CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

Water Valuation Guidance Document

PN 1443
ISBN 978-1-896997-92-6 PDF

Acknowledgement

This guidance document was authored by WorleyParsons Canada Ltd. and Economics for the Environment Consultancy Ltd and edited by CCME's Water Agenda Development Committee and its Water Valuation Sub-group. The time and expertise of those who have helped in the formulation of this publication are gratefully acknowledged.

EXECUTIVE SUMMARY

Introduction

This 'Water Valuation Guidance Document' was commissioned by the Canadian Council of Ministers of the Environment (CCME) Water Agenda Development Committee (WADC). It is a Canada-wide reference document for water resource decision-makers – in federal, provincial and territorial government, Aboriginal groups and local municipalities and boards – to help establish how water valuation can assist in addressing water management issues, particularly in relation to conservation actions, infrastructure investment, water quality standard setting, water pricing, water allocation and compensation for use or damage.

Information about the value of the natural environment, its component resources, and the range of goods and services it provides is increasingly being used by policy makers. Understanding these values can lead to better informed decisions. There are different types of "value" – including economic, cultural, spiritual and traditional values, as well as intrinsic value (i.e. value in its own right). When addressing a particular issue, it is important to consider all values that are relevant.

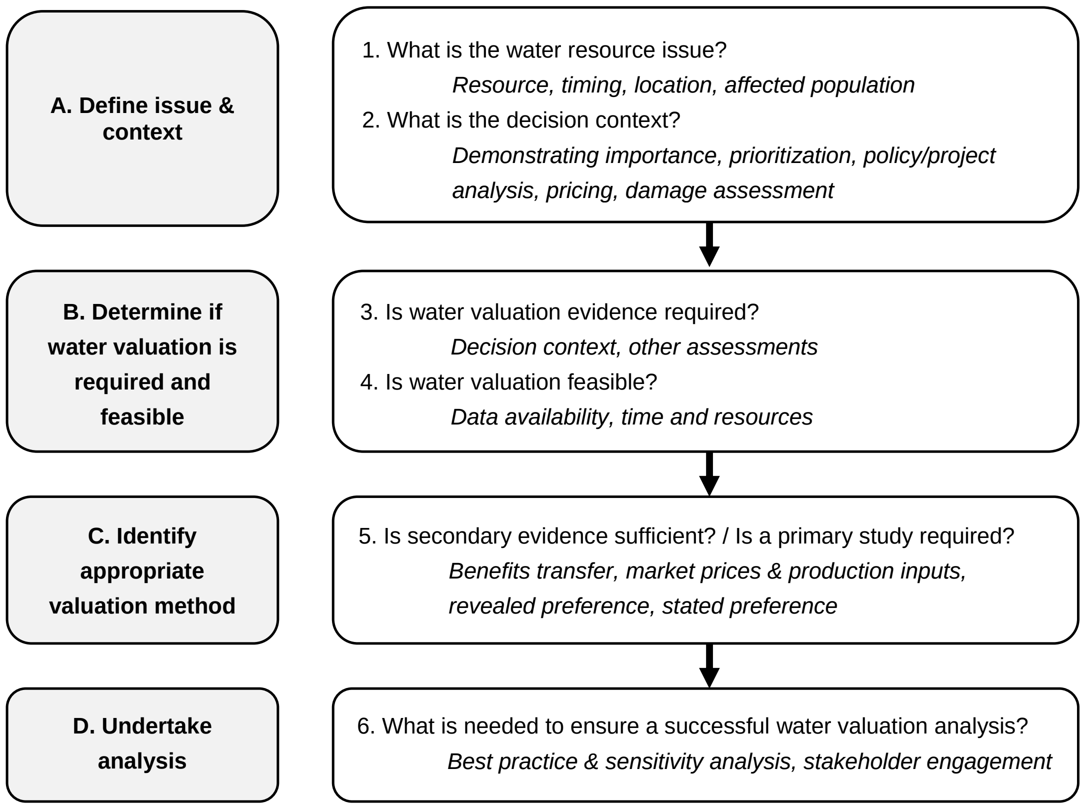
The guidance document is focused specifically on the application of water valuation and is intended to enable users to integrate water valuation into decision-making. This requires that water resource managers identify situations in which valuation evidence can assist and improve decision-making. This includes establishing the extent of evidence required and the most appropriate approach to valuation given time and resource constraints. While advice should be sought from specialist valuation experts, it is water resource managers who are best placed to formulate the decision context and interpret the outcomes and any limitations of the analysis for the purpose of informed decision-making.

Often the economic value of water is of particular interest for decision-making because economic values about other aspects of an issue are often available and it would be helpful to be able to compare the economic values of the different aspects of the issue. The document provides guidance for determining the economic value of water, accounting for both the use of water (e.g. household water supply, irrigation for agriculture, etc.) and the ecosystem services provided or supported by water resources (e.g. nutrient cycling, habitat provision, recreation, etc.). 'Valuation' is also commonly referred to as monetization, since the purpose of valuation is often to assign a monetary value – i.e. a dollar amount – to a change in the provision of commodity or service. There is a variety of so called valuation methods that are used to gather and interpret water valuation evidence and their potential role for informing water management decisions is discussed in the document.

Guidance documents are often (but mistakenly) desired to be prescriptive about the appropriate approach for any given situation. The scope of water valuation in terms of the issues it can address and the decision-making contexts it can inform is too broad and varied to prescribe a 'fit-for-all' list of approaches. Instead, the aim is to set out a framework within which water resource managers can systematically review key questions in order to identify an appropriate course of action that fits each case.

The framework is illustrated in **Figure ES.1** and six key questions to review are addressed in the remainder of this summary.

Figure ES.1: Integrating water valuation into decision-making



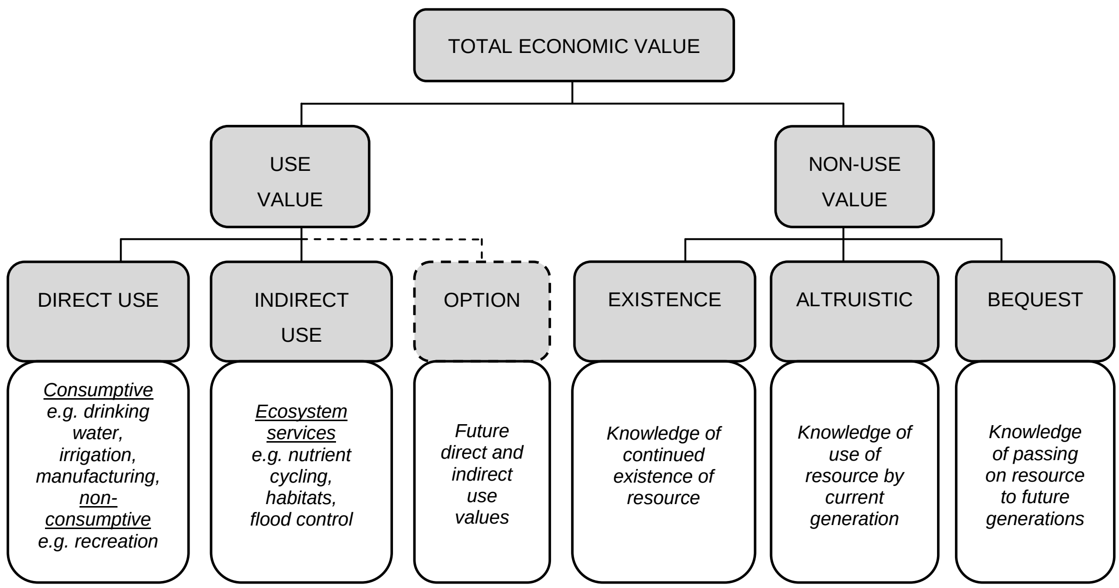
Defining the issue and context for water valuation

1. What is the water resource issue?

Broadly, water resource management is concerned with issues relating to the quantity of water, its quality, its location and/or the timing of its availability. Within this context the breadth of water management issues faced by jurisdictions can be wide ranging. Establishing the context for water valuation entails answering four fundamental questions: (i) what resource is affected; (ii) what is expected to change; (iii) where and when will the change happen; and (iv) who will the change affect and how?

A useful classification for understanding water valuation and who may be affected by changes in the water environment and supply is that of total economic value (TEV)[i]. As detailed in **Figure ES.2**, the TEV framework distinguishes between use value and non-use value.

Figure ES.2: Total economic value of water



Use values relate to current or future uses of a resource. Direct use values may be ‘consumptive’ (e.g. irrigation for agriculture) or ‘non-consumptive’ (e.g. many water-based recreational activities), while indirect use values encompass the role of water in the provision of key ecosystem services (e.g. provision of habitats, flood protection, etc.). Non-use values are not related to current or future use but are derived from knowledge that natural resources continue to exist (existence value), or are available for others to use now (altruistic value) or in the future (bequest value).

2. What is the decision context?

Two general decision contexts within which water valuation can play a role in addressing water management issues are:

i) *Appraising or evaluating policy or project (investment) decisions where trade-offs between use(s) of water and/or services supported by it are evident* – this includes policy and project analysis, water pricing and water allocation, and ‘demonstrating the importance of an issue’.

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[i] For further explanation of the TEV framework see Section 2.2 of the main document.

ii) *Assessing damages*: where evidence is required for assessing compensation for use of water or environmental damages for legal damage assessments.

Within these there are various decision-making questions that water resource management may seek to address (**Table ES.1**).

Table ES.1: Typical decision-making context for water valuation

Decision context	Typical decision-making questions for water resource management
Policy and project analysis issues (including demonstrating the importance of an issue; setting priorities; appraisal of investment projects, policies, regulations and standards)	Is a project or policy warranted? Which project or policy should be chosen among a set of alternatives? How can comparable projects and policies be ranked in order of 'worth'? On what scale should a policy be implemented? What is the appropriate standard or target for a policy measure? How much should be spent on best management practices? Is there a case for conservation actions?
Pricing and allocation issues	What is the appropriate level of a user tariff? What uses should water be allocated to?
Legal damage assessment	What is the value of environmental damages? What scale of compensation for damage is justified?

Determining if water valuation is required and feasible

3. Is water valuation evidence required?

Water valuation is not a necessary pre-requisite for decision-making. In assessing whether water valuation evidence is required, a key question to answer is *how would water valuation improve the decision made in a given situation?* This will depend on various considerations but generally:

- If the decision-making context is one of <u>demonstrating importance of an issue</u>, water valuation evidence ordinarily would improve the case made for the water management issue in question. Whether this is necessary depends on how successful other types of evidence are in demonstrating the importance of the water management issue. This is particularly useful in the context of an overall appreciation of the monetary values assigned to other resources, assets or damages involved in the discussion. In this context, the value of water can be compared on a like for like basis with other environmental, social and market goods.

- If the decision-making context is <u>policy or project analysis</u>, the requirement for water valuation depends on the analysis method used. If the context is one of appraisal or evaluation (e.g. via cost-benefit analysis or multi-criteria analysis) then water value evidence is more likely to be needed.

- If the decision-making context is one of water pricing or water allocation, water valuation is not necessarily a pre-requisite for policy formulation but is likely to be required if the objective is to identify the 'optimal' outcome in terms of economic efficiency.

- If the decision-making context is one of legal damage assessment, water valuation evidence may be a legal requirement depending on the liability regime.

4. Is water valuation feasible?

Practical considerations are also highly relevant in determining the scope for water valuation both in terms of whether it can be a realistic undertaking and which valuation method(s) can be applied. The following factors determine the feasibility of any valuation application:

- *Data availability*: Application of valuation methods requires some form of quantitative or physical data on the change in provision of interest (e.g. quantity of water, bio-chemical quality, size of user population affected and so on). Where there are gaps or uncertainty in physical data it may be necessary to first undertake scientific or other impact studies to provide a sound basis for subsequent water valuation.

- *Time and resources*: Ideally the objective of water valuation will be accounted for at the outset of any decision-making situation. This permits the overall process to allow time for sufficient evidence (both scientific and economic) to be collated. Often though, this is not the case and water resource managers can be faced with timeframes that will preclude some water valuation methods. In addition different valuation methods require different financial resources to undertake them and budget constraints will also determine their feasibility[ii].

Identifying the appropriate valuation method

When determining the valuation method to use, the key consideration should be to identify the valuation method that is most appropriate to the decision-making question and the evidence needs. Economic valuation methods differ in the type of economic value they can estimate (i.e. the components of TEV) and in the type of data they use. Given a decision context and the feasibility factors mentioned above, a single valuation method or a combination of methods could be recommended. Similarly, there is a choice to be made between commissioning primary study research and using (secondary) evidence from available literature.

5. Is secondary evidence sufficient? / Is a primary study required?

Primary study refers to an original study that is specifically designed to assist the decision-making context of concern. Primary study methods and the evidence they can generate are

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[ii] Indicative timescales and person-day inputs for different valuation methods are provided in Section 4.

summarized in the main guidance document and include: market price methods, production input methods, revealed preference methods and stated preference methods[iii].

When time and financial resources needed for primary study are not available, the process of benefits transfer provides an alternative approach to make use of secondary evidence. The basic process entails identifying appropriate value evidence from the results of existing studies and 'transferring' these to the decision-making context of interest.

While benefits transfer analysis can be quicker and cheaper, the resulting water value evidence may not be sufficiently accurate for decision-making in some instances. Specifically, estimates of the value of water in a particular use and location often do not accurately reflect the value of the same use in a different location. However in some cases, detailed sensitivity analysis can overcome this shortcoming. Overall, determining whether primary study is required or secondary valuation is sufficient depends on:

i) *The availability of existing evidence*: benefits transfer is not possible if existing studies are not relevant to the decision-making context of concern; and

ii) *The degree of accuracy in evidence required for decision-making*: benefits transfer is unlikely to be suitable where a high degree of accuracy is required (e.g. in instances of significant policy/project outcomes or expenditure).

Table ES.2 summarizes the scope of different economic valuation methods in relation to the potential role of water valuation in different water resource management decision contexts.

Undertaking water valuation analysis

The decision-making context, the scale of policy or investment expenditure, legal requirements and time and resource availability should determine the approach and the degree of effort that should be expended for water valuation in a given situation. Where it is determined that water valuation evidence is required and analysis is feasible, a further issue to understand is that valuation methods themselves are subject to continued development and improvement by practitioners, with the 'state of the art' often moving quite rapidly for particular methods.

6. What is needed to ensure a successful water valuation analysis?

Given the above considerations the following should be taken into account with respect to undertaking water valuation studies:

- *Best practice and sensitivity analysis*: Overall, the task is to ensure that analysis is implemented rigorously and robust evidence is generated. This relates to the transparency of the analysis and recognizing the key assumptions, uncertainties and limitations associated with water valuation evidence that is generated. Additionally peer review input

[iii] See Section 4 and also Annex 1 for greater detail.

and steering group oversight should be considered integral to undertaking water valuation.

- *Stakeholder involvement*: A key aspect of integrating water valuation into water resource decision-making is ensuring the approach gains acceptance among all stakeholders involved in the process. Stakeholder involvement can assist in providing technical input and an external validation of analysis and results, as well as establishing the scope of the analysis and issues to be addressed.

Table ES.2: Summary of scope of economic valuation methods in different water resource management decision contexts

Water resource management context*	**Role of water valuation**	**Market price approaches**	**Production input approach**	**Revealed preference methods** (e.g. hedonic pricing, travel cost)	**Stated preference methods** (e.g. contingent valuation, choice modeling)	***Suitability of benefits transfer***
Conservation actions	Estimating the monetary value of benefits/costs associated with conservation/degradation of (environmental) resources	Proxy for use value as far as actions influence availability of water as a commodity	Use value where water is an input to production which benefits from actions	Use value if actions affect (perceivable) amenity values and/or recreation activities	Use and non-use value associated with actions	*Likely to be suitable for actions affecting relatively small provision changes and/or impacts where a greater degree of uncertainty in evidence can be accommodated*
Infrastructure investment	Estimating monetary value of project outcomes (e.g. costs and benefits)	Proxy for use value but only likely to be suitable for relatively small provision changes	Use value where the project affects water as an input to production processes	Use value if the project affects (perceivable) amenity values and/or recreation activities	Use and non-use value associated with project outcomes	*Likely to be suitable for projects affecting relatively small provision changes and/or impacts where a greater degree of uncertainty in evidence can be accommodated*
Water quality standard setting	Estimating monetary value of changes in water quality (e.g. benefits of reduction in health risk from an improvement in quality)	Proxy for use value but only likely to be suitable for relatively small changes in water quality and providing a minimum estimate of benefits	Use value where the change in water quality affects water as an input to production processes	Use value if the change in water quality affects (perceivable) amenity values and/or recreation activities	Use and non-use value associated with changes in water quality	*Likely to be suitable for relatively small changes in water quality where a greater degree of uncertainty in evidence can be accommodated*
Water allocation	Estimating monetary value of marginal changes in the provision of water	Proxy for use value but only likely to be suitable in cases of relatively small changes	Change in use value where allocation affects water as an input to production processes	Use value in location-specific cases where allocation affects supply of water to a site or amenity and/or recreation activities	Use and non-use value associated with change in allocation between uses	*Unlikely to be suitable where requirement for accuracy in evidence is high*
Water pricing	Estimating monetary value of marginal changes in the provision of water due to pricing policy (charge, fee, tax, etc.)	Unlikely to provide suitable evidence for establishing level of price	Cannot provide evidence for establishing price level but can analyze impact on use value of change in price	Use value evidence for establishing the level of price to account for (perceivable) impacts on environmental amenity	Use and non-use value evidence for establishing the level of price to account for social and environmental impacts	*Unlikely to be suitable where requirement for accuracy in evidence is high*
Compensation for damage or use	Estimating monetary value of impacts from abstraction, use, consumption or pollution of water resources	Minimum estimate of use value for compensating the loss of water as a commodity	Use value associated with damages due to water not being available as an input to production	Use value in location-specific cases where damages are readily perceived as an element of amenity or recreation activities	Use and non-use value associated with damages	*Unlikely to be suitable where requirement for accuracy in evidence is high*

Notes: Use value is associated with direct or indirect interaction with a resource; Non-use value is not associated with current or future use but with the knowledge that resource is conserved.
* See main document - Table 3.1 links water resource management contexts (e.g. conservation actions, infrastructure investment, water quality standard setting, water allocation, water pricing and compensation for damage and use) to decision-making contexts (demonstrating the importance of an issue, setting priorities, project analysis, policy analysis, establishing the basis for charges or taxes, legal damage assessments and green accounting).

Conclusion

This guidance document is intended to assist water resource managers in identifying situations in which water valuation evidence can improve decision-making. This requires not only a basic understanding of the concepts of water valuation and the different methods that can be applied, but also a clear understanding of the decision context and recognition of practical considerations that determine the scope for water valuation.

The framework for integrating water valuation into decision-making (Figure ES.1) sets out six key questions that should be reviewed in order to identify an appropriate course of action in a given situation. The main guidance document expands upon the content of this summary and the principles that are highlighted in order to assist users in addressing each of the key questions.

TABLE OF CONTENTS

1. INTRODUCTION

This **Water Valuation Guidance Document** was commissioned by the Canadian Council of Ministers of the Environment (CCME) Water Agenda Development Committee (WADC). The guidance document is intended as a **Canada-wide reference document** for water resource decision-makers to help establish how water valuation can assist in addressing water management issues, particularly in relation to conservation actions, infrastructure investment, water quality standard setting, water pricing, water allocation and compensation for use or damage.

Development of the guidance document follows from the WADC identifying water valuation as a priority issue. A Canada-wide reference document can build on limited Canadian water valuation experience to date and draw from a substantial body of international work to demonstrate how water valuation can be integrated into decision-making. A brief summary of the use of water valuation in other international jurisdictions is provided in **Box 1.1**.

1.1 Objective of guidance document

The objective of the guidance document is to establish how water resource decision-making can be aided by water valuation information and evidence. The intended 'users' of the guidance document are decision-makers in federal, provincial and territorial government, Aboriginal groups and local municipalities and boards.

Information about the value of the natural environment, its component resources, and the range of goods and services it provides is increasingly being used by policy makers. Understanding these values can lead to better informed decisions. There are different types of "value" – including economic, cultural, spiritual and traditional values, as well as intrinsic value (i.e. value in its own right). When addressing a particular issue, it is important to consider all values that are relevant. For making decisions about specific policy issues, it is generally values pertaining to relatively small changes in the environment that are relevant rather than values of the total environment. Also, it is often the economic values related to changes in the environment that are of particular interest because economic values about other aspects of the issue are often available (e.g. values related to economic activity that would result from a proposed project), and it would be helpful to be able to compare the economic values of the different aspects of the issue.

The guidance document is focused specifically on the application of ***water valuation.*** Identifying the appropriate approach to water valuation in a given situation will depend on the water management issue of interest and the decision-making context. A series of practical considerations are also relevant in determining how and what water valuation information should be generated. These issues are addressed within the guidance document. In addition, guidance is provided for determining the ***economic value*** of water in a particular use and location, taking into account both the use of water (e.g. household water supply or as an input to production processes) and the ecosystem services provided or supported by water resources (e.g. nutrient cycling, habitat provision, recreation, etc.).

The concept of economic value has a precise meaning and a variety of methods are available to estimate the economic value of water. 'Valuation' is also commonly referred to as ***monetization***, since the purpose of valuation is often to assign a monetary value – i.e. a dollar amount – to a change in the provision of commodity or service.

Overall, the guidance document is intended to enable decision-makers to determine: (i) how and when water valuation might be appropriate; (ii) which valuation method(s) should be applied; and (iii) how to interpret water valuation evidence. Application of valuation methods can be challenging and specialist valuation experts should be involved in undertaking analysis. This document provides helpful guidance for valuation practitioners, but they will generally require more in-depth technical information than is provided in this document to ensure appropriate application of the valuation methods.

Box 1.1: Application of water valuation in other jurisdictions – the European Union Water Framework Directive

While Canadian experience with water valuation as an input to water policy has been limited, its use has been more prominent in other jurisdictions such as the European Union (EU). The EU Water Framework Directive (WFD) calls for the application of economic principles, methods (including water valuation) and instruments (e.g. water pricing) in order to achieve 'good ecological status' for all water bodies across European river basins and to encourage sustainable water use. Water bodies include lakes, rivers, coastal waters, artificial and heavily modified water bodies (e.g. canals and reservoirs), and groundwater.

A particular application for water valuation under the WFD is to estimate the benefit of measures to improve the status levels of water bodies. Specifically the WFD allows for derogations from the general requirement to reach good ecological status in cases where the costs of doing so can be shown to be 'disproportionate'. In some EU Member State jurisdictions the assessment of disproportionate costs has been interpreted as requiring a comparison of the costs of measures to the benefits of measures, as estimated via the use of economic valuation methods. Where costs are demonstrated to be 'disproportionate' (i.e. costs outweigh benefits), the WFD allows for a longer time frame to achieve good ecological status or for a less stringent environmental objective to be met.

1.2 Structure of guidance document

Integrating water valuation into decision-making

Integrating water valuation into decision-making requires that water resource managers identify situations in which valuation evidence can assist and improve decision-making. This includes establishing the extent of evidence required and the most appropriate approach to valuation given time and resource constraints. While advice should be sought from specialist valuation experts, it is water resource managers who are best placed to formulate the decision context and interpret the outcomes and any limitations of the analysis for the purpose of informed decision-making.

Guidance documents are often (but mistakenly) desired to be prescriptive about the appropriate approach for any given situation. The scope of water valuation in terms of the issues it can address and the decision-making contexts it can inform is too broad and varied to prescribe a 'fit-for-all' list of approaches. Instead, the aim is to set out a framework within which water resource managers can systematically review key questions in order to identify an appropriate course of action that fits each case.

Figure 1.1 sets out a basic framework for water resource managers to follow, where the 'key steps' are presented as a series of questions to review that are intended to establish the scope and requirements for water valuation. This includes practical considerations as to the feasibility of undertaking valuation, identifying the appropriate valuation method, and ensuring subsequent analysis fulfils the requirements for decision-making.

An ex-post demonstration of applying the framework for integrating water valuation into decision-making presented in **Figure 1.1** is provided in **Box 1.2**.

Figure 1.1: Integrating water valuation into decision-making

A. Define issue & context	<u>1. What is the water resource issue?</u> • What resource(s) is affected • What is expected to happen • Where and when will it happen • Who will it affect and how	*See:* *Background to water valuation (Section 2.1-2.3)* *Water resource management issues (Section 3.1)*
	<u>2. What is the decision context?</u> • Demonstrate importance of issue • Setting priorities • Policy/project analysis • Establishing basis for charge or tax (pricing) • Legal damage assessment • Green accounting	*See:* *Decision-making contexts (Section 3.2)*
B. Determine if water valuation is required and feasible	<u>3. Is water valuation evidence required?</u> • Decision context • Other assessment methods	*See:* *Determining the scope for water valuation (Section 3.3)*
	<u>4. Is water valuation feasible?</u> • Data availability (scientific/quantitative) • Time and resources	
C. Identify appropriate valuation method	<u>5a. Is secondary evidence sufficient?</u> • Benefits transfer <u>5b. Is a primary study required?</u> • Market prices • Production inputs • Revealed preference • Stated preference	*See:* *Determining the scope for water valuation (Section 3.3)* *Valuation methods (Section 4 & Annex 1)* *Recommendations (Section 5)*
D. Undertake/ commission analysis	<u>6. What is needed to ensure a successful water valuation analysis?</u> • Best practice design and sensitivity analysis • Stakeholder engagement	*See:* *Recommendations (Section 5)*

Guidance document structure

The structure of the guidance document follows the framework set out in Figure 1.1, where the links between the key steps and sections of the document are highlighted.

Section 2 ('Water valuation: key concepts'): focuses on establishing the conceptual basis of water valuation. This is essential background reading for those new to the topic of water valuation but can also be referred to, when necessary, for the purpose of interpreting water valuation evidence.

⇒ *Can help address: What is the water resource issue?*

Section 3 ('Water valuation and decision-making'): reviews the type of water valuation evidence that may be sought in different decision contexts and practical considerations that are entailed.

⇒ *Can help address: What is the water resource issue?; What is the decision context?; Is water valuation evidence required?; Is water valuation feasible?; Is secondary evidence sufficient? / Is a primary study required?*

Section 4 ('Valuation methods'): summarizes the main economic valuation methods that can be applied to water management issues. Summaries of individual methods can be referred to as and when required.

⇒ *Can help address: Is water valuation evidence required?; Is water valuation feasible?; Is secondary evidence sufficient? / Is a primary study required?*

Section 5 ('Recommendations'): concludes by highlighting key principles for undertaking and commissioning water valuation analysis and assessing the likely applicability of different valuation methods to different water resource management contexts.

⇒ *Can help address: Is secondary evidence sufficient? / Is a primary study required?; What is needed to ensure a successful water valuation analysis?*

Annexes: These provide detailed descriptions of valuation methods for reference purposes and a list of relevant literature.

Content of guidance document

The content of the guidance document is intended to be practically focused to assist users in establishing how water valuation can assist in a particular decision context:

- Key terminology is defined in the **glossary**;
- Key processes and steps are explained and illustrated through **flow diagrams** and figures;

- Grey **case study boxes** in the text are used to highlight practical examples and best practice; and
- Key concepts introduced in the document are explained further in white **text boxes**.

Importantly, the guidance document is not intended to provide a detailed step-by-step guide to implementing specific valuation methods. Rather, emphasis is placed on understanding the potential role, use and water valuation information that can be obtained from different valuation methods.

Box 1.2: Little Bow/Highwood Diversion Water Management Project

The following provides a retrospective application of the framework for integrating water valuation into decision-making (see Figure 1.1). The example focuses on the Little Bow/Highwood Diversion Plan reviewing the use of water valuation to provide evidence for decision-making.

1. What is the water resource issue?

Background

In 1996 Alberta Public Works, Service and Supply (APWSS) filed an application with the Alberta Natural Resources Conservation Board (NRCB) to obtain approval for the Little Bow/Highwood Diversion Plan. The proposal consisted of constructing infrastructure (the 'project') and an operating plan (the Highwood Diversion Plan). The main components of the project were the construction of the Little Bow River reservoir, canals and diversion works to enable water to be diverted from the Highwood River to the Little Bow River. The proposal also included an option for expansion of the existing Squaw Coulee Reservoir.

Water supply reliability in the Little Bow/Highwood River region

The purpose of the proposed project and diversion plan was to address the reliability of the supply of water to domestic, municipal and agricultural uses in the Little Bow/Highwood River region. The principal water resource management issue faced was the timing of supply. In particular APWSS identified inadequacy of water supply during hot and dry summer months as the primary need for the project. Overall the proposal would:

- Reduce diversions from the Highwood River during summer periods and consequently improve environmental and recreation quality in the lower Highwood River at these times;
- Supply water to the towns of Vulcan, Carmangay, Nanton, Cayley and three rural water co-operatives;
- Provide the town of Champion an alternative water source which would provide a year round supply;
- Reduce turbidity in the raw water supply and reduce water treatment costs;
- Improve water supply for users along Mosquito Creek, the Little Bow River and around Clear Lake;
- Provide water supply for 4,660 hectares (ha) of existing irrigated farming and for 8,090 ha of additional irrigation; and,
- Restore and maintain water levels at Clear Lake and wetland areas for recreation, fish and wildlife habitat.

2. What is the decision context?

A joint NRCB-CEEA (Canadian Environmental Assessment Act) review panel was established to assess the APWSS proposal. The remit of the panel was to consider the justification for the proposal, cover the water management in the Highwood and Little Bow basins, analyze the details of the proposed project and diversion plan, and consider the effects of the project. The review of the project effects included environmental, social and economic impacts. The review panel had to make the decision of whether or not the proposal was in the public interest.

In addition to assessment of the APWSS proposal, the review process also featured a public consultation phase in 1997-98 that sought input from a wide range of stakeholders.

3. Is water valuation evidence required?

In determining if the proposal was in the public interest, a key element of the review was the economic viability of the project, particularly since it would be publicly funded. The perspective taken in this regard was that of cost-benefit analysis, implying that where monetary valuation evidence could be collated, this would be an appropriate undertaking.

4. Is water valuation feasible?

Prior to application for approval of the project, detailed investigations as to water use and needs in the Little Bow/Highwood River region were undertaken, including an assessment of baseline conditions, water flow scenarios and water quality. An environmental impact assessment was also undertaken. Overall, the availability of data as to the effects of the project provided a good basis for undertaking water valuation, particularly when linked to affected user populations (e.g. domestic and municipal supply, agriculture and recreation users). In practice the analysis that was carried out focused on recreational and agricultural users (via separate studies).

In addition, sufficient time and resources appear to have been available to permit water valuation.

5a. Is secondary evidence sufficient?

In the early 1990s (the period of time relevant to this example) the practice of benefits transfer (the use of existing, or ‘secondary’ valuation evidence), was less established than currently, although evidence of its use can be traced back to the 1970s. At the time, a key limitation would have been the availability of suitable studies from which to source valuation evidence, implying that a primary study would be required.

5b. Is a primary study required?

A primary study, as documented in Adamowicz et al. (1994) was carried out to value alternative flow scenarios for the Little Bow and Highwood Rivers. This was designed to provide an estimate of the economic value of improvements in environmental quality associated with the flow scenarios at different sites in the region. Environmental quality was broken down into a series of attributes including aspects of the water resource (e.g. river, stream, lake or reservoir), recreational fishing (e.g. species, size, catch) and other aspects of recreation (e.g. activities – boating, swimming or beach access). The results of the study were used to estimate the benefit of new recreational facilities at the Little Bow River reservoir and the re-establishment of Clear Lake. This was estimated to be between $0.4 million - $0.6 million per year (on the basis of approximately 6,500 recreation visits per year). Over the lifetime of the project, this was calculated to amount to $6.7 million in present value terms (using a 7% discount rate).

In addition to the evidence generated by the valuation study, the value of increased agricultural output was also separately estimated, on the basis of irrigation of an additional 8,090 ha of land. This was calculated to be approximately $53 million in present value terms.

6. What is needed to ensure a successful water valuation analysis?

Adamowicz et al. (1994) describes the research approach, data collation and analysis for the valuation study. This documents a 'best practice' application that contributed to the development of water valuation techniques. This included demonstrating the use of a choice experiment in a water recreation and environmental amenity setting and combining data from this demonstration with a revealed preference approach (see Section 4 for details of valuation methods).

Sources:

NRCB and CEEA (1998) Little Bow Project/Highwood Diversion Plan, Application to Construct a Water Management Project to Convey and Store Water Diverted from the Highwood River, Report of the NRCB/CEAA Joint Review Panel Application #9601 – Alberta Public Works, Supply and Services, May 1998.

Adamowicz, W., Louviere, J. and Williams, M. (1994) 'Combining revealed and stated preference methods for valuing environmental amenities', Journal of Environmental Economics and Management, 26, 271-292.

2. WATER VALUATION: KEY CONCEPTS

In order to establish how water valuation can assist in addressing water management issues, an understanding of the concept of economic value and how it is measured is required. The following provides a non-technical summary of the key concepts in relation to water valuation. The concepts and terminology introduced here are used throughout the guidance document, particularly in relation to the valuation methods introduced in Section 4.

2.1 Economic value

Concept of economic value

Economic analysis is concerned with measuring the ***wellbeing*** of individuals and overall society. Trade-offs made between different goods and services reveal the value that is placed on those goods and services and their contribution to wellbeing. The existence of a trade-off is the key point; economic value is concerned with what is 'given up' (or 'foregone' or 'exchanged') in order to obtain a good or service, rather than seeking to estimate the absolute value for a resource.

In addition, economic analysis is ordinarily concerned with a ***marginal change*** in the provision of a good or service. It goes without saying that for a resource such as water its 'total value' is infinite since it is essential for supporting all life. The same is true for many other resources and services supplied by the natural environment. However, it is the marginal value of water that is of relevance when considering trade-offs relating to the allocation of water between competing uses (e.g. domestic use, irrigation for agriculture, industrial use, etc.) and services that generate wellbeing that rely on water (e.g. functioning of ecosystems, recreation). The marginal value of water is the additional economic value that is generated by the last unit of water in a particular use and is determined by its relative scarcity, not only in terms of quantity but also quality. In fact, this highlights that the value of water will depend on its use and user populations, location and timing (including seasonality).[1]

When considering trade-offs between different goods and services, if the resource that is given up is measured in dollar terms it is possible to express economic value in monetary terms. Money therefore is a 'unit of measure' that enables a common comparison of outcomes in economic analysis; for example, comparing the financial cost of measures to reduce pollution to the benefits of improved water quality.

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[1] Note also that this includes the type of water resource; e.g. surface water (rivers, lakes and wetlands), groundwater (e.g. aquifers) or sea water both in terms of an overall system and point source. Furthermore issues that affect the relative scarcity of water may differ across different sources; for example stresses on groundwater may be very different than those influencing coastal waters.

The trade-off between money and changes in the provision (quantity or quality) of goods and services - i.e. their economic value - is defined through individuals' ***willingness to pay*** (***WTP)*** for securing a gain or avoiding a loss, or their ***willingness to accept compensation*** (***WTA***) for foregoing a gain or tolerating a loss. Economic valuation methods estimate WTP and WTA using different types of data depending on whether the good or service is traded in actual markets or not.

Market goods and market prices

Many goods and services, including some related to the use of water, are ***market goods*** (e.g. bottled water). The ***market price*** at which a good is exchanged – i.e. the dollar amount – reveals some information on its economic value. In particular, for the buyer of a good, the price reveals the amount of money the buyer is at least willing to give up to obtain the good. For the seller, the price reveals the amount of money the seller is at least willing to accept as compensation for giving up the good.

Market price information, however, is an imprecise measure of the economic value of a particular good since it may not fully reflect WTP or WTA. For example, many buyers may be willing to pay more than the market price to obtain the good. The difference between the maximum amount a buyer is willing to pay and the actual price paid is termed ***consumer surplus***, reflecting the element of benefit from obtaining the good that is 'gained for free'. Similarly, the seller of the good may be willing to accept a lower amount than the market price to give up the good. The difference between the minimum amount a seller is willing to accept and the actual price received is termed ***producer surplus***, reflecting the additional benefit in exchange gained (in effect 'economic profit'). Overall, in the case of market goods and services, economic value (WTP or WTA) is reflected by the market price paid or received[2] plus any consumer or producer surplus.

Where resource inputs are required to produce a market good or service, a further concept of economic analysis, termed ***opportunity cost***, is of relevance. The opportunity cost of a resource is the value of the next best alternative use of the resource (e.g. the opportunity cost of retaining water in rivers may be the value of lost agricultural output from using water for irrigation). This concept is central to the notion of ***economic efficiency***, where scarce resources (e.g. water) are employed in uses that generate the highest (social) wellbeing. A number of valuation methods reviewed in this guidance document and also certain decision-making contexts focus on opportunity cost and economic efficiency.

[2] Note that the effect of taxes and subsidies on market prices should be factored into the analysis since these, in many circumstances, can lead to over- or under-estimates of the value of a resource.

Non-market goods

Many uses and services supported by water and indeed other environmental resources are not traded in markets and are consequently 'un-priced'. However, for ***non-market goods*** the metrics of WTP and WTA are still those of interest. For example, the economic value of an improvement in the water quality of a lake should be measured by the resources individuals are willing to give up to obtain the improvement – i.e. willingness to pay – or the compensation they would accept for foregoing that improvement – i.e. willingness to accept. The contrast with market goods is that since there is no price paid for the non-market resource, WTP and WTA are composed wholly of consumer surplus.

The valuation methods described in Section 4, for the most part, have been developed in order to measure the monetary value of non-market goods and services or of those resources for which market prices do not accurately (or fully) reflect opportunity costs of the resource use. Water resources and services supported and provided by water resources are prime examples of both instances. In fact, in many countries the price of publicly supplied water does not even reflect the full cost of supply and maintaining infrastructure, let alone the (opportunity) cost of the social and environmental impacts of abstraction of water and supply.

Summary

Overall, the conclusion to draw is that the price associated with water (or even the lack of a price) in many situations does not provide a full account of the economic value of water in terms of its quantity, quality, location and timing scarcity. The emphasis of economic analysis is that water resources should be utilized such that the greatest economic value is generated. Depending on the situation, this may imply the provision of non-market goods and services (e.g. environmental improvements) over market goods and services, or vice versa.

Without evidence of the economic value of water, however, it can be difficult for decision-makers to identify the 'optimal' outcome. A key example is water quality; much capital investment is spent on improving the quality of water so that it can be allocated to higher value uses. However, the pricing of water may not reflect this such that sub-optimal allocations occur, where high quality water is used for a lower quality application (e.g. drinking quality water used to irrigate urban lawns or yards), or where poor quality water is used for an application that requires higher quality water, to the extent that the economic value derived from its application suffers (e.g. use of poor quality water in irrigation, resulting in soil salinization and reduced crop yields).

Furthermore, in terms of long-term decision-making the future availability of water is a key consideration as to its economic value. For example, the prospect of climate change implies changes in availability of water across large spatial areas, with the likely outcome that the value of water will vary in real terms (i.e. compared to other goods and services) as a result. This dynamic effect implies that decision-making should recognize not only the economic value of water in current terms, but also changes to the expected value over time.

2.2 Total economic value

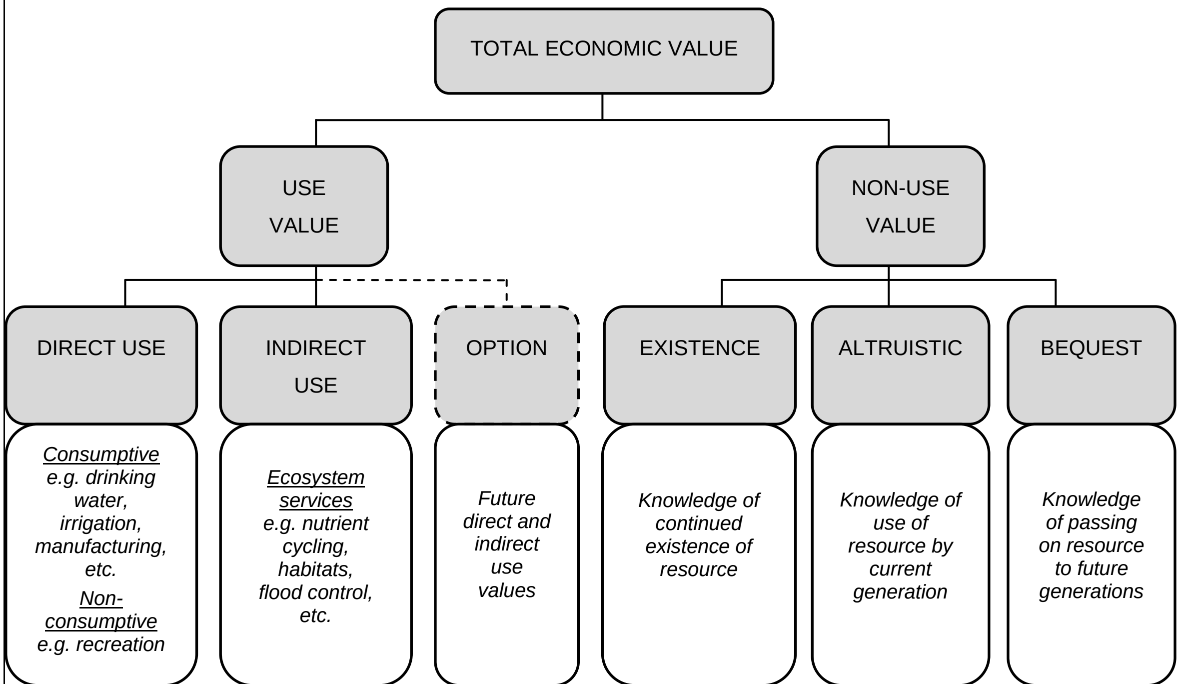
Use and non-use values

Both market and non-market goods and services may confer economic value for a variety of reasons. These relate to the uses or services provided or supported by resources such as water and are summarized by the concept of ***total economic value*** (***TEV***) (**Box 2.1**). The TEV framework distinguishes between ***use value***, which arises from either a direct or indirect interaction with a resource, and ***non-use value***, which arises due to altruistic motives (for others' wellbeing), bequest motives (for the wellbeing of future generations) and/or for the sake of the resource itself (existence). The total economic value of water is comprised of its use and non-use values:

$$TEV = Use\ Value + Non\text{-}use\ Value$$

When addressing a particular water management issue, the TEV framework can be useful in selecting the relevant valuation evidence and establishing the appropriate valuation method to be employed. In particular, valuation methods differ in the capacity to capture the full extent of the TEV of a resource. For instance, certain approaches are only able to estimate direct use values associated with a resource – such as WTP for changes in the provision of recreation opportunities associated with a river - whereas decision-making may be concerned with total economic value, including any elements of indirect use value and non-use value.

Box 2.1: Total economic value of water



Use value involves some interaction with the resource, either directly or indirectly:

- *Direct use value*: Use of water in either a consumptive manner, such as household water supply or in a non-consumptive manner such as for recreation (e.g. fishing). Note that direct use of water may not be 'fully consumptive' since it may be returned for use further downstream (hence the 'trade-off' between allocating water between competing uses and adverse effects on other uses).
- *Indirect use value*: The role of water in providing or supporting key (ecosystem) services, such as nutrient cycling, habitat provision, climate regulation, etc.
- *Option value*: Not associated with current use of water but the benefit of making use of water resources in the future. In practice option value is rarely valued separately; i.e. estimates of use value cover both current and future use of a resource. A related concept is *quasi-option value* which arises through avoiding or delaying irreversible decisions, where technological and knowledge improvements can alter the optimal management of a natural resource such as water.

Non-use value is associated with benefits derived simply from the knowledge that the natural resources and aspects of the natural environment are maintained (i.e., it is not associated with any use of a resource). For example, individuals may value knowing that iconic locations such as the Valley of the Ten Peaks will be protected even though they have no intention to visit. Non-use value can be split into three parts:

- *Altruistic value*: Derived from knowing that contemporaries can enjoy the goods and services related to natural resources.

- *Bequest value*: Associated with the knowledge that natural resources will be passed on to future generations.
- Existence value: Derived simply from the satisfaction of knowing that a natural resource continues to exist, regardless of use made of it by oneself or others now or in the future.

TEV and cultural, spiritual and traditional values

Many forms of cultural, spiritual and traditional value may also be attributed to resources such as water. These are often regarded as lying outside the economic analysis and TEV framework, although in some cases, links to use or non-use values can be made particularly in terms of providing motivations for economic values. However, it should be recognized that in cases where cultural, spiritual and traditional values are significant, the concept of TEV is likely to provide a minimum estimate of the value of a resource, where the full value is the sum of economic and non-economic values.

Defining the affected population

The TEV framework also draws out a further issue of importance within economic analysis, which is establishing the ***affected population***. Determining the appropriate population for which the monetary value of changes in the provision of good or service applies is crucial to appropriately estimate the aggregate value of monetary costs and benefits, which is required for decision-making approaches such as cost-benefit analysis. In fact, even if it is not possible to estimate the monetary value of a change in provision, consideration of the affected population (e.g. the number of households or visitors) can be valuable for providing an indication of the significance of gains and losses in social wellbeing. Stakeholder involvement in decision-making (see Section 5.1) can assist in identifying the full extent of the affected population.

In accordance with the TEV framework, two principal population groups may be identified:

- ***Users***: often this population group is readily identified as it consists of those making direct use of a resource, for example all households on a municipal water supply network or visitors to a recreation site (so long as visit data is recorded). It also includes those deriving indirect use values, for instance in terms of flood protection benefits within a river catchment. Different elements of use value can be relevant at different spatial scales; recreation and municipal supply use values may only be relevant at a local level, while others such as flood protection may confer benefit on a larger regional scale. Indirect use values in terms of carbon storage and sequestration are relevant at a global scale, since reduction of carbon emissions benefits not only a regional and national population but the global population.

- ***Non-users***: this refers to the population group that derives some wellbeing from a resource even though they do not make direct or indirect use of it. Instead, economic values are associated with altruistic, bequest and existence value motivations. Water as a resource *per se* may not lead to significant non-use values but the ecosystem services it provides or supports may (e.g. an iconic natural landmark, habitat for significant or rare species of flora and fauna).

Combining affected users and non-users results in the identification of the ***economic jurisdiction*** that is relevant to a given decision-making situation (**Box 2.2**). The economic jurisdiction is a spatial area over which some positive economic value is associated with the use of water and the services provided or supported by it. This jurisdiction may not necessarily match well with boundaries of provincial or territorial or municipal and local board jurisdictions, but the emphasis of water valuation is to account fully for use and non-use values; hence economic jurisdiction is the relevant consideration when establishing the extent of the affected population.

Box 2.2: Defining the affected population - aggregating WTP to improve urban river water quality with geographical information systems

Bateman et al. (2006) reported on a case study that was used to develop an approach to identify the population over which use values should be aggregated. The case study focuses on the River Tame in England which has suffered long term degradation. It is considered to be one of the country's most polluted rivers with much of its wildlife severely affected. However, the river represents an opportunity for the development of potential recreational and ecological areas within an urban area.

A contingent valuation approach was used and approximately 700 respondents were asked how much they were willing to pay for improvements to the River Tame. In addition, a geographical information system (GIS) was used to determine the distance of each respondent to the river, which permitted identification of the spatial area over which use values existed for improvements to the river (i.e. the 'economic jurisdiction') and the decline in use value as distance from the river increased.

Bateman et al. contrast the result of aggregation based on economic jurisdiction to aggregation based on arbitrary political jurisdictions, in order to highlight the potential for over-estimating aggregate benefits where 'distance decay' in use values is not taken into account. Selected results are shown below; the key finding being that aggregation based on political jurisdiction results in an over-estimate of aggregate benefits that is approximately 16 times greater than the estimate based on the economic jurisdiction (UK £82 million compared to UK £5 million).

Quality change		***Political Jurisdiction***	***Economic Jurisdiction with use value distance decay***
'Large' improvement	No. of households	3,494,438	1,647,777
	Aggregate benefit	£82,049,404	£5,040,526

Source: Bateman, I. J.; Day, B. H.; Georgiou, S. and Lake, I. (2006). The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP, Ecological Economics, vol. 60, issue 2.

2.3 Ecosystem services

A complementary framework for assessing the uses and services supported by water and other environmental resources is provided by the developing ***ecosystem services approach***. This is a term that has come to describe a basis for analyzing how populations are dependent upon the condition of the natural environment. The approach explicitly recognizes that ecosystems and the biological diversity contained within them contribute to individual and social wellbeing. It recognizes that this contribution extends beyond the provision of goods such as water for use in agriculture and industry to services which support life by regulating essential processes such as climate. Ecosystem services are commonly divided into four categories:

- ***Provisioning services***: ecosystems provide habitats for wild plant and animal species and act as a refuge and storehouse for biodiversity, by maintaining the conditions which allow survival of the diverse array of species on the planet. In turn, these result in goods such as food and fuel and also fresh water that are associated with direct use values.

- ***Regulating services***: refers to processes such as climate and air quality regulation, water quantity (e.g. flood control) and quality regulation that largely are associated with indirect use values.

- ***Cultural services***: may be associated with both use and non-use values and relate to the non-material benefits obtained from ecosystems, for example, through recreation.

- ***Supporting services***: these are necessary for the production of all other ecosystem services (e.g. soil formation, nutrient cycling). They differ from the other services in that their impacts on people are either indirect (via provisioning, regulating or cultural services) or occur over a very long time.

Applying an ecosystem services approach can be complex. With respect to water valuation, ecosystem services are the aspect of ecosystems that generate use and non-use values. For instance, ‘nutrients cycling’ is a service which can result in the outcome of clean water. But while nutrients cycling and clean water provision are processes, only the latter is also a benefit (e.g. for household drinking water supply, abstraction for industry or agriculture and so on). This example highlights the need to distinguish between services in themselves and outcomes that affect wellbeing, particularly with respect to the risk of ‘double-counting’ (or ‘over-valuation’). When considering ecosystem services, estimating the economic value of water should focus on outcomes in terms of benefits to human populations, rather than services and functions that contribute to those outcomes (**Box 2.3**).

Box 2.3: Applying an ecosystem services approach to valuation

Luisetti et al. (2008) provides an example of how an ecosystem services approach can be used to establish the benefits to user and non-user populations that arise from services and functions provided by the natural environment. The framework applied distinguishes between intermediate services and final services outcomes that generate economic value ('benefits' to human populations), which is particularly important with respect to avoiding double-counting when valuing ecosystem services:

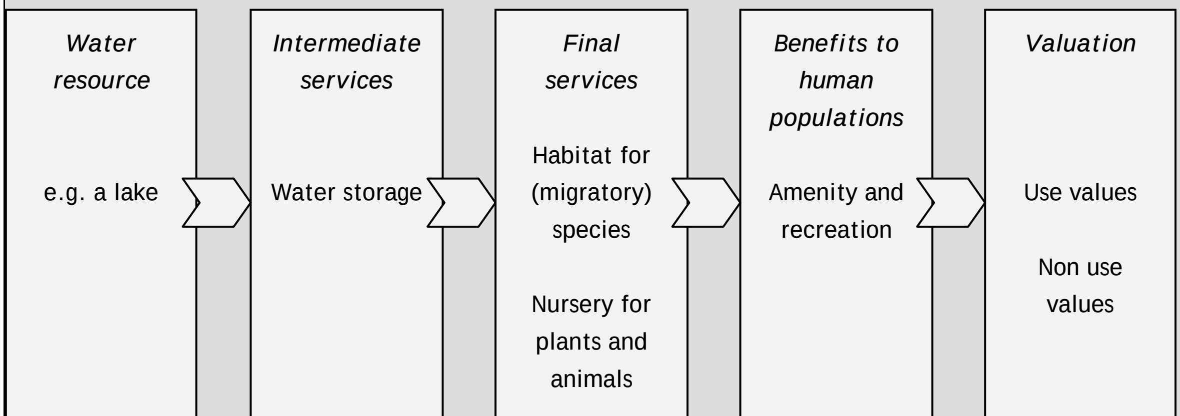


Figure: Adapted from Luisetti et al. (2008).

Source: Luisetti, T., Turner, R. K. and Bateman, I.J. (2008) 'An ecosystem services approach to assess managed realignment coastal policy in England', CSERGE Working Paper, ECM-2008-04.

For general reference for ecosystem services and economic valuation see also: Defra (2007). An introductory guide to valuing ecosystem services, UK Department for Environment, Food and Rural Affairs. Available from:

http://www.defra.gov.uk/wildlife-countryside/pdf/natural-environ/eco-valuing.pdf (Accessed April 2009)

3. WATER VALUATION AND DECISION-MAKING

Water valuation can potentially assist decision-making for a wide range of water resource management issues. This section of the guidance document reviews different decision-making contexts and the water valuation evidence that may be required, helping to address the key questions identified in **Figure 1.1**:

1. What is the water resource issue?
2. What is the decision context?
3. Is water valuation evidence required?
4. Is water valuation feasible?
5. Is secondary evidence sufficient? / Is a primary study required?

Section 5 addresses considerations required to ensure the successful completion of water valuation analyses.

3.1 Identifying the water resource issue

Broadly, water resource management is concerned with issues relating to the quantity of water, its quality, its location and/or the timing of its availability. Within this the breadth of water management issues faced by jurisdictions can be wide ranging. Establishing the context for water valuation entails answering four fundamental questions:

i) *What resource is affected?* Sources of water include surface water (rivers, lakes and wetlands), groundwater (e.g. aquifers) or sea water;
ii) *What is expected to change?* Stresses on water include pollution or increasing demand for consumption, land development, etc.;
iii) *Where and when will the change happen?* Effects may be evident at local, regional and/or national scales in the short term or longer; and
iv) *Who will the change affect and how?* Uses of water include household supply, agriculture, industrial and power generation uses, recreational purposes, etc.

The answers to these questions form the basis for water valuation in a particular situation, but the rationale for applying water valuation is driven by the decision context faced by water resource managers. As subsequently reviewed, water valuation evidence can inform a number of common decision-making contexts.

3.2 Identifying the decision context for water valuation

As indicated earlier, this guidance document is intended to enable decision-makers to integrate water valuation into decision-making for a number of water resource management contexts (including conservation actions, infrastructure investment, water quality standard setting, water allocation, water pricing and compensation for damage and use). Identifying the decision context for a specific water resource issue will include identifying the relevant water resource management context.

Water valuation largely fits within 'quantitative' decision-making approaches which seek to measure and weigh-up the relative merits of proposed actions. Within this, two fairly distinct forms of decision-making context can be envisaged for water resource management: (i) appraising or evaluating policy or project (investment) decisions; and (ii) assessing damages or compensation for use in legal damage assessments. 'Typical' decision-making questions that might arise in relation to some key decision-making contexts include:

Policy and project (infrastructure) expenditure issues

- Is a project or policy warranted?
- Which project or policy should be chosen among a set of alternatives?
- How can comparable projects and policies be ranked in order of 'worth'?
- On what scale should a policy be implemented?
- What is the appropriate standard or target for a policy measure?
- How much should be spent on best management practices?

Prioritization issues

- How important is a given issue?

Pricing and allocation issues

- What is the appropriate level of a user tariff?
- What uses should water be allocated to?

Legal damage assessment

- What is the value of environmental damages?
- What scale of compensation for damage is justified?

Further guidance for identifying the decision context for water valuation is provided in **Table 3.1** which links decision-making contexts to water resource management contexts and in **Box 3.1** which identifies some decision-making frameworks and tools that can be employed when undertaking policy and project analyses.

Table 3.1: Decision-making contexts and water valuation

Decision-making context	Water resource management context	Role of water valuation	'Accuracy' of evidence required
Demonstrating the importance of an issue Usually the need is to estimate the economic value (benefit or cost) from some activity, or the value of a policy	Conservation actions (restoration or maintenance projects)	Estimating the monetary value of benefits associated with conservation actions, or the monetary value of costs associated with degradation – particularly relevant to (environmental) non-market goods and services and estimating TEV	Potentially suited to a summary of existing evidence to support the case for conservation of a resource
Setting priorities Typically the requirement is to establish a ranking of projects for the allocation of expenditure from a limited budget	Conservation actions (restoration or maintenance projects) Infrastructure investments	Estimating the monetary value of outcomes associated with proposed projects for the purpose of providing a consistent comparison between competing projects	Requirement is likely to vary; i.e. greater accuracy required for 'more significant' decisions
Project analysis Either appraisal or evaluation of investment projects	Conservation actions (restoration or maintenance projects) Infrastructure investments	Estimating the monetary value of marginal changes in the provision of market and non-market goods and services affected by proposed project	Requirement is likely to vary; i.e. greater accuracy is required for larger investments and/or larger impacts
Policy analysis Either the appraisal or evaluation of policies, or assessing the impact of regulations, standards and best practice requirements (e.g. regulatory impact assessment)	Conservation actions (restoration or maintenance projects) Water quality standards Water allocation Water pricing	Estimating the monetary value of marginal changes in the provision of market and non-market goods and services affected by proposed policy	Requirement is likely to vary; i.e. greater accuracy is required for larger policy commitments
Establishing the basis for charges or taxes Usually the requirement is to establish a price for a good that fully reflects the opportunity cost of its consumption (e.g. for 'cost recovery' or 'full cost charging')	Water pricing Water allocation	Estimating the monetary value of non-market impacts (i.e. social and environmental) arising from abstraction, use, consumption or pollution of water resources	Requirement for accuracy is likely to be high to ensure confidence in policy decision
Legal damage assessments Assess compensation required for damages to environmental resources	Compensation for damage or use	Estimate the monetary value of environmental impact or damage	Requirement for accuracy is likely to be high to ensure confidence in legal decision
Green accounting Modification of National (income) accounts (or corporate accounts) to include environmental capital within the measure of wealth (along with man-made, human and potentially social capital)	Water resources as part of a broader environmental policy context	Estimate the monetary value of changes in the stock of environmental capital	Requirement is likely to vary depending on purpose of green accounting; i.e. as indicator of 'sustainability' or as a more accurate measure of changes in overall stock of environmental capital

Box 3.1: Water valuation and policy and project analysis

Policy and project analyses may employ a variety of decision-making frameworks and tools:

Cost-effectiveness analysis (CEA)

CEA is a decision-making tool which relates the costs of alternative ways of producing the same or similar outcomes to a measure of these resulting outcomes (e.g. quantity of water supplied). This may involve identifying either: (i) the least cost option, which is the cheapest option still capable of delivering a given objective (effectively 'cost-minimization'); or (ii) the most effective option, which is the option that gives the highest ratio of outcome (a quantified measure of the physical effect of that option) to its costs (i.e. the greatest return for $1 of cost). In water resource management CEA may be relevant where legal standards apply (e.g. for drinking water quality) or where a specific target needs to be achieved (e.g. supplying a set quantity of water for consumption), and the requirement is to choose among, or rank, alternative options to meet these objectives. Water valuation can input to CEA where there is the need to express all costs of a project (e.g. financial, social and environmental) in monetary terms; i.e. determining the least cost option for water supply (e.g. $/megalitre per day).

Cost-benefit analysis (CBA)

Water valuation is likely to be a fundamental input to cost-benefit analysis and is closely linked to this decision-making framework since both are based on the same economic analysis principles. Specifically CBA is concerned with economic efficiency, which focuses on ensuring that (scarce) resources are put to best use; i.e. that they are allocated to uses that maximize benefits to society. It can be applied to establish priorities for investment and appraise the relative merits of policies and projects (in terms of monetized costs and benefits). Moreover, CBA permits decision-making to consider the question as to whether a project or policy should be implemented at all. For a project or policy to qualify on cost-benefit grounds the present value of its benefits must exceed the present value of its costs. Water valuation can be applied to provide monetary value estimates for both costs and benefits of proposals (i.e. for environmental and social impacts, changes in provision of non-market goods, etc.).

Multi-criteria analysis (MCA)

Multi-criteria analysis approaches to decision-making normally combine both quantitative (including monetary) and qualitative assessments of alternative policy and project outcomes, typically in terms of economic, social and environmental impacts. In some respects CBA may be viewed as a particular form of MCA which focuses on monetary measures of outcomes from projects and policies. As with CBA, MCA can be applied to establish priorities for investment and appraise the relative merits of projects and policies. Where the analysis defines a 'baseline' option, it can also address the question as to whether a policy or project should be implemented at all. It can also permit consideration of 'wider issues' since it is not limited to assessing effects of policies and projects that can be expressed in monetary terms. Evidence from water valuation provides a quantitative metric for assessing impacts of a proposal in MCA.

Bio-economic models

Bio-economic models are tools that can be used to link changes in natural resources and the environment, ordinarily defined as management, land-use, infrastructure development or conservation scenarios, to outcomes in terms of expected changes in wellbeing (e.g. changes in use values for market and non-market goods). For example, bio-economic models can be applied to recreational fishing; with the level of activity modeled as a dynamic process based on the fish stocks available. Generally bio-economic models are data intensive, requiring specification of how changes in ecological functions relate to, for example, hydrological processes within a watershed. Water valuation evidence can provide an input to models for valuing changes in provision of market and non-market goods.

3.3 Determining the role for water valuation

A key point to highlight is that *water valuation is not a necessary pre-requisite for making a decision for any of the water resource management or decision-making contexts* set out in Table 3.1. For instance, water valuation is not essential for legal damage assessments, for establishing tariffs or charges associated with the use of water, or other policy instruments such as tradable permits. However, evidence from water valuation can help to improve decision-making in these instances, particularly with respect to providing a monetary estimate of social and environmental costs (e.g. establishing the full cost of water abstraction for the purposes of setting tariffs or estimating the value of damages).

Given an understanding of the issue and decision context for water valuation in a particular situation, the next step for water resource managers is to determine if valuation is actually a necessary and feasible undertaking. In some instances it may be necessary to complete an initial scoping study to draw together the basis for water valuation and the decision-context, particularly in instances where there is no established practice and the task is to develop an approach to decision-making. This may include identifying the best-suited decision-making framework and reviewing the extent of available evidence gaps (scientific, economic, etc.) in order to recommend whether further work is required (e.g. commissioning a scientific study prior to a valuation study).

An initial assessment of the role for water valuation and the “accuracy” of evidence required for different decision-making contexts is provided in Table 3.1. The role of water valuation when using different decision-making frameworks for undertaking policy and project analyses is identified in Box 3.1.

In the following section a series of practical considerations are highlighted that can assist an assessment of the role for water valuation.

Establishing if water valuation evidence is required

In assessing whether water valuation evidence is required, the main issue to address is *how would water valuation improve the decision made in a given situation?* This will depend on various considerations but generally:

- If the decision-making context is one of *demonstrating importance of an issue*, value evidence would undoubtedly improve the case made for the resource in question. This is a case-specific issue.

- The usefulness of water valuation in *policy or project analysis* (appraisal or evaluation), or *prioritization* should be viewed relative to other relevant techniques. In practice most assessment and appraisal techniques are complementary to each other rather than substitutes for one another. Various approaches differ in emphasis and their suitability to different decision- and evidence need- contexts. Water valuation may 'overlap' with a number of other assessment methods (**Box 3.2**) and it is a case of selecting the approach, or the set of techniques, that will generate the appropriate evidence to inform decision-making.

- If the decision-making context is one of *water pricing* or *water allocation*, water valuation is not a pre-requisite for policy formulation but is undoubtedly desirable if the objective is to identify the 'optimal' outcome in terms of economic efficiency. For example, water valuation can provide an estimate of the environmental and social costs associated with abstraction of water, which can be used in the setting of a charge or tax in order for pricing to reflect the 'full cost' of water use.

- If the decision-making context is one of *legal damage assessment*, water valuation would be useful but may not be necessary depending on the overall guidance on liability assessment. For example, compensation requirements may be based on habitat equivalency analysis rather than economic valuation.

- If the context is *green accounting*, value evidence would definitely be necessary to enable the comparison of non-market values to the actual price and the accounting of the market economy (all in monetary terms). For example, economic valuation can provide an estimate of the monetary value of changes in the stock of environmental capital.

Box 3.2: Assessment methods and water valuation

Ordinarily, water valuation is not a substitute for assessment methodologies such as environmental impact assessment or life cycle analysis. In fact, valuation is typically the 'next step on' from impact assessment in which either qualitative and/or quantitative impact measures are converted into a monetary metric for the purposes of decision-making. Common impact assessment methodologies include:

Life-cycle analysis (LCA)

Assesses all effects of a proposed action over the whole-life cycle of changes brought about by a project or policy. Outcomes are typically measured in their natural units (e.g. tons of emissions) or qualitatively. The results of LCA can be an input to water valuation rather than water valuation serving as an input to LCA.

Environmental and social impact assessment (ESIA)
Identifies all environmental and social impacts resulting from a proposed policy or project. As with LCA, ESIA also gathers information which can be used as an input to water valuation (in terms of where, how, what changes affect the good in question).

Health risk assessment (HRA)
Formally evaluates the probability of an adverse health outcome and provides a measure of the scale of that outcome (e.g. number of people affected). The same applies in that the results of HRA can feed into water valuation (e.g. in cost of illness calculations).

Natural resource damage assessment
Assesses the extent of injury to a natural resource (e.g. from release of a hazardous substance such as an oil spill) and determines appropriate ways of restoring and compensating for that injury. Water valuation can be an input to damage assessments, but the requirement will depend on the overall guidance for liability assessment.

Multi-criteria analysis (MCA)
As well as being a 'decision-support tool' (as described in Box 3.1), MCA also entails weighting or scoring outcomes from proposed actions (e.g. gains and losses), usually in qualitative (e.g. 'low'; 'medium'; or 'high' impact) or quantitative (e.g. reduction in number of visits) terms. The monetary estimates of water values could be used instead of or alongside other weights or scores.

Establishing if water valuation is feasible

Practical issues are also highly relevant in determining the scope for water valuation both in terms of whether it can be a realistic undertaking and which valuation method(s) can be applied. In general these considerations relate to: (i) data availability; and (ii) time and resources.

- *Data availability*: Application of valuation methods in virtually all instances requires some form of quantitative, physical or spatial (e.g. GIS) data on the change in provision of interest (e.g. quantity of water, bio-chemical quality, size of user population affected and so on). This is essential for the task of defining 'the good and the change to be valued' (**Box 3.3**), and the lack of such data can preclude water valuation.

  Where there are gaps or uncertainty in physical data it may be necessary to first undertake scientific or other impact assessment studies to provide a sound basis for subsequent water valuation. In such instances it is crucial to engage with valuation practitioners at the start of the scientific / impact study in order to ensure that it generates information that is suitable for water valuation.

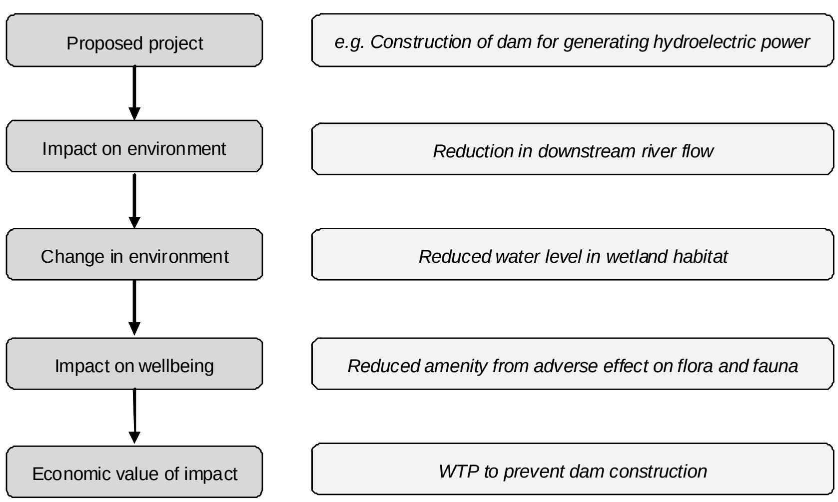
- *Time and resources*: Ideally the objective of water valuation and its role in decision-making will be accounted for at the outset of a policy, project or damage assessment decision-process. This enables the overall decision-process to allow time for sufficient evidence (both scientific and economic) to be collated. In practice though, this is not the case and water resource managers can face timeframes that will preclude some water valuation methods. Indicative timescales for implementing valuation methods are provided in Section 4.

Water valuation studies are not inexpensive and budget constraints will also determine their feasibility. However spending more during the initial analysis to make the right decision is usually better value for money than spending to correct the consequences of a wrong decision afterwards.

Box 3.3: The importance of determining the 'good to be valued'

The *(direct) use value* of water reflects a number of dimensions – the quantity available, its quality, its location and timing. In many cases the quantity of water is of interest in terms of its availability for a particular use such as household supply or irrigation for agriculture. In addition, water quality is usually important, especially for household supply, for some manufacturing uses and recreation. In other instances use values will also be determined by timing (e.g. seasonal timing and variation) and location (instream versus offstream) factors. For *direct use value*s the 'good to be valued' and changes in its provision are, in general, easily quantified (e.g. in terms of volume of water).

In contrast, for *indirect use values, non-use values* and also some direct use values associated with water, the good to be valued may be less readily quantifiable. For example, scientific evidence may not be available to predict the effects of reducing pollutant loads in rivers, or data on users of recreation sites may be limited to those engaged in more formal activities (e.g. fishing) and not available for casual users. Such issues are particularly relevant in the case of valuation methods that focus on valuing non-market environmental goods where input from engineers and environmental scientists is needed to establish the good to be valued. Changes in the provision of the resource then need to be related to the effect on wellbeing (use and non-use values) in order to establish the economic value of the change:



Note that the process depicted in the above flow chart is complementary to the ecosystem services approach highlighted in Section 2.3.

Establishing the appropriate 'level of effort' for water valuation

A common theme in policy and project analysis guidance is that '*appraisal effort should be proportionate to the action being appraised*'. For actions that entail relatively large policy or investment expenditure and/or will have significant impact on the water resource, users and other stakeholders, there is the need to base decisions on thorough and detailed assessments of the expected outcomes. Where interventions are expected to be less significant or important, systematic assessment of outcomes is still required but it is ordinarily the case that information and evidence requirements for decision-making are lower. Overall, this reflects the fact that decision-makers, individuals and organizations tasked with collating evidence are subject to time and resource constraints, and effort should be focused where it is most appropriate and valuable.

In the case of water valuation, the assessment of the level of effort required relates to the issue of whether primary evidence should be sought, by commissioning an original study, or whether secondary evidence, drawn from the results of existing studies, is sufficient. The latter case, i.e. the use of results from existing studies, is commonly termed ***benefits transfer***. The rationale for benefits transfer is simple: using the results of previous studies in new decision-making contexts saves the time, effort and expenditure involved in undertaking primary studies. For benefits transfer to be a feasible option, however, it is a requirement that relevant valuation evidence has been generated by previous studies.

The key qualification with a benefits transfer approach to water valuation is the 'degree of error' involved. This refers to the difference between the value that would be estimated through primary research specifically designed for the decision-making context of concern and the value that is estimated using existing evidence via benefits transfer. This is because the evidence of the economic value of water in a particular use and location (or point in time) often does not accurately reflect the economic value of water in the same use but at a different location (or point in time). In practice there are several approaches to benefits transfer which differ in the degree of complexity and extent to which they may address concerns of accuracy (see also Section 4.5 and Annex 1).

4. VALUATION METHODS

This section introduces the main economic valuation methods that can be applied to water management issues. These are grouped into three categories: (i) *market price a*nd *production input methods*; (ii) *revealed preference methods*; and (iii) *stated preference methods*. This grouping represents ***primary study*** methods; i.e. approaches that generate original valuation evidence that is specifically designed to assist a decision-making context of interest.

An alternative approach to water valuation is to make use of ***secondary evidence*** via *benefits transfer*, the basic process of which entails identifying appropriate value evidence from the results of existing studies and 'transferring' these to the decision-making context of interest.

Overall the following discussion can assist in addressing the questions: is secondary evidence sufficient or is a primary study required? as set out in **Figure 1.1**.

4.1 Categories of valuation methods

The main distinction between the primary study method categories is that market price and production input approaches are ordinarily applied to value *market goods and services* associated with water resources. Revealed preference and stated preference approaches are applied to value *non-market goods and services* associated with water resources. The scope of different valuation methods is summarized in **Table 4.1**. Note, however, that there can be overlaps between methods and distinctions in practice may not be great. Furthermore, combinations of methods may be required for informed decision-making for specific water resource management issues. In summary:

- ***Market price methods***: Consider use values that arise in relation to the provision of goods and services which may be observed directly from actual markets.

- ***Production input methods***: Focus on the indirect relationship that may exist between a particular resource, such as water, and the production of a market good (e.g. agricultural crops). The use value of water is inferred by changes in production that result from changes in water as an input to production (e.g. quantity or quality).

- ***Revealed preference methods***: Estimate the use value of non-market goods and services by observing behavior related to market goods and services. A classic example is valuing the water environment through the cost (both money and time) incurred in undertaking water-based or water-affected recreation activities.

- ***Stated preference methods***: Can estimate the total economic value of non-market goods and services by directly asking individuals, via questionnaire surveys, what they would be willing to pay or accept for a specified change in the provision of the good. Note that the various components of TEV, direct and indirect use value and non-use value (and the elements within these) can be estimated separately or in combination depending on the specifics of the stated preference application.

- ***Benefits transfer***: Can make use of valuation evidence generated by any of the above methods and hence can be used to estimate all components of TEV (provided sufficient evidence is available from existing studies).

Table 4.1: Scope of economic valuation methods

Valuation Method	Scope – Component of TEV	Scope – types of goods and services
Market pricing methods	Use value (direct and indirect)	*Market goods and services and market substitutes (for non-market goods and services)* Direct use value: mostly limited to water as a commodity (e.g. the spending on bottled water as a proxy for the value of drinkable public supply) or the contribution of water to marketed products (e.g. agriculture, forestry, fisheries, manufacturing, power generation) Indirect use value: estimating avoided damage (e.g. from flooding) or marketed substitutes (e.g. cost of water treatment) or tangible impacts (e.g. cost of illness)
Production input methods (e.g. production function approach)	Use value (direct and indirect)	*Market goods and services* Use value: Limited to the role of water as an input to production processes (e.g. the effect of water quality on agriculture).
Revealed preference methods		
Hedonic pricing (e.g. hedonic property pricing)	Use value (direct and indirect)	*Non-market goods and services* Use value: The contribution of water to environmental amenity that can be observed from markets (e.g. property market).
Travel cost method	Use value (direct and indirect)	*Non-market goods and services* Use value: The contribution of water to recreation activities that is revealed by the travel costs incurred by recreation users.
Multi-site recreation demand models	Use value (direct and indirect)	*Non-market goods and services* Use value: The contribution of water to recreation activities that is revealed by the choice decisions (i.e. whether to visit a specific site or not) and travel costs incurred by recreation users.
Stated preference methods		
Contingent valuation	TEV (use and non-use value)	*Non-market goods and services* TEV: The contribution of water to most non-market goods and services can be captured by contingent valuation.
Choice modeling (e.g. choice experiment)	TEV (use and non-use value)	*Non-market goods and services* TEV: The contribution of water to most non-market goods and services can be captured by choice modeling approaches.
Benefits transfer		
Unit value transfer / function transfer	*TEV (use and non-use value), depending on evidence used*	*All of the above depending on the type of study from which evidence is sourced.*

The remainder of this section provides brief summaries of each of the methods listed in **Table 4.1**, focusing on basic details, relevance to different decision-making contexts, appropriate applications and practical considerations (see Sections 4.2 to 4.5). These can be referred to as relevant by users of the guidance document. More detailed summaries of valuation methods are also provided in **Annex 1**, including the conceptual basis and methodological steps. The annex summaries are intended to assist users of the guidance document to develop a further understanding of a particular valuation method and aid the interpretation of water valuation evidence generated by the method. The annex summary should also be useful for informing the commissioning of water valuation studies.

4.2 Market pricing and production input methods

Market price methods

Description: Market price methods consider the costs that arise in relation to the provision of goods and services that may be directly observed from actual markets. In many instances these approaches can be best thought of as providing a 'proxy' for a use value estimate (since they do not reflect the underlying consumer surplus measure of value). This is particularly the case for applications that seek to value non-market environmental goods and services of water via the cost of market substitutes (e.g. using the cost of man-made flood defenses as a proxy for the value of flood protection benefits from a wetland area). The term 'market price approach' can be inclusive of a number of different approaches to valuation (**Box 4.1**).

Components of TEV: Application of market pricing methods typically inform on either direct or indirect use values associated with goods and services. In the case of non-market goods and services, the various approaches can only be applied where environmental resources have clear relationships with market-based goods and substitutes or where degradation of the resource can be mitigated against. Non-use value cannot be estimated with market pricing approaches since this component of TEV is not captured within markets.

Decision-making contexts: The use of market pricing methods may be better suited to instances where a partial estimation of TEV is sufficient. For example, valuing improvements in environmental water quality via reduced costs of treatment for water supply only accounts for part of the use value generated and excludes benefits to wildlife and recreation users. In practice mitigation costs or shadow project costs may also be used as a minimum estimate for setting compensation or legal damage assessments even though these values are not the 'correct' measure of the loss of economic value in such instances.

Practical issues: Market pricing approaches can be useful in providing a lower bound assessment of the economic value (particularly for non-market environmental goods that might otherwise be regarded as 'free'). Data are typically readily available in the form of observable market prices and often require little manipulation (other than adjustments for taxes and subsidies); hence, monetary value estimates can be obtained in a relatively short timeframe (e.g. within 1 month/10 person days if data is readily available; note also that longer timeframes may be required depending on the scope of the analysis). This fits well with decision-making instances that require a rapid assessment of likely outcomes. The limitation of market pricing approaches is that they can ‘under-value’ environmental resources such as water (see Annex 1 for further discussion).

Box 4.1: Examples of market pricing approaches

Use values may be inferred from a range of prices or costs observed directly from actual markets:

Opportunity cost

Explicitly considers the value that is foregone in order to protect, enhance or create a particular resource or services (e.g. creation or restoration of a wetland habitat may imply the conversion of land from agriculture; the opportunity cost of the land use change is the value of agricultural production foregone from the converted land, net of subsidies).

Cost of alternatives

This approach considers the cost of providing a substitute good which would provide a similar function to a resource such as water (e.g. a proxy value for flood protection from wetlands can be provided by cost of construction of man-made flood defenses of equal effectiveness).

Mitigation costs (or *‘avertive behavior’*)

This approach considers costs incurred to mitigate against particular outcomes associated with (the degradation or lack of) a resource such as water (e.g. the cost of water treatment may be taken as a proxy for the economic value of pollution of a water source).

Shadow project costs

This approach focuses on cost of compensating for the loss of an environmental resource at a particular site, by assessing the cost of providing an equal resource at an alternative site (e.g. the cost of recreating a wetland habitat).

Cost of illness

For some resources, such as safe drinking water, a proxy value can be inferred from the cost of illness incurred when it is not available (e.g. gastroenteritis or cryptosporidium). Costs include medical treatment, loss of earnings from work days lost and, if available, willingness to pay to avoid pain and suffering.

Subsidy cost

For a number of non-market environmental goods a proxy value may be inferred by considering the subsidies paid directly to producers for adopting production methods that are environmentally benign or beneficial. A common example is subsidies paid to the agricultural sector for environmentally sensitive practices such as reduced livestocking and reduced intensity of fertilizer application, both of which can reduce diffuse pollution to water-courses.

Production input methods

Description: Production input methods (ordinarily termed '***production function approach***' or '***cost function approach'*** depending on the specifics of the analysis) consider environmental resources such as water as inputs into production processes which lead to the output of marketed goods and services. The use value of water as an input to production is then inferred by assessing changes in production that result from changes in water as an input to production (see **Box 4.2**).

Components of TEV: The production function approach is ordinarily limited to estimating the at-site use value of water (e.g. use in agriculture, manufacturing, etc.). It can establish the importance of environmental goods as an input to the production of market goods and services, or alternatively the significance of the impact that pollution of the environment can have in production processes.

Decision-making contexts: The production function approach is generally suited to demonstrate the importance of issues (such as increases in water quantity or improvements in water quality), as well as being appropriate for inputting to policy and project analysis and providing a basis for legal damage assessments.

Practical issues: The main practical issues with the production function approach relate to data availability. The requirements can be considerable with the need for data on market price, output, demand and production inputs. In practice it may also be difficult to assess the response in production from changes in water inputs. This is due to scientific uncertainty and lack of data associated with understanding how ecosystems services interact with each other and are provided. Specialist (econometric) expertise is required to perform the analysis and a rigorous application will likely require a fairly lengthy timeframe (e.g. 3-12 months/ potentially 30-60 person days).

Box 4.2: The value of water in manufacturing: Application of the production/cost function approach

Industrial water use makes up a significant portion of total water withdrawals in most countries. One major use is for manufacturing, where operations are largely self-supplied and may be accompanied by in-plant circulation. Often this results in the deterioration of water quality and can use a relatively significant portion of water resources on a regional or river basin scale.

Renzetti and Dupont (2003) reported on the estimation of a cost function for Canadian manufacturers that included: the price and quantity of inputs (e.g. labor, capital, energy, materials), internal water recirculation, and water treatment, as well as water intake and manufacturing output. Other variables were also included in the analysis, such as geographic or regulatory characteristics of the province in which a manufacturer was located. The coefficients of the cost function were estimated, which allows the calculation of various features of the manufacturing process, and in particular the shadow price of intake water.

The mean value for the shadow price of water in Canadian manufacturing was estimated at $0.046/m^3 or $56.76/acre-foot. The value was significantly different from zero, but relatively small compared to previous US studies. The benefit of using a production or cost function in this context is that it is possible to identify how the value of water changes with various factors, such as other input prices or the scale of operations. Renzetti and Dupont conclude that the results are telling of the regulatory environment in Canada and illustrate potential levers to strengthen water regulation and improve allocation of water.

Source: Renzetti, S. and Dupont, D.P. (2003) 'The Value of Water in Manufacturing', CSERGE Wokring Paper ECM 03-03.

4.3 Revealed preference methods

Hedonic pricing method

Description: The ***hedonic pricing method*** estimates the use value of a non-market good or service by examining the relationship between the non-market good and the demand for some market-priced complementary good. The most common application of the approach is ***hedonic property pricing*** where the price at which a property sells in the property market is determined, in part, by the specific characteristics of the property's structure, location and environs. Among these characteristics it is reasonable to expect that environmental amenity (composed of water, landscape, air quality, etc.) may be included. The basic expectation is that properties which feature higher levels of desirable environmental characteristics will command a higher market price than similar properties with lower levels of those same characteristics (all else equal). Analysis of these price differences reveal the value attributed by property buyers to particular environmental goods.

Components of TEV: Hedonic pricing can estimate the value of non-market goods and services that buyers and sellers in a market are aware of and hence reflect in their buying and selling behavior. Within this scope, application of hedonic pricing is limited to direct and indirect use values, mostly in terms of location-specific factors (e.g. proximity to a lake).

Decision-making contexts: Hedonic pricing provides a basis for estimating the value of a range of non-market goods and services and can inform particularly well on localized and site specific impacts, e.g. the use value attributed to a lake. The scope for informing different decision-making contexts is quite broad, with hedonic pricing being suitable for inputting to policy and project analysis, demonstration of importance of an issue, and establishing the basis for a tax and legal damage assessment.

Practical issues: Hedonic pricing studies are limited to environmental characteristics that are observable by individuals. Practically this excludes changes that are yet to occur and have levels of provision of a good that have not been experienced. In addition, the method is less applicable to environmental 'bads' which are not typically perceived by individuals, such as chemical hazard, radiation and diffuse pollution. The approach requires large amounts of data on price, the characteristics of the properties in the market and socioeconomic characteristics of the population in the areas concerned, along with specialist (econometric) expertise. Rigorous application will likely require a fairly lengthy timeframe (e.g. 6-12 months/ 30-60 person days).

Travel cost method

Description: The ***travel cost method*** is a survey based technique that uses the cost incurred by individuals travelling and gaining access to a recreation site as a proxy for the recreational use value of that site. In part, travel costs determine the number of visits an individual may undertake and may be seen as the 'price' of a recreational visit to a particular site. Travel costs incurred by an individual are comprised of two elements: (i) travel expenditure (e.g. fuel, fares, accommodation, food, etc); and (ii) the value of time.

Components of TEV: The travel cost method is limited to estimating direct (non-consumptive) use value arising in relation to recreation use of a site. However the approach is particularly applicable to water resources which support a large variety of recreation activities (e.g. fishing, boating, watersports, etc.). In developing country contexts the travel cost method can be applied to the cost of collecting water.

Decision-making contexts: The travel cost method is suited to providing estimates of the use value derived from well-defined recreational sites or activities, or separable, well-perceived environmental attributes influencing such sites and activities. It is suited as an input to project analysis, demonstrating the importance of an issue, setting priorities and also establishing user charges (e.g. entry fees to a site). In common with other revealed preference approaches, the travel cost method is not able to account for environmental goods that are largely imperceptible to users.

Practical issues: A travel cost survey is required to collect data on place of residence of visitors, demographic and attitudinal information, frequency of visits to the site and other similar sites and trip information (e.g. the purpose of the trip, length, associated costs, etc). The data analysis requires specialist (econometric) expertise. Rigorous application will likely require a significant timeframe if seasonal variation in visits is to be accounted for (e.g. 6-18 months/30-60 person days, plus survey costs).

Multi-site recreation demand models

Description: The underlying principle of multi-site recreation demand models (MRD models) (also referred to as ***random utility*** *or* ***discrete choice models)*** is that the value of changes in the characteristics of goods and services can be inferred from the choices individuals make between similar alternatives. This approach is particularly flexible in terms of analyzing demand for goods and services. A specific application relates to decisions made by individuals in relation to visiting recreation sites by comparing the characteristics of each site, which can include a variety of factors related to water resources (e.g. the quality of rivers and lakes for fishing). Inclusion of data on costs of travel incurred by individuals when visiting sites permits the estimation of changes in use value resulting from differences in the quality and quantity of resources between different sites.

Components of TEV: As with the travel cost method, application of MRD models is limited to estimating direct (non-consumptive) use value arising in relation to recreation use of a site. MRD models can be viewed as an extension to the travel cost method, as they estimate the use value of a *change* in the quality or quantity of an environmental characteristic at a recreation site. In contrast, the travel cost method estimates the use value associated with a *visit* to a site.

Decision-making contexts: MRD models can provide estimates of the use value associated with different characteristics of a good, which can be suited to inputting to project analysis for specific recreation sites.

Practical issues: A MRD model can be implemented in a similar way to a travel cost method study, with a requirement to collect survey data on residence of visitors, demographic and attitudinal information, frequency of visits to the site and other similar sites and trip information. In practice the decision as to which approach to apply will depend on the required output from the survey data. Rigorous application will likely require a significant timeframe if seasonal variation in visits is to be accounted for (e.g. 6-18 months/30-60 person days, plus survey costs) and specialist (econometric) expertise is required for the analysis of the survey data.

4.4 Stated preference methods

Contingent valuation methods

Description: The ***contingent valuation*** method is a survey-based approach to valuing non-market goods and services. The approach entails the construction of a hypothetical, or 'simulated', market via a questionnaire where respondents answer questions concerning what they are willing to pay (or willing to accept) for a specified environmental change (the trade-offs respondents make constitute the simulated market) (see **Box 4.3**). A contingent valuation questionnaire can be asked in almost any context; typical applications include valuing uses of water and/or the environmental services of water based habitats, and the non-use values associated with these.

Components of TEV: With contingent valuation it is possible to estimate the total economic value of an environmental good or service, i.e. both use value and non-use value components, or the economic value held by users and non-users separately.

Decision-making contexts: Contingent valuation is particularly flexible and facilitates the valuation of a wide range of non-market goods and services including the changes that are yet to be experienced. The results can be applied to demonstrate the importance of an issue (e.g. supporting conservation actions), inputted to policy and project analysis, or used to determine an environmental tax, charge or legal damage assessment.

Practical issues: Reliable contingent valuation studies are not simple to implement and the results of such studies usually attract greater scrutiny than revealed preference approaches due to the use of a hypothetical market to establish willingness to pay (or accept). Time is required to develop the survey instrument and to ensure that the non-market good or service to be valued is clearly explained to survey respondents along with the constructed market and payment method. As with any other surveys ensuring representativeness of the results is important. Rigorous application will likely require a lengthy timeframe (e.g. 3-12 months/40-

100 person days, plus survey costs) and specialist (econometric) expertise is required for the analysis of the survey data.

Box 4.3: Contingent valuation of improvements to Hamilton Harbor

Hamilton Harbor is located at the western end of Lake Ontario. It has been identified as 'an area of concern' due to the concentration of heavy industry in the area, the small size of the harbor in relation to its watershed and the narrow outlet to Lake Ontario. Remediation actions for the harbor were identified as part of The Great Lakes Remedial Action Program (RAP) where the benefits of the program were estimated using a combination of primary study and benefits transfer techniques.

Dupont and Renzetti (2005) reported on a contingent valuation (CV) study that was undertaken to estimate direct use values associated with the RAP and improvements to the harbor. Over 700 individuals were contacted via a general mail survey, which resulted in a response rate of approximately 63%. The survey described potential improvements to Hamilton Harbor and associated costs for these improvements in terms of respondent water bills.

The survey sample was split into direct users and potential future users on the basis of responses to questions on current and future planned use of the harbor. Mean (average) willingness to pay (WTP) per household (hh) per year for swimming, boating and fishing was calculated for both current users and potential future users allowing for estimation of both current and future aggregate benefits. The following provides some selected results from the study, indicating significant use values attached to the proposed improvements (approximately $15-60/hh/yr depending on type and current or future use).

Willingness to pay for improvements to Hamilton Harbour (1995 $)			
Use type	Swimming	Boating	Fishing
Current users	$57.57/hh/yr	$33.13/hh/yr	$15.40/hh/yr
Future users	$32.65/hh/yr	$19.65/hh/yr	$30.23/hh/yr
Aggregate annual benefits			
Current users	$428,551/yr	$745,624/yr	$187,957/yr
Future users	$3,097,506/yr	$1,381,140/yr	$2,360,268/yr

Source: Dupont, D.P. and Renzetti, S. (2005) 'Cost-Benefit Analysis of Water Quality Improvement in Hamilton Harbor, Canada' in Brouwer, R. and Pearce, D.W., Cost Benefit Analysis and Water Resources Management, Edward Elgar, Cheltenham, UK.

Choice modeling

Description: The term ***choice modeling*** covers a variety of questionnaire based methods that infer willingness to pay (or willingness to accept) indirectly from responses stated by respondents, instead of directly asking these measures as in a contingent valuation survey (this method includes ***choice experiments*** and ***contingent ranking*** - see Annex 1 for further details). Choice modeling questionnaires present respondents with choices between different options for delivery of a good or service characterized by different levels of a set of 'attributes'. For example, the attributes of a lake may be its ecological quality, chemical water quality, number and type of species it provides habitat for, and so on. Different conservation policy options could consist of different levels of quality, number of species, and access to lake. If each option has a 'price' attached (e.g. in terms of increased water bill, municipal taxes, entrance fees, etc.), subsequent analysis of respondents' choices reveal their willingness to pay (or accept) for each of the attributes presented to them.

Components of TEV: As with contingent valuation, choice modeling is able to estimate the total economic value of a non-market good or service, i.e. both use value and non-use value components (and values held by both users and non-users). Since goods and services are defined in terms of their attributes and since the levels of these are varied, choice modeling is more flexible in estimating individual values for characteristics of a good (e.g. quality, quantity, etc.), rather than as a 'bundle' as is the case with contingent valuation.

Decision-making contexts: Choice modeling facilitates the valuation of a wide range of non-market goods and services, including changes in provision yet to be experienced. It is more flexible than contingent valuation, as many more potential combinations of environmental change can be presented to respondents which can allow for a better incorporation of uncertainty surrounding changes in environmental goods and services such as water resources. Choice modeling can input into policy and project analysis (**Box 4.4**), or into decision-making contexts concerning the demonstration of importance of an issue, priority setting within a sector, determination of an environmental tax or charge, or legal damage assessment (liability).

Practical issues: Practical issues with choice modeling approaches are similar to those of contingent valuation in terms of representativeness of survey, timeframe for application (e.g. 3-12 months/40-100 person days, plus survey costs) and requiring specialist (econometric) expertise. Some caution is required in the design stages to ensure that the number of choices and attributes respondents are presented with are manageable; the more complex the choice question the more likely that respondents will display inconsistent responses due to cognitive limits.

Box 4.4: Investment planning in the water sector: application of choice experiments

Water and sewerage companies are privately run regional monopolies in England and Wales (UK). Standards for services are set by the Government's industry regulator, Ofwat (Water Services Regulation Authority), and prices that companies can charge customers are reviewed every five years. As part of this process, companies are required to prepare business plans that determine the level of investment in services over the 5-year period (and beyond). For the 2004 price review, Yorkshire Water applied a cost-benefit analysis approach to investment appraisal, comparing the cost of investments to their benefits in terms of customers' willingness to pay for the service improvements that would result.

A ***choice experiment*** (CE) approach was employed to estimate benefits to customers from changes in fourteen service factors, related to the supply and quality of water, external dis-benefits of wastewater disposal and environmental impacts. The study surveyed 1000 household and 500 business customers who were presented with CEs detailing changes in the level of provision to 3 to 4 of the service factors of interest, plus a change in bill amount. The following provides some selected results from the household customer sample, in terms of willingness to pay per household (hh) per year for unit changes in the service factors (e.g. number of properties affected by sewer flooding):

Service factor	*Description*	*Willingness to pay*	*Units*
Security of supply	Increase reservoir stock	£0.32/hh/yr	% of capacity
Drinking water quality	Reduce sample failures	£0.03/hh/yr	Failure/250,000 samples
Mains pressure	Reduce number of affected properties	£1.54/hh/yr	Number of properties
Sewer flooding	Reduce number of affected properties	£0.03/hh/yr	Number of properties
River quality	Improve habitats	£0.64/hh/yr	% river length

Source: Willis, K.G., Scarpa, R. and Acutt, M. (2005) 'Assessing water company customer preferences and willingness to pay for service improvements: A stated choice analysis', Water Resources Research, no. 41.

4.5 Benefits transfer

Description: *Benefits transfer* is an approach to economic valuation that draws on the results of existing studies. It is usually described as a process that transfers economic values estimated in one context (the 'study good') to another context (the 'policy good'). The study good refers to the resource valued by an existing study, while the policy good is the resource that is subject to decision-making and for which evidence about its economic value is required. In practice there are several approaches to benefits transfer, which differ in the degree of complexity, the data requirements and the reliability of the results. The two main variants are:

- *Unit value transfer*: This is the simplest form of benefits transfer and directly applies estimated WTP (or WTA) for the study good to the policy good; e.g. application of an average WTP value in terms of $/visit for a recreation site.
- *Function transfer*: This is a more sophisticated approach that makes use of evidence collated for the study good that identifies the factors that influence individuals WTP (or WTA) amounts (typically socio-economic and demographic characteristics as well as patterns of use of a good). This allows for the study good WTP estimate to be adjusted so that it accounts for the characteristics of the policy good user (and non-user) population.

Components of TEV: Benefits transfer is relevant for all economic valuation methodologies and the approach can provide estimates of the total economic value of a good or service, depending on the context of the source study (or studies). For instance, transferring results from a contingent valuation study may enable both use and non-use values to be estimated, while transferring results from a travel cost study will lead to an estimate of use value only.

Decision-making contexts: Benefits transfer exercises may be utilized in a number of decision-making contexts including: inputting to policy and project analysis; demonstration of the importance of an issue; and priority setting within a sector. The key issue with benefits transfer is the 'degree of error' (the difference between the value obtained by benefits transfer and the value that would be estimated by a primary study). For some water resource management issues a reasonable degree of error can be accommodated; for instance in cases where 'summary evidence' is required to support a course of action. Where greater accuracy is needed, most likely in the case of significant expenditure or impacts (e.g. large projects or policies, setting taxes or legal damage assessments), benefits transfer may not be appropriate.

Practical issues: Benefits transfer is used extensively in practice and is certainly a valuable input to appraisal. Its distinct appeal is its expediency and value for money properties in relation to commissioning original valuation studies. However, while the process of reviewing relevant studies and undertaking appropriate analysis can be achieved very quickly (e.g. 5 person days, although longer timeframes may be required depending on the scope of the analysis), benefits transfer is dependent on the existing studies providing suitable valuation evidence (**Box 4.5**). Concerns as to the accuracy of benefits transfer should be explicitly addressed by the analysis, which should provide a transparent account of the available evidence and key assumptions and caveats associated with transferred values.

Box 4.5: Benefits transfer – identifying suitable valuation evidence

Selecting valuation evidence

Benefits transfer provides a quick and cheap alternative to primary valuation. However a number of conditions should be met if it is to provide reliable water valuation evidence. In particular the 'study good' (valued by an existing study) should match the 'policy good' (for which economic value evidence is required for decision-making) in a number of dimensions[1]:

1. The characteristics of the good;
2. The change in the provision of the good; and,
3. The affected population (e.g. users/non-users) and their characteristics.

It is also important to assess the quality and the reliability of source studies for benefits transfer. Potential for conducting a robust benefits transfer depends on the number, quality and diversity of valuation studies available. The larger, the greater the quality and the more diverse the existing set of studies is, the more likely there will be an existing study that is 'close enough' to the policy site for results to be transferable.

Valuation databases - EVRI

A number of databases have been developed to summarize the key content of valuation studies for the purposes of benefits transfer. The most comprehensive database in terms of coverage of valuation studies is the ***Environmental Valuation Reference Inventory (EVRI)***.

EVRI is an Environment Canada initiative and in 2009 its coverage is more than 2200 studies from North America and wider. Content in terms of Canadian water valuation is over 75 studies. EVRI provides a 'searching module' that allows users to describe the environmental good or service that is to be valued and its characteristics. EVRI provides summaries in a format intended to enable an assessment of the match between the 'study good or service' and the 'policy good or service'. (www.evri.ca).

[1] *For further detail on the practical use of benefits transfer, see recent guidance document produced by the Danish Environmental Protection Agency (2007),"Practical tools for value transfer in Denmark – guidelines and an example". Available from :*http://www2.mst.dk/common/Udgivramme/Frame.asp?http://www2.mst.dk/Udgiv/publications/2007/978-87-7052-656-2/html/default_eng.htm *(Accessed April 2009)*

5. RECOMMENDATIONS

This final section of the guidance document provides a set of recommendations for commissioning and undertaking water valuation, including the likely applicability of different valuation methods to different water resource management contexts. These can assist in addressing the question: *What is needed to ensure a successful water valuation analysis?* as set out in **Figure 1.1**. Note that these recommendations apply when it is determined that water valuation is required and feasible.

5.1 Key principles for water valuation

As reviewed in preceding sections, the decision-making context, the scale of policy or investment expenditure and legal requirements will determine the scope of undertaking water valuation in a given situation. A series of considerations are drawn together in Section 3.3 relating to the availability of data, time and resource constraints and the need to establish the appropriate level of effort for water valuation. In conjunction with these practical issues, a successful application of water valuation should also account for two further important aspects: best practice in economic analysis and stakeholder engagement.

Best practice in economic analysis

Fundamental to any water valuation application is to ensure that 'best practice' is followed, both in terms of use of valuation evidence in decision-making and application of valuation methods. In the former case, regarding primary study and secondary valuation evidence, two particular aspects should be highlighted:

- *Transparency of analysis and ensuring an 'audit trail'*: estimates of the economic value of water should always be set into context of the key assumptions, limitations, omissions and uncertainties of the analysis and these elements should always be explicitly reported. This is particularly important to ensure that all stakeholders within a decision-making process are aware of and understand the scope of evidence available for basing decisions upon.

- *Sensitivity analysis*: this should be an integral component of analysis undertaken in quantitative decision-making frameworks (see for example **Box 5.1** with respect to discounting). In particular, limitations of data and uncertainty over environmental effects and monetary values can be compensated for by appropriate sensitivity analysis. As with the approach to valuation, the scale of analysis should be proportionate to the decision in-hand.

For the application of valuation methods, it is important to understand that the methods themselves are subject to continued development and improvement by practitioners, with the 'state of the art' often moving quite rapidly for particular methods (see also discussion in Annex 1; key references for different methods are provided in Annex 2). When undertaking or commissioning primary water valuation studies an essential part of the process should be to establish an advisory or 'steering' group composed of relevant decision-makers and users of the valuation evidence, as well as relevant technical, engineering and scientific experts and other stakeholders to assist practitioners in the analysis. In addition, primary studies should be subjected to expert peer review by leading practitioners in the field, with the objective of critically reviewing the methodological approach, implementation, analysis and results. Similar considerations apply to use of secondary evidence through benefits transfer, although time and effort should again be proportionate to the decision in-hand.

Box 5.1: Discounting and sensitivity analysis

Discounting

Costs and benefits associated with water resource policies and projects may arise at different points in time. For example, the costs of implementing a habitat restoration program may be incurred in the initial years of a project, but the benefits (such as improvements in water quality) may only be experienced in the longer term.

Policy and project analysis requires that costs and benefits that occur at different points in time are comparable. The common method for doing this is discounting, which is a process that adjusts future costs and benefits to present day value terms. Discounting future costs and benefits (by multiplying future monetary values by a discount factor) reflects the general tendency that a gain or improvement that is received today is worth more than the same gain or improvement in the future.

Choice of discount rate

Discounting the projected stream of current and future costs and benefits enables the calculation of the net present value (NPV) of a policy or project. In cost-benefit analysis, NPV is the main indicator of whether a proposal 'passes' on cost-benefit grounds; where a positive NPV indicates that benefits outweigh costs, and a negative NPV vice-versa. Here, the choice of the discount rate is a key consideration for sensitivity analysis in terms of calculating NPV. For example, projects with upfront costs but delayed benefits may pass on cost-benefit grounds if a relatively low discount rate is used, but may not pass with higher rates.

For policy and project analyses in Canada, the choice of the discount rate is at the discretion of the jurisdiction, and a number of considerations may inform the choice in relation to the extent that future outcomes should be weighted via discounting. For example:

- A rate of 8% is recommended by the Treasury Board Secretariat for regulatory proposals, with sensitivity analysis conducted with rates of 3% and 10%. This is based on the opportunity cost of capital (the expected return that is foregone from alternative investment options).
- Lower rates may be more appropriate in the context of reflecting 'social time preference'. For instance, Health Canada has applied a rate of 3% in policy analysis (with sensitivity analysis considering higher rates of 10% and 15%).
- Recent empirical evidence and debate suggests that a declining discount rate over time may be appropriate, particularly for policy relating to long-term decisions (e.g. climate change mitigation).

Given a lack of consensus as to the discount rate to use, current best practice for applying the results of water valuation studies should be to consider a range of discount rate values through sensitivity analysis.

Sources:

Boardman, A.E., Moore, M.A., Vining, A.R. and De Civita, P. (2009) Proposed social discount rate(s) for Canada based on future growth, Policy Research Initiative Working Paper WP039, January 2009.

Hepburn, C., Koundouri, P., Panopoulou, E. and Pantelidis, T. (2009) 'Social discounting under uncertainty: A cross-country comparison', Journal of Environmental Economics and Management, 57, 140-150.

Newell, R., and Pizer, W.A. (2003) 'Discounting the distant future: how much do uncertain rates increase valuations?' Journal of Environmental Economics and Management, 46, 52–71.

Stakeholder involvement in water valuation

A key aspect of integrating water valuation into water resource decision-making is ensuring the approach gains acceptance among all stakeholders involved in the process. In particular, effective and meaningful stakeholder involvement in the water valuation process is essential to:

- Identifying the perspectives with which different stakeholders observe water resources;
- Increasing the appropriateness and relevance of the outcomes of water valuation studies;
- Enhancing stakeholders' understanding, acceptance and appreciation of the resulting information;
- Enhancing the legitimacy of the decision-making process; and
- Providing a strong link between water valuation and the use of this information in decision making.

In addition, recognition of the entirety of the value of water resources highlights benefits and costs that may often be overlooked when addressing water resource management issues. Overall stakeholder involvement within the water valuation and decision-making process can fulfil a role of external validation of the analysis and results. It can also assist at the outset of a study in establishing the scope of the analysis and issues to be addressed, as well as providing technical input where stakeholders hold relevant engineering and environmental science expertise and data.

A variety of approaches to stakeholder involvement in water valuation can be envisaged. The most appropriate approach will likely be determined by specific details of the water resource management issues to be addressed and the decision-making context. Ordinarily the starting point is to identify relevant organizations and groups. Following this, the task is to establish an appropriate engagement process which could involve explicit consultation exercises, establishing advisory boards, including stakeholders on steering groups, and organisation of workshops, etc. **Annex 2** provides a list of key references regarding stakeholder engagement.

5.2 Valuation methods and decision-making contexts

Determining the appropriate valuation method for a specific water resource management issue and context is subject to case- and purpose-specific factors. The choice of undertaking a primary study or benefits transfer will be determined by time and budget constraints, the availability of suitable evidence from existing studies and the need for site- and issue-specific values. Time and budget constraints will also be a factor in determining the choice between different primary study methods. However, these may be viewed as being of secondary importance once the initial decision has been made to proceed with a primary study (although they may be significant in determining the scope of the study that can be implemented, e.g., in terms of data capture or survey samples).

The key consideration should be to identify the valuation method that is most appropriate to the decision-making question and the evidence needs. **Table 5.1** summarizes the likely applicability of different economic valuation methods to different water resource management contexts and the role of water valuation within these contexts. The key 'recommendations' set out in Table 5.1 may be viewed as:

- *Market pricing methods*: are suitable in instances where there is a need to demonstrate the importance of an issue, valuation evidence is required for relatively small changes in the provision of goods and services, a significant proportion of the values is likely to be captured through actual market data and the accuracy requirement is lower. They are unlikely to be suitable for water allocation and pricing issues and many instances of legal damage assessment. However, they are limited to only a proportion of the use values and are relevant only when water is a commodity or there are marketed substitutes (e.g. bottled water for quality and quantity, spending on water filters for quality and water storage for quantity).

- *Production input methods:* can provide estimates of the use value of water as an input to the production of a market good. The requirement for such evidence can span conservation actions, infrastructure investment, water allocation and legal damage assessment issues. However, in these instances, the value from this approach will be only a partial valuation.

- *Revealed preference methods:* can provide estimates in relation to the use values where preferences for a clearly perceived non-market good (e.g. an aspect of environmental amenity or recreation) can be observed from individuals' consumer behavior in actual (surrogate) markets. The two markets of relevance are travel for recreation and housing. The requirement for such evidence can span all water resource management contexts set out in Table 3.1 so long as the water resource of concern is used for recreation or public supply.

- *Stated preference methods*: are the most flexible valuation methods and can provide estimates of both use and non-use values (either jointly or separately) of water potentially for all water management decision making contexts. The potential is determined by the availability of scientific (change) information, time and budget availability and perception of the individuals (economic approaches being limited in contexts where the decision is highly politicized).

- *Benefits transfer*: is most likely to be suitable where there is a need to demonstrate the importance of an issue, valuation evidence is required for relatively 'small' decisions and the accuracy requirement is low - at least until a significant evidence base is built for high accuracy benefits transfer.

Overall, the 'key recommendations' in Table 5.1 (following) reveal considerable overlap, particularly in terms of estimating use values. In the case of establishing how to estimate use values, further consideration of the relative merits of undertaking analysis on data observed in actual markets (e.g., production input approaches and revealed preference methods) versus data from hypothetical markets (stated preference methods) may be worthwhile (**Box 5.2**). Where non-use values are believed to be of significance, the decision is more clear-cut and water valuation will require some form of stated preference approach, although there is still the requirement to select between contingent valuation, choice modeling or apply a combination of both (**Box 5.3**).

Table 5.1: Economic valuation methods and water resource management decision contexts

Water resource management context*	**Role of water valuation**	**Market price approaches**	**Production input approach**	**Hedonic (property) pricing**	**Travel cost method**	**Multi-site recreation demand model**	**Contingent valuation**	**Choice modeling**	***Benefits transfer***
Conservation actions	Estimating the monetary value of benefits associated with conservation actions, or the monetary value of costs associated with degradation – particularly relevant to (environmental) non-market goods and services and estimating TEV	Can provide proxy for some *use values* so far as conservation action influences the availability of water as a commodity	Can estimate *use value* if water is an input to production which benefits from conservation action	Can estimate *use value* if conservation action influences the availability of water supply (or the amenity of landscape influenced by water) which in turn affect house prices	Can estimate *use value* to recreation users of conservation action	Can estimate *use value* of conservation action in terms of environmental characteristics of different recreation sites	Can estimate *TEV* associated with the entire conservation action	Can estimate *TEV* associated with the individual aspects of conservation action in terms of changes to different aspects of the water environment	*Evidence likely to be suitable in case of demonstrating importance of issue and relatively small changes in provision and/or impacts where a greater degree of uncertainty in evidence can be accommodated*
Infrastructure investments	Estimating the monetary value of outcomes associated with proposed projects for the purpose of providing a consistent comparison between competing projects and between the environmental and economic costs and benefits of a given project	Can provide proxy for *use value* but evidence only likely to be suitable in cases of relatively small changes	Can estimate *use value* if project affects water as input to production	Can estimate *use value* if the project affects the availability of water as an attribute of house price	Can estimate *use value* if the project affects the different aspects of a recreation site	Can estimate *use value* if the project affects the different aspects of a recreation site differently	Can estimate *TEV* of the bundle of project outcomes	Can estimate *TEV* of the individual project outcomes	*Evidence likely to be suitable in case of relatively small changes in provision and/or impacts where a greater degree of uncertainty in evidence can be accommodated*
Water quality standard setting	Estimating the monetary value of changes in water quality (e.g. benefits associated with improvements or avoided deterioration in water quality, such as reduction in health risk)	Can provide a proxy for *use value* but evidence only likely to be suitable in cases of relatively small changes in water quality and as a minimum estimate of benefits	Can estimate change in *use value* to users where the change in water quality affects production processes	Can estimate *use value* in location-specific cases where the change in water quality is perceived to affect house prices	Can estimate *use value* if the change in water quality impacts on recreation users	Can estimate *use value* if changes in water quality affect different recreation sites	Can estimate *TEV* associated with change in water quality	Can estimate *TEV* associated with change in water quality and individual aspects of the change (e.g. benefit to recreation users, species, etc.)	*Likely to be suitable for relatively small changes in water quality where a greater degree of uncertainty in evidence can be accommodated*
Water allocation	Estimating monetary value of marginal changes in the provision of market and non-market goods and services affected by proposed project	Can provide proxy for *use value* but evidence only likely to be suitable in cases of relatively small changes in provision and impacts and where water is a commodity	Can estimate change in *use value* to users of water as an input to their production processes (allocation to agriculture, industry, commerce, etc.)	Can estimate *use value* in location-specific cases where water allocation impacts on public supply to properties or the amount of water left in the environment (landscape)	Can estimate *use value* where water allocation impacts on recreation users	Can estimate *use value* if water allocation impacts on different aspects of recreation sites	Can estimate *TEV* associated with change in water allocation between uses	Can estimate *TEV* of each allocation of water where each allocation is an attribute of water and different uses can be prioritized	*Unlikely to be suitable where requirement for accuracy in evidence is high to ensure 'optimal' outcome*

Water resource management context*	**Role of water valuation**	**Market price approaches**	**Production input approach**	**Hedonic (property) pricing**	**Travel cost method**	**Multi-site recreation demand model**	**Contingent valuation**	**Choice modeling**	***Benefits transfer***
Water pricing	Estimating monetary value of marginal changes in the provision of market and non-market goods and services affected by proposed pricing policy (charge, fee, tax, etc.)	Unlikely to provide suitable evidence for establishing level of price	Cannot provide evidence for establishing level of charge, fee or tax but can analyze the impact on *use value* of change in water price	Can provide *use value* evidence for establishing level of price which is intended to account for impacts on readily perceived element of environmental amenity	Can provide *use value* evidence for establishing level of price which is intended to account for impacts on environmental amenity where recreation use is of relevance	Can provide *use value* evidence for establishing level of price which is intended to account for impacts on environmental amenity where recreation use is of relevance	Can provide *TEV* evidence for establishing level of price which is intended to account for social and environment impacts	Can provide *TEV* evidence for establishing level of price which is intended to account for social and environment impacts	*Unlikely to be suitable where requirement for accuracy in evidence is high to ensure 'optimal' outcome*
Compensation for damage or use	Estimating the monetary value of market and non-market impacts (i.e. social and environmental) arising from abstraction, use, consumption or pollution of water resources	Can provide a minimum estimate of *use value* for compensating the loss of water as a commodity	Can estimate *use value* associated with damages due to water not being available as an input to production process	Can estimate *use value* in location-specific cases where damages are to readily perceived element of environmental amenity	Can estimate *use value* associated with damages to recreation sites	Can estimate *use value* associated with damages to recreation sites	Can estimate *TEV* associated with the entire damage	Can estimate *TEV* associated with damages if different attributes of the water resource or environment are affected differently	*Unlikely to be suitable where requirement for accuracy in evidence is high to ensure confidence in legal decision*

Note: *See Table 3.1 for linking water resource management contexts (e.g. conservation actions, infrastructure investment, water quality standard setting, water allocation, water pricing and compensation for damage and use) to decision-making contexts (demonstrating the importance of an issue, setting priorities, project analysis, policy analysis, establishing the basis for charges or taxes, legal damage assessments and green accounting).

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Box 5.2: Observed market data versus hypothetical market data

Whether justified or not, there is a tendency for revealed preference data to be viewed as more ‘credible’ than stated preference data. This is because revealed preference estimates of use value are based on behavior observed in actual markets (e.g. property, land, agriculture) - even if the value is indirectly inferred from an actual market - rather than from stated responses to hypothetical market scenarios. In contrast, stated preference methods face potential ‘hypothetical bias’ - specifically that willingness to pay estimates may be biased upwards since no actual payment is collected from respondents - and in most instances the size of the bias may not be easy to determine.

However, stated preference techniques may be preferred over revealed preference methods on the basis of their flexibility, particularly with regards to valuing changes in provision that have not been previously experienced (and hence no revealed preference data exists), or those not ‘readily’ perceived by individuals (such as risks to health) in buying and selling decisions. Moreover, where non-use values are of interest, stated preference methods are the only approach that can capture this element of TEV.

Box 5.3: Stated preference methods – contingent valuation or choice modeling?

The choice of whether to apply a contingent valuation or choice modeling approach is in part determined by the nature of the ‘good’ that is subject to change. In a contingent valuation approach the good to be valued is ordinarily defined as a ‘bundle’ of different characteristics (e.g. water quality, abundance of species, visitor facilities, etc.) and willingness to pay is sought for the entirety of the bundle. In a choice modeling approach respondents are presented with a good that is defined in terms of its characteristics (‘attributes’), and willingness to pay is estimated for changes in the levels of individual attributes.

An example of how the two approaches differ from one another and also how they can be used in combination is given in Adamowicz et al. (2007) in relation to determining the benefits of reducing health risks from drinking water in Canada. A choice modeling approach was specifically implemented to determine the trade-off between individual attributes of the good ‘tap water’: household water cost, morbidity and mortality health risks from microbial disease and bladder cancer. A contingent valuation question was used to value specific ‘programs’ that reduced health risks.

Comparison between the willingness to pay estimates from the two approaches allows for the ‘validity’ of the results to be assessed; the study found that the estimates derived from the contingent valuation method fell within the range of values estimated by the choice experiment approach.

Source: Adamowicz, W., Dupont, D., Krupnick, A., and Zhang, J. (2007) 'Valuation of cancer and microbial disease risk reduction in municipal drinking water: an analysis of risk context using multiple valuation methods', Resource for the Future Discussion Paper, 07-39.

5.3 Conclusion

This guidance document is intended to assist water resource managers to identify situations in which water valuation evidence can improve decision-making. Water management issues where water valuation can be of use include conservation actions, infrastructure investment, water quality standard setting, water pricing, water allocation and assessing compensation for use or damage.

Application of valuation methods can be challenging and expertise of valuation practitioners will be required in undertaking analysis as well as input from relevant technical, engineering and scientific experts and other stakeholders. However, the context and scope for water valuation will be determined by the needs of water resource managers and the objective of the decision-making process.

This guidance document sets out the basic concepts of water valuation and different valuation methods, emphasizing their practical application. Key guidance provided includes:

- Identifying the role of water valuation in different decision-making and water resource management contexts (as summarized in Table 3.1); and
- Providing recommendations as to the applicability of specific valuation methods in different water resource management contexts (as summarized in Table 5.1).

The overall framework for assessing the scope and requirement for water valuation is presented as a series of questions to review, in order to identify an appropriate course of action in a given situation (see Figure 1.1). The basic steps of the framework are:

- Define the water resource issue and decision context;
- Determine if water valuation is required and feasible;
- Identify an appropriate water valuation method; and
- Undertake/commission analysis.

In applying the framework the purpose should be to make decisions about undertaking water valuation on the basis of practical considerations to ensure that subsequent analysis fulfils the requirements of the decision-making process.

GLOSSARY

Affected population	The population of the users and non-users that are affected by the change in the provision of a market or non-market good or service.
Altruistic value	Non-use benefit derived from the knowledge that contemporaries are able to enjoy the goods and services related to natural resources.
Appraisal	The process of assessing relative merits of proposed policies or projects before they are implemented.
Benefits transfer	An approach to economic valuation which makes use of secondary valuation evidence (from existing studies) in new decision-making contexts.
Bequest value	Non-use value associated with the knowledge that natural resources will be passed on to future generations.
Bio-economic models	Tools that link changes in natural resources and the environment to outcomes in terms of expected changes in wellbeing.
Choice experiment	A form of choice modeling in which respondents are presented with a series of alternatives and asked to choose their most preferred.
Choice modeling	An umbrella term for a variety of stated preference questionnaire based valuation techniques that infer willingness to pay or accept indirectly from responses stated by respondents (as opposed to directly asking as in a contingent valuation survey).
Consumer surplus	The difference between price paid and the maximum dollar amount an individual is willing to pay to obtain a good; this reflects the additional benefit that is gained by consumers in consumption of a good or service.
Contingent ranking	A form of choice modeling in which respondents are presented with a number of scenarios and asked to rank them individually on a semantic or numeric scale.
Contingent valuation	A stated preference approach to valuing non-market goods and services where individuals are asked what they are willing to pay (or accept) for a change in provision of a non-market good or service.
Cost-benefit analysis (CBA)	A decision-making tool that compares costs and benefits of a proposed policy or project in monetary terms.
Cost-effectiveness analysis (CEA)	A decision-making tool that compares the cost of different options for achieving the same or similar outcomes.
Cost function approach	A production input method which relates the output of a given good

	(e.g. agricultural products) to the cost of its factor inputs (e.g. the quantity or quality of water).
Cost of alternatives	A market pricing approach that considers the cost of providing a substitute well which would provide a similar function to a resource.
Cost of illness	A market pricing approach where a proxy value can be inferred from the cost of illness (e.g. medical treatment, loss of earnings from work days lost, etc.) incurred when it is not available.
Cultural services	A category of ecosystem services that relates to the non-material benefits obtained from ecosystems, for example through recreation.
Direct use value	Economic value associated with use of a resource in either a consumptive manner or non-consumptive manner.
Discounting	The process of expressing future values in present value terms. This allows for the comparison of flows of cost and benefit over time regardless of when they occur.
Econometrics	'Empirical economic analysis' via the application of quantitative or statistical methods (e.g. estimating a production or cost function to assess the effect of a change in water input – quantity or quality – on output of a market good, such as agricultural products).
Economic efficiency	A concept that relates to allocating resources to maximize wellbeing to society.
Economic jurisdiction	The spatial area over which some positive economic value is associated with the use of a resource and the services provided or supported by it.
Economic value	What is 'given up' (or 'foregone' or 'exchanged') in order to obtain a good or service.
Ecosystem services approach	A term that is used to describe a framework for analyzing how human populations are dependent upon the condition of the natural environment. The approach explicitly recognizes that ecosystems and the biological diversity contained within them contribute to individual and social wellbeing.
Environmental impact assessment (EIA)	Identification and assessment of environmental impacts resulting from a proposed policy or project.
EVRI	The Environmental Valuation Reference Inventory. A database of existing economic valuation evidence (i.e. secondary evidence) for the purpose of facilitating benefits transfer.
Evaluation	Retrospective analysis of a policy or project that assesses how successful or otherwise it has been.

Existence value	Non-use value derived from knowing that a resource continues to exist, regardless of use made of it by oneself or others now or in the future.
Geographic information system (GIS)	An information system that captures, stores, analyzes, manages, and presents data that is linked to geographic location.
Green accounting	The modification of national (income or corporate) accounts to include environmental capital within the measure of wealth (alongside man-made, human and potentially social capital).
Health-risk assessment (HRA)	Assessment of adverse health outcomes from proposed actions (e.g. the number of people affected and risk of illness).
Hedonic pricing method	A revealed preference valuation method that estimates the use value of a non-market good or service by examining the relationship between the non-market good and the demand for some market-priced complementary good (e.g. property or land prices).
Indirect use value	Economic value associated with the services supported by a resource as opposed to the actual use of the resource itself; e.g. key ecosystem services such as nutrient cycling, habitat provision and climate regulation are all supported by water.
Legal damage assessment	The assessment of compensation required for damages to environmental resources. This includes determining the value of environmental damages and the scale of compensation required for damage.
Life-cycle analysis (LCA)	The assessment of all effects of a proposed action over the whole-life cycle of changes brought about by a project or policy.
Marginal change	An incremental change (ordinarily a 'unit change') in the provision of a market or non-market good or service.
Market goods	Goods and services traded in traditional markets.
Market price	The value of the provision of goods and services that may be directly observed from normal markets.
Market price methods	Approaches to economic valuation that provide proxy estimates - which may be observed directly from actual markets - for use values that arise in relation to the provision of goods and services.
Mitigation costs	A market pricing approach that considers costs incurred to mitigate against particular outcomes associated with the degradation of a resource.
Monetization	The assignment of a monetary value to a change in the provision of a non-market good or service.

Multi-criteria analysis (MCA)	A type of decision-making tool that normally combines both quantitative and qualitative assessments of alternative policy and project outcomes.
Net present value (NPV)	The difference between the present value of costs and the present value of benefits.
Multi-site recreation demand model	A revealed preference method that infers the value of changes in the characteristics of goods and services from the choices individuals make between similar alternatives. May also be termed 'random utility model' or 'discrete choice model'.
Non-market goods	Goods and services that are not traded in markets and are consequently 'un-priced' (e.g. environmental goods and services).
Non-use value (passive use value)	Economic value not associated with any use of a resource, but derived altruistic, bequest and existence values.
Non-users	Population group(s) that derives economic value from a resource even though they do not make direct or indirect use of it (i.e. non-use value).
Opportunity cost	The value of the next best alternative use of resource (e.g. the opportunity cost of retaining water in rivers may be the value of lost agricultural output from using water for irrigation).
Option value	Benefits associated with retaining the option to make use of resources in the future.
Political jurisdiction	Households within a political bounded area such as provincial, territorial, municipal and local boards.
Present value	A future value expressed in present terms by means of discounting.
Primary valuation	A term that refers to undertaking an economic valuation study (as opposed to using secondary evidence sourced from existing valuation studies via benefits transfer).
Producer surplus	The difference between the minimum amount a seller is willing to accept for a good and the actual price received; this reflects the additional benefit in exchange gained by the producer (e.g. 'profit').
Production function approach	A production input method which relates the output of a given good (e.g. agricultural products) to its factor inputs (e.g. the quantity or quality of water).
Production input methods	Economic valuation methods that focus on the indirect relationship that exists between a particular resource (e.g. water) and the production of a market good (e.g. agricultural products).

Policy/project analysis	The appraisal or evaluation of policies or regulations and standards (policy analysis) or investment projects (project analysis).
Provisioning services	A category of ecosystem services which relates to products obtained from ecosystems, such as food, fiber and fuel, natural medicines and genetic resources.
Quasi-option value	A use value related to option value, which arises through avoiding or delaying irreversible decisions, where technological and knowledge improvements can alter the optimal management of a natural resource such as water.
Regulating services	A category of ecosystem services which refers to the regulation of ecosystem processes such as climate regulation, air quality regulation, water regulation (e.g. flood control), water quality regulation (purification/detoxification) and erosion control.
Revealed preference methods	Economic valuation methods that estimate the use value of non-market goods and services by observing behavior related to market goods and services (e.g. travel cost method and hedonic pricing method).
Secondary evidence	Economic valuation evidence provided by existing studies that can be an input to benefits transfer.
Shadow price	The opportunity cost to society of some activity, relating to situations where market prices do not reflect the scarcity value (i.e. opportunity cost) of the use of a good or service.
Shadow project costs	A market pricing approach that focuses on the cost of compensating for the loss of an environmental resource at a particular site by assessing the cost of providing an equal resource at an alternative site.
Stated preference methods	Economic valuation methods that use questionnaire surveys to elicit individuals' preferences (i.e. willingness to pay and/or willingness to accept) for changes in the provision of non-market goods or services.
Subsidy cost	A market pricing approach where a proxy value for non-market environmental goods may be inferred from subsidies paid to provide them.
Supporting services	A category of ecosystem services which are necessary for the production of all other ecosystem services, such as soil formation and retention, nutrient cycling, water cycling and the provision of habitat.
Total economic value (TEV)	The economic value of a resource comprised of its use and non-use values.

Travel cost method	A revealed preference and survey based valuation method that uses the cost incurred by individuals traveling and gaining access to a recreation site as a proxy for the recreational use value of that site.
Use value	The economic value that is derived from using or having potential to use a resource. It is the net sum of direct use values, indirect use values and option values.
Users	Population group(s) that are composed of individuals making direct use of a resource or indirect use of a resource.
Water valuation	The determination of the economic value of water in a particular use and location, accounting for both the use of water as commodity and the ecosystem services provided or supported by water resources.
Wellbeing	A measure of satisfaction or 'utility' gained from a good or service.
Willingness to accept compensation (WTA)	The monetary measure of the value of forgoing a gain in the provision of a good or service or allowing a loss.
Willingness to pay (WTP)	The monetary measure of the value of obtaining a gain in the provision of good or service or avoiding a loss.

ANNEX 1: DETAILED SUMMARY OF VALUATION METHODS

A1.1 Market price methods

Objective: Market price approaches consider the costs arising in relation to the provision of goods and services that may be directly observed from normal markets. Summarized here are a number of different market price approaches: opportunity cost; cost of alternatives; mitigation costs; shadow project costs; cost of illness; and subsidy cost.

Value concept/context: Application of pricing approaches typically informs on either direct or indirect use values associated with goods and services (but see discussion below). Pricing approaches are best thought of as providing a ‘proxy value’ for non-market goods and services.

Theoretical basis: Pricing approaches are ‘non-demand-curve’ methods of estimating the value of non-market goods and services. Whereas economic valuation techniques attempt to derive recognized measures of economic value, such as consumer surplus, pricing approaches do not. As such, they do not correspond with the notion of total economic value and measures of willingness to pay. Instead, these approaches provide a proxy of value by considering supply-side aspects. The following briefly summarizes the basis of several different approaches (Bateman, 1999).

- ***Opportunity cost***: This approach explicitly considers the value that is foregone in order to protect, enhance or create a particular environmental asset. For example, creation of a new forest implies the loss of land, typically for agricultural purposes. The opportunity cost of this action is then the value (net of subsidies) of agricultural production foregone from land taken for the forest. Correspondingly, the value of the forest is at least equal to this opportunity cost.

- ***Cost of alternatives***: By considering the cost of providing a substitute good which would provide a similar function to a non-market good, a proxy value of that non-market good can be inferred. For example, wetlands which provide flood protection may be valued on the basis of the cost of building man-made flood defenses of equal effectiveness. Given that flood protection is one of many wetland services, the value of the wetland is at least as much as the cost of the man-made protection that would be required in the absence of the wetland.

- ***Mitigation costs/avertive behavior***: The price paid by individuals in order to mitigate against environmental impacts provides a basic monetary assessment of those impacts. For instance the cost of water filtration may be used as a proxy for the value of water pollution damages.

- ***Shadow project costs***: The value of a non-market good foregone can be considered the cost of providing an equal non-market good at an alternative location. Typically there are three potential scenarios: (i) asset reconstruction, which is the provision of an alternative site (e.g. a habitat); (ii) asset transplantation, which is moving the environmental feature, such as a habitat to a new site; and (iii) asset restoration, which entails enhancing an existing site that is currently degraded. The cost of the preferred option may then be applied as a minimum 'price' of the threatened environmental asset.

- ***Cost of illness***: The value of a necessary non-market good, such as clean drinking water, can be interpreted as equal to the cost of illness incurred when it is not available. That could include medical expenditures, losses due to reduced labor, and personal detriments.

- ***Subsidy cost***: An indication of the value of non-market goods may be inferred by considering the subsidies paid directly to producers for adopting production methods that are environmentally benign or beneficial. A common example would be subsidies paid to the agricultural sector for environmentally sensitive practices.

Water valuation applications: The list of applications presented here is not necessarily exhaustive, but is representative of the most common applications for market-based valuation of water resources.

Approach	*Application*
Opportunity cost	Foregone revenues due to conservation areas/policies
Cost of alternatives	Natural restoration of ecosystem versus man-made alternatives
Mitigation costs	Cost of filtration of drinking water or environmental remediation
Shadow project costs	Water-related impacts of development of built environment
Cost of illness	Drinking water contamination
Subsidy cost	Payments for ecosystem services (i.e., watershed conservation)

Process of implementation: Application of pricing approaches to value the environment primarily relies on the use of price data observed from relevant markets. The first step in the process is to determine which market price approach to take. Once that is determined, the procedure can be envisaged similarly for all market price approaches (**Figure A1.1**).

Figure A1.1: Process of Implementing a Market Approach to Valuation

Step 1	Identify Approach	What are you trying to value and why?

↓

Step 2	Identify comparable good	What costs/benefits can you compare?

↓

Step	Data	Collate data and adjust to derive proxy value

3		
↓		
Step 4	Aggregate	Across community, total affected population, etc.

Data needs: Market data may be collected from secondary sources, or by primary collation. The availability of data may depend on the pricing approach which is adopted.

Other practical issues of implementation: Since pricing approaches make use of observable market data and require little manipulation (i.e. adjust for price distortions) in order to derive proxies of value, the approach (subject to the actual collection of data) can likely be implemented in a relatively short-time frame.

Principal outputs: As noted, the outputs of pricing approaches do not reflect measures of value as prescribed by economic theory. Principally, the proxy values derived will reflect the *minimum* value of non-market goods and services since they do not account for any excess of willingness to pay over price paid (e.g. consumer surplus).

Transferability of outputs: The transferability of outputs from pricing approaches will likely depend on the extent of the market. For example, the unit cost applied in the opportunity cost approach (e.g. the market price of domestic water supply) may vary according to location; hence, it would be more appropriate to use the unit cost relevant to the area of interest.

Key uses – decision-making context(s): Use of market values is typically related to appraisal contexts, and as such may be inputted into policy and project analysis. In practice, mitigation costs or shadow project costs, may also be used as a minimum/lower bound basis for setting compensation or legal damage assessments, although note that these values do not typically reflect welfare losses that are incurred.

Key uses – coverage of the natural environment: The coverage of the natural environment by pricing approaches will be dependent on the extent to which markets relevant to the non-market good or service in question exist.

Discussion: Market value approaches, as outlined above, typically only provide monetary proxies or ‘benchmarks’ against which the value of the non-market good in question can be judged. Values that may be derived from these approaches do not represent true valuations as the assessment only considers whether the non-market good is of greater value than the opportunity cost (Bateman, 1999). Primarily, the application of pricing rather than valuation methods leads to the risk of under-valuation of non-market goods. To expand, knowing the price of a good only informs on the cost of obtaining that good, rather than the actual benefit derived from the ‘consumption’ of the good. As suggested, the values derived from the opportunity cost, cost of alternatives, mitigation costs, shadow project costs, and cost of illness are a benchmark set by the market. However, it is important to note that the use of subsidy costs will typically rely on what may be arbitrary values set by government which do not reflect opportunity cost.

With regards to opportunity costs, it is likely that the market price of output is likely to over-estimate the true opportunity cost of an action due to distorted market structures which reflect the political objectives rather than competitive relationships. This may be particularly true when considering the agricultural sector. Highly intervened markets imply a certain degree of complexity in the link between market prices and underlying costs, suggesting that it may be difficult to assess the value of non-market goods in this manner.

Note also that mitigation costs will typically only provide a partial assessment of the environmental impact of interest. For instance, the cost of water filtration in order to improve water quality will only account for the impact that is experienced by water suppliers and their customers, and will not account for water pollution damages to aquatic ecosystems.

Consideration of distributional impacts: Where markets are distorted, values observed in markets may actually reflect the preferences of government, who are essentially acting as a single arbiter of valuation, and/or particular interest groups, rather than the 'true' value of the non-market goods and services to society. This may result in insufficient weighting of values held by a significant number of individuals not represented by interest groups involved in the political process.

Advantages and disadvantages: Generally, pricing approaches can be useful in providing an indicative monetary assessment of the value of non-market goods that might otherwise be regarded as 'free'. In addition, data may be readily attainable in the form of observable market prices, although some caution is needed in order to account for price distortions. Strictly though, use of market values which can inform on the price of obtaining a particular non-market good, does not inform on the value of the non-market good, and as such it is likely that pricing approaches will lead to under-estimates of the 'true' value of non-market goods and services.

Conflicts and synergies with other methods: Some aspects of pricing approaches, such as mitigation costs, may actually serve as inputs into the production function approach framework (see below). Note however, that in this context, these costs are an input to the analysis in that they are likely to alter production or cost functions. The production function approach enables estimates of changes in consumer and producer surpluses to be estimated as a result of changes in the provision of non-market goods and services which are inputs to production processes (e.g. water quality).

Example

Title: The Catskills Escarpment

Location: New York, USA

Sample: n/a

Valuation: n/a

Analysis: Mitigation costs / Costs of alternatives.

Discussion: The most widely referenced case of water valuation and management is from the Catskill Escarpment, the area from which the drinking water of New York City is drawn. To meet the U.S. Environmental Protection Agency's (US EPA) water quality requirements in 1989, the City would have had to invest US $2-6 billion to construct and US $300 million annually to operate a new water treatment plant. It was determined, however, that the same level of water quality could be reached by carrying out a widespread conservation scheme in the Catskill Escarpment, at the much lower cost of US $1-1.5 billion initially and with future maintenance costs much lower than the US $300 million for maintenance of a water treatment plant.

Although the organizations involved in this case did not seek specifically to value the water resources, the reasoning follows a market price approach to economic valuation (that of mitigation cost). The value of water can be viewed as worth the billions that the city was originally planning to spend to filter it.

Outcomes: By developing this ecological approach, the city spent considerably less than if it had carried out the industrial filtrations, and so greatly increased overall social welfare. The arrangement has been very successful and the City of New York still receives a waiver from the US EPA that allows it to not filter water from this watershed, providing it maintains the ecological quality of the region.

A1.2 Production/cost function approaches

Objective: The production function approach (PFA) focuses on the (indirect) relationship that may exist between a particular non-market good or service and the production of a marketed good. In particular, the value of the non-market good or service is inferred by considering changes in production of market goods that arise as a result of changes in the provision of the non-market good or service.

Value concept: Indirect use value component of TEV.

Theoretical basis: The PFA considers non-market goods and services as inputs into production processes which lead to the output of marketed goods and services. Specifically, inputs to production processes such as land, labor and capital as well as environmental and other non-market inputs are known as factor inputs. Accordingly, changes in non-market inputs will lead to changes in a firm's production costs, which in turn will affect the quantity of output and price of the final market good. The change may also affect returns to factor inputs (e.g. rent to land and capital, wages to labor). Ultimately, changes in market output, price, and factor returns will result in changes in consumer and producer surpluses. The change in these surpluses gives an estimate of the value of the non-market good or service in its function as a factor input.

As its name suggests, the PFA focuses on the production function, which relates the output of a given good to its factor inputs. The same effect can be analyzed, however, by considering the cost function, which relates the cost of production of a given good to the cost of factor inputs (e.g. the quantity of the input multiplied by the price of the input). Considering the cost function rather than the production function entails a cost function approach (CFA). For all intents and purposes however, the two approaches are synonymous.

Freeman (1993) identifies two channels through which a change in the provision of a non-market input can lead to changes in surpluses (although, strictly in the context of a competitive industry). In the first case, the change in the input affects the production costs of all firms. For example, an improvement in water quality could lower production costs previously associated with filtration, potentially enabling more output to be produced and reducing market price. Here, consumers benefit from increased consumer surplus. The second channel focuses on a single producer who alone experiences a change in the input. In this example the firm's marginal costs change; if the improvement in environmental quality lowers the marginal cost of production while overall market price remains unchanged, the firm will benefit from increased producer surplus.

Water valuation applications: At-site value of water to direct users (e.g. agriculture, manufacturing, etc.).

Process of implementation: Estimating the value of non-market goods and services via the PFA requires a fair degree of analytical rigor, particularly in identifying and specifying the relationship between different factors in the production and/or cost functions. The process of implementation is typically as follows: (**Figure A1.2**).

Figure A1.2: Process of implementing a production/cost function approach to valuation

Step 1	Collate data	• Market data on price, output, and demand • Data on factor inputs and outputs • Measure of the non-market input
↓		
Step 2	Derive production/cost function	Two methods to estimate function: • Econometric techniques • Simulation approaches
↓		
Step 3	Estimate changes in producer surplus	Effects of changes in production and costs are analyzed in relation to final market supply and demand in order to estimate changes in surplus.

Data needs: As indicated above, implementation of the PFA requires a considerable amount of data regarding the final goods market and factor inputs. It is also necessary that the production function and market structure be specified.

Other practical issues of implementation: Implementing the PFA requires statistical (econometric) expertise. The time frame for analysis is likely to range from 3 months to 6 months depending on the extent of analysis.

Principal outputs: The PFA enables the value of non-market goods and services to be expressed in a manner consistent with economic theory, namely in terms of consumer and producer surplus. Derivation of production and/or cost functions also enables the effect of a change in the environmental input to be expressed in terms of its impact on output or production costs.

Transferability of outputs: Transferability of values derived from the PFA is likely to be limited, since the estimates of consumer and producer surplus are based on the specific features of the final good market, the underlying factor input relationships and specified production and cost functions.

Key uses – decision-making context(s): The PFA provides an explicit method for estimating the importance of non-market goods and services in the production of market goods and services, or conversely, the negative impact that unwanted inputs (e.g. pollution) can have on production processes. Hence, the approach is suited to a 'demonstration' of the importance of issues, as well as potentially feeding into policy and project analyses and also providing a basis for legal damage assessments.

Key uses – coverage of the natural environment: Non-market goods and services serve as inputs to a number of market products and empirical examples of the PFA are numerous. For instance, a common example of the PFA applications is in the assessment of air quality (or air pollution) effects on agricultural and forestry production levels and production costs. As demonstrated by Freeman (1993) the approach can also be used to assess the effect of water quality (or water pollution) on agriculture, forestry, fisheries output and production costs as well as the cost of domestic water supply. Finally, the PFA can also be applied to assess soil fertility (or soil erosion) as a factor input to the production of agricultural commodities.

Discussion: In practice it may be difficult to assess the response of production to changes in non-market factor inputs. The PFA requires the assumption that producers (and consumers) act to optimize their behavior in order to allow estimates of change in producer and consumer surplus to be derived. Also, a number of considerations underline the complexity of analysis, including the nature of production (single or multi-product firms), the market structure (e.g. vertically linked markets) and the presence of market distortions (e.g. monopoly power, price subsidies, etc.).

Notably, Freeman (1993) distinguishes between production and cost function approaches and those based on a dose-response methodology. The latter entails estimating a dose/damage function (e.g., which relates a measure of pollution to physical damage) and applying this function to an inventory of materials exposed or at risk, which is then multiplied by some unit value. For instance, the dose-response approach may be used to analyze the effect of water pollution on agricultural production by estimating the consequential reduction in harvestable yield and multiplying this by the market price of output. This approach however ignores the impacts on consumers resulting from changes in market price and changes in production costs. Instead, Freeman highlights that the PFA and the CFA represent properly specified economic models of the effect of pollution on producers. These models link the physical effect of changes in the provision of non-market goods and services to changes in market prices and output and ultimately changes in consumer and producer surpluses. The approach incorporates the whole range of possible producer responses (e.g. material substitutions, increased mitigation activities, etc) to changes in non-market factors.

Consideration of distributional impacts: Estimates of the value of non-market goods and services are derived from real market data and therefore changes in consumer (and producer) surplus only reflect the value of the good to those engaged in the market.

Advantages and disadvantages: Due to confidentiality reasons, data on cost structures and functions may be difficult to obtain. Generally, the effect of the non-market input on output is more observable, and typically more often analyzed (i.e. the PFA approach).

Conflicts and synergies with other methods: Mitigation costs/averting expenditures and avoided costs may be included within the PFA framework, since these actions will alter production and cost functions.

Example

Title: The Value of Water in Manufacturing (Renzetti and Dupont, 2003)

Location: Canada

Sample: 58 cross-sectional observations by province and 2-digit Standard Industrial Classification

Valuation: The value of intake water to the manufacturing process

Analysis: Cost function estimation

Discussion: Renzetti and Dupont (2003) provide an example of the production/cost function method by estimating a restricted cost function for Canadian manufacturing that included variables related to water input.

The authors of this study estimate a restricted cost function that includes the price inputs of labor, capital, energy, materials, internal water recirculation, and water treatment, as well as the quantity of water intake and manufacturing output. A few other dummy variables were also included, such as geographic or regulatory characteristics of the province in which a manufacturer was located. Once the coefficients of the cost function were estimated, they could be used to calculate various features of the manufacturing process, specifically the shadow value of intake water.

The mean value for the shadow price of water in Canadian manufacturing was estimated at CAN\$0.046/m^3 or CAN\$56.76/acre-foot. The value was significantly different from zero, but relatively small compared to previous American studies. The benefit of using a production or cost function to reach this value is that the authors could easily see how that value changes with various factors, such as other input prices or the scale of operations. The results are telling of the regulatory environment in Canada, where large firms do not place greater value on water than small firms and the value of water does not significantly change when manufacturers have to pay the provincial government for their intake. It seems that the permitted uptake and price of that uptake could easily be tightened and increased respectively in order to reach a more socially acceptable value of water in the Canadian manufacturing sector.

Outcomes: Estimated the shadow price of water for Canadian manufacturers that can be used to help inform water allocation decisions (when comparing allocation across various sectors) and to input into national accounting of natural capital.

A1.3 Hedonic pricing method

Objective - The hedonic property pricing (HPP) approach to valuing non-market goods and services is based on the commonly accepted notion that the price at which a property sells in the market is determined, in part, by the specific characteristics of the property's structure, location and environs. Among these characteristics it is reasonable to expect that environmental goods and services such as landscape amenity, noise and air quality may be included. Hence, it may be expected that properties which feature higher levels of desirable environmental characteristics will command a higher market price than similar properties with lower levels of those same characteristics.

Value concept - Direct use value component of TEV.

Theoretical basis - Hedonic property pricing is a particular application of the hedonic pricing method (HPM), which estimates the value of a non-market good or service by examining the relationship between the non-market good and the demand for some market-priced complementary good (see Freeman, 1993). The HPM approach is based on the notion of 'weak complementarity' (Maler, 1974), where improvements in characteristics such as environmental quality typically raise the market price of complementary market goods. Hedonic pricing methods enable an estimate of the magnitude of that increase to be derived; or the loss if environmental quality declines. While HPM can be applied to a number of different complementary relationships, it is most often applied in practice to the valuation of environmental goods such as landscape amenity, noise and water quality as reflected in the property market (i.e. HPP).

With respect to HPP, differences in market price of property that result from specific characteristics of the property may be termed as the 'price differential' attributable to that characteristic. There are likely to be many different characteristics that might command a price differential. For example, the number of rooms, size of yard, proximity to transport links and public services, environmental quality (air quality, peace and quiet, availability of water, etc), neighborhood characteristics (e.g. rate of crime), and so on. Hedonic property pricing therefore seeks to isolate the effect that non-market goods and services have on property price.

Water valuation applications: At-source value for access to water or changes in water quantity or quality.

Process of implementation: Hedonic pricing employs multiple regression econometric techniques and requires two stages of analysis (see Day, 2005) (**Figures A1.3 and A1.4**). As with all econometric analyses, the implementation of HPP is dependent on the quality of data, the specification of an appropriate functional form for the hedonic price function (e.g. linear, etc), the inclusion or omission of explanatory variables in the initial analysis, etc.

Figure A1.3: Implementing hedonic pricing – Stage 1

Step 1	Data collection	Collate data from secondary sources (e.g. dataset of property prices) and/or primary survey
↓		
Step 2	Determine hedonic price function	Regress property price against explanatory variables (property characteristics, including a measure of the non-market good/service to be valued).
↓		
Step 3	Derive implicit price function	Take the partial derivative of the hedonic price function in relation to the non-market good/service of interest.

Figure A1.4: Implementing hedonic pricing – Stage 2

Step 1	Estimate demand curve for characteristic of interest	Regress quantity of characteristic (non-market good) against implicit price and other relevant variables (e.g. socio-economic variables)
↓		
Step 2	Change in consumer surplus due to change in environmental good	Integrate demand curve with respect to the quantity of non-market good between its initial and final levels.

Data needs: Practical applications of HPP require large amounts of data, particularly on property prices and property characteristics. Compilation of data on determinants of house prices may be difficult to measure and obtain. Data may be expert opinion of property values, self-reporting or related to actual sales, although the latter is the most accurate. Sources include the Land Title Multiple Listing Service, which reports price paid, or building society data on mortgage acceptances (although this will exclude those who buy outright). If data are collected from secondary sources (e.g. property assessment rolls, census data, etc.), it is generally not possible to link a particular individual buyer to the purchase price and other characteristics of a given property. Instead, the socio-economic characteristics of the neighborhoods are used as these are assumed to be sufficiently similar to the individual buyers who live in or move into these neighborhoods. However, HPP studies could also collect primary data by implementing surveys of home owners, providing a direct link between socio-economic characteristics and house prices.

One solution to data collection and sorting difficulties is through the application of geographical information systems (GIS) to measure and compile data (Bateman et al., 2002b). If house price data are sufficiently disaggregated (e.g. to the level of an individual property) GIS can be useful in determining accessibility variables for individual properties (e.g. travel time, distance to amenities) as well as linking socio-economic and demographic census data to neighborhood quality variables. Application of GIS to noise modeling impact analysis, for example from transport, also facilitates use of the HPP to derive values for actions such as noise mitigation (Lake et al., 2000), while using GIS to generate digital elevation models (DEMS) allows the impact of topography (the type and quality of view), an attribute which is typically omitted from HPP studies, to be incorporated into analysis (Bateman et al., 2002b).

Other practical issues of implementation: Aside from data issues, practical implementation of the HPP requires statistical (econometric) expertise. Depending on the ease of access to good data, the process can take three months to a year.

Principal outputs: If HPP studies undertake both stages of analysis then the principal outputs will be estimates of willingness to pay/consumer surplus for non-market attributes as reflected by the property market. Note though that the second stage of analysis (estimating a demand curve for the characteristic of interest) is technically demanding and is not always feasible. From the first stage of analysis, derivation of the hedonic price function and the price differential (the implicit price function), an estimate of the percentage change in property price due to a unit change (increase/decrease) in the non-market attribute may be obtained; for example, the percentage increase in property price arising from increased proximity to recreational waters.

Transferability of outputs: Estimated economic values from HPP studies are derived from the initial hedonic price function analysis which emerges from the interaction of buyers and sellers in the property market. This analysis represents a market clearing equilibrium which is specific to each individual property market. The implication is that results cannot be transferred across markets without taking into account demand and supply factors in those markets (Day, 2005). Notwithstanding this caveat, the comparison of HPP studies is encouraging as they produce similar results in terms of the percentage change in property price for a unit change in a given environmental characteristic, even though they use data from different property markets and even countries.

Key uses – decision-making context(s): Hedonic pricing provides a basis for estimating the value of a wide range of non-market characteristics and can inform particularly well on localized and site specific impacts, e.g. the effect of road traffic noise, the impact of siting waste facilities, etc. The HPP approach can be used to input into policy and project analyses, 'demonstration' of importance of an issue, and establishing the basis for a tax and legal damage assessment.

For instance, HPP can be applied to inform decision-making in the use of a Noise Sensitivity Depreciation Index (NSDI), which relates a unit increase in noise (decibels) to a reduction in property price and is considered for incorporation within the assessment of compensation payments (Lake et al., 2000). In addition, the UK landfill tax takes account of disamenity effects of landfills. An original study was commissioned to estimate the percentage decrease in property prices per mile of proximity to landfills compared to the price identical properties obtain sufficiently further away from landfills (see Cambridge Econometrics et al., 2003).

Key uses – coverage of the natural environment: The scope of HPP studies is typically limited to environmental characteristics which manifest near residential areas, are observable to buyers and are likely to have an impact over the period of occupancy (e.g. water quality, air quality, amenity value of green space). The method is less applicable to environmental goods/bads which are not typically perceived by the buyer, such as chemical hazard, radiation, etc.

Discussion: A number of theoretical issues have been raised concerning HPP. In particular, Russell (2001) highlights the problem of identification in hedonic analyses, where, with regards to the property market, shifts in demand may be difficult to detect in price terms, since prices are determined simultaneously by both demand and supply. Further, HPP will only reflect the marginal WTP of households for a particular characteristic if the actual level of that characteristic corresponds to the level perceived by the consuming household. Freeman (1993) highlights a number of theoretical issues concerning hedonic pricing approaches, including, for example, the choice of appropriate functional form for the hedonic price function (e.g. linear, quadratic, log, exponential or Box-Cox transformation, etc.). Other issues include:

- Observed correlations between the non-market good and property price may be spurious due to interactions with factors not included in the specified model;
- The necessary assumption of equilibrium in the housing market is unrealistic;
- Transaction and moving costs are non-negligible and can distort results; and
- It is necessary to assume identical utility functions and underlying structures of preference for all households for any variables not controlled in the model.

See also Hidano (2002) and Taylor (2003) for additional discussion.

Consideration of distributional impacts: Estimates of economic value from HPP studies are inferred from 'real' markets. Consequently, inequalities in the underlying income distribution can be inherent in the values derived. Hence, there is potential for price differentials to reflect ability to pay by higher income groups. Notably, housing markets are one of the few where equity goals are actively pursued (e.g. affordable housing).

While the HPP does not offer any prescriptive account of distributional impacts, it can be used to analyze equity issues and provide quantitative evidence concerning these issues, through the inclusion of appropriate variables in the regression analysis. In addition, the descriptive use of HPP in this regard may also be enhanced by GIS applications which offer a particularly appealing way of presenting results concerning equity issues.

Advantages and disadvantages: A distinct advantage of revealed preference techniques such as HPP is the use of actual market data. Hedonic pricing is grounded firmly in the principles of economic theory, relying on the derivation of demand curves and elasticity estimates. Moreover, the theoretical expectations of HPP have typically been borne out by empirical studies (Day, 2005).

Disadvantages of HPP lie in the requirement for copious amounts of data and specialist econometric expertise. In terms of undertaking hedonic analysis, other weaknesses arise from issues of identification and complementarity. More important from a decision-making perspective though, is that HPP is not suited for application where non-market characteristics are not perceived (or observed) in property purchasing decisions, or where non-market impacts are yet to occur, since fundamentally, for example, environmental values are revealed from situations with precedents. However, the corollary of this is that HPP is suitable for long-standing non-market effects, arising in relation to issues such as noise, visual intrusion (proximity of road), visibility (due to air pollution) and amenities (such as proximity of recreational waters).

Conflicts and synergies with other methods: As noted, HPP represents just one application of the hedonic pricing method (HPM) which can be applied to any differentiated product. Freeman (1993) illustrates how the HPM may be applied to agricultural and commercial land prices. A further application of the HPM focuses on wage differentials which arise from different wage-risk trade-offs which arise in the labor market. While this application mostly focuses on occupational risk (e.g. accidental injury, exposure to chemicals, etc.) it may also be applied to environmental characteristics.

With regards to HPP studies, potential conflict can be envisaged in situations where the presence of a non-market good does increase social well-being, but nonetheless has a tendency to reduce property prices, hence implying a negative value for the good.

Example

Title:	Conserving Water in Irrigated Agriculture: The Economics and Valuation of Water Rights (Veeman et al., 1997)
Location:	Southern Alberta, Canada
Sample:	230 land parcels sold in 1993 and early 1994
Value:	Access to irrigation water
Analysis:	Ordinary least squares regression

Discussion: A revision of the Water Act in 1996 opened the possibility of implementing a system of transferable water rights. As part of the economic study into this potential, Veeman et al (1997) applied hedonic property pricing to determine the value of access to irrigation water in southern Alberta.

The hedonic method indicated that agricultural land with irrigation was worth approximately CAN$190 more per acre than land without irrigation. Converting this based on the estimated average use of water per acre, the implied value of water for irrigation was CAN$126 per acre-foot. Since this value implies the amount that farmers are willing to pay to have access to irrigation water, it was thus an indirect measure of the value of water rights in southern Alberta.

The most stressed conclusion of this portion of the study into transferable water rights in Alberta was that water access added approximately 35 percent to the value of non-irrigated land.

Outcomes: The main conclusion from the authors is that the analysis demonstrates that water should "no longer be treated as a relatively free or inexpensive good." Proper incentives for the most efficient use of water are required.

Example:

Title:	Remote tourism and forest management: A spatial hedonic analysis (Hunt et al. 2004)
Location:	Ontario
Sample size:	770 sites
What is valued:	The effect of forestry activity on tourism at fly-in fishing sites
Analysis:	Ordinary Least Squares model and Lagrange Multiplier tests

Discussion: Hunt et al. (2004) analysed the effect of forestry activity (e.g. logging) on the use value of angling at remote 'fly-in' sites in Ontario. Site and price (charged by tourism operators) data were collected for 770 sites (with 136 operators). Spatial information was collected from Landsat data relating to landcover, including forest distributions for 1986 to 1996 within 3 kilometres (km) of sites. The distance of 3 km was selected as the maximum extent that forestry disturbance could have an impact on a site.

Logging in close proximity to a site (less than 3 km) was found to have a negative impact on the prices charged by tourism operators. The study also estimated marginal prices for characteristics of sites, including facilities (running hot and cold water, showers, and lodge accommodation), and the quality of fishing.

Outcomes: Overall, the study illustrates how land use policy can influence use values derived from recreation sites and the characteristics that influence this relationship.

A1.4 Travel cost method

Objective: The travel cost method (TCM) uses the cost incurred by individuals traveling to reach a site, in addition to costs incurred at the site, as a proxy for the recreational value of that site.

Value concept: Direct (non-consumptive) use value component of total economic value.

Theoretical basis: Travel costs incurred by an individual comprise of two elements, (i) travel expenditures (e.g. gas, air fares, accommodation, food, etc) and (ii) the value of time. If time spent traveling to a site is not as enjoyable as time spent on some alternative activity, then travel time involves a loss of utility (an opportunity cost), which is a genuine economic loss irrespective of whether or not a monetary cost has been paid. In part, travel costs determine the number of visits an individual may undertake and may be seen as the 'price' of a recreational visit to a particular site. Surveying visitors to a site and asking them for information concerning their travel costs, frequency of visits over a given period and other determining factors allows a demand curve for the site to be mapped out. The value of the site is equal to the area under the curve. The demand curve is derived from a ‘trip-generating function’ which explains the number of visits as a function of travel costs and other relevant explanatory variables.

The TCM can be split into two distinct variants depending on the definition of the 'visits' variable in the trip-generating function:

1. Individual travel cost method (ITCM) - defines the dependent variable as the number of visits made by each visitor over a specific period (e.g. a year).

2. Zonal travel cost method (ZTCM) - divides the entire area from which visitors to a site originate from into a number of visitor zones and defines the dependent variable as the visitor rate (the number of visits made from a particular zone in a period divided by the population of the zone). Visitor rate is often calculated as visitors per 1,000 population in a zone. Visitor zones may be defined according to pre-determined distances from the site or neighborhoods of a town, etc.

Water valuation applications: Value of recreational services of water sites.

Process of implementation: The travel cost method is a survey-based technique that comes in two forms: the ITCM and the ZTCM, although the former is the more commonly applied approach. The principal distinction between the ITCM and ZTCM approaches is the definition of the dependent variable. Using the ITCM, the dependent variable is defined as the number of visits per period by an individual (or household) to a site. The derived demand curve relates an individual’s annual visits to the cost of those visits. This allows various individual specific variables to be incorporated in the trip-generating function (such as household income). With the ITCM approach, the demand curve is derived from the change in visits over the change in travel costs (i.e. the first order derivative from the trip-generating function). Integration of the area under the curve yields an estimate of consumer surplus per individual; overall consumer surplus for the site is estimated by multiplying this by the number of individuals visiting the site annually (**Figure A1.5 and A1.6).**

Figure A1.5: Implementing the individual travel cost method

Step 1	Administer questionnaire to site visitors	Data to be collected includes: • Place of residence • Demographics • Attitudinal information • Frequency and length of visit to site and substitute sites • Trip information (i.e. purpose, length, costs, etc)

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Step 2	Determine demand function	Use econometric techniques to determine demand relationship based on relevant factors (e.g. distance to site, alternative sites, etc).

↓

Step 3	Estimate total recreation value	Integrate the demand function to estimate the total recreation value of the site in terms of consumer surplus. Considered in the context of 'price' paid (e.g. travel costs); this yields a WTP estimate of a site's recreational value.

↓

Step 4 (optional)	Estimate demand equation of site attributes	More advanced studies attempt to estimate demand equations for differing attributes of recreation sites and estimate values for these individual attributes (see Multi-site Recreation Demand Models below)

Figure A1.6: Implementing the zonal travel cost method

Step 1	Administer questionnaire to site visitors	Data to be collected includes all information for individual ITCM, but particularly important are: • Number of visits made by household in a given time period • Origin of visit

↓

Step 2	Zoning	Area encompassing all visitor options is sub-divided into zones of increasing travel cost. Then, household visits per zone are calculated based on sample.

↓

Step 3	Zonal average cost	Calculated based on survey respondents

↓

Step 4	Fit demand curve	Relate zonal average price of a trip (travel cost) to number of visits per household from that zone. For each zone, household consumer surplus is calculated by integrating the demand curve between travel cost from that zone and the travel cost at which the visitor rate would fall to zero. Divide zonal household consumer surplus by zonal average number of visits per household to determine average zonal consumer surplus per household visit.

↓

Step 5	Calculate total site value	Multiply household consumer surplus by total average number of visits per year from that zone to obtain annual zonal consumer surplus. Aggregate across all zones to estimate total consumer surplus per year for the recreational experience of visiting the site.

Data needs: The TCM survey is required to collect data on visitors' place of residence, demographic and attitudinal information, frequency of visit to the site and other similar sites and trip information (e.g. purpose of the trip, length, associated costs, etc). Practical application of the ZTCM requires data concerning the population of each of the travel cost zones that are identified. Data on explanatory variables which are also likely to influence visit rates (e.g. income), preference, and availability of alternative sites, is also important, as is the mode of travel (car, rail, etc) to the site. Limited availability of data is likely to mean that only reduced forms of the trip-generating function can be estimated.

Use of GIS, particularly in applications of the ZTCM, can help define travel cost zones to account for areas with similar travel costs, availability of substitute sites and socio-economic characteristics (Bateman et al., 2005).

Other practical issues of implementation: In addition to collecting appropriate data, the TCM also requires econometric expertise. The timescale for analysis will typically depend on the length of survey stage. For certain sites it may be necessary to sample at different times of the year in order to provide an accurate account of seasonal variations in visitor patterns and number. Given the potential need for several sampling events, implementing the TCM approach may require a time frame from 6 months to (potentially) one and half years, allowing for data analysis.

Principal outputs: TCM provides an estimate of the consumer surplus associated with visits to recreational sites; consideration of travel costs incurred provides an estimate of willingness to pay for the use value of the recreational site. The TCM may also be applied to estimate demand curves for recreational sites in order to set entry prices or user fees and to predict how visitor numbers may change as a result of the establishment of, or changes in, entry prices.

Transferability of outputs: Notably, it is difficult to compare valuations derived by different TCM studies, particularly due to potential differences in the specification of the trip generating function and demand function. Use of different functional forms, as well as use of the ITCM or ZTCM will likely give rise to different estimates of value. Moreover, it is not possible to compare summary statistics from the two different variants (see below).

In a benefits transfer context, the transferability of estimates will depend on an assessment of the similarity of the study good and the policy good for which a value is required. In particular, it is necessary to assume that the preferences of individuals are identical in the two contexts and that underlying travel costs are unchanged by the context. However in some instances it may be possible to adjust for differences between the study and policy sites.

Key uses – decision-making context(s): The TCM provides estimates of the use value derived from well-defined recreational sites, or separable, well-perceived environmental or cultural attributes within such a site. As such, the TCM is suited to be used to input into policy and project analyses of specific projects, demonstrating the importance of an issue, setting priorities and establishing user fee levels.

Key uses – coverage of the natural environment: The scope of TCM studies is typically limited to valuing non-market goods and services that have explicit recreational uses. This is likely to provide a broad coverage of the natural environment, such as woodlands, forests, wetlands, rivers and lakes (e.g. angling), national parks and coastal areas. There are numerous examples of practical TCM applications.

Discussion: A number of methodological issues concern practical applications of the TCM and resulting estimates of economic value (see for example Freeman, 1993). For instance, the approach may under-estimate the use value derived by individuals, particularly if they move to be near a site. Here then, travel cost will not reflect actual recreational value, since estimated demand will lie below true demand, principally due to the fact that the cost of travelling to the site will likely be small. While this would imply that those living near a site value it less, the opposite is likely to be true. In addition, it is unlikely that there is one 'type' of visitor. More likely, visitors may be typified as either a pure visitor (visiting the recreational site is the sole purpose of the trip), a transit visitor (someone going elsewhere) or a 'meanderer' (someone who enjoys the journey). The implication is that the value attributed to the site by different types of visitor is likely to differ depending on the purpose of the trip. For instance, it may be expected that those travelling with the sole purpose of visiting the site are likely to hold a greater preference for the site than those who 'stop-by' on the way or simply come across it by chance.

With regards to costs incurred, some difficulty can be foreseen when including both day-trippers and holiday-makers, making either single or multiple site visits. For instance, ascribing the full costs of multiple visits to a single site will lead to an over-estimation of the recreational value of that site. A common response may be to weight cost according to the proportion of the day's 'enjoyment' attributable to the site in question, although how this is carried out will likely influence estimates of consumer surplus.

In addition, the inclusion of different factors in the travel cost calculation will also likely result in different estimates of consumer surplus. Specifically, expenditure on travel may be estimated in terms of marginal cost (e.g. gasoline costs only), full costs (e.g. gasoline costs, insurance, maintenance costs, etc.) or perceived costs as estimated by survey respondents. Notably, the second formulation will lead to higher estimated costs than the first. Aside from derivation of travel costs, the way in which the cost of time spent travelling is dealt with may also lead to different estimates of recreational value. For example, omitting time costs will ensure that consumer surplus is under-estimated; however, there is no definitive assessment as to how the value of time should be accounted. The wage rate approach sets time costs as some proportion of the visitor's wage rate. Typically, this will be less than 100 percent to reflect the fact that most individuals are not completely free to trade-off between leisure and work time. Arguably, assumptions concerning the value of time are largely subjective, and therefore sensitivity of consumer surplus estimates to the value of time is a key issue in the application of the TCM.

A further issue to consider is the presence of substitute sites. Generally, alternative sites will depress demand below 'true' demand and failure to account for this may lead to an under-estimate of the recreational value of a given site. In particular, if there are several similar sites within a similar distance, then the demand for each site will be less than demand for the recreation experience. Alternative sites can be incorporated into analysis (in the trip-generating function) through specific questions to respondents in survey and GIS techniques can also be applied to generate data (Brainard et al., 1999), such as distance between sites.

In addition to the effect of substitute sites, it is also difficult for the TCM to capture fully the effects of variation in quality of sites and also individual characteristics of sites and how these influence the demand for visits to a site. In particular, an improvement in site quality should raise demand for the visits to the site at every level of travel cost. Accordingly, the difference between the original demand curve and the new demand curve represents the change in consumer surplus. However, there is also the need to account for changes in other sites and the substitution of visits from one site to another which arise from improved quality as well as the impact on travel costs that this will create (Freeman, 1993). While the TCM is suited to explaining recreation demand over a given time period (e.g. the number of visits in a year), it is not suited to consider these effects. Multi-site recreation demand models, an extension to the standard TCM, are, however, suited to consider the effects of the availability of substitute sites and changes in quality levels of specific site characteristics (Bockstael et al., 1991; Freeman, 1993) (see multi-site recreation demand models summary for further discussion).

A distinct issue concerning practical TCM applications is a lack of theoretical guidance, concerning the appropriate functional form of the trip-generating function. Moreover, different studies often use different functional forms. It is often observed that, for a single dataset, changing the functional form can result in different estimates of consumer surplus without resulting in significant differences in the statistical fit of different models (see for example Hanley, 1989). Hence, appropriate specification of functional form is typically a matter of expert judgment and consequently a potential weakness of the TCM.

Finally, there is also consideration of the comparison between ITCM and ZTCM approaches. However, this is not a straightforward issue, particularly in terms of the degree of explanation of a given dataset provided by each approach. In most instances, a higher degree of fit is found via the ZTCM, as observed in terms of the r-squared statistic. While the ITCM estimates the demand relationship by drawing on all observations and their variation, the ZTCM amalgamates travel cost into distinct bands, and consequently estimates demand from a smaller number of observations. Differences in r-squared statistics are therefore likely to be symptomatic of these differing approaches to estimating demand. Given this, it is not appropriate to compare these models on the basis of this criterion. Again though, these two different approaches are likely to generate different estimates of consumer surplus (see for example Garrod and Willis, 1991, and Willis and Garrod, 1991 in relation to woodland recreation values).

Consideration of distributional impacts: By definition, the TCM only estimates the direct (recreational) use value of a particular site; those who are unable to access the site, yet have a positive preference for the site (in effect, a non-use value) will not be accounted for in the analysis. However, appropriate survey sampling will permit analysis of the characteristics of the user population and sub-groups within (e.g. low/high income, rural/urban residents, etc.).

Advantages and disadvantages: The TCM is a potentially useful tool for producing estimates of the use value associated with well-defined recreation sites. A distinct advantage is that estimated values are revealed from actual behavior of individuals and the formulation of demand curves. Analysis of demand curves can also yield significant input to analysis of visitor rates and changes in these, which can aid the management of these sites.

Practical applications of the approach, however, may be limited by data availability. More methodological concerns may disadvantage the use of TCM results, particularly with regards to different estimates of consumer surplus that may arise as a result of adopting the ITCM or ZTCM approach, as well as the treatment of substitute sites, the choice of appropriate functional form and the calculation of the value of time (all as discussed above). Finally, the TCM is not able to account for non-market goods (or bads) that are imperceptible to short-term visitors.

Conflicts and synergies with other methods: For the synergy between the TCM and multi-site recreation demand models see the multi-site recreation demand model summary below. The survey aspect of the TCM implies that it may be combined with stated preference methods, where it would be possible to elicit information on travel costs and also directly elicit values for some constructed market involving the non-market good of interest.

A1.5 Multi-site recreation demand models

Objective: Multi-site recreation demand (MRD) models (also referred to as random utility model (RUM), or discrete choice model), infer the value of changes in the quality of non-market goods and services by focusing on the decisions of individuals to recreate at a specific site as compared to alternative substitute sites.

Value concept: Direct use value component of total economic value.

Theoretical basis: MRD models focus on the decision made by individuals in relation to visiting recreation sites. In particular, the choice among available sites is dependent on the comparison of the characteristics of each site. The conceptual basis of the MRD model is an individual's indirect utility function, which relates factors such as income, socio-economic characteristics, travel costs and site quality characteristics to the utility (well-being or pleasure) derived from a recreation visit. By specifying the functional form for the indirect utility function, the MRD model considers the probability of an individual choosing to visit a given site. This probability is determined by the arguments of the indirect utility function (e.g. income, socio-economic characteristics, travel costs and site quality characteristics). The parameters for these variables are estimated via maximum likelihood methods. The monetary value of a change in site quality may then be estimated by relating the coefficient for site quality to the implicit price of a visit, which, as in the TCM is inferred from the cost of travel to a site (see Freeman, 1993).

Water valuation applications: Value of changes in water quality or quantity at a recreational site

Process of implementation: The MRD model may be derived from a travel cost survey and implementation generally follows in similar form (**Figure A1.7).** Practical applications of the MRD model need to avoid violation of the independence of irrelevant alternatives (IIA) property, which states that the relative probabilities of two choice options being selected are unaffected by the introduction or removal of other alternatives (Bateman et al., 2002a). This situation is typically avoided by application of a nested model of choice, where an individual is assumed to choose first the type of recreation activity and then choose the site to visit within the activity category.

Figure A1.7: Implementing a multi-site recreation demand model based on travel cost

Step 1	Administer questionnaire to site visitors	Data to be collected includes: • Place of residence • Demographics • Attitudinal information • Frequency and length of visit to site and substitute sites • Trip information (i.e. purpose, length, costs, etc) It's very important to also collect data about the characteristics of each site to be compared.
↓		
Step 2	Determine MRD model	The probability that an individual will visit a given site is estimated on the basis of the costs of visiting the site and characteristics of the site relative to the characteristics of all of the sites the individual may choose between. The functional form of the utility function must be specified by the researcher.
↓		
Step 3	Value changes in non-market good/service	Relate the relevant function coefficient to the coefficient of travel cost to yield an estimate of willingness to pay for a marginal change in the level of the non-market site characteristic.

Data needs: Application of the MRD model requires a travel cost survey to collect data on visitors from a selection of recreation sites, including data on the visitors' place of residence, demographic and attitudinal information, frequency of visits to the site and other similar sites and trip information (e.g. purposefulness, length, associated costs, etc). Survey data is also required on the specific characteristics of different recreation sites and the level of the quality of these characteristics.

Other practical issues of implementation: Aside from the collation of appropriate survey data, the MRD model requires econometric expertise. The timescale for analysis will typically depend on the length of survey stage and sample size. Given this, implementing the MRD model approach may require a time frame from 6 months to one year, allowing for data analysis.

Principal outputs: MRD models yield an estimate of willingness to pay for incremental changes in the quality of recreation site characteristics, which typically include non-market goods and services. These estimates of value are consistent with underlying economic theory of welfare.

Transferability of outputs: In a benefits transfer context, the transferability of estimates will depend on an assessment of the similarity of the study good and the policy good for which a value is required. In particular, it is necessary to assume that the preferences of individuals are identical in the two contexts and that underlying travel costs are unchanged by the context. However, in some instances it may be possible to adjust for differences between the study and policy sites.

Key uses – decision-making context(s): MRD models provide estimates of the use value associated with different characteristics (e.g. environmental goods and services) related to recreation sites. As such, the MRD models are suited for inputting into policy and project analyses which may affect specific aspects of recreational sites.

Key uses – coverage of the natural environment: As with the TCM, MRD models are suited to estimate the value of non-market goods and services associated with open-access recreation resources such as national parks, woodland, forest, rivers, lakes, wetlands and coastal areas.

Discussion: MRD models are closely related to the TCM. However, the key difference between the two approaches arises from the way in which the decision to visit a recreation site is assessed (Freeman, 1993). Within the TCM approach, individuals (or households) choose to make a visit or several visits to a site over a certain period of time. The MRD model approach however, considers the point in time at which an individual (or household) decides whether to visit any site, and if so, which site. Hence, the TCM is suited to explain total visits to recreation sites over a period of time (i.e. demand for recreation over a season or year), yet within the standard TCM it is difficult to capture the role of site specific characteristics or qualities in influencing the choice of where to visit. In contrast, MRD models specifically focus on the choice as to which site to visit. In particular, the decision as to which site to visit is determined by price (travel cost) and characteristics of different sites. However, within the MRD model framework, it is difficult to explain total visits to recreation sites, although extensions to the approach, which include the Kuhn-Tucker model, have sought to address this; see for example Phanuef and Siderleis (2003) for an example in relation to water recreation (canoeing and kayaking).

Consideration of distributional impacts: By definition, MRD models only estimate the direct (recreational) use value of a particular site. Hence, those who are unable to access the site, yet have a positive preference for the site (in effect, a non-use value) will not be accounted for in the analysis. However, appropriate survey sampling will permit analysis of the characteristics of the user population and sub-groups within (e.g. low/high income, rural/urban residents, etc.).

Advantages and disadvantages: The explicit advantage of MRD models is the ability to estimate the recreational use value associated with the changing environmental quality of sites in addition to the use value of a site in total as is found via the TCM. As with the TCM, MRD models analysis is based on behavior revealed from actual markets. The two approaches are complementary methods for estimating the value of non-market goods and services from travel cost surveys, and the decision as to which one to apply will depend on the required output. In addition, MRD models are subject to similar disadvantages as the TCM, in particular the ability to collect sufficient data may be limited. As with the TCM studies, the definition and calculation of travel cost and the cost of time is important.

Conflicts and synergies with other methods: As noted, the MRD model is an extension of the TCM, and essentially uses the same survey method as the TCM.

Example:

Title:	Modeling congestion as a form of interdependence in random utility models (Boxall et al. 2001)
Location:	Nopiming and Atikaki Provincial Parks in Manitoba and Woodland Caribou, Quetico, and Wabikimi Provincial Parks in Ontario
Sample size:	1,297
What is valued:	Benefits and dis-benefits of access to and congestion of wilderness areas
Analysis:	Multi-site recreation demand model (random utility model)

Discussion: Boxall et al. (2001) apply a MRD model to the analysis of recreation demand for canoeing in wilderness parks with a particular focus on congestion (the amount of visitor groups in the park). The study surveyed users of park areas to determine how the choice to visit a site depends on the attributes of the site, the predicted congestion of potential sites and attitudes towards congestion.

Congestion avoidance was a significant factor for most wilderness canoeists in choosing a site for recreation, with the majority of canoeists viewing the presence of other recreationists negatively. As a result, the study found a tendency for users to choose to visit sites with attributes that are less attractive, but that are predicted to be less crowded, over sites with more attractive attributes but are predicted to be more crowded.

Results from the study also show improved access to parks may actually decrease overall benefits from recreation. For example an additional road into Quetico in Ontario would generate benefits valued at over $200 per trip, but the creation of more than one additional road would generate substantial dis-benefits due to congestion forecasts by users.

Outcome: The study illustrates that congestion affects the use value derived from recreation sites, implying that increased access to sites may not necessarily result in greater benefits.

A1.6 Contingent valuation

Objective: The contingent valuation (CV) method is a survey based approach to valuing non-market goods and services. The approach entails the construction of a hypothetical, or 'simulated', market via a questionnaire methodology where respondents answer questions concerning what they are willing to pay (or willing to accept) for a specified environmental change. Numerous studies relating to water resources have been conducted, with examples including changes in water quality and flow of rivers, water pollution (both increases and decreases) in marine and freshwater environments along with species and habitat changes such as fish and aquatic plant life, as well as effects to recreational use of water resources.

Value concept: Through application of the CV method, it is possible to estimate the total economic value of an environmental good or service, i.e. both use value and non-use value components, or the economic value held by users and non-users separately.

Theoretical basis: CV is based on the consumer demand theory which explains the factors determining demand, in this case, for non-market goods and services. These factors include tastes, attitudes, socio-economic characteristics, characteristics of the non-market good and/or service, the cost of (or of avoiding) the change in the good, and the price of other goods and services. Before asking a WTP or WTA question, a CV questionnaire typically provides information on:

- An introduction to the general decision-making context (e.g. a change in legislation impacting water resources);

- A detailed description of the good or service offered to the respondent (e.g. a change in the level of pollution within a specific river or lake and how this change may affect swimming, fishing and the habitat of the river or lake);

- The institutional setting in which the good or service will be provided (e.g. in this example one might imagine that government were determining how this new legislation on water resources should be applied);

- The way in which the good or service will be paid for (e.g. increase in water bills, a new tax, charges to enter a recreational area); and

- Reminders about respondents' budget constraint including other things they may wish to purchase; in addition, a statement detailing all other relevant considerations that are pertinent to the question being asked, e.g. the timings of any increased costs, when one would expect the environment to change or the improvement to be made.

In summary, this information describes the hypothetical market which respondents are required to engage in. A CV questionnaire also collects information about tastes, attitudes, prior experience of using or knowing about the good or service in question and the socio-economic characteristics of the respondents. The survey may either elicit the willingness to pay measure of economic value or the willingness to accept measure of economic value. Given that the WTP and WTA responses are elicited in the context of the hypothetical market presented in the questionnaire, the economic values estimated via the CV are 'contingent' upon this hypothetical market.

Water valuation applications: Examples of application of CV in a water context are numerous covering a wide range of uses of water and/or the environmental services of water based habitats, and the non-use values associated with these.

Process of implementation: Applying CV involves a number of steps (see for example Bateman et al., 2002a) (**Figure A1.8**):

Figure A1.8: Contingent valuation design, implementation and analysis steps

Step 1	Design scenario	• WTP or WTA • Determine payment characteristics
↓		
Step 2	Pre-testing	• Hold focus groups, cognitive interview or workshops • Implement a pilot survey • Analyze the pilot survey data and check question format • Feed results into final survey design
↓		
Step 3	Conduct main survey	• Analyze data • Conduct econometric analysis to derive WTP/WTA values • Produce final report

1. Development of the survey instrument (i.e. the questionnaire) for elicitation of respondents' preferences for the non-market good - this requires (i) design of the hypothetical market/scenario, (ii) determining as to whether WTP or WTA is to be sought and (iii) specification of the scenario concerning payment or compensation. The initial design stage of the CV implementation process is typically augmented by focus groups, one-to-one interviews, or workshops to aid the development of the survey instrument. In addition to the valuation scenario and other questions mentioned above, it is common practice to include a 'debriefing' section in which respondents state why they answered certain questions in the way they did. A final element of the design stage is typically a pilot survey which administers a draft questionnaire to a sample of respondents in order to test the survey instrument in the field.

2. Implementation of the CV survey instrument with a sample of the population of interest - the survey instrument may be administered in a number ways: on-site, door-to-door face-to-face interviews, via telephone interviews, mail surveys, or web-based surveys. The exact approach for administering the questionnaire will depend on the complexity of the scenario to be posed, the time needed to fill out the questionnaire and how quickly the data is needed. Similarly, depending on the complexity of the

questionnaire and the length of time needed from a respondent financial incentives or prizes may help to attract respondents.

Survey options			
Technique*	Potential Requirements	Advantages	Disadvantages
Face-to-face	Depending on questionnaire complexity: 'trained' interviewers, travel to respondents or a place for respondents to take part in the survey e.g. hall, possible financial incentives, finally, someone to enter all data into the appropriate format onto a computer.	Interviewer able to convey the exact meaning of the questionnaire, potentially more reliable data collection, answers can be entered into a computer directly or noted down on paper.	Interviewer bias, respondent may not give truthful answers on sensitive topics, time needed to carry out the survey.
Mail	Production of paper based surveys, pre-paid envelopes to a single collection point, someone to enter all data into the appropriate format onto a computer.	Easy to administer, interviewee not influenced by an interviewer	Low response rates, potentially high numbers of incomplete questionnaires (especially if long questionnaire), maybe considered junk mail, time taken to collect high number of good quality responses, possible misinterpretation of questions during survey.
Web-Based	Funding or expertise to put the survey online, the simpler the survey the lower cost in both money and time.	Fast way of collecting data, all data collected in an analyzable format straight away, no interviewer bias.	Expertise needed to program the survey, possible misinterpretation of questions, potential for selection bias in sample due to uneven distribution of access to internet across different demographic groups.
Telephone	Trained interviewers to gather data over the phone, space for interviewers to gather data without distraction and a method for coding results, finally, someone to enter all data into the appropriate format onto a computer.	Less time needed than door-to-door interviews and potentially less expensive.	Maybe perceived as nuisance calls given the increase of sales calls to home telephone numbers, time taken to capture data, interview team needed, possible interviewer bias.
Cable TV	Funding or expertise to put the survey in the correct format, funding for extra equipment e.g. cable box (see Albertini et al., 2001).	Fast way of collecting data, all data collected in an analyzable format straight away, no interviewer bias, issues of how to recruit individuals i.e. through the telephone etc.	Expertise needed to program the survey, possible misinterpretation of questions and costs.

Notes: R.Rate – response rates; *all methods will need time to recruit respondents

3. Analysis of the survey responses – this typically has two elements: (i) estimation of average or unit WTP/WTA from the sample data for the population of interest; (ii) estimation of WTP/WTA functions via econometric analysis to assess the determinants of WTP/WTA and to judge the validity and reliability of the survey results. The analysis undertaken will depend on the elicitation format (the way in which the WTP/WTA questions are asked). These include open-ended (respondents can state any dollar amount), dichotomous choice (respondents accept or reject pre-specified dollar amounts), or payment ladder (respondents are given a choice of dollar amounts).

4. Estimation of aggregate or total WTP/WTA for the specified change in the provision of the non-market good of interest over the relevant population - this estimate of overall WTP may then be applied in decision-making exercises, for example, for use in policy or project analysis. Practitioners can use census data to aid in this calculation; however, specific checks must be made to ensure that aggregate values relate to the appropriate population. Aggregation calculations need to be considered thoroughly, specifically a decision needs to be made and justified as to the appropriate population over which to aggregate WTP results. A further development in this area has been the inclusion of GIS data specifically within water quality studies in the UK (Bateman et al., 2006), in this context the use of GIS techniques can take into account the distance of individual households from the resource that is being valued; e.g. the water quality of a small stream. Typically, the amounts of money individuals are willing to pay to see a stream of good water quality will be influenced by their distance to the resource. Thus, aggregating the WTP for increased water quality in a local area over an entire province has the potential to distort WTP. The inclusion of distance decay within econometric models through the use of GIS data can alleviate this distortion.

Data needs: Primarily, the CV questionnaire will be designed to collate all data required for estimating WTP/WTA values and functions for determining the main influences on respondents' WTP. As mentioned above, expectations from consumer demand theory assist in deciding which factors to include in these functions. In addition, a crucial aspect of CV survey design is ensuring that the survey sample is representative of the population of interest. Generally, representativeness will be based on socio-economic characteristics (e.g. sourced from census data), since data typically does not exist on other factors that may be relevant, for instance prior experience of the environmental good or service in question.

Other practical issues of implementation: Reliable CV studies are not simple (or inexpensive) to implement. As Carson et al. (2001) point out proper practice in CV studies requires time to develop the survey instrument and to ensure that the non-market good or service to be valued is clearly explained along with the constructed market and payment method. Overall, from the initial design stages of the survey instrument to aggregating and reporting of results, practical implementation of the CV could require three months to a year, depending particularly on aspects such as complexity of the issue of concern and sample size. Considering the constant developments in stated preference techniques (including CV), leading practitioners should be involved in a study at least in a peer review capacity. Analysis of a CV dataset, the estimation of WTP/WTA values and functions, as well as validity and reliability testing requires econometric expertise and software.

Principal outputs: The principal outputs from CV studies are estimates of WTP/WTA for changes in the provision of non-market goods and services. These estimates of economic value are consistent with measures of welfare economics; the underlying basis of cost-benefit analysis. The CV approach enables the total economic value of an environmental good or service to be valued (i.e. use value and non-use value). CV studies can also provide a wealth of information on the determinants of WTP and the influence of specific variables, such as income and geographical location. This implies that information from CV studies can provide useful input into analysis of distributional and equity issues concerning non-market goods and services.

Transferability of outputs: Much discussion has focused on the potential use of results from CV studies in benefits transfer contexts. Fundamentally, the viability of transferring WTP/WTA values from the original context (the 'study' site) to a new situation for which an estimate of value is required (the 'policy' site) depends on the degree to which the contingent market (i.e. the good and the change in its provision as well as the socio-economic characteristics of the sample population) constructed for the original study corresponds to the perceived market at the policy site.

Key uses – decision-making context(s): CV studies may be utilized in a number of decision-making contexts including inputting to policy and project analyses, demonstration of the importance of an issue, priority setting within a sector according to preferences, determining marginal damages as the basis for an environmental tax or charge, and legal damage assessment (liability).

Key uses – coverage of the natural environment: CV is particularly flexible and facilitates the valuation of a wide range of non-market goods and services provided in any context, including levels of provision of the good not currently experienced (e.g. improved levels of water quality).

Discussion: Much debate has focused on numerous aspects of the use and reliability of CV studies. Indeed as Smith (2000) highlights development of CV has brought about the most serious investigation of individual preferences ever undertaken by economists. Much of the discussion concerning the CV, which covers academic, policy and philosophical issues, can perhaps be attributed to the assessment of the US National Oceanic and Atmospheric Administration (NOAA) panel, which was commissioned to critically evaluate the validity of the CV following its use to assess the natural resource damages from the Exxon Valdez oil spill (for further information see Carson, 1996; Carson et al. 2003). The panel endorsed the use of CV in assessment of natural environment damages and set-out extensive guidelines for the implementation of studies. More recently, a team of UK researchers prepared guidance on the use of stated preference techniques which was subsequently published as Bateman et al. (2002a). The following gives a brief overview of the main areas of debate concerning the CV studies.

A principal criticism of the CV focuses on the issue of familiarity; specifically respondents are required to have experience with the non-market good or service in question in order for their responses to be meaningful. However, familiarity is typically only one factor in purchasing decisions of individuals (others being information from reviews, advertising, etc.) and the question of experience with a good or service extends to market goods and services as well (see Sugden, 1999). As Carson et al (2001) note, the time spent familiarizing respondents with the good or service that is the focus of the CV survey probably exceeds the time that the respondent would spend on purchasing decisions involving similar amounts of money. The key is for the CV survey instrument to convey to respondents an understanding of what they are being asked to value, how it will be provided and how it will be paid for.

A number of survey design, administration and analysis issues have also been highlighted. In particular, WTP/WTA estimates are sensitive to the way in which they are elicited and the key features of the constructed market. For example, different payment vehicles (tax, voluntary donation, etc.) will typically influence the extent to which individuals are willing to participate in the market; certain administration formats are likely to give rise to sample selection bias (e.g. mail surveys), and so on (for a comprehensive account see Bateman et al., 2002a). Debate concerning these issues has generally led to the development of the CV and improvements in its application, where high quality 'state of the art' studies are less likely to encounter such issues.

Construction of a hypothetical market for a particular non-market good or service enables the results of CV studies to be compared with economic theory. Here, there are two key tests in relation to price and quantity. Firstly, the percentage of respondents willing to pay a particular price should fall as the price they are asked to pay rises. This effect is typically observed in all CV studies. Secondly, respondents should be willing to pay more for larger amounts of the good or service (or strictly respondents should not be willing to pay less for larger amounts of the good or service – i.e. WTP may 'plateau'). This is normally referred to as a test of 'scope'. Sensitivity to scope is perhaps one of the most debated aspects of CV studies (Carson et al., 2001). While scope insensitivity may be attributed to aspects of the CV instrument design, some concern remains in relation to the use of CV studies in valuing changes in small probabilities of risk (see for example Beattie et al., 1998). Here, the problem lies mainly in communicating low level risks to respondents; e.g. number of individuals that are likely to become ill after swimming in a lake with a certain level of pollution.

While price and scope tests are unambiguous (e.g. as price rises, demand should fall; see Hanemann, 1995; Carson et al., 2001), conjectures concerning the relationship between WTP/WTA and income, or divergences between WTP and WTA measures, or on the effect of order in which a good is valued, are subject to income and substitution effects. Here, inferences based on the properties of marketed goods and services (which are price rationed) can be misleading with respect to non-market commodities such as environmental goods and services (which are public goods and are essentially quantity constrained) (for further discussion see Carson et al., 2001).

A further concern often cited in relation to the CV focuses on strategic behavior of respondents, with regards to overstating or understating ('free-riding') WTP amounts. Crucially, whether or not respondents answer 'truthfully' depends on the elicitation format and the incentive structure presented by the survey instrument. In particular, different elicitation formats differ in the degree of incentive compatibility offered. Namely, the dichotomous choice/referendum format offers a high degree of incentive compatibility, as do payment cards, randomized card sorting and one and one-half bound dichotomous choice. Again, it is typically the case that adoption of 'best practice' can minimize doubts concerning strategic behavior.

In CV applications, the terms reliability and validity have specific meanings. Validity relates to the correspondence between what is intended to be measured (e.g. WTP) and what actually is measured. Validity is tested through comparing the results of a CVM survey against the expectations based on the economic theory (hence the estimation of WTP/WTA functions) and the results of previous similar studies. The questionnaire design also includes tests such as consistency between responses to related questions and respondents' attitudes to the questionnaire itself (e.g. do they find it clear and interesting or difficult and so on). Reliability, on the other hand, refers to the replicability of the measurement through comparison of repeat studies. Typically this is not carried out as frequently as validity tests due to time and resource constraints (see Bateman et al., 2002a).

With regards to non-use values elicited by CV studies, much debate has focused on the 'warm glow' motivation (see for example Kahneman and Knestch, 1992; Desvousges et al., 1993 Nunes & Schokkaert, 2003), which does not reflect an individual's preference for the good or service in question, but desire to register a 'virtuous response' and achieve 'moral satisfaction'. However, initial work on charitable contributions (Olsen, 1965; Becker, 1974) did not discount this form of altruism as a non-economic motivation. Moreover, a central tenet of economic theory is that of consumer sovereignty; here underlying motives are essentially irrelevant, all that counts is the welfare derived, not its source.

Consideration of distributional impacts: A noted bias of CV studies (and indeed other preference based approaches to valuation based on standard economic theory) is that the WTP measure of value is constrained by wealth. In the simplest case, ability to pay may restrict the responses of those in lower income groups and may not adequately reflect the true preference of these groups for the environmental good or service in question. In effect, it is therefore left to decision-makers to make judgments concerning equity in this context. With this in mind though, the CV survey instrument and sampling allow for separate collection of WTP/WTA and other information for different income or other socio-economic groups. Therefore, a distributional analysis can easily be conducted.

Advantages and disadvantages: Primarily, stated preference techniques (including CV) are the only approach that can estimate non-use value associated with non-market goods and services. Furthermore, the CV approach to valuing offers a great deal of flexibility; in particular the construction of a hypothetical market can be envisaged for numerous non-market goods and services at differing degrees of quality irrespective as to whether they have precedents. In addition, CV enables a great deal of information to be collated and analyzed from the target population concerning their attitudes towards, use and experience of non-market goods and services as well as eliciting WTP/WTA amounts and WTP functions concerning the determinants of WTP.

In terms of disadvantages, traditionally, economic analysis has typically favored evidence based on actual market behavior via revealed preference methods over hypothetical approaches. However, it would appear that it is necessary to trade-off this ‘real’ market data with data from hypothetical markets in order to account for non-use values, which may form a substantial proportion of total economic value and provide justification for preservation of the natural environment. Much emphasis should also be placed on ensuring that practical application of CV is guided by current best practice, particularly since the method is a focal point for much discussion concerning the measurement of individual’s preferences. This may imply that the approach is relatively expensive to undertake, although the cost of undertaking a CV study should be viewed in comparison to the actions which are the concern of the decision-making context.

Conflicts and synergies with other methods: CV is flexible and studies may be carried out in conjunction with travel cost studies or avertive expenditure studies since data necessary for these studies could be collected through a CV questionnaire.

Example:

Title:	Valuation of cancer and microbial disease risk reduction in municipal drinking water (Adamowicz et al. 2007)
Location:	Across Canada
Sample size:	407 (CV); 812 (CE)
What is valued:	Health risk reductions to individuals through the provision of safe drinking water
Analysis:	Logit model (CV) and conditional logit model (CE)

Discussion: Adamowicz et al. (2007) apply both CV approach and choice experiment (CE – see summary below) to elicit preferences for programs to improve tap water and reduce the risk of microbial disease and cancer. A particular emphasis of the study is to compare WTP estimates resulting from the two stated preference approaches.

For the CV analysis, models were estimated without covariates, and mean and median WTP values were presented for different combinations of cancer and microbial end points (analyses were conducted under two different assumptions about error terms (lognormal and Weibull). Mean WTP to reduce cancer cases was calculated as CAN$157 per household per year, and the mean WTP for a decrease in the number of microbial diseases was calculated as CAN$211. Finally, a combined reduction in both diseases yielded a WTP of CAN$294.

In the CE treatment microbial disease-risk reduction was also found to be valued more highly than a reduction in cancer risk.

Outcomes: The study is the first in a Canadian context to value reductions in health risks associated with drinking water, demonstrating that significant benefits in monetary terms are evident. The study also allows for a comparison between CV and CE approaches with the finding that estimates derived from the contingent valuation approach were within the range of values estimated by the choice experiment.

A1.7 Choice modeling

Objective: The term choice modeling covers a set of stated preference techniques which, via the use of surveys, elicit respondent's values for non-market goods and services. This is done by asking respondents to choose between alternative scenarios that are presented in terms of the characteristics (or 'attributes') of the good or service of interest. For example, the attributes of a lake may be presented as its ecological quality, chemical water quality, number and type of species it provides habitat for, and so on. Different scenarios will also include an associated cost attribute which can be represented in a number of ways, e.g. increased water bill, municipal taxes, entrance fees, etc.

Value concept: Depending on survey design, both direct and indirect use elements of total economic value may be estimated. Note however, that not all choice modeling approaches yield estimates of value consistent with economic theory (see below).

Theoretical basis: Choice modeling approaches are based around the notion that any good can be described in terms of its characteristics (or 'attributes') and the levels that these characteristics take. The following briefly summarizes the different choice modeling approaches (see Bateman et al., 2002a):

- ***Choice experiments***: in this approach respondents are presented with a series of alternatives and are asked to choose their most preferred. A baseline option corresponding to the status quo or a 'do nothing' option can be included in the choice set presented to respondents. In cases where baseline data is unavailable or inappropriate; e.g. determining the preferences across river conservation areas in general, it is acceptable to include a choice set without the status quo option. However, in cases where the total economic value is to be estimated for a move from one possible situation to a number of possible alternatives; e.g. moving from a polluted lake to various levels of clean-up, the status quo option is usually necessary. With choice experiments, respondents are required to trade-off changes in attribute level against the cost of these changes. In addition, though, the baseline option implies that respondents can opt for the status quo at no additional cost. The approach to analysis of choice experiment data is the same as for multi-site recreation demand (MRD) models – both are forms of discrete choice models – the difference being that MRD models are based on revealed preference data, while choice experiment terminology is ordinarily used in conjunction with stated preference data.

- ***Contingent ranking***: in this approach respondents are required to rank a set of alternative options. Each alternative option is characterized by a number of attributes which vary in level across different options. In order for results from contingent ranking exercises to be consistent with economic theory, one of the options presented to respondents must represent the status quo. If the status quo is not included, then respondents are effectively 'forced' to choose one of the alternative options (neither of which they may actually prefer).

- ***Contingent rating***: with this approach respondents are presented with a number of scenarios and are asked to rate each one on a numeric or semantic scale. Notably contingent rating does not involve the direct comparison of alternative options which may be unrealistic in some contexts; e.g. when asked to pick a recreational trip on a river, if an individual were offered five different trips to choose from they would only buy one or choose not to go rather than rate all five.

- ***Paired comparisons***: in this approach respondents are required to choose their preferred alternative out of a set of two choices and to indicate their strength of preference on a numeric or semantic scale. Effectively a paired comparison exercise combines elements of choice experiments (selecting the most preferred alternative) and rating exercises (rating strength of preference).

Water valuation applications: With regard to water resource management a number of studies have used choice experiments to determine the WTP for changes in water quality. There are also many examples of studies based on recreational activities such as angling, diving, rafting, etc.

Process of implementation: Regardless of the specific approach, choice modeling exercises typically feature the same common stages of implementation (Bateman et al., 2002a) (**Figure A1.9**):

Figure A1.9: Choice modeling design, implementation and analysis steps

Step 1	Design preference questionnaire	• Hold focus groups, cognitive interviews or workshops
↓		
Step 2	Design scenario	• WTP or WTA • Determine payment characteristics • Determine status quo • Design the choice set and specify experimental design
↓		
Step 3	Pre-testing	• Implement a pilot survey • Analyze the pilot survey data and check question format • Feed results into final survey design
↓		
Step 4	Conduct main survey	• Analyze data • Conduct econometric analysis to derive WTP/WTA values • Produce final report

1. Development of survey instrument (i.e. the questionnaire) – primarily, this initial step involves identifying the relevant attributes of the non-market good or service in question. Attributes may be based on impacts arising from policy or project options or those thought to be significant to the preferences of respondents. Focus groups and/or cognitive testing are typically useful for this process. Once the attributes are determined, the survey instrument is developed via the assignment of levels to the attributes (which should be realistic and span the range over which respondents are expected to have preferences). Statistical design theory is then used to combine the levels of attributes into a number of alternative scenarios to be presented to respondents (for more see Bateman et al., 2002a; Louviere et al., 2000). From this, ‘choice sets’ may be constructed which provide the alternative options with which respondents are presented. As with the contingent valuation (CV), the choice modeling survey instrument will typically be tested via a pilot survey prior to its full implementation.

2. Implementation of the survey – the survey instrument is administered to a sample of the population of interest. As with the CV method, the survey instrument may be

administered in a number of ways: on site, door to door face to face interviews, via remote telephone, mail surveys, or web-based surveys. Aside from the choice modeling exercise, the questionnaire will also collate information on the respondent's attitudes, experience and use of the environmental good or service in question as well as socio-economic characteristics in the same way as a CV survey (see table in CV section).

3. Analysis of the survey responses – as outlined in Bateman et al (2002a), analysis of choice modeling data sets can be quite involved. Initially data must be organized and coded according to the choice sets and attribute levels faced by each respondent. In the case of choice experiments, the dataset is typically estimated on the basis of limited dependent variable models, while contingent ranking datasets may be analyzed by censored dependent variable models. Analysis of choice experiment data is in fact similar to that of the MRD models (see MRD models summary, in particular the property of independence of irrelevant alternatives) where econometric methods focus on the probability that a respondent will choose a particular option (e.g. binary logit or multinomial logit/probit model – see Bateman et al., 2002a). However, if these assumptions are broken several complex methods of estimation remain including mixed logit models (Train, 2003). With choice experiment data, estimates of WTP are derived from the parameter estimates of the choice models. As with CV surveys, analysis of choice modeling data also entails validity testing, particularly through the estimation of WTP functions.

4. Aggregation of results – the final step of the analysis (in choice experiments) is to aggregate WTP estimation for the specified change in the provision of the non-market good of interest over the relevant population. This estimate of overall WTP may then be applied in decision-making exercises, for example, for use in cost-benefit analysis. As with CV, use of GIS data allows spatial aspects such as the distance to particular resources to be included within the decision making context for aggregation.

Data needs: Primarily, the choice modeling survey instrument will be designed to collate all data required for estimating preferences for non-market goods and services and in the case of choice experiments, estimating WTP functions for determining the main influences on respondents WTP. Aside from data on respondent WTP and information from debriefing questions, the dataset will also include information on respondent socio-economic and demographic characteristics, as well as information on respondent attitudes towards the non-market good or service and their prior experience of the good or service.

In addition, a crucial aspect of choice modeling survey design is ensuring that the survey sample is representative of the population of interest. Generally, representativeness will be based on socio-economic characteristics (e.g. sourced from census data), since data typically does not exist on other factors that may be relevant, for instance, prior experience of the environmental good or service in question.

Other practical issues of implementation: As with CV studies, reliable choice modeling exercises are not simple to implement and take time to develop to ensure that the survey instrument and choice sets cover the range of scenarios required and that the procedure is clearly explained to respondents. Overall, from the initial design stages of the survey instrument to aggregating and reporting of results, practical implementation of the choice modeling could require three months to a year, depending particularly on aspects such as complexity of the issue of concern and sample size. Considering the constant developments in stated preference techniques (such as choice experiments), leading practitioners should be involved in a study at least in a peer review capacity. Analysis of choice modeling datasets, the estimation of WTP/WTA values and functions, as well as validity and reliability testing requires econometric expertise.

Principal outputs: Choice modeling (as practiced in choice experiments) can provide estimates of the total economic value of an environmental good or service, or estimates of use and non-use value separately, depending on the valuation scenario. Choice modeling exercises also provide information on which attributes are significant determinants of the values individuals hold for non-market goods, as well as the implied ranking of these attributes amongst the relevant population.

Transferability of outputs: Some forms of choice modeling, particularly choice experiments may be generalized and therefore more appropriate from a benefits transfer point of view (see for example Morrison 1999). For instance, an estuary may be described in terms of its attributes (e.g. species diversity, recreation facilities, water quality, fish populations, etc) and management decisions will typically involve changing the levels of these attributes. Hence, knowledge of the marginal value of these attributes is useful, and choice experiments are ideally suited to estimate such values. Furthermore, since choice experiment models are based on attribute theory, they are particularly commensurate with hedonic and MRD models.

Key uses – decision-making context(s): Depending on the approach taken, choice modeling can be inputted into policy and project analyses, into decision-making contexts concerning the demonstration of importance of an issue, priority setting within a sector, determine marginal damages as the basis for an environmental tax or charge; or legal damage assessment (liability).

Key uses – coverage of the natural environment: As is the case with CV, choice modeling is particularly flexible and facilitates the valuation of a wide range of environmental goods and services, including those not currently provided. Traditionally, choice modeling exercises have been developed in the domain of transport decision-making and marketing, however, this technique has started to become more popular with environmental economists and international examples exist that include water quality valuation, recreational site choices, and entrance fees to protected areas (both land and aquatic).

Discussion: In order to estimate the value of a non-market good in its entirety, as distinct from a change in one of its attributes, it is necessary to assume that the value of the whole is equal to the sum of its parts. This presents two issues. Firstly, there may be additional attributes of the good that have not been included in the choice exercise (although in practice these are captured by the constant term in the estimated model). Second, much debate has focused on whether the value of the 'whole' is indeed the sum of its parts.

Evidence from the transport field has suggested that whole improvements are indeed valued less than the sum of the component values (Bateman et al., 2002a). This issue is termed the ‘packaging problem’ in choice experiment exercises. This also demonstrates that as with other stated preference techniques, estimates of value are sensitive to the study design and constructed hypothetical scenario.

A noted phenomenon in CV studies is ‘ethical’ protesting, where typically a small percentage of respondents will refuse to engage in the hypothetical market which is presented to them. This implies unwillingness to trade-off environmental outcomes with monetary amounts (e.g. a ‘protest’ response). In contrast, choice modeling approaches may avoid this issue since there is no direct question asking for a monetary valuation of the good. Instead, monetary valuations are indirectly inferred from choices, ranks and ratings by statistical techniques. However, complex choice experiments can lead to fatigue and be demanding in terms of respondent concentration, in these instances individuals may only look towards a single attribute e.g. price, to aid their decision making.

Consideration of distributional impacts: As with CV studies, the choices made by respondents may be constrained by wealth. This implies that the intensity of preference of poorer income groups may not be adequately expressed in the valuation process. However, the survey instrument will allow for separate collection of WTP and other information for different socio-economic groups, and consequently a distributional analysis can be conducted.

Advantages and disadvantages: Bateman et al. (2002a) note one distinct advantage of choice modeling is that it can be seen as a generalized form of a discrete choice CV study (e.g. a change or no-change scenario). However, in the CV approach it is not possible to analyze the attributes of the change in question without designing different valuation scenarios for each level of the attribute, which would be a costly undertaking. However, since choice experiments can incorporate more than two alternative levels for each attribute of interest, they are more suited to this form of analysis. In addition, choice experiments are more suited to measure the marginal value of changes in the characteristics of non-market goods, which may be useful from a management of resources perspective, rather than focusing on either the gain or loss of the good and more discrete changes in attributes.

Choice experiments may also avoid some of the response difficulties which are encountered in CV studies. For instance, CV studies using a dichotomous choice format may be subject to ‘yea-saying’ where respondents see a positive answer as a socially desirable response or as a strategic response. However, in a choice experiment setting, respondents get many chances to express a positive preference for a good over a range of payment amounts; hence such behavior will likely be avoided.

In terms of disadvantages, more complex choice modeling designs may cause problems for respondents leading to an increased degree of random error in responses. Therefore, it should be expected that as the number of attributes (or rankings) increase the likelihood of inconsistent responses will also increase due to limits in cognitive ability.

Conflicts and synergies with other methods: Choice modeling approaches demonstrate a number of synergies with other valuation approaches. In particular, the design process and survey instrument is similar to that of CV studies. Choice modeling exercises may also be carried out in conjunction with travel cost studies since data necessary for these studies could be collected through the same survey instrument.

Example

Title: Investigating public preferences for managing Lake Champlain using a choice experiment (Smyth et al. 2009)

Location: Lake Champlain, Quebec

Sample size: 6541

What is valued: N/A

Analysis: Binary logistic regression

Discussion: Smyth et al. (2009) apply a choice experiment to assess residents' preferences for different lake management priorities in Lake Champlain. While the study applies a choice experiment approach, the design did not include a price attribute. Instead it assesses preferences via a paired comparison of scenarios for five attributes (beach closure, water clarity, land use change, fish consumption advice and spread of invasive water chestnut). For each attribute, three levels were defined in accordance with low, medium, and high management effort.

Safe fish consumption was found to be the highest priority amongst residents, although this had previously been a low priority issue for lake management plans.

Outcomes: While the study did not focus on estimating economic values associated with different lake management options (which could then be compared to the costs of management) it does demonstrate the general principles of the choice experiment approach.

A1.8 Benefits transfer

Objective: Benefits transfer (or value transfer) is a process whereby information regarding economic value in one context is applied to a new context for which an economic value is required. As such, the value of non-market environmental goods and services may be estimated on the basis of previous economic valuation studies (e.g. applications of the contingent valuation, travel cost studies, etc).

Value concept: Since benefits transfer relates to economic valuation methodologies, the approach can provide estimates of the total economic value of a good or service, depending on the source study (or studies). For instance, transferring results from a contingent valuation study may enable both use value and non value to be estimated, while transferring results from a travel cost study will lead to an estimate of use value only.

Theoretical basis: In the terminology of benefits transfer, monetary estimates of the value of a (non-market) good or service are transferred from a 'study' good or site to a 'policy' good or site. The study good refers to the asset that is the subject of an existing valuation study, whilst the policy good is that asset for which a valuation is required. The simplest form of benefits transfer is to 'borrow' the estimated average WTP or WTA for some study good and apply it to the policy good context. This approach implies that the preferences of the average individual for the study good are an adequate description of the preferences of the average individual in the policy site context. Essentially this amounts to the assumption that WTP for the policy good is equal to WTP for the study good. This approach may be termed as ‘average (or mean) value transfer’ or ‘unadjusted unit value transfer’. However, the simplicity of this approach is subject to a number of caveats. Specifically, there are a number of reasons why it would be expected that WTP will differ between two sites, implying that the transferred value is an inaccurate measure of WTP for the policy good. These include differences in the (Bateman et al., 2000):

- Socio-economic characteristics of the relevant study site and policy site populations;
- Physical characteristics of the policy and study goods;
- Valuation context, i.e. proposed changes in the quality and/or quantity of policy and study goods that are valued; and
- Availability of substitutes at each site.

Hence in reality, the policy good and the study good are unlikely to be identical. An alternative approach therefore is to adjust the study good WTP estimate in some way to account for the difference with the policy good. A common adjustment involves modifying the policy good WTP amount to account for differences in income (which is typically a fundamental determinant of WTP) between the study good context and the policy good context. Alternatively, where there is the requirement to make multiple adjustments to WTP amounts the ‘function transfer’ approach may be applied. Rather than transferring unit estimates of WTP, the function transfer approach instead transfers information from the study good context to the policy good context regarding the relationship between WTP and a number of explanatory factors. Specifically, a WTP function (or ‘bid’ function) relates WTP for a change in a non-market good to changes in parameters of interest including the factors relating to (i) the good (e.g. price and characteristics of the good); (ii) the affected population (e.g. socio-economic and demographic characteristics and pattern of use of the good); and (iii) the change (e.g. the quantity and quality of the good available with or without the change of concern). With a function transfer approach, WTP for the policy good is predicted on the basis of the policy site value of these variables.

Water valuation applications: Benefits transfer can feasibly be applied in any instance where previous water valuation research has been undertaken and the context of the study good matches that of the policy good.

Process of implementation: Undertaking a benefits transfer approach to the valuation of environmental goods and services requires a number steps.

Figure A1.10: Benefits transfer steps

Step 1	Literature review	• Select studies to investigate • Compare population and location characteristics • Compare site/good characteristics • Compare change in the good being valued
↓		
Step 2	Review study methodologies	• Ensure the studies contain WTP functions • Ensure the studies contain information on property rights
↓		
Step 3	Adjust values	• Ensure values are adjusted • Explain how values are adjusted • Aggregate results • Produce final report

1. The initial step of any benefits transfer exercise will be to conduct a literature review. Here a search is made for relevant economic valuation studies which consider scenarios similar to the policy good valuation context. From the initial search, an appropriate study (or studies) is selected, which provides the study good and the WTP results or function to be transferred to the policy good context. An important consideration to be kept in mind when assessing the merits of different study site studies is the expectation that, as noted above, WTP for a particular good will differ between different locations. Therefore, in order to minimize concerns relating to the 'accuracy' of transferred values, it is important to select the most appropriate WTP information from the most appropriate study. Hence, what is needed is a set of criteria for assessing the appropriateness of WTP surveys for transfer purposes. Such criteria include (Bateman et al., 2002a):

   - Site/good characteristics should be the same, or differences should be accounted for;
   - The change in the provision of the good being valued at the two sites should be similar;
   - Study and policy sites must be similar in terms of population and population characteristics or differences in population must be accounted for;
   - Studies should contain WTP functions showing how WTP varies with explanatory variables;
   - Studies included in the analysis must themselves be sound; and
   - Property rights should be the same across the sites.

In theory, adhering to these conditions would enable a suitable ‘match’ to be made between the policy site good to be valued and its associated appraisal context and an existing valuation study from which to source WTP information. While not explicitly mentioned in the above criteria (but embodied within criterion (ii) and (iii)), geographical or spatial location is a particularly important consideration in assessing the appropriateness of a study for transfer purposes.

2. Adjustment of values – depending on the similarity of the study good context and policy good context it may be the case that the average value transfer approach is used. More likely though, differences in the policy and study site will require that some form of adjustment is made. In order to adjust WTP values or apply the function transfer approach it is necessary that supplementary data is collected for the policy site, in particular, information on the affected population and their socio-economic and demographic characteristics and also their pattern of use of the good in question.

3. Aggregation – once WTP amounts have been transferred to the policy site, or predicted via the function transfer approach, the final stage of the process is the aggregation of WTP over the appropriate population for the policy good context.

Data needs: Fundamentally, the benefit transfer approach can only be carried out if a suitable valuation study exists which is a suitable match to the policy good context. In addition, it is useful to have a number of suitable valuation studies which match the policy good context, in order to provide a range of results and enable key sensitivities in the value transfer process to be identified and considered. Benefits transfer exercises also require a substantial amount of data concerning the policy site. Firstly, this enables a comprehensive comparison of the socio-economic characteristics of the policy and study sites to be made in order to determine whether it is desirable to adjust WTP results. Secondly, data on the characteristics of the policy site enable a function transfer approach to be applied.

Other practical issues of implementation: A distinct appeal of the benefits transfer approach to economic valuation is its expediency and value for money properties in relation to commissioning original valuation studies. The process of reviewing appropriate studies and undertaking appropriate analysis can be achieved very quickly (i.e. a couple of days). That said, if there is need to collate supporting data (e.g. number of visitors) for the policy good context the timescale will be longer.

Principal outputs: The principal outputs of benefits transfer exercises are estimates of WTP/WTA for changes in the provision of non-market goods and services. Where values are transferred from stated preference studies, benefits transfer exercises can enable the total economic value (TEV) of a non-market good or service to be valued (i.e. use value and non-use value). If results are transferred from revealed preference studies then benefits transfer enables an assessment of use value to be made.

Transferability of outputs: See discussion below.

Key uses – decision-making context(s): Benefits transfer exercises may be utilized in a number of decision-making contexts including: inputting to policy and project analyses; demonstration of the importance of an issue; and priority setting within a sector.

Key uses – coverage of the natural environment: Benefits transfer offers the potential to value a wide range of environmental goods and services so long as they have been subject to an original valuation study. Use of benefits transfer is facilitated by access to databases of economic valuation studies which allow suitable study goods to be identified and provide information relevant to the transfer of WTP information. Currently, the most comprehensive database is the Environmental Valuation Reference Inventory (EVRI, see www.evri.ca).

Discussion: The notion of benefits transfer is, at first glance, an appealing concept. Certainly the 'value for money' property, in terms of both time and effort spent, is desirable in relation to the assessment and appraisal of projects and policies that impact upon the natural environment. However, expediency must be traded-off against fundamental questions concerning the accuracy of benefits transfer. Primarily, these concerns have arisen from empirical studies that have sought to determine the reliability of value transfer in different situations. Typically, the validity and reliability of value transfer may be tested by carrying out identical economic valuation surveys that focus on the same non-market good either at different locations or at different points in time and across two or more different sample populations. Subsequent comparison of the results from these surveys across the different populations may reveal whether or not any significant differences exist in either average WTP values or estimated bid function coefficients (Brouwer, 2000). Generally, empirical assessments of value transfer provide inconclusive findings as to the accuracy of both unit and function transfer approaches. In particular, errors reported by various studies range widely and there is no overwhelming evidence to suggest that one approach to value transfer has proved to be more successful than any other.

With regards to choice of approach (i.e. unit transfer or function transfer) a typical supposition is that function transfer is the most conceptually appealing approach to benefits transfer since it allows for more control of factors that may vary between study site and policy site (Pearce et al. 1994). Therefore, policy good WTP values arrived at through this approach may be seen, at least conceptually, as more accurate than those provided by unit value transfer. However, as noted, empirical tests of the accuracy of value transfer have not enabled an over-riding conclusion to be made on this point.

Ideally, an application of benefits transfer will source WTP information from a 'reliable' valuation study. It will take appropriate steps to ensure that any differences between study and policy goods and the change in their provision and differences between study and policy site population characteristics are minimal. This would imply that doubts concerning accuracy of the value transfer exercise are minimal. As well, the decision-making process of interest is informed by economic values that are as reliable as can be expected. Regardless however, benefits transfer exercises are subject to an inherent degree of uncertainty concerning the match between the study good context and the policy good context. Where 'accuracy' in valuation is required, for instance, in the setting of taxes or charges relating to environmental externalities or the legal assessment of damages and liability, benefits transfer is unlikely to be a suitable approach to valuation. However, where indicative assessments of the monetary value of environmental services are required, benefits transfer can provide a useful input into decision-making, although emphasis should be placed on the requirement to make explicit the assumptions and adjustments made to the WTP information.

Consideration of distributional impacts: Use of adjusted unit transfer and function transfer approaches to benefits transfer enables an explicit account for differences in socio-economic variables to be made in the estimation of WTP at the discretion of the analyst.

Advantages and disadvantages: The principal advantages of benefits transfer are its expediency and cost-effectiveness, enabling decision-making to be informed in a relatively short period of time on the likely range of monetary value that may be attributed to non-market environmental goods and services. Adjusted unit transfer and function transfer approaches to benefits transfer also enable the analysis to modify WTP according to likely determinants of WTP, giving the transferred values a certain amount of sensitivity to key differences in the study good and policy good contexts.

The main disadvantages of benefits transfer focus on questions of accuracy in the values derived in relation to original valuation studies. However, concerns regarding accuracy are a necessary trade-off if otherwise, decision-making will not be informed as to the likely monetary value of environmental goods and services. The other principal disadvantage of benefits transfer is that the approach cannot be used if there are no existing studies that have investigated the value of the environmental good or service in question, which provide suitable WTP information to transfer to the policy good scenario.

Conflicts and synergies with other methods: In theory, application of benefits transfer is compatible with all economic methods for valuing environmental goods and services provided conditions concerning the commensurability of the study good and policy good contexts are satisfied or adjusted for appropriately.

ANNEX 2: REFERENCE LIST

Economic valuation methods and examples

General

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Stakeholder engagement – annotated bibliography

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The Environmental Protection Agency (EPA). 2003. Getting in Step: Engaging and Involving Stakeholders in Your Watershed. Available at: www.epa.gov/nps/toolbox/print/stakeholderguide.pdf

The guide provides tools needed to effectively engage stakeholders to restore and maintain healthy environmental conditions through community support and cooperative action. It is intended primarily for federal, state, tribal, and local agency personnel involved in watershed management activities interested in recruiting stakeholders and involving stakeholders in local or regional watershed efforts. It includes resource information, case studies, web sites, and other how to guides related to watershed protection.

Government of Canada. 2000. Health Canada policy toolkit for public involvement in decision making. Available at: http://www.hc-sc.gc.ca/ahc-asc/alt_formats/pacrb-dgapcr/pdf/public-consult/2000decision-eng.pdf

This document aims to help health officials improve their ability to consult, engage, listen, persuade and reframe issues so that the results of their work better meet citizens' expectations and needs. This requires strengthened capacity to inform, educate and involve the public and to get feedback on how they are doing. Although targeted to health officials, it provides many useful case studies and descriptions of techniques used in successful stakeholder engagement.

IAP2 (International Association of Public Participation). 2000-2003. *The IAP2 Public Participation Toolbox*. *Available at*: *http://www.iap2.org/associations/4748/files/toolbox.pdf*

In less than 10 pages, over forty-five techniques are discussed in tabular form. The toolbox table has organized the techniques in to the following categories: “to share information”; “to compile input and provide feedback”; or “to bring people together”. Advice is provided for each technique to orient the planner’s choice as well as the strengths and weaknesses of each technique.

International Organization for Standardization (ISO). 2008. ISO 26000: Guidance on Social Responsibility Working Draft 4. Available at:
http://isotc.iso.org/livelink/livelink/7795973/ISO_CD_26000__Guidance_on_Social_Responsibility.pdf?func=doc.Fetch&nodeid=7795973

The International Organization for Standardization (ISO) has embarked on the development of a guidance standard for social responsibility, called “ISO 26000.” Although it is expected to align with and be consistent with existing ISO 9000 and ISO 14000 quality and environmental management systems standards, ISO 26000 is not intended for certification, and is not a management system standard. The ISO 26000 guidance standard is to be applicable to all types of organizations in both public and private sectors, in developed and developing countries. The working draft is aiming to:

- assist organizations in addressing their social responsibilities,
- provide practical guidance related to operationalizing social responsibility,
- assist organizations in identifying and engaging with stakeholders, and
- enhance the credibility of reports and claims made about Social Responsibility

Thomas Krick et al. 2005. From Words to Action: The Stakeholder Engagement Manual. Volume 1 available at:
http://www.accountability21.net/uploadedFiles/publications/Stakeholder%20Engagement_Practitioners'%20Perspectives.pdf

Volume 2 available at:
http://www.accountability21.net/uploadedFiles/publications/Stakeholder%20Engagement%20Handbook.pdf
The Stakeholder Engagement Manual is comprised of 2 main documents: Volume 1 The Guide to Practitioners' Perspectives on Stakeholder Engagement and Volume 2 The Practitioners' Handbook on Stakeholder Engagement. A very useful manual that provides

an extensive step-by-step guide for the organization on how to start and improve its engagement with stakeholders. A toolkit of templates for practical use is also available.

New South Wales, Australia: Planning NSW. 2003. Community Engagement in the NSW Planning System. Available at: http://203.147.162.100/pia/engagement/intro/pdf/cehandbook.pdf

The handbook is a comprehensive and easy to read practical resource for practitioners. It provides best practice community engagement principles, techniques and tools by providing practical examples and stories from the field. It is the result of a unique collaboration with leading community engagement practitioners –Lgov NSW, the Institute of Public Administration Australia (NSW Division), Planning Institute of Australia (NSW Division), NSW Premier's Department, NSW Department of Local Government and the International Association for Public Participation.

The World Bank. 1996. The World Bank Participation Sourcebook Available at: http://www.worldbank.org/wbi/sourcebook/sbhome.htm

The sourcebook provides a practical resource for participatory techniques and tools within the international context of World Bank's activities. The Sourcebook is primarily intended for readers who have already decided to use participatory approaches in their professional work. The document is available online in clearly written sections which cover a wide range of topics including: case studies; enabling the poor to participate effectively; and summaries of methods and tools for participation.

Aboriginal Consultation

Government of Alberta. 2005. First Nations Consultation Policy on Land Management and Resource Development. Available at: http://www.aboriginal.alberta.ca/documents/Policy_APPROVED-May16.pdf

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Government of Saskatchewan. 2008. Interim Guide for Consultation with First Nations and Metis People**.** Available at: http://www.fnmr.gov.sk.ca/documents/policy/consultguide.pdf

The Mackenzie Valley Review Board's Reference Library. Available at: http://www.mveirb.nt.ca/reference_lib/

The Mackenzie Valley Environmental Impact Review Board (MVEIRB) is a co-management board responsible for the environmental impact assessment process in the Mackenzie Valley. The Review Board was established by the Mackenzie Valley Resource Management Act in 1998 as an independent administrative tribunal. Although the federal government enacted this piece of legislation, it resulted from land claim negotiations. This legislation gives aboriginal people of the Mackenzie Valley, Northwest Territories, a greater say in resource development and management. As a co-management board, aboriginal land claim organizations nominate half of the Review Board members, and the federal and territorial governments nominate the other half of the board members. The Minister of Indian and Northern Affairs appoints all the members to the Review Board.

The Review Board's vision for itself is excellence in environmental impact assessment within a co-management system that balances diverse values to protect the Mackenzie Valley for present and future generations. The MVEIRB has an online reference library full of many useful resources for engaging with indigenous communities and integrating Traditional Knowledge (TK) in to decision making processes.

Publications

Leon Hermans et al. 2006. Food and Agriculture Organization of The United Nations.

Stakeholder-oriented water valuation to support the development of economic arrangements. Available at: ftp://ftp.fao.org/agl/aglw/docs/wr30_eng.pdf

"This report explores how to improve the connection between analytical efforts to place a value on water resources and the actual water resources management processes. It does so by comparing concepts from literature on integrated water resources management (IWRM) and water valuation with practical experiences from three recent cases where an effort was made to embed existing valuation tools and methods into ongoing decision-making processes by stakeholders. Using the lessons from these three cases, it provides a

first outline for a stakeholder-oriented water valuation process that could support the integration of valuation into ongoing and adaptive processes of water resources management."

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2006. The 2nd UN World Water Development Report: 'Water, a shared responsibility'. Available at: http://www.unesco.org/bpi/wwap/press/pdf/wwdr2_chapter_12.pdf

"The United Nations World Water Development Report is the flagship publication of UN-Water, the inter-agency mechanism established to coordinate the activities of all United Nations agencies and entities working in the area of freshwater resources. First published in 2003 as a contribution to the International Year of Freshwater, the Report is produced by UN-Water's World Water Assessment Programme (WWAP). Working closely with governments, non-governmental organizations, civil society groups and the private sector, WWAP monitors water problems, provides recommendations for meeting future demand, and develops case studies in order to promote informed discussion of freshwater issues."

Government of Canada: Policy Research Initiative. 2007. Sustainable Development Research Program: Canadian Water Sustainability Index (CWSI) Project Report. Available at: http://www.policyresearch.gc.ca/doclib/PR_SD_CWSI_200702_e.pdf

"With components of resource availability and demand, environmental and drinking water quality, and community water management capacity, the Canadian Water Sustainability Index (CWSI) is a framework for evaluating a community's relationship with its water resources. With this report, the first draft of the CWSI is explained and evaluated, and suggestions for improvement are advanced."