Slimming Your Waste

Towards Total Cost Assessment of Waste Management in Christchurch City

Prepared for

Christchurch City Council
Waste Management Unit

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Executive Summary

In response to the Local Government Amendment Act No. 4 (1996), and national policy trends, the Christchurch City Council introduced their *Draft Waste Management Plan for Solid and Hazardous Waste* in 1998 containing the following principle:

> *The real costs of waste management shall include social, environmental and economic costs and these will be assessed and reported annually.*

This principle has led to this study, which has the aim of providing a framework for the assessment of the total cost of waste management in Christchurch.

Waste management and its effects on biophysical, social and economic characteristics of the environment is one of a large number of complex and interconnected problems. As a response to the complexity of the issues, the approach chosen for this study is to place the issues into their political, institutional and environmental context, and through analysis of this system define the key issues that must be taken into account when implementing a total cost assessment framework. Some of the issues identified are used to develop criteria against which to analyse existing approaches to total cost assessment. The results of this analysis indicate that no single existing approach fulfils the requirements for a total cost assessment framework for Christchurch City waste management. It is therefore necessary to design an original framework that can take into account the important issues relating to waste management in Christchurch City.

The framework developed in this report provides a structure for the assessment of total cost, including tools for the identification and measurement of effects. This structure includes the definition of a matrix providing for the identification of the potential effects of waste management activities on characteristics of the environment. Guidelines are provided for decision-making regarding the use of measurement tools and the conversion of non-monetary effects into potentially comparable quantitative units.

The framework enables comprehensive identification of effects, allows the integration of most current effects assessment and management systems, and provides opportunities for strategic applications of the information gathered. In order to effectively implement and apply the framework, five high priority steps for Christchurch City Council are recommended.

- Introduce the TCA framework in stages, with continuous improvement and evaluation.
- Liaise with MfE to develop guidelines for TCA and enter into dialogue with other local authorities in the region to pursue TCA.
- Develop TCA of ‘landfill’ further as a test programme (pilot study). This includes building existing approaches, tools and information into the TCA framework, establishing new information gathering techniques, and evaluating TCA framework performance.
- Develop a protocol for combining all described, qualitative, and quantitative effects for the purpose of decision making.
- Further investigate the use of waste type data in a TCA framework.

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Glossary

The following definitions relate to terms as they are used within this report. A discussion of some of the terms used is provided in section 2.5.

The major sources for this glossary are Ryan (1995) for Maori terms, the Christchurch City Council (1998) for waste management terms, and Walker (1994) for scientific terms.

activities	individual tasks done within a programme
alluvial	associated with river and floods
aquifer	rock formation containing a recoverable water resource
benefit	a positive social, biophysical, economic or financial value or improvement of such a value
bio-hazardous waste	medical waste or waste posing a health risk
cleaner production	systems or programmes to improve the efficiency of resource and energy use and minimise waste
construction and demolition waste	materials which arise from construction, demolition and related activities (eg., roading, building, earthworks, refurbishment)
cost	a negative social, biophysical, economic or financial value or reduction in such a value
discount rate	a calculation applied to costs or benefits which occur in the past or in the future, to adjust them for the present given social time preferences
economic	relating to systems of allocating resources amongst needs and wants, particularly market systems
economic instruments	tools for influencing human behaviour that use market forces and/or principles
ecological	relating to living things (excluding humans), their physical environment and any interactions between them
effect	a change resulting from an action i.e., its cost or benefit
environment	surroundings or context, often meaning natural, physical or biophysical but also including social, financial and economic
financial	refers to costs and benefits accounted for in economic or market systems and accruing to waste management service providers
garden waste	non-manufactured organic material collected from gardens
green waste	garden waste and other organic material suitable for composting
hazardous waste	waste which can harm people, property or the environment if not correctly managed
indicator	a measurement which is used as a representative of the state of a larger system
industrial ecosystem	a concept in which an industrial system is not considered in isolation from surrounding systems, also related to sustainable production and lifecycle approaches (Marstrander, 1996, p.109)
infiltration	penetration of a liquid into soil or substrate

institutions	any formalised structure of society
iwi	tribe, bone, race, people, nation, strength
kaitiaki	guard, caretaker, manager, trustee
kitchen waste	fruit, vegetable or other waste generated in residential or commercial kitchens
leachate	liquid effluent produced by movement of water through a substance or material (eg., landfill)
Maori	ordinary, fresh, native people
mauri	spirit, life force
municipal solid waste	general refuse, eg., the mixed rubbish collected from houses and businesses
organic waste	waste which can be composted
pakeha	non-Maori, European, Caucasian
programme	an identified part of the waste management process, eg., landfill, public education, municipal waste collection, refuse stations
putrescible waste	waste which rots
refuse	same as municipal solid waste
refuse station	sites at which the public can deposit refuse or separated waste for composting, recycling or reuse (also known as transfer stations)
runanga	assembly, institute, debate, discuss, seminar, council (in this report, refers to group representing localised groups within the iwi)
social	refers to costs and benefits which accrue directly to humans and human systems (includes socio-economic costs and benefits)
socio-economic	refers to costs and benefits relating to economic and market systems and accruing to the public (as opposed to the service provider)
special waste	non-hazardous waste requiring special handling for disposal
tangata whenua	local people, aborigine, native
tauiwi	alien, gentile, heathen, foreigner, infidel
total cost	evaluation of costs less benefits of all types (social, biophysical, financial and socioeconomic)
waste	substances or materials which are currently unwanted
waste generation	the point at which materials become unwanted and thus enter the waste stream, or the act of introducing material to the waste stream
waste management hierarchy	an order the desirability of different waste management practices, which may include but is not limited to: reduction; reuse; recycling; recovery; and residue disposal
waste stream	the flow of materials from generation to disposal or diversion by reuse or recycling
water table	the level below which the ground is saturated with water

Abbreviations

AEE	Assessment of Environmental Effects
APEC	Asia Pacific Economic Cooperation
CBA	Cost-Benefit Analysis
CCC	Christchurch City Council
EIA	Environmental Impact Assessment
ERRA	European Recovery & Recycling Association
G8	Summit 8
GATT	General Agreement on Tariffs and Trade
GIS	Geographic Information System
HWAS	Hazardous Waste Advisory Service
IEM	Integrated Environmental Management
IMF	International Monetary Fund
ISWA	International Solid Waste Association
IUCN	International Union for the Conservation of Nature
LCA	Life Cycle Assessment
LGA	Local Government Act 1974
MfE	Ministry for the Environment
NIMBY	"Not in My Back Yard" Syndrome
NMV	Non-Market Valuation
OECD	Organisation for Economic Coordination and Development
PCE	Office of the Parliamentary Commissioner for the Environment
PET	Polyethylene terephthalate (Plastics)
PVC	Poly vinyl chloride (Plastics)
RMA	Resource Management Act 1991
RMF	Recovered Materials Foundation
SER	State of the Environment Report
SIA	Social Impact Assessment
SPREP	South Pacific Region Environmental Programme
TCA	Total Cost Assessment
TCM	Total Cost Management
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WMU	Christchurch City Council Waste Management Unit
WTO	World Trade Organisation
WWF	World-Wide Fund for Nature

CHAPTER 1 INTRODUCTION

> *"The consumer society has now become the norm with little thought as to its ultimate consequences"* (Boyle in ISWA, 1997, p.44).

In New Zealand, our standard of living is perceived to depend on the use of many products, which, when finally disposed of by the end user, become waste. The New Zealand economy relies on the production and export or import of goods which create 'waste' during the production process and which become waste when discarded at the end of their lifetime.

The image of New Zealand as a 'clean and green' nation has been questioned internationally (Bührs & Bartlett, 1993). As noted in the *State of New Zealand's Environment Report* "the small size of the New Zealand population and the relatively large land area and water resources at our disposal have allowed us to have our environmental cake and eat it too" (MfE, 1997). For many years New Zealand has neglected the effects and associated costs of waste and its management (PCE, 1998).

As awareness of waste management issues has risen, policy makers have given thought to the 'ultimate consequences' of a 'consumer society' for the people and environment of New Zealand/Aotearoa. This is reflected in central, regional and local government policy and is encapsulated in Principle 4 of the Christchurch City Council (CCC*) Draft Waste Management Plan for Solid and Hazardous Waste* (CCC, 1998), which states that:

> *The real costs of waste management shall include social, environmental and economic costs and these will be assessed and reported annually.*

In this report we address this issue and make recommendations on how CCC should assess the total cost of waste management in Christchurch City.

1.1 Terms of Reference

This report has been completed for the Waste Management Unit of the Christchurch City Council. The authors of the report are five Master of Science students studying in the Resource Management programme, Environmental Management and Design Division, Lincoln University. More detailed information on the authors is provided in Appendix 1.

1.1.1 Aim

The aim of this report is to provide a framework for the assessment of the total cost of waste management in Christchurch

1.1.2 Objectives

Five objectives have been established for this study. These were derived from the terms of reference set by staff from the Environmental Management and Design Division in collaboration with the Christchurch City Council Waste Management Unit.

All of the objectives are addressed within this report. However, the research group's interpretation of and approach to addressing the objectives altered through the course of the research programme. These changes reflect the nature of the research process and exploratory nature of the topic and represent a rational, logical and intuitive progression as the research group's 'body of knowledge' increased. The objectives and the degree and nature of alterations are listed and discussed below.

Objective 1: Acquire a contextual overview of waste management issues in general and specifically for Christchurch City.

Objective 1 was initially considered to encompass understanding general waste management concepts and issues as well as the specific operational environment and issues for Christchurch City. The research group recognised the need to examine issues which were not directly related to waste management practices or issues but which had a potential bearing on or implications for total cost assessment of waste in Christchurch City (eg., the importance of past and future costs, the generator-pays principle and tangata whenua issues).

Objective 2: Identify the components of 'total cost' of the Christchurch City Council Draft Waste Management Plan for Solid and Hazardous Waste - 1998.

'Components' have been consistently interpreted as any category or smaller unit of cost or benefit which contributes to the composition of 'total cost' (as a whole). Objective 2 was initially interpreted as requiring the group to identify 'categories of cost' (eg., costs associated with risk, occupational safety and health, and administration) as well as specific costs associated with waste management activities (eg., costs associated with transportation of waste). An alteration in the research approach has been to give greater emphasis to the identification and analysis of 'categories of cost' (eg., effects-, programme-, and waste type-based categories) as opposed to providing a comprehensive account of specific costs and benefits for waste management in Christchurch City.

The rationale for this emphasis is that a series of important steps precede the comprehensive identification of specific costs and benefits. Firstly, it is necessary to examine issues which affect total cost assessment in order to ascertain implications for development of the framework. Secondly, a systematic and long-term approach to the assessment of costs and benefits is required. Thirdly, comprehensive identification requires a detailed understanding of waste management programmes, activities and dynamics before specific costs and benefits can be identified.

Each of these steps requires considerable research, and the group have been strategic in terms of the order and number of steps taken. Steps taken in the course of this study are outlined in section 1.1.3.

Objective 3: Identify which components of total cost can be measured and how they may be measured.

Objective 3 was initially interpreted as requiring assessment of barriers to TCA. These include ethical (is it appropriate?), technical (is it feasible?) and resource barriers (is it efficient?). Related to this is the need to identify potential approaches or tools for assessing cost, and to assess their benefits, limitations and potential application. The research group's approach has been to give greater emphasis to evaluation of potential tools or approaches other than TCA.

Objective 4: Analyse the potential for measuring component parts of total cost in common units, including money.

Objective 4 has been consistently interpreted through the course of this study. The feasibility and appropriateness of measuring costs in common units (in general and specifically for money) needs to be determined (Is it feasible to convert costs into a common unit? Is it ethical to convert costs into a common unit?). In addition, the potential for use of Net Present Values and discount rates for the assessment of total cost should be discussed to fulfil this objective.

Objective 5: Recommend how the Christchurch City Council should assess total costs of its waste management.

This objective has been consistently interpreted through the report. An approach to implementing total cost assessment should be developed and illustrated using practical examples. The intended output of this research project has changed slightly in accordance with alterations described above, as follows:

Rather than preparing an inventory of specific effects and associated costs for waste management programmes and activities, a systematic approach to implementing total cost assessment will be presented. This will be discussed in the context of issues which effect total cost assessment of waste in Christchurch City. The research output will include practical examples of framework application, and options and recommendations which outline a clear course of action for the CCC Waste Management Unit.

1.1.3 Structure of Report

A broad overview of the report structure is presented in figure 1. This figure illustrates the overarching influence of the theoretical framework (the research group's underlying theories) which shapes other parts of the report, and from which the study methodology and approach are derived (Chapter 1).

Chapter 2 of the report examines the process of waste management in Christchurch City in a broader waste management context. Roles of organisations in waste management are discussed and policy influences on CCC are described. Key themes and trends within the policy process, and specific features of Christchurch City's waste management system are discussed. Chapter 2 closes with a discussion of important terms used.

Issues which affect a framework for total cost assessment are discussed in Chapter 3 of the report. These include the nature of effects, tangata whenua, differences between public and private delivery of waste management services, the generator pays principle, measurement of

effects in common units, import and export of waste, coordination between organisations, and issues relating to future costs and benefits.

Chapter 4 of the report presents and evaluates a framework for total cost assessment. The reasons for developing a framework are discussed and criteria for evaluating a TCA framework are specified and justified. Other approaches to total cost assessment are discussed and their benefits and limitations described. The broad approach to framework development used in this study is then discussed.

Nine steps for implementing the TCA framework are described and illustrated using 'landfill' as an example. The potential use of monitoring (including indicators) and the principle of continuous improvement are then discussed. The TCA framework is finally evaluated against the criteria specified.

Chapter 5 reviews and summarises earlier Parts of the report and draws options, conclusions and recommendations. This includes a review of options and decisions made in the process of developing the framework. Four options are then described and evaluated (in relation to specified criteria) to determine whether TCA should be implemented. Conclusions from the report are drawn and recommendations are subsequently given which advise CCC on how to implement the TCA framework. The report finishes by identifying five prioritised steps toward implementation of the framework.

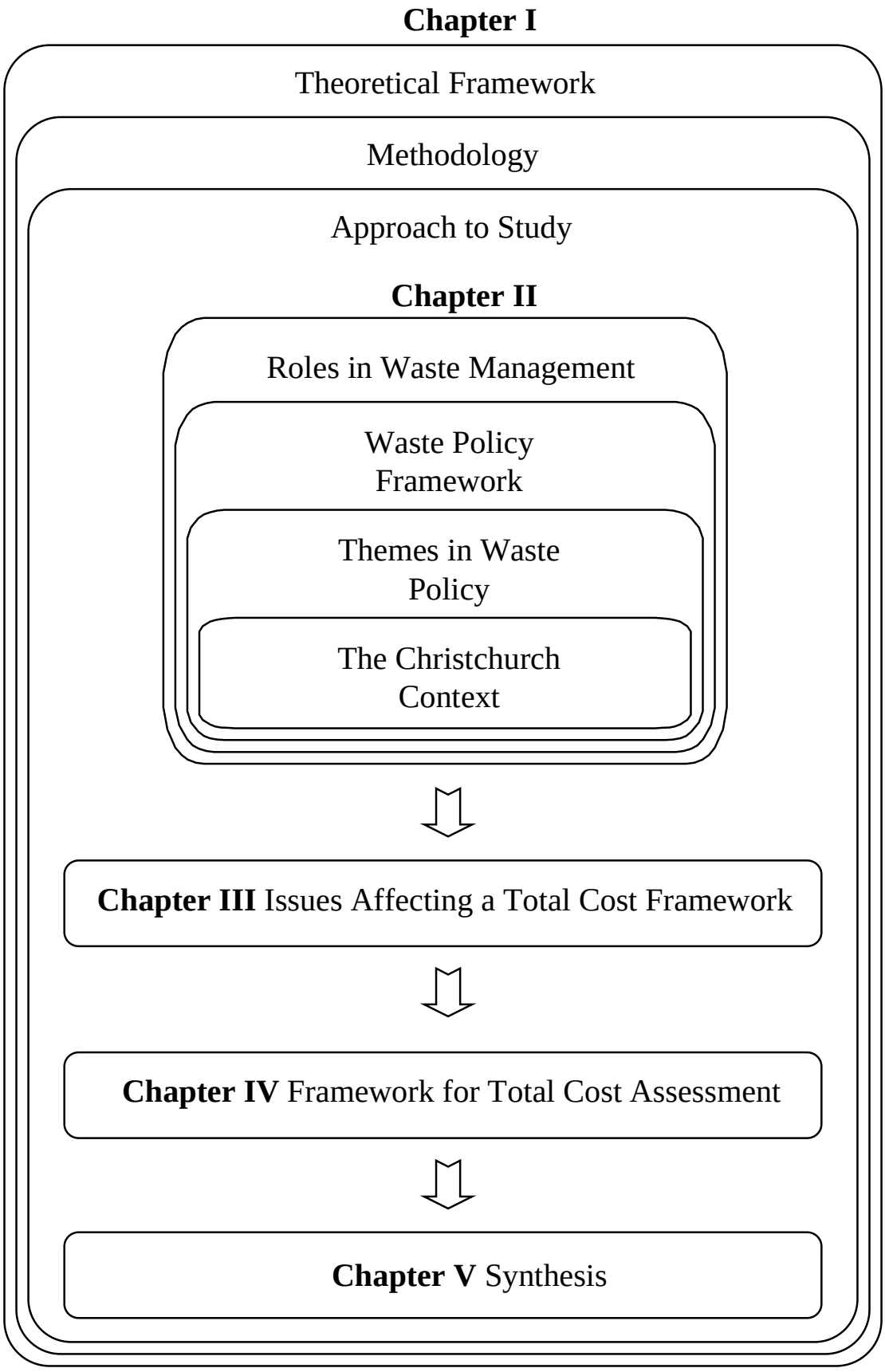

Figure 1: Report overview.

1.2 Potential Applications for Total Cost Assessment

The information obtained by TCA can be applied in various ways. A framework for total cost assessment needs to take account for the intended applications. The following main applications are possible.

1) **Annual reporting:** The hierarchical and systematic structure of a total cost assessment by using a framework contributes to transparent, accountable and understandable presentation of total cost and its use in planning. TCA can therefore be used for annual reporting. Principle Four of the *Draft Waste Management Plan for Solid and Hazardous Waste* states annual reporting as a direct application of TCA (CCC, 1998).
2) **Education and promotion campaigns:** Information on total cost can be used for education and promotion campaigns, and consultation process to address the goals of minimising waste and its effects on the environment. Therefore, TCA can facilitate the Draft Plan's sixth principle of education and consultation (CCC, 1998).
3) **Best management practices:** A systematic break down of costs and benefits allows CCC to target the improvement of specific programmes or activities within their waste management services to minimise waste and its effects.
4) **Implementation needs of the RMA:** Total cost assessment addresses the effects *of* waste management activities *on* the environment. The framework therefore has potential uses under the RMA. For example, TCA can be useful to fulfil the duty to assess costs and benefits (s32) and effects on the environment in relation to a resource consent (s88(6)(b)), and to assist councils in the efficient use of natural and physical resources (eg., landfill space) (s7).
5) **Charging:** Using the information provided by total cost assessment, generators of waste and users of waste management services can be charged on the basis of the total cost in accordance with the generators pay principle (section 3.4). It is CCC's primary focus (E. Park, pers.comm., 1998) to use TCA for developing a system for charging which is based on total cost.

This study takes a wide approach in that the framework for total cost assessment is developed in a way so that TCA can be potentially used for all applications. However, dependent on the actual applications, the framework can be developed further in specific directions.

1.3 Theoretical Framework

The purpose of this section is to make explicit the otherwise unseen theories which underpin both the problem this study group was presented with, and our approach to it. It locates waste management in context as one phenomena within the environmental 'problematique' (widespread, inter-related, complex environmental problems), which requires an integrated approach. This approach requires careful consideration of a broad range of policy, ecological, social and economic issues which surround our key 'problem'. While these influences and issues are dealt with in the body of the report, there is a particular theory which is influential both in waste management policy and in the concept of total cost of waste management itself, which is often not made explicit: neoclassical economic theory. We also recognise total cost as a product of an international trend of more integrated assessment of the effects of human activity.

Awareness of environmental issues began to increase in the 1970s (Bührs and Bartlett, 1993). In the decades that followed, there was a "growing realisation... that policies addressing only one medium (air, land or water) at a time and only 'at the end of the pipe' rather than at the source or ultimate destination, were not fully successful and in some cases were compounding the problem" (Bartlett, 1990, p.236). Increasingly, environmental 'problems' are recognised as complex and interrelated, and waste management is no exception (Bührs and Bartlett, 1993).
"One of the key reasons why environmental policies have not been very successful is that often they recognise only inadequately or not at all the complexity and interrelatedness of the phenomena that constitute the environmental problematique". (*ibid*, p.9)

The term 'environmental' is potentially all-encompassing - it includes the physical or natural environment, and also human communities (section 2.5). Solid waste management, as an 'environmental' issue, likewise contains social, political, institutional, biophysical and economic facets. Beyond that, it is also inseparable from wider environmental issues like resource consumption patterns. In response to this complexity, and frustration over the inadequacy of fragmented, reactionary responses (*ibid*), arose Integrated Environmental Management (IEM). IEM is an approach to environmental and natural resources planning and management which is:

- comprehensive and inclusive;
- interconnective;
- strategic and reductive; and
- interactive and coordinative (Born and Sonzogni, 1995).

These characteristics translate into a process for addressing environmental problems. Comprehensiveness means starting with a wide initial scope to identify all relevant factors (social, cultural, economic, political, institutional, biophysical). Interconnective means addressing the inter-relationships of these aspects through systems analysis and information management systems like GIS (Geographical Information Systems) and databases. Despite a large amount of interconnected information, "it should be possible to obtain the benefits of a comprehensive outlook without becoming so entangled with a complex web of interrelationships that that management exercise literally disappears into a 'black hole', never to re-emerge", by taking a strategic approach (Mitchell, 1987; cited in Born and Sonzogni, 1995, p.171). To be strategic means "to pragmatically scale down the effort", and refers to reducing the scope to key issues and pressure points through analysis and trade-offs between options (Born and Sonzogni, 1995, p.171). The final phase of IEM is being interconnective, which means involving and coordinating the parties and institutions affected by or affecting the 'problem'. What is being integrated by IEM is different components of the physical or biophysical environment (eg., land, air, water, biota), interpretations of them (eg., economic, socio-cultural and biophysical), and the policies and institutions surrounding them (Bührs, 1995).

The aim of this report is to provide a framework for the assessment of total costs of waste management in Christchurch. This responds directly to Principle Four of the *Draft Waste Management Plan for Solid and Hazardous Waste* (the Draft Plan), that the "real costs of waste management shall include social, environmental and economic costs and these will be assessed and reported annually" (CCC, 1998). This plan was developed to meet the requirements of the Local Government Amendment Act No. 4, 1996, which placed a new emphasis on funding, the use of economic incentives and disincentives to meet aims, and having "regard to environmental and economic costs and benefits for the district".

These changes are in keeping with a trend in the state sector's approach since 1984, when government interventionism and activism were rejected in favour of a market driven approach expressed through financial deregulation, liberalisation of markets and trade, restructuring of the state sector (including local government) and a new emphasis on fiscal restraint in government activities (Kelsey, 1995). The change this marked was hugely significant - "apart from the changeover from Maori to British government in the 1840s, no period has seen such policy change" (James, 1993, p.10). The desire to reduce general spending and the application of corporate structures to the state sector has seen transparency and financial accountability become increasingly important values. Public participation was also a feature of both the new institutions developed (such as the Resource Management Act 1991), and of the reforms themselves (Memon, 1993, p.96). These key ideologies are clearly expressed in the Draft Plan.

Central to the approach adopted by the New Zealand Government in 1984 was Chicago School economic and public theories (Jesson, 1989, p.67; Easton, 1989, p.121), "implemented in almost undiluted form" (Kelsey, 1995, p.55). The Chicago School combined economic theory with libertarianism to endorse a *laissez faire* approach which reduces state controls and increases reliance on market-based tools (Jesson, 1988; Smith, 1988). This influence has extended directly into the government's environmental management policies and waste management itself, as shown by the Ministry for the Environment's *Landfill Full Costing Guideline* (MfE, 1996a) which opens its background section with the statement: "The theory of resource economics says that environmental damage occurs because prices do not reflect the true cost of resource use". Central Government policy directly prescribes generator charges for waste management as part of an overall policy to internalise externalities wherever possible (*Environment 2010 Strategy* - MfE, 1995, pp.15, 45). This economic background is clearly significant to the concept of total cost in waste management, but is not always explicit in its policy, such as the CCC's Draft Plan. It is therefore important to outline neoclassical theory and its expression in resource economics, as relevant to total cost in waste management.

Neoclassical theory's roots are in the classical economics of the 1700s (characterised by Adam Smith's 'invisible hand' and Malthus' and Ricardo's resource scarcity theories). In this era the notion was developed that rational individuals acting in a self-interested fashion could collectively serve social interests. Long term physical constraints on growth were modelled by Malthus and Ricardo. In the late 1800s neoclassical theory developed, and the scarcity of resources facing infinite wants became central. From this focus comes the concepts of supply and demand and increasing emphasis on marginal analysis (ie. considering the trade-offs made by producers and consumers as they respond to this scarcity according to their preferences). Interaction between supply and demand results in a market equilibrium (at the point where marginal benefits equal marginal costs). The market equilibrium is socially optimum in that nobody can be made better off without making somebody else worse off (*ibid.*). This state is called Pareto optimality, and that it is the socially optimum state is the first law of welfare economics (Feldman, 1980).

The rational egotistic individual or 'economic person' is a key assumption, and the perfect market model in which equilibrium is reached includes the following further assumptions:

1. information is freely available to all actors in the market;
2. property rights are fully defined;
3. competition is complete: there are many buyers and sellers, and free entry and exit from industries; and
4. there are no transaction costs.

The absence of any of these conditions is known as market failure. In reality of course, perfect market conditions never exist, but market failure is particularly associated with natural resources because biophysical goods (eg., clean air) and services (eg., assimilative capacity) frequently have ill-defined property rights. The result is that responsibility is not taken for actions (such as pollution of public goods like air and water), by the user. This creates a divergence between social costs and private costs, as the levels of resource or biophysical capacity use chosen by the user does not include all the costs of their action. The unaccounted for costs ('externalities') are borne by society as a whole.

If these externalities can be internalised, the market will still be capable delivering correct allocations of resources, levels of pollution and so on (Pearce and Turner, 1990, p.64). This has resulted in a great popularity of 'economic instruments' for resolving environmental problems. However, Pareto optimality is not necessarily compatible with other policy goals such as equity. This relates to the second law of welfare economics, that Pareto optimal outcome will only be as fair as the initial distribution of resources (Feldman, 1980). Neoclassical theory has by no means gone uncritiqued and there are several branches of economics (eg., see Peet, 1992), as well as other disciplines, dealing with these issues. However, the reliance of overarching government policies in New Zealand on neoclassical theory seems to imply that market solutions to allocative issues are better than the solutions which could be reached by other means, despite the fact that markets will never be perfect.

The persistence of environmentalism, in combination with the desire for accountability (related in part to neoclassical economic theory), has seen a raft of approaches to assessment of the impacts, effects and costs of human activities, looking wider than traditional financial considerations. These include institutionalised requirements for Social Impact Assessment (SIA) and Environmental Impact Assessment (EIA) and, in New Zealand, Assessment of Environmental Effects (AEE) under the Resource Management Act 1991 (see appendix 8). Initiatives have also developed in the private sector such as Total Cost Management and Life Cycle Assessment. Full Cost and Environmental Accounting have developed in response to the lack of accountability (particularly social and biophysical) within traditional accounting systems. These are summarised and discussed in appendix 2, and it is important to note at this point that they contributed to our conceptualisation of total cost.

The concept of 'total cost' of waste management, used by Christchurch City Council and this study is therefore a product of economic theory and related policy influences, and of an international trend toward more all-encompassing impact, effect and cost assessment. These and further contextual issues are identified and responded to using Integrated Environmental Management or IEM.

1.4 Methodology

This study focuses on the development of a systematic and comprehensive framework for total cost assessment of waste management, rather than on measuring component parts of total cost. A justification for this approach is given in section 4.3. The research project specifically applies to waste management needs in Christchurch City. The framework for total cost assessment is developed to address issues in a Christchurch-specific context as well as universal issues. Therefore, the methodological approach of in this study is qualitative and applied.

Waste management has biophysical, social, and economic effects. The complexity and interrelatedness of these effects requires an interdisciplinary and integrated approach to total cost assessment. No single discipline can provide the whole answer to how a framework should be developed for total cost assessment. Therefore, theories and concepts from a variety of disciplines have been included and combined in the development of this framework.

The assessment of total cost of waste management, including biophysical, social, and economic effects, is a field which has not yet been researched extensively. There is no widely available theory or application of a theory which addresses total cost assessment as it is defined in this study. Theories and concept must be transferred from several other sources and further developed. Our research can therefore also be described as a combination of descriptive and exploratory research.

1.5 Approach to Study

1.5.1 Research Process

This study was conducted in 1998 (February until June). Appendix 2 shows our research process during this period. It shows the steps of our study from the interpretation of the terms of reference to the conduct of our research, analysing the nature of total cost assessment and compiling the final report.

1.5.2 Methods

The methods used in our study included document analysis, evaluating the literature. Criteria for evaluation were whether concepts and theories were applicable to total cost assessment. Policies were analysed and relevant policy processes and implications established. We also used interviews to gain knowledge from experts in waste management and total cost assessment. These interviews were semi-structured and open ended, mainly because we wanted to explore their thoughts, and did not want to narrow down the discussion. To further our knowledge and insight into waste management practices we also included visits to transfer stations as an experience.

The need to explore new ways of thinking is expressed in our emphasis on group process. Group discussions are an excellent way of generating and checking ideas, and applying concepts and theories to the study (Brilhart, 1992). Compared to individual research, group work offered advantages for the multi- and interdisciplinary approach. Investigations are a team based process, in which the setting of goals, decision making and time management remain a collective responsibility. Discussion of all major issues by the group and applying different minds throughout the research process resulted in a wider range of references

consulted, a more critical debate of the findings and overall a greater awareness of the topic than would have been possible by individual researchers. The different personal background, subject expertise and experience of each group member further helped an interdisciplinary approach.

1.5.3 Scope of Study

The particular focus of this study is on assessing the total cost of solid and hazardous waste management. The physical boundaries of this study are the Christchurch City limits, although the foreseeable joint management of a new landfill within the Canterbury Region and its implications on regional waste management are taken into account. The study focuses on post-production waste. This excludes the costs of waste production and minimisation programmes born by the private sector (eg., Cleaner Production), but includes the costs to the Christchurch community of waste collection (both private and public) as well as the costs of the various strategies to reduce, reuse, recycle, and treat the waste until its final disposal. In our study we consider previous, current and future costs of waste management. For a more detailed discussion of the definitions and meanings of the terms used above see also section 2.5.

1.5.4 Limitations

In dealing with predominantly Christchurch's waste management we focused on Western perspectives and viewpoints. Non-western perspectives could lead to other conclusions, however they are not included.

The group's findings and recommendations, although extensively researched, are focused on the Christchurch area and Canterbury Region. This may limit its transferability to other regions. We provide a framework for a possible way of assessing total costs of waste management in Christchurch, with an example (table 1). It is, however, beyond our resources to provide a complete set of methods and tools to undertake an assessment of the total cost of waste. Further development of this framework will have to be done. While developing the framework, we have taken every precaution to consider potential changes in waste management practices in the near future. The framework is flexible to many changes however, as we cannot foresee all future requirements, some adjustments will have to be undertaken in the future.

1.5.5 Assumptions

Our study is based on the assumption that the institutional frameworks are a given. Although change can sometimes happen overnight, the legal, political, and economic frameworks of New Zealand are taken as a given. This especially is true for the global marketplace and the emphasis on the generator pays concept.

CHAPTER 2 CHRISTCHURCH WASTE MANAGEMENT IN CONTEXT

In this chapter of the study we discuss the factors and issues influencing Christchurch waste management. We discuss the different roles in waste management from an international to a local level (section 2.1), and we provide a model of waste policy, analysing the different influences of agencies and organisations on Christchurch's waste management (section 2.2). We also discuss the themes and trends in waste management, for example international reviews of waste management, the international waste hierarchy, and a trend towards better information and targets in waste management (section 2.3). We then the characteristics of Christchurch's environment which are important to this study, and describe how waste is managed in Christchurch (section 2.4). We close this chapter by discussing and defining some key terms used in this study (section 2.5).

2.1 Roles in Waste Management

The provision of waste management services involves many organisations with various responsibilities and influences. The organisations with significant involvement in waste management and their roles are described in this section and presented as a model in figure 2. The model shows that these organisations are influenced, exert their influence and fulfil their responsibilities on a variety of organisational levels. These include international, national and local levels, which are discussed below. While it should be noted that each of these levels have input in both directions (eg., CCC is influenced by national government but also lobbies it, waste generators are the subject of policy but can also influence it through public participation), the Christchurch context is our main focus here, so that influences *on* rather than *of* Christchurch waste management have been considered.

2.1.1 International Organisations

International organisations have few direct responsibilities for waste management in New Zealand. They can provide general support, coordination, policy, research and information and lobbying. Inter-governmental organisations with an interest in waste management include several United Nations organisations and programmes such as UNEP and ECOSOC. Roles and responsibilities of these and affiliated governmental and non-governmental organisations (such as IUCN, WWF and Oxfam) have typically included advocacy, persuasion, lobbying, policy development and analysis, networking, information dissemination, research, programme operation and education (Clark, 1991). New Zealand is also a member nation of APEC (Asia Pacific Economic Cooperation) and SPREP (South Pacific Region Environment Programme) which address waste management issues and cooperation specifically within the South Pacific Region.

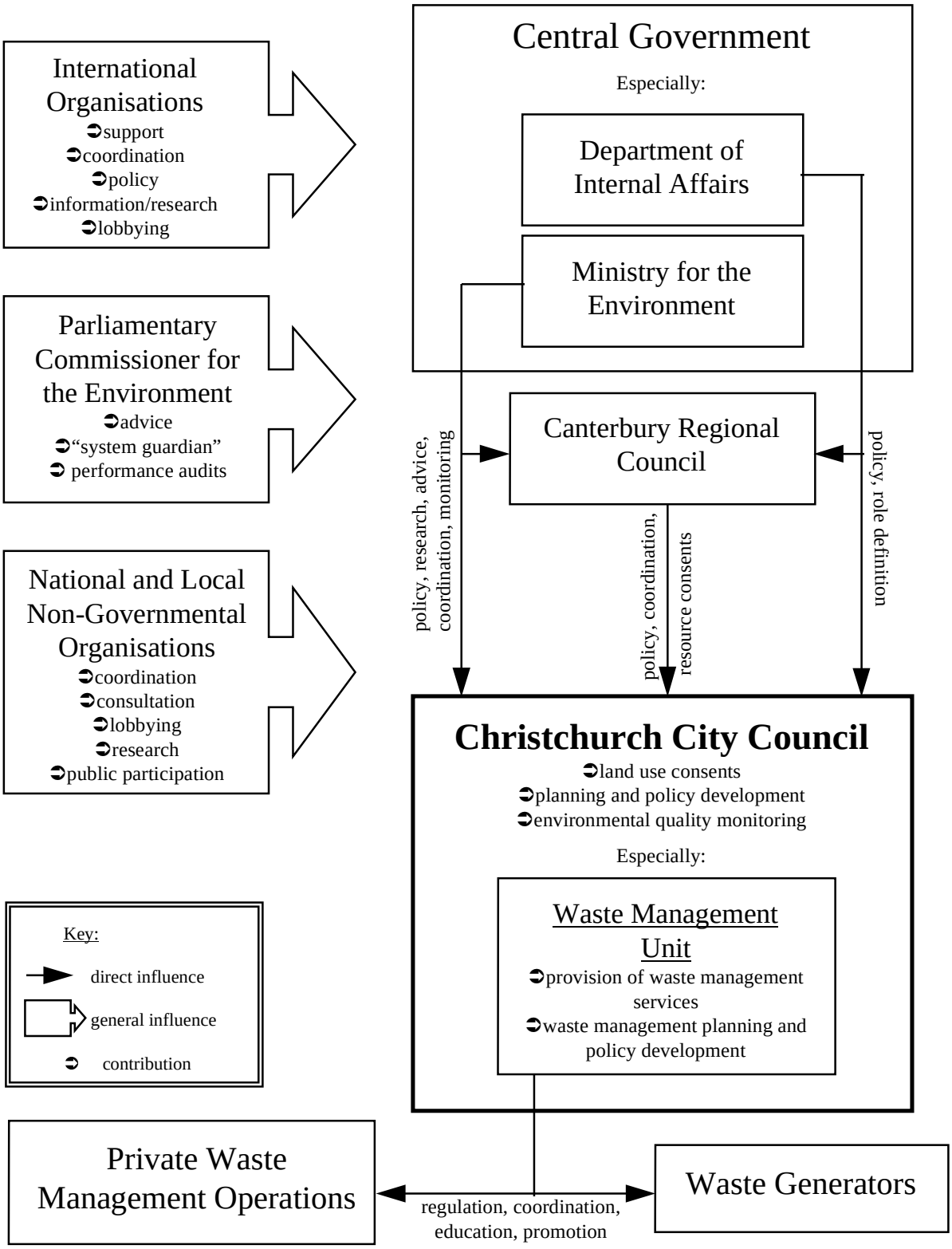

Figure 2: Roles in Christchurch Waste Management

This model depicts the major influences, direct and indirect, on waste management in Christchurch, and the lines of responsibility for waste management between national and local government agencies. It demonstrates that the provision of waste services in Christchurch, while the responsibility of Christchurch City Council, is influenced by many groups and organisations.

International organisations which have an interest in waste management policy with particular emphasis on policy implications for international financial markets include the World Bank, IMF (International Monetary Fund), WTO (World Trade Organisation), and G8. New Zealand is influenced by these organisations either directly (eg., through policy advice) or indirectly (eg., through the effects of economic policies or pressure). The OECD has had a strong influence in New Zealand, particularly through its evaluation function. This is further discussed in section 2.3.1.

Specialised organisations for practitioners in solid and hazardous waste (eg., ISWA, the International Solid Waste Association and ERRA, the European Recovery & Recycling Association) provide opportunities for networking, coordination, information dissemination, policy analysis and research, particularly through coordination of conferences and conference proceedings.

2.1.2 National Organisations

The development of waste management in New Zealand has been influenced by both international and internal organisations. Within the national structure, primary lines of responsibility are subject to the scrutiny of organisations not directly involved with waste management, but which have oversight or general policy-making responsibilities. These include Cabinet, Te Puni Kokiri, the Department of Conservation, and Treasury, which act as "checks and balances", providing advice on the effects of waste management policy on their areas of concern. The Parliamentary Commissioner for the Environment, shown in figure 2, holds a key role. It provides independent advice on the effects and effectiveness of policies and organisational systems relating to the environment (Environment Act 1986, s.16). This has included systematic review of local government activities, including a specific review of waste reduction initiatives. Some of these recommendations have been adopted, including the amendment of the Local Government Act 1974 to include a wider range of costs (eg., social and ecological) in the cost assessment of waste management programmes (PCE, 1993).

The Ministry for the Environment and the Department of Internal Affairs provide coordination functions for local government. The Minister for the Environment, supported by the Ministry, is primarily responsible for policy relating to the effects of waste management on the environment at national level. This includes monitoring the implementation of the Resource Management Act 1991 (RMA, s.24 (f)). The Department of Internal Affairs is responsible for the roles of local government agencies, for example advising Government on changes to the Local Government Act 1974.

2.1.3 Local Organisations

Territorial local authorities (district and city councils) have primary responsibility for implementing waste management policy. They are influenced by both international (eg., ISWA) and national (eg., Government, industry and non-governmental) organisations. Territorial authorities are subject to the general influences (both international and national) and are direstly influenced through their relationship with central government. At a broader level than city and district councils are regional councils, who are responsible for the management of certain natural and physical resources in the region, and for policy relating to issues of regional importance. Direct involvement in waste management by regional councils includes writing regional policy statements, and considering resource consent applications for activities relating to waste management services.

District and city councils are responsible for waste collection and disposal services, and avoiding public nuisance and health effects from waste under the Local Government Act 1974 and the Health Act 1958. Under the general trend of privatisation of services, councils are increasingly contracting out waste management services, allowing competition to improve efficiency (section 3.3). Private companies also act independently in specialised sectors of waste management, providing high volume or special waste collection and treatment, for example the disposal of bio-hazardous waste.

Private sector organisations exert influences on waste management at both national and local levels. Non-governmental organisations are particularly involved in decision making through lobbying, consultation, and participation in the resource consent process. The privatisation and diversification of waste management service providers also allows consumer pressure from those using the services. These forms of influence give waste generators a role in the determination of waste management policy, however they are predominantly the subject of policy, rather than involved in decision making. The diverse range of organisations with either direct or indirect responsibilities for waste management services contribute to a dynamic policy process.

2.2 Waste Policy Framework

New Zealand's waste management policy framework includes international, national, regional and local scales of influence. Figure 2 showed the key participants in waste management and their roles, including policy provision. This section explains how that policy evolves, illustrated by figure 3. The policy process entails varying degrees of feed back and dialogue between all of these levels, and is illustrated by the direction of solid arrows shown in figure 3.

'Other policy influences' are broadly listed on the right hand side of the figure, and illustrate that the waste policy framework is a subset of a broader policy process. Waste management is one of a vast number of government responsibilities. Although specific government agencies directly address waste management issues, these are also influenced by other legislation and government departments. For example, the advice of Treasury has a strong influence on Cabinet decisions over resource allocation and therefore affects the ability of waste managers to address waste management issues. Policy and initiatives of other local government agencies affect opportunities to coordinate activities for mutual benefit. Lobby groups influence the development of waste policy either directly (eg., through participation in policy development) or indirectly (eg., through political pressure).

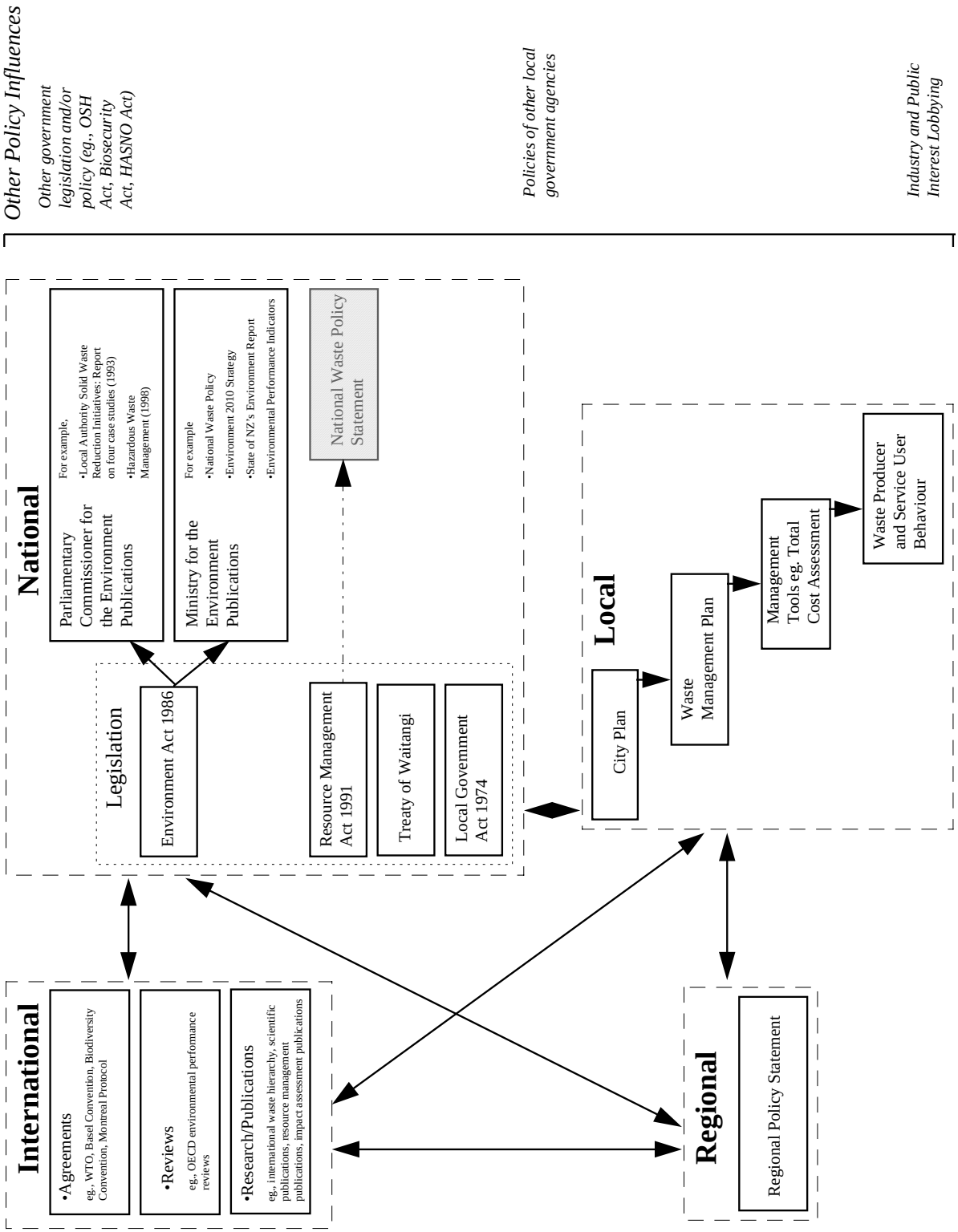

Figure 3: Waste Policy Framework.

This figure depicts the influences of policies at all levels on Christchurch waste management. Direct influences are shown by solid arrows, while general influences are listed at the right of the figure. Shaded areas depict policy options that have not been explored, but would have considerable influence.

2.2.1 International Research Publications Agreements and Reviews

Figure 3 illustrates three key international influences in the waste policy process of importance to total cost assessment: research publications, agreements and reviews.

International research publications provide guidance for New Zealand waste managers in the form of policy analysis and technological innovation. For example, international agencies such as the International Solid Waste Association (ISWA) provide a forum for discussing a wide range of international, national, regional and local waste management issues which can be accessed by an international audience through their publications. Similarly, national, regional or local research outside of New Zealand provides an invaluable source of information for Christchurch City Council. The current availability of total cost assessment research is extremely limited on an international scale but what is available will be useful as present 'interest' translates into programmes of research and implementation.

The management of New Zealand's waste was reviewed in the OECD's 1996 Environmental Performance Reviews (OECD, 1996). The OECD review the environmental performance of member countries on a five year cycle, determining a baseline for assessing future environmental progress and examining environmental performance in three major areas:

1. *Integrating environmental and economic decisions;*
2. *Implementing environmental policies;*
3. *Internal co-operation.* (OECD, 1996)

Conclusions and recommendations in the report are largely normative and directed to national environmental management agencies. The findings, recommendations and themes of the OECD 1996 Environmental Performance Review are summarised in Appendix 4 and discussed in section 2.3.1.

Some of the many international agreements to which New Zealand is party relate to waste management, such as the Framework Convention on Climate Change. An agreement which more directly controls New Zealand's international waste trade and transport is the Basel Convention (section 3.6.1).

2.2.2 Waste Management, National Reform and the Policy Process

The waste management policy framework was overhauled as part of the post-1984 reform process. The essence of the reform process was the dramatic redefinition of the role of the State, largely under the influence of 'New Right' philosophies embraced by successive governments. In particular this entailed a shift toward market-led resource management, greater efficiency and the development of new frameworks for social choice (Bührs and Bartlett, 1993, p.90). The reform process led to major changes in institutional arrangements. These changes modelled the public service on management principles which were derived from the private sector, with a view to achieving greater efficiency, flexibility and accountability. The resulting changes in approach to waste management are discussed in section 2.3. One of the fundamental structural changes for government departments was the replacement of the 'head of department' (employed on an indefinite career service basis), with a 'chief executive' (employed on a contractual basis with performance-based remuneration). The government departments and ministries enter into a contract with their ministers, who purchase their services, and require them to formulate corporate plans with quantifiable criteria for measuring 'outputs' (Bührs & Bartlett, 1993, p.101). As a result of this process,

departmental and ministerial services are provided in accordance with the priorities of their ministers, whose time horizons only extend to the next election. The potential result of this is a short term view of the policy process and the political cycle in New Zealand, of just three years, serves to exacerbate this (Bührs and Bartlett, 1993, p.104).

The rate and approach at which waste management issues are addressed is strongly affected by the relevant ministers' priorities and resource availability. For example, limited resources causes MfE to restrict itself to a few key focii in waste management (S. Baird pers. comm., 1998). This is significant for developing a system of total cost assessment, as this requires a long term commitment and ongoing development. This is further discussed in section 2.3 and is an important factor in consideration of national policies such as the National Environmental Indicators Programme.

As part of the institutional reform process, the Ministry for the Environment (MfE) and Parliamentary Commission for the Environment (PCE) were established by the Environment Act 1986 (figure 3).

2.2.3 Ministry for the Environment

At central government level, the Ministry for the Environment is the main agency responsible for waste management policy. Under the Labour Government, a national waste policy was announced in 1990 which included a target of reducing the nation's solid waste to 20% below 1988 levels by the year 1993 (MfE, 1997a, p.3.37). This policy stimulated the development of extensive recycling programmes and national guidelines for monitoring and managing solid waste (Associate Minister for the Environment, 1990). The National Government issued a revised waste policy in 1992 which stipulates that:

> *(1) as far as practicable, waste generators should meet the costs of managing the waste they produce*, and that;
> *(2) waste management programmes should encourage implementation of the internationally recognised hierarchy of waste management* (MfE, 1992).

MfE have issued some guidelines to support waste management policies, including: *Waste Analysis Protocol* with *Landfill Guidelines* (1992); the *Waste Minimisation Network*; *Hazardous Waste Management Handbook* (1994); Cleaner Production Guidelines (MfE 1997a p.3.39); *Landfill Full Costing Guideline* (1996) and *National Waste Data Report* (1997). The *Landfill Full Costing Guideline* (1996) provides guidance for landfill managers on how to identify all of the financial costs associated with landfill from planning to aftercare, but other than this MfE provide no specific guidance to support the development of total cost assessment.

MfE issued the Government's *Environment 2010 Strategy* in September 1995, which outlines a vision, principles, goals, risks, actions and priorities for environmental management to the year 2010. With respect to total cost assessment of waste, the key actions for waste managers (outlined in the strategy) are summarised in box 1.

Box 1: Key actions for waste managers (*Environment 2010 Strategy*; MfE, 1995)

- implement the government's 'generator pays' policy
- provide clear incentives to resource users which encourage waste reduction, reuse, recycling and recovery
- design and establish systems which will hold resource users accountable for effective waste management.
- promote minimisation of domestic and municipal waste through green labelling
- establish waste reduction targets for major industry
- achieve high standards for waste disposal
- promote assessment of contaminated sites and reduce barriers to clean up
- identify hazardous wastes and strategies to manage them.

In response to recommendations of the OECD environmental performance reviews (section 2.3), MfE published the *State of New Zealand's Environment Report* (SER) in November 1997. The SER includes 11 pages which specifically address waste management issues, outlining:

- the nature of waste generation and disposal in New Zealand;
- trends in waste policy; and
- current waste management options.

The SER does not attempt to provide strategic direction for future waste management, simply noting:

> *effective waste management, with its emphasis on reduce, reuse, recycling is an increasingly important environmental management issue in New Zealand* (MfE, 1997).

In response to recommendations of the OECD report, MfE are currently developing a national system of environmental indicators. MfE released some proposed indicators for public comment in the *Environmental Performance Indicators. Proposals for Air, Fresh Water and Land* in 1997. Indicators for waste managers are expected to be published in the year 2000. CCC may be able to co-ordinate the development of total cost assessment with the release of the waste management indicators if it is indeed only two years away.

2.2.4 Office of the Parliamentary Commissioner for the Environment

The Office of the Parliamentary Commissioner for the Environment (PCE) has provided some analysis and guidance with respect to the management of solid and hazardous waste since its inception. In 1993, the PCE published *A Review of Local Authority Solid Waste Reduction Initiatives* (PCE, 1993) which evaluated the performance of four local authorities. The report discussed issues related to the accurate costing of waste management services and recommended that the Minister for the Environment should "provide guidance on [the] inclusion of non-monetary costs and benefits in reporting procedures".

In addition, this report provided a list of costs which should be considered (by councillors and staff of District Councils) in the evaluation of waste management costs (box 2.).

Box 2: Costs to be included in the evaluation of waste management costs (from PCE, 1993, p.58).

a) full capitalised landfill asset value (including land value through current government valuation or opportunity cost calculation);
b) estimated asset value for landfill space (for example, value per cubic meter of capacity);
c) estimated replacement landfill disposal costs, when approaching end of existing landfill life (five to seven years away as a minimum);
d) landfill 'aftercare' costs;
e) explicit documentation (and estimation of dollar cost where possible) of environmental and social costs and benefits; and
f) all waste management services (collection, recycling, composting, landfill management).

The PCE released a report in May 1998 which assesses the progress, effectiveness and priorities of the Government's Hazardous Waste Programme, and proposes an auditing process to measure progress and effectiveness of the programme. The report addresses methods for assessing and managing the effects and risks of hazardous waste, and therefore goes a small way toward developing a system of total cost assessment.

2.2.5 Resource Management Act 1991

Waste management activities and their associated effects are subject to requirements under the Resource Management Act 1991 (RMA). The administration of land use consents is the responsibility of district and city councils and consents for discharge to air and water are the responsibility of regional councils (except where matters are considered at a national level as outlined below).

Some waste management activities will require resource consent(s) as outlined in section 87 of the RMA. Section 88 (4) (b) requires any consent applicant to assess any actual or potential effects that the activity will have on the environment. Matters that should be included and should be considered in an assessment of environmental effects are set out in the Fourth Schedule.

With respect to matters to be considered at a national level, where an activity is classified as a restricted coastal activity (in the relevant District or City Plan), any decision to grant or decline a resource consent application is made by the Minister of Conservation (s.119). Section 140 empowers the Minister for the Environment to 'call-in' an application where she or he considers a proposal to be of national significance. Section 24 of the RMA empowers the appropriate Minister with discretion to issue a national policy statement on "*matters of national significance that are relevant to achieving the purpose of*" the Act. This provides a policy tool for national coordination of waste management activities, falling under the authority of the Minister for the Environment. There is currently no National Policy Statement to guide waste managers.

Section 73 of the RMA requires Regional Councils to develop a Regional Policy Statement, which the City Plan developed by the City Council must be in accordance with. These policy documents provide guidelines for the development of the Christchurch City Council *Waste Management Plan for Solid and Hazardous Waste 1998*. Under section 32 the Council must

assess the costs and benefits of waste management before adopting any objective, policy, rule or other method necessary in achieving the purpose of the Act.

2.2.6 Treaty of Waitangi

The Treaty of Waitangi 1840 (hereafter referred to as 'the Treaty') is an agreement between two peoples living together in one country; made between the Crown (as a representative of the Queen) and Maori in Aotearoa/New Zealand. Waste management issues are fundamental to Maori people, as tangata whenua and kaitiaki, with responsibility to protect the mauri of resources and places (MfE, 1997, p.9). The requirement to carry out waste management in accordance with the Treaty agreement is reinforced in the Environment 2010 Strategy and the Resource Management Act 1991 (s.8). Tangata whenua issues for total cost assessment in waste management are discussed in section 3.2.

2.2.7 Local Government Act 1974 and Amendments

The Local Government Act 1974 and subsequent Amendment Acts assign responsibilities for waste management to Local Councils and are backed up by the Health Act 1956 (PCE, 1993, p.5). A significant product of the reform process was the reform of Local Government (Local Government Amendment Act No.2 1989) which entailed reducing the 625 existing units of local government to 13 regional councils, 74 local districts and 7 special purpose boards (Bührs & Bartlett, 1993: p.120). In this way, the number of agencies responsible for waste management were reduced, making, in theory at least, it possible to apply resources to better coordinated policy strategies and service delivery (Bührs & Bartlett, 1993).

CCC released a waste management plan in 1994 (CCC, 1994) and a summary update in 1996 (CCC, 1996). A subsequent amendment to the Local Government Act (No.4) in 1996 established a new approach to waste management planning, in response to which CCC released the *Draft Waste Management Plan for Solid and Hazardous Waste* for public comment at the beginning of May 1998. In this amendment, the council's waste management responsibilities under the Local Government Act 1974 (LGA) were changed to include a requirement to "have regard to environmental and economic costs and benefits for the district" (s.538 (b)).

As the amendment affects all territorial authorities, it is likely that other councils will choose their own approach to fulfilling this requirement. There are advantages and disadvantages to coordinating the assessment of "environmental and economic costs" on a national level (section 3.7). This could include national assessment and reporting guidelines or quality requirements. The ability of a national body to insist on a certain procedure of cost assessment can be derived from another part of the LGA, in which councils are required to use "accepted accounting procedures", and adhere to "non-financial reporting" procedures (s. 223 D (4)).

Principle Four of the Draft Plan, which requires the assessment and reporting of the real (total) cost of waste management, is the product of a complex policy process. The process is shaped by international, national, regional and local influences and trends in waste management.

2.3 Themes and Trends in Waste Policy

2.3.1 OECD Environmental Performance Review and Priorities in Waste Management

At an international level, there has been a dramatic increase in the public's awareness of waste management issues. The OECD environmental performance reviews represent an extension of this awareness, and identify shortcomings which are echoed in national trends in waste policy (1996, p.184).

A summary of recommendations from the review are provided in Appendix 4. The key recommendations with respect to total cost assessment are that central government should increase assistance to regional and local authorities (particularly with regard to the assessment of environmental effects) and that 'disposal charges' should be introduced which take into account the 'present real and future landfill costs'.

The reviews have had a considerable influence on the government's approach to waste management, evidenced by MfE publications which address the OECD's recommendations eg., *National Waste Data Report* (1997b), *Landfill Full Costing Guideline* (1996).

However, the Minister for the Environment has established that waste management is not a high priority on MfE's agenda and that within waste management, hazardous waste and life cycle assessment are priorities (S. Baird, pers. comm. 1998). Providing guidance to local councils on how to go about assessing total cost is a low priority on MfE's agenda.

2.3.2 Subsidiarity and the Waste Hierarchy

New Zealand's approach to resource management is generally 'consistent' with the principle of subsidiarity. This principle suggests that "decisions should be made as close to the effected populations as possible" and is encapsulated by the common maxim "think globally and act locally" (OECD, 1996, p.175).

New Zealand has demonstrated a commitment to the international waste hierarchy, although this commitment is "not always presented in a way that makes the policy intention sufficiently clear" (OECD, 1996, p.82). The international waste hierarchy is frequently referred to as the '5 Rs' (Reduce, Reuse, Recycle, Recover, Residue Disposal). In its most comprehensive form the hierarchy is a list of the six most effective ways to control waste in descending order of their environmental benefits (MfE, 1997a), as listed in box 3.

Box 3: The international waste hierarchy (MfE, 1997).

1. **Reduce** activities which generate waste; or otherwise
2. **Reuse** products rather than discarding them; or otherwise
3. **Recycle** waste materials to make new products; or otherwise
4. **Recover** useful materials or energy; or otherwise
5. **Treat** waste in order to reduce its impact; or otherwise
6. **Dispose** of the waste safely on land set aside for that purpose.

2.3.3 Integration in Waste Management

There is an international trend toward the increased integration of waste management policy. This recognition reflects a realisation that social, biophysical and economic issues associated with waste management are complex and inter-related. A comprehensive discussion of international trends toward the integration of waste management is provided in Bührs and Bartlett (1993, p.141-143). The Queensland, Australia, experience provides a typical example of this trend, as outlined in box 4.

Box 4: Waste management strategies in the Queensland Environment (Boase, 1997).
Separate pieces of legislation, for the protection of individual segments of the Queensland environment, were replaced by the Environmental Protection Act, 1994. This legislation was fully integrated and focuses on the control and licensing of activities with a potential to cause environmental harm, rather than to license particular emissions. This change has facilitated a more holistic approach to environmental management at such sites, and includes waste management facilities...
The Contaminated Land Act, 1991 covers the identification and management of contaminated land, including former waste disposal sites and other areas often associated with inappropriate waste disposal practices. It is also proposed to integrate this legislation with the Environmental Protection Act in due course. Financial assurances have been required of recently licensed private facilities, including coverage for a thirty year post closure care and maintenance period, to ensure adequate funds are available to address any environmental contingencies during the life of the facility.

2.3.4 A Market-Based Approach to Waste Management

A market-based approach to waste management includes the use of economic instruments, such as generator pays charging and the privatisation of waste management services. The trend toward increasing the use of economic instruments for waste management is echoed in the OECD environmental performance review which suggests that these could be used 'on a wider scale in New Zealand' (1996, p. 179). The OECD further note that 'ensuring that prices reflect the full environmental costs is essential if resource users are to factor in the full social costs of their resource use and consumption decisions'. New Zealand's strong interest in the use of economic instruments is emphasised in the Environment 2010 Strategy (MfE, 1997). This strategy outlines the Governments desire to implement a system of generator pays charging (which includes external costs) and the privatisation of waste management services wherever possible (discussed in sections 3.4 and 3.3, respectively).

2.3.5 Better Information and Targets in Waste Management

The lack of coordinated, reliable or comprehensive information for waste management is a barrier to effective management (OECD, 1996; MfE, 1997b). This equates to the need for clear definitions for waste types and a comprehensive and coordinated system of monitoring both the causes and effects of waste generation. The OECD (1996) emphasise the need to tailor environmental monitoring and reporting systems to the implementation needs of the RMA and ensure they are nationally consistent.

The abandonment of waste management targets by the National Government in 1992 (section 2.2) represents a redirection of approach from 'target setting' to emphasis on 'the importance of waste management programmes'. This has been criticised by the OECD which emphasises the "need to develop concrete targets for environmental policies, with good monitoring of progress achieved as well as detailed examination of costs involved" (OECD, 1996). Christchurch City Council have included both approaches within the Draft Plan (Appendix 5).

2.3.6 Consultation and Accountability in Waste Management

The OECD note that the "provision of environmental data to the public… is also an essential element of a democratic debate on ways to management the environment" (OECD, 1996: p.179). This sentiment is echoed in a New Zealand context (reflected in the Local Government Act No.4 (1996)- see section 2.2.7), where emphasis is given to providing for greater public consultation, set procedures and accountability, and transparency of funding options in waste management.

2.3.7 Maori Issues in Waste Management

There is increasing recognition of Maori issues in Waste Management. Claims to the Waitangi Tribunal have addressed the impacts of waste, and some iwi and hapu resource management plans include statements regarding the effects of waste on water bodies and other Taonga, and policies to address their protection (MfE, 1998). Further discussion of Maori issues in a local context is provided in section 3.2.

These themes in waste management influence the approach that needs to be taken to develop a system of total cost assessment, which must further be understood in a local (Christchurch City) context.

2.4 Christchurch and Waste Management

Christchurch is the largest settlement in the South Island, with a growing population of over 300 000 people. It is a city with active industry and commerce, and a particular reputation for large, well maintained gardens that has gained Christchurch status as the "Garden City" of New Zealand. The Christchurch environment has certain characteristics that create issues for waste management, and its waste stream and management programmes reflect these issues. It is therefore appropriate to place waste management in Christchurch into this context.

2.4.1 Natural Environment

The City of Christchurch lies near the seaward edge of the extensively farmed Canterbury Plains, a gravel outwash plain made up of material eroded from the central range, the Southern Alps (Thornton, 1985 p.194). These sediments now form the flat, low-lying land upon which Christchurch is built, and the aquifers from which the municipal water supply is drawn. A number of small rivers and streams pass through the City and its suburbs, and the water table is close to the ground surface in most areas.

In the colder months, low-lying Christchurch is prone to temperature inversions, in which a static layer of cold air is trapped close to the ground (MfE 1997a p.6.10). Christchurch's prevailing winds are from the north-west, north-east and south-west (MfE 1997a figure 6.2). The "Nor'wester" is a föhn wind, a hot, dry wind caused by air flow over the central range. The southerly wind is colder and wetter, bringing storms in the winter months. Usually, a balance of wet and dry weather make Christchurch a good climate for growing plants, however the region can be subject to drought conditions in years when westerly winds dominate.

2.4.2 Social Environment

As a population centre, Christchurch is growing more rapidly than most other New Zealand cities (*The Press*, 1998a). The population of Christchurch is spread radially over a large area, with an average density of 6.8 people per hectare (Street 1997, p.1). Residential areas are characterised by generous areas of open space and garden plantings, and planning arrangements are designed to maintain this (eg., see CCC City Plan, section 2.2.2) Industry and commerce has also expanded out of the central city to establish in scattered areas.

The characteristics of the natural and social environment of Christchurch raise several issues for waste management in the City. These issues must be taken into account when designing a management policy.

2.4.3 Issues for Christchurch Waste Management

Waste management in Christchurch needs to respond to issues raised by the natural and social environment. Of particular interest are the issues related to the composition of the waste stream, the dispersed nature of the waste sources, the distance of Christchurch from major markets for recycled goods and manufacturing areas, and limits imposed by certain elements of the natural environment.

The large area of gardens in Christchurch affects the composition of the waste stream, adding large amounts of organic waste. Excluding paper, 36% of the waste stream is organic (Street, 1997, p.3). Figure 4 shows the average composition of the waste stream entering the CCC Refuse Stations.

The dispersed nature of waste sources in Christchurch means that delivery of waste to disposal or treatment locations is a more significant waste management cost than for many other locations. Not only do vehicles have to travel longer distances between sources and facilities, but the scattered nature of waste producers makes monitoring and regulation of the waste stream more difficult.

The natural environment of Christchurch imposes certain limits on waste management practices in the City. Of particular significance is the sensitivity of the ground water and the air quality to waste management. The aquifers from which the municipal water supply is drawn are susceptible to leachate infiltration from improperly sealed landfills. The very flat nature of the land around Christchurch and the closeness of the water table to the surface in certain areas requires that the siting and design of a landfill is a careful process. The tendency of the air to form a thermal inversion layer reduces the ability of the City to dispose of its solid waste through incineration, as the static air traps air emissions, preventing dispersion, and causing high social costs through health and amenity effects.

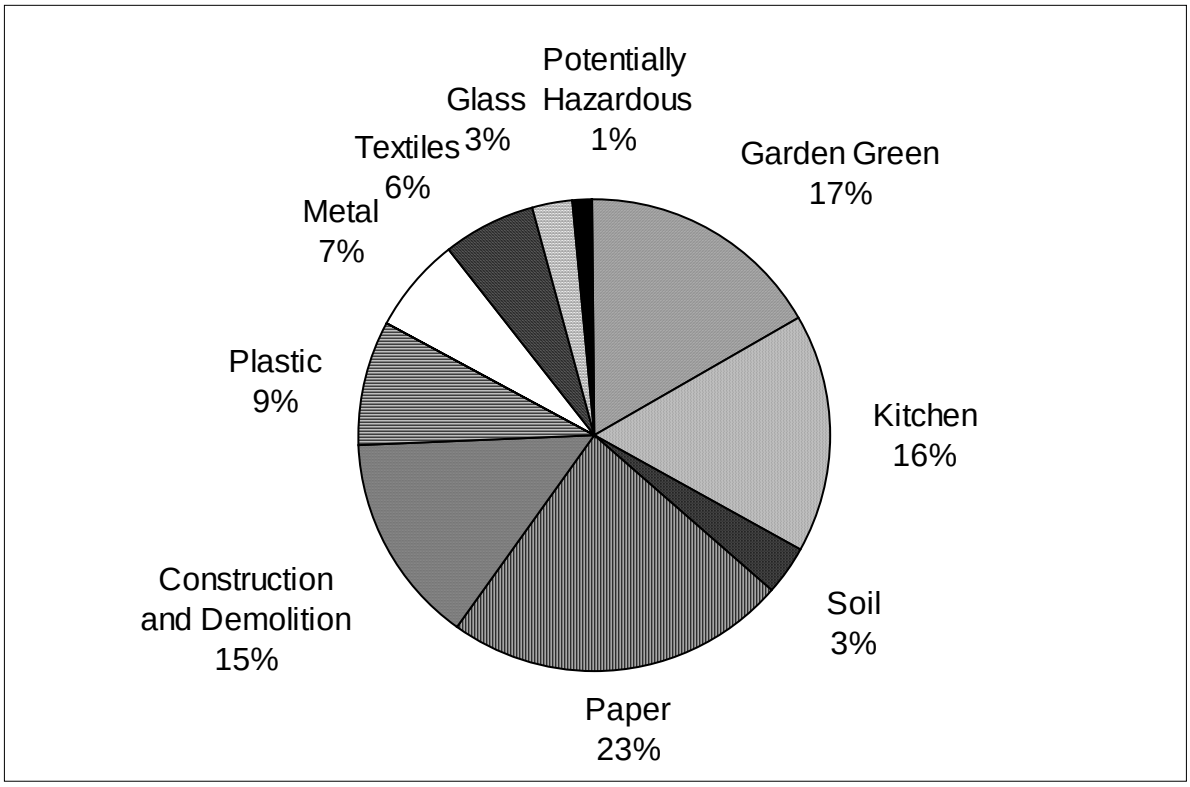

Figure 4: Christchurch waste composition
This graph shows the composition of the waste stream that enters the three Christchurch Refuse Stations, as measured in August 1996 (from Street, 1997, p.3).

Issues relating to relative isolation must also be considered. For example, the Christchurch market is not large enough to support facilities for the recycling of all recyclable materials, or the treatment of all potentially hazardous wastes, making transport costs a considerable part of any calculation. Additionally, most products consumed in Christchurch are imported from other parts of New Zealand or from other countries. Regional control of production methods is therefore ineffective and creates competitive disadvantage (section 3.4).

2.4.4 Waste Management Responses

The Christchurch City Council (CCC) hold primary responsibility for waste management in Christchurch (section 2.1.3). It is therefore the role of CCC to design a waste management process and policy that fulfils the needs of the city and the governing policy, while taking into account the particular nature of the Christchurch environment. In doing this, public and private programmes have been established to provide both competitive and complimentary waste management systems. Section 3.3 focuses on issues relating to privatisation of waste management services.

A diagrammatic representation of the Christchurch waste management process is presented in figure 5. The model classifies waste management programmes by the stage in the waste management hierarchy to which they correspond. Waste enters the city waste stream at the left of the model from sources both within the city and from elsewhere through importation. Currently, some waste is imported officially from the neighbouring Waimakariri and Banks Peninsular District Councils. Some unofficial importation also occurs when residents from neighbouring districts dump waste at a CCC refuse station, due to the station being the nearest

such facility to their home (E. Park pers. comm., 1998). Once the waste enters the CCC waste stream, it is transported by private, commercial or council means to an appropriate facility. A key response of CCC to the dispersed nature of the waste sources and sensitivity of the ground water in Christchurch is the use of refuse stations. Most solid waste entering the Christchurch City waste stream must pass through one of the city's three refuse stations, which are positioned around the city so that the maximum travel distance between waste source and transfer station is 7 km (Street, 1993, p.1). At these stations, waste is gathered, then transferred to the single city landfill at Burwood. The centralisation of the landfill programme was a decision made for cost and efficiency reasons (E. Park pers. comm., 1998). However it also simplifies disposal management, and reduces the chances of accidental environmental damage.

Refuse stations also provide reuse and recycle facilities, and in response to the large amount of garden waste Christchurch produces, green waste is collected at all refuse stations, and composted at a facility next to Metro Place Refuse Station. The compost produced is sold under the "Envy" brand, creating a source of revenue for the composting programme. The programme does not quite run at a profit using conventional accounting practices, however the diversion of waste from landfilling is considered to be a benefit that outweighs the cost of supporting the programme (*ibid.*). Dumping charges make the refuse stations self-financing (Street, 1993, p.5). Only the transfer of waste to disposal sites and associated activities are included under the refuse station programme title. Although they occur at the refuse station, the compost collection, recycling and reuse facilities are treated as separate programmes in our model of the Christchurch waste management process (figure 5), due to their differences in purpose relative to the waste management hierarchy (section 4.4.1).

As part of CCC's responsibilities for waste management, all rate paying properties have access to a kerbside mixed refuse bag collection at least once a week. Only official CCC bags are collected by the council and their contractors. Properties outside the central business district are issued with 52 bags per year, and additional bags must be purchased for a small fee. From May 1998, residential properties other than high-rise apartments have access to kerbside recycling of newspaper, cardboard, steel and aluminium cans, glass, and some plastics [1].

Waste generators have access to private waste management programmes in addition to the services provided by CCC. "Wheelie-bins", large capacity mixed waste bins collected on a regular basis by arrangement, have become a common facility, especially for commercial waste generators. For large volume waste generators, skips are available on a regular or occasional basis. Private collection of green waste is available, and is used by some garden maintenance businesses. As shown in figure 5, most waste intended for the landfill must still pass through the refuse stations, regardless of the method of collection. Exceptions to this are special wastes that require specific management such as treatment, and large commercial loads, if there is an agreement with CCC.

[1] From *kerbside re:cycling* flyer, published by CCC, RMF, Onyx and Eco Action.

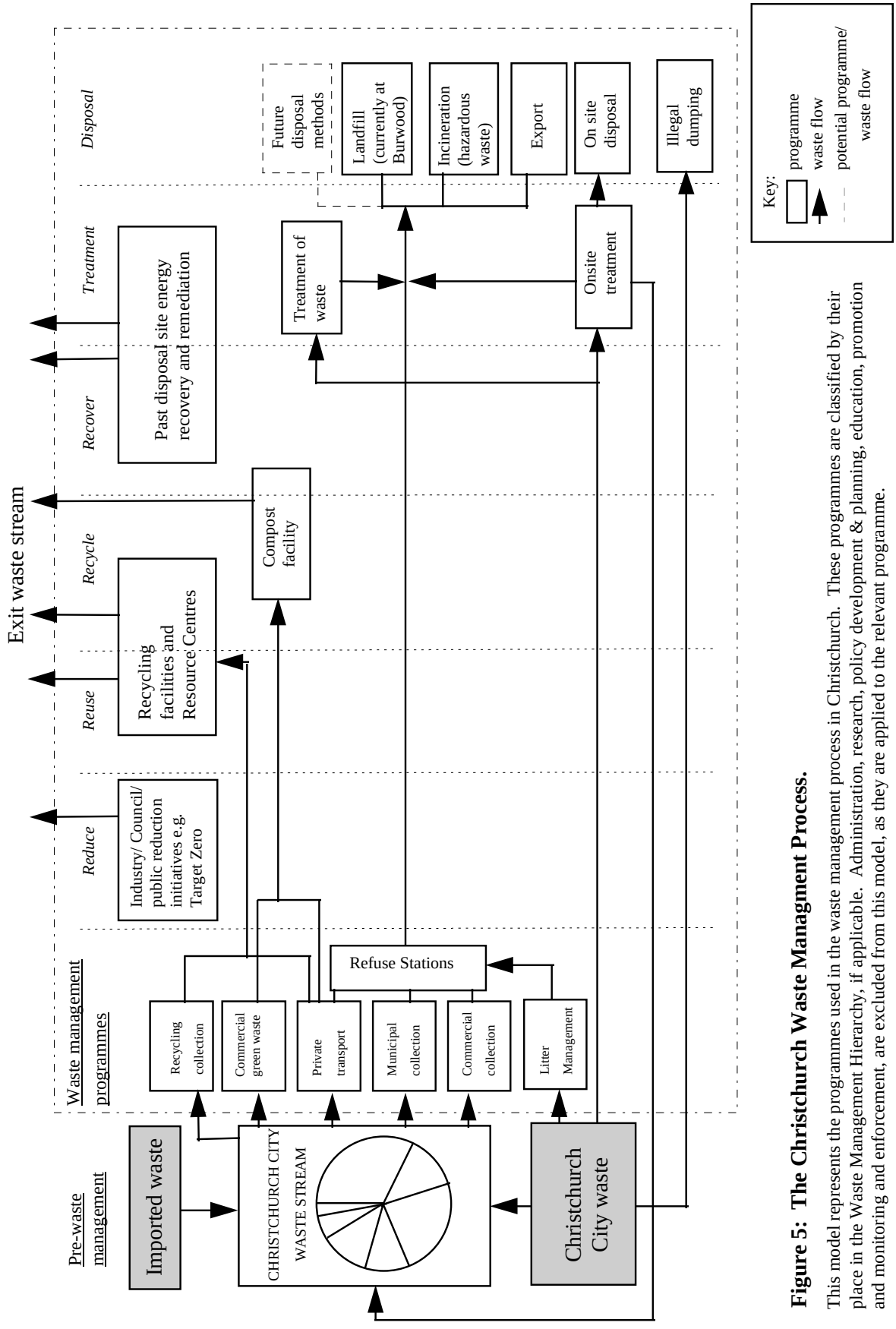

Figure 5: The Christchurch Waste Managment Process.

This model represents the programmes used in the waste management process in Christchurch. These programmes are classified by their place in the Waste Management Hierarchy, if applicable. Administration, research, policy development & planning, education, promotion and monitoring and enforcement, are excluded from this model, as they are applied to the relevant programme.

Treatment and disposal on-site is an option used by many waste generators, especially burning or composting of organic waste. Regular or large volume private treatment or disposal of waste requires a resource consent from the CCC for zoning issues and from Canterbury Regional Council for discharge issues. Establishing a private landfill in Christchurch would require a change to the City Plan in addition to several resource consents, as there is only one zone in which a landfill is permitted. This process, and the economic infeasibility of building and operating a modern landfill, has so far prevented such a programme from being established.

CCC has set up several policies designed to deal with the generation of waste, the geographic isolation of Christchurch from markets for recycled goods, and the sensitivity of the air quality over Christchurch. The policies include provisions in the City Plan, the Hazardous Waste Advisory Service (HWAS), the Recovered Materials Foundation (RMF), and Cleaner Production initiatives.

The tendency of the air over Christchurch to form temperature inversions places greater limitations on waste disposal to air, such as incineration, than in other cities. The Resource Management Act 1991 is used to regulate air emissions, and provisions in regional and city policies suggest limits for air emissions. Presently, there is no large-scale incineration programme for general waste, due to the cost and the regulatory conditions involved.

The HWAS provides advice to producers of potentially hazardous waste on how to treat their waste to a standard acceptable to landfill. This includes medical waste, which is presently incinerated by a private firm, Medical Waste Group Ltd. Potentially hazardous waste is only landfilled once it has been treated. Most treatment is carried out by private firms (MfE, 1998). The RMF is a joint operation between CCC, Canterbury Development Corporation, Canterbury Employers Chamber of Commerce, Canterbury Manufacturers Association, Sustainable Cities Trust, Clean Washington Centre (USA), and the New Zealand recycling industry. The foundation attempts to "assist the community of Christchurch with the identification, recovery and utilisation of post-consumer (and post-industrial) materials from the waste stream" (CCC, 1998, p.36), thus creating new markets in New Zealand. To this end, the RMF is involved in information gathering and dissemination, enterprise establishment and funding, and policy development and advocacy (*ibid*). The Cleaner Production initiatives include Target Zero, a group of Christchurch businesses coordinated by CCC, that are attempting to apply cleaner production and industrial ecosystem techniques to improve both environmental performance and profitability. Using these initiatives, CCC hopes to change the attitudes of Christchurch waste producers, and provide alternatives to waste disposal. Further programmes planned for the future continue this trend.

2.4.5 Future Planning

The *Draft Solid and Hazardous Waste Management Plan 1998* prepared by CCC is currently in the public participation phase. A summary of the Draft Plan is included in Appendix 5. The stated goal of the plan is the regionalisation of waste disposal, and the reduction of solid waste going to landfill by 100% before 2020. There is a proposal to make the next landfill a regional programme, with other districts and city councils transporting their waste via refuse stations to a single site for disposal. Potential sites for that landfill are presently being identified. The elimination of landfilling is to be achieved through integrated waste management by implementing the waste management hierarchy, with education, coordination

and economic instruments as primary strategies. Total cost assessment is an approach that can be used to unite these instruments because it shows how they impact on total cost. If the goals of the plan are achieved, the total cost will reflect this, and Christchurch's environment (social, biophysical and economic) will have to bear less costs than it does currently.

2.5 Discussion of Terminology Used

A brief glossary of terms is provided at the start of this document. This section explains the rationale for the terms used throughout this report and the way they are defined.

Waste is perceived. Waste is in fact "a potentially valuable resource in the wrong place" (Ahmad, 1981) which disappears when perceptions alter: as Mark Prain of the Recovered Materials Foundation put it, "When is rubbish not rubbish? When people regard it as a resource." (Crean, 1998).

The *National Waste Data Report* (MfE, 1997b) points out that New Zealand has no legal definition for waste, but it has variously been described as "unavoidable materials for which there is currently no near future economic demand and for which treatment and/or disposal may be required" (OECD, 1996). It has also been described as "objects which the owner does not want, need or use any longer, which require treatment and/or disposal" (UNEP, cited in MfE, 1997, p.9). The Christchurch City Council defines waste as "any discarded, rejected and unwanted surplus or abandoned matter". This study considers only solid waste (construction/ demolition, garden, kitchen, organic, putrescible and municipal solid waste: (CCC, 1998, p.22-23) and hazardous waste (ie. waste requiring special treatment or handling before disposal because it is potentially harmful) excluding radioactive waste. It excludes waste in the form of non-hazardous liquids, bulk hazardous liquids, sludge and suspended solids, spray and gas (MfE, 1997). The study deals with the management of waste *after entering the waste stream*, ie. after its generation. This includes management of waste up to its conversion to a useful commodity (eg., if reused, recycled or composted) or disposal, and also includes any post-disposal management or effects (eg., leachate from closed landfill sites). The cost of waste related practices pre-generation (eg., cleaner production) are excluded.

Like 'waste' the concept of **cost** is perceptual in nature. There are a variety of values, of which economic value is just one (Brown, 1984). Negative values can be termed costs and positive values benefits. Costs and benefits can be assigned within a range of disciplines or perspectives (eg., financial, aesthetic, or spiritual costs and benefits). However, the predominant recognition of the 'cost' concept in policy and decision making is economic value and, as noted by Turner (1995), "full social costs of waste disposal have traditionally been disguised or underestimated", whereas the 'full price' *should* include all relevant costs including control costs or costs of effects on the community and the natural environment. This occurs mainly because the most common expression of cost is through market transactions, but many of the costs of the types just described are not accounted for by the market.

Within environmental and resource economics, unaccounted for problems are termed 'externalities' and a way of addressing them is making sure their costs *are* accounted for within the market system. The task of this report is to find ways to systematically account for all costs and benefits (those accounted for and those currently 'external') which occur in the process of waste management, that is, to devise a system for assessing *total cost*. Total cost is

a net cost, that is it includes both costs and benefits. The term 'total cost' (taken from the study's terms of reference) corresponds directly to the term 'real cost' in the *Draft Waste Management Plan for Solid and Hazardous Waste 1998.* The term **total cost assessment** is used to refer to the framework for assessing cost developed within this document, as distinct from any of the existing costing methods or approaches outlined in appendix 2. Because both costs and benefits are considered in this study, and because the usual connotation of the term 'cost' is financial, the term **effect** is used within this study to refer to both costs and benefits of any type.

Waste management is of benefit to society because it prevents uncontrolled litter, discharge, and so on. This view, however, calculates benefits on the basis of costs avoided. In practice this is infeasible because there are infinite possibilities of costs that could be incurred without waste management. Therefore our basis for comparison is not 'what would happen if there were no waste management', but 'what would happen if there were no waste?'. In this context, all waste management activities are costs - for instance, because there is waste, we must pay for education and administration to encourage its minimisation. **Benefits** are positively valued results which would not have occurred if there were no waste - for instance generation of employment in waste management and recycling and reuse industries.

Given the interconnectedness of the issues and impacts associated with waste management, working definitions are required to differentiate between social, economic and biophysical costs. These three categories are used because, while there is considerable variety in their use, they are less likely to be misinterpreted than others, as discussed further below. They are also consistent with national documents which will influence total cost assessment, such as the *Environment 2010 Strategy* (MfE, 1997a), *The State of New Zealand's Environment 1997* (MfE, 1997a) and *Environmental Performance Indicators: Proposals for Air, Freshwater, and Land* (MfE, 1997c). It is recognised that costs and benefits will not fit neatly into specific categories, but it is necessary to establish some boundaries to avoid overestimating or omitting costs, particularly where one aspect of waste management may have several different effects.

Firstly, we will use the term **biophysical** to include all effects on living things (excluding those on people), the physical environment (including physical processes), and any interactions between them. This is a liberal definition of 'biophysical' which includes ecological processes and the intrinsic value of ecosystems. This particular term is used because it encompasses both physical and biological aspects of the environment as well as processes, but avoids the potentially wide-ranging connotations of 'environmental'. It is used rather than 'ecological' because ecology is an approach to environmental science that places particular emphasis on the interactions between elements of ecosystems. Using "ecological" would incorrectly indicate that total cost assessment also has this particular emphasis, whereas interactions are included in the definition given for biophysical, and are considered to be another characteristic of the environment, with no requirement for heavier weighting. "Biophysical" places equal emphasis on living and non-living elements in the environment, as compared with "ecological", which in common usage places emphasis on biotic elements in the ecosystems.

Hirschfeld et al. (1992) define **social** impacts as those which affect society regardless of whether there are effects on what we have termed the biophysical environment. They include traffic congestion, visible air pollution, noise, aesthetic degradation and limited land utility and would also include effects on spiritual and heritage values. Additionally, there may be

secondary effects, such as deteriorated health, which flow on from biophysical impacts. Both primary and secondary effects are included.
Finally, **economic** includes two main types of costs (or benefits). Financial effects are those accounted for in economic or market systems and accruing to waste management service providers. Financial costs are generally already included in current accounting systems. However, while all financial costs are expressed in economic or market terms, some may not currently be included in the waste management service providers' accounting systems, such as future costs (landfill site remediation and new landfill sites, risks). Other effects which are financial in nature but do not accrue to the waste management operators will be referred to as socio-economic (eg., the positive effect or benefit of increased employment, decreased land values near a refuse site, the cost of private transport to transfer stations).

2.6 Conclusion

Christchurch waste management is situated in a dynamic policy process, to which a diverse range of organisations and agencies with either direct or indirect responsibilities contribute. The process is shaped by a wide range of international, national, regional, and local influences, which add to the complexity of the system. A variety of themes and trends in waste management influence the approach that needs to be taken to develop a system of total cost assessment. Total cost assessment need to be understood in the wider context of all the influences, and particular regard to the local Christchurch context.

CHAPTER 3 ISSUES AFFECTING A FRAMEWORK FOR TOTAL COST ASSESSMENT

In chapter two of this study we have discussed the factors and issues Christchurch waste management is influenced by to establish a context for total cost assessment. In this chapter we discuss issues affecting the framework for TCA. Each section closes with stating the implications for the framework. Issues discussed include the nature of effects, tangata whenua, public and private service provision, the generator pays principle, measuring total cost in common units, transboundary issues, coordination of total cost assessment, and future costs and benefits.

3.1 The Nature of Effects

Costs and benefits are defined as types of effects, with either negative and positive value (section 2.5). In section 3 of the RMA 'effect' includes:

(a) Any positive or adverse effect; and
(b) Any temporary or permanent effect; and
(c) Any past, present, or future effect; and
(d) Any cumulative effect which arises over time or in combination with other effects—regardless of the scale, intensity, duration, or frequency of the effect, and also includes—
(e) Any potential effect of high probability; and
(f) Any potential effect of low probability which has a high potential impact.

This broad approach is required due to the nature of environmental management (including waste management): "Although for analytical and practical reasons ['the environment'] can be treated as having different dimensions, such as a biophysical (ecosystems) dimension, an economic (resource management) dimension, and a social (quality of life dimension), it should be recognised that human activities with regard to one aspect of the environment (such as air pollution) may have repercussions in many other aspects (such as forests, soil fertility, buildings, and human well-being). Such impacts may not always be direct and immediately visible [...] and they may be cumulative, adding to the complexity of environmental phenomena." (Bührs and Bartlett, 1993, p.9).

These two sources show the wide range and complexity of 'effects'. Establishing the total cost of waste management (that is, including all the effects, both positive and negative) will mean encompassing a wide variety of interconnected phenomena. Perhaps the best recognised effects which are incurred by waste management are economic ones (refer to section 2.5 for definitions of cost type). Traditionally, financial accounting in waste management has been basic, for instance landfill costing considered only the operational costs (MfE, 1996a).

Some of the economic costs relate to practices which attempt to avoid, remedy or mitigate biophysical effects such as contamination of groundwater and surface water by landfill

leachate, or atmospheric release of gases from landfills (Hirshfeld, 1992). Even with special management in place, however, the activities will still have some level of biophysical effects. New Zealand is still dealing with the effects of poorly managed past disposal sites (MfE, 1997b, p.8.62). Activities not specifically related to waste management can also have biophysical effects, such as air pollution caused by collection and transfer vehicles.

Some of the biophysical effects have social effects. For instance, water contamination may jeopardise the spiritual value of water or heritage value of sites. Vermin and vectors attracted may cause both annoyance and health risks. Other effects are directly on society, regardless of their biophysical impacts, eg., increased traffic, mud on roads, visible air pollution, odour, aesthetic degradation, limited land utility, annoyance and health effects from noise or dust (Hirshfeld et al., 1992, p.473; MfE, 1996a, p.15). Stress is also significant for communities near disposal sites (Lang, 1995, p.182). These direct social effects are the kind of effects compensated by the 'host fee' concept. In this concept, the area negatively affected by waste management (eg., the town in which a regional landfill is located) is compensated. Social effects can also be incurred via market systems, eg., changing property values.

As the above mentioned shows, the effects of waste management are interrelated. Effects have varying time frames - some current effects are caused by past practices, and some future effects need to be considered now. Biophysical and social effects also occur at different levels. Primary effects can cause more (secondary) effects, for instance leachate contamination can affect local biota. This, and the attraction of 'pests' (eg., rats, mice, seagulls and flies) can affect wildlife and potentially the biodiversity of the area.

3.1.1 Implications for a Total Cost Framework

The implication of the nature of effects for a total cost framework is that it must be able to provide for the variety of types of effect which will be encountered. That is, biophysical, social, economic effects have to be included, also primary and secondary, and present and future effects. The framework also has to be able to separate out the interrelated effects and attribute them to specific causes, ie. to minimise double counting of effects.

3.2 Tangata Whenua Issues

Section 2.2 introduced the Treaty of Waitangi as a document which formalises the relationship between Maori and Pakeha in New Zealand, and which directly influences public sector policy. Specifically, the RMA requires the Council to take into account the Treaty (s8), and "recognise and provide for the relationship of Maori and their culture and traditions with their ancestral lands, water, sires, Wahi tapu, and other Taonga" (s(6)(e)). In addition, the Waitangi Tribunal has found that "waste management systems and policy should be constant to the principles of the Treaty of Waitangi" (MfE, 1993). National support for the implementation of these policies is improving, and a new advisory committee on Hazardous Substances and New Organisms - Ngaa Kaihautu Tikanga Taiao - should soon be able to provide policy guidance on hazardous waste issues affecting Maori (ERMA, 1998). Christchurch City Council's *Draft Waste Management Plan for Solid and Hazardous Waste* (from which this study's aim is derived) acknowledges and commits to these Treaty obligations. The key principle (2) in the Draft Plan is to "ensure a consultative process" with tangata whenua. The plan's appendices also contain policies on solid waste management from a city runanga, Ngai Tuahuriri.

The MfE document *Waste Management Planning: Guidelines for Maori* (1993) note some key points that need to be considered. One is that tangata whenua generally face considerable resource constraints and are not able to direct large amounts of time, effort and money into resource management issues. Another key point is that tangata whenua have a distinctive way of seeing the world (environmental value systems), which is different in many ways to European or Western modes of understanding. Aspects which non-Maori (tauiwi) might consider quite separate are inseparable from a tangata whenua perspective. For instance, tauiwi keep religion or spirituality very separate from public planning processes but in the Maori world view these cannot be considered separately (Gray, 1997). Similarly, western science divides the world into parts such as astronomy, geology, botany, geography and other disciplines, while Maori cosmology views all physical elements as related through genealogy since creation (MfE, 1997c, p.15). Thus for tangata whenua the value of water is not simply as a resource, but includes spiritual, physical, economic, social and mental aspects (MfE, 1993, p.22). As a result of this different understanding, tangata whenua may have specialised local knowledge to contribute to total cost assessment (MfE, 1997c, p.14).

> *The environmental value systems of tauiwi and tangata whenua are like two rulers of equal length lying side by side. One sets out to measure environmental values in centimetres or spiritual, mental, physical and social terms and the other measures it in inches or materialistic and financial terms.* (MfE, 1993 p.4).

This quote suggests that tangata whenua and tauiwi are seeking to measure the same things in different ways. In fact, the approach the Council has taken in requiring total cost assessment and reporting incorporates far more than "materialistic and financial terms". In this way, CCC's approach may not be so incompatible with the tangata whenua value system described here. However, it is recognised that considerable differences do exist. Tauiwi assessment methods are reductionist - that is they break things down into components and study them to understand the whole, whereas tangata whenua tend to consider the big picture. This is true of the approach to total cost taken in this report - the whole picture is built up by understanding specific components.

3.2.1 Implications for a Total Cost Framework

Given CCC's obligation to the Treaty of Waitangi, costs and benefits of waste management need to be considered from a tangata whenua perspective (in addition to a tauiwi perspective). To at least some extent, physical and economic effects can be expected to be the same for tangata whenua as for tauiwi, and their measurement techniques mutually acceptable (MfE, 1997c, p.13). It is the spiritual, social and mental costs which flow on from physical effects which are likely to be significant. The fact that Maori have different ways of measuring means that if costs which they incur are translated into common units, some meaning may be lost in the process. Allowing values to be expressed qualitatively would negate this problem. The separation of costs into different types (biophysical versus spiritual) may be inappropriate from a tangata whenua perspective. This would seem to suggest that costs to Maori (in particular social, mental and spiritual) should be kept together for assessment, and measured in a way that retains meaning. Tangata whenua need to be asked and included in the development of total cost assessment in order to clarify this.

However, it seems unlikely that iwi or runanga would be able to spare the time, money and effort required to carry out assessment on a comprehensive annual basis. One option may be to ascertain a clear set of criteria against which to measure effects of waste management to

tangata whenua, if acceptable. This could be developed through the consultative processes mentioned in the Draft Plan, which could seek specific input on TCA implementation. Alternatively, a single statement by tangata whenua could be prepared by a representative group on an annual basis.

It is important to note that although the Draft Plan relies on policies from Ngai Tuahuriri, other runanga will be affected by waste management, particularly with developments such as a regional landfill. In addition, the Te Runanga O Ngai Tahu Act 1996 requires consultation with Ngai Tahu is done with the official Ngai Tahu body, rather than individual runanga, suggesting that the extent of consultation will have to be widened beyond Ngai Tuahuriri.

3.3 Public and Private Service Provision

As discussed in section 2.2.7, delivery of waste management services is a statutory duty of territorial authorities (s.538 of the Local Government Act). The Draft Plan sets directions for Christchurch Waste Management and promotes: 1) minimising the amounts of waste requiring disposal; 2) minimising the effects of waste on the environment; and 3) ensuring efficient use of the Council's resources (CCC, 1998).

Some services (eg., collection, operation of refuse stations, landfill) can be provided by the private sector where distinct roles and responsibilities can be defined. Boyle (1997, p.44) for example, identifies 'collection', 'operation of disposal facilities' and 'separation of recyclable waste' as services which may be contracted to private companies. In Christchurch there are currently several privately run waste services, eg., Onyx collects household recyclables through its kerbside collection scheme (Crean, 1998). A discussion of the advantages and disadvantages of private versus public supply of waste management services is beyond the scope of this study. It is necessary, however, to determine the implications of private sector participation for total cost assessment of waste in Christchurch City.

The main goal of private companies is to maximise financial return. It follows that traditional cost accounting in the private sector has been limited to financial accounting (Ostrenga, 1992). More progressive methods of cost accounting (eg., Full Cost Accounting) have focused on improving accounting systems, but retain a financial and commercial focus (Turner, 1997). This means that non-financial costs and benefits (ie. social, biophysical and some economic effects) are typically excluded from private accounting systems.

3.3.1 Implications for a Total Cost Framework

In assessing the 'total cost' of waste management, CCC must assess economic, social and biophysical effects of Christchurch's waste management services. Where those services are delivered by CCC, the Council is in a position to account for all effects (costs and benefits) associated with their programmes. Where private companies deliver waste management services, CCC can account for the commercial contract value and contract administration costs (eg., monitoring, policy development, enforcement and administration). Any further breakdown of these or assessment of the other costs (eg., social and biophysical) associated with individual activities of those companies requires further information from businesses than is currently provided.

Commercial sensitivity may restrict the type of information private business may provide to the CCC. Because assessment of non-financial costs are not currently required of private

sector service providers, they are not readily included in a framework of total cost assessment. CCC will need to develop a policy to promote the inclusion of those costs and benefits. Some possible ways are listed below.

- CCC could include monitoring conditions or accounting requirements in a contract or licence agreement[2].
- Monitoring conditions or accounting requirements could be included in conditions on a resource consent application.
- Private waste management service providers could receive incentives for providing information or meeting certain requirements (eg., money or security of contract).
- Total cost assessment might be jointly undertaken on a voluntary basis by the private service provider and CCC.

3.4 The Generator Pays Principle

In New Zealand society, waste is generated at two main levels, production and consumption (Boyle, 1997). Producers create waste as a by-product of their production process. Consumers then purchase the products and generate waste by discarding packaging and the products themselves (or their parts) as they reach the end of their useful life.

Currently, the total cost of waste is not being met by either type of waste generator. The need for this is encapsulated in policy two of the Government's waste policy (MfE,1992; section 2.2.3). The need for generators to pay for the total cost of waste management is directly related to the economic concept of externalities outlined in section 1.3. This is conveyed in Principle 4 of the Environment 2010 Strategy that:

> *"Resource management should ensure that the unpriced environmental effects (or external costs) associated with the production, distribution, and consumption of goods and services are "internalised", that is, they are assessed and consistently charged to users and consumers who benefit from them"* (MfE, 1995, p.15).

Charging the total cost of waste is regarded as a means of providing the right balance of incentives to promote desirable standards of behaviour, namely waste reduction, reuse, recycling and recovery (MfE, 1995, p.45; CCC, 1998, p.5-6). However, there is little specific research to support this belief within the field of waste management. Related to this, the issue of distributive effects should be considered in the development of any charging system. Different waste generators have a different relationship to money. A given charge for waste disposal may represent an excessive incentive for low socio-economic groups whereas it might be irrelevant for higher socio-economic groups. Establishing the relationship between various incentive structures (eg., charging systems) and the behaviour of waste generators is therefore important.

Within the waste management hierarchy reflected in government policies, reduction of waste at source is the first priority in waste management. Holding producers responsible for the waste which results from their products would do this, because there would be an incentive to design products which create less waste. This can be done through direct monetary requirements, or though requirements as exist in some European countries (where all packaging can be physically returned to the producer who must take responsibility for its reuse, recycling or disposal) (Boyle, 1997, p.48). Directly charging waste producers for the

[2]The power to license private waste management contractors through by-laws is given in the Local Government Amendment Act No. 4 1996.

cost of waste associated with their products has not yet been attempted (*ibid.* p.49). Direct charging seems particularly problematic for New Zealand given its high level of imported products as the application of charges to domestic producers only would create competitive disadvantage. Charges to imports may also contravene current trade agreements.

Charging of producers is legally and logistically beyond the scope of a local authority, and this is recognised in the Christchurch City Council's Draft Plan, which identifies encouraging consumer influence and lobbying for national legislation as the best methods of applying pressure to producers. However, waste generated during production within Christchurch City can be charged for through fees for waste management services provided. It is this form of charging that the plan identifies as being based directly on the total or 'real' cost of waste management (CCC, 1998, p.5-6).

There are several options for setting charges available. Charges on the basis of waste type (eg., plastic, paper) could provide very direct incentives to work towards the implementation of the waste hierarchy. However ascertaining the total cost for different types of waste is difficult (as discussed in section 4.4.5), if specific costs of each waste type were to be used. A system of accurate waste sorting, identification and charging would be infeasible, complex and expensive for municipal waste generators but may be feasible for larger scale waste generators.

Instead of allocating the cost of specific waste types, generators could be charged on the basis of the amount of waste assuming an average mixture. However, charging by amount for mixed waste continues to send a distorted message to waste generators. For example, a bag of shredded paper would incur the same charge as a bag of used batteries or PVC products which leach up to ten times the acceptable level of softeners known as phthalates (Greenpeace, 1997).

The economic rationale for internalising external costs is to eliminate market failure (section 1.3). Including externalities is one aspect of market failure and other potential sources of market failure need to be addressed. One of these is the lack of information to (or understanding by) waste generators (eg., how to compost garden waste privately). The Draft Plan recognises this and identifies charging as one of a range of methods or tools for meeting waste management requirements (eg., funding new initiatives, education and promotion). However, other types of market failure, such as the ability to enforce illegal dumping, are also hard to overcome and not currently addressed.

3.4.1 Implications for a Total Cost Framework

Given that the 'generator pays' principle is set down by present Government, the challenge to CCC is to minimise market distortion as far as is practicable so that the application of the generator pays principle is more robust. This requires not only economic incentives and disincentives (ie. a well designed charging system) but also other methods such as lobbying for national regulation, education and mobilising consumers to better influence producers as outlined in the Draft Plan. Identifying links between causes and effects of waste by type (of waste) is desirable, but is currently difficult and requires further attention. Thus, a total cost assessment framework should allocate the costs and benefits of waste management in a way which allows any charges to be based on a transparent, accountable system. However, the framework should also be able to contribute to the other strategies of the plan, eg., education.

3.5 Measuring Total Cost in Common Units

This section discusses the use of common units for the measurement of effects on the environment, in terms of the advantages, feasibility, appropriateness and efficiency of using a common unit. The final section discusses the implications this has on a framework for total cost assessment.

A common unit has to fulfil the following two criteria: 1) be applicable to many effects, and 2) allow direct comparison. Undoubtedly the most commonly used unit is money. The list of potential common units for use in waste management is infinite (some examples are provided below). However the general public understands and usually values money. Other units include indices which combine several units in one index unit. An example is the index of 'barrels of oil equivalent' used to compare the energy level of fossil fuels such as oil, gas and coal. 'Indices of sustainability' have been applied to waste management, for example, the 'index of sustainable economic welfare' developed by Daly and Cobb (1994) or the 'ecological footprint' indicator (MfE, 1997b, p.1.4).

Total cost assessment and charging as one of the potential applications are closely associated with neoclassical economic theory and are a product of their ideologies and theories (for a discussion see section 1.3). We also recognise that total cost is a product of an international trend of assessment of the effects and costs of human activity. However, one of the assumptions of neoclassical economic theory and ideologies is that everything can be measured in dollars.

3.5.1 The Advantages of Using Common Units

The main advantage of measuring costs and benefits in a common unit is for ease of comparison. By comparing different effects expressed in the same unit the relative significance or seriousness of costs or benefits can be compared directly. Economic methods such as Cost-Benefit Analysis compare the monetary costs with the monetary benefits, using the Net Present Value as the main measurement. The comparison allows for transparency and accountability. This includes comparison between regions or waste management programmes.

Despite these advantages, the use of common units is constraint by three limitations which relate to the absence of feasibility, appropriateness, and efficiency.

3.5.2 The Feasibility of Using Common Units

In some cases, no reliable and accurate scientific method exists to measure costs and benefits in a quantitative way, ie. no suitable unit is available. This means, preferences and trade-offs cannot be expressed because costs and benefits are regarded as incommensurable. Examples might be the spiritual benefit of clean water to tangata whenua as described in section 3.2, or the ethical cost of accumulating waste, thus compromising the state of the environment for future generations.

3.5.3 The Appropriateness of Using Common Units

The use of common units, especially money, is not always appropriate. A requirement for the appropriateness of a common unit is its ability to accurately represent value. For a common unit to be useful, there needs to be widespread agreement that this representation is accurate,

ie. that 'cost' is not diminished through translation to a common unit. In social and biophysical assessments, where frequently no market prices exist, the accurateness is often not satisfactory. For example, the benefits of protected areas is usually underestimated (Dixon and Sherman, 1991). Likewise, an underestimate of the costs of waste management is likely.

Another possible disadvantage of using common units is that this will lead to loss of understanding of costs and benefits and therefore reduction in informed decision making. The concern is that once the (monetary) costs and benefits are established in the common unit and decision makers and the public are communicating through the common unit, the degree to which the costs and benefits (ie. the effect itself) are considered may be diminished. The waste manager must carefully consider the nature of an effect in order to establish its costs and benefits, eg., in a monetary unit.

The use of money as a common unit is a source of general debate. Some people associate money with unethical decision making, and therefore strongly resent any attempt to translate particular values into monetary units. For example, O'Neill (1997) argues for the complete absence of monetary assessment, favouring policy making solely based on public participation. Winpenny (1991) claims that some items are simply unmeasurable by economics (such as biodiversity - p.72). This view would make total cost assessment at least partially redundant because of its close association to theories of externalities and generator pays (section 1.3). However, these viewpoints may be too extreme to receive general support. Also, CCC has a strong desire to use the assessment for charging purposes, requiring a monetary unit.

The appropriateness of using common units can be compromised because people can have different relationships to money. This means that people value money to differing degrees as discussed in section 5.3.4.

The discussion shows that the decision whether or not it is appropriate to express costs and benefits of waste management in quantitative, especially monetary, terms, is an ethical one. The degree to which the public wishes to use quantitative, and especially monetary units, to assess total costs in waste management, needs to be revealed through a public participation process.

3.5.4 The Efficiency of Using Common Units

By definition, economic costs and benefits can all be expressed in monetary units and most financial effects are easily assessed. In contrast, many tools currently available for assessing social and biophysical costs and benefits are less developed and give rise to costs expressed in a broad range of units. Intangible costs and benefits (eg., aesthetic or olfactory costs and benefits) can be extremely difficult to quantify with an acceptable level of accuracy, and considerable barriers exist to converting the quantities provided into common units. Tools for measuring intangible costs and benefits in common units (mainly contingent valuation methods) must be designed very precisely, if they are to mirror reality (Bjornstad and Kahn, 1996). Thus, further research is required to develop tools for the assessment of costs and benefits (eg., social and biophysical costs and benefits). Consequently, the conversion of costs and benefits into common units may require substantial investment. CCC must make a decision on which costs and benefits are important enough to be measured, and which are efficient to convert into common units. This decision is also an ethical decision, influenced by the costs of measuring, the expected magnitude of the costs and benefits, the usefulness of the

knowledge about costs and benefits, and the need for directly comparing the costs and benefits with others.

3.5.5 Implications for Total Cost Framework

When assessing total cost, quantitative assessment should be used where this is possible. Common units should be used where this is possible, especially the monetary unit because of its widespread use, established methods of monetary-based analysis such as Cost-Benefit Analysis and as this is required in accordance with central Government policy. However, it is essential to acknowledge the limitations of any units chosen in terms of their feasibility, appropriateness and efficiency. It is unlikely that all costs and benefits will be converted to a single common unit. Thus, a total cost framework must allow for some costs and benefits to be quantified in monetary terms, others to be quantified in physical units or indices, and still others to be qualified or described. Furthermore, waste management must account for ongoing assessment of the selection of the common units, due to changes in their feasibility, appropriateness and efficiency to assess total costs over time.

3.6 Transboundary Issues

3.6.1 Import and Export of Waste

In terms of waste, transboundary movement refers to the export and import of substances to and from an area outside the jurisdiction of the state (or region) in which they were generated for treatment, disposal, dumping at sea or incineration. This can be caused by scarcity of disposal facilities, NIMBY syndrome, tightening environmental regulation, or high costs of treatment or disposal (Kummer, 1995).

Two main issues are raised by transboundary waste movement. Firstly, the motivation for export or import of waste may not be 'ecologically sound'. This would include waste going to developing countries where regulation and/or enforcement is poor and practices cheap in order to avoid high costs or stringent regulations in the country of origin (as opposed to more sound reasons such as superior technology, proximity of facilities in neighbouring countries, shared or multinational facilities). Secondly, where hazardous waste is being transported there is the risk of accidents in transit or during handling. A range of policies regarding the transport of hazardous substances have been developed in response to this, including the UN Committee of Experts on the Transport of Dangerous Goods' "orange book", Part VII of the SOLAS convention, Annexes I-III of the MARPOL convention and the International Maritime Dangerous Goods Code (Kummer, 1995). Dealing with hazardous wastes more generally is the Basel Convention, which arose out of UNEP's Montevideo Programme and 'the Cairo Guidelines' they developed.
The Basel Convention states that:

- the generation of hazardous wastes should be kept to a minimum;
- if generation is unavoidable, disposal should be as close as possible to the source of generation;
- hazardous waste may not be exported from OECD to non-OECD countries, to Antarctica, to non-Convention or equivalent treaty countries, or to countries banning import of hazardous waste;

- transboundary movements may only occur where they are the best environmental solution and they occur in compliance with the convention;
- there must be prior informed consent from the receiving countries; and
- illegal export or legal exports that cannot safely be disposed of in the destination state must be returned to the state of origin (Kummer, 1995).

3.6.2 New Zealand - National Context

The Convention has been contentious and there are still problems with definitions and scope (Kummer, 1995). Nevertheless, New Zealand is party to the convention and under it exports PCBs to France, vanadium slag to Russia and China, spent cell lining to Australia and copper alloy dross to the United Kingdom. New Zealand also has approval to export aluminium dross, tungsten carbide grindhouse residue, zinc oxide baghouse dust and send lead acid batteries (MfE, 1997a; 1997b). This export is allowed because no facilities to handle these wastes exist nationally. Only two types of plastic (PET soft drink bottles and plastic milk containers) are recycled in New Zealand, whereas much paper and plastic is exported to Asian countries (Crean, 1998). However, some reductions in exports have been experienced recently, with newspaper being shredded and reused locally instead of exported.

3.6.3 New Zealand - Regional Context

Apart from this international movement of waste, there are some substances for which there are appropriate facilities nationally but not locally, leading to export and import of waste between regions. Within the Christchurch area, used tyres have caused considerable disposal issues for Christchurch and international export seemed likely. Christchurch City Council has agreements with Waimakariri and Banks Peninsula District Councils which result in some waste from those districts being disposed of in Christchurch (E. Park pers. comm., 1998). Informal import also occurs in Christchurch where residents from neighbouring districts using CCC facilities to dispose of waste. This is because facilities in their own districts can be further away or not available, eg., compost facilities (*ibid*). Glass is now being sterilised for reuse (wine bottles) instead of being crushed and sent to Auckland for recycling (Crean, 1998). It is already recognised by the Council, through initiatives like the RMF, that dealing with waste locally is preferable to exporting (in either a regional or national sense). In the future, there are likely to be more regionally shared facilities, such as current moves to establish a joint landfill program among local authorities in Canterbury. The Christchurch City Council, district councils of the Canterbury Regional area except Waitaki, the Canterbury Regional Council, and waste firms Waste Management and Envirowaste Services are close to forming a joint venture to run a regional landfill (Press, 1998b). This would obviously increase transboundary movement of waste between local government territories.

3.6.4 Implications for a Total Cost Framework

Because of the likelihood of shared waste management facilities in the future, a framework for assessing total costs of waste management must be flexible enough to be applied on both a local and a regional level. Accordingly, flexibility is a criteria for cost assessment (section 4.1). If the Christchurch City Council becomes the administrator of the new regional landfill, waste would effectively be imported into Christchurch City's waste management system (if the landfilling occurs within the City's geographical boundaries). The inclusion of import into the total cost framework as a result of a regionalisation of the waste management system is, as

explained in section 4.4.1, possible through expanding the framework by adding another distinct programme, which specifically takes into account the import activities and its associated effects.

Export of waste from Christchurch is slightly more complex, as the definition of this study in the terms of reference was assessment of total cost of wast management *in* Christchurch. The only cost of waste export to Christchurch itself is the cost of transport and the price charged by the receiving party. Ideally, any costs not covered by that price (eg., social and biophysical costs) should be assessed, although in reality this may be hampered by a lack of information and administrative costs. There could be positive implications of increased regionalism in waste management for total cost assessment, by including more linkages outside Christchurch and gaining the financial and technical support of other councils for cost assessment.

3.7 Coordination of Total Cost Assessment

The Ministry for the Environment, regional councils, and district and city councils are key organisations with responsibility for the coordination of waste management at national, regional and local levels (section 2.1 and figure 3).

The OECD (in their review of New Zealand's environmental performance) note that there is need for "regional efforts" to coordinate and harmonise waste management (OECD, 1996, p.183). They gave three recommendations to central government. They should consider:

1. increasing assistance to regional and local authorities, particularly with regard to the assessment of environmental effects;
2. providing clear definitions for waste types and a comprehensive and coordinated system of monitoring both the causes and effects of waste generation; and
3. ensuring that environmental monitoring and reporting systems are tailored to the implementation needs of the RMA and are consistent throughout New Zealand (*ibid*.)

At a national level, MfE has provided some guidance for assessing total cost by preparing the the *Environment 2010 Strategy* (MfE, 1995), the *Landfill Full Costing Guideline* (MfE, 1996a), the *State of New Zealand's Environment Report* (MfE, 1997b), and the current Environmental Performance Indicators Programme. MfE has done little specific analysis on the issue of TCA and this is not a current priority (S. Baird pers. comm., 1998).

At a regional level, Canterbury Regional Council issued a Proposed Regional Policy Statement in 1995 which addresses waste issues. With respect to coordination and total cost assessment, policy 2 of the Proposed Regional Policy Statement states: "A coordinated approach to waste management should be developed and implemented" (CRC, 1995). Methods used or to be used to achieve this include "regional plans, advocacy, promotion and cooperation and information provision" (CRC, 1995). Canterbury Regional Council currently has no internal policy to address the assessment of total cost and does not have a strategy which specifically deals with waste issues. The Canterbury Waste Joint Standing Committee was established to deal with regional waste issues and at present, has a particular focus on hazardous waste issues and issues associated with developing a regional landfill (E. Park pers. comm., 1998). A discussion of issues associated with communication and coordination between regional and district/city councils is beyond the scope of this report. These are discussed in the McShane Report (McShane, 1998).

3.7.1 Implementation Needs of the RMA

As outlined in section 1.2 and discussed in section 2.2, a system of assessing and reporting total cost has potential application for meeting the implementation needs of the RMA.

With respect to matters to be considered at a national level, there are currently no waste management activities which occur within a restricted coastal zone in Christchurch City. The Minister for the Environment has only exercised his call-in powers under the RMA on one occasion (Stratford Power Station Application) since its enactment in 1991 (Tim Bennetts pers. comm., 1998). National coordination of total cost assessment for the purpose of meeting implementation needs of the RMA is not a pressing requirement relative to regional and local requirements. This is discussed below.

At a regional and local level, CRC and CCC are required to ensure efficiency of their management plans, objectives, policies, rules or programmes, which requires the assessment of costs and benefits (s.32 RMA). Waste management activities in Christchurch City which effect the environment require a resource consent. An assessment of environmental effects must be included for any application, and their consideration is the responsibility of CCC and CRC. The respective functions and issues to be considered by each council are set out in sections 30 and 31 of the RMA. Given that some waste is imported from other districts within the Canterbury region and that the possibility of developing a regional landfill is currently being investigated (section 3.6), it would follow that assessment of costs and benefits is an issue which has considerable implications at a regional level.

3.7.2 Advantages and Disadvantages of Coordination

As well as considering implementation needs of the RMA, there are a range of advantages and disadvantages of coordination which Christchurch City Council should consider. Discussion of specific issues is considered beyond the scope of our terms of reference, but general disadvantages and advantages associated with coordinating a system of total cost assessment and reporting are described as follows:

Disadvantages of Coordination

Christchurch City Council has primary responsibility for the management of waste in Christchurch City. Waste management requirements are unlikely to be the same for any two localities. Christchurch City Council therefore has a unique waste management process (and associated costs and benefits).

The following general disadvantages may be incurred as a result of coordinating the development of total cost assessment and/or reporting with other organisations. Cooperation with other organisations:

a) may lead to a framework for or methods of total cost assessment which do not specifically meet the needs of Christchurch waste management.
b) requires external communication. This may have an associated economic cost (eg., administration costs leading to a more complex development process (for example, accountability to senior public servants, committees or ministers) and may lead to loss of control over the development process).
c) requires agreement on a scale or rate of development which may not ideally suit Christchurch City Council.

Advantages of Coordination

The following general advantages may result from coordination with other organisations.

Sharing of resources may give rise to:

a) financial savings. These may be generated through pooling financial resources (to develop a framework or tools) where this meets common needs (eg., if a general TCA framework meets the needs of multiple organisations then the cost of developing the appropriate tools to operate the framework might be shared. Similarly, where research is required to develop tools for the assessment of effects, the associated financial costs may be shared between the organisations).
b) more expedient and effective development of TCA. This may occur where expertise can be pooled between organisations (eg., for the development of cost assessment methods and for monitoring).

The development of common system for assessment and reporting of environmental effects might provide for:

c) greater public understanding of the effects (costs and benefits) of waste management (ie. information is expressed in a consistent form and is therefore less confusing).
d) greater understanding by policy analysts and ability to meaningfully compare the effect of different policies (ie. the effects of policies will be expressed in a consistent form) and greater understanding of decision makers who are required to understand the effects of waste management (eg., for the granting of resource consents).
e) meaningful comparison of management practices, programmes and activities, ie. because effects are expressed in a consistent form (This would provide a clear basis for establishing best management practices, and a comprehensive basis for comparing the performance of competing service providors (eg., one landfill operator may provide a more efficient financial service than a competitor, but the 'total cost' of that service may be higher)).

3.7.3 Implications for a Total Cost Framework

The Christchurch City Council's approach to coordination may affect a range of potential applications of a framework for total cost assessment and reporting. In addition, resource requirements, understandability of the framework and ability to compare waste management policies, programmes or activities may be affected by the chosen approach to coordination. We consider the choice of approach to be a political one, and have developed a TCA framework that allows for coordination at different stages and different levels.

3.8 Future Costs and Benefits

Current waste management can incur costs and benefits which are paid or received in the future. Likewise, past waste management can impact on current or future costs and benefits. An example is the contamination of sites in the future from current and closed landfills, causing future costs of cleaning up the sites.

3.8.1 Future Costs and Benefits which are Certain

Waste management can cause costs and benefits which will occur in the future. Although these future costs and benefits are not immediately incurred, they are part of the waste management system.

Future costs and benefits which are certain are costs and benefits for which both the occurrence and the value of the costs and benefits is certain (eg., a landfill will require monitoring after closure for 30 years at a predictable cost). Frequently people or organisations do not value costs and benefits which are incurred in the future as highly as costs and benefits which are immediately incurred. Economists refer to this devaluation as discounting and quantify the magnitude of devaluation as a discount rate (Pearce and Turner, 1990). Future certain costs and benefits can be calculated to their present monetary costs and benefits through discounting, if their monetary value in the future is known (*ibid*.).

The present value of future costs and benefits will depend on the discount rate selected. The appropriate discount rate to apply for the management of public amenities has been widely discussed in the literature (Brennan, 1995; Pearce and Turner, 1990, ch.6; Wright, 1990). High discount rates give rise to low present costs. Likewise, high discount rates lead to high present benefits. Pearce et al. (1989, p.151) state that the social discount rate tends to be lower than the private rate. This means, the rate of exploiting resources (and thus waste generation) is higher than socially desired and the future costs of waste management are valued lower than socially desired, while future benefits are valued higher than socially desired. Because the benefits of waste management (as defined in section 2.5) are usually lower than the costs, the advantages of a high discount rate with regard to benefits cannot counterbalance the disadvantages of a high rate with regard to costs. The application of a low discount rate for waste management could bring about a balance. However, in environmental areas where future benefits are more significant than future costs (eg., biodiversity protection), a high discount rate seems to be more appropriate. Overall, an adjustment of the (relative high) discount rate used in financial accounting to a lower discount rate when dealing with social and biophysical issues, is not of advantage because:

1. *"calculating the appropriate rate is extremely difficult:*
2. *a lowering of the rate overall will result in more investment with its non-counter-productive results:*
3. *a selective lowering of the rate for environmental projects is inefficient and administratively cumbersome and difficult;*
4. *there are alternative ways of dealing with many of the environmental concerns that are probably more effective"* (Pearce and Turner, 1990, ch.6).

The most important alternative way is (1) the careful identification of *all* costs and benefits, and their measurement (if appropriate), which is a main purpose of total cost assessment, combined with (2) policy making based on the total cost assessment. Additionally, a range of discount rates can be applied to obtain insight in its influence on the magnitude of changes in total costs.

3.8.2 Future Costs and Benefits which are Uncertain

Future costs and benefits are uncertain, if the timing or their occurrence is not known. There are two broad categories of uncertain cost and benefits: those which are certain to occur but for which their timing and magnitude are uncertain; and those for which timing, occurrence and magnitude is uncertain.

Where the costs and benefits will occur but the timing and magnitude is uncertain, procedures exist for modelling and estimating costs and benefits, ie. risk management (Gerrard, 1995, p.304). Where occurrence is uncertain as well, both the costs and benefits and their

probability must be modelled and estimated without formal procedures. Cost and benefit modelling is directly linked to modelling of activities and effects. For some activities the nature of associated effects may be extremely uncertain and difficult to model. For others the range of potential effects may be significant and/or irreversible. Where either of these are the case the *Environment 2010 Strategy* (MfE, 1995) stipulates that the "Precautionary Principle" must be applied. This requires that where modelling of effects is extremely difficult (eg., where scientific information relating to effects is minimal or contradictory) they must be described in detail, providing best and worst case scenarios. Emphasis should be given to the worst case scenarios and activities with potential significant or irreversible effects should be avoided (Environment Court, Barry Wratten vs. Tasman District Council).

3.8.3 Implications for a Total Cost Framework

In summary, future costs and benefits are an integral part of total cost. An accurate total cost assessment needs to include all future biophysical, social, and financial costs and benefits, whether they stem from past or present waste management. The present value of future costs need to be quantified where possible or stated qualitatively if this is not possible. Commonly used discount rates in financial accounting should be applied, however a range of scenarios with varying discount rates and values of costs and benefits should be investigated (sensitivity analysis). In addition, where modelling of effects is extremely difficult, the framework should allow application of the precautionary principle.

Future costs and benefits can be allocated (ie. discounted) within a framework for TCA in various ways. For example, the future costs of monitoring the current landfill can be allocated to the current year's accounts, to the year in which the landfill is closed, to the years in which the monitoring occurs, or evenly distributed (ie. annualised) over the years between now and some time in the future. How allocation takes place is a political decision, however this decision needs to be reflected within a framework for TCA.

Future costs and benefits from present and past waste management are an important component of total cost. However, if TCA is used for establishing a charging structure, only those costs and benefits (present and future) which relate to present waste generation should be included. Including costs and benefits which relate to past or future waste generation within a charging structure would distort the socially desired incentives. According to the theory of 'sunk costs' (Newman and Summer, 1962, p.306), past costs should be disregarded in thinking about which course of action to follow. For example, the inclusion of costs from cleaning up closed landfills into present charges would increase the charges, leading to a higher incentive to minimise waste, than if charges were based on present total costs. This would lead to a higher than socially desired investment in minimisation techniques, diminishing overall well-being. Funding for cleaning up closed landfills would therefore have to come from other sources (eg., general rates).

3.9 Conclusion

The discussions in this chapter have revealed a number of implications for a total cost framework. They are, in summary, as follows:

- The implication of the nature of effects for a total cost framework is that it must be able to provide for the variety of types of effect which will be encountered. That is, biophysical, social, economic effects have to be included, also primary and secondary, and present and

future effects. The framework also has to be able to separate out the interrelated effects and attribute them to specific causes, ie. minimise double counting of effects.

- Given the obligations of the Council to the Treaty of Waitangi, costs and benefits to tangata whenua of waste management need to be considered. Costs to tangata whenua (in particular social, mental and spiritual) should be kept together for assessment, and measured in a way that retains meaning. Consultation with Ngai Tahu should always be done with the official Ngai Tahu body.
- Assessment of the social and biophysical effects associated with individual activities of companies delivering waste management services requires further information (from those businesses) than is currently provided. CCC will need to develop a policy to promote the inclusion of those costs and benefits, and identify mechanisms to achieve this (eg., monitoring conditions or accounting requirements on contracts and licences).
- A total cost assessment framework should allocate the costs and benefits of waste management in a way which allows any charges to be based on a transparent, accountable system. The framework should also be able to contribute to the other strategies of the plan, eg., education.
- A total cost framework must allow for some costs and benefits to be quantified in monetary terms, others to be quantified in physical units or indices, and still others to be qualified or described.
- The framework for assessing total costs of waste management must be flexible enough to be applied on both a local and a regional level and to allow the inclusion of waste import into the total cost framework as a result of a regionalisation of the waste management system.
- A TCA framework must allow for coordination at different stages and different levels.
- Future costs and benefits are an integral part of total cost. The framework needs to include all future biophysical, social, and financial costs and benefits, whether they stem from past or present waste management.

CHAPTER 4 A FRAMEWORK FOR TOTAL COST ASSESSMENT

The third chapter discussed issues which influence the way in which total cost assessment should be carried out. Chapter 4 introduces a framework within which TCA can be carried out. A framework is necessary to provide a systematic approach to deal with the broad and complex range of information encompassed by 'total cost'. A framework can minimise inconsistencies in carrying out TCA, such as missing out or double counting costs and benefits. It can also incorporate other approaches such as the national State of the Environment Indicators Programme (MfE, 1997c) or current monitoring activities. A framework enables costs and benefits to be compared between CCC and other waste management organisations. In addition, a framework provides a means for integrating social, biophysical and economic aspects, enabling thus recognition of their interrelatedness. Integration of social with biophysical matters is of particular concern to CCC (LGNZ, 1998).

Chapter 4 provides criteria which a TCA framework should meet. Existing approaches to cost assessment are outlined, their usefulness discussed, and the approach taken using the framework presented in this report is outlined. Section 4.4 introduces this framework and discusses each of its steps:

1) identifying waste management programmes;
2) identifying activities and sub-activities of each programme;
3) identifying the characteristics of the environment;
4) identifying potential effects of specific activities;
5) measuring the magnitude of effects;
6) calculating effects in units of cost and benefit;
7) compiling the total cost table;
8) reporting the total cost of waste management; and
9) evaluation of the framework.

These steps are illustrated in figure 6.

4.1 Criteria for a Total Cost Assessment Framework

Box 5 specifies criteria for a framework for TCA, which have been developed to assess the various options for developing a TCA framework. These criteria are not listed in order of priority. The rationale for each criterion is provided below.

Box 5: Criteria for a framework for total cost assessment.

A Total Cost Assessment Framework should:

1. meet requirements of the *Draft Waste Management Plan for Solid and Hazardous Waste 1998* and other policy applicable to Christchurch's waste management;
2. be flexible enough to encorporate future waste management practices;
3. include social, biophysical and economic "externalities" in the assessment of costs and benefits;
4. enable the inter-relationships between social, biophysical and economic effects to be clearly identified;
5. link causes and effects of waste generation, such that effects (costs and benefits) can be directly traced back to their causes;
6. provide a clear break-down of costs and benefits of waste management practices which will allow for comparison of practices;
7. be transparent, accountable, understandable and feasible so the public can support the process; and
8. be in a format that works towards a system of generator pays charging for waste management services, without precluding other applications.

The following discusses the rationale for selecting each of the established criteria:

1. It is the aim of this report to provide a TCA framework which can be implemented by the Waste Management Unit of the CCC. Thus, the framework must be consistent with the forthcoming CCC Waste Management Plan. Also, the framework should regard legislative requirements such as the RMA and the LGA, policies such as the Environment 2010 Strategy (MfE, 1995) and the Regional Policy Statement, and international agreements which influence waste management.

2. Waste management practices can change relatively quickly over time, for example, due to changes in policies, market prices or social and ecological circumstances. It is recognised, for instance, that there may be significant changes to the Draft Plan before its final release. Planning and implementing a framework for TCA is a complex process which requires a long term approach. A TCA framework must therefore be sufficiently flexible to incorporate changing waste management practices.

3. The Draft Plan states that the "real costs of waste management shall include social, environmental and economic costs...". Social and biophysical costs and benefits are often underestimated or disregarded in current economic assessments, particularly in waste management (Turner, 1995; Hirshfeld et al., 1992). Considering a limited range of costs and benefits distorts decision making and the inclusion of current 'externalities' will lead to integrated policy making, addressing overall well-being.

4. The inter-relatedness between social, biophysical and economic effects is explained in section 3.1. For example, the introduction of pollutants to a stream can cause social, biophysical and economic effects. In accordance with IEM (section 1.3), not only the integration of social, biophysical and economic factors but also addressing their inter-relationships within a framework is essential for sound environmental management.

Clarifying the inter-relationships between waste management variables enables their effects be identified and for double counting to be minimised.

5. The link between cause and effect provides valuable information for policy making. If the effects (eg., offensive odour) of an action (eg., turning compost) are clear, management practices or policies relating to them can be revised (eg., alter time of turning compost heaps). This framework criteria reflects the structure of the RMA, which is based on the identification of effects and linking them to activities; a main purpose of the Act is "avoiding, remedying, or mitigating any adverse effects of activities on the environment" (section 5(2)(c)).

6. In order to carry out TCA, the costs and benefits of waste management must be broken down into manageable categories. The selection of the categories enable useful comparison within CCC's waste management system (to guide waste management decisions, eg., Identifying particular aspects with very high costs or benefits) and between CCC's and other waste management systems (to allow for coordination with other local waste management systems in the future if desired).

7. Transparency, accountability, understanding and feasibility are necessary to provide a sound foundation for the assessment of total cost, especially because TCA is a long-term and complex process. This is reinforced by the LGA which requires accounting systems which are generally accepted, and non-financial reporting to facilitate public understanding (section 2.2.7). Also, the CCC Draft Waste Management Plan states transparency together with openness and accountability as its third principle.

8. As outlined in section 1.2, a TCA framework has several potential applications, however charging is a particular focus identified by the CCC, reflecting Government waste policy (MfE, 1992) and regional waste policy (CRC, 1995).

4.2 Potential Approaches and Tools for Total Cost Assessment

A variety of approaches and tools currently available for cost assessment were considered in the design of the total cost assessment process. These approaches and tools were derived from multiple sources, including national legislation, international organisations, academia and the commercial sector. The following provides an overview of the approaches and tools, and the contribution they may be able to make to TCA. A more detailed description of each of the approaches and tools is provided in appendix 2. Subsequently, the rationale for and process of developing another approach (ie. the framework described in chapter 4) is given.

Approaches provide an overall structure while the tools prescribe a particular assessment method. In practice, they are not used in isolation from each other. For instance, Social Impact Assessment (SIA) could well draw in information gathered by physical measurement methods and information collected in Environmental Impact Assessment (EIA).

Approaches that include quantitative data, but also rely on qualitative description of effects are commonly used for biophysical and social assessment. An example is Environmental Impact Assessment (EIA) which requires, but does not particularly prescribe, tools for assessing biophysical effects. The Fourth Schedule to the Resource Management Act 1991 describes the procedure for the Assessment of Environmental Effects (AEE) which is an equivalent to EIA, designed to comprehensively assess biophysical and social effects.

However, no standard form of data presentation is established and effects are often measured in a variety of forms, so that comparisons between effects are difficult to make. Presenting information in a descriptive format limits its potential application, as descriptions are difficult to compare directly. The potential benefit of descriptive or mixed format system lies in the comprehensiveness of the information gathered. In this way, AEE and EIA are valuable in suggesting overall comprehensive approaches to total cost assessment.

EIA can also include Social Impact Assessment (SIA). Both approaches provide an overall structure or approach to cost and benefit assessment. There are a considerable range of tools utilised within SIA and EIA. SIA generally draws on a range of information, utilising existing data such as census figures, physical data being collected, and specialised techniques (for example, consultation or survey methods) to build up a picture of effects. In contrast to EIA, SIA is only concerned with the assessment of social effects, not biophysical effects. Both EIA and SIA can include the assessment of socio-economic effects but are not generally concerned with the financial effects for the organisations involved. Like EIA, SIA is valuable for TCA as an overall approach, used in combination with other approaches and tools.

Life Cycle Assessment (LCA) is also a predominantly qualitative approach, and the same issues relating to 'comparability of effects' and the 'variety of potential assessment tools within the approach' apply. As with SIA and EIA, LCA is not prescriptive of the specific assessment tools to be used. LCA is a 'cradle to grave' approach to assessment. Products are assessed for their effects at every stage of their "life cycle"; from the research and development of the product, through obtaining the raw materials for the manufacturing process, transportation and utilisation of the product, to its eventual disposal. This approach is a current focus of the Ministry for the Environment (S. Baird, pers. comm., 1998). Although this approach is very valuable, the scope of this study has is assess the effects of waste and waste management on Christchurch residents. As many products consumed in Christchurch are imported from elsewhere, and many others are exported out of Christchurch, a LCA approach would involve determining the effects of these. This is not inkeeping with the criteria which guide establishing a the TCA framework, and is well beyond the scope of this report.

Emergy is a system for measuring the costs and benefits of the whole economy (including the use of natural resources beyond the price paid), excluding social effects. "Emergy is the available energy of one kind of previously used up directly and indirectly to make a service or product. Its unit is the emjoule" (Odum, 1996, p.7). Apart from the exclusion of social and future effects, emergy could be a useful approach to TCA because of its comprehensive nature while also measuring effects in one single unit. However, its very complex and technical approach does not provide the transparency and understanding required to meet the seventh criteria of a framework for TCA, and may be beyond CCC's resources.

There are a range of accepted techniques for physical measurements such as air and water quality, or noise and odour levels. Because of the number of highly specific tools, these are not covered in appendix 2, but widely accepted tools should be used and carefully adhered to (eg., see CCC (1997) for water and soil sampling protocols and procedures being used for landfill monitoring). Use of physical measurements as single tools without an overall framework would not address the inter-relatedness between factors, or the link between cause and effect. Measuring the costs of waste in in many different units would limit the application of a TCA framework for developing a systeom of charging. The scientific knowledge required to understand the meaning and implications of physical measurements would also diminish transparency to the public.

Given the breadth of physical measurements and the complexity of biophysical and social systems, the use of indicators of environmental quality is considered potentially useful. An indicator is a measurement used to represent a much larger set of characteristics or system of the environment. The chief use of indicators is to compare environmental quality on large scales and/or over long periods of time with low monitoring costs. Appropriate indicators are very hard to discover, but do result in very efficient monitoring of environmental quality. However, without additional procedures, an indicators-based approach does not associate management decisions (causes) and effects. Using indicators also requires additional conversion for comparison and use in setting charges. So, while useful, indicators require the support of other approaches to fulfil the criteria.

Many assessment and management methods have been developed to use monetary values to aid in decision making. NMV tools attempt to include effects not previously accounted for through the market in a monetary unit. They can also utilise information provided through other tools such as physical measurements. NMV tools can only identify the costs and benefits of biophysical and social effects in an indirect way, ie. by finding out people's willingness to pay for benefits or willingness to accept costs, or by finding comparable substitute markets. NMV tools can not always be applied and can have various biases, as described in appendix 2. They do not necessarily identify the inter-relationships between social, biophysical and economic effects.

Cost-benefit analysis uses the monetary gains (benefits) and losses (costs) associated with courses of action to decide whether to proceed, and to choose between options. CBA is designed to help broaden and improve organisations' financial accounting systems. The approach depends heavily on NMV to assess effects not covered by market transactions. If monetary values cannot be identified appropriately (eg., through NMV), CBA cannot be applied. This is likely to be the case in some areas of waste management, as discussed in section 3.5.

CBAs usually consider the costs of a development or project over its entire life, and convert them to present day terms using discounting (discussed in section 3.8). CBA, SIA and EIA can all incorporate Risk Assessment, the tool dealing specifically with future costs and benefits, and it can be applied to any type of effect. Its outcome can be monetised quantification of risk, but need not be and can be purely qualitative. Risk Assessment is useful to TCA but must be used in conjunction with tools which assess present costs and benefits.

Total cost management (TCM) and Full Cost Assessment use monetary gains and losses to make decisions on processes within a business. They present an overall approach to assessment, and are more prescriptive of the methods within it than for instance EIA. Both TCM and FCA focus on improving accounting systems, TCM as a tool to continuously improve operations, and FCA to increase the consideration of environmental costs. Although FCA is expanding to including externalities, this application is still in its early stages. Thus, TCM and FCA do not usually not meet the third criteria of including social, biophysical and economic externalities.

4.2.1 Implications for Total Cost Assessment

The preceeding discussion demonstrates that no single approach or tool can encompass everything required for a total cost assessment framework. Every approach or tool requires other approaches or tools to be feasible and useful. Although none of the existing options that were discovered fulfilled all the criteria, many options contributed to the final output. There is overlap and interconnections between the use of many of them, suggesting a combination is feasible. Thus, the decision was made to develop a new approach, incorporating elements of the existing approaches and tools. Various methods of measurement would be placed in an integrated framework, enabling effects to be identified, assessed, and, potentially, compared directly.

4.3 Establishing a Framework for Total Cost Assessment

Waste management and associated effects on the environment are part of a complex system. Any assessment of total cost will necessarily involve some level of abstraction to reduce the complexity of this system to an understandable set of data. The challenge of designing a process for assessment is to produce a set of data that accurately represents the actual situation while presenting it in a form that allows it to be used in decision-making. The first step of the framework design process was set out in the terms of reference - the development of a categorisation system for costs.

Initially, three main options for a framework were apparent - TCA by effect, by management practice (waste management programmes or activities) and by waste type. Categorisation by effect fits well with the RMA environment and is logical because cost is essentially a way of defining an effect, however there is a need to link the effects back to their causes for this to be useful. Categorisation by waste type is useful because it relates costs of waste to generation behaviour, but it does not make the effects of specific management practices clear. Management activities alone would make the cost of the different management practices clear but not necessarily make the types of effect explicit.

A combination of categorisation methods is necessary. Categorising by both activity and type seemed problematic to the research group. This is because they entail two influencing variables, it would be difficult to see which is the cause. The effects of different types of waste within management activities are also likely to be inseparable in many cases. Categorising by effect and type would face the same challenges of inseparability of effects, and does not lead to accountability of management practices themselves. The option which seemed to best meet the criteria was therefore categorisation by effects and by activity. This would allow accountability of specific management practices, clearly identifying their effects. Because monitoring of the waste stream's composition already occurs in Christchurch on a

biannual basis, there seemed to be potential for waste type analysis to be kept as a separate but complementary system.

The total cost assessment process provided therefore involves the definition of activities grouped into waste management programmes within the Christchurch waste management process, and determining the effects that each activity has on each of the different characteristics of the environment. An affecting agent (activity)/affected characteristic (environment) matrix format is used throughout the process for recording the identification and measurement of effects. The matrix is integral to the comprehensive identification of effects, as the presence of the full list of biophysical, social and economic characteristics of the environment forces consideration of all the effects a waste management programme might have, while providing a basis both for systematically working through, and for summarising, the different effects.

Just as the wide range of types of cost encompassed by 'total cost' requires a composite framework drawing on a range of approaches, the diversity and complexity means that there are several levels of assessment required for some costs to be evaluated. The total cost assessment framework developed therefore focuses on firstly the identification of effects, then their measurement, then their calculation, and finally their summary and reporting. The framework as a whole is illustrated in figure 6.

Elements in the design of the framework ensure that the results of an assessment will meet the criteria for total cost assessment (box 5). The framework is comprehensive in the identification of effects, ensuring that all effects on biophysical, social and economic characteristics of the environment are identified. This is vital for the inclusion of externalities in the assessment and is achieved through examining each waste management programme for any effects it may have on a comprehensive list of characteristics of the environment. Using activity-based assessment also improves the performance of the framework relative to flexibility, applicability and accountability criteria. The flexibility of the framework is high, as the assessment process directly incorporates the changes in management. Costs and benefits can be directly attributed to waste management decisions, so the total cost assessment data creates incentives for changing behaviour on a large scale, such as how to manage the landfill, and whether to use landfill disposal. The link between the activities and their costs and benefits also allows effects to be traced back to the decision within the waste management process that caused them, creating accountability.

Once identified, effects are examined individually at each stage of the framework. This is important for several reasons. An effect may not be appropriate, feasible and efficient to measure, and that effect will be identified, but not measured. Different effects may require different measurement tools, and may need to be considered separately. Additionally, the sensitivity of the environment may vary from place to place, and similar activities in different locations may have different magnitudes of effects. Effects must also be kept separate where possible to ensure that the links between activity and effect are maintained.

After measurement, the magnitudes of effects will be in many different formats. To enable direct comparisons between activities, some effects can be converted into common units. As discussed in section 3.5, effects cannot be converted into common units unless it is appropriate, feasible and efficient. The framework allows decisions to be made for each effect, based on those three criteria, on whether to convert a measurement into a common

unit. Multiple types of units can be used in the framework, so as not to exclude large amounts of information which do not convert to a single unit.

4.4 The Steps of the Framework for Total Cost Assessment

The section above describes the framework for total cost assessment as a whole and has given an explanation of why we have chosen this form of framework. What follows is a more detailed description and discussion of the different steps within the framework. There are nine main steps:

1) identifying waste management programmes;
2) identifying activities and sub-activities of each programme;
3) identifying the characteristics of the environment;
4) identifying potential effects of specific activities;
5) measuring the magnitude of effects;
6) calculating effects in units of cost and benefit;
7) compiling the total cost table;
8) reporting the total cost of waste management; and
9) evaluation of the framework.

In the following sections we discuss the steps outlined above. Figure 6 gives an overview of the framework and the steps and decisions that need to be taken in the framework.

In order to demonstrate how to implement the total cost assessment framework outlined in this report, we have chosen the landfill programme (table 1) as an example. This choice follows the predominant attention landfill programmes have received in literature, especially the attention MfE has given to landfills, including a guide for full-cost accounting (MfE, 1997). The single goal of the Draft Plan also relates directly to landfilling, indicating the importance of the programme in Christchurch (appendix 5).

4.4.1 Identifying Waste Management Programmes

To provide for a systematic and understandable approach to assessment and reporting of effects and (in keeping with the criteria specified box 5), it is necessary that effects are separated into a series of categories. This means that we need a hierarchical system of categorisation. Costs associated with waste management are many, inter-related and frequently complex. In the absence of a systematic approach it would be unlikely that accounting of total costs would be efficient, understandable or would provide the required/desired information.

Our primary classification of the Christchurch waste management process is by programmes. A description of the waste management process and the programmes is given in section 4.4 and is represented in figure 5.

We have chosen a programme- and activity-based categorisation for the following main reasons:

Assessing total cost in terms of programmes and their associated activities provides for a clear understanding of ‘cost dynamics’. Costs and benefits are accounted for in terms of the

activities which give rise to them. It therefore enables clear identification of causes (activities) and effects. 'Activity-based costing' is one of the three main principles of Total Cost Management (Ostrenga et al., 1992, p.30), and is also recognised as a way of providing some degree of Full Cost Accounting information (Willis, 1997). The links between causes and effects also enables CCC to target specific areas (eg., activities with high costs to minimise effects and waste), since effects cannot be managed themselves, only the activities which cause the effects can be managed. A clear definition of the boundaries of programmes is crucial for a transparent, accountable and understandable assessment of total costs of waste management (criteria 7 in box 5). This is discussed below.

Defining Programme Boundaries

To ensure that effects are not forgotten or identified twice within the framework, it is necessary to clearly identify the boundaries for each waste management programme. This section proposes boundaries that can be applied to all waste management programmes, and expands on the information given in section 2.4.4 and figure 5.

There are a number of valid approaches to defining programme boundaries such as the scale, and temporal, operational and policy considerations.

Scale

The 'scale' of classification is arbitrary. For example, individual past disposal sites might be classified as separate 'programmes' as opposed to broadly grouping all of these in the single programme, 'Past disposal sites'. For the purpose of developing a TCA framework for this study we have used a broad system of classification. The rationale for this follows that broad definitions are more conducive to understanding by the general public and are therefore more accountable and transparent. This also allows the costs and benefits associated with a given type of waste management programme to be evaluated and compared (ie. toward best and efficient management practices).

Temporal

Another approach to defining programme boundaries relates to when the management practice occurs in time (ie. temporal separation). For example, landfill could be separately defined as 'past', 'present' and 'future' landfill programmes or be grouped together in some way. For the purpose of developing a TCA framework for this study, we have separated 'past' landfill sites from 'present-future' landfill sites. This is an arbitrary distinction, but is justified on the basis that the management of past landfill sites (including contaminated sites) and the present (Burwood) and future landfill sites is currently separate.

Grouping present and future landfills as a single programme is advised to ensure that the future effects of using landfill space today can be converted to current costs and benefits. In addition, the costs associated with a future landfill (eg., site availability and set-up costs) may affect the dynamics of cost associated with current management of the Burwood landfill. For example, if future landfill costs are extremely high, investing in waste separation and education programmes (to reduce the use of current landfill space) may be a more appropriate use of resources. For these reasons present and future landfill sites are included in a single programme (section 3.8).

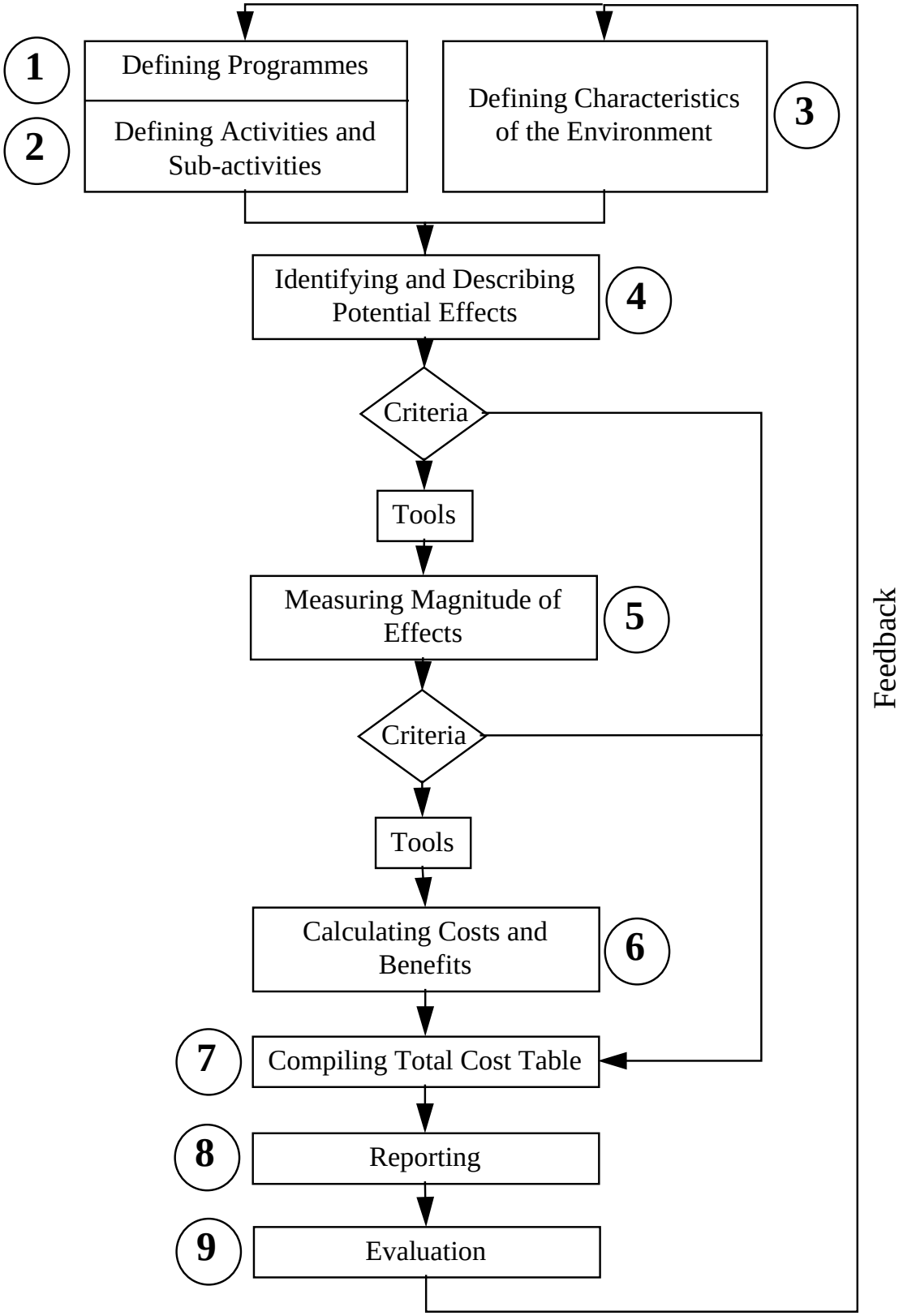

Figure 6: Flowchart of a framework for total cost assessment. Numbers refer to steps in section 4.4.

Operational

There are a number of activities which do not clearly fit into a specific programme. For example, transportation from a refuse station to the landfill might be included within either of these programmes. This study defines programmes within the TCA framework as including all costs associated with transport to the site where the programme is located (except where it is specifically defined as a separate programme, eg., municipal collection). Including transport in this way reflects the effects that changes in programmes can have on associated transportation. For example, there is a direct relationship between a reduction in the amount of waste disposed at the landfill and the costs of transportation.

There are a number of activities that are universal to all waste management programmes (eg., national policy and planning, general waste management education) or for which some associated costs are universal and some are specific to a programme (eg., on-site landfill administration, recycling education and research). Examples of these activities include administration, research, national policy development and planning, local policy development and planning, education, promotion, and monitoring and enforcement. Where such an activity can be specifically related to an individual programme, the associated cost is directly attributed to that programme. Where activities are universal, the associated costs must be assessed for the activity as a whole, and be subsequently allocated to specific programmes (according to an estimated proportion of resources used).

Policy Consideration and Programme Classification and Issues

The international waste hierarchy (box 3) is a tool used by waste managers to prioritise steps in the waste management process and is the focus of NZ Government policy (section 2.3.2). In order to facilitate Christchurch City Council's ability to use the international waste hierarchy as a policy tool, programmes within the Christchurch waste management process (figure 5) have be aligned within categories of the international waste hierarchy.

An issue associated with programme classification is that some of the costs or benefits that relate to a given programme may not be included within the boundaries of that programme. For example, extension of the Recycle and Reuse Programme will divert wastes from other programmes. This will cause in a reduction in the volume of waste disposed at landfill, resulting in a reduction in total landfill costs, and may increase marginal financial costs ($/tonne). Where this is the case, the link between 'causes and effects' (and associated costs and benefits) for a specific waste management programme (criteria 5 in box 5) can only be inferred rather than directly calculated.

4.4.2 Identifying Activities and Sub-Activities of Each Programme

For each programme, activities and sub-activities have to be defined. These are recorded within the framework in a hierarchical structure which allows all of the activities associated with a programme to be logically accessed. We propose a list of activities and sub-activities for the example of the programme 'landfill' (table 1). Information for these divisions have been derived from the *Landfill Full Costing Guideline* (MfE, 1996a), the *Landfill Management Plan* for the Burwood landfill (CCC, 1993), 1998/1999 budget notes and calculations provided by CCC, and from proposed accounting recommendations developed by the Canadian Institute of Chartered Accountants (CICA, 1997).

The landfill programme is divided into the main activities 'management and administration', 'planning', 'construction', 'operation', 'closure', and 'after-care'. Each of those activities is then divided into sub-activities. For example, the activity 'construction' (3) is subsequently divided into 14 sub-activities, including items such as roads (3.2), earthworks (3.6) and security facilities (3.15). The number of sub-activities and number of levels depend on the degree of detail required. For example, we have included 'employment' as a sub-activity in each of the activities rather then pooling it in the 'management and administration' activity to provide for more accurate information.

We have included the sub-activity 'existing landfill' in the two activities 'operation' and 'after-care'. This is because effects of disposed waste cannot be directly allocated to a specific activity, however they do have effects on the environment long after they have been disposed of, for example, the affect of leachate on waterways. The sub-activity 'existing landfill' provides for the appropriate allocation of those effects.

An example of a division of the activities for one programme is provided in table 1. This might have to be further adapted to the specific needs of the Christchurch Waste Management Unit. In addition, CCC will have to identify the activities and sub-activities for all of the other programmes in the waste management process.

4.4.3 Identifying the Characteristics of the Environment

As discussed in section 1.2, the environment is a complex, broad, inter-related and potentially all-encompassing phenomena. Bührs & Bartlett (1993, p.9) note that human activities which affect one aspect of the environment (eg., pollution of air through waste incineration) may have repercussions in many other aspects (such as forests, waterways, soil fertility and human health and safety). Any breakdown of the environment into categories is therefore arbitrary as overlap between categories is inevitable. In selecting forms of categorisation the aim has been to minimise overlap and double counting of costs in addition to meeting the criteria (box 5). For each category identified, boundaries are distinguished in order to clarify where a given effect should be recorded, as described below.

Characteristics of the environment are broadly classified into 'biophysical', 'social' and 'economic' categories (appendix 6). Definitions for each of these terms are given in section 2.5 and the boundaries of each set of characteristics are clarified below.

1. **Biophysical** includes all effects on living things (excluding effects on people), the physical environment (including physical processes), and any interactions between them (this is a liberal definition of 'biophysical' which includes ecological processes and the intrinsic value of ecosystems).
2. **Social** includes all effects on society (human populations) and human structures that are not economic effects (see below), independent of whether they are secondary or multiple effects of biophysical effects.
3. **Economic** includes all effects which are expressed in market systems. Thus, economic effects can be directly translated in financial costs, expressed as a dollar value. Effects which are economic include effects on Christchurch City Council in the delivery of waste management, and socio-economic effects.

These three categories are consistent with divisions used in the Environment 2010 Strategy (MfE, 1995), State of New Zealand's Environment Report (MfE, 1997b) and the Environmental Performance Indicators: Proposals for air, fresh water and land (MfE, 1997c).

The landfill example (table 1) illustrates how each of these broad classifications may be broken down further into sub-categories.

Biophysical

The biophysical category is sub-classified under four headings, (1) land, (2) water, (3) air and (4) atmosphere, as illustrated in table 1. Broad environmental 'media' were selected as a method of sub-classification because these are commonly understood and compatible with existing branches of science. For example, geology and edaphic studies relate to the scientific study of land or soil processes, marine science and hydrology relate to the study of the aquatic environment, and biology and ecology are concerned, in part, with the study of biodiversity. The four sub-classifications correspond to the classifications used in part 2 of *The State of New Zealand's Environment Report* (MfE, 1997b) which describe the state of New Zealand's environment. The proposed Environmental Performance Indicators are closely related to the 11 priority issues for the biophysical environment in the *Environment 2010 Strategy* (MfE, 1995, see appendix 7). The TCA framework classification system has been established to ensure that the proposed indicators will clearly correspond to framework sub-categories. A reason for this approach, in keeping with the environmental performance indicators programme, is that "standard classification systems…are essential if we want to make meaningful comparisons of indicators within and between different regions" (MfE, 1997c, p.18). This approach will also allow CCC to easily incorporate indicators into the total cost assessment process, if desired.

The category, 'Water', is sub-classified under the headings: (i) surface water, (ii) ground-water, (iii) coastal and estuarine and (iv) marine. These divisions recognise the unique nature of the different aquatic media, and correspond to the classifications used in the *State of New Zealand's Environment Report* (MfE, 1997b).

Each of the water sub-classifications and the 'land' and 'air' categories are further sub-classified under the headings (i) living, (ii) non-living and (iii) physical and ecological processes. These are defined as follows:

(i) living (biota) includes all non-human living organisms (plants, animals and other organisms);
(ii) non-living (abiota) includes all components of the biophysical environment which are not living;
(iii) physical and ecological processes include all of the cycles and inter-relationships between inorganic (not containing carbon) components of the environment and all of the interactions that determine the distribution, abundance and characteristics of organisms (Chapman & Reiss, 1992).

A process will include either just non-living components, or both non-living and biotic components of the environment. For example, the physical process of erosion only includes non-living components of the environment (ie. water and soil) and nutrient cycles include both (ie. water, nutrients and organisms). This gives rise to potential overlap and double counting of costs. To avoid this we make the following distinction: for a given process the cost associated with effects on the process is recorded under sub-category (iii) (eg., for nutrient cycles the cost reflects the importance of the process on the integrity, form, functioning and resilience of the system), the cost associated with effects on biota and the costs associated with effects on the non-living components of the environment (eg., water and nutrients). In this way the intrinsic values of ecosystems are included within these sub-

categories, to avoid double counting. Intrinsic values must be assessed to meet the implementation needs of the RMA and section 1 states that intrinsic values:

> *in relation to ecosystems, means those aspects of ecosystems and their constituent parts which have value in their own right, including-*
> *a) Their biological and genetic diversity*
> *b) The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience*

Social

The 'social' category is sub-classified into the following: (1) health and safety, (2) spiritual, (3) cultural, (4) historical, (5) scientific, (6) aesthetic, (7) land use, (8) recreation and (9) other characteristics. This system of classification is partly derived from those social effects described in the Fourth Schedule (Assessment of Effects on the Environment) to the RMA. The list of social effects in (s2)(d) of the Fourth Schedule is comprehensive, but lacks detail. For this reason, three categories have been added (health and safety, land use and recreation). Effects on tangata whenua have not been specifically included at this stage. Before this is done, consultation needs to be carried out regarding appropriate approaches to assessing and reporting effects on tangata whenua.

Economic

Economic characteristics of the environment are classified into three main divisions, the 'socio-economic', 'directs costs' and 'indirect costs' categories. For further discussion of this division see section 2.5 (terminology). Financial effects are included in an accounting system, and sub-categories are developed by the accounting system used.

4.4.4 Identifying Potential Effects of Specific Activities

The matrix as part of the total cost framework shown in figure 6 and in the landfill example (table 1) has been developed so that potential effects *of* activities/sub-activities *on* characteristics of the environment can be identified. This has to be done separately for each activity/sub-activity. The first step is to identify whether there is a potential effect or not (presence/absence). If a potential effect is identified it has to be described in the appropriate box in the matrix.

For example, employment has a financial effect in that CCC has to pay salaries and wages. Since these effects have already been translated into financial costs and are accounted for in the current accounting system, they can directly enter the table as a dollar value. Leachate of the existing landfill as another example might have a potential effect on ground water. This effect, if identified, is not accounted for in the current accounting system, and has to be described in the appropriate box[3].

Some activities have more than one effect. An example is fuel used for transport and running of machinery. The financial costs of the purchase of fuel are accounted for and can enter the table as described above. The burning of fuel, however, also has effects on the air and

[3] There are many cases where identification and measurement of effects cannot be separated. To know whether waste in an existing landfill has effects on the ground water, the ground water/leachate will have to be monitored in order to identify the effect. We have separated the two steps to allow for a comprehensive and logic process to ensure that all potential effects of waste management are identified.

atmosphere. This effect can be identified and described in the appropriate column. There may also be both primary and secondary social and ecological effects of a given activity, and both should be included. For example, the exposure of waste at the tip face in a landfill may attract vermin and create noise (ie. primary effects). The noise and vermin may in turn cause health effects on people working or living nearby (ie. secondary effects). These secondary effects must be recorded.

To address the problem of double counting of costs and benefits, effects have to be divided into single and separable effects, which can then be attributed to specific categories. For example, if the presence of vermin on the landfill affects the health of staff, it will be noted under the category 'health and safety'. An effect under the category 'Biota' in 'Land' will only be noted if there is a separate effect (and so additional cost or benefit) of vermin, such as a reduction in local biodiversity caused by predatory vermin.

4.4.5 Measuring the Magnitude of Effects

For those effects which are not measured through the market and are not already available in dollar terms, further qualification and/or quantification is needed. For example, the quantity and nature of leachate into the ground water will have to be measured.

A variety of assessment approaches were investigated in developing this framework for assessing total cost, many of which are overall approaches for evaluating impacts, effects or costs and not particularly prescriptive of actual methods or tools. An overview of these approaches and tools is provided in appendix 2.

The all-encompassing nature of total cost, as used in this study, means that there are a large range of types of effect to be measured, requiring a variety of tools. Some will require physical scientific measurement, for example air and water quality measurements or measurement of noise levels. Detailed protocols and procedures must ensure that staff carry out field work according to accepted scientific standards. An example is the sampling protocols and procedures of Christchurch landfills (CCC, 1997). Other effects can be measured using social assessment methods (see for example, Taylor et al., 1995) combining a range of information sources (eg., census data, physical impact data and consultative methods). For some effects, it is more appropriate to quantify them using indicators due to their complexity or scale. All of these measurements should be made using robust and reliable methods and tools developed by 'experts' in these fields. The focus, however, should not be only on the quantifiable measurements. It may become apparent that some qualitative effects are inappropriate to describe quantitatively (for instance, effects on spiritual values). It is also likely to be inefficient to measure particularly minor effects, or effects which are particularly expensive to measure. Some effects are still impossible to accurately measure, such as the future effects of species loss. Three criteria (box 6) therefore need to be applied in deciding whether and how to measure each effect.

Box 6: Criteria for tools.

1. FEASIBILITY: Are the tools available, reliable and accurate? Is the equipment, time and expertise required realistic?
2. APPROPRIATENESS: Would application of the tools available provide a measure or qualification that reflects the nature of the effect and takes into account social sensitivity?
3. EFFICIENCY: Would the application of the available tools make any significant contribution to our understanding of the total costs, and is the significance worth the cost required to measure this effect?

To measure the magnitude of effects decisions will have to be made on which tool to use. Ideally, effects could be clustered into a few groups with appropriate tools for each of the groups. Section 4.2 discussed the lack of specific tools prescribed within most existing approaches to cost assessment, and highlighted those existing which may be useful (appendix 2). The allocation of tools to types of effect will require further research into the tools available, and possibly the development or adoption of specific tools by appropriate experts.

Using Present Monitoring Information

The approach developed in this report introduces a comprehensive and integrative framework for environmental effects assessment. In most cases, tools are neither specified nor excluded. Instead, the framework provides guidelines for deciding which measurement tools to use and methods of integrating the data obtained. Most existing relevant monitoring procedures can be included in the total cost assessment procedure, unless there are tools available that better meet the three criteria of appropriateness, efficiency and feasibility (box 6). Continued use of present monitoring procedures would maintain the continuity of data, and conserve the resources required to design and implement new monitoring protocols.

The inclusion of the current waste stream analysis commissioned by Christchurch City Council is, however, a significant issue that will require careful consideration. The existing waste stream studies completed every two years for Christchurch City Council provide valuable information for use in waste management decision making. The studies allow the identification of issues relating to waste composition, quantity, and origin. Changes in the behaviour of waste generators between studies may be identified, demonstrating the effectiveness of management techniques, or the need for new techniques. However, waste type was not chosen as a categorisation method for the total cost assessment framework presented in this report, and this renders the data more difficult to include this type of information within the total cost assessment (TCA) framework. Two options have been considered for the utilising waste composition data within the TCA framework.

Some wastes are separated by type for recycling, composting, and treatment, and become different activities in their respective programme, such as soft-drink bottle recycling. The effects of these waste types are therefore easily separable because they are determined by the activity to which they relate. The difficulties arise with programmes which deals with mixed waste, such as landfilling and incineration. An extension of the activities list, artificially creating activities related to the processing of each waste type, would enable the waste composition data to be directly involved in the total cost assessment framework. With reference to the ‘landfill programme’ example, this would involve extending the ‘existing landfill’ activity, presently representing the action of having mixed waste present in the

landfill, to contain categories such as plastic, building waste and paper. Effects relating to the presence of a certain waste type in the landfill would then be attributed to the appropriate activity. Determining the effects of a certain waste type would initially rely on research completed elsewhere and may be most efficiently carried out on a national basis. This could include data derived from life-cycle analysis. Life cycle analysis is a complex process requiring high levels of information. The MfE is already involved in life-cycle assessment, and it would not be necessary to commit local resources to this research.

The difficulties with this approach derive from the uncertainty relating to the interactions within a landfill. The complex chemical, biological and physical processes within a landfill make tracking effects to an individual waste type difficult. External conditions such as rainfall, temperature and water table fluctuations also affect the processes within the landfill, making it difficult to directly link causes (presence of waste type) and effects.

Mixed wastes are currently included in the framework by assuming that each unit of waste passing through the same activity has the same composition. The composition is considered to be an average determined by waste composition data. The analysis of waste composition can be used in parallel to the total cost assessment procedure. Management decisions based on the composition of the waste stream could still be made from the waste composition data, as is done at present. Changes in the composition of the waste stream can be compared against changes in the effects of different activities. For example, trends in waste composition and leechate to groundwater in a landfill can be compared and statistically analysed (for example, correlation coefficient) to establish whether there is any significant relationship between them.

The second option for increasing the inclusion of the waste composition data involves retaining the waste stream analysis in parallel to the total cost assessment, but increasing the detail relating to the input. As with the first option, this would involve discovering the effects of each waste type when it passes through an activity. This information would then be used as a basis for adjusting to the "average" cost of a unit of waste, when decisions relating to waste composition are required.

The analysis of these options is not complete, but indicates that waste composition data can be included through the application of information gained through life-cycle analysis. It would be preferred that the effects of each unit of waste delivered to a refuse station could be assessed accurately based on the quantity and composition of the load. However, the direct lines of cause and effect are difficult to determine when waste is mixed and quantities are high, such as in a landfill. It is felt that this issue is one which requires more specialised research, and particular attention. The inclusion of existing monitoring data into the total cost assessment process is therefore considered a priority for future analysis.

4.4.6 Calculating Costs and Benefits

In section 3.5 we have discussed the potential of calculating costs in common units, referring both to the issues of feasibility, efficiency and appropriateness. This section reflects the conclusions from that discussion in that we consider it inappropriate, inefficient and infeasible to calculate *all* effects in the same common unit.

Traditionally, many research projects have relied on one method of data collection and analysis. However, there is realisation "that every researchers, perspectives, methods are

value laden, biased, limited as well as illuminated by their frameworks, particular focus and blind spots" (Banister et al., 1994, p.145). Triangulation, that is allowing and making use of a combination of methods, investigators, and perspectives, thus facilitating richer and potentially more valid interpretations, is increasingly used as a methodology for many research projects. It is a small step to suggest that the same is true for the use of different units in measuring costs and benefits. Using an appropriate combination of approaches and tools increases the confidence that it is not some peculiarity of the effects itself or tools used that has produced the findings (ibid., p.146). As Marilyn Waring mentioned, referring to the biased nature of calculating GDP and the need for including other aspects of 'production' not necessarily measured in dollar terms, human beings are intelligent enough to compare different units (Waring, 1996, 1998). Willis (1997) states, when discussing the wider use of Full Cost Accounting, that "where practical, external costs (and benefits) are given monetary amounts, otherwise, quantified and /or qualitative information is given" (p. 49). We agree and propose that CCC takes a similar approach.

Several options for units of costs exist (eg., dollars, indices, emergy units, or a combination of these). Financial costs will already be available in dollar terms. As discussed in the previous section, effects not accounted for in the current market and not available in dollar terms will have to be calculated into dollar terms. The criteria provided above (box 6) can guide the user on *whether* to calculate costs in dollar units. Appendix 2 helps in choosing the appropriate tools for the calculation, ie. how to calculate the effects.

4.4.7 Compiling the Total Cost Table

A total cost table summarises the results of each of the steps above. All effects, some with a description of the effect, some quantified and/or with qualitative information, and some in dollar terms, will be compiled in a comprehensive database. This table will be complex, but is needed to ensure total cost assessment and that no effects and their costs and benefits are left out.

For reporting requirements, however, there needs to be a separate structure developed to extract the most important issues and results out of the total cost table. This reporting structure is discussed in the next section.

4.4.8 Reporting Total Cost of Waste Management

At this stage in the total cost assessment process, a large amount of data in different forms will have been gathered and compiled into the comprehensive total cost summary table. Monetary values, indices, descriptions and other qualitative and quantitative measures may be present, depending upon decisions made at earlier stages.

The uptake of information by human beings is limited (Griffin, 1994). Presenting the gathered information in a brief, understandable form for decision makers and the public will be a challenge. However, it is a necessary step for fulfilling accountability and transparency criteria (see box 5). Reporting total cost of waste management will have to be flexible and adapted according to the audience (wider public, decision-makers, academics). That is, different levels of detail of information will have to be provided.

An example of how reporting could be done using a summary report table is provided in table 2. This table would allow data to be comprehended and understood more readily.

The form of a summary table would be similar to the final total cost matrix in that programmes and activities would provide one method of categorisation while the characteristics of the environment would provide the other. However, much broader categories would be used in both methods. For the highest level of summary, a list of programmes would be presented, and the biophysical cost, social cost and economic cost of each would be presented. An example of this format is presented in table 2 .

Table 2: Summary report table presenting the total cost of waste management.

Characteristics of Environment / Waste Management Programmes	Biophysical Characteristics	Social Characteristics	Economic Characteristics
Landfill			
Compost Facility			
Refuse Stations			
Municipal Collection			
Recycling Facilities			
Waste Export			
…			

The information contained in each of the cells would present an approximation of the total cost of the programme. In the "economic" column, a monetary value could be stated. However, in the other columns, non-monetary values will contribute to the total cost. Stating the cost available in monetary values within each cell may be an option, and this would provide for easy comparison between programmes. This method would also allow comparison between charges and total cost, and may be useful in the setting of charges. Unfortunately, this method would not present important non-monetary costs, that in some cases may outweigh the monetary costs of a programme. For example, illegal dumping has almost no economic cost and potentially very high biophysical and social costs. Decisions made using that type of summary report table will not take the non-monetary costs into account, reducing the usefulness of the total cost assessment for measuring environmental performance.

Another possibility is to present a combination of monetary cost together with the non monetary costs, eg., key qualitative descriptions and quantitative measurements (sums) in a summary report table. However, this reduces the understandability and conciseness of the table. To overcome both the limitations of losing non-monetary costs or being too complicated, a single indicator for each cell, or a compound index could be used. The Ministry for the Environment's Environmental Performance Indicators Programme (MfE, 1997c) would be a source of potential indicators, and this would reduce the need for primary research on the part of CCC. However, this would not provide most readers with the information they require, ie. a single value of total cost of the waste management programme. The value in the cell should be accompanied with a target value of high environmental quality, preferably the value of the indicator associated with the absence of the waste management programme (baseline). Table cells filled with actual and targeted values of indicators would then allow comparison of actual and target costs.

To avoid the need for scientific knowledge on the part of the reader, a summary table filled with monetary, indicator and index values would need to be converted into a more readily

understood system. The requirement for this system would be satisfied by a combined symbolic system, using colours to represent the magnitude of the cost of a programme, and a set of symbols showing reduction or increase in costs. The colour coding system, known as a "traffic lights" approach to environmental quality reporting, has been suggested for use in presenting sustainability assessments (John Peet pers. comm., 1998). The reduction and increase symbols allow a single table to display the effects of changes in management over time. An example of what this table might look like is presented in figure 7.

Characteristics of Environment / Waste Management Programmes	Biophysical Characteristics	Social Characteristics	Economic Characteristics
Landfill	⇓	⇑	⇑
Compost Facility	⇑	⇑	⇑
Municipal Collection	⇑	⇑	⇓
…			

Key:

⇑	High Cost, increasing	⇓	High Cost, decreasing
⇑	Moderate Cost, increasing	⇓	Moderate Cost, decreasing
⇑	Low Cost, increasing	⇓	Low Cost, decreasing

Figure 7: Combined Symbolic Summary Report Table.
A potential reporting system using level of cost and change since last report at a glance. A similar reporting system including benefits would require a five-colour system.

As illustrated in figure 7, presentation of the total cost of waste management programmes, and comparison between programmes, is easy using this system. This approach, while not aiding the assessment of setting waste charges, is very useful in environmental performance reporting. The method can be used whenever a quick assessment or comparison needs to be made, at any level of summary. For example, the same table could be used to report environmental performance within a programme, or even between related activities. Another advantage of this table is that particular activities imposing high costs on particular characteristics of the environment can be easily identified. These environmental "danger points" can then be directly addressed by management decisions.

For the application of the total cost assessment process to generator-pays charging, it is anticipated that more conventional reporting techniques would be used. Only monetary values can be directly used to set charges, so established accounting procedures can be used to monetize these values. Using only money values, "appraisal of environmental effects will inevitably omit a great deal from their attempt to value costs and benefits", and therefore affect decision making (Winpenny, 1991, p.72). There is considerable debate over the appropriateness of money-only effects evaluations, even within economics (Portney, 1998; Hausman, 1993).

Within New Zealand, MfE has stated that because it is "virtually impossible to quantify [environmental and community impacts] in terms compatible with economic analysis", they can be treated as intangibles (Young-Couper and McDermott, 1993, p.48). The PCE recommend that "intangible" costs, meaning effects that cannot be easily converted into monetary values, be "explicitly acknowledged" rather than attempting to artificially place monetary values on them (PCE, 1993, p.20). This approach is also applicable to annual reporting. For this reason a protocol on the use of monetary values would be useful, for instance, stating that totals of monetary values should not be presented without simultaneous reporting of important non-monetary costs. Attempts may also be made to offset some of these costs through charging to provide fairly based incentives and disincentives, and to ensure that transparency and accountability criteria are met. All costs potentially contributing to charging must be reported when charging decisions are considered. Finally, the method of deriving charges form the TCA must be communicated to the affected parties.

Summary reporting is the culmination of the total cost assessment process. While the form and the right kind of reporting will rely on the type of information required, enough must be provided for informed decisions to be made, and it must be in a form that is understandable for the intended audience. The options presented here, for charge-related information and for general audiences, allow reporting to meet the criteria used in the creation of the total cost assessment framework (box 5).

4.4.9 Performance Evaluation

The framework described above shows the complexity of TCA. Identification of the costs and benefits of waste management is complex because of the many programmes and activities within waste management, the many effects and their inter-relatedness, the potential use of various units for measurements, and the variety of tools to apply (many of which are resource intensive).

Comprehensive assessment of total cost of waste management will not be achieved immediately and will require a long term and strategic approach. Its full implementation requires time and will have to be done step by step. The total cost framework will therefore have to be regularly evaluated and the performance of TCA continuously improved.

Continuous improvement provides several advantages. Firstly, easier tasks can be completed relatively quickly. For example, the costs of land occupied by waste management facilities, such as refuse stations and landfill sites, can be included in the TCA. Secondly, realistic time frames remove the fear about an over-demanding task, and allow necessary skills for TCA to be developed. For example, the use of non-market valuation tools to assess Christchurch's waste management will only be accurate if its design is sound. Thirdly, the system of TCA can be tested in small parts, for example, for single programmes as a pilot study. The performance of the framework can then be evaluated and further improved. In this way, major financial and social setbacks can be avoided. Lastly, continuous improvement retains flexibility and allows for constant adjustment of how to implement TCA according to new policy developments and requirements. This advantage complements the second framework criteria , which states that the framework must be flexible enough to adjust to new policies (section 4.1).

Continuous improvement acknowledges that not everything can and should be done at once. Only a few effects can be selected for assessment at any one time. However, it is important that the quality of existing assessments is maintained, ie. backsliding is avoided. This means that total cost needs to be continuously checked to evaluate whether cost and benefits already assessed are still accurate (Ostrenga et al., 1992).

Total cost assessment can be used as a tool to evaluate and assess the performance of waste management as a whole, measured against the goals and objectives of the Draft Plan. In particular, TCA allows statements to be made on minimising effects of waste management.

4.5 Framework Evaluation

The framework provides a basis for assessing and reporting total cost. As mentioned in section 4.4.5, the framework does not provide a complete set of methods and tools to undertake an assessment of the total cost of waste. Further development of the framework is required. Waste management programmes for Christchurch City have been identified (figure 5), and further hierarchal subdivisions (into activities and sub-activities) will still have to be carried out. This includes all waste management activities which are the responsibility of CCC (including activities of private contractors). Additionally, CCC needs to identify specific tools to measure the effects for a given waste management activity. In order to select tools, these need to be evaluated against a set of criteria. The three criteria identified in this study (feasibility, appropriateness and efficiency) need to be further developed into a general schedule. The schedule can be used to decide how to allocate appropriate tools to measure specific effects.

4.5.1 Evaluation in Relation to Specified Criteria

The following evaluates the potential effectiveness of the developed TCA framework against each of the criteria established in section 4.1.

1. The framework developed for total cost assessment can contribute to Principle 4 of the Draft Plan as well as other principles and aspects of the Draft Plan. Other local, regional and national policy requirements in relation to Christchurch's waste management, particularly the Resource Management Act 1991, and the Local Government Act 1974 and subsequent Amendments are also regarded.
2. The framework is flexible and can adjust to changing waste management practices because the break down of programmes and activities can be changed. Changing social and ecological circumstances are regarded due to the comprehensive identification of the characteristics of the environment. Changes in the application of total cost assessment will be possible in the future. A variety of approaches and tools are part of the framework so that their improvement can be included in the framework. Continuous improvement is considered as important, which further enhances the flexibility. However, other options for a comprehensive framework which are structured differently could emerge. Flexibility to incorporate a completely new option would be problematic.
3. Based on the characteristics of the environment provided, the framework is designed to include all social, biophysical and economic costs and benefits in TCA, thus including 'externalities'.
4. The inter-relationship between various effects can be identified by systematically identifying whether and which effect for each activity and each characteristic of the

environment exists. This will also enable the identification of primary and secondary effects. For example, the introduction of pollutants to a stream as well as initiatives to mitigate the introduction can be identified as activities.

5. Partly, effects can only be traced back to their causes on a broad level. As discussed in section 4.4.9, the effects on the environment cannot directly be allocated to each waste type if mixed waste is disposed. However, in mixed waste disposal, cause and effect can be linked on a broad scale, ie. if big changes in the waste composition occur over a longer time period, a change in effects will be measurable. Where different types of waste are managed separately, for example, in recycling and composting, the causes and their effects can be linked.
6. The categorisation according to programmes and activities directly reflects the practices in waste management.
7. The systematic approach to TCA provides transparency, accountability and understanding. For example, the costs and benefits of one programme can be regarded separately to other costs and benefits.
8. As discussed in sections 3.5 and 4.5.5, a combination of units for measuring costs and benefits is necessary because it is not always feasible, appropriate and effective to measure effects in a common unit. This impedes the various applications described in section 1.2. However, the TCA framework pursues measuring and calculating total cost as far as possible. Thus, it still provides a valid basis for the applications, including developing a charging structure.

The framework for total cost assessment addresses the established criteria to a very high degree. Consequently, the framework can be useful for a better understanding, and management of total (particularly social and biophysical) cost. However, the framework must be developed further and continously improved.

4.5.2 Limitations of the Framework

The framework designed in this study has some features that reduce its performance in some respects. These include taking a reductionist approach, difficulties dealing with special waste types, and restrictions relating to the scope of this study.

The approach taken to total cost assessment in this study is reductionist, meaning that the form of analysis involves reducing a system into components, studying those components, then reassembling the data to study the system as a whole. Reductionist analysis, while the standard for science for the last 300 years, has drawn criticism from some sources that favour an holistic approach, studying the system as a whole. Traditional Maori analysis techniques are holistic, and in some cases, a reductionist approach to total cost assessment may not be able to encompass traditional Maori concerns.

The focus of this study is primarily total cost *assessment* as opposed to reporting. Reporting has been discussed as it is closely related to assessment, but it is an area which will require further development. Similarly, ongoing evaluation and review will be an important feature of an operational TCA framework, but the incorporation of a monitoring and review system for the framework is not undertaken in this study.

The framework designed in this study can be applied to a range of applications, one of which is charging. Consideration of generator pays issues revealed that charging by waste type would be very difficult to administer effectively on a wide scale (section 3.4). Given this and

other considerations discussed, waste type was not selected as a classification system in the TCA framework. Should charging by waste type be pursued, this framework will not provide a direct basis for setting charges.

4.6 Summary

This chapter developed a framework for total cost assessment to be used for Christchurch City Council's waste management. Firstly, eight criteria for a TCA framework were established. These addressed political requirements, flexibility, the problem of 'externalities', the inter-relationship between aspects, the link between cause and effect, waste management practices, transparency, and possible applications of the framework. A discussion of potential approaches and tools currently available such as Environmental Impact Assessment and Non-Market Valuation showed that no one of these fulfil all the criteria. Thus, the need for a new approach, incorporating elements of the existing approaches and tools was apparent. The process of developing this new approach lead to a framework which assessed the total cost of waste management according to waste management practices (ie. waste management programmes and activities) and characteristics of the environment. Subsequently, the nine steps of this framework were described. These identified waste management programmes, the activities and sub-activities of each programme, the characteristics of the environment, and the potential effects of specific activities, measuring the magnitude of effects, calculating effects in units of cost and benefit, compiling the total cost table, reporting the total cost of waste management, and evaluating the framework. The waste management programme 'landfill' is used as an example to illustrate how the framework for TCA should be used. The example included the identification of activities within the programme 'landfill', a full categorisation of characteristics of the environment, and a guide showing possible effects. Finally, the assessment of the framework against the established criteria revealed that six out of eight criteria are fully met. The two criteria 'linking cause and effect', and 'working towards a format of generator pays charging without precluding other applications' were partly fulfilled.

CHAPTER 5 SYNTHESIS

The aim of this study has been to provide a framework for the assessment of the total cost of waste management in Christchurch, achieved through five objectives:

1. acquire a contextual overview of waste management issues in general and specifically for Christchurch City;
2. identify the components of 'total cost' of the Christchurch City Council *Draft Waste Management Plan for Solid and Hazardous Waste 1998*;
3. identify which components of total cost can be measured and how they may be measured;
4. analyse the potential for measuring component parts of total cost in common units, including money; and
5. recommend how the Christchurch City Council should assess the total cost of its waste management.

The first objective is addressed throughout chapters two and three. Chapter two identified roles of organisations with an interest in NZ waste management, the waste management policy framework and themes in NZ waste management. Chapter three provided further background to total cost assessment, discussing issues including assessment of past and future costs, the difference between private and public delivery of waste management services, effects of waste management on tangata whenua, the relationship between TCA and generator pays, transboundary waste movement, national coordination, measurement in common units, particularly monetary (objective 4), and the nature of effects.

These issues have shaped development of the TCA framework as well as the approach to its implementation and applications. Chapter four develops the TCA framework, drawing on the variety of different options for cost assessment investigated. The framework identifies the programmes of the waste management system (objective 2) and the characteristics of the environment which these programmes affect. Steps of identifying, measuring and calculating costs and benefits are undertaken, guided by criteria which respond to objective 3. Although not the main focus of the study, the framework includes reporting and evaluation as its final two steps.

Having developed the TCA framework and discussed its merits, this chapter considers where CCC should proceed with implementing TCA. This chapter summarises the *process* of developing the TCA framework and considers *whether* the framework should be implemented (options). Conclusions are then drawn which bring together key themes through the report, followed by recommendations as to *how* the framework should be implemented (if implementation is desirable) and priority actions for CCC. The structure for this synthesis is illustrated in figure 8.

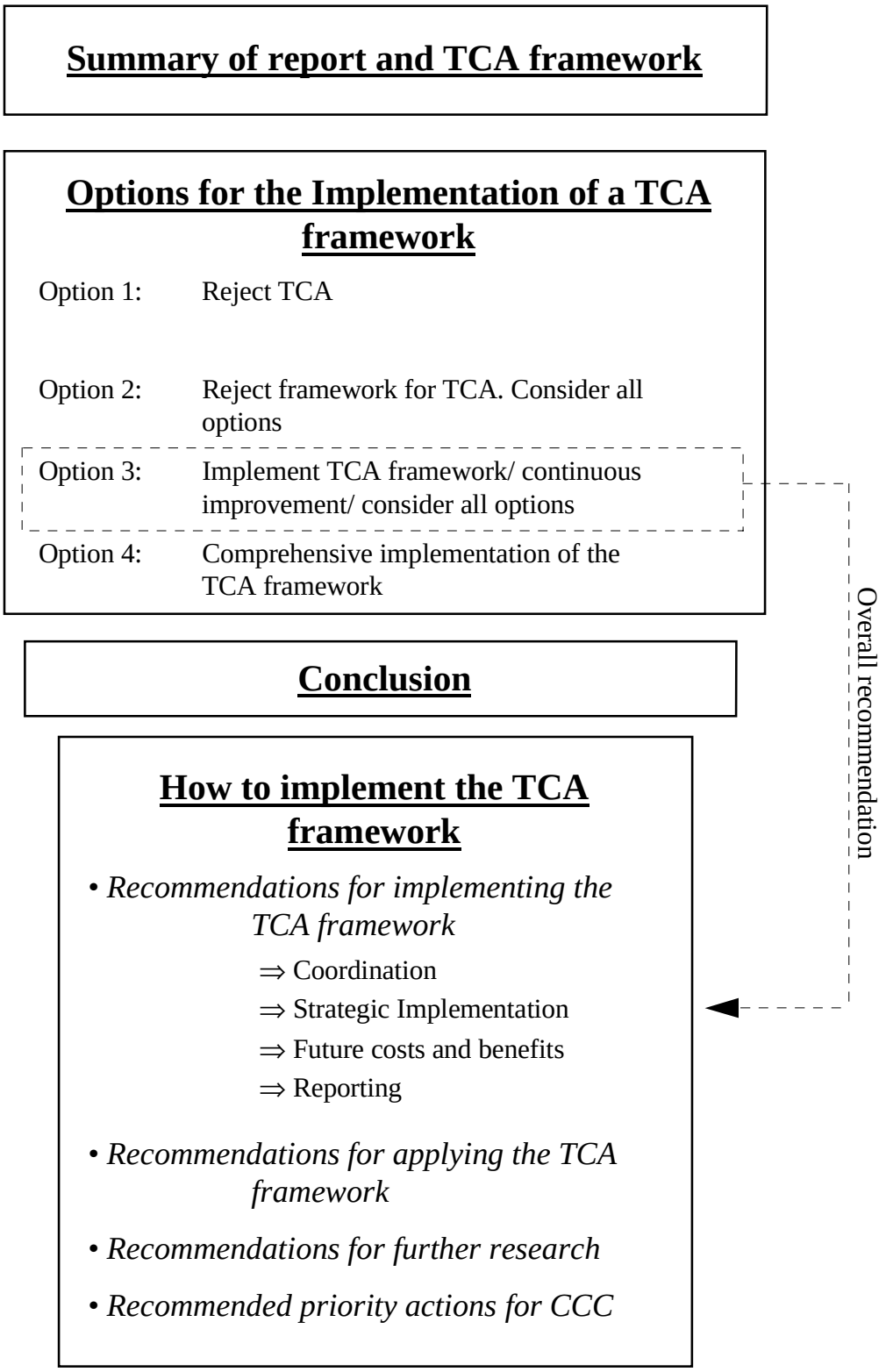

Figure 8: Diagramatic representation of the structure for Chapter 5 (synthesis).

5.1 Options for Implementation of Total Cost Assessment

In considering whether to implement total cost assessment, four options for CCC have been identified. The four options are described and evaluated using the criteria specified below. Implications of each option for Christchurch City Council are discussed. These are summarised in table 3. The criteria to assess options for CCC include those specified in section 4.1 to assess the TCA framework and two additional criteria (numbers one and two below).

An option should:

1. enable efficient use of Christchurch City Council resources;
2. not expose Christchurch City Council to an unacceptable level of risk;
3. meet requirements of the *Draft Waste Management Plan for Solid and Hazardous Waste 1998* and other policy applicable to Christchurch's waste management;
4. be flexible enough to apply future waste management practices;
5. include social, biophysical and economic "externalities" in the assessment of costs and benefits;
6. enable the inter-relationships between social, biophysical and economic effects to be clearly identified;
7. link causes and effects of waste generation, so that effects (costs and benefits) can be directly traced back to their causes;
8. provide a clear break-down of costs and benefits of waste management practices which will allow the comparison of practices;
9. be transparent, accountable, understandable and feasible so the public can support the process; and
10. be in a format that works towards a system of generator pays charging for waste management services, without precluding other applications.

Option 1: **Do not consider TCA as a potential method for meeting waste management and legislative requirements.**

Discontinue any investigation of TCA and its potential application to waste management in Christchurch City. Consider and investigate other waste management methods and tools (appendix 2).

Implications:

In ruling out TCA as an option, it is uncertain whether CCC will be pursuing the most efficient method of meeting their waste management requirements and whether this poses any risk to the council (ie. pursuit of other options may entail greater risk). Some national, regional and local waste policies or objectives will not be met (eg., including national waste policy (section 2.2) and principle 4 in the Environment 2010 Strategy). Flexibility is forfeited and all 'externalities' will not be included in the assessment of costs and benefits unless some form of TCA is undertaken. It is uncertain whether criteria 6-9 will be met as this will depend on the characteristics or qualities of alternative methods pursued to meet CCC's waste management requirements. This option will not provide a sound basis for generator pays as it is defined in principle 4 of the Environment 2010 Strategy.

Option 2: **Do not implement the TCA framework (described in chapter 4). Continue to investigate TCA and other potential methods of meeting waste management requirements and/or wait for further national or regional guidance on total cost assessment and reporting.**
Other potential methods for meeting waste management requirements are discussed in section 4.2 of this report.

Implications:
The TCA framework developed in chapter 4 should be judged on its merits, limitations and soundness of rationale used in the selection of options. If the framework is not utilised, then a new approach needs to be developed given the absence of established models or examples of TCA. For this option, further resources are required. This option is relatively risk averse as the information will not be lost through further investigation. Criteria 4-10 may be met for this option but this is uncertain and will depend on the quality of alternative approaches to TCA or other methods pursued. The success of this option may depend in part on whether national or regional guidance for total cost assessment and reporting is likely to be forthcoming.

Option 3: **Implement the TCA framework (described in chapter 4) in stages, using a process of continuous improvement and evaluation, and continue to consider other potential methods for meeting waste management requirements.**
Implement the TCA framework using one waste management programme as an initial pilot case. Evaluate the usefulness of the framework using the criteria specified above. Continuously improve the TCA framework as further guidance or information is made available and as practical implementation issues are encountered. Continue to evaluate other methods for meeting waste management requirements.

Implications:
This option allows for efficient use of CCC resources given that the TCA framework provides a foundation for developing a system of total cost assessment and reporting. Treating the TCA framework as a 'starting point' (for developing a system of total cost assessment and reporting), incrementally implementing and continuously improving the framework using a small-scale approach, enables CCC to better plan resource requirements over time. This increases the council's ability to plan efficiently and minimises risk associated with large-scale implementation (ie. any changes to the framework and associated resource requirements will only be incurred for the pilot case).

All national and regional policy requirements and Principle 4 of the Draft Plan are met for this option. CCC would be able to take a leadership role in total cost assessment, as it would likely be the first Regional, District or City Council to implement a system of total cost assessment and reporting in New Zealand (and possibly further abroad). Requirements to address tangata whenua issues are accommodated within the framework but require further development and input from tangata whenua (section 4.4.1).

This option retains flexibility by continuing to consider other potential methods and by adopting an implementation process based on the principle of continuous improvement. The TCA framework meets criteria 5, 6, 8 and 9 (section 4.5.1). It is uncertain how

comprehensively criteria 7 and 10 are met (see discussion above). By adopting option 3, the TCA framework will be of limited availability for potential applications (section 1.2) in the short term. However, this gradual process facilitates greater education and understanding, and enables a smoother transition (from existing accounting and assessment to the TCA framework) and greater 'ownership' by staff, private contractors and the public (section 4.4.5). It will be necessary to develop a method for evaluating the performance of the framework and to identify methods/tools for the assessment of specific effects (costs and benefits).

Option 4: **Comprehensively implement the TCA framework (described in chapter 4)**
Immediately follow each of the steps required to implement the TCA framework (chapter 4) for all of the waste management programmes outlined in figure 7. Develop the framework as quickly as possible within resource constraints.

Implications:
It is uncertain whether this option will provide for efficient use of CCC resources. This follows because of increased risk associated with comprehensive implementation. Given the complexity of and limited existing research on TCA, the risk associated with comprehensive implementation and potential large-scale changes to the framework is considered high. The same advantages of meeting policy requirements and providing leadership as for option 3 are provided. Tangata whenua issues are accommodated within the framework but require further development and input from tangata whenua (section 4.4.3). Some flexibility is retained for this option as the framework is designed to include future changes in waste management practice (section 4.5.1). However, flexibility is limited because CCC will commit to this particular method for meeting waste management requirements and therefore preclude input from other potential methods. Flexibility is also reduced by limiting the council's ability to successfully implement the TCA framework over time. Eliminating the need to investigate other methods for meeting waste management requirements corresponds to a decrease in CCC resource requirements. The TCA framework meets criteria 5, 6, 8 and 9. It is uncertain how comprehensively criteria 7 and 10 are met. Adopting a comprehensive approach to implementation of the TCA framework may enable more rapid use of the framework for the applications described in section 1.2. However, there is a risk (described above) that large-scale changes to the framework and reduced understanding and 'ownership' by staff, contractors and the public will limit usefulness for potential applications (eg., if staff or private contractors are unhappy with the new system and will not assess or record costs, then the accuracy of the framework is compromised). It will be necessary to develop a method for evaluating the performance of the framework and to identify methods/tools for the assessment of specific effects (costs and benefits).

Table 3. Assessment of Options: This table summaries the extent to which each of the options for implementation of total cost assessment meet the selection criteria (in section 5.1)

Options / Criteria	Option 1	Option 2	Option 3	Option 4
1. Efficiency	?	?	👍	?
2. Risk	?	👍	👍	👎
3. Policy	👎	?	👍	👍
4. Flexibility	👎	?	👍	👎
5. Externalities	👎	?	👍	👍
6. Interrelationships	?	?	👍	👍
7. Linkages	?	?	?	?
8. Comparison	?	?	👍	👍
9. Public	?	?	👍	👍
10. Generator pays	👎	?	?	?

Key	
👍	= meets criterion
👎	= does not meet criterion
?	= uncertain if criterion is met

5.2 Conclusion

The requirement to establish a method for assessing and reporting total cost is made clear in national and regional legislation and policy guidelines, and gives rise to principle 4 in the Draft Plan. Some guidance on the assessment of environmental effects has been provided at a national level, although specific guidance on how to assess and report the total cost of waste has been limited and is not a current priority.

The management of waste is a complex and inter-related process which involves many organisations with direct or indirect responsibility for policy development and/or implementation. Developing a system of total cost assessment for CCC therefore requires a comprehensive, integrated and systematic approach which considers relevant issues and the specific needs of Christchurch City.

Irrespective of the method (ie. TCA or 'other' methods) used to address waste management requirements, it is important that waste managers retain a clear focus on long term and fundamental objectives or goals. In developing any type of information system (such as TCA), the objective is to provide a sound basis for waste management decisions. The ultimate goal of these decisions is to establish a system of waste management which will give rise to desirable standards of behaviour (eg., following the international waste hierarchy).

CCC have commissioned this research with a primary interest in the potential application of TCA toward a system of generator-pays charging. This study identifies inherent limitations associated with this application, but recognises that TCA may still provide an imperfect but valid basis for a system of generator pays. The ultimate goal of generator-pays charging is to create the appropriate balance of (market) incentives which give rise to desirable standards of behaviour. A system of generator-pays is only one of several potential TCA applications which include annual reporting, education and promotion campaigns, best management practices and meeting the implementation needs of the RMA.

TCA of waste management is a relatively new field of research which has received little attention internationally. The TCA framework (described in chapter 4 of the report) provides a first step or 'starting point' for Christchurch City Council, and is not intended as a complete or prescriptive approach to implementing a system of TCA. Areas for future research have therefore been identified and recommendations are provided. The recommendations relate to the implementation and reporting of total cost assessment.

In deciding whether to implement a system of TCA, having considered the four options and their implications (in terms of the degree to which specified criteria are met), it is clear that option 3 best meets the criteria (as summarised in table 3). Accordingly, our recommendation is to follow option 3, as follows:

Implement the TCA framework in stages, using a process of continuous improvement and evaluation, and continue to consider other potential methods for meeting waste management requirements.

5.3 Recommendations for Implementation

The recommendations in this section provide guidance for how to go about the implementation (option 3) selected above. These recommendations address the issues raised in chapters three and four of the report, and have been evaluated against the criteria specified in box 6, within the respective sections where they are raised as an issue. As illustrated in figure 8, the first set of these recommendations is broken into those relating to coordination, strategic implementation, future costs and benefits, and reporting. The further recommendations relate to application of the framework, further research and the priority actions for CCC.

5.3.1 Coordination

- Consider the advantages and disadvantages of coordination with central, regional and other local government agencies. Make this report available to MfE, CRC and other district or city councils within the Canterbury Region and communicate CCC's interests and intentions relating to total cost assessment to these agencies.

- Consult with all tangata whenua groups in Christchurch City to establish an appropriate approach to assessment and reporting procedures. Liaise with MfE and tangata whenua to establish how proposed environmental indicators for tangata whenua might be included in the TCA framework.

- Liaise with private waste service providers in the development of the TCA framework, and jointly identify mechanisms for including private service providers in both development and implementation of the framework.

5.3.2 Strategic Implementation

- Introduce the TCA framework in stages, with continuous evaluation and improvement.

- Continue to examine existing approaches, tools and information for potential inclusion in the framework and utilise where possible.

- Develop total cost assessment of 'landfill' further as a test programme.

- Use indicators, particularly national measurements such as Environmental Performance Indicators, where appropriate, and utilise new indicators as provided. Establish schedules for measuring indicator effects in certain cycles (each year or longer), and assess the appropriateness of the used indicators. This includes periodic re-assessment of effects to ensure that indicators are representative.

5.3.3 Future Costs and Benefits

- Future costs and benefits of present waste management activities must be identified and assessed.

- Conduct a sensitivity analysis, using a range of possible magnitudes of effects and discount rates when assessing future costs.

5.3.4 Reporting

- For summary reporting, use methods that are clear and easy to understand at a glance, that are representative of all effects, such as the "traffic lights" matrix.

5.4 Recommendations for Applying the Framework

- The TCA framework can be used for many applications, and all of them should be evaluated for their usefulness to Christchurch's waste management. The development of a charging structure based on TCA should only be regarded as one among several applications.

- Total cost assessment should include the costs and benefits of past, present and future waste management. However, for the purpose of applying total cost to a charging system, only current and future costs and benefits related to present waste generation should be included. Costs and benefits which relate to past or future waste generation should be excluded.

- Develop a protocol for considering all described, qualitative, and quantitative effects for the purpose of decision making.

- Lobby the Government to develop a method of producer liability for waste generation, so that a framework for TCA can be applied at source.

5.5 Recommendations for Future Research

- Further investigate the use of waste type data in a TCA framework (eg., build on Life Cycle Assessment).

- Research the actual effects of methods for waste minimisation on human behaviour, eg., varying the level of charging, applying the generator pays principle, and information campaigns.

- Conduct research into which methods and tools can be used for TCA and in what way.

5.6 Recommended Priority Actions for CCC

Out of all recommendations identified above, the following are considered priority actions for CCC.

- Pursue the recommended option and introduce the TCA framework in stages, with continuous improvement and evaluation.

- Liaise with MfE to develop guidelines for TCA and enter into dialogue with other local authorities in the Canterbury Region to pursue TCA.

- Develop TCA of 'landfill' further as a test programme (pilot study). This includes building existing approaches, tools and information into the TCA framework, establishing new information gathering techniques, and evaluating TCA framework performance.

- Develop a protocol for considering all described, qualitative, and quantitative effects for the purpose of decision making.

- Further investigate the use of waste type data in a TCA framework.

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APPENDICES

Appendix 1: Authors' Backgrounds.

Sigrid Speidel Dipl-Ing. Agr.(agricultural economics)
Sigrid Speidel received a Masters degree in agricultural economics from the University of Hohenheim, Germany. After graduation she was employed in the Ministry for the Environment, Department of Water Protection, Hessian, Germany. She now indulges in the 'kiwi' lifestyle and has found herself back in studies in the M.Sc (Resource Management) programme at Lincoln University.

Martin Keller Dipl. Phil. II (hydrobiology)
Martin Keller was born in Christchurch and has been brought up in Switzerland, where he has spent most of his life and received his Masters degree in microbiology at the University of Zürich. After working as a scientific consultant at an environmental management firm in Zürich for three years, he has decided to undertake further studies and to come to New Zealand. Next to his studies he enjoys the outdoors with biking, tramping, mountaineering and photography

Conrad Henson B.Sc.
Conrad Henson is a graduate in geography from Victoria University of Wellington, and was a lifetime resident of the capital prior to enrolling in the M.Sc (Resource Management) programme at Lincoln University. While at Victoria, he was involved in student politics, and worked in many facets of the footwear industry, including manufacturing, distribution, accounting, information technology and other internal services. Since his graduation in 1994, he has been involved in the footwear industry full-time, in sales, purchasing and management. He enrolled in the MSc programme in 1997, to reestablish a career path directed towards environmental management.

Andrew Harrison B.Sc.
Andrew Harrison graduated from Massey University with a Bachelor of Science in Ecology and Environmental Science (1994) and is currently enrolled in the M.Sc (Resource Management) programme at Lincoln University. Andrew has worked as a research scientist (weed control) for the Department of Conservation and as manager of an Auckland Landscape Design/Construction firm (Bill & Bens- Landscaping). Andrew is the Director of Harrison & Associates Ltd, a 3 year old company which provides resource management and Landscape design/construction services. Andrew is currently commissioned by the Department of Conservation (Head Office) to investigate the roles, responsibilities and participation of non-governmental organisations in the development and implementation of New Zealand's Biodiversity Strategy.

Rebecca Gee BRS.
Rebecca Gee graduated in Resource Studies from Lincoln University and continued on to the MSc Resource Management programme. Her previous work experience has included a summer research scholarship with the Institute of Geological and Nuclear Science, working on a historical database. Her current individual research is into integrating New Zealand's Antarctic environmental monitoring, and she works part time at Antarctica New Zealand.

Appendix 2: Approaches and Tools for Cost Assessment

The table below considers a range of broad methods for or approaches to cost assessment, and the contribution they may be able to make to total cost assessment. Some relate to specific types of effect, while others assist in the calculation of common units, and others in fact provide an overall structure rather than prescribing particular assessment methods. In practice, the tools may not be used in isolation from each other, for instance, Social Impact Assessment (SIA) could well draw in information gathered by physical measurement methods and information collected in Environmental Impact Assessment (EIA). Each of the tools and approaches on the table are discussed below.

Table A1: Potential usefulness of Tools and Approaches. The table shows the aspects of total cost assessment to which a variety of approaches and tools available may *potentially* contribute. An 'x' denotes potential usefulness. A description of the approaches and tools, including limitations, is provided below. For definitions of effect types, refer to glossary and section 2.5

Contributes to: / **Tool or Approach:**	Biophysical effects	Social effects	Economic effects	Future effects	Common Units	Overall structure
Cost Benefit Analysis	x	x	x	x	x	x
Emergy	x		x		x	x
Environmental Impact Assessment	x	x	x	x		x
Full Cost Assessment			x			x
Indicators	x	x	x			
Indices	x	x			x	
Life Cycle Assessment	x					
Non-Market Valuation	x	x			x	
Physical Measures	x					
Risk Assessment	x	x	x	x		
Social Impact Assessment		x		x		x
Total Cost Management			x			x

1. Total Cost Management

Total Cost Management is an approach to the management of costs which has evolved within the private sector in response to changes in the nature of business (Ostrenga et al., 1992). This approach holds that cost management must be based on a solid understanding of *cost dynamics*, the key to understanding 'cost dynamics' being to clarify the relationship between activities and causes, and the relationship between activities and costs. This approach to cost management may be understood in terms of its three key principles, as follows:

1. **Business process analysis**- Total cost management adopts a process-oriented approach to the management of costs in order to overcome the problem of 'division of labour'. A process is defined as a series of activities that lead to the delivery of a service or product (Ostrenga et al., 1992:p.21). 'Division of labour' refers to a traditional accounting approach whereby costs are accounted for within departments which only partially contribute to the process of delivering a product or service. For example, in a company which produces a range of five tables, three departments ('Design', 'Manufacturing' and 'Sales and delivery') may contribute to the process which leads to the sale of tables. If costs are accounted for by Department, it is impossible to assess the cost dynamics for a given table. Accounting for costs in terms of programmes and their associated activities provides for a clear understanding of 'cost dynamics'.
2. **Activity-based analysis**- Within each process, costs are accounted for in terms of the activities which give rise to them. This follows because costs cannot be managed themselves, only the activities which cause costs can be managed. The goal in activity-based costing is to mirror causality in the process of producing a good or supplying a service (Ostrenga et al., 1992: p.30).
3. **Performance measurement**- To manage costs successfully it is necessary to establish a performance measurement system which mirrors the goals and objectives of the manager. This requires the following:
    a) identifying and measuring the 'critical success factors' related to the delivery of the product or service (the attributes or activities which are essential to the success of the organisation).
    b) developing a performance measurement system which integrates financial and non-financial costs.
    c) developing a performance measurement system which reflects the spirit of 'continuous improvement' ie. improving the management of costs by incremental steps. For example, when implementing a system of accounting, test and refine the new system using a single product or service. In this way, any changes or refinements (and associated costs) are incurred on a small scale. (Ostrenga et al., 1992:35)

Total cost management can be further described as having the following characteristics:

1. a focus on cost prevention as opposed to reporting
2. provides a direct link between causes and effects
3. a focus on measurements of profitability and cash flows in addition to cost flows and accumulation
4. entails a cost system which includes administration, selling and general costs in 'total cost'.
5. allocates overhead costs on a cause and effect basis
6. is a way of doing business as opposed to an accounting system (Ostrenga et al., 1992:p.20)

Potential:
A detailed discussion of total cost management is provided in Ostrenga et al. (1992). In relation to 'total cost assessment' (as defined in this study), 'total cost management' generally adopts a narrower definition of non-financial costs, being costs which are not financial but which have an impact on financial costs. As noted, it was developed in response to commercial needs, however it seems as applicable to the provision of waste management services and related products. The key concepts of total cost management, such as linking cause and effect and dividing the overall system by the activities which contribute to the process rather simply by management units, have been incorporated into our framework. Total cost management's further potential contribution to total cost assessment for is guiding the use of total cost in waste management decisions, eg. measuring the 'critical success factors' related to the delivery of the product or service, developing a performance measurement system which integrates financial and non-financial costs and seeking 'continuous improvement'.

Energy-based Systems

Based on the laws of thermodynamics, all physical activities decrease the availability of energy, so that a possible conceptualisation of 'cost' is reduction in available forms of energy (Peet, 1992). The LBJ School of Public Affairs developed a specific system which accounts for physical changes in the economy by converting all materials and processes into a common unit of equivalent solar energy (called 'emergy'). It uses four main premises:

1. The Universality of Systems (everything is part of a system, systems are interrelated).
2. A common unit is required to compare the relative worth of inputs and outputs.
3. Nature's Subsidy (current financial systems do not relate to the actual environmental goods and service being used)
4. The Maximum Emergy Principle (systems will maximise emergy use). (LBJ, 1987, p 2).

This Emergy system was trialed using the Texas economy, and waste disposal was one unit of the economy which was studied. The emergy unit is converted to dollars to give financial costs and benefits. The calculations for the current waste disposal system found it had a net cost because it diverted emergy from the economy by removing land from 'productive use', diminishing water quality though leachate, effectively removing valuable materials though disposal, and using fuel unnecessarily (*ibid.*, pxv). Costs were offset by reuse, recycling and diminished waste collection: "If appropriately recycled, partly by reuse within the economy and partly by dispersal for appropriate incorporation into environmental systems, ...so-called 'wastes' become by-product resources" (*ibid.*, p44). Different options for waste disposal ranged form a net cost of $25.7 billion to a net benefit of $9.2 billion to the Texas economy (in 1987 $ US, *ibid.*, p 78).

Potential:
Emergy is a very ambitious system. Its benefits include the conversion of all elements to common units and the calculation of net costs or benefits of each component of the economy, which can be directly converted to monetary units. Its intended use integrates waste management into the economy as a whole and treats the minimisation

of waste and implementation of the waste management hierarchy as improvements in the whole economy. The major drawback for its smaller scale use for Christchurch City's solid waste management is the large amount of highly detailed data and technical understanding required. Without external support, it is unlikely to meet the criteria of feasibility for Christchurch City Council because of the expertise which would have to be brought in. Social effects would have to be measured additionally in a separate system.

Full Cost Accounting

Often, accounting or costing systems within public waste management have not recorded the actual costs of programme implementation or attributed costs to particular programmes, resulting in hidden costs and cross-subsidisation of costs (Turner, 1997. p58; MfE, 1996a, p7). Full Cost Accounting (FCA) systems are activity based costing methods which seek to account for all time, equipment, capital, facility and overhead costs of an organisation (Turner, 1997, p58). It is a more comprehensive and systematic application of traditional accounting methods, programme by programme based on their activities.

The USEPA also promote an expanded version called Full Cost environmental Accounting, which combines full cost accounting, environmental cost accounting (ie. accounting of non-financial costs) and life cycle costing. The increasing convergence of financial and non-financial accounting is also illustrated by a recent CICA report on FCA, which proposed that FCA should be "the integration of all costs, both internal and external, resulting from an entity's activities, operations, and products or services", while it is acknowledged that "a more limited scope of FCA may be the best that can be aimed for in the near future" (Willis, 1997, p 49). The wider version of FCA aims for monetisation of all costs (Boone and Rubenstein, 1997, p18).

Potential:

The potential for full cost accounting is great because (in its simple form) it does not require any new or specialised accountancy skills (Turner, 1997, p59). In New Zealand there are also supports such as the *Landfill Full Costing Guideline* (MfE, 1997). In our framework, full cost accounting is the method we assume for the calculation of all financial effects.

The fuller sense of FCA would be reflected to some extent in the complete implementation of our programme, including both full cost accounting of financial affects, and assessment of ecological and social effects, as well as the inclusion of information regarding the long term effects of different substances, particularly in landfill (as discussed in section 4.4.5). The major limitation on this fullest implementation of FCA is the lack of market prices (or even transactions in the commercial sense - Luscombe, 1997, p3) for many environmental and social effects which need to be accounted for, and the potential confusion that inclusion of such information within 'financial' assessment may cause (Willis, 1997, p49).

Life Cycle Assessment:

"Lifecycle Assessment (LCA) consists of a systems analysis of the lifecycle of a product or service. It considers all of the inputs to the system, in terms of resources (materials and energy) and all the outputs of the system, in terms of the emissions to air, water and land" (ERRA, 1997, p4). LCA first defines system boundaries, then

makes an inventory analysis (that is, identifies and quantifies all material and energy flows into and out of the system), which is then interpreted for its impact, and finally opportunities for environmental improvement are identified (*ibid*.). The usual application is to one commercially produced product, from 'cradle to grave', but it is now beginning to be applied to various products within one main step of their lifecycles (eg. waste management).

Potential:
ERRA has developed a model for applying LCA for integrated waste management, placing system boundaries to include post-generation to disposal. At present it has only limited inclusion of ecological effects of waste management, and none of social and economic effects (ERRA, 1997, p 10). The major application of LCA as it is currently done is as a basis for understanding the waste management system, rather than for costing per se. The type of process modelling done in this report (see figure 7) does reflect this approach. A very significant potential contribution of LCA to the understanding of total cost would be its application to specific types of waste to plot their different impacts through the waste stream and end disposal.

Environmental Impact Assessment

Environmental Impact Assessment (EIA) can be defined as the "official appraisal of the likely effects of a proposed policy, program, or project on the environment; alternatives to the proposal; and measures to be adopted to protect the environment." (Gilpin, 1995). EIA has been designed provide a systematic analysis of effects to be used for improved, strategic policy making. "In principle, EIA should lead to the abandonment of environmentally unacceptable actions and to the mitigation to the point of acceptability of the environmental effects of proposals which are approved. EIA is thus an anticipatory, participatory environmental management tool"(ibid).

In New Zealand, the RMA introduced EIA as a central element within the policy process towards sustainable management. Section 88 (4)(b) states that applications for resource consent "shall include an assessment of any actual or potential effects that the activity may have on the environment, and the ways in which any adverse effects may be mitigated". The elements of the Assessment of Effects on the Environment (AEE) are described in the Forth Schedule of the Act.

In practice EIA is often restricted to effects on the ecological environment, but theoretically encompasses social and economic aspects as well (Caldwell, 1987, p7). The approach incorporates the tools appropriate to the issue in question. These can be tools such as qualitative descriptions, ecological measurements, social surveys, cost-benefit-analysis, non-market valuation and risk assessment.

Although there is no uniformity in how to implement EIA, the following elements of the EIA process can be identified:

- consideration of alternative means of achieving objectives
- designing the selected proposal
- determining whether an EIA is necessary in a particular case (screening)
- deciding on the topics to be covered in the EIA (scoping)

- preparing the EIA report (ie., *inter alia*, describing the proposal and the environment affected by it and assessing the magnitude and significance of impacts)
- reviewing the EIA report to check its adequacy
- making a decision on the proposal, using the EIA report and opinions expressed about it
- monitoring the impacts of the proposal if it is implemented.

(Wood, 1995)

Consultation and public participation as well as the mitigation of environmental impacts at each of the elements is integral to the process.

Potential:
To some extent the nature of EIA is similar to TCA (as we define it). Both approaches are designed to integrate social, biophysical and economic aspects. Also, both approaches use a variety of tools, appropriate to the issue in question. However, there are also differences, especially with regard to the application in practice. EIA is most commonly carried out during the planning and implementing stages of projects, where as TCA is continuously carried out, eg. annually as envisaged in the CCC Draft Waste Management Plan. EIA is mostly applied to assess biophysical and (to a lesser extend, but increasingly) social aspects, while economic aspects are usually not regarded (see for example Wood, 1995). In contrast, it is - by definition - crucial for TCA that all, social, biophysical and economic effects are captured. Although it is not sufficient to use EIA instead of TCA, EIA provides a useful and important approach within TCA, especially with regard to assessing biophysical effects.

Social Impact Assessment

Social Impact Assessment (SIA) is similar to EIA and can be regarded as its subset. Taylor (1995) provides a detailed discussion of SIA in New Zealand. He defines SIA as "a process of research, planning and management to deal with social change arising from intended and current policies and projects. It is focused on individuals, groups, communities and sectors of society affected by change, although its focus is usually local and regional. It is a process that uses social analysis, monitoring, and methods of public involvement." Indeed, public participation through cooperation, coordination and communication among all affected is seen as fundamental to the approach, providing a tool for proactive policy making.

Taylor defines six main steps within the SIA process:

Scoping	Identification of issues, variables to be described/measured, links between bio-physical and social variables, likely areas of impact, and study boundaries
Profiling	Overview and analysis of current social context and historical trends
Formulation of alternatives	Examination and comparison of options for change

Projection and estimation of effects	Detailed examination of impacts of one or more options against decision criteria
Monitoring, mitigation and management	Collection of information about actual effects, and the application of this information by the different participants in the process to mitigate negative effects and manage change in general
Evaluation	Systematic, retrospective review of the social effects of the change being assessed including the social assessment process that was employed

Potential:
The potential for SIA to be used as a framework for TCA is closely linked to that of EIA. SIA is most important at the stage of planing and implementation and of the closure of projects, and is thus different to the continuous nature of TCA. Most important, in contrast to TCA, SIA is only concerned with social effects and does not assess biophysical and economic effects which have no direct social effect. Thus, it can only be used for the assessment of some effects, ie. social effects within TCA. However SIA is a valuable and necessary in this respect.

Risk Assessment

Risk can be defined as "exposure to the possibility of such things as economic or financial loss or gain, physical damage, injury or delay, as a consequence of pursuing a particular course of action", and can relate to both human and non-human communities (MfE, 1996b, p1). The assessment of risk can include:

- identification of risks (or hazards);
- evaluation of the nature and severity of risks;
- determination of options and decision making about reducing or eliminating the risk; and
- communication of information about the risk to the public and decision makers (*ibid.*, p2).

The evaluation of risk can be done quantitatively or qualitatively. The quantitative approach estimates probability of the occurrence and evaluates its consequences, simplified in the formula below (where R is risk, p is probability and L is loss):

$R = p \times L$

Qualitative risk assessment recognises that there is often a large gap between this 'scientific' risk assessment and the public understanding of the same risk. It therefore focuses on identifying personal perceptions of the risk. Both forms of risk assessment can be utilised in risk management, which is the decision making and action taken to reduce the identified risk.

Potential:
The limitations of risk assessment include the fact that (since it deals with uncertainty) it is often based on imperfect understanding and assumptions, and cannot be considered a 'precise science' (Gerrard, 1995, p304). A major drawback for its use

in total cost assessment as considered in this study is that it is used almost exclusively for the assessing and managing the potential of *negative* occurrences or costs, rather than benefits (*ibid.*, p 301). The major potential for risk assessment for a total cost framework is its use in estimating future costs (or benefits) which may be faced. Risk assessment is also likely to be used within waste management in the comparative assessment, design and management of major developments such as landfills or hazardous waste facilities (in which case, it is a cost accounted for within the total cost of waste management).

Non Market Valuation

Non-market valuation (NMV) techniques are used to assess the value of goods and services which do not have market prices ascribed to them currently. They aim to make this valuation in monetary terms. There are three main types of NMV:

Travel Cost Method (TCM)

This method uses travel costs as a proxy for the willingness to pay to visit a site. The higher the travel costs people are willing to pay, the higher the site is valued. And, the higher the travel costs, the fewer visitors to the site. According to travel costs and number of visitors, a demand curve can be derived. The method is useful to value (open access) recreational sites, historic sites and wilderness areas. It is not useful in waste management because people do not gain benefit from visiting waste management sites.

Hedonic Pricing (Property Value Approach)

This approach values environmental goods by tracing the effect of environmental quality on property prices. The method is based on the economic concept that the value of a property is directly related to the present value of the expected stream of benefits, including environmental benefits. A requirement is that people use the property and are therefore affected by the surrounding environment. Therefore, the method is often applied to residential housing. In waste management, for example, the price of land for residential housing next to a refuse station can be compared to the price of land away from the refuse station (with other influencing variables accounted for).

Contingent Valuation Method

Using the Contingent Valuation Method (CVM), the consumer is asked what he/she is willing to pay for a non-market good. It is based on the assumption that consumers reveal their true willingness to pay (WTP). In contrast to the Travel Cost Method and the Property Value Approach which use surrogate markets, CVM asks consumers directly about their preferences for non-existing markets. Like WTP, the willingness to accept (WTA) compensation for loss of non-market goods can be measured. CVM can be used to gain information about people's WTP for benefits of waste management or for the avoidance of costs of waste management. For example people could be asked about their WTP for the collection of their waste (ie. for the avoidance of the costs which would occur if the waste were not collected). Likewise, CVM can be used to elicit the WTA costs of waste management or the loss of benefits of waste management.

CVM has important limitations because it is based on a hypothetical market. The respondents' determination of their WTP is open to the following biases:

- Strategic bias: WTP might be overstated to show environmental awareness. On the other hand, understatement might occur if actual payment is feared and if it is hoped that the environmental good will be provided by others (free rider problem).
- Starting point bias: Often, it is necessary to provide a first bid. This bid may be viewed as being in the proper range. Thus, the given WTP (or WTA) might be closer to the first bid than the true WTP (or WTA).
- Information bias: This bias can occur due to the inability of the respondent to completely visualise all changes connected with the proposal. The design of the question and additionally provided information influences the outcome. This leads to a dilemma: with too little information, the respondents are unable to make informed decisions; providing too much information influences the respondents dependent on how and what information is provided.
- Instrument bias: The vehicle for collecting (or paying) the bid may influence WTP (or WTA). For example, annual waste charges included in the general rates might cause understatement of WTA because rates generally bear negative connotations.
- Research shows that WTA consistently exceeds WTP. This might be because of budget constraints which are only applicable to WTP, or because the loss of a currently provided good is valued more highly than the gain of a good not currently provided.
- Because individual WTP is influenced by the individual's budget (or wealth), the calculated social benefit is influenced by the distribution of wealth. Therefore, using WTP as measurement for social benefits means that the CVM is built upon the current distribution of wealth.

For further readings see Bjornstad and Kahn (1996), James (1994), and Winpenny (1991).

Potential:
NMV is useful because it expresses costs and benefits for which there are no market prices in monetary units, allowing for greater use of money as common units within a total cost assessment. An important debate continues within economics about the appropriateness of using NMV methods to calculate all types of value in monetary terms (Portney, 1994, p3). Winpenny (1991) claims that some items are simply unmeasurable by economics (such as biodiversity - p.72). While the matrix in table A1 shows NMV as evaulating biophysical effects, this is only done indirectly, through social values of those environmental effects. Apart form methodological limitations, the major restrictions on the usefulness of NMV for total cost assessment will be this issue of appropriateness and the availability of resources, as NMV requires high expertise, at least in the design stage. Where TCM and hedonic methods are inappropriate, the contingent valuation methods must be used which require a large scale of study for accurate results. Although CVM can (theoretically) be applied to most values, it cannot cover intrinsic and future values.

Cost-Benefit Analysis

"Cost Benefit Analysis (CBA) is an information system that has evolved to assist decision makers to compare social welfare under varying states of the world. It is an extension of the financial analysis undertaken by business firms to determine the profitability of different investments. Instead of maximising profits, CBA is concerned with social welfare and uses the social cost of inputs and social benefits of

outputs instead of the purchase and selling prices of inputs and outputs used in financial analysis" (Kerr and Odgers, 1987, p.67)

The social values are calculated using NMV where they are not already in monetray terms. At its simplest, CBA involves the calculation of net benefit (ie. benefit less cost) for use as a decision tool (eg. do not carry out projects with a negative net benefit, if choosing between options choose the one with the highest net benefit). CBA typically considers all costs and benefits of a project or activity within a given time frame. Costs occurring in the future are usually preferred to present costs. Conversly, benefits occurring now are preferred to future benefits. In order to value future costs and benefits adequately compared to present costs and benefits, future costs and benefits are discounted. Usually all costs and benefits over the time frame are calculated into net present value (NPV).

A range of variables used could be flawed, so sensitivity analysis is used to see how the outcome varies depending on the data used. This is important to ensure potentially distorting influences are identified. Hanley and Spash (1993: 20) define the following six parameters which need to be include in the sensitivity analysis:

- discount rate,
- physical quantities and qualities of inputs,
- shadow prices of these inputs (= marginal social costs),
- physical quantities and qualities of outputs,
- shadow prices of these outputs (= marginal social benefits),
- project life span.

Potential

The potential of CBA for TCA, especially as a charging tool, is theoretically immense, since it attempts to assess all effects in monetary terms. However, it relies heavily on NMV and therefore inherits all its limitations. From table A1 it would appear that CBA can measure all types of effects. However, it must be noted that biophysical effects are only measured by the social values placed on them, rather than by the physical or ecological impacts themselves. Because CBA is only concerned with allocative efficiency, not with aggregated utility through improvement of distribution, using CBA means accepting the current distribution as optimal. A sensitivity analysis with different weights on values of particular groups within society can mitigate this problem, though the choice of the weights are subject to value judgement. Discount rates used vary not only depending on the general current economic situation, but also depending on how heavily the preferences of future generations are considered, and considerably alter the outcome. Again, the limitation can be mitigated through sensitivity analysis, however, an adequate social discount rate is particularly important in environmental decisions, because environmental damage is often irreversible.

Indicators

"Indicators are information tools. They summarise data on complex environmental issues to indicate the overall status and trends of those issues" (MfE, 1997c, p4). Essentially, an indicator is a measurement that is taken as a representative of a larger system or whole. For example, a small pond may have a species of plant that exists at certain levels when the pond is healthy and normal, but flourishes when fertilisers

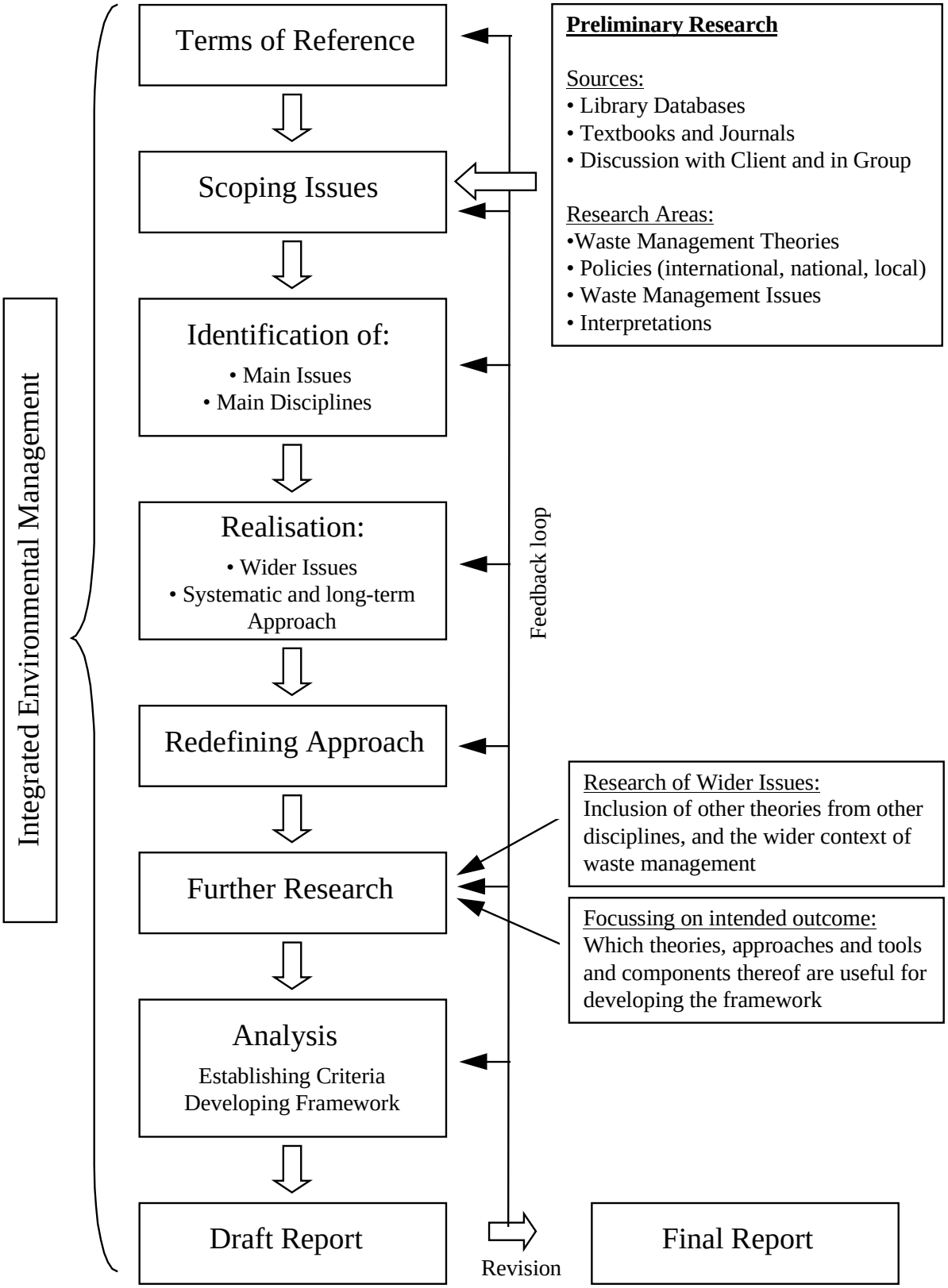
pollute the pond. Measuring that species therefore provides a benchmark of the biophysical and ecological state of the pond overall. Indicators can also be used for social systems (for instance the economy, using gross domestic product or consumer price indexes).

Indicators simplify complex information, convert it to a form which is comparable over time and communicate it in a meaningful way. The National State of the Environment Indicators Programme is working towards a standardised set of indicators, on the basis that they can: measure the extent to which policy goals are being met; contribute to sustainable management and understanding of the effects of our actions; focus attention on key issues; link environmental impacts and socio-economic activity; provide early warning of problems; and guide the gathering of environmental information (*ibid.*).

However, there are some limitations of indicators. They simplify information, and therefore cannot describe all aspects of every environment. It is difficult to find reliable indicators for some systems, and the nature of some issues mean they would not be appropriately or accurately represented through an indicator. Physical and social systems are dynamic, and changes in them aren't always attributable to a particular cause, especially in the short term (*ibid*.).

Potential

The main advantage for Christchurch City Council of using indicators would be a reduction in the number of measurements which have to be made, and an increase in the understandability of information to decision makers and the public. However, the selection of meaningful indicators is a difficult process requiring some level of specialised experience. The development of the national set of indicators should assist the Council by providing reliable indicators and allowing for comparison and (potentially) coordination and support with other councils.



Appendix 3: The Research Process

Appendix 4: Summary of OECD Review.

The OECD Environmental Performance Reviews (1996) recommended that consideration be given to the following proposals (re: NZ's waste management performance):

- develop a *national waste information database*, including definition and classification of different kinds of waste;
- increase the *involvement of the central Government* in assisting regional authorities with guidelines on waste management practices, especially regarding assessment of environmental effects;
- implement *specific legislation* for the control, treatment and disposal of *hazardous waste*; take steps to facilitate the siting of dedicated treatment facilities within the country and negotiated disposal agreements of other OECD countries, as the need be;
- promote *cleaner production* and *recycling*, including waste reduction at source, creation of recycling facilities within the country or promotion of exports to other countries, by securing markets for recycled products;
- *improve landfill disposal practices* by tightening disposal standards, providing for the collection and treatment of leachate and closing substandard landfills;
- introduce *disposal charges*, taking account of present real and future landfill costs;
- clean up those *contaminated sites* that present the highest risks of contamination to waterways and aquifers.

Appendix 5: Summary of the Draft Waste Management Plan

Principle four of the *Draft Waste Management Plan for Solid and Hazardous Waste 1998* states that the "real costs of waste management shall include social, environmental and economic costs and these will be assessed and reported annually". As shown in the diagram on the following page, 'real cost' (ie. total cost) is one of six principles which address the plan's goal to end landfilling by 2020. This goal is in turn an expression of the plan's overall vision of minimising waste generation and disposal.

The key principles of the plan are inter-related. Principle Four influences on the others and is influenced by them. They are summarised as follows:

1. The first principle, integrated waste management, means that the waste stream is considered as a system, the components of which need to be considered one by one to identify the most strategic approaches to meeting the plan's goals. Total cost must therefore identify and work with components of the waste management system.

2. The principle on tangata whenua identifies Maori as a particularly significant affected party. Development of a total cost framework should therefore give specific consideration to the effects of waste management on Maori.

3. Transparency, accountability and the importance of annual reporting are emphasised in Principle Three. This means a framework for Total Cost Assessment must be very clear (possible to communicate to the public) and reveal lines of accountability.

5. Principle five is about charging of generators or users, directly associated with the 'real cost', in order to provide economic incentives and generate funding to achieve the plan's goal.

6. The informed involvement of the community in waste management policy development and implementation is given emphasis in the plan through principle six. Education and consultation are identified as the vital components of this principle.

A total cost framework must therefore contribute to clearly identifying what the costs are and how they can be attributed to waste management activities and ultimately generation.

Key strategies suggest tools for the implementation of the principles. The main tools suggested are the funding of groups or individuals who are promoting the principles, by-laws (including the licensing of private operators), regular performance evaluation and reporting, and the utilisation and influence of international and national supports. Five objectives respond to the waste management hierarchy, and specific strategies pertaining to the achievement of each of them are provided. The final objective provides strategies for the management of hazardous and special wastes.

'Real Cost' within the Draft Waste Management Plan:

VISION:
- minimise waste generation
- minimise impact of waste disposal
- make the next landfill the last

GOAL:
- nil landfill by 2020.

KEY PRINCIPLES:

Integrated Waste Management:
- Waste management hierarchy
- consider all components of waste stream and address strategically

Tangata Whenua:
- consultative process to identify affecting issues

Transparency:
- open and accountable planning and implementation
- annual progress reporting

Real Costs:
- social, environmental and economic costs
- annual reporting

Charging:
- economic incentives
- transparent charging associated with real cost
- generators and beneficiaries pay
- minimisation funding
- avoidance of cross-subsidisation

Education/Consultation:
- two-way communication
- inform the public

KEY STRATEGIES:
- grants
- by-laws
- evaluation and annual reporting
- international/national involvement

OBJECTIVES (AND SPECIFIC STRATEGIES):

reduce at source	maximise reuse	maximise recycling	maximise recovery	meet residue disposal needs	minimise effects of hazardous and special waste

Appendix 6: Categorisation Guide for Characteristics of the Environment

The following list provides examples of how characteristics of the environment can be further broken down into sub-categories and gives examples of effects in each of those categories. This guides the user of the matrix to help with the identification of potential effects of a specific activity on the environment.

Examples of sub-categories of characteristics of the environment and examples of effects.

Characteristics of the environment					**Examples of effects**
Category		**Sub-categories**			
Biophysical characteristics					
Land		Living (Biota)	Flora (land and soil)	Trees, shrubs, grass, crops, microflora (algae)	Destruction of habitat through new landfill; Effect of dumped or windblown waste on vegetation; Effect of incineration by-products on micro-flora
			Fauna (land and soil)	Birds, land animals, insects, microfauna	Effects of vermin on avifauna and invertebrates; Changes in soil invertebrate populations through chemical contamination;
			Other (land and soil)	Fungi, bacteria	Spreading of bacteria or fungi through waste transportation
		Non-living elements (Abiota)	Rocks		Effects on mineral composition through changes in ground water pH.
			Soil		Soil compaction by vehicles
			Landform		Re-contouring hills

		Physical and ecological processes	Chemical and Nutrient Cycles		Salinisation of soil; Changes in the nitrogen/carbon balance in soils and the effects on plant growth.
			Erosion/Deposition		Landslides; Accelerated topsoil loss due to earthworks; Accelerated weathering.
			Drainage		Reduction in stormwater run-off at compost site; Effect of landfill on ground water infiltration.
			Succession		Repeated disturbance and increase in invasive species.
			Subsidence		Compaction of waste on landfill

Water	Surface water	Living (Biota)	Flora	Aquatic plants etc	Change in microflora population
			Fauna	Fish, eels, mussels	Effects on eel age distribution
			Other	Fungi, bacteria	Effects on fungi distribution
		Non-living elements (Abiota)	Water Quality		Heavy metals and chemical contamination through dumping
		Physical and ecological processes	Flow Characteristics		Reduction in average water velocity through reduction in run-off
			Flood Characteristics		Increase in flood frequency
			Erosion/Deposition		Sedimentation through higher sediment input from earthworks
			Chemical and Nutrient Cycles		Eutrophication through nutrient run-off; Changes in acidity or salinity

	Groundwater	Living (Biota)	Microbes		Changes in microbial concentration through pH changes
		Non-living elements (Abiota)	Water Quality		Increase in nitrate levels; Contamination by hazardous chemicals
		Physical and ecological processes	Water Flow Characteristics		Changes in ground water flow rate through altered soil structure
			Water Table		Localised drop in water table
			Chemical and Nutrient Cycles		The process of acidification or salinisation
	Coastal/Estuarine	Living (Biota)	Flora	Sea weed, microalgae	Destruction by leachate from landfill; Effects of illegally dumped rubbish on dune flora.
			Fauna	Fish, shellfish	Leachate of landfill, old deposal sites
		Non-living elements (Abiota)	Rocks		Increased weathering
			Landform		Dune removal for access road
			Soil and sediments		Introduction of foreign elements
			Water		Increase in suspended solids
		Physical and ecological processes	Erosion/Deposition		Dune immobilisation
			Water Currents		Effects of structures in coastal marine area on currents
			Chemical and Nutrient cycles		Increased nutrient in estuary due to run-off

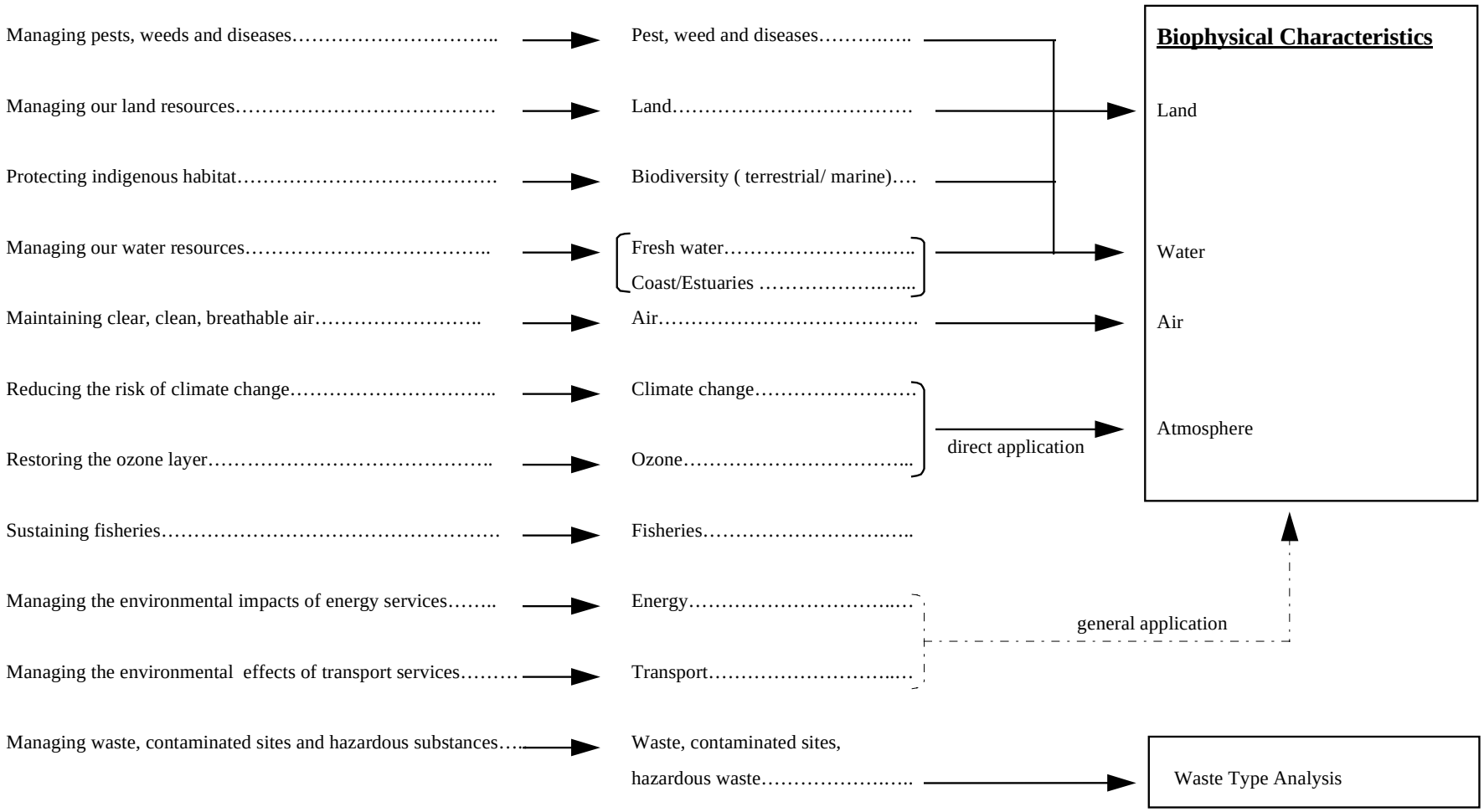
Marine	Living (Biota)	Flora	Sea weed, phytoplankton	Change in species balance due to nutrient input
		Fauna	Fish, coral	Increased fungal growth on fish
	Non-living elements (Abiota)	Sea floor	Sediments, rocks	Change in sediment size through fine sediment run-off
		Water Quality		Pesticide contamination
	Physical and ecological processes	Erosion/Deposition		Increased sedimentation due to sediment-heavy run-off
		Water Currents		Change in currents due to decreased fresh water input
		Chemical and Nutrient Cycles		Increased nutrient flow to seafloor ecosystem

Air	Living (Biota)	Flora	Algae, bacteria, fungi	Effects of increased airborne sulphurous compounds on airborne fungi
		Fauna	aerial “plankton”	Increased number of windblown invertebrates due to landfill
	Non-living elements (Abiota)	Air Quality		Particulate levels increased by burning
	Physical processes	Air movement		Effects of rising warm air from compost.
		Microclimate		Reforestation after closure of landfill

Atmosphere	Physical processes	Greenhouse Effect	CO_2, CH_4, CFC’s levels	Landfill gas and vehicle exhaust emissions
		Ozone Layer	CFC’s	Landfill gas and air conditioning
		Other processes		

Social characteristics		
Health and Safety	Staff, community	Exposure to hazardous waste; Diseases born by vermin.
Spiritual values		Defiling of sacred land
Cultural values		Effects of using of culturally offensive methods on sector of community
Historical values	Historic sites and objects	Effects of loss of historically significant building
	Monuments	Effects of loss of symbolic structure eg statue
Scientific values	Geology, Ecology, Architecture etc	Effects of loss of access to geologically significant outcrop or local population of species
Aesthetics	Odour	Compost facilities, refuse stations, landfill
	Noise	Machinery at refuse station, landfill, collection vehicles
	View (landscape)	Change of landscape through new landfill; Presence of rubbish in streets
Recreation	Fishing, boating, swimming, camping, walking, tramping, picnicking	Decreased recreational value caused by pollution of waterways,
Land use	Wilderness and open space, wetlands, forestry, grazing, agriculture, residential, commercial, industrial, mining and quarrying	Opportunity costs of land for refuse station.
Other		

Economic characteristics		
Socio-Economic Costs	Property Values	Cost of reduced property values near landfill
	Transport Costs	Cost of travelling to distant refuse station
	Employment	Benefit to society of hiring new staff for waste recovery programme
Direct Financial Costs	CCC	Cost of running Waste Management Unit
	Contracted service providers	Cost of petrol in collection trucks
	Independent service providers	Cost of buying wheeli-bins
Indirect Financial Costs	CCC	Cost of needing larger building to accomodate the Waste Management Unit
	Contracted service providers	Cost of paying for sick leave due to unexpected health effect of waste
	Independent service providers	Cost of reduction in resale value of buildings due to operation of waste management service



Appendix 7: Diagrammatic representation showing the links between goals of the Environment 2010 Strategy, proposed Environmental Performance Indicators and broad categories used in the framework for total cost assessment in table 1 (p.69).

Appendix 8: Resource Management Act 1991. Fourth Schedule (s 88(6)(b))

ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

1. Matters that should be included in an assessment of effects on the environment—

Subject to the provisions of any policy statement or plan, an assessment of effects on the environment for the purposes of section 88(6)(b) should include—

(a) A description of the proposal:

(b) Where it is likely that an activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity:

(c) *Repealed, as from 7 July 1993, by s 225 Resource Management Amendment Act 1993 (1993 No 65).*

(d) An assessment of the actual or potential effect on the environment of the proposed activity:

(e) Where the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment which are likely to arise from such use:

(f) Where the activity includes the discharge of any contaminant, a description of—

(i) The nature of the discharge and the sensitivity of the proposed receiving environment to adverse effects; and

(ii) Any possible alternative methods of discharge, including discharge into any other receiving environment:

(g) A description of the mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect:

(h) An identification of those persons interested in or affected by the proposal, the consultation undertaken, and any response to the views of those consulted:

(i) Where the scale or significance of the activity‘s effect are such that monitoring is required, a description of how, once the proposal is approved, effects will be monitored and by whom.

2. Matters that should be considered when preparing an assessment of effects on the environment—

Subject to the provisions of any policy statement or plan, any person preparing an assessment of the effects on the environment should consider the following matters:

(a) Any effect on those in the neighbourhood and, where relevant, the wider community including any socio-economic and cultural effects:

(b) Any physical effect on the locality, including any landscape and visual effects:

(c) Any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity:

(d) Any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural, or other special value for present or future generations:

(e) Any discharge of contaminants into the environment, including any unreasonable emission of noise and options for the treatment and disposal of contaminants:

(f) Any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations.