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Guideline for economic effects and evaluation in EIA

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PlanningNSW welcomes feedback on these Guidelines.

DISCLAIMER

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1. Setting the context

1.1. Introduction

This chapter of the EIA Manual has been designed to assist proponents from the public or private sectors in assessing the economic effects and significance of development proposals as part of an EIA. The guidelines may be applied to specific, local-scale projects as well as to large-scale projects, policies and strategies of regional economic or environmental significance.

The chapter is intended to complement and be compatible with guidelines issued by the NSW Treasury for the evaluation of environmental impacts of investments in capital works by NSW Government agencies. Many investment proposals by NSW Government agencies require both an economic appraisal under the requirements of Treasury guidelines as well as under the environmental impact assessment (EIA) requirements of the Environmental Planning and Assessment (EP&A) Act 1979. Whether prepared as part of Treasury requirements or under the EIA requirements of the EP&A Act, the economic analysis should have similar objectives, scope, assumptions, methods and results.

There are essentially two ways in which an economic evaluation can be incorporated into EISs:

- undertake the entire EIA as an applied economic analysis, or
- include an economic section as a distinct component of an EIS

In most cases, the latter approach is more practicable.

The term 'evaluation' refers to a consideration of a set of alternatives (options) and applying pre-determined criteria for the purpose of making a decision. The main aim of an *economic* evaluation is to provide information that will assist decision makers make efficient use of available resources to maximise the well-being or welfare of the community. A resource is anything that is capable of affecting the human condition. Thus, from an economic perspective, the term 'resources' includes natural resources and the environment. The mechanisms linking resources to community well-being may involve direct use of resources (for example, commercial exploitation of forests or water-based recreation) or non-use (such as the preservation of natural ecosystems, species or special areas).

The main aims of an economic efficiency analysis are to:

- assess whether specific development proposals are desirable on economic efficiency grounds
- provide a framework for the evaluation of feasible alternatives (options)
- assist in the design of economically efficient environmental mitigation and protection measures

For some EIAs it may be necessary to provide additional information as an adjunct to the economic efficiency analysis concerning:

- the regional or State-wide economic impacts of development proposals
- the financial aspects of the proposal including the pricing of outputs or services supplied by the development

The requirements for meeting ESD criteria in EIA all have economic implications:

- the precautionary principle reinforces the need to take risk and uncertainty into account, especially in relation to threats of serious or irreversible environmental damage
- intra- and inter-generation equity requires consideration of the distribution of benefits and costs to different groups within the community, currently and in the future
- the principle of conservation of biological diversity and ecological integrity necessitates consideration of environmental criteria and constraints on the use of natural resources
- improved valuation and pricing of environmental resources is an essential aspect of economic efficiency analysis

1.2. Legal requirements for economic analysis

General obligations under the EP&A Act

The legislative requirement for economic analysis in EISs arises from the definition of the environment in the EP&A Act, the objectives of the Act and the specification of the content of EISs provided in the EP&A Regulations 1994. Under the EP&A Act, the environment is defined to include 'all aspects of the surroundings of man, whether affecting him as an individual or in his social groupings'. This includes the social and economic environment, as well as the biophysical environment.

One of the objective of the Act also relates to the consideration of economic welfare by focusing on encouragement of 'the proper management, development and conservation of natural and man-made resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment'. This general obligation should be considered by proponents and decision-makers when exercising their responsibilities under the EP&A Act.

EIS Requirements

Schedule 2 of the EP&A Regulations requires the EIS to provide a justification for undertaking a proposal in the manner proposed in terms of biophysical, social and economic considerations and the principles of ecological sustainable development. This requirement can be interpreted to require a consideration of economic matters when:

- giving a general and detailed description of the environment likely to be affected by the proposal;
- considering feasible alternatives;
- considering the consequences of not carrying out the development;
- providing justification of the proposal;
- considering the likely impact of the proposal; and
- identifying measures to ameliorate impacts on the environment.

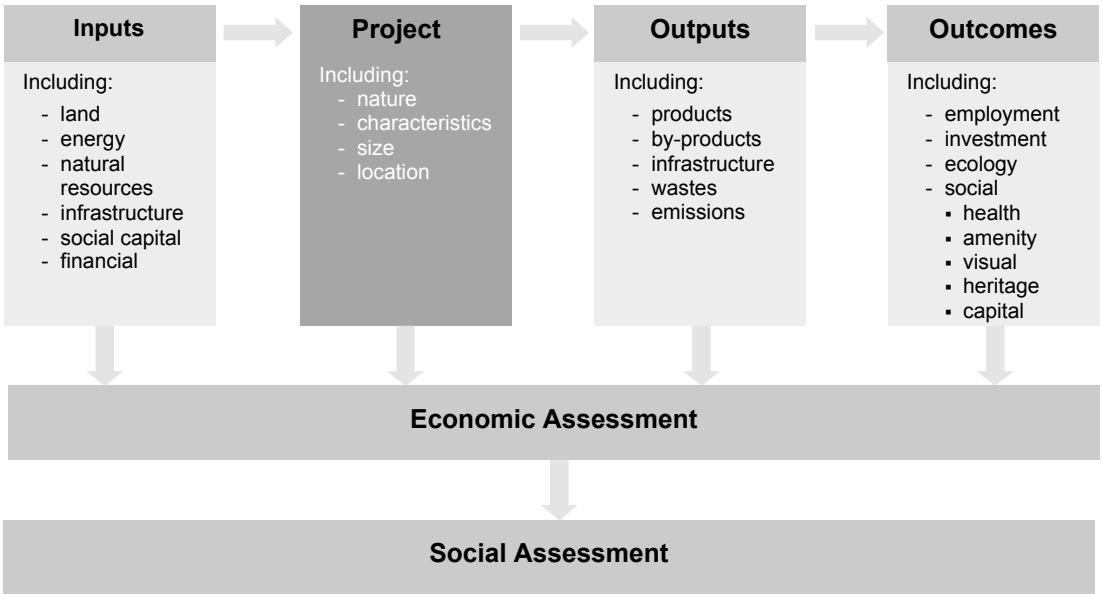
The requirement to have regard to the principles of ESD when justifying the proposal can also be interpreted to require a consideration of economic matters since ESD draws heavily on economic concepts and analysis.

Legal precedents Judicial statements made in Land and Environment Court provide further guidance on legal requirements for economic analysis in EISs. Justice Stein, when considering a benefit cost analysis (BCA) prepared by Shoalhaven Council in an EIS on alternative road routes, stated that because environmental values were not included, the value of the BCA was limited (Leatch v Director General of National Parks and Wildlife Service and Shoalhaven City Council, Land and Environment Court No. 10376, 1993). Justice Stein commented that 'there are a number of environmental economic models which factor environmental values into cost benefit analysis' and that 'an approach which attempts to integrate economic and environmental factors is preferable.' While the Court's finding does not determine whether economic analysis should be mandatory in all EISs, it does provide clear support for the use of economic techniques to derive environmental values and approaches that integrate economic and environmental factors.

1.3. Linkages with other sections of the EIS

The economic guidelines are meant to be applied in a multi-disciplinary contexts. Significant environmental impacts also have economic significance, thus it is essential to collaborate with other experts contributing information on physical, ecological, cultural and social impacts (Figure 1). The role of economics is to interpret this information in terms of economic efficiency as well as identifying other aspects of economic importance in an EIA.

Figure 1. Interrelationship with other sections of the EIS



1.4. Economic assessment techniques

Economic evaluations are not primarily concerned with the financial viability of a project or the financial transactions occurring within the economy. The primary focus of economic analysis in an EIA is to evaluate resource-use options in terms of their effects on the economic well-being or welfare of the community. Many of the benefits enjoyed by the community, especially those relating to the environment, are unpriced. Adverse environmental impacts are also often unpriced but also have effects on the well-being of the community. The main characteristic of an economic evaluation is that it compares the favourable and unfavourable effects of options for proposed developments using a common yardstick - monetary value.

The accepted technique for assessing changes in the economic well-being of a community is benefit-cost analysis (BCA). This is the main tool of economic efficiency analysis, especially where unpriced effects must be taken into account. In a benefit-cost analysis, maximum economic efficiency is achieved when the present value of net benefits (total benefits less total costs) is maximised. This evaluation criterion is described as net present value (NPV).

Note: *To conduct a proper economic evaluation of the options associated with a proposed development that is likely to have significant environmental impacts it is essential to undertake a benefit-cost analysis.*

In special circumstances, the economic efficiency analysis may involve cost-effectiveness analysis (CEA), cost tradeoff analysis or estimation of threshold values. The aim of CEA is to find the least-cost option that will achieve the same project and environmental objectives. Cost tradeoff analysis can assist in determining acceptable level of environmental mitigation or protection based on the shape of the abatement cost curve. Threshold values comprise the opportunity costs that the community would be obliged to incur to achieve specified environmental objectives.

In the course of scoping a benefit-cost analysis, complementary evaluation techniques may be applied, such as multi-criteria analysis (MCA). MCA is a collection of mathematical techniques designed to facilitate the ranking of mutually exclusive options according to a predetermined set of decision criteria, without necessarily using monetary units of measurement. MCA is a useful tool to screen out options that are clearly undesirable and identify a set of options that should be subject to more detailed analysis.

Where additional kinds of information are required as an adjunct to the economic efficiency analysis, special economic techniques are usually applied. The economic impacts of a proposal on the regional or State economy are usually estimated by means of input-output (I-O) analysis, computable general-equilibrium (CGE) models or macro-econometric simulation models. Fiscal impacts are assessed using techniques such as cost-revenue analysis. Financial assessments usually rely on discounted cash flow analysis (DCF) although other accounting approaches may be applied.

Evaluating options in terms of the criteria for ESD may involve a variety of economic techniques such as probability analysis (for the assessment of risk), decision analysis techniques (to deal with the problem of uncertainty), incidence

analysis (to assess intra-generational equity), variation of the discount rate (when addressing inter-generational equity), and estimating the opportunity costs or threshold values of special environmental objectives (such as safe minimum standards - SMS) to protect biological diversity or ecosystem integrity.

As ESD is clearly a multi-attribute concept, it may be appropriate to conduct the final integrated assessment using MCA. The relevant criteria in the MCA should cover efficiency, equity and ecological integrity.

1.5. Techniques for valuing environmental impacts

A fundamental goal of benefit cost analysis is to incorporate, as far as possible, environmental impacts that affect the 'use' of an environmental resource as well as 'non use' (refer to section 4.3). These environmental impacts are valued in terms of changes in producers' and consumers' surplus (Refer to section 2.2). The main techniques for valuing environmental impacts are described below.

(a) Market-Based Techniques

Productivity Changes Method

This approach can be used when an environmental change leads to changes in production levels, costs or prices. Dose-response functions are usually needed to estimate physical changes in production in relation to changes in environmental conditions.

Where changes occur only in output levels and/or costs, changes in producers' surplus can be estimated. If the change in productivity also results in a change in price, changes in consumers' surplus also need to be considered. Before using this approach prices and costs may need to be adjusted to reflect shadow prices.

Human Capital Approach

Changes in labour productivity can be measured using the human capital approach. This provides an estimate of the forgone earning stream resulting from adverse environmental effects. It is frequently used as a means of partially assessing the damage cost of adverse health effects resulting from environmental pollution or other deleterious impacts.

Results obtained using the human capital approach should not be interpreted as the value of human life. Most economists prefer to avoid placing direct values on life, although it is possible to obtain implicit policy values by observing the expenditures by public authorities to reduce mortality rates (for example, safety features for transport infrastructure) or the willingness to pay by individuals to reduce the statistical risk of premature mortality.

Defensive Expenditures

Defensive expenditures indicate the minimum amount that people would be willing to pay to prevent an environmental impact. These expenditure do not necessarily correspond to the environmental benefits resulting from the defensive measures. However, if people are observed to be actually making such expenditures (for example, the construction of levees to prevent flood damage) it can be presumed that their valuation of environmental protection benefits will be at least as great as the costs incurred.

Replacement/ Repair Expenditures

These expenditures are typically undertaken after environmental damage has occurred, such as the application of fertiliser to offset soil loss or the cleaning costs incurred by households after soiling from air pollution. It is spurious to make estimates of such costs and assume that they can be equated with environmental benefits. Empirical observations or surveys should be undertaken to prove that the expenditures will be undertaken. In addition, it is possible to presume only that this represents a minimum value for the associated

environmental benefits.

Shadow Projects Expenditures on shadow projects (man-made replications of lost or damaged ecosystem functions or attributes) are a special instance of replacement cost. The same qualifiers apply in using the costs of shadow projects to value the environment as with defensive and replacement expenditures.

Opportunity Cost Method The opportunity cost method is applicable in situations where environmental improvement involves a sacrifice of some other, more easily valued economic benefit. A common application is the calculation of threshold environmental values, as described in section 4.3.

(b) Surrogate Market Techniques

Wage Differential Method The wage differential method values differences in environmental quality or risk in terms of the wages accepted by workers in different locations or jobs. Statistical techniques are used to estimate the implicit values. The method is difficult to apply in Australia as most wages are determined by other processes.

Property Value Approach In a competitive market, property asset prices and rents reflect the value of service from a property, including productive and consumptive environmental services. The hedonic price method can be used to estimate the implicit price of environmental attributes. A common application is the use of house prices to estimate environmental values. The analysis can be conducted using statistical models. Property differentials generated by differences in environmental quality may alternatively be assessed by property valuation experts. Property owners are also often aware of the effects of environmental change on the value of their properties and may be asked for their valuations by means of interviews or questionnaires.

Travel Cost Method The travel cost method assumes that the willingness to pay for recreation at a particular site can be inferred from the cost of travel by visitors to the site. To apply the method, an on-site survey is undertaken to ascertain the frequency of visits, distances travelled, the cost of travel (including the implicit value of time), details of each visiting group and other socio-economic information. Population statistics must be obtained for different zones of trip origin, and visitation rates by zone are calculated. A regression equation is derived showing the relationship between visitation rates and travel costs. This equation is then used to simulate the effect of hypothetical entry charges to derive a demand curve for recreation at the site. The area under the demand curve and above the price line gives an estimation of the consumers' surplus.

Variations of the travel cost model allow for substitute sites, congestion externalities and individual versus zonal models.

To estimate changes in benefits for a particular site resulting from a change in environmental quality, such as a deterioration in water quality, it is necessary to predict a downward shift in the demand curve, indicating a lower visitation rate and lower consumer surplus for those still visiting the site. The decrease in benefits is measured as the difference in total area between the original and new demand curves.

(c) Hypothetical Market or Survey Techniques

Contingent Valuation Method

The contingent valuation method establishes a hypothetical market for an environmental good or service and uses a survey questionnaire to elicit people's willingness to pay for some change in the supply or quality of the good or service. CVM can be used to measure use values as well as non-use values. It is the only known method of directly measuring existence values and prospective values in an economic evaluation.

CVM is subject to a wide range of potential biases, thus careful consideration must be given to the kind of scenario conveyed to respondents, the type of question asked (for example open ended questions, payment card method, bidding game techniques, dichotomous choice) the specified payment vehicle and the statistical models applied. Application of the CVM must be carefully designed and administered to minimise biases.

Constructed Markets

Constructed markets are contrived situations in which money actually changes hands for a usually non-marketed good. They are mainly designed to test CVM results, for instance the importance of free riding, or the difference between willingness to pay and willingness to accept. Constructed markets may be considered a complement to CVM rather than a substitute for it.

Contingent Ranking

Contingent ranking asks people how they rank alternative combinations of environmental and other attributes rather than how much they would be willing to pay. From such a ranking, a maximum likelihood estimator routine can be used to estimate an indirect utility function. Contingent ranking has been shown to be inconsistent with theoretical principles. Choice modelling is a step forward from this method.

Choice Modelling

Choice modelling is a stated preference technique in which respondents choose their most preferred resource use option from a number of alternatives. Each alternative exhibits a number of attributes such as land affected, impacts on threatened species, household cost etc. Through statistical means (multinominal, nested or mother logit) choice models produce estimates of the value in changes in individual attributes as well as the value of aggregate changes in environmental quality. Choice modelling can thus be used to produce estimates of the value of multiple resource use alternatives.

Choice modelling has been applied to evaluation of choices involving consumer goods, transportation, tourism and the selection of landfill sites. There have been only a few applications that have valued environmental goods. Nevertheless the technique appears to have considerable potential for providing a useful and valid estimates of environmental values that may be particularly suited to benefit transfer.

Delphi Technique

This approach uses direct questioning of experts or community representatives to place a value on particular goods. It is usually applied in an iterative fashion, in group sessions, to achieve a consensus result.

(d) Benefit Transfer Method

The benefit transfer technique borrows the values from so-called 'study sites' for application to a site that must be evaluated (the 'policy site'). The values may be transferred as:

- unadjusted unit values (for example, the typical value of a recreation visit)
- adjusted unit values (derived by substituting different values for explanatory variables in a study-site regression model)
- meta-analyses of comparable study sites (the compilation of large data banks from numerous studies to permit generalised statistical analysis of economic values

The robustness of the method depends largely on the quality of results for the study sites and the presence of similar conditions at both the study site and the policy site. Criteria for reliable use of benefit transfer are:

- the study and policy site should be similar
- the environmental change under consideration at the policy site is similar to the proposed change at the study site
- the socioeconomic characteristics and preferences of the population should be similar.

The NSW EPA (1995) has developed a comprehensive environmental economics database (ENVALUE) to facilitate benefit transfers in benefit-cost analyses.

1.6. Summary of Main Environmental Valuation Techniques

A summary of environmental valuation techniques, compiled by the NSW EPA (1993) is shown in Tables 1 and 2. It assesses the techniques against a number of criteria.

Table 1: Comparison of Environmental Valuation Techniques considering 'use' criteria

	Reliability of results	Data requirements	Timing	Ease of application	Technical development	Accumulated expertise
Market-based techniques						
Productivity Approaches	High	Medium	Low	High	High	High
Opportunity Cost	High	Medium	Low	High	High	High
Defensive Expenditure *Special features: based on market transactions, assumes no distortions in market prices*	High	Medium	Low	High	High	High
Surrogate market techniques						
Property Market *Special features: assumes mobility and perfect information*	High	High	Medium	Medium	High	Medium
Wage Differential *Special features: main techniques for valuing risks to life, assumes mobility and perfect information*	Medium	Medium	High	Medium	Medium	Medium
Travel Cost *Special features: use limited to recreation benefits*	Medium	Medium	Low	High	High	High
Hypothetical market or survey techniques						
Contingent Valuation *Special features: the only technique that covers existence values can suffer from a lot of biases*	High	Medium	High	Low	High	High
Delphi Technique *Special features: applicable to a wide range of impacts*	Medium	Low	Low	Medium	Medium	Low

Table 2: Comparison of Environmental Valuation Techniques considering 'impact' criteria

Source: (EPA, 1993: 28)

	Health Impacts		Aesthetic Impacts	Ecosystem Impacts	Recreation Impacts	Production Impacts/ Material Damage
	Illnesses	Mortality				
Market—Based Techniques						
Productivity Approaches	Yes	—	Yes	Yes	Yes	Yes
Opportunity Cost	Yes	—	Yes	Yes	—	Yes
Defensive Expenditure	Yes	Yes	Yes	Yes	—	Yes
Surrogate Market Techniques						
Property Market	—	Yes	Yes	—	Yes	—
Wage Differential	Yes	Yes	Yes	—	—	Maybe
Travel Cost	—	—	Yes	—	Yes	—
Hypothetical Market/Survey Techniques						
Contingent Valuation	Yes	Yes	Yes	Yes	Yes	Yes
Delphi Technique	Maybe	—	Maybe	Yes	Maybe	Maybe

1.7. Economic Assessment Checklist

The recommended sequence of assessments, making use of the techniques described above, is set out below. In general, the assessment involves:

- preliminary assessment
- scoping the economic study
- carrying out the analysis (including valuing environmental impacts)
- addressing special issues, including ESD
- reporting the results of analysis

The required steps, defined in greater detail, are as follows.

(a) Conduct preliminary assessment:

- Review main elements of proposed project (including impact mitigation measures), its alternatives and surrounding environments
- Review information on environmental impacts of proposed project, from other disciplines
- Screen options using MCA, where necessary
- Determine spatial and temporal boundaries for analysis
- Specify relevant community and major groups favourably or unfavourably affected
- Specify the kinds of economic values affected
- Obtain preliminary estimates of likely magnitude of benefits and costs
- Assessment of the scale of the economic effects of the proposed development relative to the regional economy or local community
- Assessment of potential environmental costs and benefits relative to the local or regional economy
- Determine whether an economic impact assessment is required
- Determine whether a fiscal impact assessment is required
- Determine whether a financial analysis is required

Steps in Preliminary Assessment:

1. **Screen and select options**
2. **Determine required studies:**

	When undertaken	Reasons for undertaking	Possible methods
Economic Efficiency Analysis	Always	Economic efficiency	BCA, CEA, TVA
Economic Impact Analysis	Sometimes	Economic and distributional impacts	I-O, CGE
Financial Analysis	Sometimes	Financial viability	DCF or other
Fiscal Analysis	Sometimes	Fiscal impacts	Fiscal assessment, pricing, funding

3. **Obtain Preliminary Estimates**
4. **Scope Detailed Studies**

(b) Scoping the Economic Study

- consider environmental impacts and economic values predicted in the preliminary analysis
- consider the time, skills and budget that are available to undertake the analysis
- determine values to be quantified in the benefit cost analysis, sources of information, valuation methodology and techniques to be used
- determine extent of, and approach to, any community consultation that is to be undertaken
- identify the level and extent of any other economic assessments that are required

(c) Derive economic values and conduct economic efficiency analysis of the proposal and alternatives:

- Specification of the baseline scenario (without the proposed project)
- Valuation of direct benefits and costs of the project and its alternatives
- Valuation of environmental effects
- Set up the benefit-cost assessment framework
- Summarise all economic values
- Calculate NPV and other criteria specified by State Treasury
- Apply Treasury criteria to proposed project and its alternatives, including options for environmental mitigation
- Rank options according to Treasury criteria
- Conduct incidence analysis identifying the distribution of benefits and costs
- Where appropriate, analyse cost effectiveness of alternative mitigation measures

Possible methods to be used in Detailed Assessment:

Economic Efficiency:	BCA, CEA, TVA
Economic Impacts:	I-O, CGE
Financial Viability:	DCF or other
Fiscal Impacts:	Fiscal assessment, Pricing, Funding

(d) If required, conduct economic impact analysis to assess economy wide-effect:

- Specify economic boundaries for the assessment (regional, State or national)
- Specify linkages between the project and the economy
- Apply relevant economic impact assessment model
- Estimate results, including changes in output, employment and income for sectors of the economy
- Incorporate any economic efficiency results in the benefit-cost analysis

(e) If required, conduct fiscal impact assessment

- Identify government agencies involved (local, State and Commonwealth)
- Specify relationship of project to agencies
- Assess cost and revenue implications for agencies
- Incorporate any economic efficiency results in the benefit-cost analysis

(f) If required, conduct financial analysis:

- Conduct discounted cash flow analysis or other financial analysis
- Assess financial viability of the proposal
- If required, determine the implications for pricing
- Incorporate any economic efficiency results in the benefit-cost analysis

(g) Apply ESD principles:

- Ensure that predicted changes in natural resources and environment have been comprehensively valued
- Assess risk, uncertainty and irreversible environmental impacts
- Address intra- and inter-generational equity issues
- Specify ecological targets, objectives or safe minimum standards and apply cost analysis or threshold value analysis

Considerations of ESD in economic assessment:

Internalise Environmental Values:	BCA and Environmental Valuation
Precautionary Principle:	Risk Assessment, Risk Aversion
Intra- and Inter-Generational Equity:	Incidence Analysis, Economic Impacts
Ecological Integrity:	SMS, Application of threshold values

(h) Conduct integrated assessment of options:

- Summarise results on economic efficiency
- Summarise results on intra- and inter-generational equity
- Summarise results on risk aversion
- Summarise results on ecological aspects and integrity
- Where appropriate, apply integrated assessment methods such as MCA

(i) Document and report main findings.

- Report results taking into consideration the following criteria:
- Economic Criteria
- Ranking of Options
- Mitigative Measures
- ESD Criteria

2. Economic aspects of EIA

2.1. Economic consequences of development

The economic effects of development are usually complex and extensive, influencing different groups within the community, the financial viability of businesses and the finances of government agencies. The main purpose of conducting an economic analysis is to interpret these effects in a way that guides decisions on how to shape the development process, including the management of environmental impacts.

Changes in the economic welfare of the community are the main focus of an economic analysis. An essential task is to predict what might happen to the environment with and without specific development options, and translate the differences into changes in the economic welfare of the community. The concept of economic welfare is discussed in the next section.

2.2. Economic Welfare and Efficiency

Efficiency in resource allocation is achieved when the so-called Pareto criterion is met, namely that 'no re-allocation can make anybody better off without making another worse off'. In reality, it is unusual for changes in resource allocations, such as the introduction of new developments, not to affect some individuals or social groups adversely. The criterion of economic efficiency that is accordingly applied in economic appraisals, and which underlies the concepts and techniques of benefit-cost analysis, is the so-called potential Pareto improvement. This criterion states that a change in resource allocation is desirable on economic grounds if, in principle, the gainers are able to compensate the losers. Compensation need not be made in practice. In other words, the operational criterion of economic efficiency regards the resulting incidence of benefits and costs as acceptable or irrelevant in evaluating the change.

Changes in economic welfare resulting from a development proposal comprise the sum of any changes in consumers' surplus and producers' surplus. Consumers' surplus is the difference between what a person would be willing to pay for a good or service and what they have to pay. It is measured as the area between a demand curve and the price line. Producers' surplus is the difference between the costs of the inputs used in the production process and the price received for the finished product. It is measured as the area between a supply curve and a given price for a specified quantity supplied. In practical terms it is the net revenue that is earned by producers. These concepts are explained in standard texts in micro-economics and benefit-cost analysis (see *Guidelines and other references)*).

Changes in benefits for consumers for price increases and price decreases should theoretically be measured in terms of compensating variation and equivalent variation, using so-called Hicksian compensated demand curves. In reality, empirical data are usually available only as an observed so-called Marshallian market demand curve, in which case total benefits are measured as the area under the demand curve, for a given price and quantity. Total benefits comprise market expenditure plus Marshallian consumers' surplus.

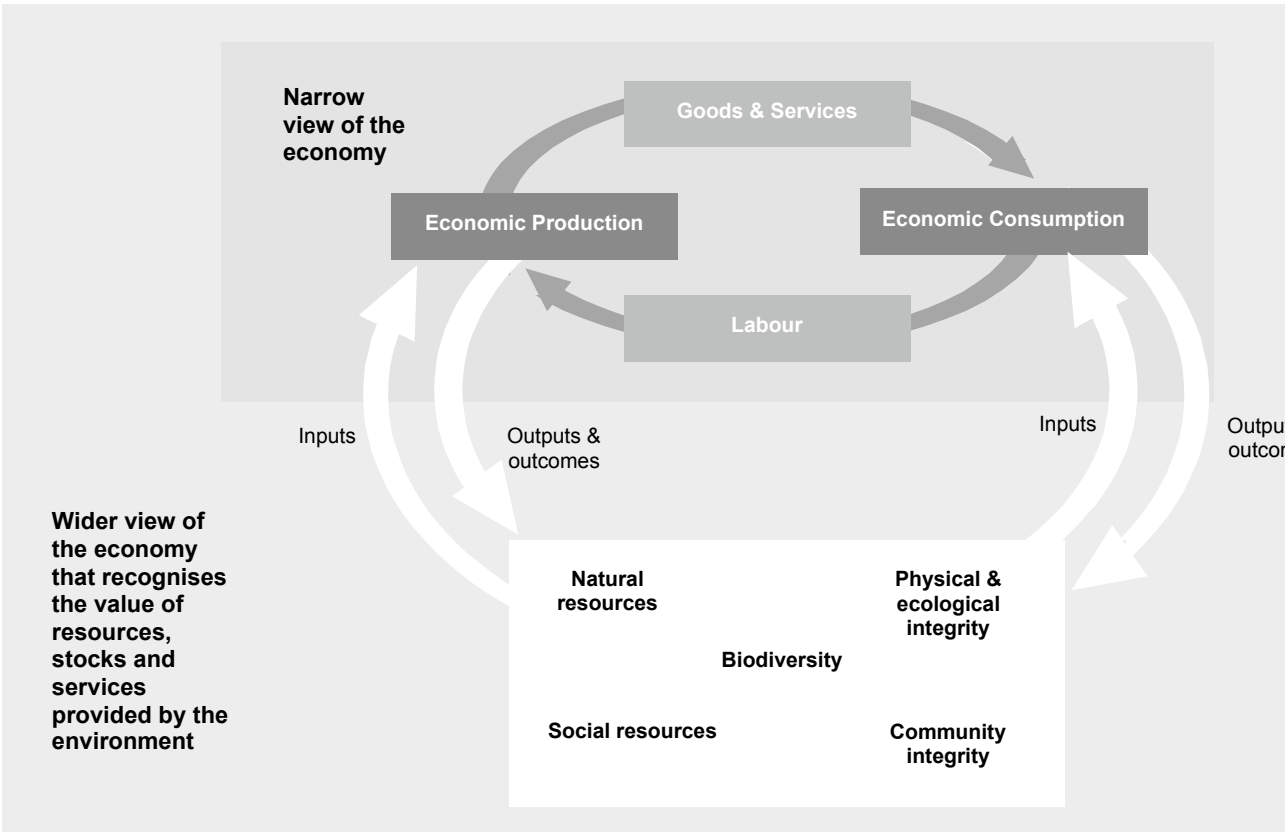
The professional literature indicates that in practice, empirical estimates derived from Hicksian demand curves will generally not differ significantly from those derived from Marshallian demand curves. Indeed, only rarely will empirical estimates be available for market demand curves or elasticities of demand. Applications of Hicksian concepts may, however, be incorporated in the design of survey instruments for economic valuation, such as contingent valuation questionnaires.

2.3. Environmental Aspects of Economic Welfare

From a broad perspective, community economic welfare relates to the quality of life, which in turn depends not only on the consumption of conventional goods and services produced by the economic system but also on the enjoyment or use of attributes, materials or services provided by the environment. Economics is concerned with all aspects of resource use and management that contribute to the welfare of the community, including the environment.

Figure 2 illustrates the difference between the traditional, narrow view of the economy and a wider view showing the linkage between the traditional economy and the environment.

Figure 2. Resource stocks, flows and the economy



Adapted from Young, 1992: 10

Many welfare aspects of the environment do not show up in markets and thus may be unpriced. The concepts of consumers' surplus and producers' surplus apply to environmental goods and services, even though this is not always directly observable in markets. The failure of markets to give correct pricing signals on the environment is a major cause of overuse or abuse of the environment. Impacts on the environment resulting from development which have either a negative or positive environmental effect on a third party without accountability are defined as 'environmental externalities'.

Where use rights to the environment are well defined, private parties assume responsibility for adverse impacts on others. However, where the system of rights is not clear or enforced, government intervention via the EIA process or other policy and regulatory mechanisms is required to achieve efficient resource allocation. It is here that techniques such as EIA and benefit-cost analysis can play a role.

From an economic perspective, one of the main functions of the EIA procedure is to recognise the significance of adverse environmental effects on economic welfare and 'internalise' them in the decision making process. The task of economic analysis is to identify and measure, as far as possible, the value of changes in the environment and its attributes and functions, as a guide to better decisions on how developments should be planned and implemented.

Special economic valuation techniques are needed to estimate environmental values. The techniques (which were explained more fully in Section 1.5) can be conveniently classified as:

- market-based techniques
- surrogate market techniques
- hypothetical market or survey techniques

2.4. Distributional and Equity Considerations

BCA ignores distributional considerations, yet it may be necessary - and indeed is required as a criterion of ESD - to assess the distribution of benefits and costs as part of the EIS. The distribution of effects should be assessed in terms of:

- **intra-generational equity effects –** the incidence of benefits and costs within the present generation
- **inter-generational equity effects** – the distribution of benefits and cost between present and future generations.

Distributional effects may be assessed in terms of different groups within the community and/or at the regional scale. These assessments, especially at the local scale, may be assisted through social impact assessment. Some of the results of distributional assessments may be relevant to the economic efficiency analysis. For example, certain kinds of social impacts, such as social dislocation or adverse health effects, may be partially appraised in monetary terms.

Economic impact analysis is most commonly carried out at the regional, State and sometimes national scale to assess the predicted impacts of a proposed new development in terms of criteria such as direct and indirect employment, income, output and value added. The methodology can also assist in considering economy-wide environmental externalities, secondary and cumulative impacts stimulated by or flowing from the proposed development. Economic impact analyses may reveal changes in the efficiency of resource use that should be incorporated in the benefit-cost analysis, such as the creation of new jobs for otherwise chronically unemployed labour or capital.

Financial and fiscal analysis can also provide information on the distributional consequences of proposals. Other means of addressing distributional and equity issues include the use of distributional incidence matrixes or qualitative descriptions.

It is beyond the assumptions and ethical premises of economics to determine whether the particular distributional consequences of a proposed development are desirable or undesirable. Value judgements are required which usually are the responsibility of the determining authority or the political process. The task of the economic analyst in the EIS is to identify the key stakeholder groups and conduct an impartial analysis of how each may be affected.

2.5. Financial Aspects of the Proposal

A financial feasibility study of a proposal is concerned with the more narrow objective of assessing the impact of the proposal on the financial welfare of the owner or operator of the proposed development. Financial benefits and costs of the proponent may nevertheless be linked to community welfare and may provide a useful starting point for the evaluation of benefits and costs from a community perspective. The net returns of the project (with appropriate corrections from financial to economic values) may simultaneously comprise net benefits to the community. In translating the financial analysis into an economic analysis, additional information is usually included and different estimations are performed (see Table 3).

Table 3: Differences Between Financial and Economic Analysis

Characteristics	Financial Analysis	Economic Analysis
Purpose	Assess financial viability of proposal	Assess economic welfare of proposal
Accounting Stance	Developer	Community
Prices	Market prices, real or nominal values	Shadow prices, real values
Costs/Returns	Financial costs and revenue	Social costs and benefits
Taxes/Subsidies	Included in costs and returns	Excluded if transfer payments
Interest/Discount Rate	Real or nominal interest rate	Real discount rate

It is common to conduct an assessment of the financial viability of proposed developments when they occur within the public sector. With public enterprises, the method of financing the proposal may need to be considered. In some circumstances, the proposal may be feasible only if certain forms of federal or state government assistance or user pay mechanism are applied. The possible extent and implication of the application of user pay mechanisms such as levies, tolls or increased rates is an issue of public concern as well as requiring consideration by the Independent Pricing and Regulatory Tribunal.

For private sector proposals, it may be appropriate, for reasons of commercial confidentiality, for sensitive financial information, including that used in undertaking benefit cost analysis, to be supplied to the Department of Urban Affairs and Planning for in-camera consideration and withheld from public inspection in the EIS.

Financial information on export prices, profitability and tax revenue for private projects involved in the export for commodities such as woodchips or minerals may be required if there is a possibility of transfer pricing. Transfer pricing practices could result in Australia and NSW being deprived of appropriate economic returns on its natural resources through an arrangement of exporting the commodity to a parent company at a price below world average, with the parent company profiting from the transfer.

Another reason for considering financial viability is that the commercial success (or potential failure) of the proposal may be relevant to environmental risks and environmental outcomes. As the financial failure of major private or public projects can have significant detrimental social, economic and environmental consequences, their potential viability may be an important consideration in the justification for undertaking the project. Projects which may have low financial return but high off-site economic returns (such as environmental improvement alterations to an existing facility) may also be of public interest.

2.6. Fiscal Aspects of the Proposal

Fiscal impacts primarily concern the financial revenues and costs of governments. Where a development proposal is likely to have a substantial effect on the budgets of local, State or Commonwealth Governments, fiscal impact assessment may be undertaken as one aspect of an economic impact analysis.

In many cases fiscal impacts represent a series of transfer payments. However, where governments are obliged to supply supporting infrastructure such as sewerage and water supply schemes, port facilities, roads and power supplies to service new projects, this may involve additional costs that should count as part of the overall costs to the community and be included in the economic efficiency analysis.

2.7. ESD and Economics

The National Strategy for Ecologically Sustainable Development defines ESD as 'd*evelopment which meets the needs of Australians today, while conserving our ecosystems for the benefit of future generations.'* Key principles of ESD are as follows:

- **The precautionary principle** — namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- **Inter-generational equity** — namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- **Conservation of biological diversity and ecological integrity**.
- **Improved valuation and pricing of environmental resources**.

Ecologically sustainable development is therefore clearly a multi-attribute concept that includes economic efficiency, equity and environmental integrity.

Evaluating options in terms of ESD criteria therefore may involve economic efficiency analysis as well as a variety other economic techniques for addressing risk and uncertainty, intra and inter generational equity and conservation of biological diversity and ecological integrity.

An important requirement to achieve ESD - especially in relation to the objectives of keeping options open for future generations - is wise management of the community's capital stock, which includes man-made or physical capital, human capital and environmental or natural capital. Defining an appropriate balance between natural and other capital is by no means straightforward, as it depends greatly on substitution possibilities among different forms of capital and on social values concerning the kinds of goods and services - hence capital base - that best meets the community's preferences and expectations, currently and in the future.

The concept of the environment comprising part of the community's capital stock draws on parallels with man-made capital. The asset value of man-made capital is usually determined either as its cost of supply or in terms of the present value of the future net benefits expected from its use. Natural capital differs from man-made capital in that it has been supplied 'free' by nature, thus it cannot be valued on the basis of the cost of supply. In principle, however, natural capital can be valued in terms of the expected net values of materials and services (including unpriced services such as existence values and ecological support functions) that it is capable of yielding.

The development process results in, among other things, modification of the natural capital stock, for example through changes in land use, pollution or the exploitation of natural species. These changes alter the attributes and flows of materials and services associated with the natural capital stock and have implications for the economic welfare of the community, currently and in the future. These changes will be reflected in changes in the asset value of the natural capital stock.

Ecologically sustainable development requires careful and efficient management of the total capital stock to ensure ongoing supplies of all forms of goods and services and to keep resource use options open for future generations. It is especially important to achieve effective management of the natural capital stock, as impacts upon it often have unforeseen consequences that are pervasive, cumulative and irreversible. This raises complex issues concerning appropriate usage rates for natural resources and limits to acceptable change for other environmental attributes. Practical guidelines for maintaining sustainable supplies of materials and services from the environment and addressing the different principles of ESD in an economic context are provided in section 6.

3. Preliminary assessment and scoping of economic studies

An economic analysis provides a framework for interpreting, in terms of community values, the consequences of a development proposal and its feasible alternatives. The economic analysis can be conducted in a number of stages, in close collaboration with other consultants, engineers, scientist and specialists responsible for the social, biological and physical aspects of the assessment.

A preliminary analysis is essential in setting up the economic study. It saves time, uses research resources more efficiently and minimises the chances of neglecting important aspects of analysis.

Questions to be answered in the preliminary analysis include the following:

- what are the main elements to be assessed in the economic analysis
- whether other assessments should be undertaken in addition to the efficiency analysis (eg economic impact assessment, distributional effects, financial assessments, fiscal impacts)
- what alternatives should be included in the assessment
- what should be the level and extent of assessment

3.1. Conducting a Preliminary Analysis

The preliminary assessment and scoping of economic studies should be carried out in close collaboration with scientific experts involved in the EIA. These experts must be relied upon to provide an indication of the kinds of environmental impacts that may need to be investigated and evaluated. Checklists and screening guidelines may assist in the preliminary analysis. Some guidance manuals (see Planning NSW EIS Guidelines and the Workbook issued by the Asian Development Bank) contain checklists of environmental impacts that may be expected for projects belonging to particular economic sectors.

The following tasks should be undertaken in the preliminary assessment:

- identification of environmental variables/indicators and mechanisms likely to be of significance in terms of community economic welfare
- preliminary assessment of predicted changes in the environment with the proposed development and with alternatives to the proposed development (construction phase and operational phase)
- prediction of major groups or stakeholders potentially affected
- specification of the kinds of economic values affected
- preliminary assessment of likely magnitudes of economic effect (rough estimates of benefits and costs)
- preliminary assessment of the scale of the economic effects of the proposed development relative to the regional economy or local community
- preliminary assessment of potential environmental costs and benefits relative to the local or regional economy
- consideration of alternatives
- consideration of impact mitigation measures

Options may be subjected to preliminary evaluation and screening, using MCA or other methods if appropriate. Only feasible options should be selected for more detailed economic analysis. Options may include alternative locations, modes of transport, resource sources or uses, technology, operational management, mitigative measures and rehabilitation or environmental protection

management plans. Criteria used for preliminary screening of options may include efficiency, distributional, financial and environmental objectives. The level of certainty of the predicted performance of proposed options in terms of the criteria should be considered. Where there is uncertainty about the prediction of the effectiveness of the proposed options in meeting the criteria, a precautionary approach should be adopted.

3.2. Determining the level and extent of assessment

Once it has been established that various environmental and economic effects are likely to be significant, the extent of the assessment should be established. Establishing the level and scope of the economic study is an important task. The decisions that are made in this process will affect the time and resources required, the assessment framework, the methodology and valuation techniques, the accuracy and reliability of analysis and the credibility of the results.

The scope and level of detail in the assessment should reflect the level of importance of the likely impacts. It is not possible to specify in advance what level of economic analysis should be applied to different kinds of development projects, as the potential economic significance depends on the kinds of environmental impacts and their importance to the community. This will vary according to specific circumstances and will require careful preliminary investigation, in collaboration with experts from other environmental disciplines and in consultation with the community. Where possible, preliminary estimates of economic benefits and costs (or other aspects of economic importance) should be derived.

3.3. Steps Required in Scoping the Economic Assessment

The steps required in the scoping process should take into account:

- The kinds of environmental impacts and economic values that are predicted in the preliminary assessment
- The choice of valuation methodology and techniques. Techniques relying on financial and market data are usually easier and cheaper to apply. Other techniques, such as travel cost, hedonic pricing or contingent valuation are generally more time-consuming and expensive.
- The time, skills and budgetary resources that are available to undertake the analysis.
- The values to be quantified in the benefit-cost analysis. This will often be related to the kinds of impacts and valuations that are involved and the available time and resources. Levels of risk and uncertainty should be gauged.
- The magnitude of initial economic impacts (whether directly attributable to the proposed development or predicted to occur through environmental impacts on economic activity). A consideration of these impacts relative to the regional economy or local community will give an indication of whether an input-output analysis or similar modelling should be carried out.

3.4. Community Consultation

The scoping process can usually benefit from consultation with stakeholders and other interested parties. This will ensure that the appropriate environmental variables and mechanisms have been properly identified and understood in the preliminary assessment. Citizens often have detailed knowledge of their immediate environment and can provide valuable insights into potential impacts of proposed environmental impacts.

It is also helpful to consult with potentially affected individuals and groups as a precursor to the valuation process. This is particularly important if techniques such as contingent valuation are likely to be applied to assess community values and preferences.

4. Conducting the economic efficiency analysis

The objective of the full economic efficiency assessment is to obtain more detailed estimates of all economic values, evaluate the alternatives according to the prescribed criteria and rank the alternatives in terms of economic efficiency. The results of the efficiency analysis can then be incorporated in a more comprehensive evaluation of the alternatives, taking into account additional criteria such as equity and ESD.

4.1. The proposal

The characteristics of the proposal and any alternatives (brought forward from the preliminary assessment for full analysis) which are likely to have economic consequences should be identified including:

- site establishment phase: land acquired for the proposal
- construction phase: including materials, labour, plant, equipment, energy, overheads, profession services
- operational phase of facility and any ancillary facilities: size or capacity; process technology or production methods; inputs to the operation such as materials, energy, labour, capital, plant, equipment and administration; outputs from the operation including products, by-products or services; wastes (gas, liquid, solid, noise, heat etc) generated and potentially discharged to the environment
- exposure to risks
- transport aspects, including traffic generated by or affected by the proposal

4.2. The location - baseline information

A description of the principal characteristics of the area is required in order to identify the costs and benefits of base case or 'without-project' option. The base case is not necessarily static, as even without implementation of an alternative resource allocation, changes may occur. Information should be collected on:

- specification of the spatial boundaries of analysis (local, regional, NSW or Australia)
- principal characteristics of the economy of the area including population, projected population growth, visitor rate, demographic profile, household income distribution and mean, housing characteristics
- estimated total annual income, principal industries in terms of production and employment, growth trends and unemployment rates in industries likely to be affected by the proposal
- principal characteristics of the biological and physical environment including natural resources likely to be affected by the proposal. An understanding should be gained from other specialists of the relative importance, vulnerability or fragility of the natural resources (including ecological systems) likely to be affected, recent changes or depletion to the resource and an estimate of the likely threats to the long term sustainability of the resources.

- interaction of the economy activities with the biological and physical environment under 'without-project' options taking into consideration factors such as the dependency of production and consumption on natural resources (including ecosystems), economic explanations for existing environmental problems (both input and output related as well as policy related issues), the economic consequences of environmental problems
- the prospects for sustainability: for instance, whether the short-term economic objectives are consistent with long-term ecological objectives and whether the 'supply' characteristics of the ecosystem are in equilibrium with the 'demand' pressures of economic activities

4.3. Assessing the economic significance of environmental and other effects

Benefit Cost Analysis

Benefit cost analysis is the technique required to evaluate options in terms of economic efficiency. Dollar values are used as a common yardstick of community value. Monetary estimates are derived for all sources of economic welfare, whether occurring in markets or as implicit values, as is often the case with environmental goods and services.

In a benefit-cost analysis, benefits are defined as the monetary value of goods and services enjoyed by the community as a result of a change in resource allocation, such as a result of a proposed development. As far as possible, benefits should be measured in terms of the community's willingness to pay for them.

The costs of using resources in a particular way should be measured in terms of opportunity costs - that is, the value of the benefits foregone from the same resources in alternative uses. Costs of development projects typically can be divided into capital costs and ongoing operation, maintenance and replacement costs. Other costs may include those associated with adverse environmental impacts, which are classified and measured as environmental damage costs.

There is a reciprocal relationship between benefits and costs, in that certain kinds of benefits may comprise costs avoided, and certain costs may be benefits forgone. All estimates of benefits and costs for a development proposal should be made at specified points in time in the future, relative to the projected 'without-project' baseline.

The main features of the technique and rules for its application are summarised below.

(a) Determination of the scope and objectives of the analysis

This stage requires specification of the reasons for the proposal, the general approach to the analysis and the spatial and temporal aspects of the study.

(b) Identification of constraints

To ensure that all alternatives for meeting the identified objectives are feasible it is important that consideration be given to the various constraints that may apply eg. financial, distributional and environmental constraints

(c) Identification of the base case and alternatives

Identification of the base case or 'without-project' option is required in order to identify the costs and benefits of alternatives. The base case is not necessarily static, as even without implementation of an alternative resource allocation, changes may occur.

(d) Identification of costs and benefits

It is necessary to identify the costs and benefits over time of the proposal and different feasible alternatives. Costs are defined in terms of marginal opportunity costs. The main categories of costs are:

- resource costs over the life of the project eg. capital expenditures, operating and maintenance costs, labour costs, costs of other inputs (materials, manufactured goods, transport and storage), research design and development costs
- negative externalities
- benefits from the status quo that would be given up under the alternatives

Benefits are defined in terms of willingness to pay. Benefits fall into the following main categories:

- cost savings ie. costs associated with status quo that would not be incurred with the alternatives
- use benefits (including positive externalities)
- non-use benefits (including positive externalities)

In identifying costs and benefits care must be taken to:

- include only costs and benefits that change the net benefit to society
- include only incremental benefits and costs of alternatives
- exclude sunk costs and benefits that do not change net social benefits of alternatives
- exclude transfer payments
- avoid double counting
- exclude or include taxes and subsidies on inputs and outputs as appropriate (refer to Commonwealth Department of Finance 1991)
- include government costs at their true opportunity costs
- consider changes in asset value over the life of the project
- include all externalities
- exclude secondary costs and benefits

(e) Quantifying of costs and benefits

Where economic values can be placed on some or all of the identified costs and benefits BCA can be progressed to its next stages. In a perfectly competitive market (ie where there are marketable goods and transferable assets, numerous independent and informed sellers and buyers, freely determined prices with no government price or quantity controls on inputs or outputs, indirect taxes or subsidies and no impacts on third parties) market prices would reflect WTP values for goods and the opportunity costs of resources. For some costs and benefits market price may therefore give a reasonable estimation of the economic costs and benefits of alternatives.

Quantification problems can arise if some benefits and costs relate to goods and services which are either:

- traded in markets that are subject to distortions; or
- not traded in conventional markets.

In both circumstances, economists have been required to develop estimation techniques that go beyond the use of immediate market data and derive imputed economic values or so-called shadow prices. To impute a price or value is to make the best possible estimate of what the price or value would be if a competitive market existed.

Costs and benefits that do not lend themselves to valuation should still be included in the analysis through qualitative description. Qualitative measurement may be descriptive, ordinal (with a ranking system) or binary (with a yes/no scoring system).

Generally, costs and benefits over time should be valued in real (non-inflationary) prices. Real prices may not necessarily remain constant. Real prices of some scarce resources (often the natural environment) are likely to rise over time relative to real prices for other inputs to production and real prices of produced goods and services.

(f) Consolidation of value estimates

To consolidate the identified streams of costs and benefits over time into a single measure of potential Pareto improvement, they must be discounted to present values. There are two main approaches to determining the appropriate discount rate: the social time preference rate and the social opportunity cost of capital. In NSW the discount rate set by the NSW Treasury in the NSW Government Guidelines for Economic Appraisal is 7% with sensitivity testing at 4% and 10%.

(g) Application of decision criteria

The most commonly used and reliable decision rule is that alternatives should be ranked according to their present value of net benefits (the NPV criterion). As long as the present value of the net benefits is positive it will be economic for society to allocate resources to the project. The alternative with the highest net present value is the most desirable in terms of economic efficiency.

A second criterion required to be reported by NSW Treasury is the benefit-cost ratio (BCR). The benefit cost ratio is the present value of the benefit stream divided by the present value of the cost stream. A BCR greater than one means that the economic benefits exceed costs for the project.

The third Treasury criterion is the internal rate of return (IRR). The internal rate of return is the discount rate that equates the present value of the benefit stream to the present value of the cost stream. If the internal rate of return is greater than the chosen discount rate then the allocation of resource is considered to be desirable on economic efficiency grounds. Where the stream of net benefits changes sign (becomes positive and negative) more than once over time, there may be more than one IRR.

The fourth criterion is NPV per dollar invested (NPVI). This is a useful means of indicating the returns that can be achieved from investment.

The BCR and IRR give reliable conclusions about whether a project is acceptable or unacceptable from an economic viewpoint but should generally not be used to rank alternatives. NPV is the most reliable criterion. The NPVI criterion is useful as a means of ranking options where there is a constraint on the overall supply of capital.

Valuing Changes in the Environment

Attempting to put monetary values on changes in the environment emphasises that the environment is not free. It also forces the decision maker to think in a rational way about the costs and benefits of alternative actions. It should also be noted that environmental values are implicit in decisions whether attempts are made to value the environment or not.

To ensure that a full and correct account of changes in environmental values is undertaken, the analyst should endeavour to measure the change in total economic value, which can be defined as follows:

Total economic value = use values + non-use values

Values may relate to use or non-use of the environment as listed below**:**

(a) Use values

- direct use values such as commercial activities, for example forestry, fisheries, agriculture and tourism, as well as non-commercial activities such as recreation
- indirect use values such as functional benefits derived from a reliance on natural ecosystems for life-support functions, through the provision of clean air, water and other resources

(b) Non-use values

- option values such as the benefit of maintaining the right to use resources without necessarily doing so. It may include future use by existing individuals or by future generations.
- quasi-option value refer to the welfare obtained from the opportunity to get better information by delaying a decision that may result in irreversible environmental damage
- vicarious use values are gained by people from the knowledge that others may be enjoying use of a natural environment. for instance for recreational activities such as white water rafting, skiing and scuba diving
- bequest values refer to the maintenance of environmental attributes for the benefit of future generations
- existence values is the satisfaction that the community derives from simply knowing that certain features of the environment such as rare species or special ecosystems exist.
- ecological function values are the value of the ecological services and functions provided by a resource. Some economists consider these values as a special category of environmental values, but they can usually be decomposed into the above categories of use and non-use values.

Environmental impacts generally fall into three categories, those which:

- can be readily identified, measured in physical terms and valued in monetary terms
- can be identified and measured in physical terms but cannot easily be valued in money terms
- are known to exist but cannot be precisely identified, measured or valued.

Appropriate techniques for the valuation of environmental impacts are described more fully in *Section 1.5*.

Care should be taken, in selecting and applying these techniques, to avoid the problem of double counting benefits and costs, especially where several techniques are used to assess different kinds of benefits and costs. Pitfalls to avoid include the following:

- Double counting changes in the predicted values of net benefits from the environment and changes in the asset value of natural capital
- Simultaneous use of the defensive expenditures method and replacement/repair cost method may result in double counting of prevention and damage costs.
- Recreation and health benefits assessed by means of the travel cost model or human capital method may be double counted with environmental benefits measured through the property value method. Recreation and health benefits may be partially capitalised in property value improvements.
- Environmental benefits assessed as CVM estimates of the willingness to pay for environmental improvement may be double counted with recreation benefits assessed through the travel cost model and/or through the property value method.

Cost-Effectiveness Analysis

The aim of cost-effectiveness analysis (CEA) is to compare the costs of different options with the same or similar outputs or performance criteria. CEA can be used to identify the project alternative that can achieve the performance criteria at least cost. The approach should be used only as a last resort and where management objectives (such as environmental

quality standards) have been established by a regulatory authority or expert group. An example might be water quality standards appropriate to different kinds of water-based activity (primary or secondary contact).

CEA can be conducted through manual search procedures (setting up tables of options and their costs), simulation modelling (exploration of options and costs through 'what if' scenarios) and mathematical programming models (for example, choosing the least-cost option of meeting fixed targets by means of integer programming or mixed linear-integer programming techniques).

Cost Trade-off Analysis

When environmental quality targets cannot easily be established, subjective judgments about the required level of environmental protection can be assisted by cost tradeoff analysis. Cost-tradeoff analysis may assist in determining acceptable levels of environmental mitigation or protection, where different levels of some kind of environmental indicator are achievable at different costs. Usually the total costs and marginal costs of abatement increase sharply as higher levels of abatement are approached. The shape of the cost curve often suggests a logical cutoff point for environmental mitigation or protection. Environmental targets are determined as part of the cost-tradeoff analysis.

Threshold Value Analysis

In cases where development and environmental preservation alternatives are mutually exclusive, where irreversible environmental impacts would be caused by development, and where there are difficulties in estimating the non-market values of development proposals, the threshold value approach can serve as a useful 'second best' way of considering resource use options. A relevant example is deciding on the use of a wild river either for construction of a reservoir or for its preservation for recreational use and wilderness values.

Threshold value analysis is based on the concept of opportunity cost. The opportunity cost of the preservation option consists of the value of net benefits forgone for the development alternative. The environmental benefits are thus not valued directly, but a reference value is provided against which the relative value of the environment may be assessed. The threshold value indicates the price that the community must be prepared to pay to justify the preservation option. This value can be measured as a capitalised value or as an annually recurring value. A more sophisticated measure, pioneered by Krutilla and Fisher, allows for differential growth rates in development benefits versus environmental benefits and calculates the required initial year's cost or payment.

Threshold values may also be applied in benefit-cost analyses involving several options with environmental effects that are difficult to measure, where the NPVs and rank order of the options are sensitive to the environmental values. Calculations can be made to determine the threshold values of environmental benefits that would be required to change the NPVs and hence the rank order of options under consideration. Decision-makers are thus able to judge whether the required willingness to pay for these environmental benefits is a reasonable basis for changing the rank order of the options.

4.4. Mitigation of impacts

A full description of the measures proposed to mitigate any adverse effects of the development or activity on the environment is a general requirement for EISs.

Mitigation measures may include those relating to project design, management practices, technologies, restoration or compensation. For example:

- With respect to project design, impact may be minimised by identifying those measures which have either been incorporated in the design of the proposed development or which may be added to the development, in order to mitigate the potential adverse impact of the development.
- Alternatively impact may be avoided by not undertaking actions or parts of actions. For example, postponing action, pending further study.
- There are instances when a technological fix may be appropriate to ameliorate environmental impacts, for example the installation of scrubbers for smoke stacks or rubber tyred dozers to reduce compaction of soil etc.
- Management practices to eliminate or reduce impacts may include operational controls and proposals for monitoring and feedback to management practices.
- Mitigation measures may also include rectifying the impact through restoration of the environment or compensating for the impact by providing substitutes.

A number of possible mitigative measures depending on the basis of the residual impact of a proposal have been identified in Table 4.

Table 4: Residual impacts and possible mitigation measures

Residual impacts	Possible mitigation measures
Associated with inefficiency	▪ modifications to the proposal to achieve higher environmental benefits and lower costs for environmental protection ▪ cost effective measures to reduce negative environmental externalities
Associated with inequities and distributive patterns on complying with governments objectives	▪ modifications so increases the share of target groups in income from natural resource use, to enhance their access to natural resources or to increase their ownership of natural resources ▪ develop social programs to compensate target groups for deteriorating income or access opportunities related to natural resources
Associated with non-sustainable resource use	▪ modify the design to reduce uses of natural resources ▪ modify project or initiate an additional project to compensate for the use of resources by the original project by creating natural or man-made capital else where

Source: Van Pelt: 254.

Economic techniques such as CBA and CEA can be helpful in identifying the most economically efficient environmental protection or mitigation measures. Once the appropriate mitigative measures are identified and incorporated into the project proposal
the costs and benefits of these would be reflected in the economic efficiency analysis undertaken of the proposal.

5. Conducting other economic assessments

5.1. Assessment of Economy-Wide Effects

If a proposal is predicted to have significant economic impacts at the regional or State scale, it is appropriate to assess these economy-wide effects. For example industries which are large in scale relative to the scale of the regional economy such as major new coal mines or major forestry operations with associated timber processing operations or major infrastructure projects such as a major new irrigation dam which could significantly change the regional economy. These impacts can be assessed by means of a multi-sectoral or input-output model which identify regional impacts in terms of changes in the value of output for separate sectors of the regional economy, as well as changes in value-added, income and employment.

Multi-sectoral or input-output model

Construction of regional input-output tables is usually an expensive and time-consuming task. At the outset, the economic boundaries for the assessment (regional, State or national) should be identified as well as the linkages between the project and the economy. Tables are derived from primary data collation or through the application of short-cut methods such as the 'rows only' method or through the GRIT (Generation of Regional Input-Output Tables) procedure developed by the University of Queensland.

Regional economic impacts are assessed by conducting simulations of changes in the regional economy using the input-output model or by means of multipliers derived from the input-output model. Type I multipliers capture the indirect production effects within the regional economy, while Type II multipliers incorporate indirect production and induced consumption effects. Impacts can be estimated separately for the capital construction phase and the normal operating phase of development projects. References listed at the end of the chapter explain how input-output multipliers can be calculated and applied.

Where an input-output table is not available, analysts commonly draw on multipliers from 'similar' regions to estimate economic impacts. While the careful borrowing of multipliers may provide indicative estimates, the practice should be viewed with caution. It is a matter of judgement as to whether two regions are basically similar in their size and economic structure.

It is important not to confuse the results of an input-output analysis, which focuses on direct and indirect output (expenditure/revenue), value-added, income and employment, with estimates of benefits and costs in an economic efficiency analysis. Income and expenditure comprise transfer payments between individuals within the economy. Changes in employment and income predicted to result from a development proposal may simply represent a re-allocation of resources within a region, so that what is lost by one party is simply gained by another. Gains often reported in employment from a new project or losses of employment from cessation of some activity, may not comprise a net increase or loss of jobs to society but a transfer of jobs from one location or position to another.

Nevertheless, where otherwise unemployed labour resources within a region can be shown to be productively employed as a consequence of a new development, this can be regarded as an improvement in the efficiency of resource use and welfare level of the community. The net effects of the development proposal should be estimated by comparing the 'with-project' and 'without project' situations.

Other models

Other kinds of models may also be used to assess the regional economic impacts of development proposals. These include computable general-equilibrium models that contain consumption preference functions, production functions, factor supplies and trading conditions. Such models assess the economy-wide effects of a 'shock' to a pre-defined baseline situation, such as a development proposal. These models are usually complex and expensive, but have the advantage of simulating price changes and substitution effects in consumption, production and trade.

Another approach to regional impact assessment is to construct and apply Keynesian macro-models at the regional scale, including the calculation of investment and autonomous consumption expenditure multipliers. Keynesian models generally do not provide sufficiently detailed information to be of much use in assessing the economic impacts of development projects.

5.2. Secondary or cumulative economic-environmental impacts

Cumulative impacts may pose a serious threat to environmental sustainability. Such impacts can take various forms:

- the accumulation of non-assimilated substances in the environment, such as phosphorus in waterways
- bioaccumulation of substances within organisms at different trophic levels in food chains
- the totality of impacts arising from the overall impact of multiple development projects within a region or locality
- direct and indirect impacts on the environment resulting from linkages among activities, such as air quality impacts arising from a coal/power generation/aluminium smelting production chain

The ongoing accumulation of substances in the environment or in organisms should be identified in the time profiles of environmental impacts and valued accordingly. Reference to relevant economic research or previous EISs on similar proposals may provide information on the likely indirect regional environmental impacts of particular types of economic activity or development.

Generalised environmental input-output models may also be used to assess indirect environmental impacts, especially those associated with production linkages within regions. Such models are particularly useful for the estimation of total emission loads or requirements for inputs to production such as water resources. Other impacts may result from the likely induction of ancillary industry or activities, changes in income distribution and implications for infrastructure and government services investment. The extent and importance of economic linkages between the proposal and the regional economy will provide an indication of the importance and hence the required assessment of secondary or indirect impacts.

5.3. Fiscal Impact Assessment

Where a development proposal is likely to have a substantial effect on the budgets of local, State or Commonwealth Governments, fiscal impact assessment may be undertaken as one aspect of an economic impact analysis. In addition it may also be relevant when there is a BOO(T) project (Build Own and Operate (Transfer) for major infrastructure projects such as freeways, sewage treatment plants or water treatment plans and part of the EIS is justifying the role of private operators.

As part of the analysis, all government agencies involved (local, State and Commonwealth) should be identified and the relationship of project to agencies specified along with the cost and revenue implications for agencies. Estimation of fiscal revenue impacts can be undertaken through methods such as:

- property tax estimation
- income and sales tax estimation
- production and severance taxes
- population-related taxes and charges
- inter-governmental transfers

Estimation of fiscal expenditure impacts can be undertaken using the following methods:

- per capita expenditure method
- service standard method
- cross-sectional regression methods
- the case study method
- the comparable city method
- the economic engineering method

Any economic efficiency results should be incorporated in the benefit-cost analysis.

5.4. Financial appraisal

Financial appraisal in the context of EIA, is more likely to be undertaken for public sector projects. However it may be appropriate:

- where there are financing implications of public or private sector proposals proceeding, such as the application of levies, tolls, increased rates or other user pays mechanisms.
- where there are concerns regarding the possibility of transfer pricing occurring with private sector projects
- where there are concerns regarding financial failure of private or public sector projects and the associated environmental, social and economic impacts that may result.

The financial appraisal should be undertaken using discounted cash flow analysis or some other approach. The financial viability of proposal or proposal options should be considered, if relevant taking into consideration the implications of pricing.

Any economic efficiency results identified in undertaking the financial analysis, should be incorporated in the benefit-cost analysis. Results from this analysis may also need to be considered with regard to distributional and equity issues.

6. Addressing ESD

The four principles of ESD identified in Schedule 2 of the Regulations to the EPA Act essentially reflect the themes of risk minimisation, efficiency, equity and environmental integrity. Techniques for dealing with these four principles in the integrated assessment are discussed in the following sections.

6.1. Improved valuation and pricing

One of the major reasons for degradation of the environment is that market failure tends to result in environmental goods being free or undervalued and consequently overused. Economic efficiency requires that environmental costs and benefits are internalised. If this is done, the true economic value of natural capital will become an integral aspect of the economic analysis. An outline of techniques for the valuation of environmental goods and services is provided in *Section 1.5*.

Deriving such values and undertaking economic efficiency analysis is a necessary but not sufficient outcome to achieve sustainable development.

The goal of improved valuation of natural capital has been included in Agenda 21, Australia's Intergovernmental Agreement on the Environment and the National Strategy for Ecologically Sustainable Development (see below).

Improved Valuation of Natural Capital
Agenda 21
Agenda 21 'calls for countries to improve their valuations of the environment in order to:

- incorporate environmental costs in the decisions of producers and consumer, to reverse the tendency to treat the environment as free goods and pass the costs on to other parts of society, other countries, or to future generations.
- move more fully towards integration of social and environmental costs into economic activities, so that prices will appropriately reflect the relative scarcity and total value of resources and contribute towards the prevention of environmental degradation.' (EPA 1993, p. 5).

Australia's Intergovernmental Agreement on the Environment
This agreement includes 'mandates for improved valuation and pricing. The document indicates that future policy making and program implementation should be consistent with the following principles:

- inclusion of environmental factors in the valuation of assets and services
- polluter pays, ie. those who generate pollution and waste should bear the costs of containment, avoidance or abatement
- pricing of goods and services should be based on the full life cycle of costs including use of natural resources and assets and the ultimate disposal of any wastes.' (EPA 1993, pp. 5-6)

National Strategy for Ecological Sustainable Development
This strategy 'recognises the need for incorporating environmental externalities into pricing and market mechanisms, and environmental resource values into pricing policies. It includes an objective to ensure that adequate attention is given to social and environmental costs when assessing economic use of pricing, taxation and other economic instruments.' (EPA 1993, p. 6)

6.2. Applying the Precautionary Principle

Risk and uncertainty are encountered in most economic assessments of projects or their options because of difficulties in predicting the nature and operation of a project, valuing all inputs and outputs, and in predicting and valuing its environmental impacts. It is common for unanticipated environmental events to affect a development.

Application of the precautionary principle has a range of implications in an economic analysis. The main purpose for observing the principle is to minimise the risk of serious or irreversible damage to the environment. This rule is based on the premise that many of the potential benefits of the natural environment may be unknown, and it is prudent (and ethical) to keep options open for current and future generations.

Economic analysis is capable of producing information on the trade-offs between risk and different levels of potential damage.

Risk occurs where the probability distributions of causative or response variables are known. Risk can be defined as the probability and magnitude of an adverse event occurring. Probability distribution can be used to estimate the risk of occurrence of adverse events. Risk assessment requires the identification of the characteristics of likely adverse events and the corresponding probabilities and an assessment of the community's attitudes to the risks, and their preferences in the management of the risks.

Risk can be accommodated in a benefit-cost analysis by conducting a Monte Carlo simulation. This technique assumes that probability distributions are known for input variables to the analysis, and generates a probability distribution for net benefits. The use of a risky (higher) discount rate is not recommended as a way of dealing with risk. If decision-makers are risk neutral, expected values (arithmetic means) are the estimates that should be incorporated in a benefit-cost analysis. Allowance should be made for risk aversion, which typically applies to environmental impacts, and is encompassed in the precautionary principle.

Uncertainty is characterised by a lack of information on probabilities. Economists are dependent on the predictive ability of other specialists to estimate the likely nature and scale of social, ecological and physical impacts prior to estimating the potential economic effects. As a result, economic assessment is exposed to all the uncertainties of other assessment methodologies as well as those inherent in the economic predictive, analytical and valuation methodologies.

When uncertainty is encountered in an economic appraisal, the most commonly applied technique is sensitivity analysis. This involves changing the values of critical environmental variables in the analysis, to determine how the results might be affected. Even after 'best case' and 'worst case' scenarios have been simulated, the results (eg ranking of alternatives) might not differ. Where the results are sensitive, this gives a strong indication of where more research could be undertaken to improve the quality of information. In addition, especially where there is uncertainty, it is possible to incorporate other decision criteria such as safe minimum standards and assess the opportunity costs or threshold values that may be involved in meeting them. In other words, economic efficiency may be maximised in conjunction with the fulfilment of specific measures to protect the environment. Other methods of dealing with uncertainty

include decision analysis models and adaptive environmental assessment and management.

6.3. Intra- and inter-generational equity

Intra-generational equity can, in principle, be accommodated within a benefit-cost analysis by applying explicit weights to the benefits and costs incurred by different groups affected by a development proposal. However, it is not the place of economists to judge the relative importance of different groups in society. Such judgements are usually left to the political process. Therefore, in practice, weighted benefit cost analysis is not recommended and instead matters relating to distributional effects are usually left to the political process. However, political judgements can be informed by approaches that identify the distributional consequences of alternatives such as regional or State–wide impact assessment methods, financial and fiscal impact assessments, a distributional incidence matrix, social impact assessment or a simple qualitative consideration of distributional issues.

Addressing concerns about inter-generational equity raises complex questions about use of the social discount rate. There are basically two rationales for discounting of future streams of costs and benefits to present values in a benefit cost analysis:

- People prefer the present to the future because of impatience, risk of death, uncertainty about the future, and diminishing marginal utility of consumption (this reflects the social rate of time preference).
- There an opportunity cost of capital, comprising the benefits forgone in other avenues of investment elsewhere in the economy. The discount rate is a measure of the opportunity cost incurred.

Environmentalists often maintain that discounting in economic analysis is inconsistent with the notion of sustainable development. Reasons given for this include the arguments that:

- discounting future costs and benefits results in insufficient regard for future generations
- discounting encourages the extinction of resources.

To address this concern environmentalists have sought a reduction of the discount rate, in some cases to zero. In other instances environmentalists have sought an increase in the discount rate to reflect the risk and uncertainty associated with the environmental repercussions of investments.

For both practical and logical reasons neither approach is generally supported by economists, for the following reasons:

- use of a zero discount rate raises practical difficulties as it implies an infinite planning horizon.
- often the economic feasibility of projects and ranking of alternatives is not sensitive to the discount rate.
- the effect of the discount rate on the environment is ambiguous, as low discount rates may result in greater consideration being given to long-run environmental benefits and costs but may also lead to higher rates of investment and economic development, resulting in increased impacts on the natural environment.
- adjusting the discount rate is an inefficient means of accommodating the problem of risk and uncertainty and of meeting the objective of intergenerational equity.

It is generally considered that problems of inter-generational equity is best dealt with by evaluative approaches such as:

- improved valuation of future costs and benefits, including external environmental costs and benefits
- improved approaches to the problems of risk and uncertainty
- introduction of an external constraint such as a safe minimum standard to the economic analysis
- application of multi-criteria analysis to address the multiple objectives associated with sustainable development.

6.4. Protection of Ecosystems and Biodiversity

Environmental criteria should be considered in circumstances when governments do not favour an unlimited trade-off between environment and other welfare determinants. They may also be considered when markets do not lead to environmentally acceptable outcomes, and/or environmental policies cannot be implemented effectively. Individual projects may then be considered a tool to achieve environmental objectives.

Environmental criteria may include:

- objectives to maximise environmental protection or improvement (eg safe minimum standards or environmental shadow projects)
- constraints on the use of natural resources that are related to key parameters for sustainability such as spatial and time factors and the scope of trade-offs between natural and man-made resources. Constraints may include those on the harvesting of renewable resources eg. harvesting at rate that is less than or equal to the natural rate at which they regenerate, or relate to other responsibilities and obligations such as those embodied in codes of practice.

6.5. Application of Multi-Criteria Analysis

Sustainability is a multi-attribute concept, involving criteria such as economic efficiency, ecological integrity, prevention of irreversible damage and inter- and intra- generational equity. A useful means of conducting comprehensive and integrated assessments of sustainability, after an economic assessment has been completed, is multi-criteria analysis.

Options evaluated for sustainability within an MCA may refer to different development alternatives, different project designs or different environmental management regimes and mitigation measures for environmental protection or enhancement. MCA may also be used to determine whether changes resulting from a particular development proposal, occurring in future years, can be expected to move the economy closer to or further away from sustainability.

The relative importance of criteria in an MCA is represented by criterion weights. The weights may be elicited from technical experts, community representatives or decision-makers themselves. Various mathematical methods and elicitation processes (including Delphi) may be used to derive weights. These weights perform a similar function to the values in a benefit-cost analysis, but may include value judgements relating to other objectives.

Once the basic data and decision weights are entered into the MCA framework, appropriate mathematical formulae are then applied (depending on the type of MCA model) to evaluate and rank the options.

The use of MCA, including results from an economic efficiency analysis, is considered to be a sensible and practical way of evaluating proposals, taking into account the principles and criteria for sustainable development. Nevertheless, careful interpretation of any MCA is necessary as there may be various overlaps, within the MCA, between matters addressed in the economic efficiency analysis and matters relating to other aspects of sustainability.

The main challenge in using the MCA method is to identify which options, which criteria and whose value weights are to be taken into account when setting up the evaluation framework and deriving the results. The success in using MCA depends as much on the processes of defining the decision problem and ensuring that representative community values are incorporated in the analysis as on the mathematical specifications of the calculations undertaken.

7. Presentation of information in the EIS

To facilitate understanding by the decision makers and the public, economic information in an EIS should, as far as possible, be presented in plain English. The use of summary tables and graphs where appropriate, may assist understanding by the reader. Detailed analysis, more relevant for the technical specialist, including underlying assumptions, calculations, techniques, applied and sources of information, should be provided in supporting reports or in appendices.

When presenting the information the following should be considered (James 1994):

- all assumptions underlying the economic analysis should be stated
- where possible information and analysis should be presented succinctly in charts, diagrams, details of model simulations, base-case benefit-cost calculations and sensitivity studies
- where a benefit cost analysis has been conducted, impacts that could not easily be valued should be presented in descriptive form alongside the measured economic effects
- an account should be given of the economic techniques used, together with sources of data
- any reservations about limitations of the methodology or accuracy of the results should be indicated.

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