be implemented. These are general types of measures relating to different approaches that can be taken to reduce or eliminate particular pressures. Table 3.2 presents the different types of measure with examples of each for different sectors. The measures are organised in this way so that they reflect the expected outcome if the measure is implemented. It is then easier to identify the relevant cost elements that need to be considered when estimating the costs of that measure.

Table 3.2: The Types of Measures		
Ref. No	Type of Measure	Examples
1	Treatment/transformation of emissions	Discharges, dredged material, minewater
2	Relocation of activities	Moving abstraction point, moving discharge point
3	Recycling or re-use	Within process recycling/re-use, take-back schemes, deposit-refund schemes
4	Substitution of polluting substance	
5	Process changes or re-design	
6	Reduced levels of input use	Chemical, fertiliser, pesticides, etc.
7	Product-related restrictions	Restrictions on content, restrictions on final use
8	Improved management	Modifications to fishing gear, planning controls, minimise dredging requirements
9	Changes in consumer/ producer behaviour	Classification and labelling, product labelling, information campaigns, guidance documents
10	Changes in prices	Tax, subsidy
11	Conditions/controls on activities	Tightening abstraction licences, development controls, tradeable permits, site remediation conditions, operating conditions, conditions on time of ploughing, fertiliser application, dredging, reforestation requirements, seasonal bans, restrict shipping movements
12	Natural processes and monitoring	Use of natural attenuation and natural processes (e.g. wetlands or measures taken in relation to contaminated land) and monitoring of natural processes (where there are no costs associated with this type of measure, it should be assumed to form part of the baseline; thus, this measure type is only relevant where some costs would be incurred)
13	Modifying/ removing/building physical structures	Flow restoration/augmentation, channel modification, drainage modification, winter storage reservoirs, use of soft engineering
14	Waste minimisation	
15	Restoration/remediation/re-creation	Compensatory habitat, bubbling of oxygen into river, gravel cleaning
16	Research	Research to better understand processes, applicability, feasibility or the costs and effectiveness of measures

There is a range of different mechanisms that could be used to implement these measures. The mechanisms to be used to implement the measure are identified in Step 2 of the effectiveness methodology (see Table 2.5 of the effectiveness methodology (Part B) for the full list of delivery mechanisms). Note that where different delivery mechanisms could be applied to a single measure, then these should be treated as separate options for the purposes of the assessment. This is because the

different delivery mechanisms may result in different costs to both industry and regulators, and may also imply different levels of effort.

As indicated earlier, one may want to examine the impact that different delivery mechanisms and levels of effort have on meeting the gap and on the associated costs and, hence, cost-effectiveness of combinations of measures. Where cost functions have been developed that link the effectiveness of different mechanisms and levels of effort to costs, then this process will be simplified by examination of the marginal costs of increasing levels of effort. Such functions would provide a valuable means of fine-tuning combinations of measures.

3.3 Setting out Baseline Assumptions

In predicting the effectiveness of measures, the effectiveness methodology will require recording of the assumptions that have been made in the risk assessment as to what would happen in the future in the absence of any additional controls or measures under the WFD. These assumptions should be examined and understood as they provide the baseline (or counterfactual) against which the costs of measures are estimated. It is important that the cost analysis considers only the additional or change in costs arising from the adoption of a measure (with expenditure on existing activities or capital ignored).

Particularly, important factors to determining the baseline in relation to the cost analysis include:

- information on current technologies, processes and production activities, at a level of detail which will enable costs of changes to or increases in efficiency of these to be predicted;
- any expected/planned changes in all agreed to/funded regulation or government interventions (e.g. CAP reform and introduction of Single Farm Payments, IPPC, etc.) up to 2015 and the implications of these for the technologies, processes or production activities of those that would be affected by a measure; this may be particularly important as other regulatory drivers may result in technological and other changes that would reduce/increase the costs associated with proposed measures. The Business as Usual projections should also feed into the baseline; and
- expected trends in the market for different goods, for example, due to changing consumer demand or due to changes in world markets.

The above factors should also be considered in combination, as taken together they may reduce the likelihood that some pressures may persist in the longer term. The gap remaining between current and the WFD objectives at 2015 is then to be addressed by the Programmes of Measures (PoMs).

Longer-term planning issues should also be considered (with this also corresponding to the need to address such issues when looking at the effectiveness of measures in Step 3 of the effectiveness methodology) at this point in time. This will help avoid proposing investment in measures that could become prematurely redundant; it may

also help improve the long term sustainability of measures and help ensure that the most cost-effective programme over time is adopted. In this regard, discussions with the business sectors involved on what their long term requirements are likely to be is important, particularly where they are planning for new capital investments.

3.4 Application of the Formula to the Different Types of Measure

For each of the types of measures listed in Section 3.2 above, a cost formula has been defined. These cost formula have been developed so as to identify, in general terms, the cost variables that should be examined when estimating the change in costs (i.e. the net costs) associated with a particular type of measure. The aim is to help ensure that all relevant costs are taken into account, and that there is consistency across sectors as to what types of costs are considered when developing cost estimates. The formulas are presented in Table 3.3, together with an indication of the core cost variables that should be considered and other cost variables that may potentially need to be considered depending on the specific measure or sector affected¹.

A measure is essentially an action to be taken and a mechanism is the process for implementing that action. The relative magnitude of costs associated with the different cost variables may change depending on the mechanisms through which a measure is to be delivered. For example, one mechanism of delivery may result in higher recurring costs to businesses than an alternative mechanism (e.g. due to a higher administrative burden or greater monitoring activities), even though the measure being implemented would essentially be the same. Alternative mechanisms of delivery may also have different cost implications for regulators. For further discussion of the different types of costs and cost variables that may need to be considered see Section 4 of this Part of the report (Part C).

Measures required under the WFD may result in the loss of productive capital, either directly as a result of controls on a process itself, through restrictions on inputs or outputs, or due to a decision to shut down. Within an assessment such as this, existing capital is treated as a 'sunk' cost and the loss of such capital assets is typically ignored within the cost assessment. This is because such assets are likely to be specific to a particular sector/process and have no value in alternative uses (where there is the potential for an alternative use, then the assessment should take into account the salvage value of the asset). This is likely to apply to many industrial processes as well as to the water industry.

However, as discussed in RPA *et al* (2004), consideration of sunk costs (existing assets) may be important to identifying any cost synergies that may arise with bolt-on solutions compared to stand alone solutions. Furthermore, sunk costs may be important to the ability of companies to incur changes in costs and hence the potential need for time derogations. Ignoring sunk costs may result in some sectors incurring a disproportionate level of costs compared to their contribution to pressures. In

¹ Note that the Steering Group has indicated that the cost equations presented in Table 3.3 will not be carried forward to operational guidance.

Table 3.3: Cost Functions for Main Types of Measures			
Ref No.	Type of Measure	Core Cost Function	Potential Cost Elements
1	Treatment/transformation of emissions	$MC = f(C_{\text{capital}}, C_{\text{design}}, C_{\text{variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	Q_{quantity}
2	Relocation of activities	$MC = f(C_{\text{capital}}, C_{\text{design}}, C_{\text{variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	$C_{\text{fixed}}, Q_{\text{quantity}}, C_{\text{hidden}}$
3	Recycling or re-use	$MC = f(C_{\text{capital}}, C_{\text{design}}, C_{\text{variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	C_{hidden}
4	Substitution of polluting substance	$MC = f(C_{\text{variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	$C_{\text{capital}}, C_{\text{design}}, C_{\text{hidden}}, Q_{\text{revenue}}, W_{\text{consumer related}}$
5	Process changes or re-design	$MC = f(C_{\text{capital}}, C_{\text{design}}, C_{\text{variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	$C_{\text{fixed}}, C_{\text{hidden}}$
6	Reduced levels of input use	$MC = f(C_{\text{variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	$C_{\text{hidden}}, Q_{\text{quantity}}, W_{\text{producer related}}, W_{\text{consumer related}}$
7	Product-related restrictions	$MC = f(Q_{\text{quantity}}, NW_{\text{benefits}}, NW_{\text{costs}})$	$W_{\text{producer related}}, W_{\text{consumer related}}$
8	Improved management	$MC = f(C_{\text{variable}}, C_{\text{semi-variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	$Q_{\text{quantity}}, C_{\text{hidden}}$
9	Changes in consumer/ producer behaviour	$MC = f(Q_{\text{quantity}}, W_{\text{producer related}}, W_{\text{consumer related}}, NW_{\text{benefits}}, NW_{\text{costs}})$	C_{hidden}
10	Changes in prices	$MC = f(P_{\text{prices}}, Q_{\text{quantity}}, W_{\text{producer related}}, W_{\text{consumer related}})$	$C_{\text{fixed}}, C_{\text{variable}}, C_{\text{semi-variable}}, NW_{\text{benefits}}, NW_{\text{costs}}$
11	Conditions/controls on activities	$MC = f(Q_{\text{quantity}}, C_{\text{variable}}, C_{\text{semi-variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	C_{fixed}
12	Natural processes (including monitoring)	$MC = f(C_{\text{fixed}}, NW_{\text{benefits}}, NW_{\text{costs}})$	
13	Modifying/ removing/building physical structures	$MC = f(C_{\text{capital}}, C_{\text{design}}, C_{\text{fixed}}, C_{\text{variable}}, C_{\text{semi-variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	
14	Waste minimisation	$MC = f(C_{\text{capital}}, C_{\text{design}}, C_{\text{variable}}, C_{\text{semi-variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	
15	Restoration/remediation/re-creation	$MC = f(C_{\text{capital}}, C_{\text{design}}, C_{\text{variable}}, C_{\text{semi-variable}}, NW_{\text{benefits}}, NW_{\text{costs}})$	
16	Research	$MC = f(C_{\text{variable}})$	

Non-recurring costs: C_{capital} : costs of any capital investments, including new plant and land
 C_{design} : costs of engineering studies, site investigations, modelling work, etc. required as part of determining capital requirements
 C_{hidden} : hidden or transitional costs associated with implementation of an option (these can also be recurring costs)

Recurring costs: C_{fixed} : fixed costs such as rents on land or buildings; this also includes any fixed costs that may change as a result in a change in scale of activity
 C_{variable} : costs that vary with production such as energy, labour, raw materials (water, chemicals, feed, fertilisers, etc.), waste disposal, etc.
 $C_{\text{semi-variable}}$: costs associated with maintenance works, administration, monitoring activities, enforcement
 Q_{quantity} and P_{price} : changes in quantities or prices giving rise to changes in producer or consumer surplus

Non-water environment: $NW_{\text{benefits}}, NW_{\text{costs}}$: non-water environment costs or benefits

Wider economic effects: $W_{\text{producer related}}$: indirect impacts on related markets, where these may stem from a change in demand or a change in prices and represent costs or benefits
 $W_{\text{consumer related}}$: impacts on consumer surplus arising from either a change in price or a change in the quality or the availability of a good

addition, if the loss in productive capital to one firm/sector results in a financial gain to another firm/sector, then significant distributional effects may arise. As a result, information on existing costs and contribution to the problem will also need to be collected at this stage, even though it should not influence estimation of the most cost-effective combination of measures.

3.5 Linear or Non-Linear Cost Functions

The formulas in Table 3.3 are presented as functions, using the term f . This is because costs are not static but vary according to a number of different parameters. These changes can occur because of time, the size or scale of the measure, sector (or sub-sector) specific factors, potential economies of scale, etc. Cost functions are built up from static cost data by considering a range of different attributes that may affect costs. The overall aim is to identify whether the cost function is linear or not. Linear functions are the simplest to deal with as any increase in size/scale of the measures (e.g. an increase in the area of land where new agricultural practices are implemented) will result in a proportional increase in costs. Non-linear functions are more difficult as more information is needed on the attributes such that the shape of the function can be determined. Making a distinction between cost functions in this regard will be most important where alternative measures effectively involve taking the same actions, but at different levels of effort.

4. STEP 3: ESTIMATE NON-RECURRING AND RECURRING COSTS

4.1 Overview

From Step 2, users will have identified the cost variables that are likely to be important to estimating the total economic costs associated with a given measure. The focus of Step 3 is to develop estimates of the non-recurring and recurring costs for both private sector companies and regulators. Costs to regulators are considered separately as they are not always directly involved with implementation of a measure, but rather with checking that the measure is implemented correctly, is working correctly and, as such, is effective.

Table 4.1: Summary of Tasks in Step 3

<ul style="list-style-type: none"> i) Identify the cost variables that are likely to arise under the measure. ii) Describe each relevant cost variable. iii) Identify the unit costs associated with each cost element. A low, mid and high estimate should be developed to reflect uncertainty (where known this should be based on specified probabilities (e.g. the 10%, 50% and 90%iles); where probabilities are not known, an equal probability should be assigned to the low, medium and high estimates). iv) Identify the units affected or required. v) Specify the timing of each type of cost. vi) Identify any costs variables which cannot be quantified in money terms and test the likely sensitivity of non-recurring or recurring costs to these missing data. If the non-quantified costs may be significant enough to change the rank order of measures, then undertake a more detailed analysis. vii) Record key assumptions and data sources. viii) Consider the potential for adaptation and phasing of measures as this may affect the cost estimates.

Note that there is no difference between the local and national level assessments for this Step.

4.2 Definitions of Cost Variables

Non-Recurring Costs (C^{NR})

Non-recurring costs will relate mainly to capital costs, but more generally are the additional one-off costs generated by a new measure/change in policy. These costs include the purchase of any necessary equipment, the costs associated with its installation, and any other one-off requirements (transitional costs) arising from the implementation of a measure. Examples of typical non-recurring cost items are:

- the purchase and installation of plant and machinery;
- the purchase or construction of buildings and infrastructure;
- legal, design, management and other experts' fees;
- training and other associated start-up costs;
- mitigation costs and any compensation payments required as part of works;
- machinery or production down-time arising from the installation of new equipment;
- the purchase or modification of computer systems;
- product research, development and marketing costs; and

- loss of inventory and productive capital if an adequate transition period is not allowed (relevant to the financial analysis).

For the purposes of this methodology, three cost elements are allocated to the non-recurring cost variable:

$$C^{NR} = C_{\text{capital}}: \text{ costs of any capital investments, including new plant and land}$$
$$C_{\text{design}}: \text{ costs of engineering studies, site investigations, modelling work, etc. required as part of determining capital requirements}$$
$$C_{\text{hidden/transitional}}: \text{ costs arising to industry and regulators associated with structural changes to systems, education and training, etc.}$$

Depending on the time horizon adopted for the assessment, there may be a need to 'repeat' a measure that would have a fairly short-life so that it is considered on a comparable basis to other measures that would remain effective (or where capital investment would remain functional) over a longer period. Where this would result in a renewal of the capital equipment, then costs may need to be entered into the assessment more than once.

Recurring Costs (C^R)

Recurring costs/savings include changes in fixed costs (costs that do not vary across levels of production), in variable costs (costs that vary across levels of production or levels of activity) and in semi-variable costs (costs that have both a fixed and a variable component). Recurring costs or savings may arise on an annual basis (e.g. increase/decrease in chemical usage) or may be more periodic in nature (e.g. dredging every five years).

Recurring costs may arise from the need to make changes in production processes, for example to accommodate a change in inputs or as part of more fundamental changes in process technology. Changes in output or levels of production may stem from restrictions on activities or through changes in demand for the product of concern (e.g. due to a tax increasing its price to consumers). Such changes will affect the revenues earned by companies, and may be short-term in nature or on-going depending on the mechanism driving the change in output and the ability of the company/business to adapt its activities.

The more detailed variables comprising recurrent costs are:

$$C^R = C_{\text{fixed}}: \text{ fixed costs such as rents on land or buildings; this also includes any fixed costs that may change as a result in a change in the scale of activity}$$
$$C_{\text{variable}}: \text{ costs that vary with changes in levels of production such as energy, labour, raw materials (water, chemicals, feed, fertilisers, etc.), waste disposal, etc.}$$
$$C_{\text{semi-variable}}: \text{ costs associated with maintenance works, administration, monitoring activities, enforcement activities}$$
$$C_{\text{hidden/transitional}}: \text{ recurring hidden or transitional costs (associated with implementation of an option)}$$

Hidden and/or transitional costs (which may also be referred to as transaction costs) include the non-financial costs incurred by businesses, as well as costs arising from the need to undertake training, to change internal systems, etc. For example, in the case of small businesses, and farm businesses in particular, they may also include the non-financial costs of self-employed family labour (which can be imputed based on labour costs).

In addition to the above more 'standard' cost variables, some measures may impact directly on either the quantities of a particular good that can be produced or on the price charged for that good. Thus, there are two additional cost elements that are relevant to estimation of recurrent costs:

Q_{quantity} : impacts on producer and/or consumer surplus due to changes in quantity produced

P_{prices} : impacts on consumer and/or producer surplus due to changes in prices

Regulator Costs

Because of their potential significance, it is important to highlight the need to consider the potential costs to regulators (in addition to those to businesses). These costs will be associated with the set-up, administration, enforcement and monitoring of a new measure or a change in policy; and it is likely that their magnitude and significance will vary across the different mechanisms for implementing a given measure and across measures.

Regulator costs often fall into a category of costs that are referred to as hidden or transitional costs. These are costs that relate to the direct costs of implementing an option that are not immediately related to a change in technology, a change in inputs, a change in management, use of resources etc.; they may be borne by the public sector or the private sector. They are costs that arise in the short-term as part of the implementation of an environmental improvement measure, e.g. planning, training, monitoring, people's time and so on. Or they may be associated with reducing or minimising any transactions costs arising from a new measure (the costs incurred in facilitating the exchange of goods and services).

Costs to regulators may be non-recurring (e.g. associated with the set-up of a new policy or scheme) or recurring costs (e.g. administration and enforcement). As indicated above, they may vary considerably across measures and may result in some measures (or mechanisms for implementing those measures) being extremely costly to implement in comparison to other measures. This will be particularly true where a measure would require considerable regulatory manpower to implement or enforce.

Their exclusion from the assessment of measures could result in significant underestimation of the actual economic costs arising from the adoption of individual measures, with subsequent implications for indicators of cost-effectiveness.

4.3 Estimating Non-Recurring and Recurring Costs

All of the non-recurring and recurring cost elements, relevant to a specific measure should be identified. In order to assist in this process, a series of sector specific look-up tables is proposed. Such tables (for example building on the type set out in the Task 4 report) could provide summary information on: the types of options available as a means of implementing a measure for different sectors; the pressures that would be addressed by the identified options; the sector specific mechanisms (or plans) available as a means of delivery for an option and the level at which this would take place (national versus local); and the cost variables and what they translate to in practice when assessing costs for the specific sector, including the units of measure and any special considerations.

Readily available costs are frequently presented as overall estimates (within a range of low to high) and cannot be easily broken down into non-recurring and recurring costs. The range of costs arising from comparison of different sources may also be very wide. Thus, it will be necessary to obtain information on costs directly from stakeholders. However, it should be recognised that stakeholders may view such information as commercial sensitive and may be unwilling to provide it, particularly if there is the potential for it to be made available to competitors or other stakeholders (although the Environment Agency, for example, frequently handles commercial data). There may also be issues regarding strategic bias, where a stakeholder may provide costs that are higher for some measures (and potentially lower for others), in order to promote one measure (or type of measure) over another. The potential for optimism bias should also be considered. This may be more of an issue with the use of generic cost data, but is less likely to be an issue for data provided by stakeholders (as there is a tendency to overestimate the costs of environmental compliance).

As noted above, early stakeholder involvement may be important to ensuring that stakeholders actively participate in the process and provide good quality data for use in the CEA.

Costs should first be described in terms of the impacts that are likely to arise and to what production activities they relate. Information on unit costs and the number of units affected forms the base data for assessing the costs of a measure. Unit costs should be defined in terms of a range (low, mid, high reflecting specified probabilities of occurrence, for example based on the 10, 50 and 90 percentile (%ile); where these are not known, then equal probabilities should be assigned to low, mid and high costs) to reflect uncertainty surrounding the assumptions underlying these estimates; and these should ideally be converted to expected values. In some cases, there may also be a range in terms of the number of units that will be affected by the change in costs (for example due to changing production levels over time), and it will be important to capture any uncertainty in the size/extent of works considered necessary.

Note that it is important to consider not only costs to industry, and to different sectors within industry, but also to regulators. These should be identified separately so that differences in the incidence of costs can be analysed later as required.

Where data are only available for a sub-set of the costs, then this should be indicated, together with a description of whether those variables may be significant. Note where money values cannot be placed on all of the costs, it will be important to test the sensitivity of the choice of the cost minimising measure to this lack of information. Where the ranking of measures in terms of their relative costs would be sensitive to small changes in estimated costs, then the analysis should progress to the more detailed level (quantifying any costs described in qualitative terms and reducing uncertainty around low, medium and high estimates).

It will also be important to record the timing of implementation, which relates to the year in which the work needs to be undertaken. In some cases, it may be necessary to undertake a programme of works such that later activities can only begin once previous activities have been completed. It is useful to note this since it could introduce uncertainty into the timing of the costs. Timing is also required because costs that are incurred in the future need to be discounted (as discussed in Section 1.5 of this Part (Part C)).

For recurring costs, timing should include specification of a start year and end year; it may also include the periodic spacing of costs over the analysis time horizon. This allows costs to be aggregated over the life of the measure (through the use of different discount factors) and calculated in present value and equivalent annual terms to take into account the varying timing of non-recurring and recurring costs.

Several factors may affect the magnitude of non-recurring and recurring costs. For example, it may be important to record design assumptions, technology assumed, capacity of works, etc. The potential for these to affect the cost estimates should be made clear where significant differences could result from small changes in assumptions.

It will also be important to identify the information required from any modelling or other studies to be adopted as an interim measure. It may be possible to reduce the costs of measures by reducing the scale or extent of studies, but this will result in greater uncertainty in terms of the future costs.

4.4 Determine the Appropriate Level of Assessment

One may need to move from the broad to the more detailed levels of assessment for two main reasons:

- because non-quantified costs are likely to be significant and change the ranking of measures in cost terms; or
- because the level of uncertainty surrounding the cost estimates is so great as to make it impossible to develop a robust ranking of measures in cost terms.

If the non-quantified costs are likely to be sufficiently significant to change the rank order of the measures in terms of total non-recurring, recurring or regulatory costs, then more cost data should be collected and the assessment should move to the next level for that cost variable.

Similarly, if the assessment has relied on national or other standard cost data and there is a considerable degree of uncertainty as to whether the data are applicable to a particular measure at a given location, then the assessment may need to move to the detailed and/or in-depth level of assessment. This more detailed analysis may need to only consider the one measure characterised by a high level of uncertainty or all of the measures, depending on how robust the original cost data is considered to be and how important the uncertainty is to the differences in cost (and cost-effectiveness) of the measures.

4.5 Accounting for Adaptation and the Phasing of Measures

The potential for adaptation, technical innovation and other capacity related activities to reduce costs over time should be borne in mind when developing cost estimates. These are likely to vary by sector and by measure. In general, it is suggested that the most appropriate way of accounting for technological change and innovation is through discussions with experts or others with a good understanding of the sector (e.g. a trade association) to understand the potential for adaptation and innovation in response to potential measures (and methods of implementation).²

The outputs of Step 3 of the effectiveness methodology (see Part B) will provide first indicators as to whether cost impacts are likely to be temporary or permanent and their likely duration. Step 3 of the effectiveness methodology (see Part B) requires the specification of a level of effort to be applied for individual measures (with this being either a single level or a range of possible levels of effort). This together with the description of what is required should provide an indication of whether the measure relates to a one-off action or to more continuous action.

Step 5 of the effectiveness methodology (see Part B) also requires scoring combinations of measures in terms of their likely ‘speed of effect’ and ‘durability of effect’. These two aspects should provide further information for understanding when costs may be incurred and the period of time over which they will be incurred.

Whether a measure involves the phasing of actions over time (for example due to capacity constraints), it will be important to ensure that any delays in the timing of measures are properly reflected in the cost assessment. Furthermore, where a measure involves delaying action until the future, this should be clearly stated, and any cost savings that are assumed to occur as a result of delaying actions into the future should be clearly identified. As indicated earlier, the most appropriate approach to doing this is to test the new ‘delay’ version of the combination of measures for both its relative effectiveness and costs (see Section 11 of this Part (Part C) on analysing uncertainty).

² Alternatively, one could assume a constant rate of technological change and incorporate this into the discount rate [discount by $1/(1+r)(1+g)$], for example, when assessing costs at the broad level of assessment; although Defra suggest that this approach should not be recommended.

5. STEP 4: COST SAVINGS

The process to be followed in Step 4 is essentially the same as for non-recurring and recurring costs. This Step has been separated out to ensure that any potential cost savings are considered and to ensure that the net costs of a measure are not over-estimated (thereby ensuring that there is an even-handed costing of measures).

The types of savings that may arise from the adoption or implementation of a measure include savings in materials (inputs), reduced energy requirements, the recovery or sale of by-products, reduced maintenance costs, reduced manpower requirements, etc.

Money estimates of cost savings should be developed at the broad level assessment (as well as at the detailed and in-depth) as these, together with the non-recurring and recurring costs, form the basis for predicting the net costs of a measure. Note where money values cannot be placed on cost savings at the broad level, it will be important to test the sensitivity of the choice of the most cost-effective combination of measures to this lack of information. Where the ranking of measures in terms of their relative net costs would be sensitive to even a small level of savings, then the analysis should progress to the more detailed level (quantifying any savings described in qualitative terms and reducing uncertainty around low, medium and high estimates and their associated probabilities of occurrence).

As for the other costs, the timing of any cost savings should be recorded to allow them to be properly accounted for in estimates of the net present value of costs.

Table 5.1: Summary of Tasks in Step 4

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| <ul style="list-style-type: none"> i) Identify the cost savings that are likely to arise under the measure. ii) Describe each relevant cost saving. iii) Identify the unit costs associated with each cost saving. A low, mid and high estimate should be developed to reflect uncertainty (where known this should be based on specified probabilities (e.g. the 10%, 50% and 90%iles); where probabilities are not known, an equal probability should be assigned to the low, medium and high estimates). iv) Identify the units affected or saved. v) Specify the timing of each type of cost saving. vi) Identify any costs savings which cannot be quantified in money terms and test the likely sensitivity of costs to these missing data. If the non-quantified cost savings may be significant enough to change the rank order of measures, then undertake a more detailed analysis. vii) Record key assumptions and data sources. |
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Note that there is no difference between the local and national level assessments for this Step.

6. STEP 5: ADJUST FOR TRANSFERS

6.1 Overview

Transfers should be treated similarly to non-recurring and recurring costs, in that they are taken account of over the life of the measure, with the start and end year recorded. The extent of the transfer should be described in unit cost terms and the number of units affected/involved recorded (e.g. the number of businesses, the unit area over which a payment is made, etc.).

It may not always be possible to break transfers down in this way, in which case, the total value of the transfer should be recorded. Discounting can then be applied in the same way as for the non-recurring and recurring costs and cost savings to estimate the total net present value of the transfers over the life of the measure. Factors affecting transfer costs, such as possible future changes in approaches to paying subsidies, should be recorded alongside reference information concerning the transfer. This will ensure that the assessment is fully transparent; it also provides a good basis for updating the assessment should more or better data become available, or the nature of transfer payments change over time.

Table 6.1: Summary of Tasks in Step 5

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| <ul style="list-style-type: none"> i) Identify any potential positive or negative transfers related to taxes, subsidies or compensation payments. ii) Determine whether transfers may be significant enough to change the likely rank order of measures in terms of their costs (and hence cost-effectiveness). iii) Identify the unit value associated with each transfer and reflect any uncertainty surrounding the transfer value (for example, where it may change over time) using low, medium and high values. Probabilities should be assigned to low, medium and high estimates to reflect uncertainty (where known this should be based on specified probabilities (e.g. the 10%, 50% and 90%iles); where probabilities are not known, equal probabilities should be assigned to the low, medium and high estimates). iv) Identify the units affected or required. v) Specify the timing of each transfer and of any changes in the value of the transfer. vi) Identify any transfers which cannot be quantified in money terms and test the likely sensitivity of non-recurring or recurring costs to these missing data. If the non-quantified costs may be significant enough to change the rank order of measures, then undertake a more detailed analysis. vii) Record key assumptions. |
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The process to be followed for local/sub-regional and regional/national level assessments does vary for this Step.

6.2 Definitions of Transfers

Economic costs may differ significantly from financial estimates of compliance costs, where the latter includes payments which are essentially transfers from one sector or economic actor to another. Financial costs will often include elements that do not relate to the consumption of resources; examples include taxes which are effectively a transfer payment from the private sector to the public sector and distortions as a result of government subsidies.

For example, subsidies or payments linked to agricultural productivity would be classified as transfers. It could be argued that payments under the Single Farm Payment scheme do not represent transfers where these are linked to the provision of environmental benefits. In these cases, the payments are made by the government for the provision of a public good. Where such payments do not affect agricultural practices, then they do represent transfers (Hodge, pers. comm., 2005).

Compensation payments from one organisation to another as part of gaining approval for a new development may also act as a form of transfer payment, where it is not linked to any damages or other impacts but is more related to ‘planning gain’ at a local level³. Similarly, where rents paid for the use of land or buildings (e.g. agricultural land) include not only an element of payment for the services provided but also an element of pure economic rent (pure profit), this rent essentially equates to a transfer.⁴

It is important to note though that taxes aimed at ‘internalising environmental externalities’ should not be treated as transfers. The aim of these is to encourage more environmentally sustainable behaviour by making ‘polluters’ pay the economic costs of any damages or use of the environment. Such taxes essentially provide a measure of the non-water environment costs and benefits associated with an activity. The degree to which they are a measure of external effects will depend on whether or not they are assumed to reflect the full external damage costs, or vary from this amount and are more a means of influencing behaviour. Where environmental impacts are not fully reflected in a tax (or subsidy), then the component that is not covered needs to be considered separately and added (or subtracted) to the total costs of complying with the Directive.

In many cases, the magnitude of such transfers may be small and, thus, any differences between financial and economic costs resulting from the ‘transfers’ are unlikely to be significant. Where this is the case, one can assume that financial cost estimates provide a good indication of the likely economic costs. Where transfers do have a significant impact on the difference between financial and economic costs, a distinction will need to be made in the assessment, with separate estimates provided for financial and economic costs. This is likely to be of most relevance when assessing compliance costs in relation to changes in agricultural productivity and practices, where these are affected by agri-environment subsidies.

The failure to account for transfers in the economic estimates of costs will result in over- or under-estimation of the real resource costs of a measure and may affect the end ranking of the cost-effectiveness of alternative measures. It will also result in an improper indication of the incidence and distribution of costs, which is important to the assessment of disproportionate costs.

³ Defra (then MAFF) (1999): **FCDPAG 3 – Flood and Coastal Defence Appraisal Guidance – Economic Appraisal**, London: HMSO.

⁴ Note that rents related to capacity constraints should be tested through the development of separate measures that examine the costs savings associated with postponing action to a future period. The issue of rents and unregulated monopolies is also addressed in Step 7 (Section 9).

6.3 Local/Sub-Regional Level Assessments

At the local/sub-regional level, only transfers related to non-general taxation, subsidies, compensation payments and rents should be considered. Taxes aimed at correcting an environmental externality (carbon tax, landfill tax) should be identified but, as discussed above, should not be part of any adjustments as they are important to ensuring that non-water environment impacts are fully accounted for (see also Step 6, Section 8).

Wherever possible, money values should be placed on transfers at the broad level assessment (and in subsequent levels). It should be possible to place money estimates on transfers related to most government subsidies and compensation payments as the per unit value of these is readily available.

Where data are not readily available from published or government sources on subsidies or compensation payments, then it is suggested that a sensitivity analysis based approach is adopted to first determining the need for more detailed data as part of the broad level of assessment. The proposed steps are as follows:

- 1) Ask the affected sector/businesses a series of questions to determine whether or not the potential transfers are likely to be significant and vary across measures.
- 2) Where these questions give rise to concerns, then sensitivity analysis can be used to determine how great the transfers/rents would have to be to affect the ranking of options in terms of their costs (and likely cost-effectiveness). For example:
 - a low scenario could assume that transfers were equal to zero;
 - a medium scenario could assume that transfers were equal to 5% of the costs of the relevant equipment/inputs; and
 - a high scenario could assume that transfers were equal to 10% (or more) of the costs of the relevant equipment/inputs.
- 3) Where the ranking of measures in terms of costs (and likely cost-effectiveness) would change depending on the assumptions made, then the analysis may have to move to a more detailed or in-depth analysis.

Alternatively, one could calculate the level of transfer needed to alter the ranking of measures and “sense check” whether any distortions in markets are likely to be this high and significant enough to drive such a wedge between financial and economic costs.

6.4 Regional/National Level Assessments

For regional/national level assessments, there are five main types of transfers or market imperfections that should be considered as part of the regional/national level assessment:

- taxes (excluding general taxation which would apply equally across measures);
- subsidies;
- compensation payments (i.e. payments between private sector operators – for example, by port operators to neighbouring land owners);
- joint products and common costs (e.g. in relation to water resource management by the water industry); and
- economic rents (supernormal profits) where there is only one or a small number of suppliers of the inputs to production, or where the rents paid for land or buildings includes a pure profit element above payment for services provided, or where there are timing/capacity constraints which allow abnormal profits to be realised.

Again, should data not be readily available from published or government sources (for example on economic rents), it is suggested that a sensitivity analysis based approach, such as that proposed above, is adopted to first determine the need for more detailed data as part of the broad level of assessment.

Compensation payments may or may not be aimed at compensating a third party for business, environmental or other damages. Where they are, then they are essentially helping to internalise externalities and should not be treated as transfers. Where they relate instead to ‘planning gain’ and getting agreement to a proposed action, then they may represent transfers. It may be difficult for the private sector to provide an indication of the likely magnitude of any compensation payments (at least a preliminary range, representing likely low to high values for such payments) at the regional or national level. Similarly, placing a money value on transfers related to economic rents is unlikely to be appropriate at the broad and detailed levels of assessment. Firstly, it will be difficult to identify whether such rents actually exist and, secondly, more detailed data than proposed generally for this level of analysis would be required to put a figure on the magnitude of such rents.

6.5 Determine the Appropriate Level of Assessment

For both levels of assessment, where the end decision is sensitive to the potential magnitude of any transfers, then a more detailed analysis would be required to reduce uncertainty around the potential difference between financial and economic cost estimates.

7. STEP 6: NON-WATER ENVIRONMENT COSTS AND BENEFITS

7.1 Overview

Non-water environment costs and benefits relate to impacts on the environment that are not directly associated with a move to meeting the WFD objectives within the water body. They include changes in habitat, landscape, emissions to air, noise, etc. that may result from changes in land use (e.g. due changes in agricultural practices or forestry), the construction of new treatment plants and pumping stations, and other types of works.

Water-related environment impacts are not considered in the CEA, as they are essentially assumed to be captured through the establishment of the gap to be addressed and the relative effectiveness predicted for different measures. Their assessment will, however, be a key activity when assessing whether combinations of measures may be disproportionately expensive. Table 7.1 sets out the tasks that are involved in undertaking Step 6 of the costs methodology.

Table 7.1: Summary of Tasks in Step 6	
i)	Review a checklist of potential impacts for relevant sector and measure (with the checklist to be developed as part of Project 2c).
ii)	Identify the non-water environment costs and benefits that are likely to arise under the measure. Check that these are not already included in financial cost estimates. If so, ensure that they are carried forward to economic cost estimates (i.e. do not remove taxes aimed at taking account of environmental impacts when estimating the impact of transfers).
iii)	Describe each relevant cost and benefit in qualitative terms and add any quantitative data in relation to the area affected, other physical units, etc.
iv)	Determine whether these impacts are likely to be significant enough to affect the end ranking of measures. Identify whether there are any significant non-water environment impacts that may affect the long term sustainability of a measure or which go against other key Government policies. If this is not known or is unlikely then move to step vi.
v)	If the impacts are likely to be significant enough to alter the end ranking of measures, then establish whether benefits transfer values, replacement costs, or mitigation costs, as appropriate, are available for the type of impact under consideration. If they are, apply these values including any ranges to reflect low, medium and high transfer values. Probabilities should be assigned to the low, medium and high estimates to reflect uncertainty (where known this should be based on specified probabilities (e.g. the 10%, 50% and 90%iles); where probabilities are not known, then equal probabilities should be assigned to the low, medium and high estimates).
vi)	Specify the timing and duration for each type of cost/benefit for discounting purposes.
vii)	Describe all assumptions and sources of data and record these in relevant proformas.
viii)	Check whether any of the conditions set out below are met, such that a more detailed analysis or new data collection is required. Undertake an analysis to determine what value would have to be assigned to the impacts for the ranking of measures to change. Assess whether that value is likely to represent an over-, under- or good estimate of people's willingness to pay.
ix)	Record decision to undertake more detailed analysis or to stop.
The process to be followed for local/sub-regional and regional/national level assessments does vary for this Step.	

Non-water environment costs and benefits should first be described in qualitative and, where available, quantitative terms. To assist in this process, either the Government's checklist of sustainability indicators can be used or a checklist could be developed (as part of the development of guidance) at the sectoral level to highlight the potential

types of impacts that may be relevant to the different types of measures that they may be required to adopt⁵. Such checklists could also highlight those non-water environment externalities that are likely to be either part or fully captured in estimates of direct compliance costs (e.g. due to the landfill or carbon tax). (See also the Task 4 report). Note that there should be a link between the checklists and the Environmental Impact Assessment work which will be undertaken on the river basin level.

7.2 Definitions of Non-Water Environment Costs and Benefits

Non-water environment impacts refer to any environmental costs or benefits that may arise from the introduction of a measure and which are not directly related to changes in the status of the water body. When including them in the cost estimates, care is required to ensure that they have not also been included within estimates for other cost components. For example, the climate change costs of increased energy consumption should be captured by the carbon tax; as a result, such non-water environmental impacts should not be taken into account in the assessments. Similarly, impacts related to increased waste disposal requirements may be taken account of by the landfill tax.

The environmental changes which may comprise non-water environmental costs or benefits include impacts on the following:

- non riparian/estuarine habitat (creation or loss) and species (including links to Government targets – e.g. to SSSIs and farmland birds);
- non riparian, etc. landscape;
- amenity (noise, odour, other nuisances);
- energy and global warming;
- air quality more generally;
- transport related impacts (congestion, accident risks, vehicle related air pollution);
- waste generation and disposal costs (although these should be included in cost estimates);
- change in risk of flooding or erosion;
- disruption/inconvenience;
- soil quality; and
- non renewable resource use more generally.

It may not always be straightforward to completely separate environmental improvements into water (i.e. those included in Step 3 of the effectiveness methodology) and non-water environment (i.e. those included in Step 6 of the costs methodology). Where there may be overlaps or where it is not clear whether an effect is water or non-water related, it is recommended that this be recorded in both the effectiveness and costs methodology to ensure impacts are not overlooked. At the

⁵ Annex 1 to the Task 4 report provides examples of some of the non-water environment impacts that may be relevant to the assessment of agricultural measures. Similar lists could be developed for other sectors, to provide a series of checklists for inclusion in guidance on how to carry out the CEA. Any such checklists should, however, be developed to avoid any overlap between the non-water environment costs and benefits and the specification of water-related environment costs and benefits to be considered as part of the assessment of disproportionality.

cost-effectiveness stage (Step 10) (in Part D of this methodology report), care will be needed to avoid double counting of these effects.

It will also be important at the cost-effectiveness stage to highlight separately any non-water environment impacts that are significant in their own right, that may have implications for the long-term sustainability of a measure and that otherwise contradict other government policies.

7.3 Determine the Appropriate Level of Assessment

The first step of the assessment is to identify whether or not the non-water environment impacts are actually ‘additional’ in that they would not otherwise occur in the absence of the WFD measures. For example, there may be other Government policies, regulations and initiatives that have as their aim delivery of the same environmental benefits as may arise from introduction of a particular WFD measure (e.g. creation of a particular type of habitat). If the impacts of the WFD measure would be additional to those delivered by other existing policies then they should be assessed. If they are not, then they should be excluded from this assessment, as they would occur in any event.

Identification of the non-water environment costs and benefits and accompanying descriptions of impacts in qualitative and quantitative terms (where readily available) is considered to be sufficient at the broad level. It will also be important to provide an indication of the factors that may affect these costs and/or benefits as a guide to any likely uncertainty surrounding the degree to which these may arise and their significance.

There will be situations when it will be necessary to move from the broad level assessment to placing a money value on these costs (or benefits) through a more detailed level assessment. The situations where valuation is most likely to be important include:

- the non-water environment costs and benefits are likely to be significant (individually or in combination), for example being equal to more than 5% of the estimated non-recurring and recurring costs;
- where there is likely to be conflict or controversy over the selection of the measure (e.g. where stakeholders do not believe that the ‘true’ costs of a measure are reflected in the non-recurring or recurring costs or where there are additional benefits, such as habitat creation, that need to be included to better reflect the perspective of society);
- where there is one (or more) important feature that should be highlighted (note that it may not always be possible to fully reflect, in money terms, the value of an important feature);
- where there are major differences in the non-water environment costs and/or benefits and these may lead to differences in the rankings attached to competing measures in terms of which is the least costs; and/or
- consultation with stakeholders suggests they want to see more (or all) of the costs quantified.

Note that the approach is the same for both the local/sub-regional and regional/national level assessments. However, it is more likely that the assessment will move to the detailed level of analysis for the regional/national level assessment. The need to move to the in-depth level of analysis, with this including the development of new valuation data, is only envisaged for the national level.

It is also important to note that the approach should consider not only the significance of the non-water impacts associated with individual impacts, but also the significance of the impacts when aggregated across all measures within a combination.

7.4 Valuing the Non-Water Environment Costs and Benefits

There are two different approaches that could be adopted in order to value non-water environment costs and benefits at the broad or detailed level. These are:

- the use of costs based methods such as replacement costs, or mitigation costs; and
- the use of willingness to pay estimates derived from benefits transfer methods or original valuation studies.

In general, the use of methods such as replacement costs or mitigation costs is considered second best to the use of willingness to pay values. This is because they rely on the costs of physically replacing/creating a good or of mitigating an effect rather than a measure of people's willingness to pay for the benefits or willingness to pay to avoid the damages. Because replacement cost methods are not based on willingness to pay, they may over- or underestimate actual benefits or damages.

However, where the impacts of concern are linked to the achievement of other national policies or targets, then the use of replacement cost-based methods is appropriate. For example, where valuation is of benefits related to protection of designated sites or the fulfilment of air quality targets, then a replacement costs approach is appropriate. In such cases, one can argue that such improvements 'replace' or offset expenditure that would have to take place otherwise.

Where impacts are not linked to policy targets, then willingness to pay (WTP) based values provide a more appropriate measure of impact (where these may be based on revealed preferences, expressed preferences and direct financial costs of measures consistent with economic theory). For example, impacts associated with changes in landscape quality due to changes in farming practices or forestry practices are unlikely to be directly linked to policy goals. In such cases then the most appropriate basis for valuing such impacts is likely to be WTP based figures.

Similarly, there will be conservation/habitat gains that are not linked to a national policy objective, such as those associated with improvements at sites of local nature conservation importance. Because these are not strictly linked to national policy, the arguments for using a replacement costs-based approach is weak, as the argument that that such improvements 'replace' or offset expenditure that would have to take place in any event no longer holds.

Where the non-water impacts would be negative, then use of the replacement costs method may be more difficult to apply and may provide a measure of value that is significantly different from individuals' WTP to avoid (or willingness to accept compensation for) the loss of that habitat. However, in such cases, it would probably be appropriate to use replacement costs where the impacts are unlikely to have a significant impact on the decision (i.e. would not change the ranking of options) but their consideration may be important to discussions concerning disproportionate costs. Where the potential economic value of the impacts may be important to the choice of measures (i.e. they are non-trivial), then willingness to pay based measures are more appropriate.

Other key non-water environmental impacts are likely to be changes in energy usage and in sludge arisings. Although there may be policies related to these, the impacts of the WFD are likely to be negative and thus to directly oppose the achievement of policy goals. Potentially one could use the landfill tax and the CO₂ tax as the approach to costing these externalities (plus an addition for the failure of the taxes to fully recover damage costs or a subtraction from the tax value where it is an overestimate of the value of the damage costs (as is the case with the landfill tax)). However, in the case of sludge arisings, this will need to be added to the costs of disposal.

Although it is unlikely that replacement costs or mitigation costs methods can be relied upon to address the full range of non-water environment related costs and benefits, they may provide a practical approach where resources are limited. However, where these methods are used, this should be theoretically consistent with the approaches taken to valuing water-related environmental costs and benefits and non-water related costs and benefits.

The next question concerns the validity and robustness of using benefits transfer as opposed to the commission of impact specific valuation studies. It is recommended that the starting point for addressing this issue is to differentiate between use and non-use values.

If the issue concerns the valuation of use benefits, then it is suggested here that the first step in the detailed level assessment is to determine whether or not benefit transfer techniques could be used to derive a robust valuation. This would require that the transfer exercise followed 'good practice' as set out in the academic literature, paying due regard to temporal and spatial limits and whether the environmental changes were equally similar.

If the impacts relate to non-use values, then the use of benefits transfer should be treated with more caution. If good quality, composite benefits transfer values are not available from the academic literature, then it would be more appropriate to either develop issue specific WTP valuations through the commission of a new study or to use the replacement costs methods (subject to the caveats set out above).

It should be noted that the Environment Agency's Benefits Assessment Guidance (BAG)⁶ may provide the basis for benefits transfer across a number of the non-water environment impacts listed above. The approach set out in the BAG relies in some cases on very few data points, raising issues over reliability and validity. Such deficiencies should be addressed before recommending the use of the BAG approach in its entirety as the basis for valuation.

The BAG was also developed in relation to the activities undertaken by the privatised water and sewerage companies. As a result, it would need to be expanded considerably to be more generally applicable to the fuller range of non-water environment costs and benefits that may arise. This may be feasible for some resources (e.g. some farming related changes such as impacts on landscape, some impacts on forestry and some additional impacts on wetlands). It is unlikely though that all potential non-water environment externalities can reliably be assessed using benefits transfer based methods.

Numerous economic valuation (mainly willingness to pay and travel cost) studies have been carried out in relation to agricultural activities (including pesticide use) and their impacts on landscape/habitats/species and on the value of forests for recreation and other non-market goods. Similarly, there are several studies that address valuation of the environmental and health effects associated with changes in energy demand and waste management requirements. This wider literature is not covered by the BAG but may be relevant to developing transfer values or to providing indicators for assessing non-water impacts associated with the full range of potential WFD measures.

This suggests that, at the detailed level, the assessment will need to rely on a mix of qualitative and quantitative data. Where the lack of, or poor quality of, the quantitative data is considered significant to the ranking of measures in terms of their relative cost-effectiveness, then it may be appropriate to undertake new valuation studies (the in-depth level of analysis), with this being most important in relation to regional/national scale measures.

Again, it would be worthwhile applying sensitivity analysis to determine the money value that would have to be assigned to these non-water externalities individually and in combination for the rank order of measures to change. This exercise alone may make it possible for stakeholders to reach agreement as to the relative ranking to be assigned to competing measures.

⁶ This is a document that was developed to assess the benefits and costs of water quality and water resource schemes under the 2004 Periodic Review.

8. STEP 7: WIDER ECONOMIC COSTS

8.1 Overview

The process to be followed in assessing the likely significance of wider economic costs depends upon whether a broad or detailed level analysis is sufficient, or whether it is considered important to move to a more in-depth level of assessment to better understand the wider economic effects that may result from a measure or combination of measures.

The aim of either the broad or detailed levels of assessment is to determine whether direct cost estimates, adjusted to take account of any transfers and any non-water environment costs and benefits, provide a good indicator for the overall costs of a measure when knock-on effects on other organisations, sectors and the national economy as a whole are taken into account. For the local/sub-regional level of assessment, it will be important to screen measures to determine the potential for them **individually and in combination** to give rise to wider economic effects. It should be recognised that there is real potential for the aggregate effect of a combination of measures to be significant at the local or regional level, even though the impact of individual measures would not be significant. Determining when there may be wider economic effects may have to be carried out at the regional level, by Regional/National economists rather than by Area staff (as it may be difficult to assess the likely significance of effects at the more local level).

Only where the screening identifies a potential issue should the analysis move to the in-depth assessment, as this requires more detailed analysis of impacts at the sectoral level and multi-sector level.

In contrast, where a measure would be introduced at the regional or national level, then the assessment of wider economic impacts would start at the broad/detailed level but would be more likely to move to the in-depth level, with this to be undertaken by Regional/National economists rather than by Area staff.

Table 8.1 summarises the tasks to be undertaken as part of Step 7.

Table 8.1: Summary of Tasks in Step 7	
i)	Identify whether the conditions set out in Section 8.3 apply to determine when direct cost estimates cannot be relied upon to fully reflect the total costs of a measure.
ii)	Where any of the answers are yes, refer to the Regional Economist for the in-depth assessment.
Consider the potential for wider economic effects to be omitted if assessments are undertaken at the local/sub-regional scale and aggregated.	
The process to be followed for local/sub-regional and regional/national level assessments does vary for this Step.	

8.2 Definition of Wider Economic Effects

Wider economic effects are essentially any knock-on effects that are passed on or through to other sectors, organisations, etc. Such effects may occur where a measure would result in either a change in the prices charged for a particular good or in the level of that good produced. Either of these changes may affect the supply and demand for a related good in secondary or related markets (i.e. they are the effects on the sectors that supply or purchase goods from the primary market that result from the changes in costs faced by the primary market as a result of new). For example, should a measure result in shifts in agricultural production activities, then this may have impacts on the demand for inputs (e.g. fertilisers, machinery, labour) and the prices of outputs (e.g. an increase in the price diary products, meat, or other produce).

Wider economic effects may be permanent or temporary, and are defined here as including foregone future opportunities, lost business, etc., which are key concerns for a number of stakeholders.

The variables used to reflect these wider economic effects, which may be costs or benefits (denoted by the *c* and *b* in the general cost formula page C-3) are:

$$W = \begin{array}{l} W_{\text{related product markets}}: \text{ indirect impacts in related markets, where these} \\ \text{may stem from a change in demand or a change in prices and represent} \\ \text{costs or benefits} \\ W_{\text{related consumer markets}}: \text{ impacts in related markets arising from either a} \\ \text{change in price or a change in the quality or the availability of a good} \end{array}$$

In most circumstances, impacts on related markets (the wider costs/benefits) will already be reflected in the direct costs, but this will not always be obvious and may need to be communicated to stakeholders. Where wider effects are not reflected in the direct costs, they may also be insignificant. Significant wider economic costs not covered elsewhere are likely to arise only infrequently and should be assessed by an economist. Wider economic costs should not be highlighted as an issue without guidance from an economist about whether they are real/significant.

8.3 Determine the Appropriate Level of Assessment

The approach that has been adopted here is to start from the basis that estimates of the direct costs to businesses (adjusted for transfers as appropriate) and regulators are a good proxy for economic costs (the basis for the broad and detailed levels of assessment). The next step is to then determine whether this assumption is likely to hold. If it does not, then the first step is to identify what the other impacts may be and their likely significance; if necessary, one would then assess these quantitatively.

A series of questions should be developed to act as the basis for the screening of measures in the broad and detailed levels of assessment; a preliminary set is provided below although these may need some expansion. The aim of these questions would be to help indicate when direct cost estimates cannot be relied upon to fully reflect the total costs of a measure.

The questions should be aimed at determining when a related market would be affected by a change in another market in the sense that their demands (or supplies) shift in response to price changes in the primary markets. Users would be asked to establish, for example, whether any of the following types of conditions are likely to apply, through discussions with stakeholders, to the sectors affected by a proposed measure:

- Are the magnitude of the costs relatively small in relation to total production costs or the value of the directly affected activities? If so, then impacts on related markets are unlikely to be significant. If they are considered to be significant in terms of total production costs, so that price increases would affect the supply curve for the market and hence the price of the associated products or services, then there could be a significant impact on related markets. In such cases, it may be important to assess the wider economic effects;
- Would a production activity have to cease as a result of the measure? (for example due to a ban of the activity or due to businesses not being able to pass costs on)? Would this have knock-on effects on downstream customers or on employment? If the answer is yes, then wider economic effects may need to be considered;
- Would the prices of end-products or intermediate inputs increase as a result of the need to introduce a measure? If so, do these end-products or inputs have many substitutes (in other words can consumers easily move to alternative products)? If the answer is yes, then there is less likely to be a significant wider economic effect, as downstream users can switch to substitute products at little extra cost. If the product or input has few substitutes, then wider economic effects may be more important, due to the likelihood that switching to substitutes will increase costs;
- Is the input/product that would be affected by price increases essential to another production process? If there are no alternatives then the downstream users of these inputs/products may have to increase the prices charged to their customers, and potentially end consumers. This could lead to significant indirect effects;
- Have supply and demand conditions changed significantly over time, for example, in response to innovation, changing consumer patterns, etc.? If supply and demand vary considerably in response to such changes, then one might expect the wider economic effects of impacts on these markets to be lower than impacts on markets that have been highly stable for long periods of time;
- Are the companies affected by the measure producing specialised end-products or are they producing a commodity? Products commonly traded on world markets have their prices determined globally, thus, any changes in price are likely to result in consumers purchasing products from other companies at the world market price. As a result, there is little impact on secondary markets as downstream business shift to new suppliers. Only if a significant share of the global supply is affected will the global market price change. However, for more specialised products, it will be more difficult for the consumers of these products to switch to other suppliers without facing changes in price; and

- Are the related or secondary markets themselves distorted (e.g. are they characterised by monopolies?) or would the impacts on these markets result in significant externalities? For example, where a monopoly exists, then one could expect any increases in prices to that monopoly to be passed on to consumers, with this also potentially affecting the level of economic rent earned by the monopoly further distorting the differences between financial and economic effects.

Note that the above questions are not mutually exclusive and are instead aimed at making those carrying out the assessment think about the businesses, their products and the markets that they operate in from different perspectives.

If the answers to the above questions indicates that wider economic effects could be significant, then the assessment should move to the in-depth level. It is proposed that the in-depth level of analysis is undertaken by a Regional Economist as it will require a good understanding of economic principles and potentially the use of quite complex economic processes.

8.4 Partial Equilibrium versus General Equilibrium Analysis

It is proposed that the in-depth assessment essentially takes the form of an expanded partial equilibrium analysis, based on analysis of the supply and demand relationships for the primary and secondary markets of concern.

This type of framework is considered preferable to the use of either an input-output model or a general equilibrium (GE) model. Input-output models can be used to predict the impact that expenditure by one sector can have on other sectors, in terms of changes in their output and employment. The main reason for not recommending input-output (I-O) models, however, is that they cannot easily be used to determine how demand for a sector's output would respond to changes in price (as opposed to changes in another sector's demand). Because they fail to take into account the impacts of changes in relative prices on the demand for the various inputs of production, they also ignore several of the relevant channels of secondary impacts on production and employment. In addition, the models are based on inputs and outputs at the sector level, not at the commodity level may be the more relevant level for many WFD related measures.

It is likely that a GE model would have to be created/adapted so as to be specific to the WFD and the types of measures likely to be introduced under it). GE models, such as that adapted for use by the Government in looking at climate change policy, will essentially provide information on the difference in the economy in terms of GDP and employment before and after a policy shock. In order to model these changes, one essentially needs estimates of the direct costs to the sector affected by a measure and any costs to other related markets that are obvious from the direct costs assessment work (as per the current CEA methodology).

Within the context of the WFD, the underlying assumptions of any existing GE model would need to be developed in sufficient detail so as to allow changes in costs

associated with environmental compliance requirements to be fed into sectoral input and output functions. Often, these input and output functions are not developed in a way that readily allows modelling of how an increase in the costs of one aspect of environmental compliance (waste treatment/management, for example) would affect them. This is because the models have generally been developed to illustrate the impacts of more substantial price shocks occurring at a multi-sectoral level and at a national scale.

Thus, where compliance with WFD measures would result in a significant cost impact on more than one sector, and that impact is spatially extensive (i.e. national), then GE modelling may have a role. But this role may be more important for assessing disproportionate costs than for use in the CEA of alternative programmes of measures, with the outputs being an indication of impacts on GDP and employment at the national level (K Turner, pers. comm., 2005).

8.5 In-Depth Assessment (to be Undertaken by a Regional Economist)

Assuming that the approach adopted is based on an expanded partial equilibrium framework, then the first step in the in-depth assessment is to develop a simple model reflecting supply and demand for the products/services that would be affected by a measure. This will require either the use of existing data or making a series of assumptions on the supply and demand relationships (and the underlying price elasticities) of both products and inputs in the primary and secondary markets. By looking at these relationships (based on the elasticities), the responsiveness of a market to any changes in quantities or prices resulting from the introduction of a measure can be established, allowing analysts to make a decision as to the need to consider impacts on secondary markets.

Data on supply and demand elasticities are currently available for some sectors and certain types of products⁷. In particular, elasticities of supply (including cross-price elasticities of production) exist for agriculture, including for production activities at the enterprise level⁸. These types of relationships provide the basis for the various farm models that have been developed and that can be used to provide a ready indicator of the degree to which direct costs are likely to reflect economic costs.

Where elasticities do not exist, the first step should be to try and infer them from data provided by stakeholders and national statistics (advice should be sought from the DTI sector branches). In order to infer/estimate elasticities in supply and demand, information would be collected on, for example:

⁷ UKWIR comment that information on the supply and demand elasticities that should apply to the water sector does not exist. Water and wastewater are characterised by a large number of dimensions, many of which are public goods. The service that is being provided is a bundle of a large number of services. As a result, this sector and the services that it provides are significantly different to other goods and markets.

⁸ See <http://statistics.defra.gov.uk/esg/resports/produagri/paper2.pdf>.

- prices charged over the past say, 3 years, and the corresponding quantity of the product/service consumed; an example would be landing fees charged by the port in question for different size vessels and the number of vessels landing;
- the availability of substitutes (UK and wider) and the current price and quantity consumed of these; e.g. the availability of alternative berths for ships of a given size and the prices charged for landing by other ports; and
- likely changes in demand for the products/services over time due to changes in technology or innovation.

Collection of available data in many cases should allow the implications for related markets to be inferred without requiring formal modelling of supply and demand functions. If it appears that more than one related market would be affected due to the markets being highly integrated (particularly vertically integrated), it may be necessary to undertake a multi-market analysis. In such cases, more formal modelling work will be required. This could involve the use of input-output models (assuming that they have been properly developed to account for the types of changes in expenditure that will arise under the WFD or the development of an econometric model to predict the demand or supply functions in the various markets of concern and to estimate the corresponding impacts on the structure, prices, turnover and employment in the secondary markets.

The output of the extended partial equilibrium analysis proposed above would essentially be a prediction of the changes in demand that would occur in related markets and estimates of the corresponding net changes in welfare. These estimated changes in welfare (whether positive or negative) would then be added to the costs estimated for the directly affected sectors to derive estimates of the total economic costs of the combination of measures.

9. STEP 8: ESTIMATING THE PRESENT VALUE COSTS OF A MEASURE AND COMBINATION OF MEASURES

9.1 Overview

Once all of the cost elements making up each measure/combination of measures being considered have been estimated and the uncertainty surrounding the costs for each measure assessed, it is necessary to estimate the discounted costs of individual measures. These discounted costs are then aggregated across the measures comprising a combination to provide an estimate of the total marginal costs for each combination.

Two sets of cost estimates will be generated for each measure and, thus, combination of measures: a financial cost estimate (i.e. the cash flow costs to private sector operators and regulators) and an economic cost estimate (i.e. the overall costs to society). These estimates should reflect the expected value of costs based on the associated probability distribution reflecting the likelihood of the low, medium and high estimates being realised.

The cost estimates are also to be presented in two different forms (as discussed in Section 1.5):

- (net) present value costs; and
- equivalent annual values (EAV).

The PV and EAV cost estimates would be developed for both financial and economic costs, where there are significant differences between the two. Estimates should be presented in both forms, as the PV of costs gives an indication of the total costs of adopting a proposed measure, while the EAV provides a better means of comparing the relative costs of different measures having different time horizons.

As indicated above, the low, medium and high estimates developed in the earlier steps to reflect uncertainties in the underlying cost assumptions should be carried forward to develop corresponding estimates for the expected PV and EAV of each measure and combination of measures.

9.2 Discounting

In order to aggregate quantitative estimates of costs to give an overall indication of the costs of a measures/combination of measures, it is important that they are estimated over the same time horizon. For example, some costs may be one-off and may occur immediately, while others occur annually or may occur periodically (e.g. every 5 years) into the future. The application of the CEA methodology requires that all future costs and benefits are converted into comparable units of value. This means that they need to be discounted to convert streams of future costs and benefits to present value terms.

For all government related assessments, the standard discount rate set by the Treasury should be used, with this being 3.5% (but reduces in year 31 to 3% and in year 76 to 2.5%). For the purposes of the financial analysis, it is proposed that the rates appropriate to the sector are used, these may be those applied under IPPC, or for the water companies the rates set by Ofwat, so as to reflect the time preference/opportunity costs of capital of the organisations incurring the costs.

The formula for calculating the PV of costs is embodied in the generic formula given in Section 1.2, but a simplified version is as follows:

PV = 1 / (1+r)ⁿ * Monetary value per year of costs and/or benefits, where:

r = interest rate; and

n = year in which benefits and/or costs accrue.

As discussed in Section 1.5, it is suggested that all measures are assessed over the same time horizon and that the time horizon to be considered in an assessment is agreed with stakeholders. The time horizon should be specified so as to take into account the life of the types of assets that are likely to be either required of affected by WFD measures. This may require consideration of a time horizon well in excess of 30 years (to cover the life of assets within the water industry and flood and coastal alleviation).

In addition, all costs and benefits should also be expressed in a common price base. In other words, they should reflect the real prices that existed in a single year, and it is proposed that 2003/4 is taken as the relevant price base (with this likely to require some prices to be inflated up from previous years and some downward adjustment to future cost data so that it is consistent with 2003/4 prices). Where costs and benefits are expected to increase at a significantly higher or lower rate for one sector than for another, then this relative price change should be taken into account when calculating future prices.

10. STEP 9: CHARACTERISING UNCERTAINTIES SURROUNDING COST FUNCTIONS

10.1 Overview

At the broad and detailed levels of assessment, there may be considerable uncertainty as to the actual costs that would arise from the introduction of a measure. Although uncertainty should be reflected to a large degree through the use of cost ranges (the low, medium and high estimates and their specified probabilities of occurrence), ranges set out in look-up tables or quoted in literature sources may not reflect the full range of factors that may affect the reliability and robustness of cost estimates.

For example, the ranges may reflect the more obvious factors that will affect the cost estimates, such as the timing, size/scale of the measure and duration required to meet the assumptions made about effectiveness of the measure (with these assessed qualitatively as part of effectiveness methodology). Other factors, however, will also affect the costs, including sector, sub-sector and even individual organisation specific issues. This means that any given cost estimate, however detailed it may be, is unlikely to give a ‘true’ estimate of the eventual costs if the measure is implemented. The cost estimate will always have uncertainty associated with it.

At the broad level, it should be sufficient to consider the impacts of the ranges on the relative ranking of the combinations of measures and highlighting the degree to which the choice of combinations is sensitive to the uncertainties surrounding the expected values. If it is not sensitive to the uncertainties, then there is no need to progress to the more detailed analyses aimed at refining or reducing uncertainty. Where there are considerable differences between different cost factors (non-recurring, recurring, cost savings, transfers, non-water environment costs and benefits, or wider economic costs), it may be necessary to further refine the cost estimates.

There may also be cases where the level of uncertainty (e.g. when equal probabilities have been assigned to low, medium and high estimates) is so great across a number of measures or cost variables that a more comprehensive, in-depth analysis is required in order to further refine the estimates. In this regard, it is important to highlight the key principles underlying the use of sensitivity analysis:

- **focus on key variables:** often a full sensitivity analysis is not feasible (due to time or data constraints) and the analyst must limit the analysis to those assumptions that are considered key. In determining which parameters are key, the analyst should carefully consider the range of possible values for the input parameters and each one’s functional relationship to the output of the assessment. A plausible range of values for each key parameter should be specified, including a rationale for the range of values tested;
- **identify switching points:** switching points are those values at which the recommended policy decision would change from shift from the selection of one option to another; they can often provide an indication of the robustness of choosing one option over another; and

- **assess the need for more detailed analysis:** sensitivity analysis can also be used as a screening device to determine if more extensive analysis is required. This may include further research to minimise or better characterise uncertainty or to identify the need for more sophisticated analysis. Value of information or decision analysis can be used to prioritise further research and/or actions in terms of the expected net benefits of the research results.

10.2 Characterising Uncertainty

The pilot trials indicated that the proposed method for characterising the level of uncertainty surrounding cost estimates was too subjective and required too many assumptions or judgements to be made. As a result, an alternative approach is proposed here, based on only two different indicators of the level of confidence that can be placed on cost estimates.

These are based on the assessor making a judgement as to the reliability and accuracy of the unit costs used in the assessment (with this likely to involve some degree of stakeholder consultation). The frameworks for assessing reliability and accuracy are given in Table 10.1 and 10.2 below, with these based on those used in the water sector to provide an indication of the uncertainty surrounding capital cost estimates⁹.

Reliability Band	Main source of data used in standard cost estimate
A	Costs generated specifically for the measure, purpose and site being assessed.
B	Costs taken from similar project/measures within the same region/area.
C	Costs taken from similar projects/measures but from a different region/area.
D	Costs based on generic information and/or different projects/measures.

In using these tables, a reliability band of A would normally be associated with accuracy bands of 1 or 2. At this stage, we have adopted the confidence intervals used in the Ofwat methodology, although it may be necessary to modify these to the data available for costing WFD measures in the first planning round.

⁹ Based on: Ofwat (2005): **June Return Reporting Requirements and Definitions Manual**, 31 March 2005.

Accuracy Band	Accuracy to within +/-	But outside +/-	Comments
1	5%		Source data are directly relevant to the measure and site/area being assessed and/or costs have been accurately adjusted for site specific factors.
2	10%	5%	Source data are relevant to measure or similar measures but for other (similar) sites or areas and/or costs have been adjusted reasonably accurately.
3	25%	10%	Source data are relevant to measures or similar measures but may relate to different (non-similar) sites and/or there is less confidence in the results of site specific adjustments.
4	50%	25%	Source data are relevant to similar measures but relate to different (non-similar) sites and/or confidence in the results of site specific adjustments is low.
5	100%	50%	New/innovative measure or where source data are not specific to measure and are from a non-similar site. Adjustments for site specific factors have not been made.
X		100%	Difficult to specify measure and/or costs data not readily available or based on other measures that are incompatible with the measure being costed.

10.3 Managing Uncertainty

Once the reliability and accuracy of the cost estimates have been assessed, a judgement needs to be made as to whether a more detailed analysis should be undertaken to improve either the reliability or the accuracy of the estimates. It is proposed that where the reliability band is assessed as being either C or D, then further work should be undertaken to improve the reliability of the underlying data, if it could affect the relative ranking of combinations of measures in terms of their cost-effectiveness. Similarly, if the accuracy of the data is assessed as falling into bands 4 or 5 (or even X), then it is also likely to be important to undertake work aimed at improving the accuracy of the estimates. Whether or not refinement of the estimates is necessary for those assessed as falling into reliability band B or accuracy band 2, this will depend on the importance of uncertainty surrounding the estimates to the end choice of combinations of measures.

In general, it is proposed that the following approaches are adopted to dealing with uncertainty and incorporating it into the final assessment of cost-effectiveness:

- **Broad Level Assessment:** for this level of assessment, pair-wise comparison and/or hedging and flexing techniques can be used to provide an indication of what combination of measures would be adopted from different risk taking perspectives. The use of these would be accompanied by data on the expected value, lower, mid and upper bound estimates to allow a simple form of sensitivity analysis and calculation of switching points.
- **Detailed Assessment:** as the assessment becomes more detailed, assessors may still want to consider the implications of hedging and flexing criteria, but the

assessment should be accompanied by the use of expected values. At this stage, it may be important to consider the use of more probabilistic analysis to aid in a formal analysis of the impacts of uncertainty. Value of information or decision analysis may be of particular value here in determining what types of research/further data collection may be of most value as part of a more in-depth assessment.

- **In-Depth Assessment:** decision making as part of the in-depth assessment would rely on the use of expected values, with further analysis of the associated probability distributions. For example, this may rely on the use of stakeholder and expert opinions and encoding techniques to refine assumptions concerning the likelihood of low, medium and high estimates, or the use of Monte Carlo analysis where the probability distributions across the range of key uncertain variables are known.

Table 10.3 provides a brief overview of how the different criteria referred to above, hedging and flexing, expected values and value of information analysis, can be used as aids to decision making.

Table 10.3: Decision Criteria for Managing Uncertainty

Hedging and flexing: these assume that either the worst, or the best, outcome will occur for each option and one then chooses the option which gives the least bad outcome, or the best possible outcome; the criteria essentially capture ‘regret’ based approaches using minimax and maximin criteria. These of criteria are most appropriately used together with a scenario based analysis, which defines upper and lower bounds.

Expected values: in contrast to the above, the expected value directly incorporates estimates of the likelihood of a particular outcome occurring into the analysis results. In other words, estimates of costs and benefits are presented in probabilistic terms (e.g. the 10, 50 and 90%iles suggested in Steps 6), taking into account the range of uncertainties underlying them.

Value of information: this type of decision rule builds on the use of expected values and takes into account the value of delaying a decision in the first period while further information is collected to reduce the level of uncertainty surrounding costs/benefit. To apply this approach in full would require information on the foregone benefits of delaying a decision (e.g. as part of a disproportionate costs assessment), but a reduced form could be applied here looking only at changes in costs due to postponing action now.

10.4 Uncertainty and the Potential Value of Delaying a Decision

Value of information or decision analysis is based on the principle that, in the face of uncertainty, a number of different outcomes may occur once a decision has been taken, and that each of these outcomes has a different probability of occurring. This is important where there is uncertainty over the long term (i.e. over investment planning time horizons) about the marginal costs and marginal benefits of adopting one particular measure over another. It can help in understanding the value of retaining flexibility in investment planning, particularly where there is the potential to

develop more sustainable, environmentally sound and effective and lower cost solutions in the future.¹⁰

As a first step, a decision tree is developed which provides a structural framework for setting out what the options are, cause and effect pathways, and the associated uncertain outcomes. Expert judgement or the outputs of research and monitoring studies are used to assign probabilities to the likelihood of different potential outcomes. Once a preliminary analysis has been undertaken, it can then be tested through the application of sensitivity analysis to determine key uncertainties. The value of deferring a decision to the next period in order to reduce uncertainty and the value of undertaking additional research can be determined through the sensitivity analysis process.

Value of information' analysis (VOI) can be used as part of an economic appraisal to determine whether or not it is more appropriate to base a decision on incomplete or inaccurate information or to delay any actions until sufficient data have been collected to minimise (or at least reduce) the key uncertainties. Value of information analysis, therefore, allows additional data collection with a commitment to taking a decision in the future to be considered as an additional, viable option within the decision making process. For a more detailed discussion see, for example, Thompson & Graham (1996).

The value of this additional information is derived by considering the expected outcomes with and without the information. The approach, therefore, relies upon the use of conditional probabilities and expected values. If the additional cost of gaining the extra information is outweighed by its expected health or environmental benefits (in terms of improving the decision, e.g. decreasing the costs of risk reduction or increasing health and environmental benefits), then it is worthwhile obtaining the additional information.

Value of information analysis will be most relevant to those cases where:

- uncertainty could be reduced (or resolved) through further monitoring and/or research; or
- uncertainty as to the reduction in pressures that will be delivered by a preliminary set of measures means that delaying a decision until a future period could result in significant cost savings (by avoiding unnecessary expenditure on additional measures aimed at overcompensating for the uncertainty).

In cases of significant uncertainty, such analysis can provide an important means of supporting arguments for time derogations (although this assumes that the necessary research and monitoring will be put in place). It requires, however, that probabilities can be assigned to the likelihood of different outcomes, and can become quite complex when there are several competing options and a number of different uncertainties to be analysed.

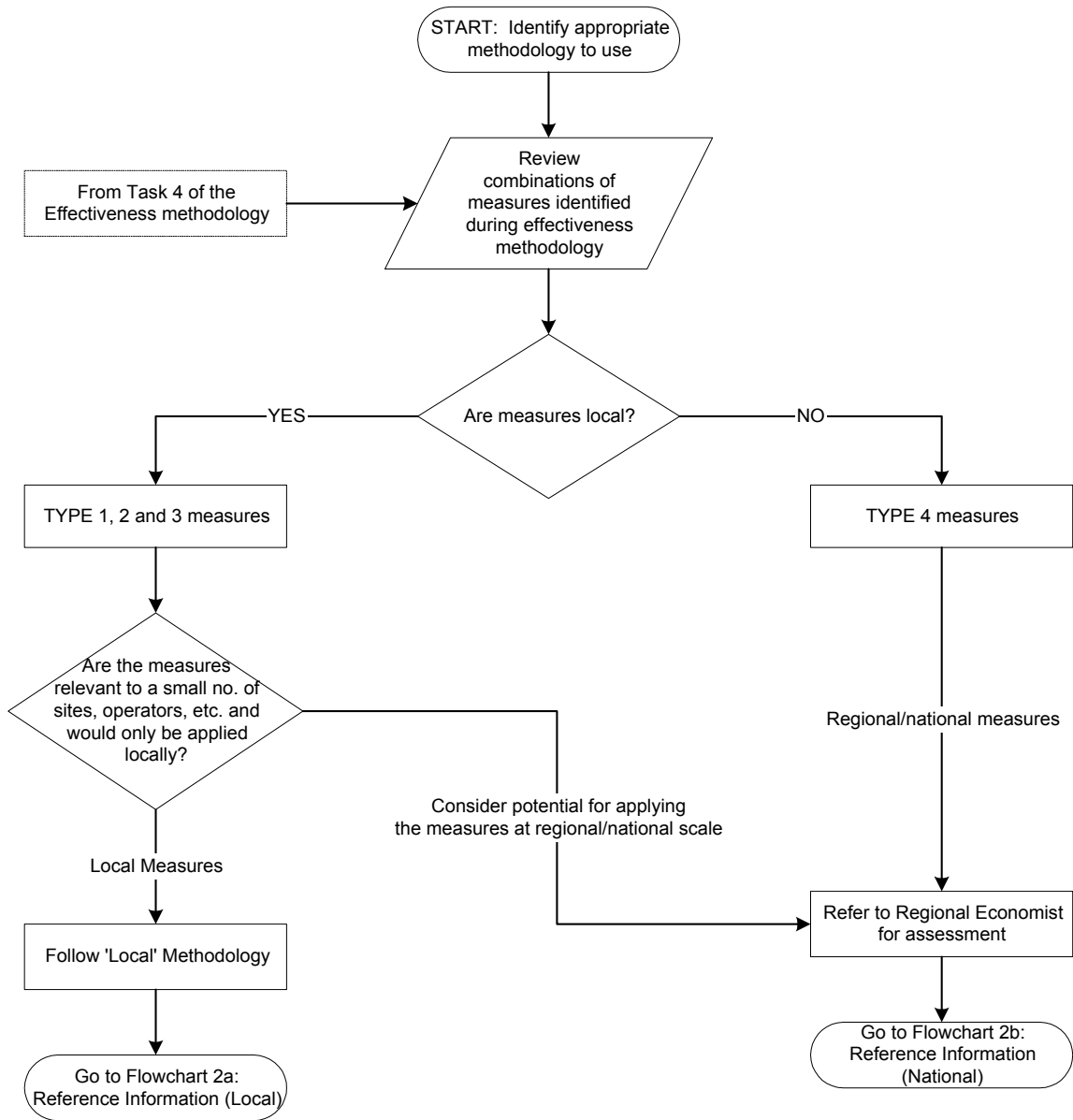
¹⁰ This issue is also addresses in a paper provided by Ofwat on 'Application of uncertainty to the economics of environmental policy decision making' which develops ideas in the economic literature on investment planning under uncertainty, taking into account option value and irreversibility.

Under this type of approach, wherever research is proposed, clear actions must also be defined contingent on the outputs of that research. The analysis must indicate that research followed by the contingent actions may be the most cost-effective measure, otherwise there is no economic argument for undertaking the research. If research followed by the contingent actions would not be the most cost-effective combination, then this measure should fall out of the analysis (e.g. when screening for technical feasibility or in Step 10 (See Part D)).

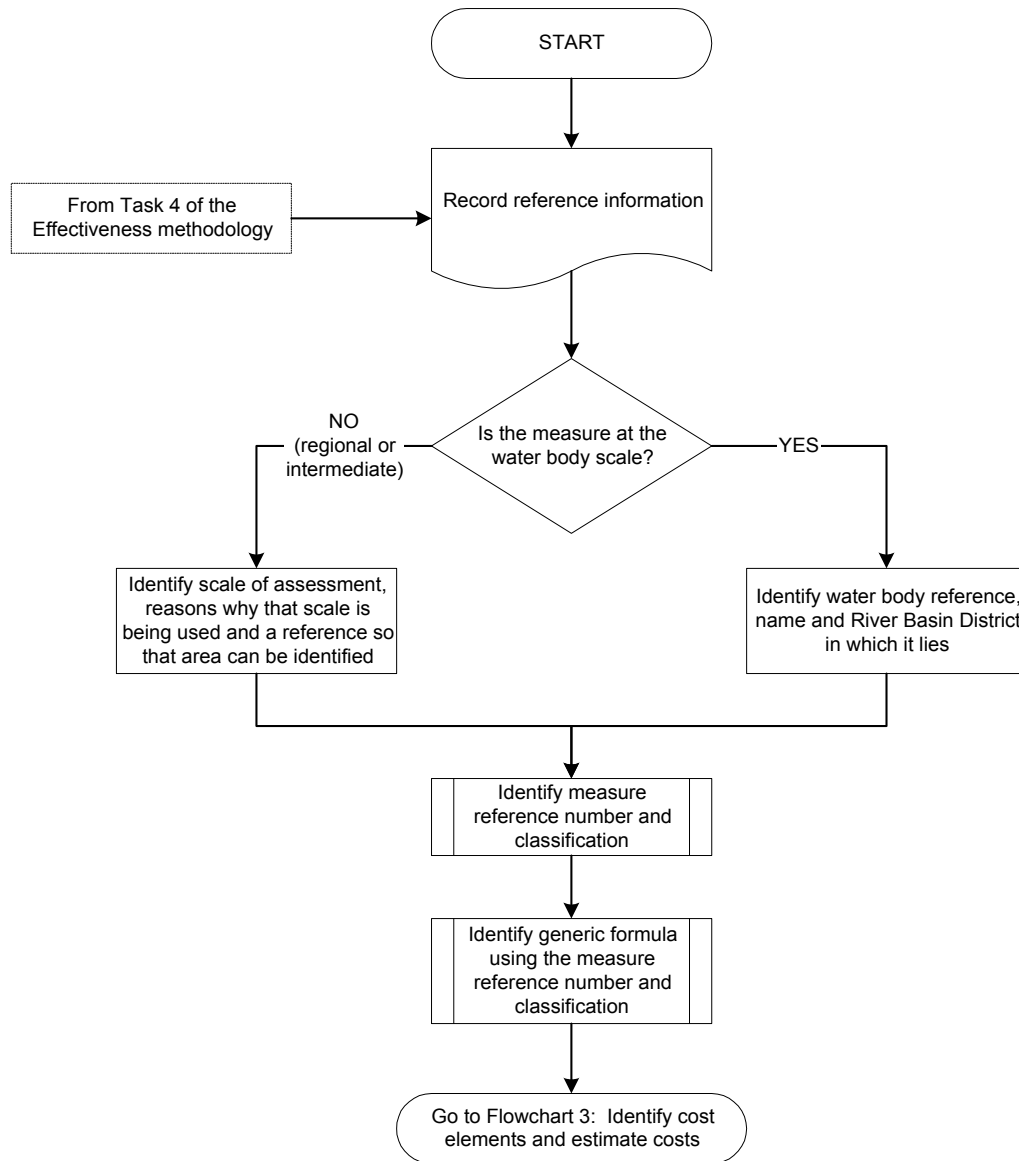
Although such an approach complicates the analysis, it may be important in cases of high uncertainty and where there may be arguments for proposing a time derogation. The previous report prepared for Defra (RPA, 2004) provides a worked example of the application of value of information analysis to the CBA component of the assessment. Such an analysis could also be applied to the cost-effectiveness assessment, examining whether to adopt a relatively certain but expensive programme of measures now or to defer the decision to the next planning period while uncertainty surrounding the effectiveness of significantly less costly measures is reduced.

ANNEX 1:
**FLOWCHARTS FOR EACH STEP OF THE COSTS
METHODOLOGY**

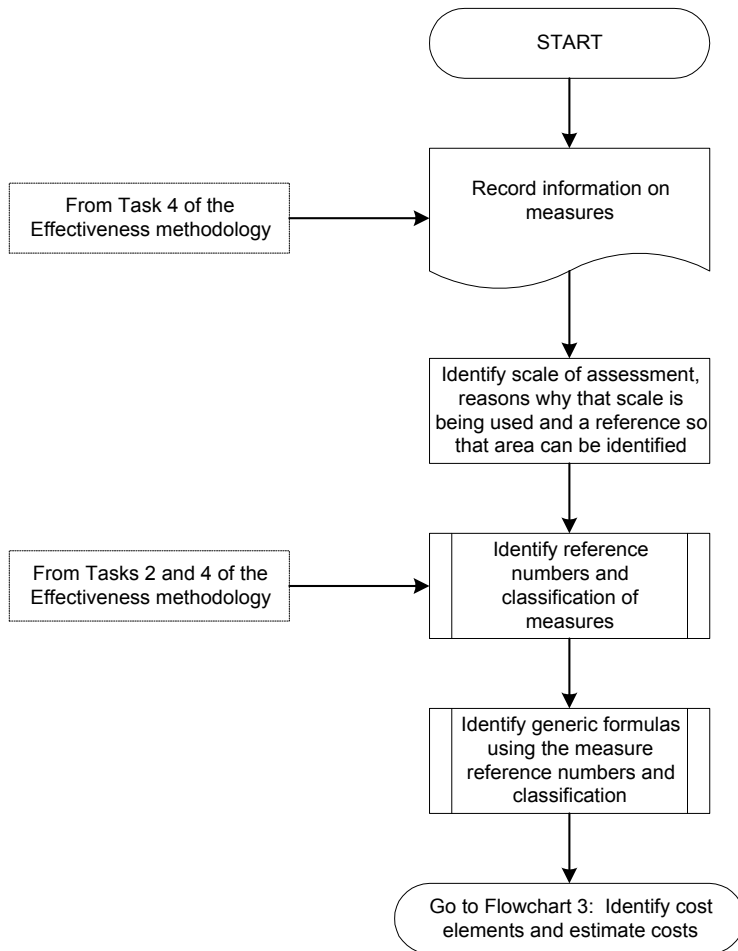
Flowchart 1: Identify Appropriate Scale of Assessment



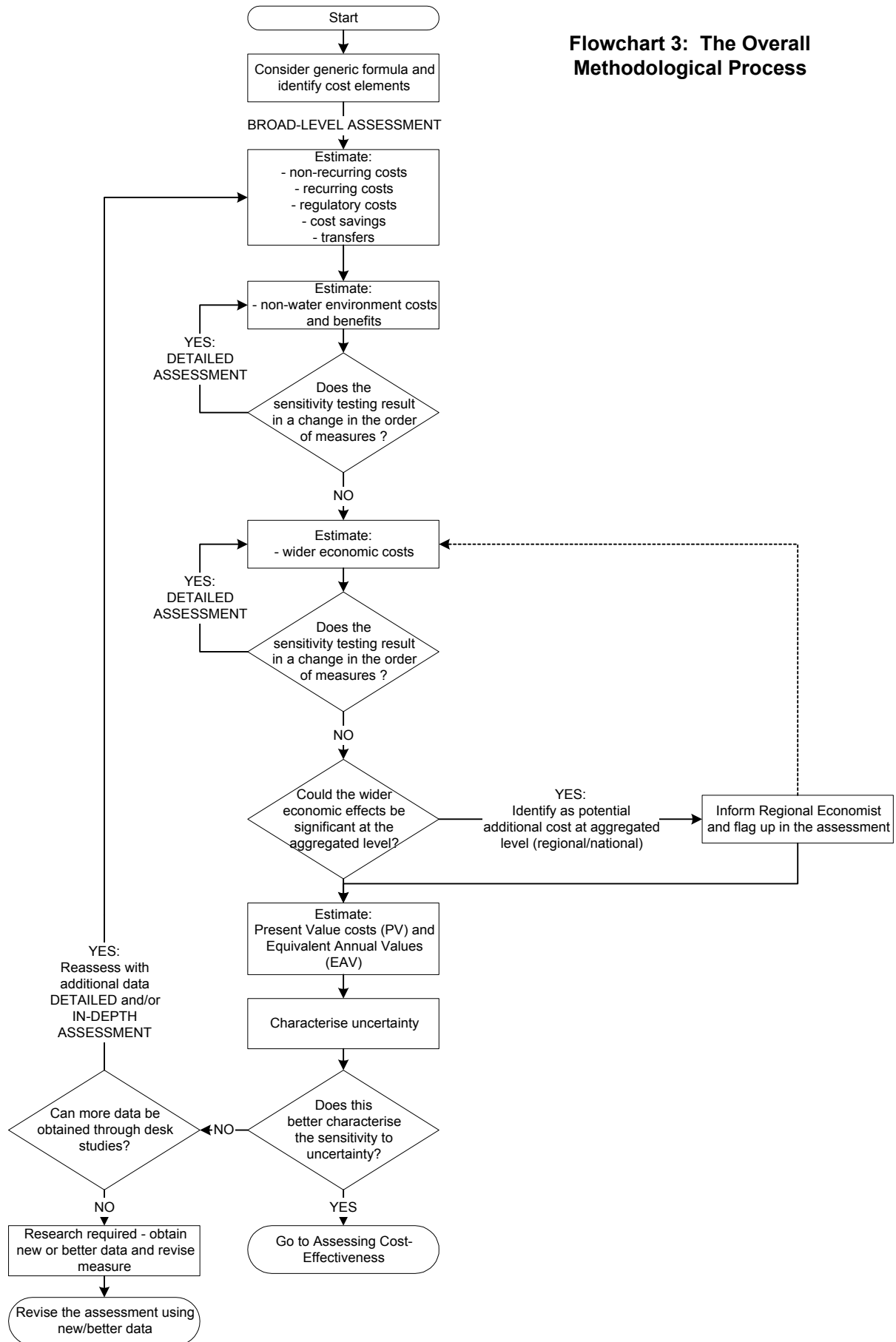
Flowchart 2a: Entering Reference Information for LOCAL/SUB-REGIONAL MEASURES



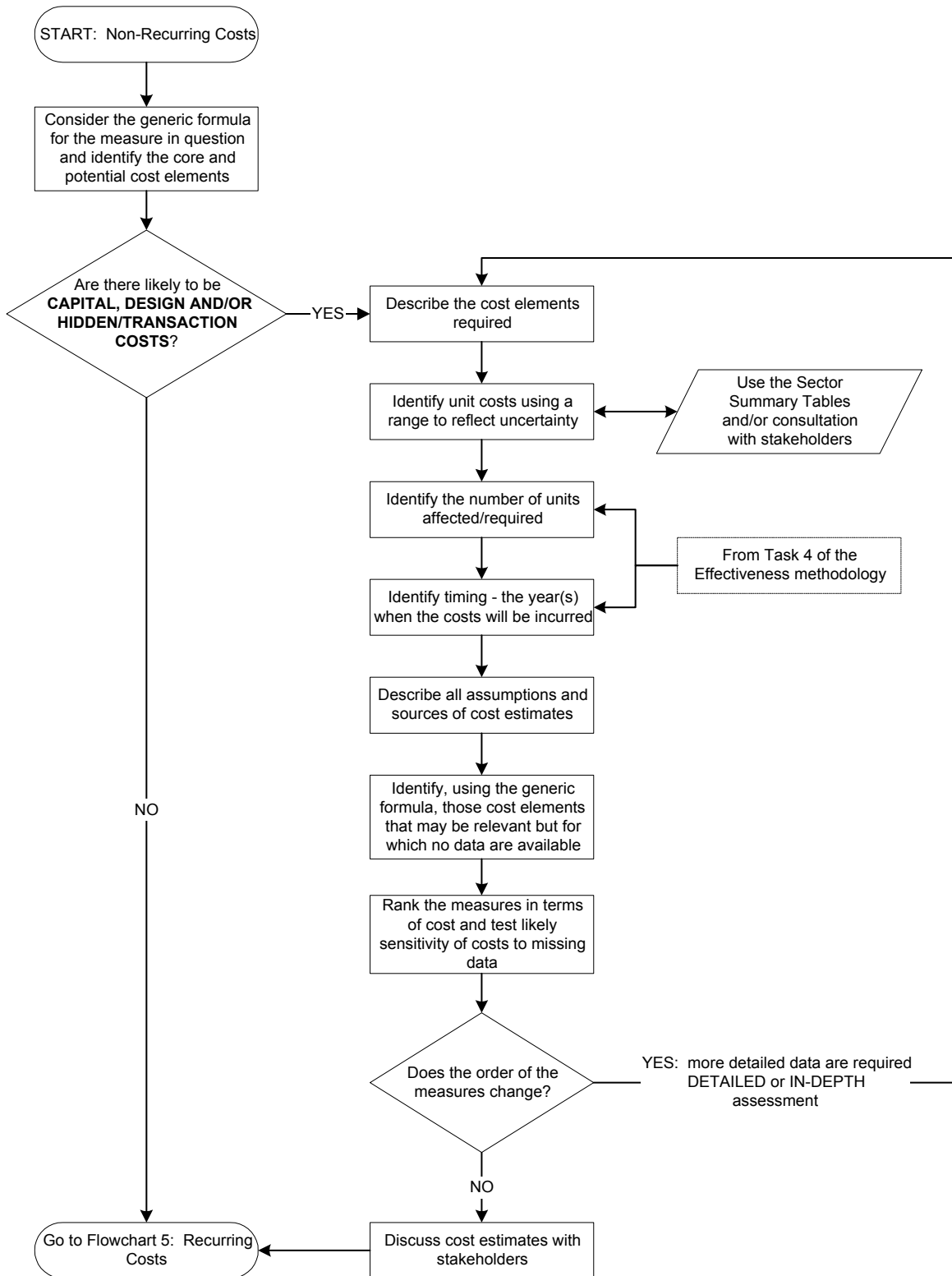
Flowchart 2b: Entering Reference Information for REGIONAL/NATIONAL MEASURES



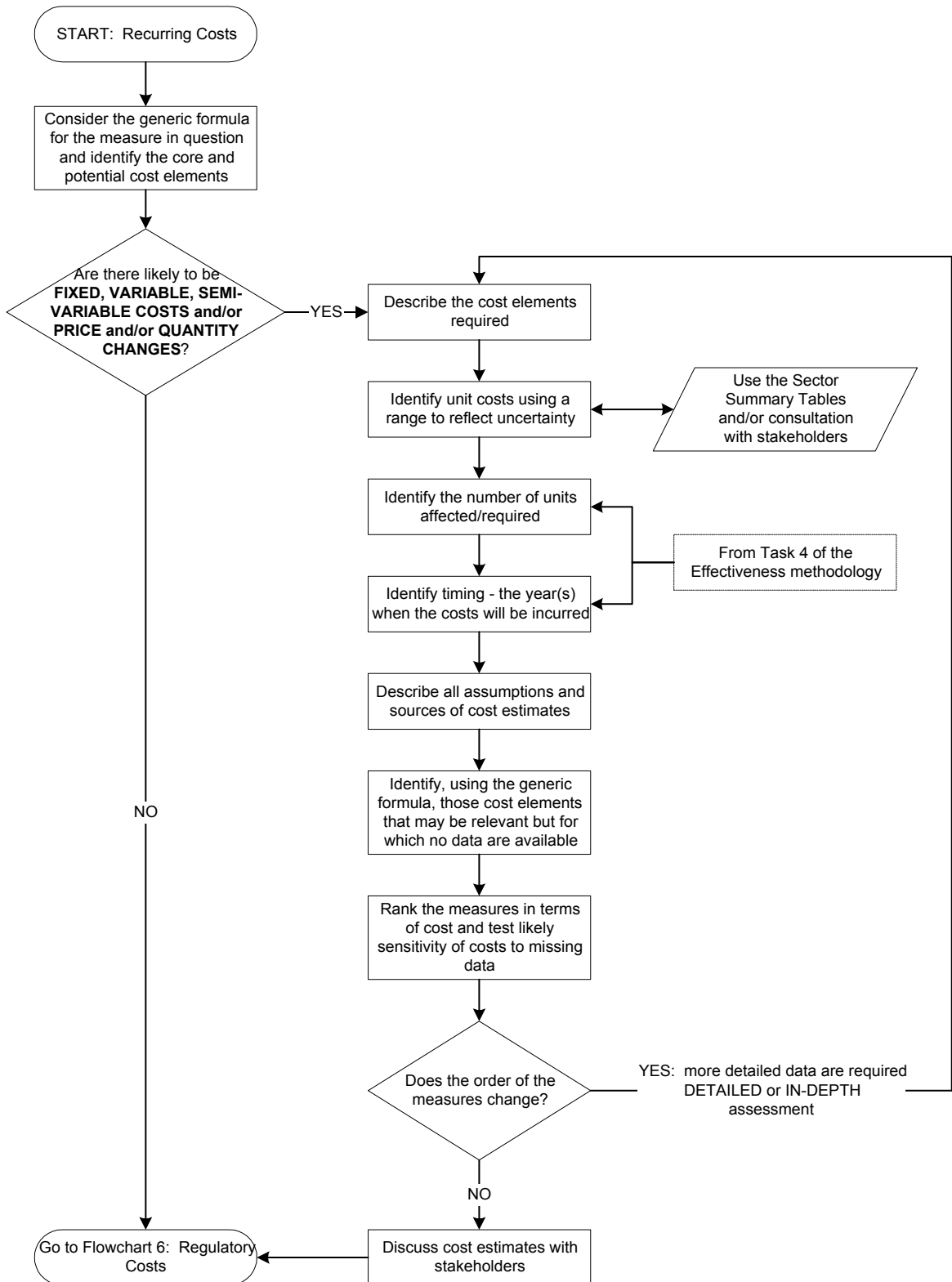
Flowchart 3: The Overall Methodological Process



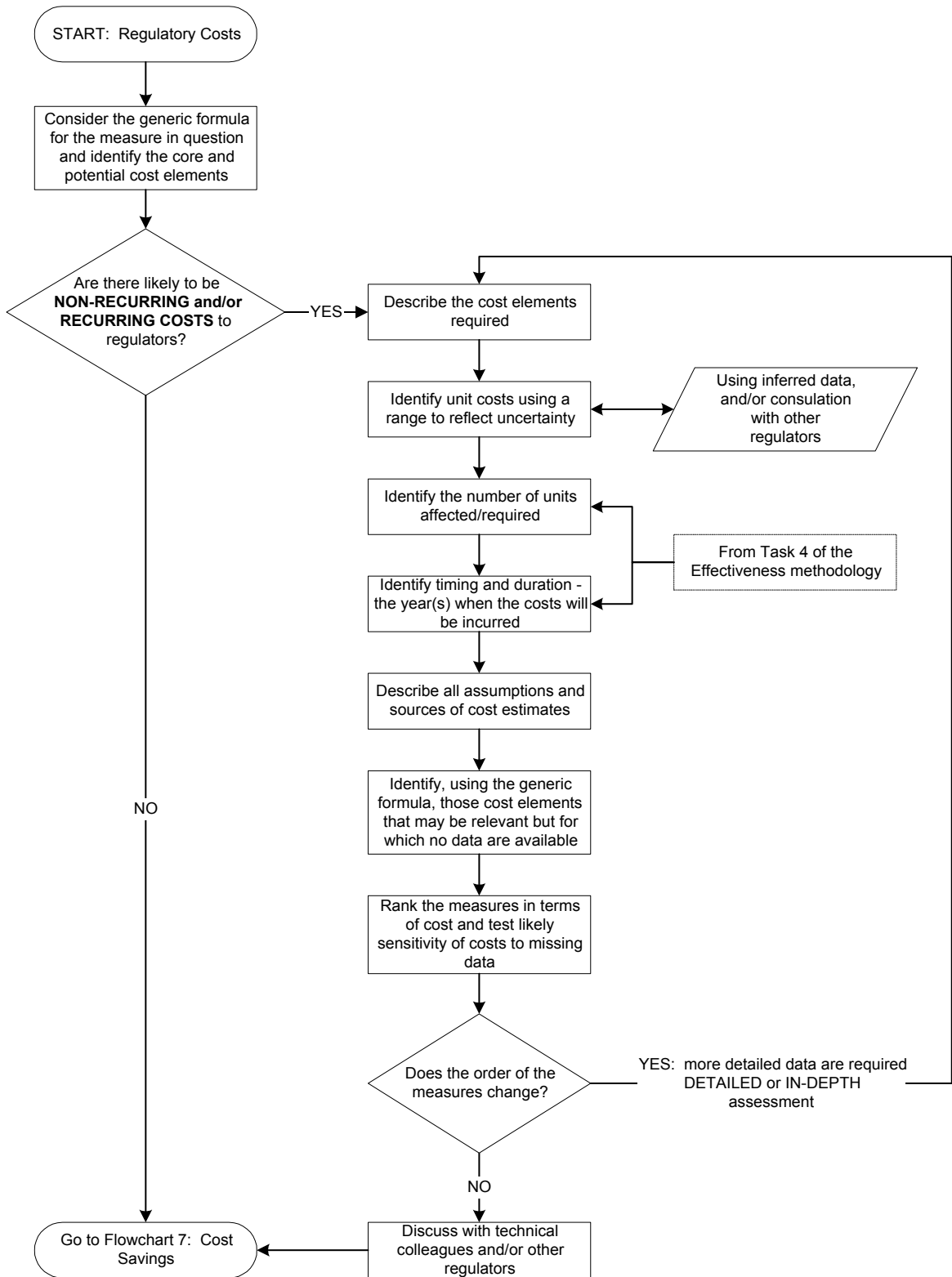
Flowchart 4: Non-Recurring Costs



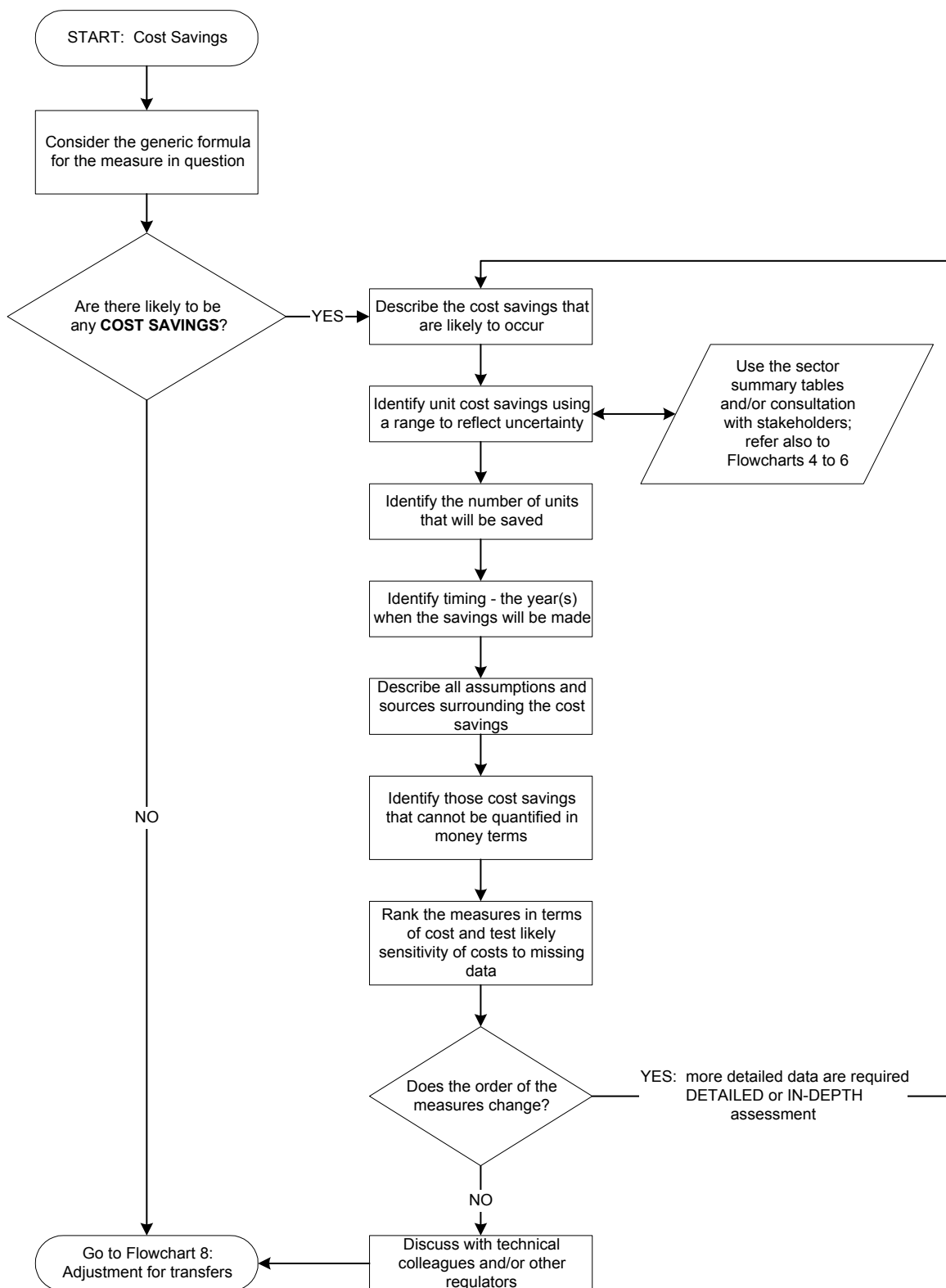
Flowchart 5: Recurring Costs



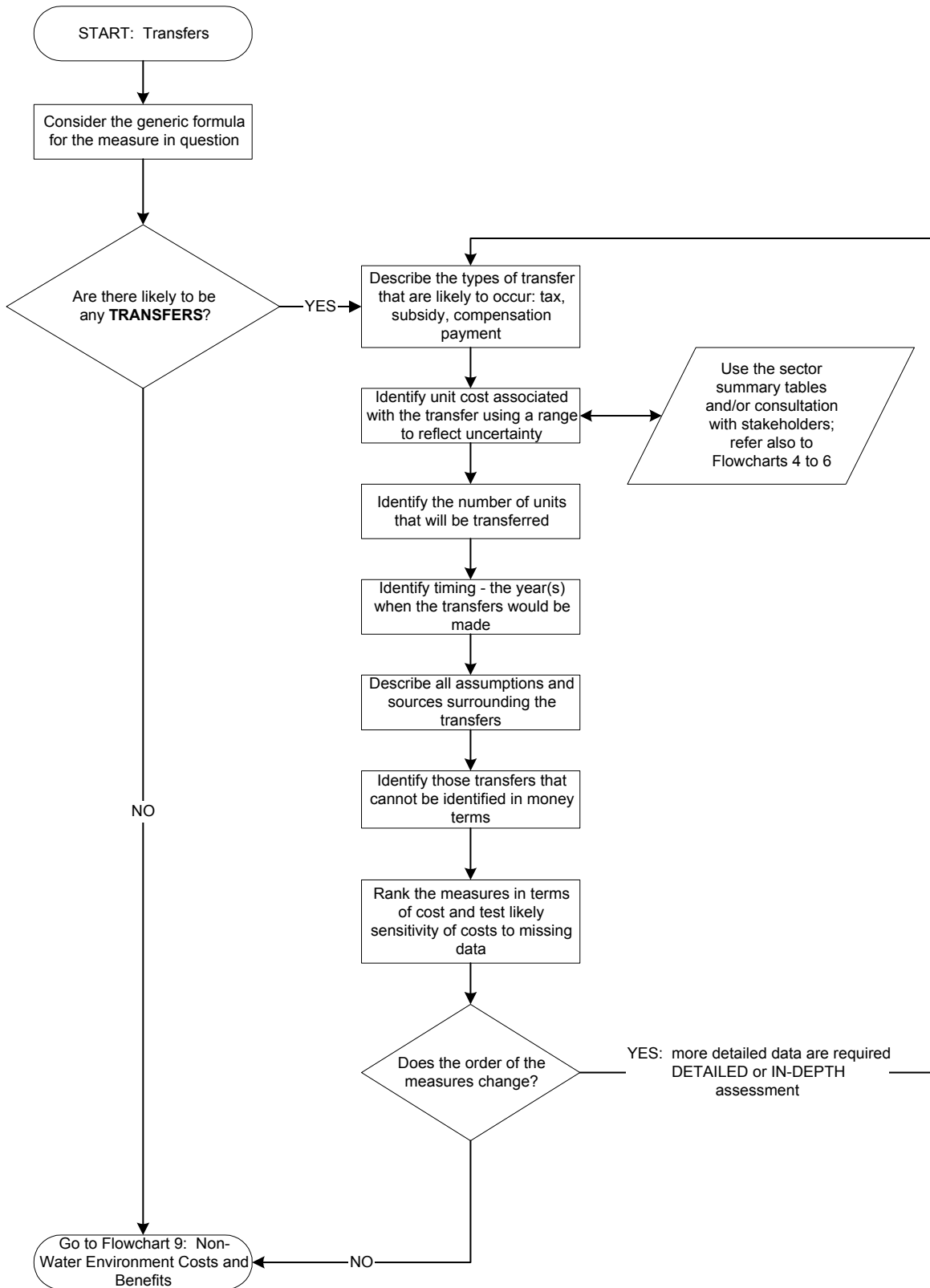
Flowchart 6: Regulatory Costs



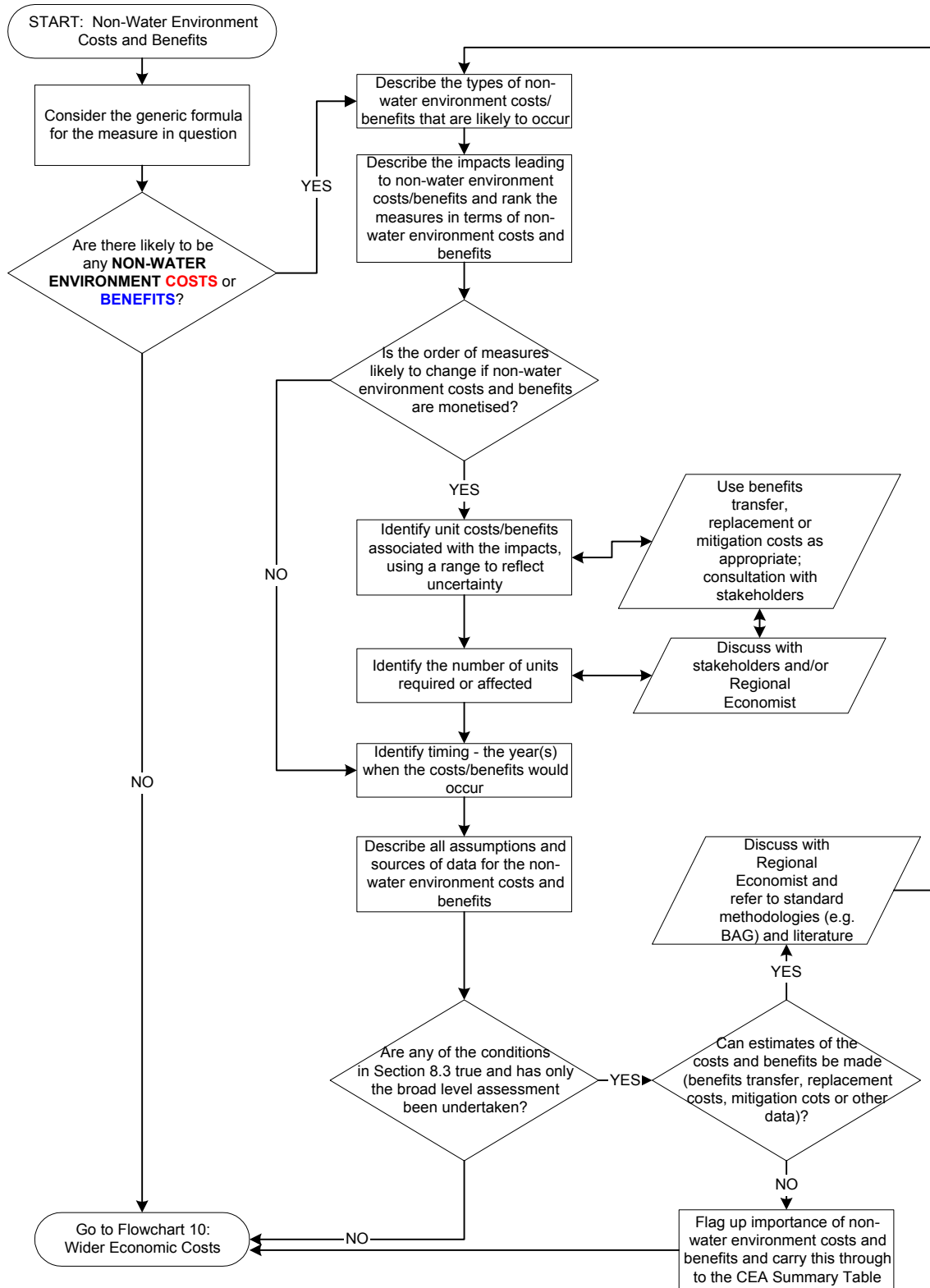
Flowchart 7: Cost Savings



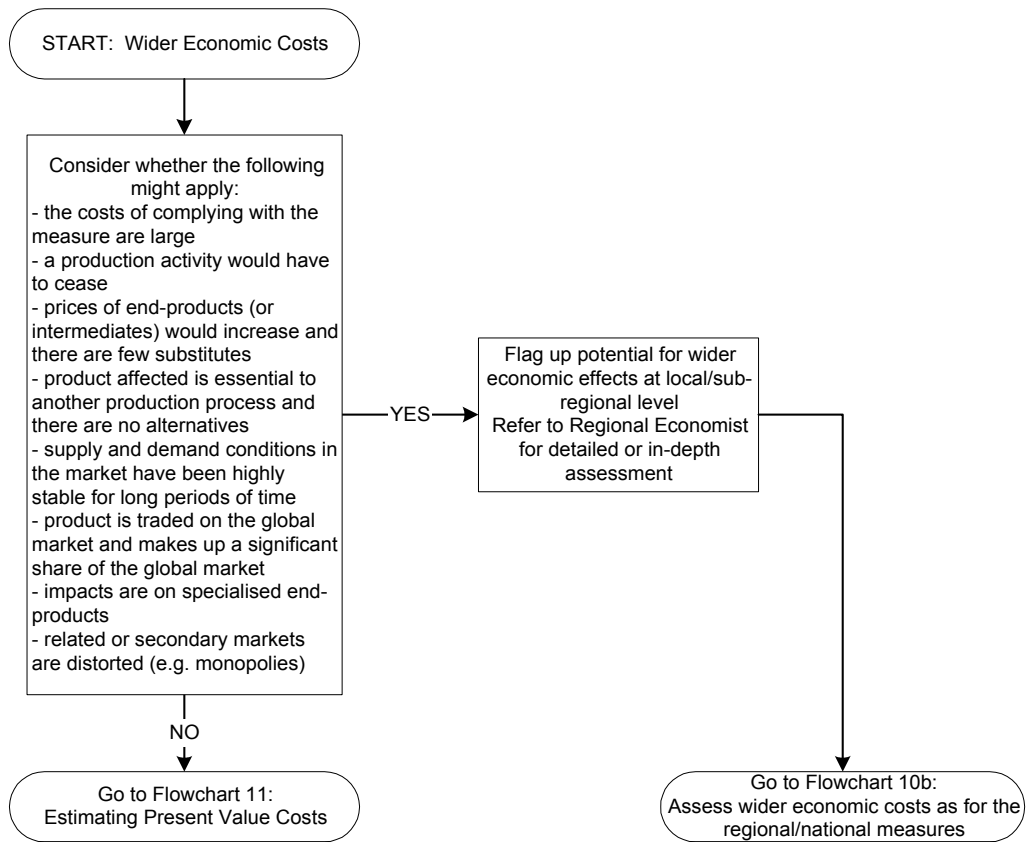
Flowchart 8: Adjustments for Transfers



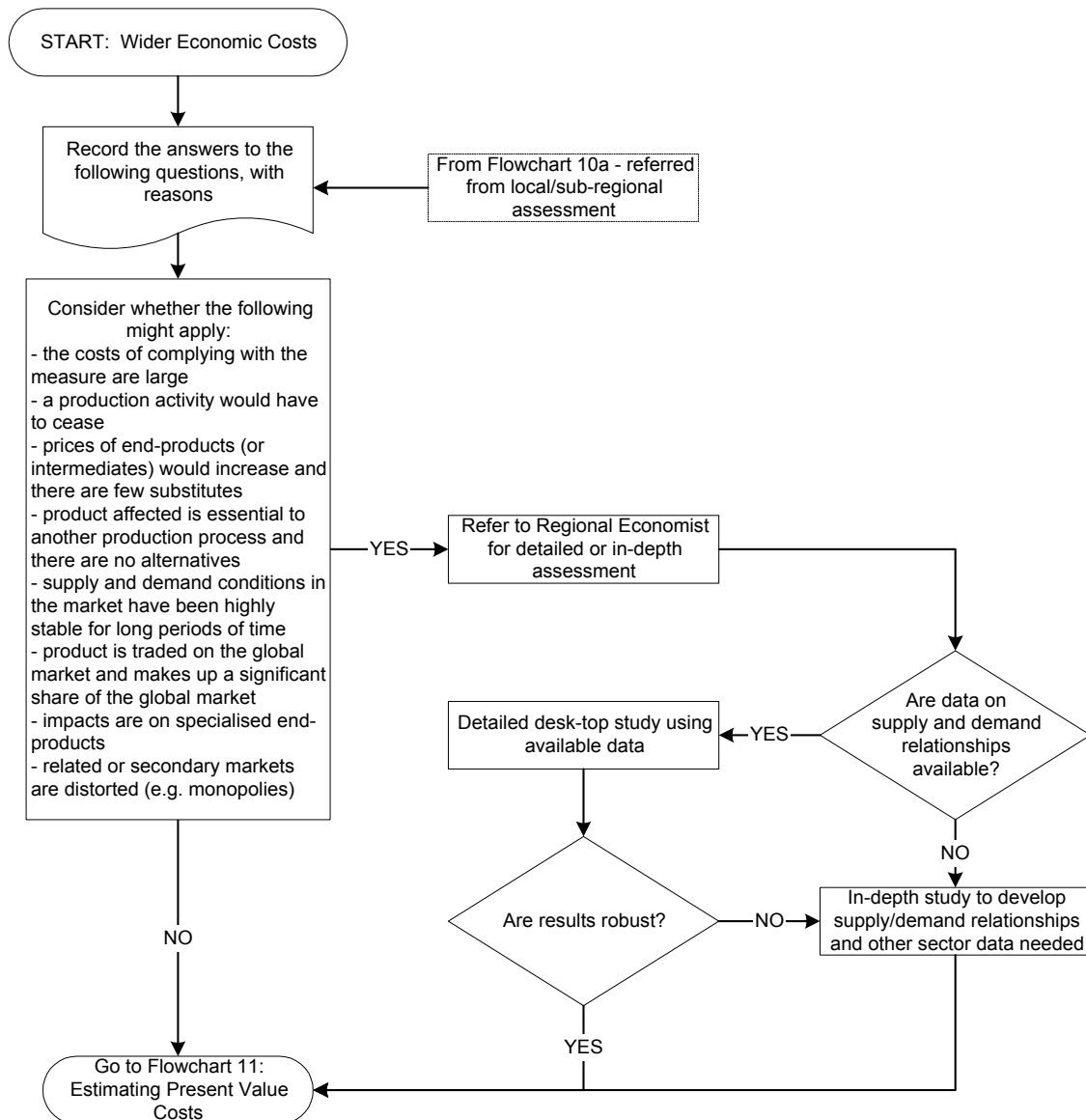
Flowchart 9: Non-Water Environment Costs and Benefits



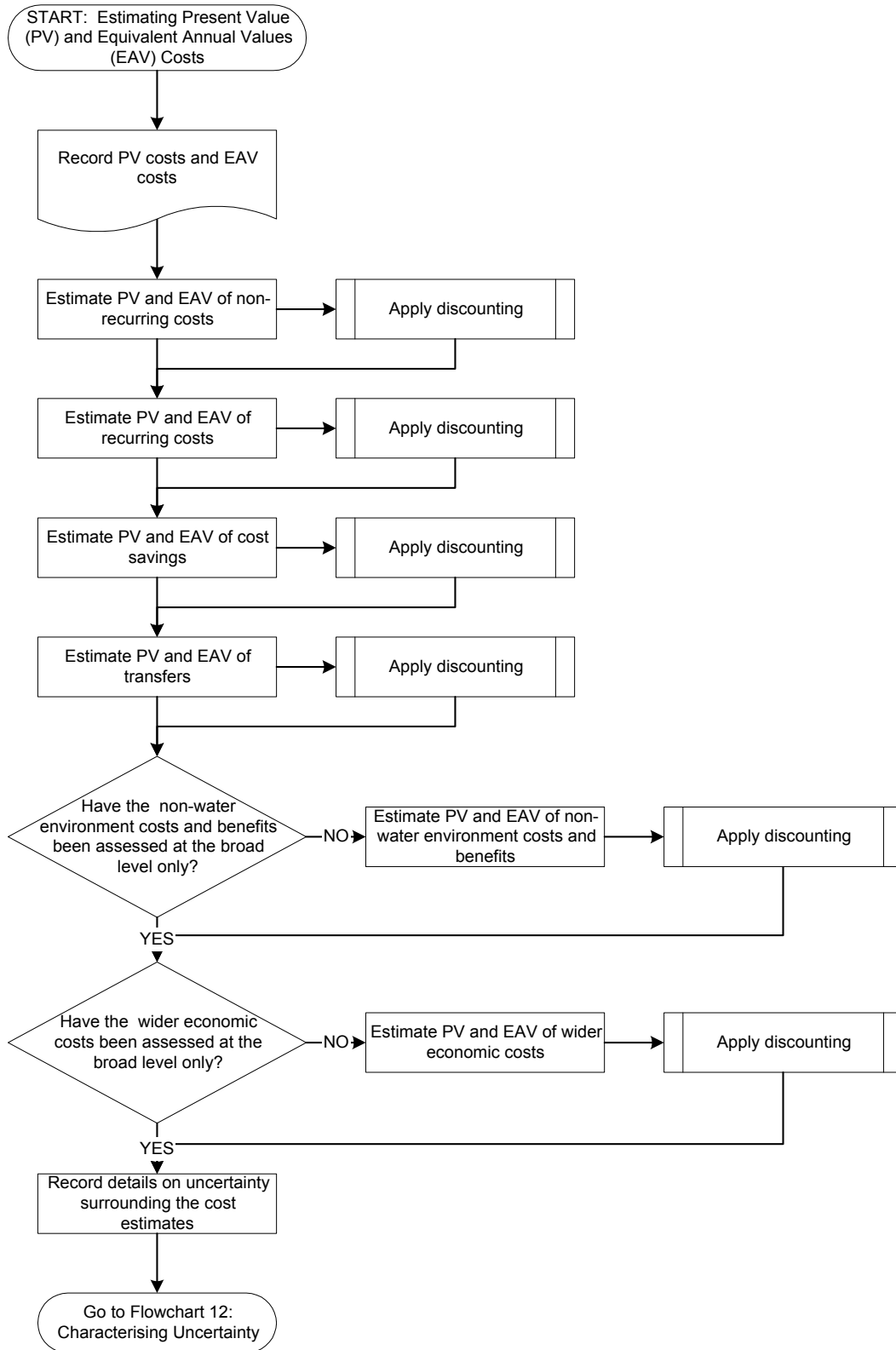
Flowchart 10a: Wider Economic Costs for LOCAL/SUB-REGIONAL MEASURES



Flowchart 10b: Wider Economic Costs for REGIONAL/NATIONAL MEASURES



Flowchart 11: Estimating Present Value and Equivalent Annual Costs



Flowchart 12: Characterising Uncertainty

