INTEGRATED WASTE MANAGEMENT

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Abstract

Integrated waste management is considered from a systems' approach, with a particular emphasis on advancing sustainability. The focus of the thesis is to examine the various subsystems as they apply in a New Zealand context and to scrutinize the developments of these subsystems in a time where there has been a renewed worldwide interest in sustainability.

Fonterra is evaluated as a prime industry example along with the Ministry for the Environment as the government representative. Both Fonterra and the government have made some progress in addressing the problem of waste and so far they have followed a similar path as their sectors worldwide in that they have addressed parts of the waste issue but not as an ongoing and systematic approach to provide a sustainable solution to waste.

The initial aim was to investigate the current state of practice to gain an insight into the integration of waste management. Research into the relevant literature along with a combination of data collection and interviews were organised with practitioners and stakeholders from Fonterra, the Ministry for the Environment, local government waste officials, local and central government politicians, consultants and non-governmental organisations.

The thesis identifies pockets of an integrated approach to waste management internationally and even some elements of a systems approach. The path to an integrated approach usually starts with a simple framework like a waste management hierarchy operating in one medium and progresses to multiple media. A range of existing tools provides the flexibility for a systems approach focusing on the processes that increase resource efficiency. The use of leverage points at opportune times can enable substantial improvements in a waste management system that provides opportunities for ongoing systems based integration and the saving of both money and resources.

Additionally, integrated waste management systems require agents including site managers, company head office, councils, central government and the community to work together in a cooperative, transparent and coordinated manner. The thesis has provided a way forward to move towards sustainability through an integrated approach to waste management.

Preface

The genesis of this thesis came about as a result of looking for a research-based direction for my life. I had been a programme director for the Bachelor of Engineering (Environmental) and the associated Diploma in Environmental Technology for five years. During that time I had led the degree from the stage of meeting the academic standards for accreditation to the Institution of Professional Engineers to full accreditation. I could have kept on doing the same thing for many years to come, but I wanted to have a new challenge in my life.

During the time I was a programme director I had been conducting research and publishing, and that was an area that excited me. While considering that I wanted to spend more time following my passion of research and publishing, I thought it would be good to undertake a coherent body of research – and that was the start of this thesis.

One of the hard bits is always deciding what area and what topic. I knew that something in the waste minimisation area was appropriate (having focused on this area in my lecturing and research) and I investigated the possibilities around this within the disciplines of engineering and science. In the end the technological aspects of engineering did not excite me so much as I knew that, while technology is extremely important in the area of waste, it was not the prime solution to New Zealand's waste problems – we have well engineered landfills that capture leachate and methane emissions, wastewater treatment plants that can almost produce drinking water quality outputs, filters and scrubbers to take care of air emissions and industrial energy-saving methodology was well known. To me there was more to waste minimisation than technology and with all the technology there was still a long way to go until New Zealand could say that we are a sustainable country.

It was with this in mind that the idea of integrated waste management evolved as a topic.

Integrated waste management has been around for a long time. In the earlier years, in the 1970's, it was centred on the newly invented concept of a waste management hierarchy. With the advent of the idea of pollution prevention in the 1990s waste researchers suggested the idea that the waste management hierarchy could also be applied to media other than solids – liquids, gases and energy.

Along with these expansions were an underlying set of tools that could be used to assist waste minimisation – voluntary, educational, legislative and economic.

To make the tools work required people to engage and move the frontier forward. The people come from all walks of life – central government, local government, business and people in the community.

Just as the main body of experimental work for this thesis was being completed the waste scene in New Zealand went through a momentous step forward with the introduction of New Zealand's first waste focused legislation. The opportunity arose for me to make a significant contribution to the passage of this legislation, by leading the team within the Ministry for the Environment

that was responsible for assisting Parliament in getting a workable piece of legislation enacted – the Waste Minimisation Act 2008 finally passed on 25 September 2008. It was quite an unorthodox process in that the Bill started off as a Private Member's Bill (the Waste Minimisation (Solids) Bill), was supported by the government and then was finally unanimously passed by Parliament. This provided valuable background to this thesis.

In developing the thesis I have seen a systems approach showing how people can work together (from disparate backgrounds and viewpoints) to use a variety of tools to minimise waste in an integrated manner. While elements of this are commonly found in many countries, this thesis brings them all together.

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My sincere thanks go to my initial primary supervisor, Dr Lesley Stone from the School of Environment who provided the initial vision for this topic and guided me through the initial phases to add the framework to the concept. Your ideas for a topic were by far the most exciting of all of those I surveyed and took me down the path I wanted and needed to go.

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Glossary

ACT	Australian Capital Territory
BOD	Biochemical oxygen demand
CIP	clean in place
CIWMB	California Integrated Waste Management Board
COD	chemical oxygen demand
DAF	Dissolved Air Flotation
Defra	Department for Environment, Food and Rural Affairs
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
EPR	Extended Producer Responsibility
EU	European Union
EUREPGAP	European Partnership for Good Agricultural Practice
EW	Environment Waikato
GRI	Global Reporting Initiative
HDPE	High Density Polyethylene
IE	Industrial Ecology
IPP	Integrated Product Policy
ISO	International Standards Organisation
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MAF	Ministry of Agriculture and Forestry
MfE	Ministry for the Environment
MoRST	Ministry of Research, Science and Technology
NGO	Non-Government Organisation
NH_4^+	Ammonium Ion
NO_x	Mixture of nitrogen oxides
NYC	New York City
OECD	Organisation for Economic Cooperation and Development
P2	Pollution Prevention
PM_{10}	Particulate with a diameter smaller than or equal to 10 µm
RIS	Regulatory Impact Statement
RMA	Resource Management Act
RONZ	Recycling Operators of New Zealand
SMF	Sustainable Management Fund
SO_x	Mixture of sulfur oxides
TLA	Territorial Local Authority
UN	United Nations
UNEP	United Nations Environmental Programme
USEPA	United States Environmental Protection Agency
WasteMINZ	Waste Management Institute of New Zealand

Chapter 1: Introduction

1.1 Setting the Scene

1.1.1 Purpose

The purpose for this thesis is to research integrated waste management through a systems approach, with a particular emphasis on advancing sustainability.

The need for research in this area is that there is a growing awareness that a consideration of waste on its own is not an effective way of dealing with an inefficient use of the world's resources. With a finite resource base in the world and the continued unsustainable practice of depleting these resources beyond the world's carrying capacity for renewal, future generations will not be able to have the resources that we now have available to us.

1.1.2 Context

The context for this research is provided by the growing quantities of emissions and the reduced capacity of the earth to effectively deal with these emissions. It is within this scenario that an effective way must be found to provide a system that moves towards a less wasteful economy and hence, uses our resources more efficiently. A possibility to achieve this is through integrated waste management.

Integrated waste management is an encompassing concept in which an integrating framework is considered in such a manner that waste generators utilise their waste streams more efficiently.

There are examples of integrated waste management applied to aspects of waste streams (Seadon, 2006) and some are even quite complex. For example, Project Integra in Hampshire, England has fifteen formal partners – 14 councils and a waste management company (Slater *et al*., 2007). The largest frustration noted in this combination was the governance structure which resulted in cumbersome management duplication. The resolution of one partner, one vote and the management board able to act within the

annual plan, once developed, has enabled the partnership to operate more efficiently (Slater *et al*., 2007).

The trend towards integration has meant that waste companies have needed to become more innovative as well as resource and capital intensive. The old paradigm of collect, transport and dump has been replaced by diversion methods that have reduced the amount of material that is collected and even more the amount that is dumped. The UK strategy for sustainable development (Department of the Environment, Transport and the Regions, 1999) led to an increasing trend of integrated waste management contracts for solid waste that required injections of capital and resources for local authorities to meet national targets for waste diversion (Adams, Phillips and Morris, 2000).

The often performed reductionist cost-benefit analysis provides limited information on the viability of a project. Integrated waste management also incorporates input from political, social, environmental, technological and financial disciplines. As these disciplines demand different skills, an integrated waste management approach also requires a team-based approach (Skordilis, 2004). In addition, the influence of a locality comes into the mix as the subsystems of global, national, regional, local and finally households influence the process (Eschet, Ayalon and Schecter, 2006).

Many industry organisations embark on small-scale programmes to save resources, but once small initial gains are made (picking the low hanging fruit) the enthusiasm and the perceived necessity for carrying on dissipate. Various agents (community, business and government) can be brought into the mix to encourage the continuation of the programme, but many of the programmes that we have experienced so far in New Zealand have reached the same point in their evolution and then stopped. It is time to evaluate what can be done by various agencies and using a variety of mechanisms, in order to move the process further down the track to sustainability.

This study, using Fonterra as a prime industry example, starts from the position that Fonterra has done a little to reduce some of its wastes and so far it seems to be following the same path as many other businesses that have

reduced a bit of waste and then stopped that part of the process. This is an opportunity to change that and to produce a different outcome.

1.1.3 Contribution to Knowledge and Focus

The author's contribution to knowledge, within the scene set above is the development of the concept that the complexity of integrated waste management means that it needs to be treated as a complex adaptive system. Within that system the subsystems of the waste management hierarchy, multi media, tools and agents interact with each other.

The focus of the thesis is to examine the various subsystems as they apply in a New Zealand context and to scrutinize the developments of these subsystems in a time where there has been a renewed worldwide interest in sustainability.

1.2 Key Issues

Waste in New Zealand is not the problem. New Zealand has the capacity to contain solid waste in landfills that capture leachate and methane emissions. Waste water can be treated to almost drinking water quality and the harmful nature of air emissions can be mitigated through the application of technologies like scrubbers and precipitators. Waste is actually only an indicator of the real problem – the inefficient use of resources and the unsustainable manner in which New Zealand uses resources.

In the broader environmental sense the key planning tool in New Zealand has been the Resource Management Act 1991, an Act which focused on outcomes rather than processes. When the Act was passed New Zealand became one of the first countries in the world to incorporate the concept of sustainable management in legislation, and with it an integrated framework and goals for resource and environmental management. This Act had its most effect on the resource efficiency when it came to discharge of wastes to the environment.

This end-of-life approach was an inefficient approach to encourage resource efficiency. Merely increasing the costs of disposal, caused by the requirement

to reduce environmental impacts, did not have much effect on quantities discharged to the environment.

A more focused approach to dealing with waste minimisation issues was the enactment of the Waste Minimisation Act 2008. This Act enables a systems approach to be adopted through the provisions of mandatory reporting, targeted funding, and enforced product stewardship schemes to deal with specific waste products. All of this is backed up with provisions for enforcement, monitoring and auditing.

With a baseline of legislation including economic instruments, and a history of using voluntary mechanisms and educational programmes, the key issue will be to use the combination in an effective manner to "*move towards zero waste and a sustainable New Zealand*" – as described in the strapline for the New Zealand Waste Strategy (MfE, 2002a).

1.3 Research Questions

The thesis addresses the key issue of how to get integration across all components of the waste sector to achieve a more sustainable use of resources in a manner that produces a feasible outcome for all the stakeholders. This will be done by answering the following primary questions.

1. Can integrated waste management contribute to sustainability, and if so, how?
2. What does integrated waste management mean in different societal contexts?
3. How does a systems approach assist the movement to a sustainable waste management system?
4. How can a waste management hierarchy be used to manage waste in an integrated manner?
5. How are tools used to manage waste in an integrated manner?
6. How do agents coordinate to manage waste in an integrated manner?

1.4 Method

The research for this thesis addresses these six questions in the context of the New Zealand system.

The overall approach to the investigation involved a picture of the current state of practice through a number of means to gain an insight into how waste management could be integrated. An extensive research into the relevant literature and a combination of data collection and interviews were organised with practitioners and stakeholders.

A central case study of a business, Fonterra Co-operative Group, was investigated in depth.

Fonterra is one of the world's top dairy companies, coming 7th in the world based on turnover (Danish Dairy Board, 2008). The history of dairying in New Zealand is one of expansion enabling a proliferation of dairy companies and then a gradual amalgamation of those dairy companies, until now Fonterra Co-operative Group Ltd became the dominant player representing 95% of the dairy outputs of New Zealand. Over the years, as the number of dairy cattle increased, the number of dairy companies decreased (Hill, 2003). The driving factors in the decrease in the number of dairy companies were the transportation infrastructure improvements that started in the 1950s that allowed factories to be at greater distances from the producers and the milk storage and processing facilities improved so that larger quantities could be processed at each facility.

The history of dairy production in New Zealand is one of diversification of products and markets. Changes that have occurred through the years have first led to improving the quality of the milk coming in and then later moved on to processing greater quantities of milk as dairy production increased in New Zealand and export markets also increased. While the accent has been on extracting more materials from the milk, the results have also indicated that the quality of the effluent has also improved, thus reducing the environmental impact.

The boundaries chosen with Fonterra were delivery to the milk processing sites and departure from those sites. The interactions with this business was

interlaced with input from local and central government, and community and industry groups to give triangulation between all three sectors.

In the process a large amount of process data was collected from Fonterra, 83 Fonterra employees (management, environmental management, production staff and union employees) were interviewed from 23 sites throughout New Zealand. In addition, local government waste officials, local government politicians, consultants, non-governmental organisation officials, Ministry for the Environment officials and central government politicians from three parties were interviewed on issues from the application of the waste management hierarchy to sustainability concepts.

1.5 Thesis organisation

The thesis itself has been organised in a series of chapters that will take the reader through the key components of the research in a sequential manner.

Chapter 1: Introduction

This chapter sets the scene by giving a background for the research and introduces the issues, research questions, the methodology and how the rest of the thesis ties together.

Chapter 2: Integrated Waste Management – Looking Beyond the Solid Waste Horizon

The chapter gives a background on what has been done in regard to integrated waste management in different contexts. The literature search covers case studies from Asia, Europe and North America. New case studies revolve around the United States and the ways in which individual operations are using an integrated waste management approach in various contexts.

It looks at integrated approaches by considering various subsystems of methods to deal with waste. In its simplest sense, integrated waste management incorporates the waste management hierarchy (reduction, reuse, recycle, recovery, treatment and disposal) and considers how application of a hierarchy has been used to divert waste from disposal options.

Consideration is then given on how a common approach using the hierarchy has been used in different media (solid, liquid, gas and energy) to reduce products and materials entering the waste disposal stream and then how it has been used in multi-media applications.

In order to implement waste minimisation change agents need to be involved. These agents consist of government (both local and central), business and the community committing to change and using a series of drivers to achieve that change. The drivers include economic factors, political, socio-cultural and technological advances working in combination.

The chapter then considers what tools have been used to implement an integrated waste management approach. The tools considered fall into the categories of legislative, economic, voluntary and informational mechanisms. Consideration is given on how they have been applied in an integrated manner and the results and learning that came from the case studies. The majority of this chapter is published in *Waste Management* (Seadon, 2006)

Chapter 3: Sustainable Waste Management Systems

This chapter considers waste management viewed as part of a generation, collection and disposal system. A systems approach that examines waste from the perspective of it acting like a complex adaptive system is taken. Thus, a soft systems approach was needed to understand the behaviour of waste systems.

The understanding of waste systems through a systems approach allowed for identification of ways to change the effectiveness of the operation of a system. When applied effectively to waste management systems, the systems approach enabled them to become more sustainable. Examples are used to show how this happened.

Chapter 4: The Waste Management Hierarchy

This chapter considers the waste management hierarchy as a tool to advance sustainable waste management systems. Although worldwide there are many versions of the hierarchy, the one that is adopted is the New Zealand version

– reduction, reuse, recycle, recovery, treatment and disposal. It considers the implementation of the Hierarchy from a multipronged approach, where some actions can be taken at the local level and others need to be carried out as national initiatives.

The Hierarchy as a framework for waste reduction at Fonterra is examined as a practical application in industry. Within that case study barriers to implementation are reviewed and effective ways of implementing waste reduction that Fonterra has carried out are presented.

This chapter also considers the subject of integration across media. The interpretation used here is to cover the three physical media (solid, liquid and gas) as well as energy. This approach was adopted as it became obvious from previous studies that there was a great overlap of methods used with the inclusion of all four 'media'. To consider media in isolation would mean that conveying waste from one medium to another would constitute a solution to a waste problem, instead of merely transferring the problem. In the light of a systems approach, all media needed to be considered as an integral part of the process under consideration.

Chapter 5: Integration of Tools

This chapter considers the various tools (policy, economic, voluntary and informational) that are available and how they can be used in an integrated manner to effect change to a system.

During the course of producing this thesis, New Zealand was in the fortuitous stage of enacting its first waste specific legislation and the process that the legislation went through to get multi-sector and multi-party buy-in is reviewed. This showed a systems approach by the government and examined how various drivers were used to effect change.

An examination of the tools that were available to the government and business individually was also considered and how these could be integrated.

Chapter 6: Integration of Agents

This chapter considers the roles of agents (central and local government, business and the community) in moving towards sustainable waste management. Each of the agents is an agent for change and they have different tools available to them to effect change.

The ways of coordinating within the groups of agents and between agents are considered and ways to achieve better cooperation are brought out. For a system to work effectively, the components (which include agents) must be able to work together effectively. Methods for achieving this were presented from across the spectrum.

In addition, the integration of waste management into business practices was examined. The system to address waste management was studied to see the effectiveness of having it as part of every business expenditure decision annually as well as on a project by project basis and how the risks were analysed. The precautionary principle was included in the analysis phase and how that was handled by the Company.

Chapter 7: Conclusions

CHAPTER 2: INTEGRATED WASTE MANAGEMENT – LOOKING BEYOND THE SOLID WASTE HORIZON[1]

2.1 Purpose

The purpose of this chapter is to examine what has happened internationally to manage waste in an integrated manner.

2.2 Context

Waste as a management issue has been evident for over four millennia. Disposal of waste to the biosphere has given way to thinking about and trying to implement integrated waste management. In 1996 the United Nations Environmental Programme defined 'integrated waste management' as '*a framework of reference for designing and implementing new waste management systems and for analysing and optimising existing systems'* (UNEP, 1996).

In this chapter the concept of integrated waste management is considered, along with the parameters that constitute integrated waste management. The examples used are put into four categories:

1. integration within a single medium (solid, aqueous and atmospheric wastes),
2. multi-media integration (air, water, solid and energy wastes),
3. tools (regulatory, economic, voluntary and informational) and
4. agents (governmental bodies, businesses and the community).

This evaluation allows for the development of guidelines for enhancing success:

1) as experience increases, it is possible to deal with a greater complexity and
2) integrated waste management requires a holistic approach, which encompasses a life cycle understanding of products and services.

[1] This chapter was published in the paper: Seadon, J. (2006), "Integrated waste management – looking beyond the solid waste horizon", *Waste Management*, vol. 26, no. 12, December 2006, pp. 1327 – 36

This in turn requires different specialisms to be involved in the instigation and analysis of an integrated waste management system. Together these advance the path to sustainability.

2.3 Introduction

An estimation of the usage of raw materials consumed by the USA each year shows that only 6% ends up as product (Ayres, 1989) and only 1% ends up as durable products (Hawken *et al*., 1999). The rest is waste in one form or another. Given the size of the US economy, the resulting management problem is immense.

In primitive societies small communities could bury solid waste in middens just outside their settlement, discharge aqueous waste onto the ground or into the local stream and release gaseous emissions into the air. As communities grew in size, a more organised form of waste management was needed to avoid odour and disease. For example, some of the earliest records show that by 2000 B.C. Mahenjo-Daro (Indus Valley) had organised solid waste management processes, Crete had trunk sewer systems (Vesilund *et al*., 2002) and London banned the burning of soft coal in kilns in 1285 to counter air pollution (Molak, 1997).

Historically, health and safety issues have dominated waste management (Ponting, 1991). Once personal health issues had been stabilised, community health issues became the focus (e.g. the proliferation of landfills, the odour problems associated with sewage treatment plants and the health-impacting air emissions from industrial and domestic sources).

In order to enable legislators to deal with the problems of waste it was necessary to define what constitutes waste in order for them to outline articles and practices that needed to be dealt with in a managed way. For example, the German Waste Act (1972) defined waste as *"portable objects that have been abandoned by their owner(s)"* or *"requiring orderly disposal to protect the public welfare"* (Bilitewski *et al.*, 1994). The USA defined waste in the Resource Conservation and Recovery Act (1976), as "*any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid,*

semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities". The definition goes on to specifically omit "*solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges*" (Legal Information Institute, 2003). This definition broadens the scope beyond solid forms of waste.

A more concise, encompassing definition is found in the New Zealand Waste Strategy (Ministry for the Environment, 2002) which defines waste as "*any material, solid, liquid or gas, that is unwanted and/or unvalued, and discarded or discharged by its owner"*. These definitions lay the foundation for waste management to be considered in an integrated manner.

2.4 The Development of Integrated Waste Management

Some firms, in order to avoid or mitigate a regulated medium, have switched routes for waste disposal (e.g. landfill disposal to incineration) (Clayton and Radcliffe, 1996). Such behaviour reinforces that waste management issues are inter-related and therefore need to be treated in a more integrated manner.

Integrated waste management in its simplest sense incorporates the waste management hierarchy (Turner and Powell, 1991) by considering direct impacts (transportation, collection, treatment and disposal of waste) and indirect impacts (use of waste materials and energy outside the waste management system) (Korhonen *et al.,* 2004). It is a framework that can be built on for optimising existing systems as well as the design and implementation of new waste management systems (United Nations Environmental Programme, 1996). Integrated waste management is also a process of change that gradually brings in the management of wastes from all media (solid, liquid and gas) (United Nations Economic Commission for Europe, 1991).

This is best dealt with through a soft systems approach. A concise definition of a system is: "[a] *set of interacting units or elements that form an integrated whole intended to perform some function*" (Skyttner, 1996). In a systems approach the problems are multidimensional and multidisciplinary and so the

solutions must reflect this complexity. The multidimensional aspect also includes the economic sector. In this regard, both monetary and non-monetary analyses need to take place and there needs to be recognition that many of the non-monetary resources are unique and their depletion is irreversible. The systems approach requires a long-term perspective, and analysis may need to extend across geo-political borders (Södeerbaum, 1987).

Despite an initial systems approach to waste management by Lynn (1962), one of the first areas to consider waste in an integrated manner was Palm Beach County (PBC) in Florida in 1975, which used solid waste as the starting point. They considered waste as an integrated system when they proposed that their waste management programmes would integrate *'solid waste transportation, processing, recycling, resource recovery and disposal technologies'* (McDougall *et al.,* 2001). The PBC currently operates collection contracts, a waste-to-energy plant, five regional transfer stations, landfill operations, a compost facility, household hazardous waste collections and two material recycling facilities. By 2004, PBC was dealing with 1.78 Mt of municipal solid waste: 48% was landfilled, 12% recycled, 9% reused, 28% reduced and the remaining 4% was kept as inventory (Solid Waste Authority of Palm Beach, 2004).

The idea of waste reduction further developed in 1995 out of the total quality management construct, to the ideal of zero waste in which there is no generation of waste since all materials (whether solid, liquid or gaseous) will be diverted before they reach the waste stage (May and Flannery, 1995). .

Integrated waste management has meant different things in different societal contexts. As will be seen in the following sections, for some it has meant considering different methods of diversion within a single medium, for others integrating waste management across different media, for others using a variety of tools, and for still others a variety of organisations working together. In considering these subsystems, it should be possible to integrate them in a manner to move towards sustainability of the system.

2.5 Integration Within a Single Medium

The requirement by governments for a more refined waste management system has been quite apparent, particularly when dealing with solid waste. It is only more recently that the same thinking has been applied to aqueous waste and air emissions.

2.5.1 Solid Waste

Many programmes have adopted a waste management hierarchy to address solid waste. A recent example is given in New Zealand's Local Government Act Amendment No. 4 (1996) which defines the hierarchy as: *reduction, reuse, recycling, recovery, treatment and disposal*.

The ready endorsement of the hierarchy coupled with an almost mantra-like acceptance among waste professionals, has stymied discussion on its worth. However, challenges to the suitability of the hierarchy are starting. The strong selling point to the public of simplicity belies a need for a deeper understanding of its limitations. McDougall *et al.,* (2001) called attention to: the lack of scientific or technical basis; it being little use for combinations of options; it did not address costs and it did not allow for unusual constraints (e.g. low population or isolation).

To incorporate a long-term, viable, solid waste management system into a societal context requires that all the elements in the waste management hierarchy be addressed in an integrated approach. The system needs to be one that is market oriented, has the benefit of the economy of scale and is socially acceptable (McDougall *et al.*, 2001).

An integrated system would inevitably require some cross subsidisation as some parts would be profitable and others loss-making, and so the system must be considered in a holistic way. It would need to cater for all materials (and not just those that could be exploited immediately), and from all sources (domestic, commercial, industrial, institutional, construction and agricultural) (McDougall *et al.*, 2001).

Integrated waste management is more than providing a waste collection and recycling solution to the problem of waste. Thornloe *et al*. (1997) observed that much of what was termed integrated waste management in the USA was

focused on individual components making up the scheme and not on the scheme as a whole.

Technical and economic aspects are just two facets of a scheme. To gain social acceptability public participation is vital and communication is a vital part to secure this. In an industrial district study, Evans and Seadon (2003) found that 28% of the participants joined simply because they were personally asked. This was only exceeded by those who joined for environmental reasons (50%). Only 12% joined for financial reasons, which was surprising as many references focus selling programmes on their financial objectives (e.g. de Groene and Hermans, 1998 and McDougall *et al*., 2001)

Another factor assisting success is targeted communication. In Evans and Seadon (2003), the communications were targeted to the industrial sector which produced measurable benefits, including a ten-fold increase in kerbside recycling. When Auckland City (New Zealand), changed its waste collection system in 2001, the associated blanket communications through newspapers, radio and leaflets delivered to households had variable results (Seadon and Hopkins, 2003). The 50% downsizing of the mobile garbage bins resulted in an average 42±4% drop in quantities across all socio-economic sectors, but the expansion of the recycling programme had mixed results with increases of 54% for the medium-low socio-economic group and 19% for the highest group to a decrease of 80% for the lowest grouping. The study concluded that a more targeted communications programme using pictures, multiple languages and groups that were familiar to the communities would have produced better participation (Seadon and Hopkins, 2003).

2.5.1.1 Government-Led Initiatives

Governments in many countries have actively encouraged waste reduction. Governmental organisations have championed the move for waste diversion to reduce the quantities sent to landfill.

In the USA, Congress addressed the perceived growing problems of solid waste, material, energy and conservation issues from the 1970s (Kovacs, 1993). The results of ongoing monitoring have shown a steady increase in

the amount of municipal solid waste from 110 Mt/y in 1960 to 214 Mt/y in 2003 which amounts to a change from 1.2 kg/person/day in 1960 to a plateau of 2.0 kg/person/day from 1990 (USEPA, 2005). The implementation of the more proactive Pollution Prevention Act (1990) appears to have levelled the per capita increase since 1990.

In a democratic system, bureaucrats are answerable to politicians who are ultimately answerable to the citizens. Hence, the power of the citizens is not to be underrated. Politicians are also more likely to get behind an idea when they sense that there is popular support for that idea. For example, in New York City (NYC), an integrated waste management plan that focussed on the solid waste stream was adopted in 1988 (Clarke *et al*., 1999). A 20-year plan worked on by twelve consultancies produced twelve different outcomes. Half called for a waste-to-energy plant with associated composting and landfill sites and the other half used a combination of material recovery facilities, processing plants, composting and landfills as their solutions. Citizen Advisory Boards rejected all twelve plans in 1992, and after meeting with communities, called for a plan that gave greater emphasis to source reduction and recycling.

A major factor for generating support for a plan is the need for education. In NYC's case, one of the negative outcomes from the eventual plan was that with sporadic, basic education campaigns, participation by the community was quite low (40% of targeted recyclables) but with quite high costs (up to $300/t), which resulted in the programme coming under attack at each funding round (Clarke, *et al*., 1999). However, due to the overwhelming support of the Advisory Boards, NYC continued to support the programme and by the mid-1990s the process bore results. The kerbside recycling programme reached a peak of 20% (877 000 t/year) in 2002. However, market-driven political interference by the newly elected mayor led to a suspension of plastic and glass recycling (recycling dropped to 11.5%) but these were gradually restored over the next two years as the cuts were seen to have a minimal effect on the budget and pressure mounted from recycling advocates, but the recycling rate has not yet returned to the previous levels (Department of

Sanitation New York, 2005, Council of the City of New York, 2004 and New York City Independent Budget Office, 2004).

In a different approach, politicians enacted the Californian Integrated Waste Management Act (1989) in response to the increased solid waste stream and decrease in landfill space in California. The Act set up the California Integrated Waste Management Board (CIWMB), which laid down diversion rates of 25% by 1995 and 50% by 2000 (El Dorado County, 2003). By 2000, California had achieved a 42% diversion which rose to 48% by 2002 (CIWMB, 2005).

The CIWMB (2001) reported that the most difficult part of the waste analysis was to determine the quantities of recycled materials since the number of recycling outlets was quite large. The issues centred on the metrics: some facilities did not have scales, determination of the origin relied on the hauler providing correct information and the survey cycle of one week per quarter lacked accuracy. The solution was to change to a disposal-based measurement system. More recently, the attainment of the 50% reduction caused difficulties (CWIMB, 2004) with large numbers of Counties seeking time extensions to fulfil their target reductions.

A government initiative that regarded community consultation and buy-in as pivotal to the success of the programme came from the Australian Capital Territory (ACT) government in 1996 (Palmer and Hurren, 2002). This was the first scheme in the world to set a goal of no waste (zero waste) by 2010. As part of their programme, ACT implemented an integrated waste management plan that focused on solid waste reduction. To achieve this, they set up a resource recovery centre, which diverted materials from the combined waste stream and stored those materials that were not yet economic to sell until the time came that they became revenue-effective. Starting from an initial 22% of waste diversion in 1993/94, ACT diverted 70% (492 000 t) of the total waste in the 2003/04 year (ACT NOWaste, 2005), well on the way to their target.

2.5.2 Aqueous Waste

The integration of wastewater treatment has occurred within the industrial setting, as part of a municipal wastewater treatment system or an overall

water treatment scenario which encompassed freshwater through to wastewater treatment.

An early example of integrated waste management occurred in the 1970s when the term was applied to chemical rinsing of an electroplating plant effluent (McDonough and Stewart, 1971). This type of rinsing prevented the majority of heavy metal solids formed in the chemical rinse from reaching the succeeding water rinses by streaming the chemical rinse solution to a treatment reservoir. The overflow from the reservoir was pumped back to the rinse tanks, forming a complete closed-loop system (McDonough and Stewart, 1971).

The options available to industrial users for wastewater utilisation focussed around the reuse of the water, regeneration and reuse, regeneration followed by recycling and finally process changes as demonstrated by Ujang *et al*. (2001) at an old textile plant. They sought to minimise water usage by means of an integrated design process that employed the reuse of the water and the treatment followed by its reuse.

In another example Downing *et al.* (2002) looked at the integration of wastewater treatment by integrating wastewater pond design, solid separation equipment and membrane technology to regenerate the water. The efficiency of removal of contaminants went from 82% of BOD and 80% N to >99% for both.

2.5.3 Air Emissions

The consideration of air emissions was a development that generally came after the consideration of solid and aqueous waste. In the USA, The Clean Air Act (1970) allowed the Federal Government to set emission standards (USEPA, 1999). Revisions in 1977 and 1990 encouraged industry to reduce air emissions that produced acid rain and further amendments in 1997 centred on reducing ozone and particulate matter (USEPA, 1999). In a parallel move, the Superfund Amendments Reauthorisation Act (SARA) (1987), which made reporting of toxic chemical usage and discharges mandatory for industry, was enhanced by the Pollution Prevention Act (1990) and the Clean Air Act Amendments (1990). These three Acts worked

together to require reporting on emissions, source reduction measures, recycling and treatment (Ohshita *et al.*, 1993). As a result, from 1970 to 1990 air pollution levels had reduced by 27%; in the subsequent 14 years they reduced to 54% of the 1970 value (USEPA, 2005).

An example of the influence from a group of countries occurred in the UK where the Environmental Protection Act (1990) laid the foundation for integrated air pollution control. The Act resulted in the Department for Environment, Food and Rural Affairs (Defra) requiring operators to use best available technology for prevention and then reduction of pollutants to acceptable levels (Defra, 2005). The Act has been assisted by the European Commission's Directive (96/62/EC) on ambient air quality assessment and management. The results have shown an approximate 15% per annum decrease in the number of pollution days from 1993 – 2003, but with wide fluctuations between individual years, which have been attributed to changing weather patterns (Environment Agency, 2005).

2.6 Multi-Media Integration

A multi-media approach, which considers the air, water and solid emissions, enables a more holistic picture to become evident. All too often, the transfer of waste from one medium to another is seen as a solution to a problem (e.g. incinerating solid waste) rather than a "sweep under the carpet" solution. The implementation of a multi-media approach encourages reflection on upstream processes with a view to emissions reduction (Stiles, 1996).

The idea of integrating across media is one that started with individual companies and then progressed to countries before economic blocs and international agencies recognised the advantages of adopting the approach.

An early example of integrated waste management applied to a multi-media situation was the Dow Chemical Company (Calvin *et al*., 1988). The Company recognized the need for effective waste treatment as early as the 1930s. Dow started by applying a rudimentary diversion of some of its waste and used the debatable axiom that incineration was better than landfilling by installing a set of 'trickling filters' and operating a waste incinerator. In 1948, Dow developed and operated the world's first rotary kiln for the destruction of

chemical wastes. Over the years the Company investigated the use of a set of options to deal with their waste which included: elimination, reclamation, treatment and destruction, secure landfill, incineration, and wastewater treatment. As a result, their recent sustainability scores put them in the top 10% globally for chemical companies (Dow Chemical Company, 2003).

An example at a country level was the Netherlands, which started by considering separate media waste streams in the 1970s through instituting environmental permitting procedures. The government found that the compliance rate was dismal (Stiles, 1996) and on reflection established that enforcement was complicated, not only by the fragmented nature of the laws and regulations, but also by the multitude of authorities that were charged with implementation and enforcement (Bakx *et al*., 1998). The response by the government was to pass the Environmental Management Act (1993) which detailed the implementation to be accomplished by regulations and thus simplified procedures by integrating the legislation regarding air, waste and nuisances. The passing of the Act encouraged the establishment of provincial and regional consultative bodies to make optimal use of the available knowledge and skills (Bakx *et al*. 1998). A further step in the process was the publication of the *Environmental Law Enforcement in Practice in the Netherlands, an Integral Approach* (1995), in which a multi-media procedure for all environmental policy making was detailed (Bakx *et al*. 1998). As a result, in the 2004 Environmental Balance Report (Environmental Assessment Agency, 2004) waste management was one of only three measures (out of 18) that had improved over the past 18 years and they expected would meet the EU target set for 2010.

Many European countries had acted individually like the Netherlands to undertake legislation encompassing multi-media waste. The emergence of a more expansive approach came from the European Union when it produced the Integrated Pollution Prevention and Control Directive (1996) (Council Directive 96/61/EC), which set out to prevent or minimise emissions from all three media. The target actors were specified high polluting industries. The Directive allowed a transition period of 11 years until 2007 to bring everyone into line. In the most recent progress report in 2003, it was found that there

was some progress, but there needed to be more commitment to reach the targets set for 2007 (Commission of the European Communities, 2003).

On an international scale, the United Nations Environmental Programme (UNEP) (2000) produced a definition of integrated waste management, which they restricted to solid waste and wastewater. In acknowledging that the principle extends trans-media, they noted that this negated the possibility of dumping waste generated in one medium into another, and even that combined sewer systems which mix stormwater and sewage, were not an acceptable solution.

In considering multi-media wastes, the study of energy along with the three media has been slower to catch on. One of the reasons for this is that working with material media has different expertise to working with energy (Amundsen, 2000). In a study on a Norwegian turkey and chicken slaughterhouse, Amundsen (2000) found that the advantages in integrating an energy management system within an environmental management system were fourfold: the avoidance of parallel management systems, easier maintenance, higher economic savings and better environmental performance. Along with these came the disadvantage of the complexity of the system.

An emergent approach to dealing in a multi-media situation is 'integrated chain management' which encompasses the triple-bottom-line approach (De Groene and Hermans, 1998). The rationale calls for minimum discharges (including energy) over the product's life cycle from cradle to grave.

2.7 The Role of Agents in Integrated Waste Management

Integration requires the coordination of governmental bodies, businesses and the community, each of which is an agent for change. Each of the change agents comes from a different perspective and the ability to communicate between them is a crucial factor in achieving success.

The process to get agents to commit to change requires a driver or a series of drivers. Common drivers include economic factors (e.g. market pressures and customer requirements), political (e.g. governance), socio-cultural (e.g.

community expectations) and technological (e.g. advances in equipment or automation) (Stone, 2003b). It is usual for these drivers to operate in some sort of combination and from a systems perspective this creates a greater momentum for change.

In addition to a determined political resolve, and public awareness and community participation, Chua *et al*. (1992) suggested that the key drivers for an integrated waste management approach were:

- cooperation to develop multi-national waste management strategies, which included the appropriate technology, availability of manpower and the exchange of information; and
- a multi-sectoral approach to environmental projects.

The identification and inclusion of stakeholders are important aspects for the implementation of an integrated approach to waste management. Common stakeholders for policy matters are: governments; investors (that could be either governments or private sector companies); managers from both the public and private sectors; and users who were the communities or community organisations. Elkington (1997) added emerging stakeholders (trade associations, professional and academic organisations, and community and environmental groups) and surrogate stakeholders (the planet's biosphere, world population and future generations). However, overall responsibility for the process had to lie with the government since they provided the highest level for change ability. From an operational perspective, UNEP (2000) raised the issue of jurisdiction and the need for the importance of the jurisdiction and responsibility of each agent. They viewed the integration as occurring through different specialists in different organisations working together, rather than one organisation doing the lot.

In a follow-on from the 2000 publication, the UNEP Division of Technology, Industry and Economics 2002 Annual Report (UNEP, 2002), referred to the adoption of a Regional integrated waste management Strategy to promote the application of environmentally sound technologies for sustainable integrated waste management. The Strategy outlined a framework for regional collaboration among governments and partner organisations to tackle the

growing problem of waste. The approach adopted was intended to assist "*policy makers and urban managers identify the appropriate measures, techniques and technologies that should be adopted and applied to deal with each type of waste*" and to manage waste in a holistic manner (UNEP, 2002).

2.7.1 Case Studies

The case studies below are representative of different approaches that organisations have used to integrate the different agents in their waste management processes.

An example of a company using integrated waste management is the ThyssenKrupp Stahl AG (TKS) steelworks in Duisburg, Northern Germany whose plan based around the waste management hierarchy (Gamble *et al*., 2002). In preparing their plan, the company consulted widely with the local community and worked with them to achieve mutually agreed outcomes for the facility. A major target was air emissions, which were monitored and the results transmitted every half hour to the local authorities. This enabled a quick response to excessive emissions and provided incentives to not exceed emission levels. The interrelationship with the local community was enhanced by TKS channelling waste heat from its operations to the district-heating network, which saved fossil fuel combustion and the resultant air emissions. Gamble *et al*. (2002) noted that the TKS plant also used the integrated waste management plan to minimise the consumption of water and solid materials. The results recorded that only 2.5% of the total water extracted from the Rhine River by TKS was discharged back to the river; 96% was recirculated and 1.5% was lost as vapour. In addition, the slag from the steel-making was used for cement production, road construction and fertilisers. Other factory solid wastes were separated and recycled. In addition, the Company incinerated waste to produce heat for the local community (Gamble *et al*., 2002).

An example of a local authority is Sonoma County, California, USA, where a green business programme set out to use a multi-agency approach to deal with multi-media emissions (Stiles, 1996). The authority designed an incentive programme to attenuate the adversarial relationships between

inspectors, business owners and the different agencies. The programme required inter-agency co-operation, whereby those involved in any aspect drafted a permit that covered all relevant issues. After inspection businesses that complied were issued a decal for public exhibition. The observed effects from this approach were four-fold: compliance increased, relations between businesses and regulators improved, businesses had the competitive advantage of being 'clean' and the customers also had an active part in that they could choose 'clean' businesses. In their latest report (Sonoma County, 2005) 98% of respondents (representing 10% of the workforce including most of the major employers) were interested in voluntarily adopting good environmental practice, more than 90% made voluntary energy savings, 81% conserved water and 98% voluntarily reduced waste.

2.8 Implementation Tools

Implementation of integrated waste management benefits from frameworks that allow for consistency and greater objectivity. Such frameworks or tools (also called instruments, mechanisms or devices) include: legislative/regulatory, economic, voluntary and informational. The legislative/regulatory, informational and economic tools tend to be government-led (either local or national) and operate at a societal level. Examples of legislative tools are discussed above and include the Pollution Prevention Act (1990) in the USA and the Environmental Management Act (1993) in the Netherlands.

Industries or industry groups often use voluntary tools, which include systematic guides, manuals and management systems (Stone, 2003a).

Over the past decade, many new tools have been developed to assist in the greening of products and services. Much of this development has been at the conceptual stage. While the development of conceptual tools was useful, it wasn't until they were tested in the field that the merits of the tools were really discovered. As an example of the proliferation of tools, Baumann *et al*. (2002), in the engineering field alone, found 201 different tools for 'greening' of which only 29% had been tested empirically.

Even when tools are implemented, the process of utilising them is one that changes over time. Those at the forefront of trying to institute change aim at the highest goal (e.g. not producing waste). Once the tool has been established for a while the visionaries give way to the bureaucrats who then adapt the tool to fit into organisational structures. This has happened in the case of the pollution prevention (P2) approach in the USA through the 1980s and 1990s (Hirschborn, 2000). Those in the forefront of the P2 revolution adopted a stance that integrated prevention technology with prevention economics. By the time the Pollution Prevention Act 1990 was passed, the 'visionaries' had given way to the bureaucrats who were quite comfortable at aiming for recycling and treatment options (Hirschborn, 2000).

While the development of each new instrument adds to the body of knowledge, no single instrument is the ultimate answer. The recognition of this concept leads to the conclusion that the integration of a variety of tools using a systems approach is a way to achieve a greater effect. In an example of how this concept could be applied, Robèrt *et al*. (2002) considered a number of tools that could be used to move towards sustainability. They chose seven (ISO 14001, Life Cycle Assessment, Ecological Footprinting, Factor 10, Sustainable Technology Development, Natural Capitalism and The Natural Step Framework) to show how they might work together in a suppositious business enterprise. In their simulation, the enterprise embarked on determining the critical flows within its activities and then moved on to quantitative data acquisition. By the application of their tools at different times in the life of the programme, the authors showed how it would be possible to integrate different ones to move the enterprise toward sustainability.

2.8.1 Voluntary Approaches

Voluntary approaches can be powerful motivators when they are truly voluntary because it means that someone with passion and commitment is driving the process. One such person was Dr Joseph Ling from 3M, the pioneer of the Pollution Prevention Pays programme in 1975. Over 30 years 3M cumulatively prevented 1 Mt of pollutants and saved $1b in costs (3M, 2005).

A more usual approach is a guided approach whereby legislators threaten to invoke legislation unless an industry group or type of waste generator adopts a voluntary approach to reduce waste (Krarup, 2001).

Voluntary approaches can be placed into three broad categories: industries acting independently without any public engagement, negotiated agreements between public authorities and industry, and public voluntary programmes designed by public authorities (OECD, 1999). The efficiency of voluntary agreements rested on a number of factors (Krarup, 2001).

- The information available to the public;
- The auditing and exchange of information that was available to the negotiating parties;
- The positive and negative inducements made available by the regulator to encourage industry to engage in the process; and
- The consumers' demand for environmental quality either through lobbying or a general demand by consumers

One of the tools that developed in the 1990s was the concept of integrated product policy (IPP). It was an attempt to consider the whole lifecycle of a product and reduce waste emissions in all forms. IPP was defined as: "*public policy which explicitly aims to modify and improve the environmental performance of product systems*" (Ernst and Young, 1998). Rubik and Scholl (2002) analysed the implementation in five 'mature' countries within the European Union and found those countries focused on the product end of the spectrum, without defining which products they were going to target. In addition, the environmental targets were expressed in vague terms and their principles were determined by compatibility with the 'market economy' (Rubik and Scholl, 2002).

In a further refinement, the Commission of European Communities (2003) adopted a more integrated approach which covered services and included co-operation with stakeholders and the utilisation of multiple tools (Commission of European Communities, 2003).

Schemes for standardisation across industries can be implemented either regionally or internationally. A regional example was the European Union

Council, which implemented the Eco-Management and Audit Scheme (EMAS) in 1995, a comprehensive environmental management system involving external verification and the release of public information (Honkasalo, 1998). Within the EU, 3093 organisations have implemented the EMAS scheme with Germany (1529) and Spain (483) the leading countries (EMAS, 2005a). By comparison, the ISO 14001 Environmental Management System was developed internationally so that individual companies could adopt as required (Kolln and Prakash, 2002). ISO 14001 has had a greater uptake (e.g. UK: 2918 organisations compared with EMAS 62 (EMAS, 2005b)) which may be due to the more international perspective of ISO14001. Both of these systems include environmental auditing which is typically a descriptive assessment that includes environmental and resource use aspects (Finnveden and Moberg, 2005).

2.8.2 Informational Campaigns

Regulatory bodies are the ones that normally conducted informational campaigns, which have shown varying success. As mentioned earlier, Seadon and Hopkins (2003) found variable effects when the differing socio-economic groups were considered.

An example of a national informational campaign was in New Zealand during 2003 for waste reduction which was a test of whether national and local government could work together (Bradshaw, 2003). National messages in a variety of advertising media were backed up with local action and support from local government. Research during the three month campaign, showed that 20% of the population said it had a positive effect on their awareness, attitude or behaviour. The key lessons learnt from the campaign were that a long lead-time was needed to secure funding and generate support, the messages needed to be simple and the same across the media and that single campaigns have a limited impact over the long term (Bradshaw, 2003).

2.9 Conclusions

Applications of the components of integrated waste management exist. As yet there is no evidence that users are considering the integration of media,

agents and tools to provide a better waste management system, which would assist the move towards sustainability.

Historically single-media waste streams have been considered. Many organisations and governments still consider waste according to the medium it is produced in without trying to integrate across media. The strong selling point to the public of the simplicity of dealing with a single waste stream belies a need for a deeper understanding to see the limitations of the adopted approach.

The lack of a multi-media approach has meant that the transfer of waste from one medium to another has been seen as a solution to a problem. In adopting a wider perspective, the implementation of a multi-media approach has encouraged upstream process reflection with a view to emissions reduction. There is a growing recognition that looking at the problems in an integrated manner may help to resolve the escalating waste problems.

The level of complexity that arises when integrating waste streams means that a systems approach, which adopts a long-term perspective and extends across geo-political borders, is an appropriate methodology.

An integrated system would inevitably require some cross subsidisation as some parts would be profitable and others loss-making, but in order for the system to succeed, it must be considered in a holistic manner. In doing so, each unit is contributing and complementing neighbouring units and thus provides reinforcement to the process.

In order to integrate waste management different tools and agents need to be utilised. The use of tools and agents has led to both integration and singularization of systems and processes, depending on the tools that are used. However, no single instrument is the ultimate answer and even when tools are implemented, the process of using them is one that changes over time. It may also be appropriate to utilise a range of tools in any given situation to maximise the benefits of waste management.

Likewise, the integration of authorities needs to happen so that there is a consistent message.

Voluntary approaches to integration are powerful motivators, especially when they are backed up with the threat of more punitive legislation. One of the important issues in the implementation of an integrated waste management approach is the identification and inclusion of the appropriate stakeholders. Once that is achieved the message to the public must be simple, a task that is difficult when the problems and solutions are in themselves complex.

Integrated waste management requires a broad participation for success. A societal change is formalised by a regulatory change, which encourages further societal change when specialists from different backgrounds work together to a common goal.

Integrated waste management means a variety of things in different societal contexts, all of which are components of a bigger, more complex picture. An understanding of the bigger picture requires an approach that integrates processes in an effort to move towards sustainability.

Chapter 3: A Systems Approach to Waste Management

3.1 Purpose

The purpose of this chapter is to examine how a systems approach is an effective approach to manage waste in an integrated manner.

3.2 Context

Waste is a result of inadequate thinking. The traditional approaches to waste management of “flame, flush or fling” are outmoded customs. Waste management using these practices resulted in an unsustainable society. In the United States of America the total annual wastes exceed 115 billion tonnes, of which 80% is wastewater (Hawken *et al*., 1999). Of that amount less than 2% is recycled. Emitting waste into the environment resulted in nearly 40% of all USA waters being too polluted to support their designated functions (Council on Environmental Quality, 1996) and more than 45% of the USA population lived in areas where air quality was unhealthy at times because of high levels of air pollutants (USEPA, 2002).

Conventionally, waste is treated as irrelevant to production, only to be managed when the pressure to handle the problem is greater than the convenience of disposal. The push to deal with a problem comes when the impacts of waste disposal (polluted air, water or full landfills) affect people.

Traditional practices for dealing with waste management fall short in a number of ways.

- Interventions may be irreversible, rather than providing for mechanisms to deal with emerging side effects that could be corrected. For example, when Auckland City increased the size of waste collection containers from 40 L to 240 L they did not anticipate that waste quantities would increase and did not plan for this increase (Seadon & Boyle, 1999).
- Solutions are based around short term goals rather than longer term sustainability thinking. This is exemplified by accentuating reports of container recycling quantities while ignoring advances in the reduction

of quantities of packaging (e.g. the New Zealand Packaging Accord (PackNZ, 2004)).

- Time lags between intervention and effects are underestimated, thus misinterpreting the perceived lack of response as a need to invoke stronger interventions resulting in over-correction that then needs to be fixed. An example is the New Zealand Waste Strategy that was reviewed for progress in 2004 (one year after it was instituted which changed work programmes) and again in 2006 (MfE, 2009a).
- Disregarding or undervaluing the side effects of intervention. An example is Fonterra changing the construction of multiwall bags for milk powder to make them easier to recycle, rendering 250,000 old bags to waste.
- The focus on fixing individual problems rather than the viability of the waste management system. An example of this is the litter problem in New Zealand caused by the proliferation of one-way packaging in the 1990s including glass milk bottles being replaced by non-recyclable waxed cardboard cartons and high density polyethylene (HDPE) bottles. This was corrected by instituting a Packaging Accord that focused on recycling used food containers (PackNZ, 2004), but still did not address the waxed cardboard cartons.
- A lot of time is spent collecting and analysing immaterial data. For example, conducting annual surveys of household waste composition when waste management practices do not change.
- Reliance on linear extrapolations of recent short-term events. This is exemplified by a comparison of the trends in waste disposal to landfill in New Zealand. The Targets in the New Zealand Waste Strategy 2006: Review of Progress (MfE, 2007b) considered five years of waste data (from the adoption of the New Zealand Waste Strategy) and found a 4.2% increase in waste quantities disposed to landfill, while the Environment New Zealand 2007 report on decadal progress found almost no change in waste quantities (MfE, 2007a). A linear interpolation over 25 years showed an annual increase averaging 6.2% per annum.

Vester (2007) found that these shortfalls are common when dealing with complex systems.

3.3 Complex Systems

When waste is seen in isolation it is an aggravation, but when seen as part of a production system, the relationship of waste to other parts of the system is revealed and thus the potential to increase the sustainability of the operation therefore increases. Conceptually, this broader view increases the difficulty of managing waste and an approach that deals with complexity needs to be taken.

In trying to adopt a methodical approach to deal with waste management a spectrum emerges. This is depicted in Table 3.1 with increasing complexity going to the right.

Table 3.1. Waste management approaches. Adapted from Max-Neef (2005)

Disciplinarity	Multidisciplinarity	Pluridisciplinarity	Interdisciplinarity	Transdisciplinarity
Reductionist. Splitting into separate waste streams for management	*Reductionist*. Consider different waste streams without links	Cooperation but no coordination between waste stream management	Waste stream management coordinated from a higher level	*Systems*. Coordination of management between all levels and all waste streams

The disciplinarity and multidisciplinarity approaches use a scientific/engineering model based on the two concepts of reductionism and cause-and-effect thinking (Ackeroff, 1973). The major difference between them is the number of waste streams considered.

A central tenet of the reductionist image has a hierarchy in which everything can be broken down into smaller and smaller parts. By gaining an understanding of each of these parts and then combining them, the observer assumes they can explain and understand the behaviour of the system as a whole and this will achieve the ‘best’ solution, where best has been defined as operating with the highest economic efficiency (Daellenbach, 2001). In the past, this has not proven to be the best solution from an environmental perspective (Stone, 2002).

The second basic tenet of the reductionist scientific model is assuming cause-and-effect relationships that rely on splitting everything into parts and looking

for relationships between those parts. The assumptions usually include the concept that unmeasured variables are unimportant. This may also be inadequate, because new relationships and new (emergent) properties appear, some of which are planned, but others that may be unexpected. The relationship can have added complication since the causal relationship may be two-way and thus there could be mutual causality (Daellenbach, 2001). Alternately, there may be no direct relationship and the linkage is predominantly through a mutual covariant. Observation and interpretation are required to determine which of the above scenarios are present.

While the scientific model is presented as a methodical progression of concepts and experiments, an historical exploration provides a different viewpoint. Kuhn (1996) likened scientific progression to political processes and personality cults in that it was more important who was promulgating the postulate and how they went about it, rather than the 'facts' behind it. He observed that science tended to move forward in a series of steps (which he labelled revolutions in keeping with the political context) that caused paradigm shifts, not by a blinding revelation on the part of scientists but more, as Planck (1950) described it, "*because its opponents eventually die, and a new generation grows up that is familiar with it*". Kuhn concluded that this does not invalidate science, but that there is a need to accept a new perspective on what constitutes a scientific process.

A second picture is represented by a systems approach which has holism as a central tenet. In this approach an attempt is made to view the whole process under study, not only by looking at the interaction of the parts, but also by looking at the dynamic processes and the emergence of properties at different levels (Tippett, 2005). A comparison of the systems and reductionist approaches is provided in Table 3.2.

Table 3.2. Comparison of Reductionist and Systems Approaches.

Reductionist	Systems
Analytical Objects Parts Context independent Practitioner independent Hierarchies Structure	Synthesis Relationship Holistic Context dependent Practitioner dependent Networks Process

Adapted from Tapp & Mamula-Stojnic, 2001& Capra, 1996

3.4 The Systems Approach

The systems approach developed out of an attempt to unify science. Von Bertalanffy (1955) formulated a General System Theory (GST) which had interdisciplinarity as its essence. In coming from a naturalistic perspective, von Bertalanffy hoped to be able to generalise the principles of living systems to be applicable to all systems (concrete, conceptual, abstract or unperceivable). However, von Bertalanffy was not able to go beyond the general concept of holism (von Bertalanffy, 1968). While the progress in unification of science by utilising a GST has been debatable (e.g. Checkland, 1999), GST thus far has been unable to formulate principles applicable to all systems (Capra, 1996 & Dubrovsky, 2004).

Rather than seeking an approach to try to unify science, a more useful purpose is to use a systems approach to deal with complexity. The understanding of the complexity of a system can enable the reconstruction of the underlying system principles (Dubrovsky, 2004), some of which will be applicable to various systems and others specific to the system under study.

3.5 The Characteristics of a System

A common sense definition of a system is that it is a "*set of interacting units or elements that form an integrated whole intended to perform some function*" (Skyttner, 1996). A system is generally not something that is presented to an observer, but rather it is something that the observer recognises. Often a system does not refer solely to physical entities, but it is a more abstract unit that allows the observer to organise their thoughts about the world. At the

edge of a system is the boundary, one of the most important delineations of the system. Across the boundary there are interactions that affect the environment surrounding the system and concomitantly, the environment also affects the system. The boundary is normally defined in such a way that the interactions across the frontier are less than the interactions within the defined system. Another delineator of the boundary is that to cross the frontier requires some sort of modification or transformation (Skyttner, 1996).

The two modes in systems are hard and soft systems approaches. A hard systems approach is appropriate when dealing with a highly defined problem (e.g. the operation of a material recovery facility), but when dealing with a more open-ended problem (e.g. waste management) a soft system approach provides a better outcome (Clayton & Radcliffe, 1996). In a soft systems approach feedback loops, which provide reinforcement and balancing processes that are reactive mechanisms utilized to induce a system towards its goal, are incorporated between the stages in the process. Reinforcing (positive) feedback amplifies a change and balancing (negative) feedback dampens the effect of a change (Skyttner, 1996).

Another mechanism that is often utilised is that of feedforward, a more proactive approach whereby a prediction is made about future influences on a system and actions are taken to either fulfil or defeat those predictions. With both feedback and feedforward, it should be borne in mind that there is generally a time delay between the cause and effect in the system and the length of the delay is dependent on the complexity of the system. If the application of feedback and feedforward are made injudiciously, overshooting the goal or oscillation around the goal can occur (Skyttner, 1996).

In order to understand how a system operates it is useful to summarise the basic properties of systems (Table 3.3).

Table 3.3. Properties of Systems.

- A system must have a purpose or a goal.
- A system has order and regularity which are preferable to chaos and randomness.
- Everything is an organised system of energy, matter and information to lead towards the goal.
- A system is a defined entity that is constituted from components that have a relationship with one another.
- Systems can be closed, open or isolated. A closed system does not allow inputs or outputs (except for energy), but an open system allows for inputs and outputs. An isolated system is closed to all kinds of input and output.
- Systems transform inputs into outputs.
- Systems are constantly synthesising and disintegrating.
- The behaviour of the system depends on relationships rather than the components themselves.
- There are many possible connections between the parts of a system.
- Each system is a member of a suprasystem and is composed of subsystems.
- There are novel characteristics of all systems that apply upward to greater complexity, but do not apply downward to greater simplicity.
- The observed properties of a system belong to the whole system, and not any component or group of components of the system.
- A system has holistic properties which are not detectable by reductionist analysis.
- The greater the complexities of a system, the more unpredictable are the properties and behaviours of that system.
- Breaking down the parts to analyse the system causes the system to lose its properties.
- Adding or removing components changes the behaviour of the system.
- Each component of a system is affected by the system and each system is affected by the individual components.
- The components of a system are regulated by feedback loops, which enable deviations from the route to the goal to be detected.
- Systems operate under convergent or divergent routes. Starting from any point it is possible to reach different goals (divergence) and there is more than one-way to reach a goal (convergence).
- Someone who has an interest in the encompassed system defines the system boundaries.
- An environment surrounds a system which provides inputs to the system and receives outputs from the system. An environment is beyond the immediate control of the management of the system.

Adapted from: O'Connor and McDermott (1997), Daellenbach (2001), Churchman (1971), Boulding (1964), Kefalas (2001) and Litterer (1969).

3.6 Waste Management as a Complex Adaptive System

Waste management has many of the characteristics reminiscent of a living system, an example of complex adaptive system. Complex adaptive systems interact with their environment and change in response to environmental change (Clayton & Radcliffe, 1996). Many of the properties of living systems identified by Choi *et al.* (2001) can be observed in waste management systems. A comparison of the major characteristics of a complex adaptive system and waste management are shown in Table 3.4.

Table 3.4. Waste Management Systems as Complex Adaptive Systems. Adapted from Choi et al., (2001)

	Description of Complex Adaptive System	**Waste Management Example**
Internal Mechanisms		
Agents and schema	Agents share interpretive and behavioural rules and fitness criteria at different levels of scale	Waste management companies or groups of companies work together through alliances based on shared norms and economic incentives
Self organisation and emergence	Patterns are created through simultaneous and parallel actions of multiple agents	A supply network emerges with no one firm deliberately organizing and controlling it
Connectivity	Extensive inter-relationships are possible even at low levels of connectivity	Reuse, recycling, recovery and disposal operations can be connected and may compete for common resources
Dimensionality	Negative feedback and controls reduce dimensionality, while autonomy and decentralisation increase dimensionality	Waste management variation is minimized by over-arching control schemes, whereas waste management creativity and adaptation is enhanced by autonomy and decentralisation
Environment		
Dynamism	Changes are constant and interdependent	The membership of the waste management supply chain is constantly reassessed and reshuffled through mergers, takeovers and contract changes.
Rugged landscape	Global optimization is simple when criteria are independent, but becomes very complex when criteria are interdependent	Waste management is a complex interdependency where local optimisation needs to be balanced with global influences
Co-evolution		
Quasi-equilibrium and state change	Attractors are sensitive to change as the complex adaptive system is pulled away from quasi-equilibrium state to a far-from-equilibrium state	Changes to recycled commodities prices
Non-linear changes	There is lack of linear correlation between causes and effects	Changes to pricing mechanisms can have perverse effects
Non-random future	Common patterns of behaviour are observable	Changes in waste quantities are linked to economic changes

3.6.1 Internal Mechanisms

Internal mechanisms consist of agents and schema, self organisation and emergence, connectivity and dimensionality.

Agents (people) have varying connectivity with others in the system. Through their connectivity agents are able to influence the schema, and vice versa. Agents behave so that they benefit from the schema by increasing their fitness for the system (Choi *et al*., (2001). For example, the two major waste companies in New Zealand, TransPacific Industries and Envirowaste, own landfills located at opposite ends of the Auckland region. Depending on convenience, waste that belongs to one company can be delivered to the other company's landfill. The result is a more economic operation that also has less impact on the environment through less truck movements.

In a market driven economy agents work together to achieve a degree of organisation that allows a waste management system to function economically and more efficiently, which can have environmental and social downstream effects. Out of the self organisation new properties of the system emerge. In the TransPacific Industries/Envirowaste example above, market share by those two companies arose over a long period starting with local government contracting out waste collection for residents. Initially many small companies collected waste and then companies amalgamated and drew the interest of global players, which further developed market share. Results that emerged from the changing waste management system were as follows.

- Landfills became larger and better engineered, thus reducing the environment impact by reducing contamination and small, poorly engineered landfills closed (MfE, 2007a).
- The economic viability of producing energy from methane from landfill emissions increased. This consequently reduced the impact on the environment from the effects of greenhouse gases by 95% (Landcare, 2007).
- Byproducts from the waste disposal service like recovery of organics, recycling packaging and reusing goods became economic to set up for large urban catchments (MfE, 2007b).
- Solid waste operations extended to liquid and hazardous wastes.

Connectivity and dimensionality in part determine the level of complexity in a network. For example, a study was undertaken covering the Waikato region in New Zealand (EW, 2007). The region consists of 12 councils whose waste infrastructure was much interconnected in a dynamic pattern. The snapshot study principally looked at recycling, recovery (organic) and waste disposal. The findings showed that there was a lot of movement of waste into and out of the region.

- Three councils sent their recycled material outside the region for processing and nine processed it within the region.
- Paper was exported overseas as well as being processed at one plant within the region from throughout New Zealand.
- Organic material was composted at five facilities in the region and used for bioenergy at a further eight facilities. Organic material was brought into the region as well as being distributed throughout the North Island.
- Five landfills within the region dealt with waste from the region as well as major waste streams imported from up to 360 km away.

The variety of operations in the Waikato example enabled a mix of dimensionality through large scale operations (paper reprocessing, bioenergy and some landfills) mixed with smaller creative solutions (community recycling schemes in small towns). It was noted in the study that the Waikato system was constantly undergoing change (EW, 2007).

3.6.2 Environment

The environment consists of agents and their links that are external to the system and are characterised as being dynamic and rugged landscapes (Choi *et al*., 2001).

A complex adaptive system is in constant change; sometimes it is incremental and at other times it is substantial. With constant change also comes a change in the boundaries of the system which alter by including or excluding agents or links (Choi *et al*., 2001). An example of this occurring in the New Zealand waste management system is the enactment of the Waste Minimisation Act (2008). This caused a substantial change in the New

Zealand WMS as it provided for: injection of money for waste minimisation; provision for mandatory product stewardship schemes, reporting requirements on waste and a Waste Advisory Board that provides advice to the Minister for the Environment. The waste management landscape became more rugged due to the changes imposed by the Act. The increase in ruggedness means that while it is more difficult to optimise the New Zealand waste management system, the Act provided more tools to be able to achieve optimisation, which in New Zealand's case has been defined as 'towards zero waste and a sustainable New Zealand' (MfE, 2002a).

3.6.3 Co-evolution

A WMS and its environment interact and create dynamic, emergent properties through quasi-equilibrium and state change, non-linear changes and non-random futures. The environment in which the waste management system operates gives feedback to the system and changes the system. In turn, the waste management system causes changes to the environment.

Under normal conditions a waste management system maintains a balance between order and disorder in a quasi-equilibrium state (Goldstein, 1994). Over time the environment pushes the system far away from its equilibrium state to the edge of chaos that can result in sudden, unpredictable changes. This is exemplified by the trend for commodity prices for recycled materials like copper (LME, 2009) where the value of the pound is taken as the base unit. Over the period from 1998 – 2004 the spot price of copper varied from £1,000 to £2,000 per tonne (equilibrium). From 2004 to midway through 2006 the price of copper gradually rose to just under £9,000 per tonne (system change) due to increasing productivity, particularly in emerging economies like India and China. From midway through 2006 till late 2008 the price fluctuated wildly between £5,000 and £9,000 (edge of chaos), before plunging to £3,000 (sudden change) before gradually recovering to between £4,000 and £5,000 (a new equilibrium).

Behaviour in waste management systems stems from the complex interaction of many loosely coupled variables and thus the system behaves in a non-linear fashion. Where a change is imposed on the system there is no direct

correlation between the size of the change and the size of the corresponding change in the outcome (Guastello & Philippe, 1997). For example, a change in pricing mechanisms can have perverse effects. An increase in the price of waste disposal to encourage diversion can reduce the amount of recycling when the recycled goods contain a high percentage of non-recyclable materials (e.g. microwave ovens in New Zealand) (MfE, 2006a). The behaviour of a waste management system is thus not amenable to prediction using a parametric model, such as a statistical forecasting model (Choi *et al*., 2001).

However, this does not imply that the future is random. Similar systems tend to behave in similar patterns when subjected to similar changes. Hence, past events can lead to predictions about behaviour in a waste management system, though not the actual timing of the behaviour. For example, the stock market crash in 1987 lead to a slow decline in waste generated in Auckland City for the next four years which paralleled a decline in economic activity in New Zealand. Once the economy started to gain momentum waste quantities also increased (ARC, 1995).

3.7 Depicting Complex Systems

Depicting complex systems where all the relevant factors are grouped in a concise form to allow them to be viewed as a whole can be achieved through a simple figure. The use of figures provides a clearer picture to record relationships and connections than linear prose. The purpose of these figures is to provide an *aide-memoire* to gain an appreciation of a complex situation (Davis and Ledington, 1991). In addition, the use of figures can help to encourage holistic rather than reductionist thinking (Checkland, 1999). The figures can be used as a starting point for discussion to resolve problems and understand the complexity of the real world situation.

In producing a figure to model a real world situation, a number of factors need to be taken into account (Davis and Ledington, 1991).

1. The model needs to represent the activities to achieve the purpose of the system.

2. The model should meet the criteria for being a system: have a goal; all parts need to be included for the system to reach its goal optimally; the arranged order of the parts affects system performance; and systems strive to maintain stability through feedback (Kim, 1999)).
3. The model should be rigorous and defensible.
4. The model also needs to be flexible.

An example of a system that models a real life situation in Minnesota, USA, is demonstrated in Figure 3.1.

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Figure 3.1. The Minnesota Solid Waste System High Level Causal Map (Minnesota Office of Environmental Assistance, 2001)

This was a causal model developed to understand the solid waste system in Minnesota and to provide recommendations for the State. The model shows how six categories of agents (Protectors of Public Health and Environment (blue), business (purple), citizens (red), the solid waste and recycling industry (green), the state government (magenta) and the future technology research sector (black)) interact to produce a more sustainable waste management model. The key to the symbols is given in Figure 3.2.

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Figure 3.2. Causal Map Key (Minnesota Office of Environmental Assistance, 2001)

The model includes some of the essential elements of a system – links between components, positive and negative feedback to provide balance, and recognition of the delay in response time to actions.

The purposes of the study in Minnesota were to: protect the environment and public health; reduce waste; increase reuse and recycling; reduce waste toxicity; increase the use of incentives to protect the environment; and collect better data (Minnesota Office of Environmental Assistance, 2001). These principles tried to progress the Minnesota waste management system towards a more sustainable society.

3.8 Sustainable Societies

The writing on the wall is clear. Societies that have ignored sustainable practices by damaging their environmental support systems through making demands beyond the carrying capacity of the area, have witnessed the demise of the society. Examples of this kind of disintegration of society are thought to be the Kingdom of Egypt around 1950 BC, the Sumerians in 1800 BC, the Maya at about 600 AD, and the Polynesians of Easter Island at about 1600 AD (Ponting, 1991).

Sustainability has been often associated with resource constraints and the maintenance of the status quo, rather than opportunities for continued innovation, growth and prosperity (Clark, 1978). The Triple Bottom Line approach (Elkington, 1999) gave the impression through the intersecting circles model, that balancing economic profits against the environmental and social benefits resulted in the utopia of sustainability. A better model is shown in Figure 3.3.

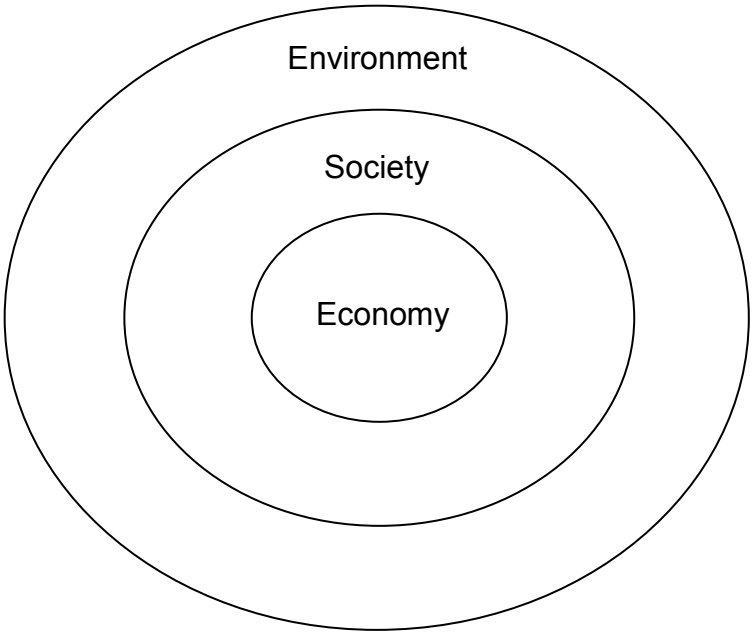

Figure 3.3. Strong Sustainability. Adapted from Lowe (1998).

In Lowe's model, the economic subsystem acts within a social subsystem. This in turn acts within an environmental system. That way all decisions are made on an economics basis within a socially acceptable construct which is within the carrying capacity of the environment.

The relationship between sustainability and sustainable development has been the subject of conjecture. In one context sustainability has been defined as the goal of sustainable development (Lewis, 2005). In this concept sustainability is an asymptotic target, with even the target meaning different things to different people depending on their own goals (Kelly, 1998). However, if sustainability is not thought of as a goal, but as a set of characteristics of a dynamic, evolving system (Fiksel, 2003), then sustainability becomes a more reachable and conceivable concept.

The discussion about what constitutes sustainability is ongoing. Various models have been proffered (e.g. (Keiner, 2005) and references therein), but the underlying concept is that it is the ability to sustain life and biodiversity on the planet. The movement towards sustainability can be broken into two key stages (Clayton & Radcliffe, 1996).

1. *The identification of policy options that will enhance sustainability and*
2. *The development of appropriate mechanisms, strategies and techniques for implementing the policy options*.

The first of these requires an understanding of the behaviour of natural and human systems and the interactions between them. The second requires the development of political systems that enable the transfer to occur. Additionally, it requires the understanding acquired above to be transformed into the actual decision-making process (Clayton & Radcliffe, 1996).

In regard to sustainable development, there is general agreement on the two key concepts (World Commission on Environment and Development, 1987).

- "*The concept of needs, particularly that of the world's poor, to which the overriding priority should be given.*
- *The idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet the present and future needs*."

The adoption of a paradigm shift to sustainable development as opposed to unrestricted development is hindered by the notion that protecting future generations is a remote conception in the face of today's pressures, especially when it is difficult to determine the needs of future generations (Fiksel, 2003). Nevertheless, the vision for a sustainable society can be drafted in terms that are realistic. Meadows *et al.* (1992) pictured a sustainable society as one that has various characteristics.

- It is capable of having growth.
- It is technically and culturally advanced
- It is dynamic in regard to all factors including population and production

- Non-renewable resources are used thoughtfully and efficiently
- It is a society that is diverse, democratic and challenging.

In order to transition to a sustainable society a number of mechanisms need to be put into place (Kelly, 1998 & Meadows *et al.*, 1992).

- The information infrastructure to support an improvement in the signals (indicators) needs to be implemented.
- The response times to the indicators need to be shorter.
- The use of renewable resources and the erosion of renewable resources need to be minimised.
- All resources need to be utilised with maximum efficiency.
- The exponential growth of population and physical capital needs to be curtailed.

In short, the dynamics of a transition to a sustainable society require a systems approach and waste management is a fundamental system that must be confronted.

3.9 Waste Management as a System

Waste generation, collection and disposal systems are often planned on the premise that they are independent operations. However, it has become obvious over the years that all three are very closely interlinked and that each can influence the other. The planning required for these operations requires that a number of factors be taken into account. A balance is required between the subsystems of manufacturing, transport systems, land use patterns, urban growth and development, and public health considerations (Clark, 1978). This presents the interaction and complexity between the physical components of the system and the conceptual components that include the social and environmental spheres. In addition, in New Zealand's case, cultural components are identified as another sphere to be appraised (Local Government Act, 2002).

As has been demonstrated in Table 3.3 waste management has many of the characteristics of a complex adaptive system.

One of the earlier attempts to use a systems approach for solid waste management was in Cleveland, Ohio (Clark, 1978). Clark attempted to analyse the factors that affected the solid waste management function by looking at population trends, densities and dwelling unit densities. He found that they do have a significant impact. In considering the transportation networks, he accounted for the changes in street mileages and the location of major arteries and expressways. As well as these physical components, it was necessary to consider planned and current urban renewal projects as changing population densities had a definite influence on solid waste planning. The legislation, from federal, state and county perspectives was also factored into the process, as these had an effect, in particular, on capital and operating revenues. Overall, the process was carried out with changes (mainly feedback) being made *en route* as the project progressed. The reported successes were in the form of increased efficiencies with the collection and disposal of solid waste, which had the direct benefit of reduced cost. While this was an admirable start, the chosen boundaries of the system meant that the focus was on what to do with the waste once it was generated. In some quarters there has been little movement in thinking since the first attempts at a systems approach. A slightly refined methodology was used by Eriksson *et al.* (2005) in considering municipal waste generated in Sweden, but once again it still focussed on what to do with the waste after generation.

The extension of the system boundaries to the waste generation phase (manufacturing) and consideration of waste from all media enables the inclusion of waste reduction and prevention methods, an approach that presents itself in industrial ecology (IE) which is an attempt to mimic the utilisation of the waste of an ecosystem into an industrial context (Korhonen, 2001). The goal of IE is to "*generate the least damage in ecological and industrial systems through optimal circulation of materials and energy*" (Cowan-Rosenthal, 2004).

The concepts of IE can be applied to Robèrt's (2002) systems model (Table 3.5) where he portrayed a hierarchical five-level systems model for the process of sustainable development which was termed *strategic sustainable development* (SSD).

Table 3.5. Industrial Ecology and Strategic Sustainable Development (Robèrt et al, 2002).

Level 1. Principles for the constitution of the system.

- IE argues for systems interdependency between economic and social subsystems and the parent ecosystem
- IE contributes to material and energy flow principles
- IE systems and networks philosophy has the potential to contribute to social principles

Level 2. Principles for a favourable outcome of planning within the system; principles for sustainability as the desired outcome.

- IE provides material and energy flow limits and thresholds of ecological sustainability

Level 3. Principles for the process to reach the above outcome sustainability e.g. principles of sustainable development to reach sustainability.

- IE offers planning principles and/or it offers constructs that can be used as hypotheses in sustainability systems analysis, from which systems planning principles can be derived

Level 4. Actions and concrete measures.

- IE offers suggestions for material and energy flow reduction and/or substitution
- IE provides a network and systems approach for these reductions and substitutions

Level 5. Tools and metrics to monitor and audit.

- IE offers inter-organisational and management systems and concepts
- IE can be used to develop systems-level indicators
- IE suggests for 'what if'' scenarios, the economic, ecological and social effects of which one can measure and calculate for decision-making, policy and management

The field of IE is relatively young and most effort has gone into the flow aspects (level 4) (Ehrenfeld, 2004) and tools (level 5). The systems aspects of interdependence, closed-loop, community or locality are still in their infancy (Korhonen, 2001).

One of the key principles for an industrial ecosystem is that of gradual change (Korhonen, 2001). The starting point for an enterprise, the principles (IE) and the destination (sustainability) are relatively well defined, but the processes to encourage the change are still being developed. To enable the change to occur, Kuhn (1996) considered that the following determinants were necessary.

- It must be all at once (though not necessarily in an instant) or not at all.
- The transfer of allegiance is a diversion experience that cannot be forced.

- An increasing shift in the distribution of professional allegiances occurs rather than a single group conversion.
- For a paradigm to succeed the number and strength of the persuasive arguments in its favour will increase with a concomitant increase in the number of adherents to the paradigm and a resultant increase in exploration of the new paradigm.
- The move to a new paradigm occurs when the new one seems better than the old one, not that the new one necessarily explains all the facts.

This has been the experience with IE, where the term first appeared in the literature in the 1970's (Erkman, 1997) through to the *Journal of Industrial Ecology* making its debut in 1999, which is devoted to the discipline.

3.10 Elements of a Sustainable Waste Management System

To achieve a sustainable New Zealand, it must have a sustainable waste management system.

The necessary elements for a sustainable waste management system are discussed below.

- Negative feedback loops dominate positive feedback loops. Negative feedback provides an element of self monitoring and self-regulation. For example, in Auckland City a halving in mobile garbage bin size with an added cost to dispose of excess weight (negative feedback) had a better effect than years of messages saying that recycling was good for the environment (positive feedback) (Seadon, 2006).
- System vitality is independent of quantitative growth. Waste management systems that rely on growth are unsustainable. For example, Transpacific Industries in August 2008 relied on substantial growth in its business model and predicted 'double digit growth' (Sydney Morning Herald, 2008) when they announced a 70% increase in profit for the previous year due to 'acquisitions and organic growth'. By May 2009, after the onset of a world recession, the company had been suspended from the share market and was seeking to secure

equity injection to maintain their operation (Brisbane Times, 2009). In contrast, The Recycling Center in Portland, Oregon, worked successfully on the concept of better utilising the waste that was collected rather than requiring greater quantities of waste (Suzuki and Dressel, 2002).

- The system is function-oriented, not product-oriented. A basic solid waste management operation consists of collection, transportation and storage. Societal changes required changes in end-of-life usage by waste companies. For example, Waste Management New Zealand set up Recycle New Zealand as a subsidiary that focused on collecting materials that could be diverted and sorting them (and storing if necessary) before reuse, recycling or recovery operations. Thus the functions were very similar, but the 'products' changed with time.
- Multiple uses of products, functions and organisational structures. The integration of products, functions and structures enables a waste management system to make the most efficient use of available resources. Waste streams can be used effectively to achieve better resource efficiency. Examples include Fonterra which uses waste hot gases in heat exchangers to preheat incoming milk.
- Diversion processes for the utilisation of waste. Waste is a resource that can be reused, recycled, recovered or treated. Many examples of this exist; see for example (Seadon, 2006).
- Symbiotic usage by employing coupling and exchange. Symbiotic relationships in a waste management sense emerge as industrial ecology, which is explained in more detail below.
- Biological design of products, procedures and forms of organisations by feedback planning. The basic biological design processes are exemplified by the application of The Natural Step programme (Korhonen, 2004). In a sustainable waste management context the system conditions require that:
    - materials are not extracted from the earth at an increasing rate
    - wastes are not emitted by society at an increasing rate

    - wastes are not disposed of to the earth faster than they can break down through natural processes
    - resources are used fairly and with waste minimisation to meet the basic human needs globally.
- Use existing forces, instead of opposing forces. The use of leverage supports a waste management system, but uses less effort to achieve a desired change. The effective use of leverage points is described below.

The elements for sustainable waste management are similar to those for sustainable living systems developed by Vester (2007). The mechanism to achieve change is through the use of leverage points.

3.11 Leverage

One of the prime motivators for understanding how a system works is to effect a change on the system to produce a desired position. Each change in a system produces side effects, not the least of which is that systems demonstrate inertia to change due to the numerous interconnections between components in the system (O'Connor & McDermott, 1997). With careful planning and an understanding of the dynamics of the system under study, together with a degree of fortuitousness, there are occasional "windows of opportunity" when large changes can be effected with very little effort, similar to a lever.

To make changes within a system implies that a decision-maker exists, who can change the performance of the components. This implies that there is also a designer concerned with the structure of the system and that the designer can direct the actions of the decision-maker and can therefore affect the result of the actions of the system. Churchman (1971) sees the purpose of the designer is to change the system to maximise its value to the user. Thus, in a societal context, the maximum value corresponds to a sustainable society.

Kuhn's (1996) viewpoint suggests a degree of politics and personality is involved in effecting change, and while this has merit there are also leverage

points within a system that can effect significant change with an apparently small effort.

If a system does behave as an observer desires, it is only a temporary condition due to the complexity of its self-organizing, non-linear, feedback systems that are inherently unpredictable (Meadows, 2001). This makes systems theory a tool to understand what is happening and not a control mechanism for a system under study.

Meadows (1997) suggested ten ways to change the effectiveness of the operation of a system. The increasing order of effectiveness and difficulty (from least to greatest) is shown in Table 3.6 and their application to waste management systems is discussed below.

Table 3.6. Leverage Points in a System. Adapted from Meadows (1997).

1.	Parameters
2.	Materials stocks and flows
3.	Regulating negative feedback loops
4.	Driving positive feedback loops
5.	Information flows
6.	System rules
7.	The power of self-organisation
8.	The system goals
9.	The paradigm out of which the system arises
10.	Transcending paradigms

3.11.1 Parameters

The usefulness of the numbers generated is that they are able to give corroborative evidence, rather than motivate change. The quantities of wastes being generated and how much is being diverted are certainly important parameters to have, but the reliability of these figures can be highly questionable (e.g. CIWMB, 2001). Meadows (1997), suggested that 95% of the effort in trying to change a system is usually targeted at changing parameters. In addition, the changes that do occur through parameter collection are normally aimed at increasing the efficiency of the system under study and are often achieved through a technological change (e.g. greater compaction, concentrating or diluting a discharge or removing contaminants from air emissions). The realised change is a low impact, end-of-pipe change and so requires a minimal change in behaviour on the part of the operator.

Where this information can be of benefit is where it is used to supplement a leverage point that is further down the list. An example of this is reducing the delay time in a feedback loop (e.g. having a heating control close to the object being heated). This can allow a fine-tuning of the system such that oscillations do not gain in amplitude and cause over- and undershooting. An example of a beneficial outcome was in a Kraft paper mill where water savings were used as a means to also reduce energy (Wising *et al.*, 2005). Reducing the water reduced the energy needed for live steam and also allowed excess energy to be used for evaporation, giving an overall saving of 4 GJ/t.

3.11.2 Material flows and stocks

A greater commitment to change behaviour is required here, but in combination with basic data collection, substantial waste reduction can be achieved.

Leveraging the flows and stocks allows an understanding of the limitations and bottlenecks in the system which allows for operating it so that there is the least strain on the system (Meadows, 1997). In the previous example pinch analysis was used to eliminate the pinch points and this produced over 60% of the energy savings (Wising *et al.*, 2005).

As well as flow considerations within the process it is essential to have sufficient material to act as a buffer for the process, but not so much that stock expires. Thus the equilibrium between stocks and flows is crucial to reduce wastage.

3.11.3 Regulating Negative Feedback Loops

The absence of feedback loops is a common cause of system malfunction. No system can be allowed to work without feedback loops, since their absence results in the classic stages of a system's existence: unchecked growth, explosion, erosion and collapse of a system (Meadows, 1997).

Negative feedback loops can be a powerful mitigator of uncontrolled growth leading to system collapse. Financial disincentives (e.g. levies, user charges, environmental fees and liability costs for waste generation) act as negative feedback loops but include self-regulation and self-monitoring (Vester, 2007).

The ability of a negative feedback loop to correct system deviations depends on a combination of parameters and links. Among these are: the accuracy and speed of reporting, the speed and power of the response, and the directness and size of the correction instituted (Meadows, 1997).

The strength of a negative feedback loop is relative to the impact it is designed to correct (Meadows, 1997). For example, a nationally applied tool gives everyone a level playing field, but it is very blunt and results in a much slower response time to achieve changes in behaviour. A localised application increases the possibility of tailoring the tool to the local conditions and provides a quicker response. In the Auckland region two of the cities instituted user pays rubbish bag collection and quickly achieved a per head disposal rate about half that of the other comparable cities (Seadon & Mamula-Stojnic, 2002). In the State of Victoria, Australia, a state-wide levy on waste disposed to landfill took eight years from institution to achieve a decrease in per head quantities (Sus Vic, 2005).

3.11.4 Driving Positive Feedback Loops

Positive feedback loops reinforce actions on a system (Meadows, 1997). The ultimate conclusion of an unchecked positive loop is the destruction of the system and hence, wherever there are positive feedback loops there also need to be negative feedback loops which predominate to provide balance. An example of this is the implementation of a glass recycling scheme in New Zealand to divert waste from landfill.

The first successful bottle works was set up in Auckland in 1922, driven by the beer bottle market (Bowey, 2007). Over the years the operation expanded and was relatively cyclic. Glass recycling was originally managed through a container deposit system, which gave way in the 1990s to a well advertised kerbside or dropoff recycling systems (positive feedback). With the introduction of cheaper bottles sourced from overseas, the amount of glass for recycling in New Zealand went beyond the capacity of the sole recycling facility, resulting in a price drop in 2004 (negative feedback) and consequent glass ‘mountains’ around the country. Simply recycling the glass back into containers became uneconomic in many areas. Since the ‘crash’, alternatives

to recycling into bottles have been investigated by the Glass Packaging Forum including a cycle track development (MfE, 2006c). The Glass Packaging Forum set up a contingency fund to initially subsidise glass recycling (to keep the glass recycling rates constant while alternatives were found) and then to provide funding to research additional uses for end-of-life glass (MfE, 2006c).

Other mechanisms to encourage positive feedback loops include grants and subsidies, lower environmental fees, technical assistance for operations and subsidised cleaner production programmes.

One way to lessen the speed of the loops is to reduce the gain around the positive loop and hence reduce growth. In the glass example above, all glass was accepted at the facility, but quotas were paid for at the previous prices and all above quota amounts were paid for at reduced prices, thus discouraging increasing quantities.

3.11.5 Information Flows

This is a loop which delivers new information to where it was not going before. For example, in 1986 the US government required every factory releasing hazardous air pollutants to publicly report those emissions. There were no fines attached, no determination of safe levels nor any prohibitions, just information. Over four years, emissions dropped by 40% and companies acted to get off the list of heavy emitters (Meadows, 1997).

Information flows also increase the amount of accountability that can be attributed to individuals or groups. In 1997, the Auckland City Council analysed the city's solid waste production per capita (Seadon & Boyle, 1999). Upon discovering that the City had the highest per capita production in the region, significant moves (reversing previous decisions) were instituted to reduce that figure. The initial process was aided by the implementation of the Local Government Amendment Act (1996) which required local authorities to prepare waste management plans, taking into account the waste management hierarchy. No time limit and no penalties were imposed but local authorities around New Zealand responded in a similar manner to Auckland City.

3.11.6 System Rules

The rules of the system define it scope, boundaries and degrees of freedom. A change in the rules of the system changes behaviour and so whoever makes the rules has great power over the operation of the system (Meadows, 1997). In the previous example the Auckland City Council ruled that all mobile garbage bins would be reduced in size from 240 L to 120 L and that more recycling capacity would be introduced. The result was an overnight reduction of waste by a third and an increase in recycling (Seadon & Mamula-Stojnic, 2002).

3.11.7 The Power of Self-Organisation

The initial design can change items that are less powerful leverage points on the list. Within this is the power to create whole new structures and behaviours and change any system aspect lower on the list (e.g. adding or deleting physical structures, changing feedback loops, information flows or rules). This reveals itself as technical advance or social revolution.

There are periods when humans are more open to social revolution. Elkington (1999) ascribed wave peaks and downturns to the environmental movement between 1969 and 1999. The peak in 1988 – 90 coincided with formulation of the Resource Management Act (1991) in New Zealand and a resultant focus on waste management issues. The Ministry for the Environment encouraged cleaner production programmes and local government supplemented with local cleaner production programmes for industry, municipal recycling and pay-as-you-throw schemes. After initial resistance the populace accepted pay-as-you-throw and that, along with recycling are now normal activities for householders (Seadon & Mamula-Stojnic, 2002).

The next wave started through the growing awareness of the effects of climate change in 2006, highlighted by the publication of the Stern Review (2006) and Al Gore's (2006) film 'An Inconvenient Truth'. These events provided impetus for the New Zealand Prime Minister, in 2007, to announce broad initiatives in the 'Sustainability Six Pack' (public service carbon neutrality, sustainable procurement for government goods and services,

sustainable households programme, support business sustainability, eco-verification and improving waste management) (Clark, 2007).

The perceived difficulty in this intervention point is that it opens up the possibility of creating diversity (Meadows, 1997) and in doing so there is a loss of control and thus a loss in influence over the sub-systems.

3.11.8 The System Goals

Each of the above categories has a set of goals which conform to the goals of the whole system. If the goal of a waste management system is to reduce waste, then the system is seen in an isolated manner. However, if the boundaries are set so that the goal is set to improve efficiency of the production system, then everything from the design phase to the production and transport phase are seen in the context of the whole system. This is the basis of the New Zealand Waste Strategy (MfE, 2002a). Being able to formulate the goals is a powerful leverage point.

3.11.9 The Paradigm out of which the System Arises

Goals, information flows, feedbacks, stocks and parameters flow from the paradigms. The ability to change and define a paradigm is determined by people who have bought into that paradigm and hence the paradigm gains its supremacy until a new paradigm takes its place. A paradigm change requires enunciation of the anomalies and failures of the old paradigm, a loud and insistent proclamation of the new one, bringing people of influence and power adopting the new paradigm into the foreground and ignoring the reactionaries (Kuhn, 1996). Through this process 'flame, flush and fling' have been replaced by 'reduce, reuse, recycle and recover'.

3.11.10 Transcending Paradigms

No paradigm is the true paradigm. This is the biggest leverage point (Meadows, 1997). It is the ability to realise that others may come up with better paradigms and to be able to adopt a new paradigm because it has greater merit that enables progress to be made. The evolution of waste management from a simplistic disposal mentality to the recognition that it is an

integrated process requiring a systems approach shows the success of allowing for paradigm shifts (Seadon, 2006).

3.12 Conclusion

A conventional reductionist approach to waste management falls short of being sustainable for a number of reasons.

- Focusing on collecting and analysing immaterial data.
- Implementing irreversible interventions rather than mechanisms to deal with modifiable emerging side effects.
- Finding short term solutions rather than longer term sustainability thinking.
- Misinterpreting time lags between intervention and effects as a lack of response thus employing stronger interventions, resulting in over-correction that has to be mitigated.
- Disregarding or undervaluing the side effects of intervention.
- Fixating on singular problems rather than the viability of the waste management system.
- Relying on linear projections of recent short-term events.

The start to a change in thinking is to realise that waste management system share many of the characteristics of complex adaptive systems.

- Waste management organisations work together through agreements based on shared customs and economic motivations.
- Numerous agents work simultaneously in parallel creating patterns of development.
- Extensive interconnections between agents are possible.
- Negative feedback curbs scope while independence increases the scope.
- The system is dynamic.
- The greater the degree of interdependence of the components, the harder it is to achieve global optimisation.
- As the system moves away from equilibrium it becomes more susceptible to radical readjustment.
- The correlations between causes and effects are not linear.
- General performance patterns are discernible.

A sustainable waste management system has the following elements.

- Negative feedback loops dominate positive feedback loops.
- The system's strength does not depend on expansion.
- The system is focused on the processes not products.
- Products, functions and organisational structures need to be adaptable and multi-purpose.
- Wastes do not exist as excess materials and products are diverted.
- Linking and transposition are used to the mutual advantage of all parties.
- Products, procedures and organisational forms utilise feedback planning to model biological systems.
- Leverage points are used to effect system change.

The process to transition to a sustainable waste management system is achieved through the use of leverage points, with each succeeding leverage point more powerful than the previous one.

- Changing the parameters of a waste management system to make the system more effective.
- Changing the material flows and stocks to gain an understanding of the limitations and bottlenecks in the waste management system.
- Regulating the system through negative feedback loops to mitigate uncontrolled growth.
- Driving positive feedback loops to provide direction to the waste management system.
- Extract new information for specific parameters to establish trends.
- Changing the scope, boundaries or liberty that the waste management system operates under.
- Allowing the waste management system to organise or change itself.
- Setting the waste management system goals so that they are resilient over time and can adapt to changing circumstances.
- Changing the model under which the waste management system operates.
- Adopting a new model to achieve a more sustainable waste management system.

Chapter 4: The Waste Management Hierarchy

4.1 Purpose

The purpose of this chapter is to examine how a waste management hierarchy is used to manage waste in an integrated manner.

4.2 Context

The adequate identification of alternatives to waste generation requires a decision-making framework. In its simplest form, such a framework incorporates a waste management hierarchy. A waste management hierarchy is a common tool that is used as a menu by countries and businesses to develop sustainable strategies (Sakai *et al*., 1996). This is a structure that has come to underpin the development of sustainable waste management strategies (Price and Joseph, 2000).

4.3 Elements of a Waste Management Hierarchy

There is no single version of the waste management hierarchy. However, among the many versions in operation the guiding philosophy is that those actions described at the top of the hierarchy are preferable to those described lower down.

This is exemplified by the United States Congress which defined a waste management hierarchy in the Pollution Prevention Act (1990), as:

> "…*pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.*"

Different countries, and even different states within countries, define their waste management hierarchy variably as demonstrated in Table 4.1.

Table 4.1. Examples of Waste Management Hierarchies

NZ[a]	**EU**[b]	**USEPA**[c]	**South Australia**[d]	**Queensland, Australia**[e]
Reduction Reuse Recycling Recovery Treatment Disposal	Prevention *or* reduction Reuse Recycling Recovery Disposal	Reduction & reuse Recycling/Composting Energy recovery Landfill & incineration without energy recovery	Avoid Reduce Reuse Recycle Recover Treat Dispose	Avoid Reuse Recycle Energy recovery Disposal

a) Waste Minimisation Act, 2008

b) Ffact, 2006

c) US Environmental Protection Agency, 2006

d) Zero Waste South Australia, 2007

e) Environmental Protection Agency, 2007

4.4 Limitations of a Waste Management Hierarchy

Regardless of the actual components in the hierarchies, the value of them is that they provide a guiding framework to consider waste minimisation in a systematic manner. This was recognised in the United Kingdom where the waste strategy for England and Wales described the hierarchy as a *guide* (Department of the Environment, Transport and the Regions, 1995).

The guiding framework of a waste management hierarchy has limitations. One of the limitations is that the context of the system in which a hierarchy operates must also be considered. For example, New Zealand and Ireland, with similar population sizes, have quite different constraints. New Zealand is isolated from its primary European, Asian and North American markets and suppliers, has a low population density and low industrial development. Ireland has a more compact geography, a population density four times greater than New Zealand, more intense industrialisation and is very close to its major markets in Europe (Central Statistics Office, 2008). In terms of waste diversion, New Zealand generates small quantities that are very dispersed and thus needs to attract a much higher return than Ireland to provide for economic processing.

Waste in Ireland comes under the European Union Landfill Directive which compels member states to reduce biodegradable waste disposed to landfill and increase recycling and recovery rates of household waste (Burnley, 2001). To achieve targets in the Landfill Directive costs for disposal have increased. If the targets are not met then financial penalties will be imposed (Burnley, 2001). This is a far more regulated and financially incentivised programme than what operates in New Zealand.

Other limitations need to be taken into account when dealing with a waste management hierarchy. The simplicity of a hierarchy does not consider using a combination of options. For example, The Ark Computers (2009) work with New Zealand businesses to utilise computers that have reached the end of their lives. Some computers are utilised for their parts to refurbish other computers for reuse and some parts are disposed of because they are obsolete. This combination of recycling, reusing and disposal is not covered

well by a single classification under a waste management hierarchy. In addition, McDougall *et al.* (2001) added that limitations included waste management hierarchies had little scientific or technical basis. However, waste management hierarchies are a useful tool as demonstrated by their implementation.

4.5 Implementation of the Waste Management Hierarchy

The implementation of a waste management hierarchy requires a combination of approaches. For those elements that are higher up the hierarchy (prevention or reduction) where there are multiple suppliers, significant results can only be achieved by taking a nationwide approach, especially in a small economy like New Zealand. This is exemplified in a report completed by the New Zealand Office of the Auditor-General, (2007), where local councils responded that waste reduction initiatives needed central government leadership.

Central government leadership is needed to set the direction and to encourage the commitment that is needed because working at the top of the hierarchy requires a greater effort to change behaviour. However, the benefit is that working at that level is an approach that generates lower consumption and produces more durable materials. The top categories in the waste management hierarchy, reduction/prevention and reuse, prevent emissions to the environment, whereas all the others still result in emissions. Mont and Plepys (2008) note that the move to sustainable consumption is gaining momentum but there has not yet been a shift from a material-intensive consumer society to one less materialistically driven.

The initiatives at central government level also need to be complemented by others at the local level. Initiatives that are lower down the hierarchy, like recycling and recovery, depend on adequate resources at the local level, particularly for collection. In New Zealand, much of the responsibility for implementation of the hierarchy for household waste is devolved to local authorities. Where they are not adequately resourced, as in the UK, for example, 70% of the local authorities indicated they cannot perform as required (Read, 1999). The primary reasons given by Read (1999) for failure

were the costs of options, staffing levels, local government cut-backs and the introduction of privatisation. However, intentions do not always come to fruition in practice.

A common disconnect is where local authority, and even business people, cite the desirability of implementing the hierarchy, but then send most of their collected material to landfill (or incinerators where they exist). The experiences in the UK showed this was the case in early stages of implementation (Read, 1999), but as the requirements of the European Union started to influence the UK practices, the response has been to increase landfill charges to encourage diversion and to put more emphasis on reducing waste (Defra, 2007).

The influences on the UK of the European Union Landfill Directive have long been known (Burnley, 2001). In the Waste Strategy for England (Defra, 2007), the government signalled actions to meet the Directive targets. These include: a doubling of the landfill tax from £24 in 2007 to £48 by 2010 to provide more economic diversion; introducing enhanced capital allowances in combined heat and power facilities; restricting biodegradable and recyclable wastes to landfill; taking effective action on flytipping (illegally dumped waste) and waste exporting (primarily to developing countries); and producer responsibility for nominated waste streams. Each of these is designed to encourage development in pollution prevention. However, in deciding on the best methodology to use it is also necessary to decide on the importance of various drivers.

A waste management hierarchy is dependent on the use to which is put. In a Danish study looking at paper waste in relation to five environmental drivers, Schmidt *et al.*, (2007) concluded that if global warming potential and acidification were important, the results supported the waste management hierarchy. However, taking into account eutrofication and photochemical smog changed the hierarchy order so that incineration was found to be better than recycling. But there was little difference between incineration and recycling when the effects of ozone depletion were examined.

Extending the waste management hierarchy to other media adds a level of complexity.

4.6 Integration Across Media

A multi-media approach (Chapter 2), which considers the atmospheric, aqueous and solid emissions, as well as waste energy, enables a more holistic picture to become evident.

When waste in each media is considered in isolation, the transfer of waste from one to another is seen as a solution to the waste problem rather than a transfer of the problem. For example, incineration of solid waste solves the problem of reducing solid waste quantities, but merely creates an air pollution problem. The implementation of a multi-media approach encourages reflection on upstream processes with a view to an integrated emissions reduction approach (Stiles, 1996). An integrated approach that uses methods appropriate to the situation under consideration is needed when dealing with a multi-media process.

4.7 The Hierarchy as a Framework for Waste Reduction at Fonterra

4.7.1 Waste Compared to Product

The size of the cost of the waste problem for Fonterra can be demonstrated by considering a typical plant. Liquid waste constituted about 0.9% and solid waste about 0.12% of the income generated by the site. In addition, recycling added about 0.04% to the income. Although these percentages are small, the positive effects of not producing the waste in the first place extend beyond the financial to the social (the good feeling generated by not producing waste) and environmental (lessens the environmental impacts and hence the environmental footprint). These factors were sufficient for Fonterra to participate in waste reduction programmes using the waste management hierarchy.

4.7.2 Waste at Fonterra

Fonterra produces liquid, gaseous and solid wastes as part of its operation. Traditionally, the Company has managed wastes in each medium separately, but there are recent examples of integration across media.

Fonterra's sophistication in dealing with liquid wastes and their treatment before discharge has been evolving since the earliest times in New Zealand, but has gained considerable momentum since the enactment of the RMA in 1991 through its provisions to require the management of the environmental effects of human activity. In Fonterra's case, the extraction of material from milk produced 21 million cubic metres of wastewater in 2004 ranging from almost pure water to high strength wastes (high BOD levels). The efficient utilisation of these liquid streams is a major focus of the company. In response to the high levels of generation, Fonterra targeted a 60% reduction in their high strength waste and a 40% reduction in general wastewater volumes produced in their most productive region, the Waikato, by 2009 (Pollard, 2006).

The focus on air emissions has also been increasing since the Resource Management Act 1991 became law. Air emissions are monitored at each Fonterra plant. They primarily consist of particulate material derived from the drying milk to produce milk powder as well as from burning coal. The total particulate material emitted annually by Fonterra in New Zealand is 1,056 t.

The focus on solid waste has only happened since 2003 when Fonterra's environmental performance was being questioned more closely by its principal international customers. Fonterra spends $2.4M on solid waste management activities each year. To reduce this spending and the Company's environmental impact, a target of 75% reduction in solid waste to landfill by 2008 was set in 2004 (Fonterra, 2006b). This has been achieved and a further target of 90% reduction is likely to be met by the end of 2009.

When the wastes are considered in relation to the production process at Fonterra, the cost of dealing with them is relatively small.

4.7.3 Applying the Waste Management Hierarchy at Fonterra

Fonterra has used the New Zealand waste management hierarchy as a basis for waste reduction. When asked for examples of where the waste management hierarchy has been applied, 100% of respondents (n=79) gave examples relating to solid waste. Among environmental managers (n=19) 77% gave liquid examples, 23% gave energy examples and 8% gas

emissions without prompting. Among managers (n=31), 32% also gave liquid examples. Across the 22 New Zealand sites investigated, the waste management hierarchy was applied to 36 solid wastes, 28 liquid wastes, 19 air emissions and 34 energy reduction methods. Figure 4.1 shows the spread of the application of the waste management hierarchy to factory wastes.

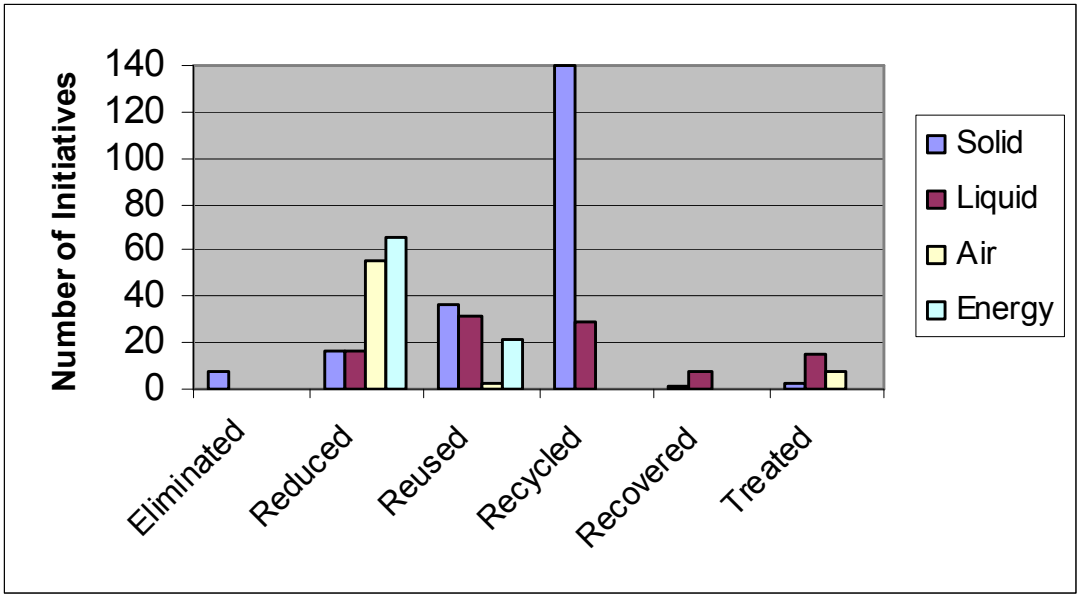

Figure 4.1. Application of the Waste Management Hierarchy to factory wastes.

Figure 4.1 shows that air and energy wastes rely more on reduction, while liquids are predominantly reused or recycled and solid wastes are predominantly recycled with reuse coming a distant second. There are different drivers for the selection of methods used to manage emissions.

The preponderance of reduction initiatives for air emissions results from the necessity to observe resource consent conditions placed on the factory sites. Failure to observe these conditions can result in abatement notices that could potentially stop production at the site or result in substantial fines (up to $200,000 under the Resource Management Act, 1991).

Energy management options most closely follow the sequence of the waste management hierarchy. This is because Fonterra can accurately measure losses as energy is transformed from one form to another (e.g. electrical to heat). For energy usage, reduction is the preferred option over reuse by a factor of over 3:1 due to the high cost of energy and the losses incurred in transformation.

Liquid wastes are mainly reused or recycled as the large quantities generated through drying milk are difficult to reduce without impairing the quality of the milk arriving at the factory for processing. The reuse and recycling options often relate to cleaning processes (e.g. clean-in-place flushes) when counter current rinsing is used to clean vats, silos and pipes. In counter current rinsing the dirtiest water is used first to clean the dirtiest equipment. Several rinses are used, each time using cleaner water. Fresh water is fed into the cleanest equipment. This process reduces the amount of water and cleaning chemicals needed for cleaning which results in savings in water (generally a cheap resource for Fonterra since most sites do not rely on municipal water reticulation) and cleaning chemicals.

Another programme involves recycling the high strength wastes in the most concentrated dairy production area, the Waikato. Options for recycling include: drying to use it as stock food replacement; use as a fertiliser and soil conditioner; converted to biodiesel; and production of biogas by anaerobic digestion for heat and power for the operation with the remains used as a fertiliser (Pollard, 2006).

Finally, recycling of solid wastes gives a commercial return, both in not paying for landfill fees and transportation costs to the landfill, or for the recycled material. These savings don't require a major change in behaviour as the practices do not change – just a change in where the wastes are deposited. Recycling programmes are also easy to quantify on a balance sheet, thus showing quick success for such a programme.

Consideration of the waste management hierarchy across media allows for even more possibilities to integrate waste management.

4.7.4 Applying the Waste Management Hierarchy across Media

Consideration of wastes across media allows for greater innovation and a greater range of solutions for wastes that are generated. For example, Fonterra integrates waste heat and waste water to lower its energy and water usage as shown in Figure 4.2.

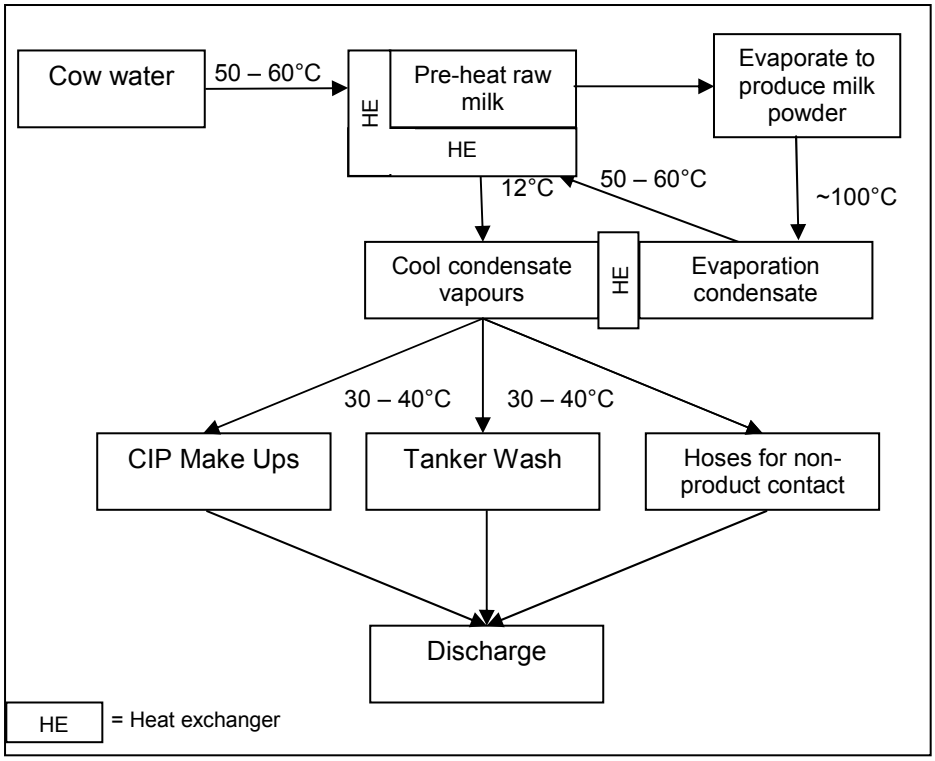

Figure 4.2. Reuse of Cow Water.

The system involves two heat exchangers. Cow water (water extracted by concentrating milk) at a temperature of 50-60ºC is passed through a heat exchanger to pre-heat raw milk. This process reduces the energy required to evaporate water from milk in the milk powder production process. The condensate produced from the pre-heating process reduces in temperature to 12 ºC. The cool condensate vapours are then passed through another heat exchanger with evaporation condensate at near-boiling point from the milk powder evaporation process. The heat exchanger lowers the evaporation condensate to 50-60 ºC and raises the cool condensate vapours to 30-40 ºC. The evaporation condensate is then passed through a heat exchanger to pre-heat raw milk. The lukewarm condensate is used for clean-in-process make ups, washing milk tankers and as a water supply for non-product contact before being discharged.

In another example, energy and washwaters are reused. Ethanol is one of the byproducts of whey utilisation. The heat from waste steam in milk production is used in the ethanol plant to vaporise the ethanol. The hot water that results goes through a heat exchanger in a demand water tank where the water

comes in at 10°C. Water is heated to 60°C and sent off to the cleaning-in-place tank.

In other applications, milk permeate from lactalbumin is used to wash the casein washwaters. This integration saved 600m^3 per day of water loss to ponds and the loss of lactose and lactalbumin at one plant. In addition the usage of fossil fuels to produce heat is reduced.

These processes were arrived at after a consideration of the waste management methods available.

4.7.5 Waste Management Decision Making at Fonterra

Decisions made by Fonterra on waste management methods related to the degree of impact on the Company. The order for applying waste management methods were influenced by: cost, legal compliance, eco-efficiency and environmental effect. Cost considerations followed on directly from the capital expenditure process. Costs and the associated internal rate of return (how much would be returned for every dollar spent) were not always the driving factor. The ranking of the project also depended on the amount of money available and the number of projects being proposed at any one time. Legal compliance was principally related to conditions that had to be met for waste discharges from the factories, while eco-efficiency encapsulated waste composition and utilisation. Environmental effects were often linked closely with legal compliance, in which case these measures took precedence.

Different personnel approached the decision-making process from different perspectives. Environmental managers were concerned about the ease of implementation because they were generally the ones who had to implement waste reduction processes. Management rated consultation, both inside and outside the Company, as more important to identify the important parts of the waste stream, as they were more exposed to criticism, particularly from the community.

Identification of the waste stream(s) requiring attention is one part of the process. Once identified, it was necessary to decide on the waste management method to be adopted. In Fonterra, historical solutions were the most used. This made for an efficient problem-solving process and one where

there was likely to be expertise within the Company to implement the solution. Second to historical solutions was consultation within the Company which gained support for the process and brought in added expertise. The next most used processes were cost-benefit analyses (including the internal rate of return) and the legal need, both of which were used as tools to persuade higher management to adopt the proposed solutions.

Within the decision making process there were a range of potential barriers that had to be addressed.

4.7.6 Barriers to Implementation

When technology substitutions or process changes occurred there were potential barriers that needed to be overcome, preferably before the change occurred.

The barriers can be divided into externally and internally driven. The externally driven ones were identified by Fonterra staff as:

- regulatory – in which case it was mandatory;
- relationships with local authorities – developing these were regarded as important and it was necessary to work with them;
- markets – where a waste was to be diverted there had to be markets that made it economically viable for the diversion to happen; and
- outdated technology or lack of spare parts. This came down to economic viability to determine if the change happened.

In considering the internal barriers, most responses noted that there was no systematic process in the Company to look at these barriers. However, the following were expressed.

- **Economic Viability.** There was a requirement for economic viability, and associated with that were increased efficiency, cost reduction and whether any extra costs were acceptable. A change that caused extra costs did not necessarily rule out that change. It was decided on a case by case basis that may change over time, depending on the tight or loose spending restrictions from corporate management.

- **Consultation.** It was necessary to consult within the site to determine priorities and overcome objections. Associated with on-site consultation was bringing in appropriate people from around the country and conducting appropriate investigations.
- **Reproducibility**. By researching where a proposed measure had been implemented before the results and reliability were considered.
- **People**. It was important to determine who was going to do the job and if there was extra work involved how this was allocated. The unions were vigilant in monitoring this aspect.
- **Upscaling**. This is considered firstly from a small scale investigation to a full plant or site and then adoption as appropriate at other sites.

Reliable and easy access to information is one of the most crucial aspects for problem solving. Respondents noted that the most widely used methods for getting information were discussions with the Eco-efficiency Manager, the Eco-efficiency Update newsletter and connections with other people on other sites. The Company's intranet hardly rated a mention as a source of information for waste reduction by either managers or staff. Several people mentioned the difficulty of navigation through the intranet as a reason for not using it much.

4.7.7 Effective Ways to Implement Waste Reduction

Effective implementation of waste reduction requires an understanding of the needs of different people involved in the process. Management and staff approach things from different perspectives.

Management were looking to have their needs implemented with a minimum amount of disruption. Staff were looking for leadership from management, reinforcement during the process and to be appreciated when they accomplish management's requirements. This was borne out in the responses from the Fonterra managers and staff to questions of effective ways to implement waste reduction shown in Table 4.2.

Table 4.2. Effective Ways to Implement Waste Reduction.

Management	**Staff**
Education and publicity Simple to implement Doesn't compromise liability and costs Have a few well-focussed initiatives	Driven by management Simple to implement Management working with staff Clear explanations on what is expected Engage people who can make a difference Management to show continuing interest by spot checks and talking to staff Good advocates encouraging informally Build a long term plan Make an undesirable action more difficult Give incentives – monetary and non-monetary

The first of the management responses (education and publicity) appears to be very different from the others. When all four responses are regarded as a package, the first response underpins the others. When adequate education and publicity is provided at both the beginning and during the programme, management of the programme becomes easier. This is because there is a constant reminder that the programme is important to the Company and it enables understanding of the reasons for engaging in the programme for management and the staff. Choosing a few initiatives and making them simple to implement means that it requires less effort for management to support implementation. The fourth response, not compromising liability and costs, ensures that there are no effects in other parts of the operation that would require further management intervention.

4.8 Conclusions

A waste management hierarchy provides a systematic guide as one of the tools in a holistic approach to waste management. In addition, waste management needs a consideration of environmental, social and economic impacts of a product or service. For the best effects, all people need to be involved in a programme with the recognition that waste reduction is a long-term project.

When embarking on a long-term project it is often easier to find steps that will produce quick results and so waste streams are considered independently of each other. These initiatives are often at the recycle and recover part of the hierarchy.

To operate at the top of the waste management hierarchy (the pollution prevention level) requires more effort to change behaviour. However, it is also an approach that generates lower consumption and produces more durable materials. To gain significant results at the pollution prevention level, many of the opportunities require a nationwide approach, with the provision of incentives.

Organisations, like Fonterra, which embark on reducing their environmental impact, firstly apply the waste management hierarchy to a single medium, usually the one which has the greatest driver for efficiency. As their experience increases they expand to other media and finally work across media. In working through these processes the organisation uses a set of criteria to determine the order of priority for dealing with waste streams and which element or combination of elements of the hierarchy are the most appropriate.

The order of priority to deal with waste related to the degree of impact on Fonterra. Those that had the greatest impact (cost and legal compliance) received the highest priority and those that had the greatest potential for long-term reputational change (eco-efficiency and environmental effect) came next. In developing approaches to dealing with waste, historical solutions were the most favoured method when deciding on the waste management method adopted because these called on readily available expertise in the company. In general, collaborative processes were high on the list of methods used.

There were no systematic methods within the Company for dealing with barriers to implementation of change. However, the barriers were most readily overcome through the access to information that was either provided through distributed material or from specialist people. This informal arrangement provided the necessary solutions.

Overall, a waste management hierarchy is a useful tool as a start to effective waste management, but it must be borne in mind that it is part of a process.

Chapter 5: The Integration of Tools

5.1 Purpose

The purpose of this chapter is to examine how tools are used to manage waste in an integrated manner.

5.2 Context

The available tools (also called instruments, mechanisms or devices) to effect change in waste management practices, as discussed in Chapter 2, include: legislative/regulatory, economic, voluntary and informational. The ability to use a variety of tools enables a waste management system designer (as discussed in Chapter 3) to be able to achieve desired behaviour changes by the application of different combinations of tools. To effectively minimise waste an integrated framework of tools is necessary throughout the planning, development and implementation stages of a waste management programme (Ernst and Young and the Science Policy Research Unit, 1998).

5.3 Use of Tools

5.3.1 Government Utilisation of Tools

Legislative/regulatory, informational and economic tools tend to be government-led and operate at a societal level. Countries, or blocks of countries (e.g. European Union) often use legislative tools to drive trends. For example, the European Union has instituted regulations that mandate recycling and disposal requirements and set limits for contaminants in foods. Over the decade from 1994 – 2004, forty barriers to trade to promote environmental policies in Europe were introduced (Osborne, 2004).

The European Union's emerging voluntary codes of practice (e.g. EUREPGAP, Global Partnership for Safe and Sustainable Agriculture (EUREPGAP, 2006)) are important indicators of the developments that can be expected in other developed markets like Japan and the USA which, due to the size of their population and consumption rates, can have significant

influence over the methods adopted by producers . The purposes of the Integrated Farm Assurance scheme are to (EUREPGAP, 2006):

> … "*facilitate mutual recognition through transparent benchmarking, boost worldwide participation in farm assurance, encourage continuous improvement, and provide performance and integrity measurement for assurance schemes*".

On a wider scale, governments use a variety of tools to steer industry in the direction they want. The New Zealand government uses a broad range of tools to drive change that focus primarily on approaches and principles. The New Zealand government has used the following tools to encourage change in industry: cleaner production (e.g. guidelines (MfE, 2009d)), environmental management strategies (e.g. New Zealand Waste Strategy (MfE, 2002a)), reporting to stakeholders (e.g. Environment New Zealand 2007 (MfE, 2007a)), sustainable development, voluntary environmental agreements (e.g. Packaging Accord (PackNZ, 2004)), zero waste (e.g. New Zealand Waste Strategy (MfE, 2002a)) and legislation (e.g. Waste Minimisation Act (2008).

5.3.2 Business Utilisation of Tools

Industries or industry groups often use voluntary tools, which include systematic guides, manuals and management systems. These tools work at the sub-system level because they tend to focus on their industry in isolation of the rest of society and the biosphere. Such tools include industrial ecology, environmental engineering and environmental technology.

Historically, industry has been at the forefront of the adoption of tools to reduce environmental impacts and governments have reacted later with policy and legislation (Seadon, 2006). This is a standard approach in democracies where governments must be followers (e.g. Boven 2003).

5.4 Policy Tools

Tools help alter behaviours in more sustainable directions and hence an absence of policy tools in the waste area leads to increasing quantities of waste being produced. The Organisation for Economic Co-operation and Development predicted that municipal solid waste would increase by 43% in the period 1995 – 2020 in the absence of additional policy tools (Commission

of European Communities, 2003). Policy tools in New Zealand represent one area that traditionally has relied on a narrow set principally composed of education and a limited amount of regulation. In New Zealand the focus for legislative processes was initially on reducing harm, firstly to the public, then to the environment (Seadon, 2006).

The development of policy tools ideally follows a systems-based process. Scientific observation and analysis determines the risks that are then appraised and subjected to an option analysis. Policy measures are formulated and implemented and then evaluated (Smith and Berkhout, 2000). The feedback, both negative and positive, provides information on the direction of the policy which can then be amended if deemed necessary by cabinet.

However, there are challenges with this approach. Often the contested nature of the environmental problems leads to reactive environmental policies. In addition, there is a lack of integration with policy for other environmental problems and there is a focus on laggards, not leaders (Smith and Berkhout, 2000) as expected in a democracy (Boven 2003).

5.4.1 International Conventions and Codes

Like in most developed countries, waste management in New Zealand has progressed from indiscriminate dumping, to include first treatment, then recycling and reduction of wastes at source (applying concepts such as pollution prevention and cleaner production). The progression was brought about by the pressure from international conventions that New Zealand signed; an increase in public awareness of the effects of wastes, firstly on human health, then on the environment; and more recently on long-term sustainability considerations. Table 5.1 demonstrates the relationship between some international waste conventions and the respective New Zealand legislation.

Table 5.1. International Waste Conventions and Codes and Related New Zealand Waste Legislation

First Date	International Convention/Code	Objectives	New Zealand Legislation
Water Pollution			
1972	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)	To control pollution of the sea by dumping and to encourage regional agreements supplementary to the convention	Maritime Transport Act (1994) and RMA (1991)
1973	International Maritime Organisation International Convention for the Prevention of Pollution from Ships (MARPOL Convention)	To prevent pollution of the marine environment by the discharge of harmful substances or effluents containing such substances from ships	Maritime Transport Act (1994) and RMA (1991)
1990	International Convention on Oil Pollution Preparedness, Response and Co-Operation	To prevent marine pollution by oil, to advance the adoption of adequate response measures in the event that oil pollution does occur, and to provide for mutual assistance and co-operation between states for these aims	Maritime Transport Act (1994) and RMA(1991)
Air Pollution			
1979	Convention on Long-Range Transboundary Air Pollution	To limit and as far as possible, gradually reduce and prevent air pollution, including long-range transboundary air pollution	RMA (1991)
1985	Vienna Convention for the Protection of the Ozone Layer	To protect human health and the environment against adverse effects resulting from modifications to the stratospheric ozone layer	Ozone Layer Protection Act (1996)
1989	The Montreal Protocol on Substances that Deplete the Ozone Layer	To protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion	Ozone Layer Protection Act (1996)

1992	Framework Convention on Climate Change	To achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system	Climate Change Response Act (2002)
Health and Safety			
1977	International Labour Organisation Convention Concerning Prevention and Control of Occupational Hazards in the Working Environment due to Air Pollution, Noise and Vibration	To protect workers against occupational hazards in the working environment	Health and Safety in Employment Act (1992)
Chemicals			
1985	Food and Agriculture Organisation International Code of Conduct on the Distribution and Use of Pesticides	To promote policies which ensure the safe use of pesticides while minimising health and environmental concerns regarding such use, establish responsible and generally accepted trade practices and assist countries which have not established controls designed to regulate the quality and suitability of pesticide products	Hazardous Substances and New Organisms Act (1996)
1990	International Labour Organisation Convention Concerning Safety in the use of Chemicals at Work	To enhance the existing legal framework for occupational safety by regulating the management of chemicals in the workplace, with the broad purpose of protecting the environment and the public, and the specific objective of protecting workers from harmful effects of chemicals	Hazardous Substances and New Organisms Act (1996)
1994	United Nations Environment Programme Code of Ethics on the International Trade in Chemicals	To set forth principles and guidance for private sector parties governing standards of conduct in the production and management of chemicals in international trade, taking into account their life-cycle, with the aim of reducing risks to human health and the environment	Hazardous Substances and New Organisms Act (1996)

		that might be posed by such chemicals	
2004	Stockholm Convention on Persistent Organic Pollutants	To protect human health and the environment from persistent organic pollutants	RMA (1991) and Hazardous Substances and New Organisms Act (1996)
2004	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	To promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm and to contribute to their environmentally sound use	Hazardous Substances and New Organisms Act (1996)
Waste			
1987	United Nations Environment Programme Cairo Guidelines and Principles for the Environmentally Sound Management of Hazardous Wastes	To assist governments in the process of developing policies for the environmentally sound management of hazardous waste	RMA (1991) and Hazardous Substances and New Organisms Act (1996)
1992	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	To ensure that the measures taken by states in their management of hazardous wastes and other wastes, are consistent with the protection of human health and the environment whatever the place of disposal	RMA (1991) and Hazardous Substances and New Organisms Act (1996) Customs and Excise Act (1996)
1997	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management	To achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management	Radiation Protection Act (1965)
2001	Waigani Convention (South Pacific regional convention)	To ban the importation into forum island countries of hazardous and radioactive wastes and to control the transboundary movement and management of hazardous wastes within the South Pacific region	RMA (1991) and Hazardous Substances and New Organisms Act (1996)

Adapted from (UN, 2009 and New Zealand Legislation, 2009)

As can be seen from Table 5.1 legislation specific to waste management in New Zealand has been a relatively recent occurrence relative to when similar legislation occurred elsewhere. The prime tool for waste policy that has been used by the New Zealand government is the New Zealand Waste Strategy (2002) (MfE, 2002a).

5.4.2 The New Zealand Waste Strategy (2002)

The policy tool that drives waste minimisation in New Zealand is The New Zealand Waste Strategy (MfE, 2002a). The production of the Strategy signalled the first attempt to deal with waste across the media (solid, sewage and air emissions). It recognises that moving towards zero waste and a sustainable country is a long-term challenge. The goals of "l*owering the social costs and risks of waste, reducing the damage to the environment from waste generation and disposal and increasing the economic benefit by more efficient use of materials*" encapsulates a triple bottom line approach to waste in New Zealand.

The cornerstones for the success of the Strategy are: legislation, efficient material utilisation, full cost accounting, environmental standards and environmental reporting. Effective legislation to achieve these goals in waste minimisation and waste management occurred in 2008 with the enactment of the Waste Minimisation Act (2008). The Strategy also recognised that the full cost of waste disposal (environmental and economic costs) would also assist waste reduction.

Driving up the cost of wastage through increased landfill charges and providing for funds for waste minimisation programmes (provided for in the Waste Minimisation Act (2008) and resource consent conditions for discharges to air, water and land (provided for in the RMA (1991), encourages more efficient material utilisation.

The inclusion of environmental standards that are monitored and reported as well as the provision of adequate and accessible information are other tools that support the move to waste reduction.

The 31 targets in the Strategy had associated responsibilities and actions that build towards longer term sustainability for the waste sector. Figure 5.1 shows

when each of the 31 targets in the New Zealand Waste Strategy was due to be completed. The vertical dashed red lines represent the reviews of progress in 2003 and 2006.

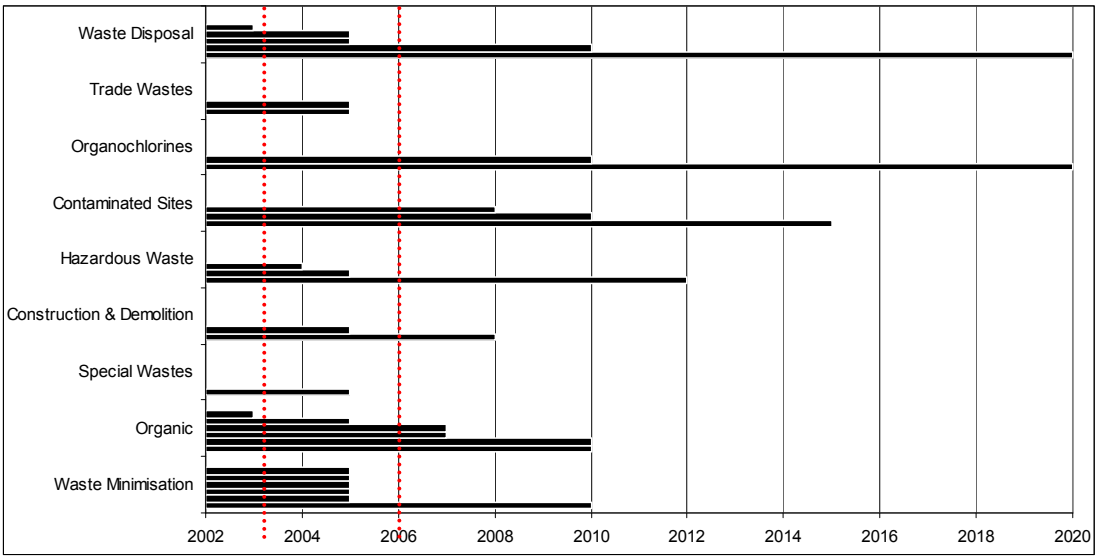

Figure 5.1. Completion target dates for the New Zealand Waste Strategy (with review dates in red dashed lines)

The targets presented both short and longer term completion dates. Each of these targets required actions. For example, the landfill and cleanfill programme included (MfE, 2002a): complete and implement guidelines for cleanfills and landfills by 2002; complete landfill classification and acceptance criteria for hazardous waste by 2003; undertake a landfill review by 2003; and the upgrade of substandard landfills by 2012. Coupled with the substantial programmes on waste minimisation, these targets represent a significant step forward for the country. To track the progress on the targets, two reviews were carried out on them by MfE.

5.4.2.1 Reviews of Progress of the New Zealand Waste Strategy

Reviews of Progress of the targets in the New Zealand Waste Strategy were carried out in 2003 and 2006. The 2003 Review, one year after the adoption of the Strategy, noted good progress by councils in setting local and regional targets, difficulty in meeting some targets – particularly organic waste targets, but recommended that no changes should be made to the targets (MfE, 2004). The very short time between the adoption of the Strategy and the

measurement of results that showed little real progress was not surprising. From a systems perspective, the time between adoption and measurement did not allow for the interventions to take effect.

The second review in 2006, after four years of operation, was more thorough and showed some progress (MfE, 2007b). Ten (of 31) targets had been achieved, a further 8 were in the future so no comment was made on them and the other 13 had either not been achieved (10) or some progress had been made (3). Reasons for non-achievement included: targets being outside the influence of the Ministry for the Environment and baselines being unable to be determined. Some of the original targets were predicated on the Ministry working with other ministries an action that did not occur. An example of this are targets 1.2 and 1.7 that required regional councils to include waste management and minimisation plans in building resource consents (MfE, 2007b). The review found this target was outside the bounds of the RMA (1991). However, this could have been a consideration in the enactment of the Building Act (2004), but the Ministry for the Environment was not able to influence the Department of Building and Housing to include these provisions in the revised Building Act because the Department could not see the significance of the issue. To overcome this problem it would have also been possible to seek cabinet approval for a “whole of government” approach to be taken (Cabinet Office, 2008), but this was not undertaken due primarily to the inexperience of the people involved in the negotiations.

5.5 New Zealand Legislation

As can be observed in Table 5.1, there is a network of legislation that has built up over the years that impacts on waste generated in and around New Zealand. Until 1991, New Zealand legislation regarding waste management focused on its collection and disposal.

5.5.1 Health Act (1956) and Local Government Act (1974)

The primary pieces of legislation until 1991 were the Health Act (1956) and the Local Government Act (1974). The former was concerned only with wastes as they related directly to human health. Local councils were thus

enabled to collect and dispose of solid waste and sewage. There were pieces of legislation that dealt with specific wastes like radiation and litter.

5.5.2 Radiation Protection Act (1965)

All stages of the life cycle of radioactive substances and equipment are covered in this legislation (Radiation Protection Act, 1965). In the event of a radioactive substance (above specified levels) getting into the environment, the potential effects are similar to other hazardous substances – a small amount is able to contaminate a relatively large area. However, not all radioactive wastes are treated as hazardous substances. For example, the Ministry of Health recommends that domestic quantities of smoke detectors containing Americium-241 are disposed to landfills (National Radiation Laboratory, 2008). In these cases the quantity of radiation is so small (1 microcurie) that it is below background readings and hence poses little risk to humans.

5.5.3 Litter Act (1979)

The deposit of litter, either on a public place or on private land is controlled by this legislation. In addition to controlling the deposit of litter through abatement notices and infringement notices, the Act puts an onus on public authorities to provide litter bins in public places. Through the legislation businesses are required to take responsibility for litter on their site and litter that is carried off their site. The provision of solid waste bins that adequately contain domestic and business waste is a necessity under this legislation.

5.5.3 Resource Management Act (1991)

The most effective policy instrument to stimulate the development and diffusion of efficient technology has been the RMA (1991). A change of emphasis occurred with the RMA (1991), which focused on avoiding, remedying or mitigating the effects of discharges to the environment. It is '*the main statutory framework … for an holistic and integrated approach to environmental planning based on ecological and democratic principles*' (Memon, 2000). The purpose of the Act is to '*promote the sustainable*

management of natural and physical resources'. The Act requires every regional council to:

- Establish, implement, and review "*objectives, policies, and methods to achieve integrated management of the natural and physical resources of the region*", and
- Control the "*discharge of contaminants into or onto land, air or water and discharges of water into water*."

The adoption of the Act requires regional councils to manage their region's resources in an integrated manner and to control discharges to all three media. In terms of wastes, this meant that people in charge of the wastes that are discharged to different media have to liaise with one another, particularly so that waste emitted from one medium (e.g. solid waste) cannot just get transferred to another medium (e.g. by incinerating) to solve a problem.

As noted earlier, the purpose of the RMA is to "*promote the sustainable management of natural and physical resources*". In the RMA sustainable management means:

> *"Managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while –*
>
> *(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
>
> *(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment."*

In practice, the RMA establishes a framework within which the environmental effects of human activities can be identified and dealt with. Since one of the RMA's principles is that decision-making is best left to those who are affected by the results of decisions, the Act devolves authority to the most appropriate level (MfE, 2006b). For example, because Fonterra deals most frequently with discharges to the land, waterways and the air, it deals most often with regional councils in New Zealand.

5.5.4 Health and Safety in Employment Act (1992)

The heightening in safety in a workplace can benefit waste reduction. The Health and Safety in Employment Act (1992) has an objective of promoting "*the prevention of harm to all persons at work*" and those in the vicinity. This objective can result in the reduction of waste through the protection of workers from air pollution, noise and vibration.

Noise and vibration are also indicators of inefficient energy utilisation, thus wasting energy and hence resources. Therefore, elimination or reduction of these aspects can therefore reduce waste.

Air pollution is another example of inefficient resource use producing waste. Cleaner production approaches implementing the installation of vent condensers, graphite scrubbers and substitution of less harmful chemicals for more harmful ones have been used in, for example, agrochemical production plants, to lessen the workers exposure to air pollution (Unnikrishnan & Hegde, 2006).

5.5.5 Maritime Transport Act (1994)

New Zealand's 4,100,000 km^2 exclusive economic zone is the fourth largest in the world (Statistics New Zealand, 2009). The control of waste disposal in this zone is divided into two parts. Within 12 nautical miles of the New Zealand coastline the RMA (1991) applies and control is given to regional councils. Outside the 12 mile limit, administration is carried out by Maritime New Zealand under the Maritime Transport Act (2004).

The Maritime Transport Act (2004) is the basis of maritime activities in New Zealand and is part of the global framework for combating marine pollution. It consolidates maritime transport law and enables New Zealand to implement international obligations under maritime agreements as well as provisions for environmental protection and "*… international conventions relating to pollution of the marine environment*" (Maritime Transport Act, 2004).

The Marine Protection Rules regulated under the Maritime Transport Act (2004) provide for restrictions on the deliberate disposal of waste into the sea

as controlled under the London Convention. Wastes under these rules are defined as:

- dredged material;
- sewage sludge;
- fish waste from processing operations;
- manmade structures at sea;
- organic material;
- inert, inorganic geological material;
- bulky items constructed from iron, steel concrete and other harmless materials; and
- CO_2 streams from CO_2 capture processes for sequestration.

5.5.6 Ozone Layer Protection Act (1996)

The Ozone Layer Protection Act (1996) is New Zealand's response to the Montreal Protocol and the Vienna Convention. It controls ozone depleting substances throughout their lifecycle including safe collection and disposal at the end of their lives.

5.5.7 Local Government Amendment Act (1996)

A further development in waste legislation was an amendment to the Local Government Act in 1996, which required local councils to develop and implement waste management plans based on the waste management hierarchy. The amendment required all territorial authorities to "*promote effective and efficient waste management within [their] district*", taking into consideration "*environmental and economic costs and benefits*". The waste management plans have to be consistent with the waste management hierarchy, i.e. have to incorporate reduction, re-use, recycling, recovery, treatment and disposal in that order of priority.

They also have to:

- Provide for efficient and effective implementation.
- Consult with key stakeholders for their comments and input. (Many local councils identified those stakeholders as: waste collectors,

industry representatives, residents, local Maori tribes and environmental groups.)

The Amendment also gave the local council the following powers to implement the plan.

- Undertake or contract services for any activity the local council considers appropriate to implement the plan;
- Allocate the costs incurred in implementing the plan (could be incentives or disincentives);
- Retain any proceeds from the sale of marketable products resulting from the local council's activities;
- Provide bylaws to regulate the disposal, collection and transport of waste, and
- Provide financial grants to organisations, groups or individuals to implement the plan.

Local councils around New Zealand have started to develop and implement their waste management plans. An example of the process is as follows.

The public are informed that a plan is being produced and they are invited to participate.

1. A workshop is held where a voluntary working group is established with the aim of drafting the waste management plan;
2. The plan is then put to the community for their input and the working group reviews the plan and finalises a draft plan;
3. The plan goes to the local council committee responsible for it and the draft plan is released for public submissions;
4. Hearings are held and the final plan, with any necessary amendments, is presented to the full council for endorsement and implementation (Seadon and Boyle, 1999).

5.5.8 Hazardous Substances and New Organisms Act (1996)

In 1996 the Hazardous Substances and New Organisms Act was enacted. This legislation was a flow on from the RMA (1991) and espoused similar means. The Hazardous Substances and New Organisms Act (1996)

addresses the management of the life cycle of hazardous substances that pose a significant risk to the environment and/or human health because of their intrinsic properties. Although hazardous substances only formed about 8% of the solid waste stream (MfE, 1997b), they can contaminate the rest of the waste stream so easily and render it hazardous, that it was considered important to deal with them separately. It does this by ensuring that hazardous substances and new organisms are adequately tracked with documentation and managed appropriately throughout their life cycle.

5.5.8.1 Integration of Legislation in Hazardous Waste Transport

The transport of hazardous waste involves a combination of legislative tools. Legislation covers the hazardous waste from the time that it is generated and stored on a site through to the treatment and disposal of it. Table 5.2 shows the combination of legislative tools applied from the generation of the hazardous waste on a site to the treatment or disposal of the waste at a recognised facility. Some of the legislation only applies to particular circumstances (e.g. the Radiation Protection Act (1965) only applies where threshold levels of radiation are exceeded, the Civil Aviation Act (1990) only applies when the waste is transported by air

Table 5.2. Legislative Tools that Apply for the Collection, Transport and Disposal of Hazardous Waste

Hazardous Waste Generation	Transport	Treatment/Disposal
Building Act (2004) Fire Service Act (1975) Hazardous Substances and New Organisms Act (1996) Health Act (1956) Health and Safety in Employment Act (1992) Litter Act (1979) Local Government Act (2002) Ozone Layer Protection Act (1996) Radiation Protection Act (1965) Waste Minimisation Act (2008)	Civil Aviation Act (1990) Customs and Excise Act (1996) Fire Service Act (1975) Health Act (1956) Health and Safety in Employment Act (1992) Land Transport Act (1998) Litter Act (1979) Maritime Transport Act (1994) Radiation Protection Act (1965)	Fire Service Act (1975) Health Act (1956) Health and Safety in Employment Act (1992) Litter Act (1979) Ozone Layer Protection Act (1996) Radiation Protection Act (1965) Waste Minimisation Act (2008)

The Acts that have not covered in detail above are: the Building Act (2004), Fire Service Act (1975) Civil Aviation Act (1990) and Customs and Excise Act (1996).

The Building Act (2004) provides for buildings to be fit for the purpose that they are intended for and hence in this context has provision for the safe storage of hazardous substances.

The Fire Service Act (1975) provides for adequate protection for life and property in the event of a fire and the minimisation of fire danger.

The Civil Aviation Act (1990) applies to the safe or prohibited transport of hazardous substances by air.

The Customs and Excise Act (1996) regulates the export of hazardous waste under the Basel Convention.

The number of Acts that apply to hazardous waste indicate the level of concern that is attached to this type of waste. The complex nature of the legislative requirements to handle hazardous waste means that specialist training is required to handle this waste. The liquid and hazardous waste collection companies were aware of the low levels of performance in the industry and developed a code of practice to raise the standards within the industry (WasteTRACK, 2007).

5.5.9 Climate Change Response Act (2002)

Greenhouse gas emissions can arise from many sources. In 2007 New Zealand emitted 75.6 million tonnes of CO_2-equivalents (MfE, 2009b). The major sources in New Zealand are shown in Table 5.3.

Table 5.3. New Zealand's Greenhouse Gas Emissions 1990 – 2007 (MfE, 2009b)

Primary Classification	**Significant Secondary Classification**
Agriculture (48%)	Dairy Cattle (23%) Sheep (13%) Non-Dairy Cattle (10%)
Energy (43%)	Transport (20%)* Energy Industries (10%)* Manufacturing and Construction (7%)* Agriculture, Forestry and fisheries (2%)*
Industrial Processes (6%)	Metal Production (3%)*
Waste (2%)	Landfills (2%)* Wastewater (<1%)*

*The sum of the greenhouse gas emissions that can be directly related to waste emissions amounts to 51% of New Zealand's total emissions.

Under the Framework on Climate Change and the Kyoto Protocol, New Zealand has to take responsibility for its greenhouse gas emissions. It does this by a providing for a greenhouse gas emissions trading scheme that supports and encourages global efforts to reduce greenhouse gas emissions (Climate Change Response Act, 2002).

5.5.10 Local Government Act (2002)

A full review of the Local Government Act (1974) resulted in the Local Government Act (2002). Under the Act, local authorities are required to "*promote and action social, economic, environmental and cultural well-being*" of the people within their territory. This was a major shift by the government to coerce local authorities to consider their actions with a wider responsibility to the community. Hence, traditionally waste management was just the pick up and disposal of waste at the least economic cost without regard to the effects on the environment and society. Under the Act local councils had to consider the well-being of the community within the four categories (social, etc.). The new Act endorsed the previous Act's requirement for waste management plans, as described above.

5.5.11 Waste Minimisation Act (2008)

The primary legislation to handle waste is The Waste Minimisation Act (2008). Its purpose is "*to encourage waste minimisation and a decrease in waste disposal in order to—*

(a) protect the environment from harm; and

(b) provide environmental, social, economic, and cultural benefits"

It achieves this through the imposition of a hypothecated levy on waste disposed to landfill that is used to fund waste minimisation programmes and the provision of mandatory product stewardship schemes for priority wastes. The development of this legislation is examined in more detail in Chapter 6.

5.5.12 Integration of Legislation

When legislation is applied to a business situation, it is unusual for only one tool to apply to a situation. In reality, a combination of legislative tools applies. This increases the complexity of conducting business. An example of the complexity of the legislative tools that apply to handle waste in Fonterra is contained in Table 5.4.

Table 5.4. Legislative tools that apply to waste discharges at Fonterra

Acts	Regulations	Other
RMA (1991) Local Government Act (2002) Hazardous Substances and New Organisms Act (1996) Land Transport Act (1998) Health Act (1956) Building Act (2004) Health and Safety in Employment Act (1992) Civil Aviation Act (1990) Agricultural Compounds and Veterinary Medicines Act (1997) Customs and Excise Act (1996) Fire Service Act (1975) Litter Act (1979) Waste Minimisation Act (2008)	Land Transport Rule: Dangerous Goods (2005) Trade Waste Bylaws Resource Consents	District Plans Regional Water, Soil and Air Plans Regional Waste Disposal Plans Landfill Guidelines

These legislative tools apply at different times in the life cycle of the company's products. Some activities require tools (e.g. resource consents) to be applied on an ongoing basis.

5.5.12.1 Resource Consent Conditions

Resource consents mandated under the RMA (1991), give permission to "*use or develop a natural or physical resource and/or carry out an activity that affects the environment*" (MfE, 2006e). In the case of Fonterra, resource consents are obtained from regional councils. Consents are granted in relation to regional and district plans which have been arrived at through community consultation. Granting of resource consents is a process for consent authorities to ensure the stakeholders (council, the community and the applicant) that the activity in question avoided, remedied or mitigated any adverse effects on the environment (MfE, 2006e). Resource consents are issued with monitoring requirements. Although the Resource Management Act was passed in 1991, the requirements for monitoring and reporting on the quality of discharges on Fonterra's predecessors extended back to 1983. However, as environmental considerations became more important, the responses from the Company changed from ignoring or taking minimal action to one where there is active dialogue and working together to resolve problems. Table 5.5 shows the different monitoring conditions for liquid streams imposed on 12 of the Fonterra sites.

Table 5.5. Monitoring requirements for wastewater at selected Fonterra sites.

Parameter	Kauri	Maungaturoto	Te Rapa	Edgecumbe	Lichfield	Reporoa	Kapuni	Whareroa	Brightwater	Kaikoura	Stirling	Edendale
1												W
2												W
3				W								
4			U	DWB	M						DB	**D**
5					M							W
6				BQ								M
7		W	U	WBQ	D			**D**			DB	W
8			C	B								**D**
9											A	
10			C									W
11	U	D	U	DW	D			**D**			D	
12			U									
13		D		D								
14			U									
15				BQ	M							M
16				B	W							**D**
17	U		U	DQ	D						MA	**D**
18			U									
19		W	C	DWIBQ	D						D	**D**
20	U		U	DBQ	M			**D**			M	**D**
21	U			BQ	M							
22	**U**	**D**	U	W		D						
23				D								
24				BQ	M							M
25				DQ	D						DB	
26			C	I				**D**			DB	
27				DW								
28			U									
29		D		D			D	D	U	U		

A = Annual, B = Bi-monthly, C = continuous, D = Daily, I = Bi-weekly, M = Monthly, Q = Quarterly, U = Frequency unknown, W = Weekly; Bold = beyond consent requirements

Parameters in Table 5.5

1 = Ammonium total	11 = Fat total	21 = Potassium
2 = NH_4^+ total oxidised	12 = Grease	22 = Protein
3 = Ash	13 = Lactose	23 = River flow
4 = BOD	14 = Loss monitoring	24 = Sodium
5 = Black disc clarity	15 = Magnesium	25 = Suspended solids
6 = Calcium	16 = Nitrate	26 = Temperature
7 = COD	17 = Nitrogen total	27 = Total solids
8 = Conductivity	18 = Oil	28 = Turbidity
9 = DAF Sludge	19 = pH	29 = Volumes
10 = Dissolved oxygen	20 = Phosphorus	

One reported difficulty for the Company is that the regional councils work independently of each other and so their interpretations on discharging their obligations under the RMA 1991 can differ. The result is that Fonterra customises monitoring regimes for each site. For example, Kapuni only monitors volumes on a daily basis but Edgecumbe monitors 20 characteristics on varying timescales. This reflects the different operating conditions in differing regional council areas.

However, even within regional council boundaries differences exist. An example of this is the Northland Regional Council which regulates the Kauri and Maungaturoto sites. Both sites monitor fat (regional council requirement) and protein (self imposed – see Table 5.5), but Kauri is required to monitor phosphorus and potassium, and Maungaturoto is required to monitor COD, lactose, pH and volumes discharged. In the Northland situation, the different monitoring regimes resulted from more discharge incidents occurring at the Maungaturoto site. However, Northland Regional Council also tends to look at the sites as two parts of the same operation. Hence, when firstly Maungaturoto had discharge problems and then Kauri had an incident, the response to Kauri was considered by Kauri employees to be disproportionate to the event. Kauri was given an infringement for discharging only about 10g of fat in the milk to the stream, a minor amount.

Wastewater discharges have a more complex system of monitoring than air emissions. The variability for air emissions reporting around the country is not as great as for water. This is due to the more recent emphasis on air quality and to regional councils working more closely together. The resource consents issued for air emissions contain monitoring requirements for the various sites are dependent on the regional council requirements in issuing

the consents. Table 5.6 shows the different monitoring conditions required by regional councils for air emissions at Fonterra sites.

Table 5.6. Monitoring requirements for air emissions at selected Fonterra sites.

Parameter	Kauri	Maungaturoto	Te Rapa	Hautapu	Edgecumbe	Lichfield	Kapuni	Whareroa	Edendale
Carbon dioxide									A
Obscuration by Steam									B
Odour	B	B							
Particulates	A	A	A	A			D	D	A
PM_{10}					A	A			S

A = Annual, B = Biannual, D = August – December, S = September – November

The use of ambient air monitoring is starting to gain momentum around the country. This has been mainly driven by National Environmental Standards. The standards prescribe threshold concentrations and permissible excesses for carbon monoxide, nitrogen dioxide, ozone, PM_{10} and sulfur dioxide (MfE, 2005). The conditions on levels of air emissions and monitoring have resulted in Fonterra taking action to reduce their emissions. Table 5.7 summarises the methods used at the various sites to reduce emissions.

Table 5.7. Methods Used to Reduce Air Emissions.

Method	Kauri	Maungaturoto	Morrinsville	Waitoa	Te Rapa	Hautapu	Edgecumbe	Te Awamutu	Tirau	Lichfield	Reporoa	Kapuni	Whareroa	Longburn	Pahiatua	Brightwater	Kaikoura	Mainland	Clandeboye	Stirling	Edendale
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					
18																					
19																					

Methods in Table 5.7

1 = Baghouse
2 = Biofilter
3 = Burner tuned
4 = Burner upgrade
5 = CIP more to reduce odours
6 = Co-generation
7 = Cyclone
8 = Dust collector
9 = Electrostatic precipitator
10 = Filters
11 = Hydrogen peroxide
12 = Observation testing
13 = Op. procedures changed
14 = Pressure reduction monitoring across stacks
15 = Scrubbers
16 = Stack design changed
17 = Tuning
18 = Turbidity meter
19 = Wet scrubber

The accent by regional councils on monitoring particulates (whether total particulates or PM_{10}) is reflected in the methods applied by Fonterra to reduce emissions. Seventeen of the 19 methods in Table 5.7 act on particulates. The other two methods, CIP more and hydrogen peroxide are odour reducing methods. Many of the restrictions placed on air emissions were brought about through community action.

The importance of working with the community is illustrated by the Edendale site. The residents around Edendale complained about the soot deposition from the coal burners. The complaints were attributed to the changing expectations from the residents as the population grew due to people from nearby Invercargill getting away from that population centre and moving to the cheaper properties in Edendale. In addition, the Fonterra site got larger over the last decade, increasing the particulate emissions. Generally, the residents complained to Fonterra, but there was a small group who complained directly to Environment Southland. The regional council then worked with Fonterra to alleviate the situation by getting the Company to install baghouses for the stacks.

Additionally, the Edendale site is the only one that measures obscuration by steam. This is due to the site being located on a sharp corner in the highway creating the potential for reduced visibility on the road leading to dangerous driving conditions.

5.6 Economic Tools that Affect Waste Management

5.6.1 Economic Tools Imposed by Government

Economic measures are normally imposed at a governmental level through legislative or regulatory devices. The measures are based on what is politically acceptable at the time of implementation. Measures include: taxes, levies, charges, tradable permits, deposit schemes, subsidies and credits (Parliamentary Commissioner for the Environment, 2006).

There is no single approach that fits all occasions and economic instruments may change with time (Stavins, 2003). The progress in New Zealand has been one of escalation over the years as shown in Table 5.8.

Table 5.8. Tools used in New Zealand and their Economic Effect on Waste Management

Legislation	Provision	Economic Effect on Waste
Local Government Act 1974	Local authorities were responsible for waste management in their territories	Waste charges included in rates or user pay charges
Resource Management Act 1991	Manage the environmental effects of human activity	• Waste diversion incentives through subsidised recycling collections • Higher standards required for landfills, wastewater treatment and air emissions to mitigate environmental effects increased disposal charges
Local Government Amendment Act (No. 4) 1996	Local authorities produced waste management plans based on a waste management hierarchy	Waste collection charges rose to offset diversion scheme costs
Waste Minimisation Act 2008	• Landfill levy • Mandatory product stewardship schemes for priority products including material controls and disposal bans	• Provide funding for waste minimisation programmes • Pay for waste diversion

The recent groundswell for increased environmental responsibility has been reflected in the public reaction to impose greater controls on activities to reduce environmental impacts. The willingness to pay for waste diversion has recently been measured in relation to a cost benefit analysis for looking at increased rates of recycling in New Zealand (MfE, 2007f). The study showed that the general public is very willing to pay more to achieve an increase in materials diverted from landfill and thus it was more acceptable to promote increased recycling, even though economically it may cost more to do this.

5.6.2 Non-Legislated Central Government Economic Tools

The government supports all sectors in a range of practical environmental management initiatives through the Sustainable Management Fund (SMF).

The fund was set up by the government in 1994 to help achieve the government's environmental objectives. Analysis of the funded projects gives an indication of where the government sees itself concerning the waste sector. Since the inception of the SMF in 1994 until 2002, 53 projects based around solid waste management have been funded. In the same time interval, 22 projects focussed on wastewater and 7 on air quality (SMF, 2002). The accent on solid waste is largely because of the requirement under the RMA for public participation which has made it increasingly difficult to acquire resource consents to construct new landfills. For the other emissions the 'out of sight, out of mind' perception is present. Air pollution is quickly dispersed in most parts of the country and wastewater is flushed away and only poses a problem when the treatment processes malfunction and the effluent affects other water bodies.

5.6.3 Economic Measures in Industry

As well as the imposition of economic measures to effect waste management through legislation, economic measures have been in existence through market based approaches in industry. Table 5.9 ranks the economic measures that affect waste management at Fonterra from a sample of 81 responses.

Table 5.9. Economic measures that affect waste management at Fonterra.

Rank	Measure	Percentage
1	Disposal costs	62%
2	Budgets	50%
3	Reducing production costs	37%
4	Key performance Indicators	25%
5	Balance the problem with efficiency	12%

Costs to the company are foremost considerations and solutions that require deeper analysis to balance the problem with efficiency are much lower down the scale. The diversity of tasks to be undertaken as part of the business as usual means that people are required to formulate quick answers. These answers do not necessarily give the best long term or integrated approach. To achieve a more integrated approach, people need to be given time, processes

and training to work in that manner. Economic incentives are key motivators for businesses to participate in voluntary schemes.

5.7 Voluntary Schemes

While there are now some regulatory and economic mechanisms for progressing waste management in New Zealand, the focus has been on voluntary mechanisms. As a result, a large number of non-governmental organisations have sprung up. One example of these has been the Zero Waste New Zealand Trust (Zero Waste). It differs from the others in that it provided funding (in the form of grants) for activities that reduce wastes. While these grants are more modest than those provided by the SMF, they enable a wider range of groups to undertake programmes that contribute to the ultimate aim of "zero waste".

The Trust was established in 1997 with a mission to: "*encourage and motivate all sectors of New Zealand society to work towards a target of zero waste*" (Zero Waste, 2002). Since that time over 70% of the 73 local authorities have adopted "zero waste" targets and most of those aim to achieve "zero waste" by 2015, with a few aiming to do so by 2020 or 2010 (Zero Waste, 2009). To be recognized as a "Zero Waste" council, a council is required to minute a resolution from a full council meeting that they will aim for zero waste by 2015 and will review the progress by 2010. In addition, they commit to full and open community, business and local council participation in the process. The process adopted to become a "Zero Waste" council is very simple. It does not require any further action to remain a member of the group. An important feature of the process is that it enables local councils to gain access to ideas and information that they can use before, when or if the legislation requires them to seriously address the issue of waste.

Voluntary approaches have the advantages that they have low establishment and administrative costs, and the participants have the flexibility of how to meet the goals (ABARE, 2001). However, the disadvantages of such an approach are that they depend on the level of participation and motivation of those involved in the initiative. The level of motivation may be difficult to sustain without appropriate incentives. Free riding can be significant when

significant players absent themselves from a programme. Efficiency is also generally low as it was generally geared to the lowest (and slowest) adopter (McKerlie, Knight and Thorpe, 2006). In addition, poor or non-compliance are also possible outcomes (Parliamentary Commissioner for the Environment, 2006). One motivator that has worked is the threat of legislation if the waste generator does not enter into a voluntary agreement or reach agreed targets (Krarup, 2001).

Business leaders have voluntarily reduced their waste before schemes were made mandatory to give them an edge in either environmental or economic performance. For example, during the last quarter of last century many businesses adopted waste prevention practices to reduce or eliminate waste rather than controlling it after production (Morrow and Rondinelli, 2002). The adoption of schemes by multiple businesses led to the integration of environmental practices and a systemisation of approaches, developed into e.g. ISO 14001 Environmental Management Systems and the European standard EMAS (Morrow and Rondinelli, 2002). The adoption of international standards made it easier for different companies to compare each other. Unlike regulations, the voluntary adoption of environmental management systems gave companies the opportunity to develop schemes that were appropriate to their conditions. A hierarchy of adoption of waste-related environmental programmes with examples of from Fonterra is shown in Table 5.10.

Table 5.10. Adoption of Waste-related Voluntary Programmes.

Type	Definition	Fonterra Examples
1. Individual Programmes	Business implements a programme that typically involves business partners, e.g. suppliers	Adoption of an environmental policy (FG13) and the subordinate Eco Efficiency Standard. For example: reuse pallets and slipsheets; recycle stretchwrap, cardboard, plastic drums, toner cartridges
2. Agreement among multiple firms	Firms come together and agree to comply with a code of practice or programme	Members of NZ Business Council for Sustainable Development and the Sustainable Business Network
3. Business-to-business challenges	Firms require partners to meet set standards	Sets specific standards for suppliers to meet
4. Government to Industry challenges	Government agencies define rules, compliance and monitoring requirements for firms.	Ministry for the Environment, Ministry of Agriculture and Forestry, Regional Councils and Fonterra signed the Dairying and Clean Streams Accord to promote sustainable dairy farming in New Zealand
5. Industry and government performance agreements	Partners negotiate performance agreements that may waive some legal requirements in return for commitments to improve environmental performance	Work with regional government to improve air and water discharge levels in return for gradual improvement concession. Signatory to the Packaging Accord that sought to reduce wasteful packaging (PackNZ, 2004).
6. Agreements between industry and NGOs	Firms partner with NGOs to achieve environmental goals	Corporate sponsor of Keep New Zealand Beautiful which runs the Clean Up New Zealand week
7. Global agreements	Stakeholders design a programme to address environmental performance across a range of industries and countries	The ISO 14001 Environmental Management System has been adopted across all production sites

Adapted from Collins *et al*, 2004.

Fonterra needs to be connected to developments from the local level to the international level. As can be seen in Table 5.10, Fonterra has engaged in every level of the voluntary programme types above. From an environmental perspective, Fonterra policies advocate environmental responsibility and their actions in developing their environmental policy, the eco efficiency standard, the Dairy and Clean Streams Accord, individual site programmes, comprehensive environmental reporting and their support of the Packaging Accord are testament to the importance they place on this area.

5.7.1 Fonterra Environmental Policy

Policies set the direction for an organisation. The Fonterra Environmental Policy (FG13) is the pre-eminent guidance tool for the Company in environmental issues. In the Policy Fonterra committed itself to protecting the environment through the cornerstones of sustainability, good environmental practice and environmental improvement (Fowler, 2003). The FG13 policy covers a number of areas of environmental performance.

- Legal compliance;
- working in partnership with shareholders (suppliers);
- promotion of environmental awareness to stakeholders;
- implementation of environmental management systems;
- development of technologies to mitigate environmental impacts;
- waste reduction;
- communication of environmental performance to stakeholders; and
- response to environmental incidents.

5.7.2 Fonterra Eco Efficiency Standard

The Fonterra Eco Efficiency Standard (Fonterra, 2005c) is subordinate to FG13. It demonstrates a global commitment to eco efficiency principles and practices across all parts of its operation. Included in the policy are measures to:

- minimize resource use at source and improvements that reduce wastage.
- extend eco efficiency into business relationships.

- enhance the recyclability of goods
- promote to stakeholders.
- reduce waste.
- use energy efficiently.
- minimise hazardous substances
- monitor, measure and report key parameters
- embody product stewardship into business as usual.

5.7.2.1 Fonterra Eco Efficiency Toolkit

The eco efficiency standard is supplemented by the eco efficiency toolkit that takes participants along a structured pathway. The toolkit provides a good analysis tool to establish where a site is along the path of eco efficiency. Developed in 2004, this toolkit takes the participants through five stages of development from: confusion to tidy up, clean living, site and boundaries and the final stage of maintain and make better. Each stage develops the themes of: strategy, items, cleanliness, storage, standards, support systems and training and development that are appropriate to identify the stage that the site is along the path. The toolkit is used to augment the eco efficiency programme.

5.7.2.2 Fonterra Eco Efficiency Programme

The programme initially focussed on solid waste. Included in the toolkit is a systematic worksheet that surveys waste disposal which some sites have used. Other sites feel that this worksheet takes too much time and involves too many resources and so have not employed it. Without the use of a systematic manner to identify where the wastes are occurring, it is unlikely that a site will be able to identify these wastes. The process of using the worksheet has enabled sites to identify more effectively where the losses are occurring. The worksheet identifies the various locations around the site, contact people (champions), waste streams (source, quantity and cost), current disposal, contractor, options available and updates on practice.

One site that has used it successfully is Whareroa. In May 2004, 268 waste streams were identified (7% of these were not solid waste). At that time 35% of the streams were already being diverted in some way (reducing, reusing or

recycling). At the April 2005 update, an extra 15% of the waste streams were being diverted, 3% were in the investigation stage, leaving 47% where there was no change. These figures only identify the waste streams and do not attempt to quantify them. In addition, the solution of one problem (e.g. polystyrene cups replaced by reusable mugs) may cause multiple waste streams to disappear (e.g. the replacement of polystyrene cups removed 11 waste streams). This was only achieved through a systematic analysis of the problem.

5.7.3 Dairying and Clean Streams Accord

The Dairying and Clean Streams Accord is an Accord between Fonterra, central government and Local Government New Zealand representing the regional councils (who are responsible for water quality in their regions) (MfE, 2003c) to work together to voluntarily reduce waste at the farm level.

The initiative originated with Fonterra who encourage their shareholders to participate in improving the water quality of streams by separating cattle and their effluent from the waterways. One of the main tools used is gentle coercion of the farmers who, in many cases, can see the benefits of the scheme. Part of the initiative has been for regional councils, farmers groups and Fonterra to support the Accord through group facilitation, subsidies for fencing and riparian planting and farm planning (MAF, 2008).

Although the Accord is a voluntary agreement, it is reinforced with a series of regulatory tools from central government: National Environmental Standards for Ecological Flows, Water Measurement, and Drinking Water Sources, and a National Policy Statement for Freshwater Management that requires regional councils to manage freshwater through plans and policies (MAF, 2008). Adequate incentives and the willingness on the part of the agents have enabled significant progress. As a result the following targets were achieved ahead of time: dairy cattle excluded from 50% of waterways by 2007, 50% of dairy cattle crossing points bridged by 2007, and 50% of regionally significant wetlands fenced by 2005. In addition, farming effluent and nutrient management were close to their targets of 100% compliance by 2007 (MAF, 2008).

5.7.4 New Zealand Packaging Accord (2004)

The New Zealand Packaging Accord (2004) (PackNZ, 2004) is an example of product stewardship. Product stewardship (a variation of extended producer responsibility (MfE, 2005b)) can enhance a producer to better design for the environment and result in a range of other advantages such as (McKerlie, Knight and Thorpe, 2006):

- reduced materials and energy usage;
- toxic chemical reduction;
- increased reusable, recoverable, recycling and recyclable content;
- improved logistics for transportation and production; and
- new approaches like leasing and selling a 'service' rather than selling a product.

Product stewardship is a favoured methodology in New Zealand to encourage business to become more resource efficient as it is more inclusive of the whole supply chain (rather than just the producer) and has been given official status through the Waste Minimisation Act (2008).

Fonterra's is a signatory to the Packaging Accord and since it uses a very large amount of packaging it can considerably influence the packaging and recycling market. The results of the Packaging Accord showed that the packaging sector overall (represented by central government, local government, manufacturers, retailers and recyclers) exceeded or equalled their recycling targets in year 4 of the 5 year Accord (Packaging Accord, 2008). While the focus for the Accord has been on recycling rates, measures that are higher up the Waste Management Hierarchy like reuse and reduction are not addressed. This is a serious omission in the Accord.

5.7.5 Individual Site Programmes

Fonterra's individual site campaigns (focus projects) are run to achieve determined targets. At any one time there can be upwards of ten campaigns running on any particular site, some of which have been instituted nationally and others specific to a site. Comments made by staff were that there were too many campaigns and the changing nature of them made it difficult to

engage in each new campaign. Other comments made were that "*the campaigns were just rebranding exercises with a few twists*" and thus lost their relevance as new campaigns. However, as they were campaigns, reporting on them was a requirement.

5.7.6 Environmental Reporting

The importance of environmental reporting is increasing all the time. The current 'environmental' movement is seeking accountability on environmental procedures from business and industry. Environmental performance indicators form an important part of how a sector measures progress. The indicators separate into four categories: the state of the environment; corporate environmental policy; environmental management systems; and the products and processes of the company as evaluated by an ecobalance improvement (Azzone *et al*., 1996).

The state of the environment indicators show the company's contribution to environmental problems and are normally reported through an environmental report. Fonterra produced the Fonterra and the Environment report (Fonterra, 2008) in this category.

Environmental management systems show how companies are able to manage their environmental problems in an effective manner (Azzone *et al*., 1996). The ISO 14001 Environmental Management Systems reports on the Fonterra sites are utilised as internal documents for improvement of site performances.

An ecobalance tool provides a snapshot that measures inputs and outputs from a company – a pulse check on the progress of the environmental management system. Fonterra provides a range of programmes for monitoring within the Company. The ecobalance tool for Fonterra is an online system that can be accessed from anywhere within the Company network to provide real time information and comparison on production parameters. In addition, a variety of newsletters are sent out periodically within the Company to provide specific updates in specialist areas (e.g. Energy Edition (energy costs, data analysis and reduction ideas), Green Matters (news and

development in the environmental field) and Eco-Efficiency News (progress in eco-efficiency and profiles on people and sites).

Public environmental reporting amongst leading dairy companies is on the increase as dairy companies are trying to back up their environmental claims. Jarvis (2004) points out that it is routine for customers to inquire about the environmental conditions that were met in producing the product.

To compare environmental reporting between Fonterra and other multinational dairy companies, six companies from the World's top 20 in addition to Fonterra were chosen by the author (see Table 5.11). The characteristics of the chosen examples are listed below.

- Four were private companies and two were co-operatives
- Four came from Europe, one from Japan and one from the USA
- Half the examples had larger turnovers and the other half had lower turnovers than Fonterra Co-operative Ltd
- Excluding Fonterra Co-operative Ltd, the chosen companies represent 44% of the total turnover of the top 20 dairy companies.

Table 5.11. Annual Environmental Reporting by six leading multinational dairying companies.

Category	**Arla (2005)**	**Danone (2004)**	**Friesland (2004)**	**Kraft (2005)**	**Meiji (2005)**	**Nestlé (2005)**	**Fonterra (2006a)**
Energy consumption							
Water consumption							
CO_2 emissions							
NO_x emissions							
ISO 14001 accreditation							
Solid Waste total							
Solid Waste recovered							
Solid Waste recovery rate							
COD wastewater total							
Wastewater generation							
Emissions – significant accidental							
Greenhouse gas emissions							
SOx emissions							
Ozone layer depleting substances							
1° & 2° packaging consumption							
Plastic bottle recycling							
Paper & cardboard packaging recycling							
Environmental initiative examples							
Reducing packaging							
Energy composition							
Gas consumption							
Electricity consumption							
Oil consumption							

The figures provided by Fonterra are generally reduction percentages or quantities and show trends based on either a single year or a drop over several years. This basic reporting is becoming less acceptable as consumers are starting to demand better quality data from producers (Boston Consulting Group, 2009). By comparison, Groupe Danone, which has adopted GRI reporting, publishes on 16 of the above parameters. Fonterra, reporting on 11 parameters, is at the median of the above grouping.

Internally, Fonterra produces a comprehensive set of annual data with responsibility resting on environmental officers to produce the annual environmental reports. The material contained in these reports varies from site to site which makes it difficult to adequately compare environmental performance between different sites. Table 5.12 summarises the topics reported on in the environmental reports from selected sites and compares it with parameters in the Global Reporting Index (GRI, 2006).

Table 5.12. Topics Reported on in the Annual Environmental Reports.

Parameter	Maungaturoto - 2006	Waitoa - 2005	Hautapu - 2005	Lichfield - 2005	Reporoa - 2005	Kapuni - 2004	Whareroa - 2004	Brightwater - 2006	Clandeboye - 2006	Stirling - 2005 & 6	GRI Categories
air quality											
air quantity											
cooling water quality											
cooling water quantity											
freshwater biological monitoring											
groundwater levels											
groundwater quality											
maintenance											
marine ecological survey											
meteorological data											
river water flow rates											
river water quality											
sewage (treated) quality											
sewage (treated) quantity											
sludge quality											
sludge volumes											
soil quality											
spillages											
stormwater quality											
stormwater quantity											

surface water quality											
wastewater application rates											
wastewater quality											
wastewater quantity											
water abstraction rates											

The most universally reported parameters by Fonterra sites are those required under the resource consents issued by regional councils although no parameter is reported by all sites. These parameters were: wastewater quality and quantity, stormwater quality and air quality. Thus, there is a focus on the requirements of the New Zealand authorities and less attention on the world's best practice and benchmarking against leaders in the dairy industry who use the global reporting initiative.

5.7.6.1 Global Reporting Initiative

The Global Reporting Initiative (GRI, 2006) has grown to be the de facto international standard for corporate reporting on environmental, social and economic performance. The transparency of the reporting process provides accountability to stakeholders and demonstrates the progress of sustainable development over time. It is supported by UNEP and CERES (an international network of investors, environmental organisations and public interest groups to work with companies and investors to address sustainability issues) and over 850 large companies follow the process, including dairy companies like Groupe Danone (GRI, 2006). GRI has been adopted primarily by large multinational corporations in the utilities, oil and gas, banking, automotive industry, mining, chemicals and synthetics, forestry and paper sectors. There is little engagement by small and medium size companies (Brown, de Jong and Levy, 2009). Table 5.13 shows the GRI reporting indicators.

Table 5.13. Global Reporting Initiative Reporting Indicators (GRI, 2006).

Performance Indicator	**Category**	**Aspect**
Environmental	Environmental	Materials Energy Water Biodiversity Emissions, Effluents and Waste Products and Services Compliance Transport Overall
Social	Labour Practices and Decent Work	Employment Labour/Management Relations Health and Safety Training and Education Diversity and Opportunity
	Human Rights	Strategy and Management Non-Discrimination Freedom of Association and Collective Bargaining Child Labour Forced and Compulsory Labour Security Practices Indigenous Rights
	Society	Community Bribery and Corruption Political Contributions Competition and Pricing
	Product Responsibility	Customer Health and Safety Products and Services Advertising Respect for Privacy
Economic	Economic	Economic Performance Market Presence Indirect Economic Impacts

One of the difficulties in the manner in which the GRI has been used is that in separating the reporting into the three categories of the triple bottom line approach (environmental, social and economic), companies have not integrated across the boundaries and do not provide context into the prevailing conditions where the companies operate.

Adoption of environmental reporting has focused on demonstrating how sustainable a business is and results are often profiled in terms of absolutes (e.g. waste reduced by a percentage) rather than putting it into the context of what it means for the company, the district, region or country. Moneva, Archel and Correa (2006) argue that while development and acceptance of GRI reporting mechanisms has occurred, there has been a 'relaxation' of the basic aim of sustainability. They call for reporting and monitoring of the extent that an organisation acts '(un)sustainably".

5.8 Informational Tools

The use of information on its own provides an opportunity to change a system (Meadows, 1997). However, it provides a powerful tool for moving a system towards sustainability when used in conjunction with other leverage points.

The resistance by industry in New Zealand to disclose information has been compounded by the difficulty of trying to get timely and reliable information. This has led to an inability of getting an information management system that monitors changing dynamics and assesses the desirability and feasibility of various options. These three problems were identified by Mirata (2004) as influencing the development and operational characteristics of a system.

Coordination bodies provide a role in the provision of relevant information regarding technological alternatives, environmentally preferable practices, markets and their dynamics and regulatory issues (Mirata, 2004). These coordination bodies can be intra-company or they can be more removed like a business organisation or a government body.

5.9 Government Tools

A government is best placed to coordinate nationwide campaigns. The New Zealand government has developed waste informational tools. The Reduce

Your Rubbish campaign was a social marketing tool used to raise householders' awareness of the waste problem and develop a collaborative model for regional councils to engage in cost-effective awareness leading to action to reduce waste (MfE, 2003a). The programme ran for three months using all media, bus shelter and supermarket advertisements, supporting councils in their programmes and working with nationwide businesses. The analysis showed that 20% of people surveyed said that the campaign had a positive effect on their awareness, attitudes or behaviour. As a result, kerbside-recycling operators noticed unseasonable increases in the amounts of material collected of between 11% and 22% by the end of the programme. One of the findings from the campaign was that the public education needed to be linked to other policy tools like regulation and economic incentives (MfE, 2003a). Ministry officials noted that the government commences with a voluntary scheme, learns from it, then legislates and tries to move forward within the existing framework. For example, The Waste Minimisation Act (2008) provides a framework that allows for customisation of schemes through regulatory intervention in the future.

The application of complementary tools in an integrated manner provides for the most effective results. The recent development of tools for waste in New Zealand has been an example of this approach as shown in Table 5.14.

Table 5.14. Application of Waste Tools in New Zealand

Year	Waste Tool	Result
1992	Information: Waste Analysis Protocol	Provided a systematic way to determine composition of waste going to landfill or being generated by business or households.
1996	Legislation: Local Government Act (1974) amended	Local Councils had to produce waste management plans based around the waste hierarchy.
1997	Information: National Waste Data Report	Summarised all reliable data on waste (solid, liquid and gas) in New Zealand and highlights where robust data is needed or is available.
2002	Policy: New Zealand Waste Strategy	Waste defined to cover solid, liquid and gas emissions. 31 targets set to reduce solid and liquid waste and work with business to reduce waste.
2005	Policy: Product Stewardship discussion document	Focus on waste products that have significant environmental harm.
2006	Information: New Zealand Waste Strategy Progress on Targets	Showed 42% not achieved, 29% achieved, 26% in the future and 10% good progress. Showed direction for future progress.
2007	Information: National Environmental Indicators	Required trends in volume and composition of waste to landfill. Required reporting on progress on determination and remediation of contaminated sites. Entailed changes in air quality and energy use which are, in part, due to manmade waste emissions.
2008	Legislation: Waste Minimisation Act	A non-government bill designed to provide additional tools to deal with waste: mandatory product stewardship, waste levy, reporting requirements and a waste advisory board.

Adapted from Ministry for the Environment (2008a)

Sometimes information tools can provide the impetus for change merely by the information that they provide leading to action. An example of this is the ongoing series of landfill censuses carried out by the MfE as shown in Table 5.15.

Table 5.15. Landfill Management Improvements

Year	Landfill Report	Result/Information
1995	National Landfill Census (MfE, 1997a)	• A varied approach to landfill consenting processes around the country • Hazardous wastes were poorly managed • Landfill operators were poorly trained • Economic incentives and disincentives needed more work
1998/99	The 1998/1999 National Landfill Census Report (MfE, 2000)	• A much greater number of unconsented landfills gaining consents • A small improvement in operator training
2002	The 2002 Landfill Review and Audit (MfE, 2003b)	• 'Older style' operations improved their management practices and ultimately replaced by modern facilities • Significant improvements in the use of landfill liners, stormwater management and landfill gas management
2006/07	The 2006/07 National Landfill Census (MfE, 2007c)	• Landfills continue to improve and move towards generally accepted best practice • Total number of operating landfills continued to decrease, down 48 per cent from 2002 • All landfills have the appropriate resource consents to operate • Over half of all landfills have an engineered liner in place to prevent leachate, and over three-quarters of landfills collect leachate • Over 80 per cent of landfills require documentation when hazardous waste is disposed, and over 90 per cent measure and charge for the disposal of waste • The proportion of landfills collecting landfill gas has doubled since 2002

5.9.1 Product Stewardship

The New Zealand government has been a party to product stewardship schemes since the first Packaging Accord was signed in 1996 (Packaging Council, 2009).

Product stewardship and extended producer responsibility are closely related concepts. The OECD (2001) defines extended producer responsibility (EPR) as ''*an environmental policy approach in which a producer's responsibility, physical and/or financial, for a product is extended to the post-consumer stage of a product's life cycle*'' In an EPR approach the producer is recognised as having the most opportunity to influence the environmental effects of their product and thus responsibility is given to them to take full responsibility for the environmental effects of their products. Alternately, product stewardship approaches responsibility from the perspective that all parties in the product chain from designer and producer to user and disposer have responsibility to minimise the environmental effects of the product (MfE, 2006d).

While product stewardship allows for negotiated outcomes from all stakeholders, it can provide for uncertainty and avoidance of responsibility. A shared responsibility lifts the burden from either the user or the polluter and distributes it along the whole supply chain. In a voluntary product stewardship scheme, only those who participate in the scheme bear the costs involved. Thus, the "free riders" who do not participate automatically have an economic advantage over those who engage in the scheme (McKerlie, Knight and Thorpe, 2006).

New Zealand adopted product stewardship over EPR which was formalised in the Waste Minimisation Act (2008). Prior to the enactment of the Waste Minimisation Act (2008) the MfE identified companies in 10 different sectors in New Zealand that have elements of product stewardship (MfE, 2007b). In a review of the New Zealand Waste Strategy targets they noted that hindrances to escalation of the number of product stewardship schemes were due to the free rider issue and the possibility of major players in the sectors not engaging in voluntary product stewardship schemes (MfE, 2007b).

5.10 Business Tools

While the government has a role to lead in nationwide tools, the role of business is to incorporate tools that enhance their environmental performance. Examples of business tools that are commonly used are life

cycle assessment and environmental management systems. Environmental management systems focus on the operations of a business while life cycle assessment focuses on individual products. Within those categories are a whole set of tools that can be utilised at different stages of a company's or product's life cycle.

5.10.1 Life Cycle Assessment

Life Cycle Assessment (LCA) is a useful tool to assist resource efficiency. LCA quantifies the potential impacts associated with a product or service by compiling an inventory of inputs and outputs of a system, evaluating the potential environmental impacts and interpreting the results of the inventory analysis and impact assessment phases using a standard system developed by the International Standards Association (ISO, 2006). The system consists of four phases: goal definition and scope; inventory analysis; impact assessment and interpretation (ISO, 2006).

The goal definition and scope are particularly important as they define what is contained within the study and the objective of the study clarifies the expected use of results and the receiver of the study.

The inventory analysis involves gathering data relative to inputs and outputs at each stage of the product life cycle, while the aim of impact assessment is to interpret these data in terms of environmental impacts (ISO, 2006). This stage involves classification into impact categories and evaluation of the level of impact. Assessment models may include normalisation, grouping and sorting or weighting procedures to facilitate the interpretation phase. However, none of these last mentioned procedures are mandatory according to ISO standards (ISO, 2006). Finally, the results are interpreted according to goal definition and scope throughout the interpretation phase.

LCA is a methodology that considers the whole life cycle of a product from its extraction from the earth until it is disposed back to the earth – the "cradle-to-grave" approach that considers waste to be the final outcome (ISO, 2006). The current trend of cradle to grave thinking is progressing to "cradle-to-cradle" thinking devised by McDonough and Braungart (2002). With the cradle-to-cradle concept every product is reformed into another product

resulting in zero waste, thus everything is reused, recycled or recovered. The cradle-to-cradle approach changes the focus from a product to the service it is providing (Senge et al., 2007).

Depending on the focus of the study, quite different results for LCAs can occur. An evaluation of various life cycle assessments on several dairy products by Berlin *et al.*, (2007) concluded that the greatest environmental impacts occurred in the on-farm part of the life cycle. For example, in the production of camembert cheese, Berlin *et al.*, (2007) determined that the farm contributed 94% of the global warming impacts, 99% of acidification, and 99% of eutrophication. When water was the focus, the impacts from the processing infrastructure were only a small portion of the entire life cycle. Nicol (2004) found that when manufacturers significantly reduced water use in processing facilities, this typically accounted for about 1% of the total water use in the life cycle analysis. The greatest water usage occurred in the many farms associated with the dairy plant. The energy profile for the production of cheese gave a different profile. Nicol (2004) determined that the total energy required to produce a tonne of cheese was 40.5 GJ. The proportion of energy consumption over the life cycle is as recorded in Table 5.16.

Table 5.16. Energy Consumption over the Life Cycle of Cheese in Australia (Nicol, 2004).

Life cycle	Energy used (%)
Farm	29
Raw milk transport	6
Manufacturing	20
Packaging	0.3
Transport to supermarket	6
Warehouse	6
Supermarket	27
Consumer transport	5
Home refrigeration	2

Nicol (2004) found that 76% of the energy is consumed by only three parts of the life cycle: the farm, the supermarket and the manufacturing process.

When considering energy costs across different products, Fonterra found that cheese represented less than 6% of the energy costs in plants as Table 5.17 shows. The dehydration of milk to produce milk powder was far more energy intensive. Hence a saving in this area represented a larger gain for the Company.

Table 5.17. Energy Cost by Product (Fonterra, 2005a).

Product	Factory Energy Cost (%)
Milk Powder	58.4
Protein Products	8.0
Milk Collection	6.4
Whey Products	6.1
Cheese	5.8
Fat Products	5.6
Lactose	4.2
Town Milk	2.6
Ethanol	1.7
Other	1.2

Hence, in an LCA it is very important to determine the goals of the study.

5.10.2 Environmental Management Systems

Environmental management systems (EMS) are frameworks to integrate corporate environmental policies, programmes and practices. Many companies that adopt EMSs implement one of the standard EMSs. Multi-national corporations tend to adopt EMSs that are international. For example, Fonterra uses ISO 14001 throughout its facilities.

5.10.2.1 ISO 14001

ISO 14001 is a set of guidelines that enable an organisation to (Weaver, 1996):

- institute or reinforce its environmental policy;
- identify environmental aspects of the business;
- define environmental objectives and targets;
- execute a programme to attain environmental performance goals;
- monitor and measure effectiveness;
- correct deficiencies and problems; and
- review the system to ensure continual improvement.

Changes were made to ISO 14001 in 2004 which were relatively minor (Jørgensen, Remmen and Mellado, 2006).

- Improved coherence with ISO 9001:2000;
- More focus on complying with regulations and other environmental provisions;
- Objectives and targets must be measurable (not qualitative);
- Registrations are moved to a joint paragraph; and
- The management review is described, point-by-point.

Criticisms of ISO 14001 were that it focused on management procedures rather than environmental improvement, that it depended on national environmental regulations to set the standard for pollution levels and that it was used as a market tool rather than an environmental improvement tool (Brouwer and van Koppen, 2008).

A study of Japanese manufacturers found that the determinants for adoption of ISO 14001 changed over the years (Nishitani, 2009). In the initial phase of introduction of ISO 14001 around 1996, large firms that had low debt ratios were most likely to adopt the ISO standard as the cost was seen to be justifiable. By 1999, those firms that had high export ratios, higher proportions of stock held by outside corporations, larger size and produced a better performance were more likely to adopt ISO 14001. By this stage foreign customers and large international stockholders were expecting better environmental performance from these firms. The study also found that there was a positive correlation between adoption of ISO 14001 and better economic performance of the firms concerned.

Fonterra has adopted ISO 14001 at all of its New Zealand sites. In 2003-04 four sites were accredited (Kauri, Maungaturoto, Te Rapa, Te Awamutu) (The Homestead, 2003 a, b, c & 2004). The complimentary feedback across multiple sites was that there was good staff induction, housekeeping and project initiation, all areas that were generic across different projects. Areas for improvement were: planning for emergency procedures, documentation, training, calibration procedures, determining relevant objectives and determining the environmental aspects of outputs all of which were specific to ISO 14001 implementation. Thus, the specific components in these projects were the ones that required more attention. From the results of these audits Fonterra learnt that sharing expertise across the Company enabled barriers to be anticipated and overcome.

Barriers to adoption of ISO 14001 were analysed by Balzarova and Castka (2008). Of the 46 barriers identified by the authors, two were present in the Fonterra audit results: guidance on environmental aspects and procedures needed for emergency preparedness. As the Fonterra audit was an initial audit, nine of the barriers identified by Balzarova and Castka (2008) were not applicable as they referred to the results of ongoing actions.

5.10.2.2 European Eco-Management and Audit Scheme (EMAS)

EMAS is similar to ISO 14001, but ISO 14001 is designed to improve management whereas EMAS is designed to improve environmental performance. The differences of approach are listed below (Morrow and Rondinelli, 2002).

- EMAS requires an organisation to produce an environmental statement.
- It is more meticulous in mandating environmental impact levels to not exceed economically viable applications of the best available technology.
- It requires organisations to have a greater transparency through publicly available information.
- EMAS registration is completed by a State authority whereas ISO 14001 certification is done by a private registrar.

- EMAS must report on environmental effects and legal requirements; ISO 14001 allows the company to decide how to have its environmental management system verified and what information it will disclose.
- The internal system compliance and performance audits and external verification for EMAS must be conducted at least triennially whereas ISO only requires system audits against internal benchmarks.
- EMAS requires compliance with environmental regulations on continuous improvement while ISO entails an environmental improvement but does not specify the extent.

Uptake on EMAS by the European Union has been more limited than adoption of ISO 14001. Within the European Union, 3093 organisations have implemented the EMAS scheme with Germany (1529) and Spain (483) the leading countries (EMAS, 2005a). By comparison, ISO 14001 has had a greater uptake (e.g., UK: 2918 organisations compared with EMAS: 62 (EMAS, 2005b)), which may be due to the more international perspective of ISO 14001.

In New Zealand there are other environmental management systems based on similar ideals to EMAS and ISO 14001. These are shown in Table 5.18.

Table 5.18. Environmental Management Systems operating in New Zealand.

Environmental Management System	**Target Audience**	**Comments**
Responsible Care (2008)	Chemical Industry	Adapted from the Canadian original scheme Available in 45 countries Performance standard for safety, health and environmental protection
Green Globe (2008)	Tourism Industry	Global performance brand for sustainable tourism Available in 52 countries
Enviro-Mark (2009)	General businesses	Adapted from British scheme 5 Step process: • Bronze – health, safety and environment legislation compliant (Achieved by 14 businesses) • Silver – Environmental policy, impacts and aspects produced (13 businesses) • Gold – Continuous improvement targets and objectives implemented and monitored (51 businesses) • Platinum – Environmental operational procedures documented (none) • Diamond – Internal management and audit programme for continual improvement implemented. Ready for ISO 14001 audit (13 businesses)

The focus of these EMSs is different to ISO 14001 and EMAS. The Responsible Care and Green Globe schemes link participants to international standards and recognition, while Enviro-Mark provides a stepped progress to enable participants to reach ISO 14001 certification in smaller, manageable steps if they so desire.

All environmental management systems begin with needs identified through planning.

5.10.3 Fonterra Strategic Planning

The Natural Resources Management Group is the prime guardian of sustainability in Fonterra and is an umbrella for: company farms management; environmental management; strategy and development; Glencoal operations; and HSNO legislation implementation. The Group Strategic Plan (Natural Resources Management Group, 2005) has a vision of "an energised, innovative team striving for sustainability in all aspects of natural resource management to provide for the long term future of Fonterra". The Group Strategic Plan is reinforced by the environmental operations strategy and the eco efficiency strategy.

The environmental operations strategy has as its key themes:

- environmental compliance and targeting strategies beyond compliance to underpin environmental sustainability;
- technical support and best practice initiatives to focus on innovation and technological advances for continued improvement and future growth;
- retention and development of staff;
- community involvement and partnership opportunities with key stakeholders and interest groups; and
- effective by-product reduction and disposal.

The key themes for the eco efficiency strategy are:

- identification and deployment of eco efficient principles, practices and processes;
- develop the culture of doing the right thing so that staff actively participate in and maintain the momentum for initiatives;
- technical support and best practice initiatives to focus on innovation and technological advances for continued improvement and future growth; and
- partnership opportunities with key stakeholders and suppliers supporting green purchasing strategies.

The eco efficiency strategy fits well within the environmental operations strategy and through use of the various tools mentioned above there are

sufficient tools available to successfully move towards fulfilment of the strategy.

5.10.3.1 Business Plans

Each site is required to produce an annual business plan as part of the Operations Journey to become a more efficient producer. The Company has a hierarchy of programmes to enhance it progress towards sustainability as shown in Table 5.19.

Table 5.19. Tools to Progress Fonterra towards Sustainability

Tool	**Purpose**
Operations Journey	A high level strategy designed to deliver value through: • the scale of procurement and asset management • implementing lean manufacturing • optimise performance through integrated systems and business performance management • accelerate competitive advantage and become a preferred partner internationally
Operational Excellence	• Manufacturing excellence (see below) • Maintenance best practice • Standard operating procedures • Yields measurement (losses and composition) • Energy reduction • CIP best practice • Good manufacturing requirements – an emphasis on resource efficiency
Manufacturing Excellence	A continuous improvement programme that takes small steps. • TRACC – best practice toolkits for measuring and monitoring (Fowler, 2003) • The 5S programme based around Japanese concepts (seiri – sorting and removing unnecessary items, seiso – cleaning the work area, seiton – putting everything in its place, seiketsu – establishing standards and shitsuke – maintaining the standards in a disciplined way) (Warwood and Knowles, 2004)
Green Chemistry and Green Engineering	These appear informally in the Company, but are not systematically adhered to.

5.10.3.2 Operations Journey

The Operations Journey was part of the process that aimed to improve efficiency through five key strategies.

1. Leverage scale – in asset management and procurement scale.

2. Achieve operational excellence – implementing lean manufacturing that results in a skilled, motivated and involved workforce, and processes to focus on the elimination of waste and de-bottlenecking within the plant through a pattern of thinking and problem solving skills. It consists of eight key projects that focus on best practice and waste minimisation.
3. Optimise performance – through integrated systems and business performance management.
4. Accelerate competitive advantage – through technologies and products.
5. Become a preferred partner.

Each of the strategies in the Operations Journey sought to focus on an aspect of the business that could deliver better value to the shareholders (farmers). The scale of Fonterra enables it to dictate to suppliers what it wants and when it wants it. It also makes it viable for the suppliers to change processes or technology to supply Fonterra.

The operational excellence that is aimed for requires a dedicated workforce that wants to exceed previous performances. Management noted in many interviews that the workforce was well paid and that management worked well with the unions and so, in management's opinion, the workforce should be motivated. The underlying feeling from the workforce was that, though it was well paid and the working conditions were good, the constant restructuring that led to a shrinking workforce and more responsibility for those that are left. This acted as a demotivating factor which did not lead to achieving operational excellence.

The optimisation of performance through integrated systems worked well for critical systems like maximising the extraction of product from milk and led to reduction of the concentration of wastewater resulting in compliance with resource consent conditions. There was still capacity to improve the cross-media efficiencies (e.g. reduction of carbon emissions by dissolving carbon dioxide in wastewater).

The acceleration of competitive advantage through technologies and products was progressing with an accent given to development of new products being reflected in the annual payout by a portion labelled ‘value added component’ (Fonterra, 2009). The value added component changes each year but in 2008 it represented about 4% of the final payout (Fonterra, 2008b). Over the past five years the value added component has averaged 5.4 ± 2.0%. The intention of Fonterra is to grow this portion of the payout over time (Fonterra, 2009). This adds credence to the concept that what gets measured gets attention.

A preferred partner status refers to international alliances with similar large dairy companies like Dairy Partners of America and Nestlé (Fonterra, 2008b). To align with those companies Fonterra has to meet similar standards of operation and performance.

5.10.3.3 Operational Excellence

The Operational Excellence programme is embedded as a subset of the Operations Journey programme. Operational Excellence incorporates the principles of Manufacturing Excellence (see below) plus the elements of operations that make the process run smoother. It calls for best practice in maintenance (including preventative maintenance), CIP and resource efficiency backed up with standard operating procedures and appropriate measurements.

5.10.3.4 Manufacturing Excellence

Manufacturing Excellence is a key tool to support the Operations Journey. It is described as a continuous improvement programme that takes small steps that lead to big results for the Company (Fowler, 2003). The targets are improved “organisational performance, international competitiveness and profitability” (Fowler, 2003).

Within Manufacturing Excellence the primary tool is TRACC, a series of best practice toolkits that go from a ‘status quo’ situation to being world class through teamwork at different levels of the Company (Fowler 2003).

One of these, the 5S programme for creating an organised workplace based around Japanese concepts, was widely quoted as being useful as it helped achieve the goals needed. The 5 S's (Seiri – sorting and removing unnecessary items, seiso – cleaning the work area, seiton – putting everything in its place, seiketsu – establishing standards and shitsuke – maintaining the standards in a disciplined way) were easily grasped by site personnel (Fowler, 2003).

It was recognised that along with tools there had to be performance indicators. Within this programme, they were represented by visual performance measurements; a toolkit that displays relevant information on visual scoreboards around the workplace. This also works in with the focussed improvement toolkit, targeting losses and wastes and setting improvement goals (Fowler 2003). The presence of these visual scoreboards, and particularly the regular updating, provided motivation for many staff to improve their performance or confirmation that they were doing a good job.

In support of Manufacturing Excellence are tools that deal with nominated aspects of manufacturing like green chemistry and green engineering.

5.10.3.5 Green Chemistry

Green Chemistry seeks to eliminate a hazard rather than the traditional approach to reduce the risk by minimising exposure to the chemical (Warner, Cannon and Dye, 2004). Green chemistry is an emerging approach that addresses sustainability at the molecular level through the life cycle of chemical products and processes to reduce or eliminate substances hazardous to humans and the environment (Miller *et al.*, 2008). The twelve principles that have been embraced by the chemical industry and gained wide acceptance are shown in Table 5.20.

Table 5.20. The 12 Principles of Green Chemistry (Warner, Cannon and Dye, 2004).

Brief	Principle
1. Prevent Waste	It is better to prevent waste than to treat or clean up after it is formed.
2. Atom Economy	Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
3. Less Hazardous Synthesis	Wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. Safer Chemicals	Chemical products should be designed to preserve efficacy of function while reducing toxicity.
5. Safer Solvents and Auxiliaries	The use of auxiliary substances (e.g. solvents, separation agents, etc.) should be made unnecessary wherever possible and, innocuous when used.
6. Energy Efficiency	Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.
7. Renewable Feedstocks	A raw material of feedstock should be renewable rather than depleting wherever technically and economically practicable.
8. Reduce Derivatives	Unnecessary derivatization (blocking group, protection/deprotection, and temporary modification of physical/chemical processes) should be avoided whenever possible.
9. Catalysis	Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. Design for Degradation	Chemical products should be designed so that at the end of their function they do not persist in the environment and break down into innocuous degradation products.
11. Real Time Analysis for Pollution Prevention	Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
12. Inherent Safer Chemistry for Accident Prevention	Substances and the form used in a chemical process should be chosen so as to minimize the potential for chemical accidents.

Fonterra has engaged in aspects of green chemistry without formally adopting the practices. The elements of green chemistry that have been most prominent in the company are: preventing waste, safer chemicals, safer solvents and auxiliaries, energy efficiency, renewable feedstocks and inherent safer chemistry for accident prevention.

Initially the change in practices at Fonterra was brought about by legislation, particularly the RMA (1991) concerning discharges, the Health and Safety in Employment Act (1992) for safer workplaces, the Hazardous Substances and New Organisms Act (1996) for managing hazardous substances safely. More recently economic factors like the cost of energy and the focus on the environment have been catalysts for Fonterra to improve energy efficiency and examine their feedstocks for sustainability.

5.10.3.6 Green Engineering

Engineering, as an applied science incorporates aspects of chemistry. In a way that is analogous to Green Chemistry, 12 principles have been developed for Green Engineering by Anastas and Zimmerman (2003). Green Engineering seeks to achieve green design and sustainability through science and technology and the principles (Table 5.21) provide a framework for sustainability when designing new materials, products, processes and systems so that they are benign to the environment.

Table 5.21. The 12 Principles of Green Engineering (Anastas and Zimmerman, 2003).

Brief	Principle
1. Inherent rather than circumstantial	Designers need to strive to ensure that all material and energy outputs are as inherently non-hazardous as possible.
2. Prevention instead of Treatment	It is better to prevent waste than to treat or clean up waste after it is formed.
3. Design for Separation	Separation and purification operations should be designed to minimise energy consumption and materials use.
4. Maximise mass, energy, space and time efficiency	Products, processes and systems should be designed to maximise mass, energy, space and time efficiency.
5. Output-pulled versus input-pushed	Products, processes and systems should be "output pulled" rather than "input pushed" through the use of energy and materials.
6. Converse Complexity	Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse or beneficial disposition.
7. Durability rather than immortality	Targeted durability, not immortality, should be a design goal.
8. Meet Need, Minimise Excess	Design for unnecessary capacity or capability (e.g. one size fits all) solutions should be considered a design flaw.
9. Minimise Material Diversity	Material diversity in multi-component products should be minimised to promote disassembly and value retention.
10. Integrate Local Material and Energy Flows	Design of products, processes and systems must include integration and interconnectivity with available energy and material flows.
11. Design for commercial "afterlife"	Products, processes and systems should be designed for performance in a commercial "afterlife".
12. Renewable rather than depleting	Material and energy inputs should be renewable rather than depleting.

The principles apply to complex and integrated systems and application of single principles may enhance other principles, or there may need to be a balance of principles for optimal system operation ((Anastas and Zimmerman, 2003).

The motivation to engage in green engineering can come from a number of drivers as listed below (Hendry and Vesilund, 2005).

- Legal concerns – to avoid litigation and financial penalties.
- Financial concerns – protect the interests of stockholders, and present a better image to other stakeholders including customers, suppliers and employees.
- Ethical concerns – to show concern for the environment and protect future generations.

The movement from the first to the third concern portrays a movement from self protection to protection of the wider society.

The green engineering principles work when applied to the waste management hierarchy. For example, treatment of an effluent by scrubbers or filters inherently builds in the potential for technological failure leading to an increased environmental impact. Design of systems that do not produce effluent that needs treatment lowers the environmental risk and eliminates the chances of failure. Once again, Fonterra does engage in this green practice without formally embracing it.

5.10.3.7 Environmental Product Development

The concept of environmental product development has a range of tools available. They can be divided into: a shift to a systems focus, developing sustainable products and services, developing products with a reduced environmental impact, improving the environmental performance of industry and improving the triple bottom line performance of industry (Maxwell, Sheat and van der Vorst, 2006). Within each of those broad categories is a range to tools. Table 5.22 shows the tools that Fonterra uses.

Table 5.22. Environmental Product Development Tools

Fonterra's Use of Tools
Shift to a Systems Focus Sustainable Consumption and Production Product Service Systems Eco-efficient Services Eco-effectiveness
Developing Products with a Reduced Environmental Impact Design for the Environment Life Cycle Thinking Life Cycle Assessment Product Stewardship/Extended Producer Responsibility Green Chemistry Green Engineering
Improving Environmental Performance of Industry Clean Technology Clean Production Integrated Pollution Prevention and Control Eco-efficiency Factor 4/10 Environmental Auditing Environmental Impact Assessment Environmental Management Systems Environmental Performance Indicators Environmental Reporting Green Procurement Environmental Supply Chain Management Green Marketing
Improving the Triple Bottom Line Sustainability Performance of Industry Sustainable Development Triple Bottom Line Reporting Sustainable Production Corporate Social Responsibility Reporting

Adapted from (Maxwell, Sheat and van der Vorst, 2006)

The tools that enable the greatest shift are the tools that act on the system as a whole, the system focus tools of sustainable production and consumption, product service systems, eco-efficient services and eco-effectiveness.

The sustainable production and consumption framework considers short, medium and long term impacts on production, markets and consumption and considers actions for business, the government and consumers. The role of business, as exemplified by Fonterra, is to: apply cleaner production, eco-design and other tools; manage supply and customer chains and promote industry self regulation (Tukker *et al.*, 2008). Fonterra is engaged in each of

these activities. In the medium term, the role of business is to develop '*competing for the future*' capabilities. Fonterra has shown through its actions that it is cognisant of this need and in some areas (e.g. carbon emissions) it has an active research and application programme to reduce its emissions. The model for the long term calls for deliberation on fundamental issues related to markets: a vision of sustainable growth; promote markets that foster equity; lower consumption and a higher quality of life; and restoration of power balances between government, business and the community. There is little evidence that Fonterra is addressing these issues, but as Tukker *et al.* (2008) note, these issues are not ones for business alone, but require engagement of all sectors to make progress.

The evolution from the accent on product systems to product service systems is the paradigm change from selling a product to providing a service. If product is defined as also the packaging that it comes in (as in the Waste Minimisation Act (2008)), then it can be demonstrated that Fonterra has made significant advances in reducing the amount of packaging through bulking, reuse and redesign with the end user in mind. Similar concepts are eco-efficient services where some of the property rights are kept by the producer (Cook, Bhamra and Lemon, 2006) and eco-effectiveness where the impacts of products, processes and technologies are more environmentally oriented (Dyllick and Hockerts, 2002). In the case of Fonterra this would relate particularly to packaging and support (e.g. pallets used in transportation are reused as often as possible and repaired and then recycled if possible). While Fonterra has made progress in the above areas, there is still potential to apply the concept more fully. The shift in the system's focus is aided by the incorporation of product development with reduced environmental impacts, improving environmental performance and improving the triple bottom line performance of Fonterra.

5.10.4 Implementation

One of the business plans for one site (that wished to remain anonymous) was examined to see how waste management featured in their F06 Business Plan.

The business plan has six key initiatives plus four other key areas of focus, one of which is labelled environment. Although the word ‘waste’ is not mentioned, five of the six key initiatives are directly related to waste reduction and the sixth one relates to improving standard operating procedures and staff competency, which will result in less wastage. Hence, while waste is not specifically mentioned, the overall thrust of this business plan is the reduction of it in all its forms.

Another site had a Site Vision under their Team Charter and Business Plan. Three of the seven objectives related to reducing waste (zero lost time for incidents, lift first time grade (product is within specification the first time it is measured) and understand where milk solid losses are coming from), the others mainly covered people aspects (Top 5 for plant availability, continue social camaraderie, improve aesthetics and create a professional training culture). These last four will engender the spirit that will make the first three possible.

Another site set out a strategy to achieve Operational Excellence as part of the Operations Journey Roll Out Plan. Within the Operational Excellence programme the focuses are on: manufacturing excellence, maintenance best practice, standard operating procedures, yields (losses and composition), energy reduction, CIP best practice, good manufacturing requirements and the way they work. To implement these things there are steering committees and task forces at the sites and these can be used in various roles. An example of this is that energy reduction is seen as being part of the Manufacturing Excellence loss/waste analysis, which indicates a degree of integration in thinking is occurring here. Within the same plan, the eco-efficiency part is seen to be something that focuses on quick wins that it are fairly low on the priority list, as they feel that the other items on the list have much greater competing demands. To achieve greater resource efficiency will require an integration of the available tools.

5.11 Integration of Tools by Fonterra

The integration of tools requires that the changing circumstances need to be monitored carefully. As time progresses the mix of tools needed to effect a desired change can also alter.

In the manner of Robért *et al*. (2002), Fonterra has used a range of tools to accomplish waste reduction. The Fonterra Environmental Policy is the pre-eminent guidance tool for the Company in environmental issues. Fitting under the environmental policy is the Eco-Efficiency Standard which is used to balance improved production, profitability, stewardship of the natural resource base and ecological systems, and enhancement of the vitality of rural communities. The eco-efficiency programme has so far focused on solid waste and this has been assisted with the development of a toolkit that provides a good analysis tool to establish where a particular site is along the path of eco-efficiency. In an example of where this was applied, one site identified 268 waste streams with 35% of them being diverted through reduction, reuse or recycling. A year later an extra 15% of the waste streams were being diverted and another 3% were under investigation.

Other tools that Fonterra used were Factor 4 (75% reduction in waste) and Factor 10 (90% reduction) to set short and medium term targets. Measuring, monitoring and reporting were used to reach the requirements of the ISO14001 Environmental Management System. Product stewardship was being used with suppliers and customers to utilise resources more efficiently, particularly packaging. These tools have been applied at different points in their development of waste minimisation. The adoption of the ISO14001 Environmental Management System has gone a long way to giving confidence to its customers that Fonterra is trying to be environmentally responsible while still aiming for the short term easily accomplished programmes.

5.12 The Low Hanging Fruit

It is customary to pick off the easy options first – to go for the ‘low hanging fruit’, to get ‘runs on the board’. The early history of dairying in New Zealand supports the notion that the easy, but necessary options were targeted first

(e.g. consistent milk quality). The sophistication of the solutions changed over time as the easy options were first implemented and then the more complex problems were worked on (e.g. production of milk powder and casein). The progression is shown in Table 5.23.

Table 5.23. Developments and their effects on waste.

Year	Event	Waste Effect
1931	Milk grading system introduced	Gave standardised inputs with less waste
1944	Work started on byproducts (skim milk powder)	Less BOD in wastewater
1948	Cheese mechanisation started	Reduction of cheese waste
1949	Application of the Vacreator for cream treatment	More wasted steam and energy but less wasted buttermilk due to being able to be made into a powder
1951	Whole Milk Collection by tanker begins	Reduction of transportation costs and emissions
1970	Work on industrial uses of casein	Lower BOD of wastewater
1979	Commercial production of 850 kg butter block	Solid packaging waste reduced
1979	Tubular washing of casein curd developed	Energy recovery and heat exchange, less wastage of product
1982	Whey protein and casein powders used for functional purposes Whey is established as a fertiliser	Lower BOD of wastewater
1987	Integral fluid bed spray drier is designed and commissioned	Less energy needed through recovery

Adapted from Fonterra, 2006c and Hill, 2003

Fonterra undertakes non-regulatory projects when the benefits outweigh the costs. The adoption of the eco-efficiency programme resulted in a four-fold saving on the material being sent to landfill. Although material is still sent to landfill, the savings that were identified through a systematic analysis meant that the scope was much wider than landfilled material and extended to the reduction and reuse of material as well as recycling. Such successes can only be achieved through the effective engagement of staff.

5.13 Effective Ways to Implement Waste Reduction

Staff and management approach things from different perspectives. The staff are looking for leadership from management and to be appreciated when they accomplish management's requirements. Management are looking to have their needs implemented with a minimum amount of disruption. This is borne out in the responses from the environmental managers and staff.

The environmental managers commented that more education and publicity were needed and that it needed to penetrate down to the factory floor. Comments from environmental managers suggested that environmental engagement stops at the supervisor level. Comments were also made that the initiatives need to be small in number and easy to implement.

The staff noted that they needed to see management firstly talking in a way they can understand and then pushing it hard to give their backing. The staff also called for implementation of simple things like engaging people who can make a difference, conducting spot checks, getting ownership from each department and provide incentives (e.g. barbeques or morning teas as well as money incentives). In addition, make the undesirable action more difficult (e.g. a readily available recycling bin but have to ask for a rubbish bin) is another approach. Environmental training was seen to be vital to the accomplishment of many of these objectives.

5.14 Environmental Training

In order to be well informed about environmental problems and approaches to provide solutions, appropriate training is needed. The level of environmental training engaged in by Fonterra employees' shows the level of commitment by the Company. All nineteen of the environmental management staff interviewed, 48% of 31 management and 41% of 29 staff interviewed indicated that they had undertaken environmentally related training.

The main forms of environmental training undertaken by environmental managers were environmental auditing (53%), a tertiary environmental qualification (42%) and company environmental conferences (32%).

Managers had a greater variety of environmental training with a tertiary environmental qualification leading the list and then a variety of others including environmental impact assessment, cleaner production and life cycle analysis.

In addition, changes to induction training meant that all new personnel undertake basic eco-efficiency initiation to show some quick wins (reducing printing, using the balers properly and turning off switches) to a practical exercise (making something useful out of scrap metal from a bin) to the broader concepts (the ecological footprint and the Company's environmental management system).

In looking at the training overall, 10% of the 79 interviewed rated it as excellent, 32% very good, 48% as good and only 10% as not good. This is a good measure of the quality, need and applicability of what was experienced.

5.15 Conclusions

The absence of tools in the waste area generally has led to increasing quantities of waste being produced. An integrated package of tools is vital in order to progress effectively deal with waste management. Traditionally tools have progressed from managing indiscriminate dumping to treating waste, then encouraging recycling before managing reduction of wastes at source. The development of these tools requires a multi-pronged approach.

Governments have the role of setting the policy direction and providing legislative back up. In New Zealand's case this mix includes environmental legislation, health and safety legislation, waste minimisation legislation and sustainable consumption policies. Progression in waste management developed through firstly pressure brought about through international conventions that New Zealand signed up to and then increasing awareness by the public of the problems with waste production. In developing tools at government level engagement with the public builds confidence in the resultant product and gets buy in from the various sectors. The difficulties with this approach are that it leads to reactive environmental policies and there is a lack of integration with other environmental problems. There is a focus on

stragglers not leaders, thus the leadership role rests with business which provides direction.

The policy framework normally starts with a voluntary and informational/educational approach. Eventually it becomes evident that there are gaps that need to be filled by legislation. A legislative solution for waste can only become a reality once there is recognition by the politicians that the public would support it and that it makes good sense for political reasons. In New Zealand these reasons can be either nationally or internationally driven. Government uses a variety of tools to guide industry in the direction it wants.

In business, waste management practices change when a sound financial case can be made for the change. Industry prefers voluntary tools which include systematic guides, manuals and management systems. Business will enlist in voluntary tools when they can be shown to be beneficial to the business for economic reasons or reputational reasons. Large businesses like Fonterra are involved in initiatives from the local to the international level.

Changes within business start off at the fairly rudimentary level, but as experience is gained, the level of complexity increases. Business tends to focus on management tools to identify the desired changes and targets, which is the approach they are most familiar with.

Where business fails to make the progress that the public expect, government and/or local government utilise regulations that act either locally or nationwide as additional tools to manage specific situations.

The results of imposing either voluntary or regulatory tools are normally reported to show the success of the measure. However, results are often shaped in terms of the measured quantity without providing the societal context in which the mitigated effect occurs.

The integration of tools is needed when dealing with greater complexity of problems. One of the encompassing tools is the use of an environmental management system. The adoption of the ISO14001 Environmental

Management System has gone a long way to giving confidence to its customers that Fonterra is trying to be environmentally responsible.

EMSs are gaining prominence but resolution is still needed on merely reporting the environmental effects (e.g. ISO 14001) and taking a more proactive role in managing the effects within their societal context (e.g. EMAS).

Fonterra utilises an integrated framework of tools to reduce waste in the Company. The tools enable Fonterra to shift to a systems focus, develop products that have a reduced environmental impact, improve the environmental performance of the industry and improve the triple bottom line sustainability performance. There is evidence of integration of tools as they are embedded within companywide programmes (e.g. Operations Journey, Operational Excellence and Manufacturing Excellence) that provide a linkage from waste to all operational aspects of the Company. Progress is measured through a series of key performance indicators and enhanced by an active research programme and regular reporting to internal stakeholders through specialised publications like Ecoefficiency News. Fonterra has come under increasing scrutiny and responded with the Dairying and Clean Streams Accord to manage effects of the operation within a societal context.

A focus on managing effects within a societal context will have the flow on effect of companies moving from an accent on selling products to service provision. This change in attitude is the basis of the new ‘cradle to cradle’ approach which enables substantial waste reduction leading to better resource efficiency and a move to sustainability.

Chapter 6: The Integration of Agents

6.1 Purpose

The purpose of this chapter is to examine how agents coordinate to manage waste in an integrated manner.

6.2 Context

Agents for the progression of integration in waste management include: central government, local government, business and the community. The ability to work across agents enables a system designer to be able to achieve desired behaviour changes in combination with the available tools used as drivers.

The achievement of a sustainable society requires the cooperative efforts of agents for change. Each of the change agents comes from a different perspective and the ability to communicate between them is a crucial factor in achieving success.

Integration within agent organisations and between central government, local government, business and the community sectors are examined in this chapter.

6.3 The Cooperative Approach

Cooperation can occur at three levels: interpersonal, inter-group and inter-organisational. Interpersonal cooperation occurs between individuals, whether from the same organisation or from different organisations. Inter-group cooperation can occur between different groups within an organisation or between groups in different organisations. Inter-organisational cooperation occurs between different organisations. Lozano (2008) concluded that collaboration is a key element to help individuals understand how they belong within a system of organisations. Cuthill (2002) found that collaborative action can facilitate development processes leading to a sustainable community.

A cooperative approach has benefits, depending on the types of groups that are cooperating. Groups that feel they are not heard properly can cooperate to become a more powerful lobby. An example of this in New Zealand is the

Community Recycling Network, a small, diverse group that achieved such a significant voice in governmental circles that one of the skills needed on the Waste Advisory Board created under the Waste Minimisation Act (2008) was for community projects in waste minimisation.

A cooperative approach is also useful for networking purposes and sharing skills. This can be seen in New Zealand with the Waste Management Institute of New Zealand conferences, where opposing ideas and approaches are aired in the conference sessions while still maintaining communication in the periods between the various sessions at the conference (WasteMINZ, 2008).

Providing direction and support is an important function of cooperation. This has been recently exemplified by the implementation of the Waste Minimisation Act (2008). Consultation on regulations for the collection of the waste disposal levy and collection of information on disposal quantities and composition of waste in landfill was carried out in October 2008 in meetings nationwide. Additionally, the consultation process also provided an opportunity to generate support for the new levy regime that came into force on July 1 2009 by the landfill operators.

The importance of agents working together in an integrated manner extends across the sectors.

6.4 Central Government Integration

Integration at the central government level occurs at the project level, the group level and the ministry and departmental level.

6.4.1 Integration at Project Level

The MfE restructured in June 2007. As part of the restructure the Waste Unit, consisting of 19 people was formed. The prime purpose of the Unit was to lead the Ministry's work on waste, which was interpreted by senior management as the work related to solid waste. At the time the major work areas were: the development of what became the Waste Minimisation Act (2008), development of industry product stewardship schemes for priority

waste streams and managing other priority wastes, for example, organic, hazardous and construction and demolition wastes.

The Unit identified a snapshot of 37 projects they were undertaking; 13 product stewardship related and 24 policy-related. Figure 6.1 shows the links between the various Waste Unit projects as identified by the Unit members. The members were also asked to identify whether they thought the links between projects were strong (vital or continuous), medium (needed to be involved on a regular basis) or weak (need to take into account). The largest number of links was to the Waste Minimisation Act project (17 links, 11 strong, 3 medium and 3 weak). The development of the Waste Minimisation Act was the focus of attention as this was regarded by the government as the development of an important tool to change waste behaviour in New Zealand. The Waste Minimisation Act was followed by local government (13, 9, 3, and 1 respectively). The preponderance of local government was due to their being partners with the Ministry in the ongoing delivery of waste minimisation in New Zealand for the previous decade (MfE, 2009a).

At the other end of the scale were the Cook Islands recycling project, the Dairying and Clean Streams Accord and biosolids, each with one weak linkage. This indicated that they are not mainstream projects for the Waste Unit, but provided linkages to New Zealand's foreign aid programme, waste contaminating water and treated waste derived from water, respectively. Thus, there was recognition that for the Waste Unit to succeed, it needed to integrate with programmes that went beyond solid waste.

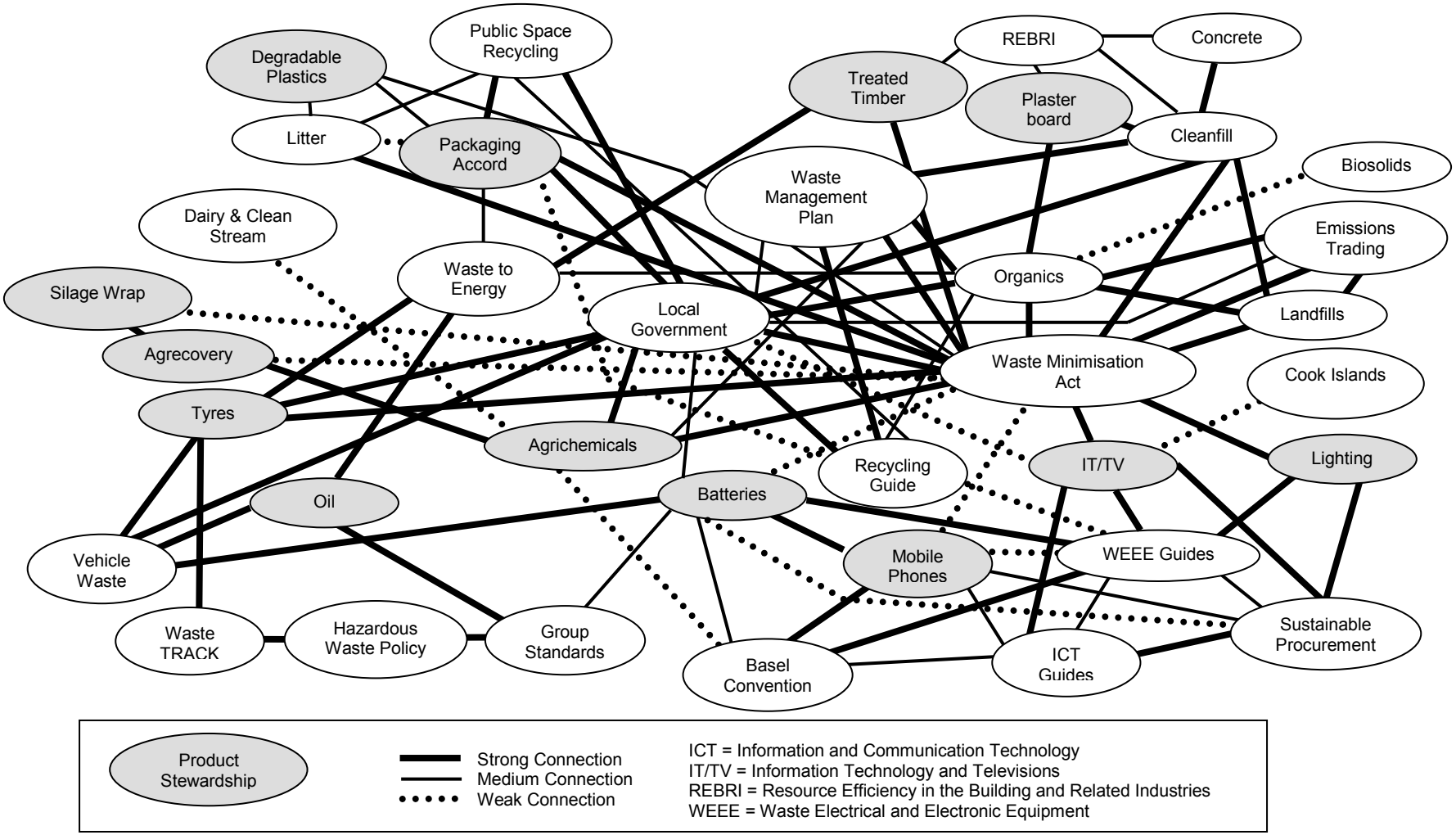

Figure 6.1. Project Links within the Waste Unit.

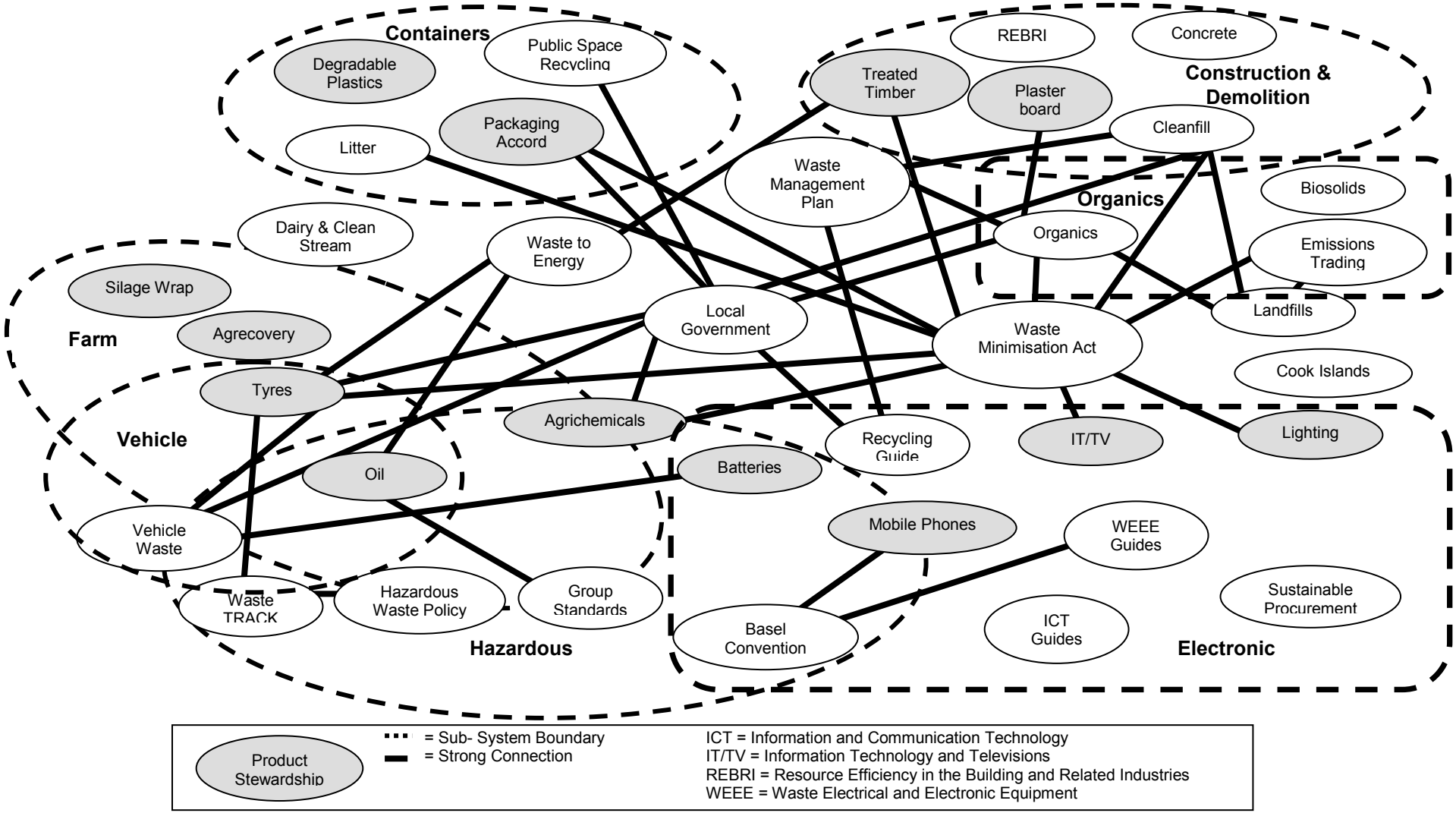

Figure 6.2. Waste Unit Subsystems.

The number of links between projects meant that project teams were assembled that delivered on multiple projects. This not only provided integration across the various projects, but it provided resilience of corporate knowledge in the event of people leaving the Ministry (which was running at about 20.9% in the 2007-08 year (MfE, 2008b)).

The links emanating from the seven waste subsystems that were operational during the parliamentary stages of the Waste Minimisation Act (2008) were containers, construction & demolition, electronics, farm, hazardous, organics, and vehicles. The figure shows only the strong links that crossed the subsystem borders (Figure 6.2). Out of 105 strong links, 44 crossed subsystem borders. This is a strong indicator of the dependency of the projects on each other and the complexity of the internal system managed by the Waste Unit. All of the subsystems have strong linkages to the Waste Minimisation Act (2008) and local government. The links showed how central these projects were to the Ministry's work for the New Zealand waste sector.

6.4.2 Integration across the Groups in the Ministry for the Environment

There are a large number of links between the Waste Unit and other teams throughout the Ministry (Figure 6.3). The Sustainable Business Group, in which the Waste Unit resided, was the most interlinked with the Unit (10) followed by the Local Government Group (8), then the Corporate and Community Group (6). This reinforced the strong links that the waste sector had to local government and, through project work, to the community.

The conceptual flow was for policy and tools to be developed by the Waste Unit in consultation with government, business and community sectors, then to be applied and refined across government by the Leading Government Sustainability Team and then disseminated to the business sector by the Sustainable Business Development Team. Within the Sustainable Business Group, the greatest number of links was with the Leading Government Sustainability Team. The Leading Government Sustainability Team focused on identifying best practice and promoting practical solutions within government agencies in four key areas: waste management, buildings,

transport and office consumables and equipment (MfE, 2009c) – all areas to improve resource efficiency.

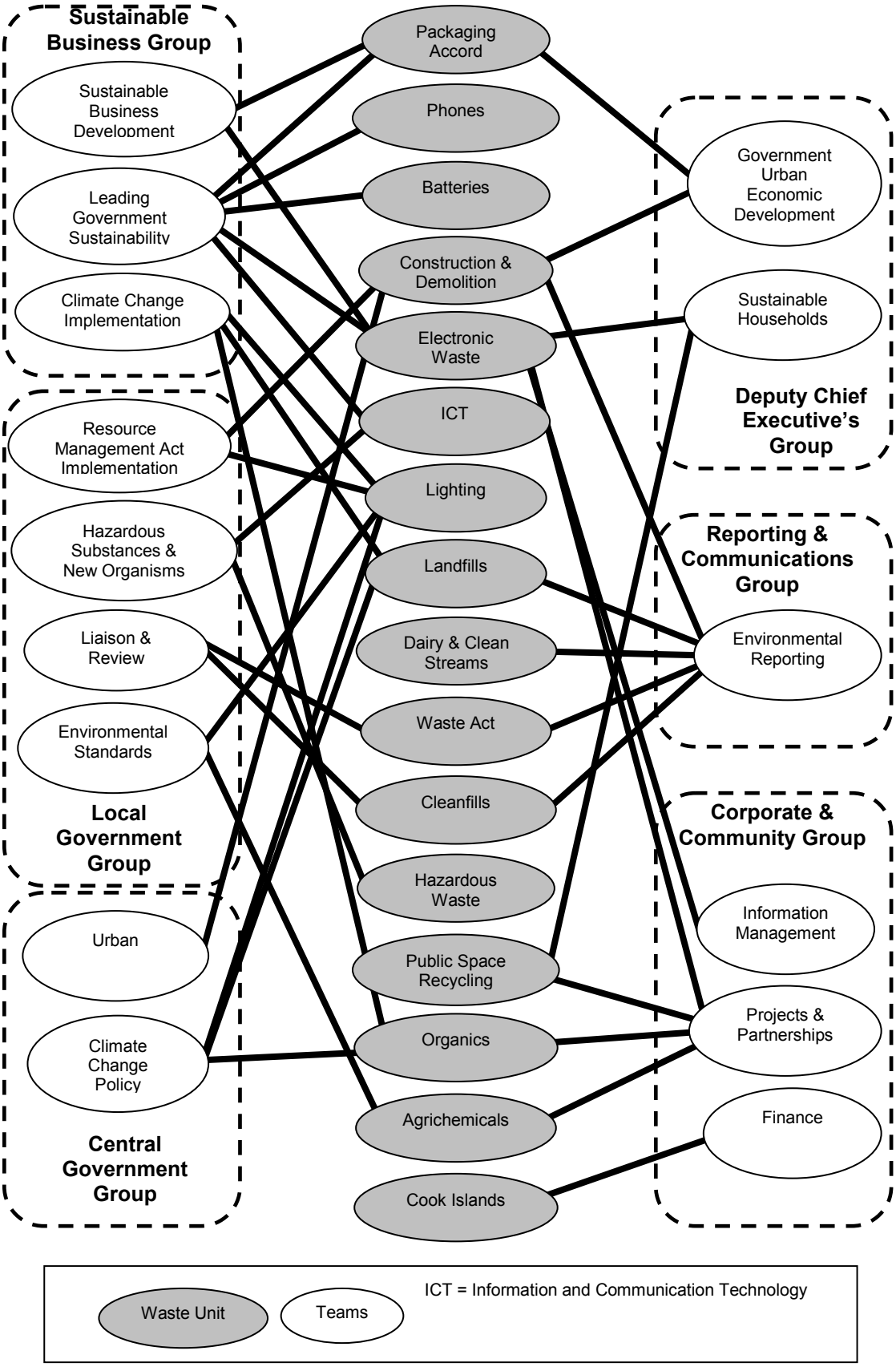

Figure 6.3. Project Links with other Ministry for the Environment Teams.

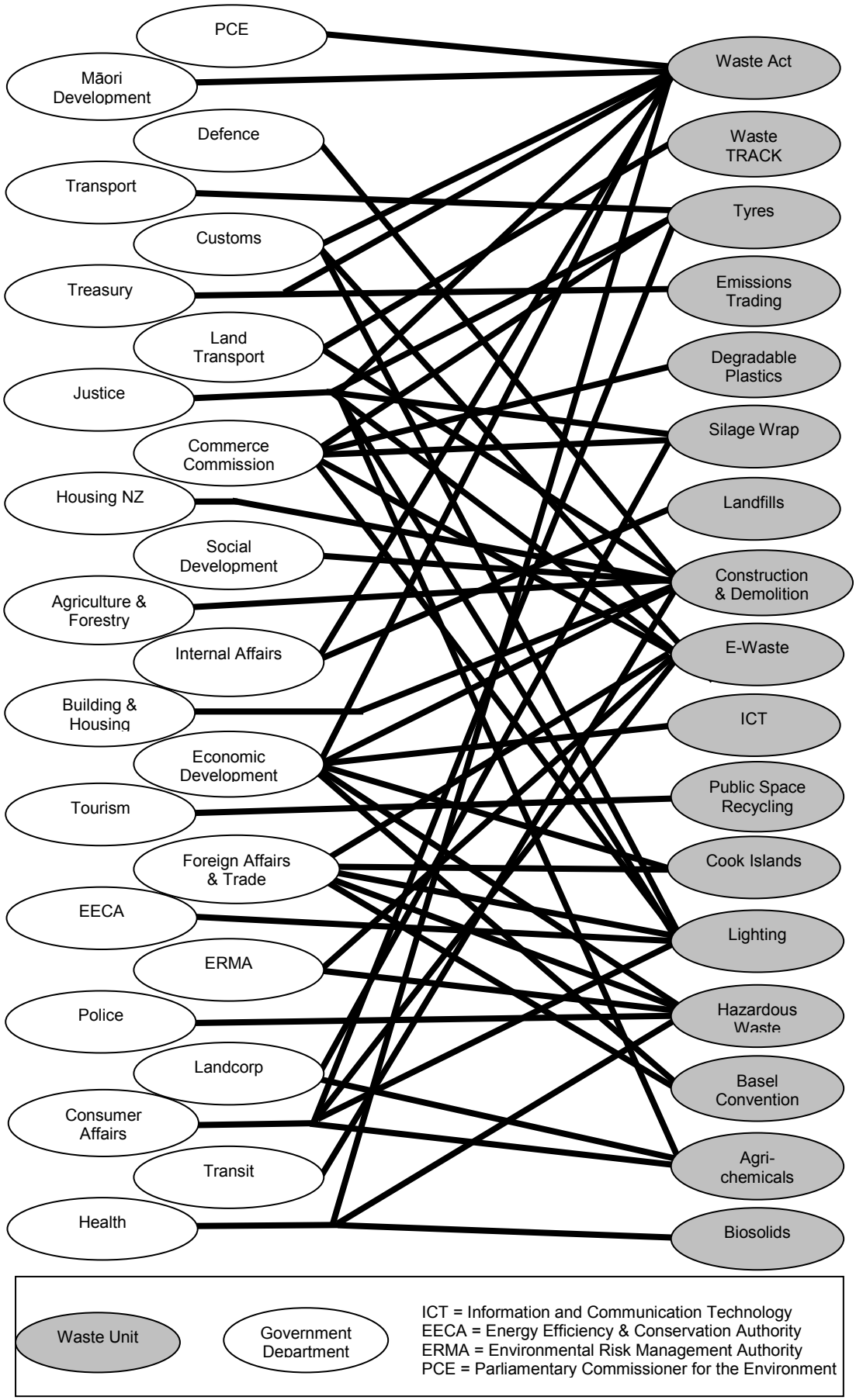

Figure 6.4. Project Links with other Central Government Departments.

6.4.3 Integration between Central Government Departments

Waste work at central government level involved more than just the Ministry for the Environment (Figure 6.4). The Waste Unit worked with 66% of the 35 public service departments and the greatest numbers of links were with the Ministry of Justice (6), the Ministry of Economic Development (6), the Commerce Commission (5) and the Ministry of Foreign Affairs and Trade (5). These links showed the importance of working within the legal system, with minimal economic impact on business and in line with New Zealand's international obligations.

The projects that had the greatest connection with other government departments were: construction and demolition (8), Waste Minimisation Act (7), electronic waste (6), hazardous waste (5) and lighting (5). These projects reflected the priorities of the government at the time – waste legislation, high volume wastes and high profile wastes. Consulting across government was a complex process as different departments had different drivers and requirements, some of which were contradictory between departments. Negotiated outcomes were quite common, and sometimes involved the intervention of cabinet ministers.

By contrast, three government departments (Department of Conservation, MoRST and Statistics New Zealand) were noticeable by their lack of interactions with the Waste Unit. In the area of waste, the Department of Conservation does not have a significant presence except in managing the waste from tourists as they move through conservation land. Hence their needs are no different to other consumers. There is potential for a closer working relationship with the Ministry of Research, Science and Technology (MoRST) since one of their responsibilities is to "*encourage innovation and commercialisation of scientific and technological knowledge and ideas*" (MoRST, 2009). Innovation and commercialisation would be applicable in some of the projects like, for example, organics, treated timber and concrete reuse, but MoRST has not seen a role in these areas as they saw it was the domain of the MfE.

At the time of the survey, the role of Statistics New Zealand was not being considered. However, later in the course of development, it was decided

through consultation that Statistics New Zealand could provide a very useful role in determining how and what statistics should be collected, resulting in a closer working relationship between the Waste Unit and Statistics New Zealand.

6.5 Integration in Territorial and Local Authorities[2]

In a study of territorial and local authorities in New Zealand, 86 councils were successfully contacted (99% of the total), and 78 responded (90% of total). The response rates for different types of councils are given in Table 6.1. Of the nine (10%) that didn't respond, seven were district councils and one was a city council. District Councils are predominantly rural and City Councils are predominantly urban. The responses covered local councils representing 91.6% of the New Zealand population. Table 6.1 provides a summary of local council demographics, specifically the size of population that the local council serves.

Table 6.1. Council Demographics

Parameter	Regional Councils	City Councils	District Councils
Response rate	100%	93%	89%
Highest population	1 179 000	377 000	91 000
Upper Quartile	336 000	180 000	40 000
Mean ± s.d.	300 000 ± 300 000	140 000 ± 113 000	29 000 ± 21 000
Lower Quartile	133 000	50 000	13 000
Lowest population	34 000	37 000	4 000

The response rate is given as the number of local councils in the category that responded out of the total number of local councils. The highest and lowest are the extremes within that category of council. The mean was calculated with the standard deviation (σ_{n-1}) to give some indication of the spread of the

[2] This section was part of the paper: Seadon, JK, and Stone, LJ.(2003), "The Integration of Waste Management by Local Authorities in New Zealand". *Air and Waste Management Association 96th Annual Conference and Exhibition*, San Diego, United States of America, 22 June - 26 June 2003

population. The upper and lower quartiles were taken from the spread of populations. From Table 6.1 it can be seen that there is quite a considerable spread of populations in all the council categories. In general, there are significant differences in the means of the populations served by the district, city and regional councils. Within the individual council categories, there is a large spread of populations with overlap between the three types of council.

The population sizes of the councils were correlated with the structure of the local councils. The results are shown later under the various council headings.

6.5.1 Waste Management Implementation Structure

6.5.1.1 Responsibilities within Councils

As mentioned earlier, the survey identified who was responsible for solid waste, sewage, air emissions and waste minimisation. A spreadsheet was constructed that tabulated the type of council, population, departmental headship and zero waste membership. The results have been categorised accordingly (see Table 6.2).

Table 6.2. Council Responsibilities

Departmental Heads' Responsibilities	Regional	City	District
Single departments only	4	6	6
Both Solid Waste and Waste Minimisation	2	5	15
Both Solid Waste and Sewage Treatment	4	3	14
Both Air Emissions and Waste Minimisation	0	0	1
Solid Waste, Sewage Treatment and Waste Min.	0	0	15
Solid Waste, Sewage Treatment and Air Emissions	1	0	0
All departments	1	0	1

6.5.1.1.1 Regional Councils

Under the RMA (1991), the regional councils are required to control the discharge of contaminants into the air, land or water. All twelve regional

councils have people in charge of air emissions. Many of the functions of solid waste and sewage treatment have been delegated to the respective district and city councils with the regional councils providing a co-ordinating role. Eleven regional councils (92% of all regional councils) have someone who takes on the co-ordinating role for solid waste; ten councils (83%) have co-ordinators for sewage and seven (58%) have co-ordinators for waste minimisation.

Two-thirds of New Zealand councils have heads of departments that are responsible for more than one waste stream (Table 6.2). However there is no apparent relationship between the number of waste streams that a departmental head is responsible for and the size of the population being serviced. There is also no apparent relationship between the waste streams that a departmental head is responsible for and the number of councils within the boundaries served by the regional council. The conclusion that can be drawn from this is that where a person is responsible for more than one waste stream, it is done for convenience purposes rather than population-driven demands.

6.5.1.1.2 City Councils

All the city councils have someone in charge of solid waste, 13 (93% of all city councils) have someone in charge of sewage services, 7 (50%) have someone in charge of air emissions and 12 (86%) have someone looking after waste minimisation. 57% of the councils have heads of departments that are responsible for more than one waste stream (Table 6.2), but the degree of multiple waste stream responsibility is not as great as with the regional councils. Two of the councils that have a common manager for the solid waste and the sewage, are in the lower quartile of the population. There is however, no apparent relationship between geographical location, clustering of the cities, size of the population or degree of multiple waste stream responsibility.

6.5.1.1.3 District Councils

Analysis of the data showed that two (14% of all district councils) in the upper quartile populations had no-one assigned to manage waste minimisation, nine

(26%) in the interquartile populations had no-one to manage waste minimisation, and four (44%) in the lower quartile had no managers. Interestingly, six of the councils that had become “Zero Waste” councils did not have anyone assigned to manage waste minimisation. Of those, one was in the process of appointing a waste minimisation manager.

In some of the local councils, particularly at district level, two people will jointly head up both the solid and sewage wastes (and/or waste minimisation). One of those people will be looking after the policy implementation side (often a planner) and the other will be looking after the compliance side of things (often an engineer). This suggests that cooperation is happening at that level.

88% of the district councils have heads who are responsible for more than one department (Table 6.2). While at first appearance this seems promising, it must be borne in mind that with the generally smaller populations, and hence the smaller number of council employees, the workload is distributed among fewer people. The grouping of waste stream responsibilities that has occurred appears to have been more for pragmatic staffing reasons than genuine attempts to integrate across media. The trends become more obvious when considered in relation to population size (see Table 6.3).

Table 6.3. District Council Linkages

Departmental Heads’ Responsibilities	**Upper Quartile**	**Inter-quartile**	**Lower Quartile**
Only one department	4	2	0
Solid Waste and Waste Minimisation	4	6	5
Solid Waste and Sewage Treatment	1	8	5
Air Emissions and Waste Minimisation	1	0	0
Solid Waste, Sewage Treatment and Waste Min.	4	8	3
All Common	0	1	0

In the upper quartile, 29% of the councils had separate people responsible for each area; this dropped to 8% for the interquartile group and zero for the lower quartile. A reasonable assumption is that many councils see that the natural person to oversee the waste minimisation role is the same person who also oversees the solid waste collections. This has been a result of the

councils' focus on the solid waste portion of the waste stream, at least as far as waste minimisation is concerned.

Forty waste management plans were examined to see what types of waste were covered, what the councils have achieved so far and what they plan to do in the future. The plans were also examined to see if there was any evidence that integration across media was occurring. It was found that the significant focus of all local councils has been on solid waste. This is further narrowed to looking at recycling schemes as the first solution to the problem of what to do to comply with the Local Government Act Amendment No. 4 (1996). With the provision of a recycling scheme, many local councils appeared to have no further intentions other than public education and waste reduction targets. Little evidence appears in the plans on how to integrate the process of waste reduction to different media

A common approach to dealing with perceived waste problems has been for a local council to announce an increase in charges and the provision of a recycling programme. This has been met with protests at meetings and through the media from members of the public (Eve, 2001). Once the change has been implemented and a month has passed, no further protests are heard (Eve, 2001). To try to apply a "decrease waste" message across a range of media has been much more difficult and success has yet to be attained.

Legal requirements to improve this situation have been progressively applied to local councils. Since the RMA (1991) they have been on notice that they have to devise processes that will achieve the outcomes of a sustainably managed environment. Defining what a sustainably managed environment is and how to go about the process does require co-operation between different departments. From the results there appear to be some local councils where the structure suggests that cooperation is more likely to occur, while there are others where structure could make it more difficult. An even larger problem can exist where different councils have to work in collusion to achieve a common outcome (as may be the case with urban city councils).

Some councils have shown that they can work quite well across boundaries in certain ways. For example, the Auckland Regional Council conducted a

campaign to “Clean Up Auckland”. As well as the focus on all waste media in an effort to reduce waste being generated, it also covered other aspects like pest eradication.

The move to encourage change nationally does not necessarily have to come from the larger players. The Opotiki District Council (population 9,051) was one of the leaders in the “Zero Waste” movement, which has since spread throughout the country. The principal driver in that district was the mayor, who took an interest in waste reduction (Gardner, 2002).

One of the factors investigated by the author was whether there was a threshold of population for the potential for integration to increase. It appears that in smaller districts one manager tends to look after more than one waste stream and that there is some sharing of the workload in a number of cases. The planning might be the responsibility of the planner, the infrastructure is in the domain of an engineer, and they both work across, for example, solid waste and sewage. This is the beginning of a possible integration process. (Of course, that’s assuming they all talk to each other and work together to achieve common goals.)

The legislative moves over the last decade have opened up the possibility of integrating waste streams, but meaningful integration is still a long way off. Most of what has been referred to as integration within the council waste management plans, involves the waste management hierarchy applied to solid waste.

6.6 Integration in Industry

Fonterra, as an example of an industry, is atypical of most industries in New Zealand as it was inaugurated as a cooperative. The differences between a cooperative and a business are tabulated in Table 6.4.

Table 6.4: Operational characteristics of cooperatives vs businesses

Cooperatives	**Businesses**
People, professionalism, excellence of products and satisfaction of clients are the priority	Priority is on the highest and most rapid return on investment
People are part of the purpose and participate in management	People are a means and are expendable
The tendency is to lifetime employment with cooperation between shareholders and capital	The contract is to the worker and the commitment is to a task
Policies tend to be long term and provide for social good	Policies are short term and directed to short term profits
Priority is to growth through self-development of the shareholders	The enterprise is constantly trying to minimise costs including downsizing the workforce
Power is shared between the various sectors	Power lies in the hands of the financial controllers
The profits and losses are shared evenly amongst all proportionately	The profits are privatised and the losses are socialised
Human resources policy is oriented towards people invested with dignity	Employees are considered entities with a capacity for work

(Adapted from Stevens and Morris, 2001)

However, characteristics of both a business and a cooperative exist within the Company depending on the audience. The interaction between the Board and the dairy farmer shareholders is a cooperative one, while the relationship between the Board and senior management is characteristic of a business. Between senior management and site-level management the relationship is also characteristic of a business. At site level the relationships traverse from an almost total business association to a very cooperative one. It was noted by interviewees that levels of satisfaction among staff were much higher in those sites where management were perceived to be acting in a more cooperative style than those who took a more business-like approach. The governance structure of Fonterra is shown in Figure 6.5.

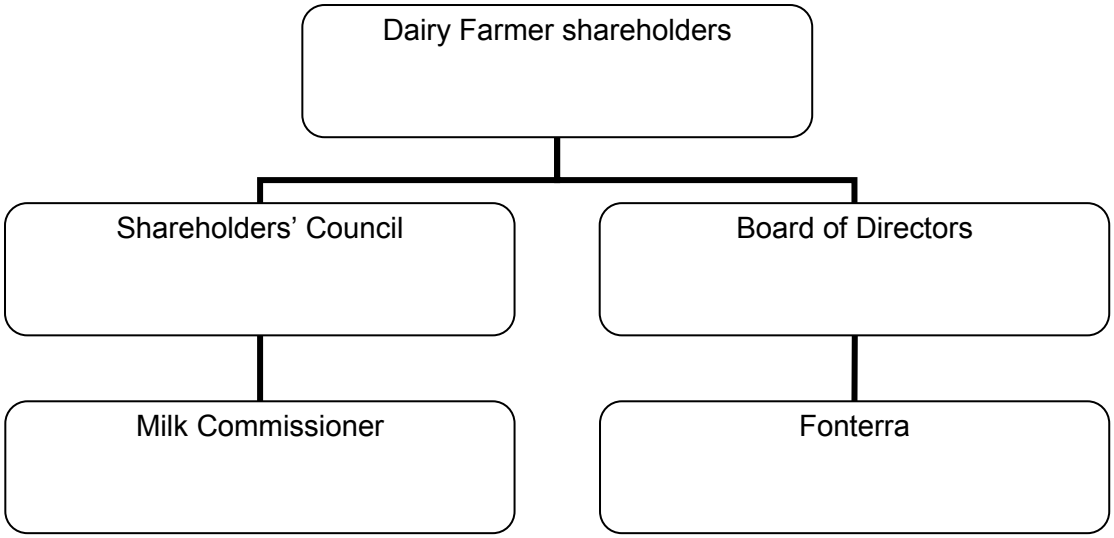

Figure 6.5. Fonterra Governance Structure (Adapted from Fonterra, 2008)

The Fonterra definition of governance is "*operation between shareholders, directors and management of the company as set out in the constitution, formal policies of the company and the general law*" (Hunt, 2004). The dichotomy of global and local governance needed a unique approach. The global operation of Fonterra needed governance at a level of complexity considerably greater than being a local industry, but the local cooperative needed to have representation. To accommodate the dichotomy, a shareholders' council of 35 members was elected through a ward basis. The shareholders' council acts on issues that would normally be managed by directors (Hunt, 2004). The role of the Milk Commissioner is to mediate on disputes between shareholders and Fonterra (Fonterra, 2008). The Fonterra approach with the two arms of governance helps the directors to focus on the primary goal of augmenting shareholder wealth (Hunt, 2004).

6.6.1 Integration of Waste Management Policies into Business Practices

6.6.1.1 Policies to Key Performance Indicators

The overarching policy for environmental performance in Fonterra is the Fonterra Environmental Group Policy (Fonterra, 2007) which aims to "*demonstrate a global commitment to protecting the environment*". The Fonterra Eco Efficiency Standard is a subset of the environmental policy which seeks a "*global commitment to eco efficiency principles and practices*

across all parts of its operation" (PackNZ, 2008). The Standard recognises that :

> "*the sustainability of Fonterra's operations is dependent on the complete integration of eco-efficiency across all aspects of the business, through a commitment to working toward economic, environmental and social sustainability of the Co-operative*".

An indicator of Fonterra's recognition of the importance of the programme was that, at each production site, the Environmental Group Policy was displayed at the entrance along with the Health and Quality policies (some sites had other policies as well).

The integration of waste management policies into the business practices commences with the induction process, where staff and contractors are familiarised with the environmental policy's key features.

The process of incorporating the environmental policy and the eco efficiency standard into the business plan is undertaken annually. Each site produces a site plan for the coming season (1 July to 30 June). In November priorities for the following season are set for the Company and each site. Emanating from the priorities are budgets, needed resources and management plans. The management plans require considerations of any environmental aspects.

The site business plan links into operations, product safety, environmental performance and standard operating procedures. At the end of the process, the site business plan gives the goals and objectives that translate into individual KPIs. Progress during the season is monitored and reported in real time for some key parameters (e.g. protein and fat losses) and delayed up to monthly reporting on others (e.g. recycling and waste to landfill).

6.6.1.2 Developing Infrastructure

Infrastructure development starts with the design process. The traditional method of design is to complete the design phase of a project, implement it and then evaluate the waste management factors that need to be taken into consideration. A more proactive approach, and one adopted by Fonterra, is to consider waste management factors as part of the environmental aspects in

the design phase of a project, particularly in the capital expenditure (capex) process.

The capex process at Fonterra is quite comprehensive and must address environmental, health and safety and quality issues including: waste water, stormwater, sewage, air discharge (including odour), noise, water uptake, hazardous substances licenses and solid waste. The process is approached from a risk management perspective (Table 6.5) whereby risk severity and environmental consequences are tabulated on a five point scale to produce an overall environmental risk score.

Table 6.5. Environmental Consequences of the Severity of Incidents

Severity	Environmental Consequence
Minor	Minor spillage or emissions at consent border line.
Significant	Considerable spillage or emission on site but contained within consent condition.
Serious	Localised pollution, loss of containment, prosecution not likely.
Critical	Significant local pollution of air or water. Prosecution possible.
Disastrous	Major pollution of sea or river, fish kill, public outcry, prosecution certain.

A significant difference from standard risk management matrices (e.g. Markowski and Mannan, 2008) is that the Fonterra version above does not include the frequency of incidents. The frequency estimates the probability of an event occurring which assists decision-makers to determine the appropriate treatment. The lack of a frequency measurement is a severe hindrance to adequate risk assessment and treatment.

The focus for risk analysis in Table 6.5 is on negative outcomes which presents several treatment options (Standards New Zealand, 2004).

- Avoidance by either not commencing or not continuing an activity.
- Reduce the likelihood of an adverse event occurring.
- Change the consequences of an event by, for example, inventory reduction, increasing protection and devising continuity plans for post event preparation.

- Risk diffusion through, for example, contracts, insurance, partnerships and joint ventures to spread the responsibility if an event occurs.
- Risk retention. This becomes the default position whereby non-identification of the risk or non-application of the above treatments retains the risk within the Company.

Other factors within the capex proposal are categories relating to the drivers for the proposal: legislative and regulatory compliance, cost benefit analysis, best available technology and ease of introduction. The accent on waste management factors in the capex process has been driven primarily by legislative and regulatory compliance. Secondary to compliance has been cost-benefit analyses. The crucial figure in the cost benefit analysis is the internal rate of return which, for Fonterra, varies throughout the year from about 1.5 to greater than 3 depending on how the financial people view the financial outlook for the rest of the year. Following the priority on the cost benefit analysis has been what the best technology is and what is easiest to introduce into the Company. Reaction to the status of the environmental considerations of the process varied according to the managers and environmental mangers interviewed (Table 6.6).

Table 6.6. Evaluation of the Status of Environmental Considerations in the Capex process

	Managers	**Environmental Managers**
Number who answered	26	6
Effective and given major consideration	58%	50%
Supplementary consideration	27%	42%
No problem to address	8%	0%
Inadequate	8%	8%

While the managers and environmental managers interviewed considered the process effective, several environmental managers commented on how the processes could be made more effective. There needed to be more involvement by the environmental people in the discussions, but often time

didn't allow for this. One environmental manager commented that often the project originators don't know the details of resource consents, monitoring requirements and regulations and truncating the environmental processes can result in extra work later. Another environmental manager related a story of when the environmental processes were bypassed the result was that inferior product was being produced. Both of these resulted in greater work to repair the damage.

One of the difficulties was that the formal process of assessing environmental effects was only completed when there was a need for capital expenditure or to assess hazardous operations. This meant that environmental input could be bypassed when there was no or very little cost attached to a project and this was viewed as being a time saver. Thus, the importance of environmental considerations was often circumvented in practice, sometimes resulting in detrimental effects.

6.6.2 Responsibility for Integration of Waste Minimisation

For any programme to work there is a necessity for someone to bear responsibility. The interviewees were asked who they thought should have the responsibility to take the lead in implementing waste minimisation in Fonterra. The results are shown in Table 6.7. The first part of Table 6.7 identifies who should have primary responsibility and the second part of the Table shows other people who have important, but secondary roles. While the primary responsibility was seen to be a collective one (everyone), it was also realised that individuals had to take real responsibility. Management were cited as the primary drivers, with site level and corporate level being cited most frequently.

Table 6.7. Responsibility for Implementation of Waste Minimisation in Fonterra

Responsible Person/Group	**Environmental Managers**	**Managers**
Number Answering this Question	15	26
Primary Responsibility		
Everyone	4	8
Site Managers	4	7
CEO	4	4
Corporate Level	2	3
Eco-Efficiency Manager	1	2
Director of Operations		2
Secondary Responsibility		
Championed at corporate level	7	3
Plant managers	1	7
Everyone	3	1
CEO		3
Eco-efficiency manager	1	2
Site champion	2	

Considering the primary and secondary responses, 51% identified the responsibility for implementing waste minimisation should be adopted at a higher level than the site. To gain preference, actions initiated by the corporate team were the ones that were implemented at site and plant level. The facilitation of the process required help from key people (e.g. Natural Resources Group Manager and the National Eco-efficiency Manager).

The 20% of respondents who considered everyone should be responsible expressed that each person has a responsibility to do their job to the best of their ability and to maximise the utilisation of resources, so waste minimisation is a 'business as usual' practice. To achieve a business as usual convention required the environmental and production teams to cooperate. Across the

company there was variable cooperation between the two teams which was often dependent on the personalities involved.

Centralised programmes to drive efficiency do exist but the concept of waste minimisation within them is downplayed, especially KPIs related to waste reduction excluding wastewater. The success of incorporating waste minimisation KPIs was evident in one plant where solid waste minimisation became a KPI for a manager which progressed to a KPI for everyone on site. Over three years there was a 50% decrease in solid waste going to landfill.

6.7 Integration in Community Groups

Community groups present a public aspect of the waste sector. Within this category non-government organisations are also considered as they often represent a specialised community of interest and behave in a similar way to community groups.

While numerous community groups appear to similar benefits, the community groups see relevance in maintaining independence. A survey of eight waste community groups found that they perceive they have points of difference and different values. The groups perceive the value of differentiation aligning to the concept of the mixed member proportional representation parliamentary system, whereby there was a mixture of perspectives represented, but the minor players can still have some degree of influence in the outcomes. One of the reasons given for organisations to not coalesce was that they perceive they do more good as independents and the diversity provides for more robust discussion. A detrimental effect is that diversity brings slowness to progress. Progress was also hindered by the political cycles in New Zealand which had a significant impact on community organisations. Organisations had three years to make an impact with either central or local government (with the cycles one year apart), and then it had to repeat the cycle with a new set of politicians. Getting recognition from politicians was seen as an important avenue to receiving funding for a cause.

6.7.1 WasteMINZ

The integration of groups is influenced by market forces. This was exemplified by the Waste Management Institute of New Zealand (WasteMINZ) and the Recycling Operators of New Zealand (RONZ). In the mid 2000s, RONZ was financially insolvent and it approached WasteMINZ to provide administrative support with a view to possible integration. At the end of two years RONZ decided it would remain independent and change its fee structure to become solvent.

During the period of integration WasteMINZ moved to initiate sector groups that provide opportunities to shape the future of the industry sector they worked in and a forum for knowledge sharing and networking (WasteMINZ, 2009). WasteMINZ acts as the umbrella organisation to provide the forum and currently 9 sector groups exist as shown in Table 6.8.

Table 6.8. WasteMINZ Sector Groups

Sector Group	Function
BusinessCare	Provide training and support to promote sustainable business.
Compost New Zealand	Promotes organic recycling and use.
Contaminated Land Management	Support for contaminated land industry.
Education	Promote waste behaviour change implementation practices.
Liquid and Hazardous Waste	Manage liquid and hazardous wastes.
Landfill and Residual Waste Management	Support for landfill and residual waste processing.
Health and Safety	Reduce the human, social and financial cost of workplace injury and illness by establishing best practice health and safety standards for the waste management industry.
Resource Efficiency	Help the uptake and delivery of waste minimisation and cleaner production programmes
Resource Recovery	Reduce, reuse, recycle, and recover materials from the waste stream

Adapted from WasteMINZ, 2009

There are significant areas of overlap between the sector groups. For example, the BusinessCare, education and resource efficiency sector groups target the business community. Recent activity in the BusinessCare and resource efficiency groups has been minimal as work in specific areas like e-waste and composting took precedence based on signals from the Ministry for the Environment. Thus, the prominence given to work in the sector groups mirrors the work programmes decided at central government level. To facilitate progress each sector group formulated goals and a work plan that was then approved by the Board of Directors of WasteMINZ. The Board of Directors gives an overarching view to the proposed work, including how overlap is handled and whether the proposed financial resources are available or can be sought. The process maintains cohesion, accountability and direction for the organisation.

Sector groups can, and do disagree with each other. For example, in the Select Committee stage of the Waste Minimisation Bill, the compost and landfill sector groups made opposing submissions. While they both disagreed in their presentation to the Local Government and Environment Select Committee, both groups remained sector groups within WasteMINZ.

WasteMINZ as an organisation did not make a submission to the Select Committee. This decision was made due to the lack of unanimity in the organisation and the belief that sector groups were the appropriate organs to make representation. To have done otherwise would have polarised WasteMINZ and curtailed the forum for discussion among members with divergent views.

6.7.2 Community Recycling Network

One of the more recent success stories with community organisations is the Community Recycling Network. Establishment of the organisation for small recyclers took four years. Since members were operating recycling businesses, it was easier for these to turn a profit and thus the collective organisation became more viable.

When the Community Recycling Network was in the formation stage, they were approached by WasteMINZ and offered the opportunity to come under

the WasteMINZ umbrella, but they felt this was too restrictive as they saw WasteMINZ was dominated by the major waste companies, Envirowaste and TPI. In the subsequent period the Community Recycling Network has moved closer to WasteMINZ, firstly by attending the WasteMINZ conferences and having workshops and other sessions dedicated to their interests, and secondly by regularly contributing articles for the bi-monthly magazine Waste Awareness under the Community Recycling Network banner. Closer cooperation has occurred as the trust levels for WasteMINZ have developed and the recognition that representation on the Board is not necessary to have a voice in the organisation.

6.7.3 Membership

The issue of whether membership for an organisation was necessary was one that also had divergent views. The prime example of an organisation that did not have a membership base was ZeroWaste New Zealand. At the time of the survey, they noted that they felt that membership restricted the part of the population that were part of the concept to adopting a consistent approach. In addition, they were goal oriented and saw themselves as bigger than a business concept. Their lack of membership resulted in major problems to show who they represented and consequently to receive enough funding to enable them to carry on their operation. ZeroWaste relied on the standing and political connections of people on the self-appointed Board to generate esteem and funds. Since the survey, ZeroWaste restructured to put them on a business footing to enable them to carry on as an organisation.

Organisations that relied on membership observed that association provided people with a feeling of belonging and it let outsiders know exactly who the organisation represented. Membership usually required a fee which gave tangible proof of commitment as well as resourcing for the organisation to operate. A defined membership also meant that the organisers needed to consult members for agreement on issues, whereas non-membership organisations did not. Membership-based organisations were more able to discuss issues and come to a resolution that tended to be somewhere between the poles of opinion.

6.8 Integration between Sectors

For an efficient waste management system to operate, the government, business and the community must work together in an integrated manner. Figure 6.6 shows the links between the government (represented by the MfE's Waste Unit), business (represented by Fonterra Co-operative Ltd) and the community (represented by WasteMINZ). The figure shows that all three sectors had common links to three government agencies – the Ministry of Agriculture and Forestry (represented the base of New Zealand's industry), the Ministry of Economic Development (highlighted New Zealand's desire to improve its economic performance) and the Parliamentary Commissioner for the Environment (Parliament's watchdog for the environment). Another set of common links occurred in the local government sector where central government and the community work with Local Government New Zealand (representing local government) and the community and business sectors work with the local government agencies – the regional councils and territorial authorities. In this way there was a cascade effect from central government to local government to the community.

To achieve an integrated approach required the agents to identify how they could work together effectively as described below.

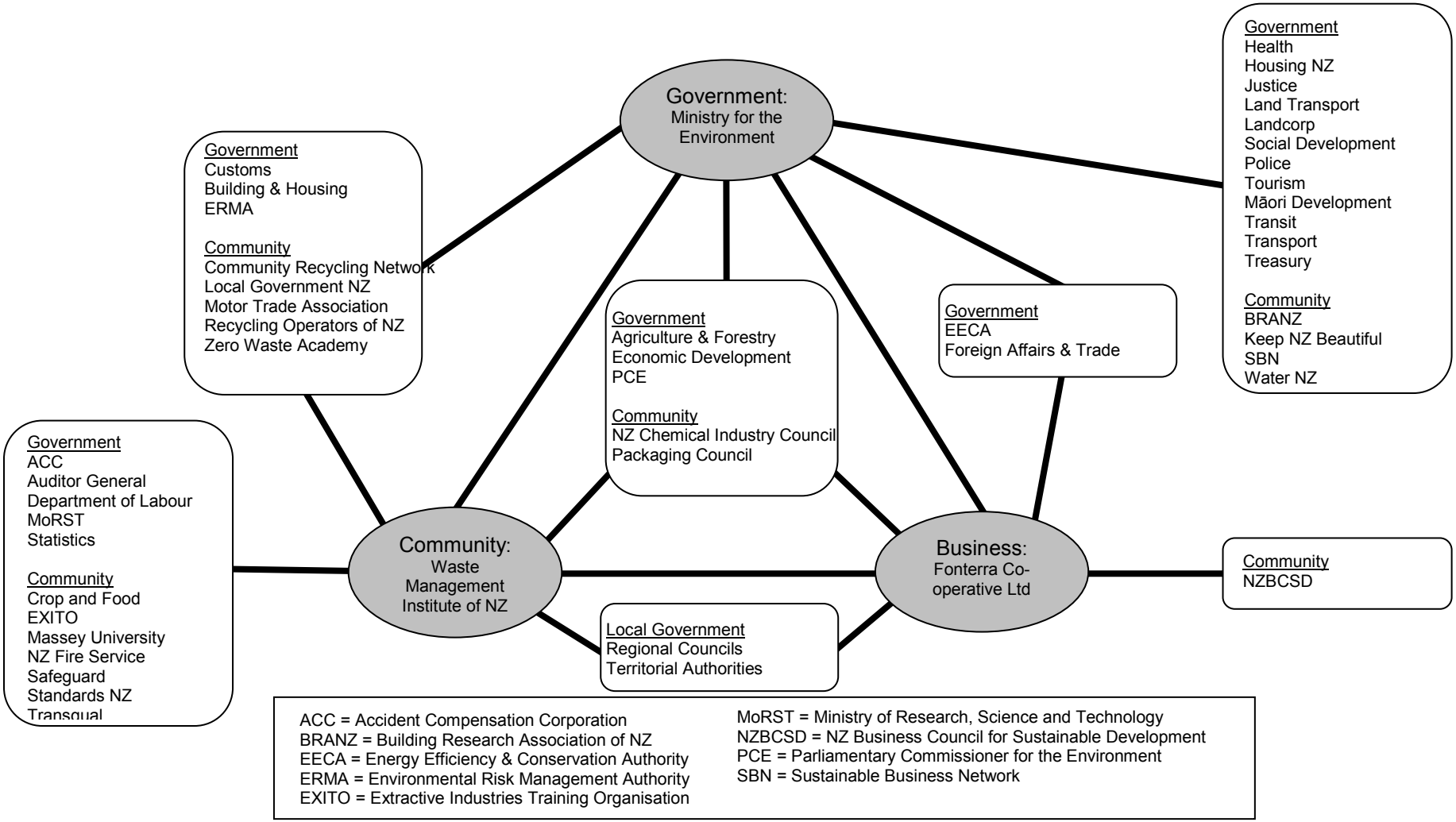

Figure 6.6. The Links between Sectors.

6.8.1 Industry and Central Government

The approach to industry and the government working together relied on good communication and trust being built between the central government agency and individuals in business. Table 6.9 summarises the effective approaches for government (represented by the MfE) and business (represented by Fonterra) to interact with each other.

Table 6.9. Effective Approaches to Interact with Industry and Central Government

Central Government Interacting with Industry	Industry Interacting with Central Government
Understand the issues Understand their key drivers Understand where central government can add value Follow through on issues with honesty	Personal contact developed through mutual respect Openness Talking about concerns early and suggesting alternatives that may be more practical Work with the government to scope alternatives Form partnerships Being on a similar wavelength

The approaches were based on trust between the parties and relied on each party acting with integrity. To build the relationship requires time, but with a staff turnover of 20.9% annually (MfE, 2008b) building resilience in the relationship when the participants are so transient is difficult. One solution adopted was to have more than one person as the contact so that when a person was absent the institutional knowledge was still available. The retention of institutional knowledge was assisted by a centralised document management system to which all employees of the Ministry had access.

Other difficulties expressed by Fonterra people about central government related to the slow pace that things happened and the limited awareness of industrial situations that central government employees had. Central government employees raised the issues of different speeds and priorities between the two organisations as well as the following.

- A better rapport between the Minister and the Chairman of the Board, and the Secretary for the Environment and the Chief Executive Officer.
- Finding ways to add value to what Fonterra was already performing.
- The pressure of Fonterra being a big organisation and thus being able to take on the role of the driver in the relationship.

To overcome the difficulties proper communication was fundamental to the relationship. Fonterra expressed that more regular contact with central government people would enable both sides to be able to update each other on developments and both sides would gain a better understanding of each other.

6.8.2 Central Government and Community Groups

Community groups have an important role in waste management in New Zealand. For example, the Community Recycling Network represents a collection of 30 small recyclers from Kaitaia in the north to Stewart Island in the south (CRN, 2006). Ministry officials found that, as with interacting with other organisations, effective approaches revolved around listening to their viewpoint and trying to understand the issues from their perspective as well as giving an interpretation of government processes. Often these community groups had limited financial support so they required support to persevere with mainstream methodologies for those that have the ideas but not the resources.

The difficulties in dealing with these sorts of organisations were that, while they were passionate and therefore motivated about their cause, they had little understanding of government processes and drivers. A significant hurdle was to get the groups to understand the broader issues from a government perspective. One solution for central government to manage the many community groups was if they spoke with one voice. However, this was made more difficult through different issues being present in different parts of the country which resulted in slow progress on issues. Frustration with the speed of progress was a significant driver for group formation. The government has traditionally been seen as being slow in making progress in the waste sector

which resulted in the formation of pressure groups to fortify support and lobby for progress which requires resources.

A constant battle for the small, diverse groups is securing financial resourcing. Government funding from the MfE traditionally does not go beyond a three-year horizon. This can be seen with BusinessCare which received three years of funding from the Sustainable Management Fund run by the Ministry for the Environment in 2001(BusinessCare, no date). The mandate was to become self-sufficient within the funding period. When the funding ran out without securing ongoing financial sourcing, the organisation's future was uncertain until it became a sector group within one of its sponsors, WasteMINZ. Since BusinessCare's re-emergence as a sector group, its work has had very low profile.

6.8.3 Industry and Community Groups

The communities surrounding Fonterra sites played an important part in the functioning of the Company. Company workers live in those communities, and shareholders constituted a significant portion of the surrounding community. As part of their community responsibility, Fonterra assisted community groups in mainly small scale, low profile support that generated little publicity, but helped the community. Examples of community efforts by Fonterra are shown in Table 6.10.

Table 6.10. Fonterra Community Programmes

Site	Community Group/Activity
Nationwide	Fonterra Brands donated Primo Milk for fundraising activities RD1 supported farming competitions Actively supported Keep New Zealand Beautiful during conservation week Scouts and football teams strip multiwall bags to fundraise
Clandeboye	Supported Cancer Society Supported St John's Ambulance Supported local Scouts
Edendale	Provided Hi Vis jackets to all school children due to dangerous road conditions
Edgecumbe	Planting along the railway tracks Created an outdoor environment for an old folks home as a team building exercise for the engineers Provided judges and trophies for a local science fair Hosted suppliers, and local high school students at open days Donated food to Foodlink Planting trees with the Department of Conservation at Ohope Beach Cleaning tracks in the Urewera National Park
Hautapu	Roadside and lakeside rubbish collection
Kapuni	Education book sponsorship Provided classroom resources – health and safety advertising Purchased a fire tender for the local fire brigade Funded trees for riparian planting Gave plastic to the IHC (people with intellectual disabilities) to sort and on sell to raise funds
Kauri	Cleaned up a local beach 1 ML of water per day given to horticultural farmers (part of resource consent) Sponsored environmental awards at the local science fair Ran the Gateway programme – day sessions for high school pupils introducing dairying Donated plant diggers for grounds and gave free compost to the kindergarten Sponsored environmental studies at local school to encourage farming
Lichfield	Ran the Gateway programme aimed at pupils from low decile schools Support mechanical and electrical apprenticeships
Pahiatua	Rotary use the facilities Waste paper is donated to the kindergarten Broadband aerial installed on top of the factory for the local school
Stirling	Partnership with Geography classes at South Otago High School Cutting the grass at the community hall
Te Awamutu	Picked up rubbish around the streets
Tirau	Sponsor school galas and wine and cheese evenings Support the South Waikato Economic Development Trust
Waitoa	Collected rubbish around the perimeter of the site as part of Keep NZ Beautiful
Whareroa	Funded trees and manpower for riparian planting

Communication with the surrounding communities was vital to build up trust. Periodically opening a site to the surrounding community was one way that many sites used to gain their support and lessen suspicion about what might be planned or was going on at the site. Other methods of communicating with the surrounding community are shown in Table 6.11.

Table 6.11. Communicating with the Surrounding Community

Site	Community Group
Clandeboye	Neighbourhood meetings 2-3 times a season
Edendale	Quarterly community liaison meeting Community liaison committee meets monthly 0800 Edendale confidential line to receive complaints Meet with the Edendale Community Board
Kaikoura	Meet with the local Iwi six-monthly on a Sunday morning
Maungaturoto	Annual community meeting with the Guardians of the Kaipara
Lichfield	Public meetings on open days Retired employees run tour groups and raise the profile of the site on the open days Neighbourhood consultation nights twice a year
Hautapu	Yearly meeting for the neighbours where they have a barbeque and presentations School groups tour the site
Te Awamutu	One open day per year Meet with Iwi
Te Rapa	Yearly community meeting including Iwi, community and Department of Conservation Visit by the Royal Forest and Bird Protection Society Visit by a wetland group
Tirau	Meet with the Tirau Community Board Neighbourhood consultation nights twice a year Tours through the site
Waitoa	Meet with the Waitoa community
Stirling	Meet with neighbours, local school, the salmon hatchery, 2 local iwi and Fish and Game New Zealand

Effective ways to engage the community were to consult with them early in a process and keep them participating throughout the project. A summary of successful engagement techniques are shown in Table 6.12.

Table 6.12. Effective Approaches to the Engage the Community as Identified by Interviewees

Approach	Environmental Managers	Managers
Number Answering this Question	12	8
Include the community groups in decision making	33%	62%
Be open	25%	25%
Have regular meetings	25%	25%
Honesty	25%	25%
Be constructive	25%	
Work co-operatively	25%	
Invite to the site	17%	12%
Keep technical stuff away from meetings	17%	12%
Have one person to approach	17%	
Listen to them	17%	
Respect their culture	17%	
Wine and Dine	17%	
Be proactive	8%	12%
Follow up complaints quickly	8%	12%
Take them on monitoring trips	8%	12%

The high percentage of managers that supported consultation is reflective of the past responses from communities where Fonterra undertook projects without engaging with the community. Consequently the communities would formulate their own thinking about what was happening at the sites and would react to changes they perceived as negative, whether or not there was any substance to their perceptions. Accordingly, management then had to contend with the antagonism and try to regain the confidence of the community. Adoption of a proactive approach alleviated much of the antagonism and the resultant containment.

Managers initiated communication between the Company and the community which allowed for a cooperative approach. This was achieved by managers being readily available to community representatives, even to the degree of having community representation on development projects. The cooperative approach built trust between the Company and the community. Further building of trust will make it easier to interact with the community. To build trust, site managers need more latitude in dealing with the community rather than constant referral to the corporate office before engaging with community members.

From the Company's perspective, the difficulties identified in dealing with community groups revolved around the personalities and approaches used. Community groups with a lack of technical or business expertise created the most difficulties. Progress could be exacerbated by people with hidden agendas or those who were just antagonistic to the Company, either through a bad experience with the Company or through misinformation. One solution was for the Company to work with one or more representatives of the community groups to try to educate them on the technical issues so that they could in turn work with the wider membership of their groups. This approach had been successful on several occasions.

A specialised form of community group is the Māori iwi (tribes), who are vital participants in the resource consent process under the RMA (1991). One of the difficulties expressed in dealing with iwi, was that each party operates on different time frames. The Company tends to have fixed time frames and iwi work through a process of resolution by extensively talking through the issues where time was not an important factor to them. Early consultation with iwi was therefore an important consideration in project planning. One of the initiatives put in place is to use specialists in dealing with Māori issues and protocols and indications are that this is more successful.

6.8.4 Industry and Local Government

Industry, of which Fonterra is a significant member, works with both tiers of local government: regional councils and local authorities.

6.8.4.1 Regional Councils

Regional councils are responsible for discharges to air, land or water under the RMA (1991). Fonterra's major interactions occurred with granting resource consents and compliance with the conditions in the consents. The majority of the interaction is for waste water discharges and air emissions.

The original milk industry attitude was that money could solve any problem. As the impacts of the RMA (1991) took effect, this approach became less effective. As a result the industry had to take a different approach resulting in 63% of the 50 Fonterra respondents indicating there were no difficulties in dealing with regional councils. Regional council officers noted that there was a major change in philosophy in the mid 1990's as the effects of the RMA (1991) started to take effect.

To interact successfully with regional council officers, effective approaches needed to be found. Communication was the most important principle to being effective. The most effective approaches were to be open and honest with the officers. This in turn improved the relationship and trust that the council has with Fonterra. One issue Fonterra staff had with regional councils was that changes in personnel meant that relationship building with new officers took a couple of months, during which time the negotiating skills of the Fonterra representatives were called upon.

Regional council officers observed that the relationship with Fonterra was a very positive one where the Company was seen to be proactive and well resourced. If there was an incident the Company would self-report promptly and, as issues developed, both sides would deliberate on solutions and Fonterra would remedy the situation. Fonterra took the perspective that the cost of prosecution for the Company was not as relevant as the cost to the reputation of the Company.

The four regional council officers interviewed ascertained the following approaches to be effective mechanisms to manage industry.

- Regulate until industry achieves compliance.

- Provide support and fund an advisory service for efforts beyond compliance.
- Give information and offer tools to help them out of non-compliance
- Work with industry.
- Offer encouragement to industry.

Regional council officers perceive that the greatest difficulties are at the farm level in the co-ordination between the Fonterra directors, the Shareholders Council and the ordinary farmers. The environmental impacts of farm level issues associated with water quality were addressed by the Dairying and Clean Streams Accord (MfE, 2003c). Regional councils have the responsibility for water quality under the RMA (1991) and hence are essential partners in the Accord.

6.8.4.2 Territorial Authorities

The major interactions between Fonterra and territorial authorities were through compliance and planning processes.

It was recognised by four district council officers dispersed through the country, that there were no difficulties in dealing with Fonterra from a territorial authority perspective. The officers perceived that an effective way to manage Fonterra was to give them the scope to resolve their issues. The territorial authority officers noted that one phone call normally resulted in any necessary actions.

The 19 Fonterra environmental managers interviewed perceived that the most effective approaches were to develop personal relationships with council officers and the managers achieved this by being open and honest with them. This in turn improved the relationship and levels of trust that councils had with Fonterra. The ongoing relationship between Fonterra and the district councils could be improved by more regular meetings between the parties and for councils to adopt more standardised practices in relation to setting out conditions for operation across the country.

The lack of standardisation of processes across the country by councils was embedded the Local Government Act (2002) which states, in part, in the purpose: "*accountability of local authorities to their communities*". This provides an introspective context which many local authorities do not effectively utilise Part 2, Section 14(e): "*a local authority should collaborate and co-operate with other local authorities and bodies as it considers appropriate to promote or achieve its priorities and desired outcomes, and make efficient use of resources*".

Territorial authorities have also assisted local industry to improve their environmental performance through voluntary programmes. Examples of this include the Waitakere City Council's Boat Building Industry project established in 1999 (WCC, 2008a) and the Green Print Guide in 1996 (WCC, 2008b).

The Council worked with the boat building industry and central government to establish the Boat Building Information Group made up of representatives from Waitakere City Council's Cleaner Production team, Marine Industries Association, Boating Industry Training Organisation, Accident Compensation Corporation, Occupational Safety and Health and the Auckland Regional Council (WCC, 2008a). The group examined environmental issues and health and safety practices. Under the environmental issues they ascertained that the pressing issues were hazardous waste, recycling rates, energy management and air quality. For their part, the Council gave cleaner production assistance to the boat builders to improve their environmental performance.

The Waitakere City Council also worked with the printing industry in the period 1996-99 and then reviewed the project in 2002. The aim of the project was to: "*encourage the adoption of better environmental practices within the printing industry and provided an opportunity for Council to work with a group of its suppliers to buy products that had less impact on the environment*" (Waitakere City Council, 2008b). The project resulted in the following outcomes.

- A local industry group offering environmentally preferable services was developed.

- The process provided a source of environmentally preferable printers for the Council. The Council were able to use vegetable-based inks and elementary or totally chlorine-free recycled paper.
- The Council allowed a premium to be paid for these products, as the products supported the Council's Eco-city vision and were generating new local environmentally-preferable markets.

6.8.5 Industry and the Unions

In Fonterra, the unions act on behalf of the workers, principally those workers associated with the Fonterra sites. The relationship between the Company and the unions has changed over the years from a confrontational approach to the current situation of having a cooperative working relationship.

The two main predecessors to Fonterra from which the cooperative was formed, the New Zealand Dairy Group and Kiwi Cooperative Dairies Ltd, had different approaches to interaction with the unions. The New Zealand Dairy Group was seen by the unions as being very confrontational and centrally controlled. Kiwi Cooperative Dairies Ltd was working in collaborative manner and more decisions were made at site level. When Fonterra was formed they chose to adopt the Kiwi Cooperative Dairies model which was probably heavily influenced by the chief executive, Craig Norgate, who emanated from Kiwi Cooperative Dairies Ltd.

Communication and consultation were regarded as the most effective ways of working with the Company. When union officials had problems they were comfortable engaging with management at any level in the Company to overcome the difficulties.

One of the difficulties in being such a large cooperative was that changes in structures and people in the Company slowed down response times. Additionally, having a large bureaucracy did not facilitate a rapid and flexible approach that was perceived necessary in the industry in today’s conditions where change is a constant factor in the Company.

6.8.6 Central Government and Local Government

Central government interacts with local government at both the regional council and territorial authority level.

The RMA (1991) places responsibilities for discharges on regional councils (e.g. landfills) while the Waste Minimisation Act (2008) and its predecessors the Local Government Acts (1974 & 2002) placed responsibility for waste management and minimisation on territorial authorities. While the responsibilities under the Acts are clear there are differing situations around the country. Some regional councils (e.g. Canterbury) operate waste management policies throughout the region, while in other areas (e.g. Auckland) the regional council acts as an organiser for discussions within the region and coordinate some of the waste functions (e.g. collection of hazardous waste). Whatever distribution of waste responsibilities the regions have adopted, central government needs to build effective relationships with both types of councils.

6.8.6.1 Regional Councils

Central government officials perceived that to develop an effective relationship between central government and regional councils the following attributes were necessary.

- A good understanding of the common objectives.
- An open dialogue.
- Show respect and understanding of regional government issues.

These attributes are only developed over time as trust and the working relationship are built up. The transient nature of the staff at central government (e.g. MfE turnover in 2007-2008 was 20.9% (MfE, 2008b)) signals that, while the long term relationship may be maintained at an organisational level, the individual relationships that bring coherence are less likely to occur. This view was supported by the regional council officers who also related other difficulties such as: the inconsistency between staff approaches and expectations; and a lack of internal communication which was exhibited by a silo mentality.

Regional council officers perceived that the most effective approach to central government was a supportive one involving an understanding of the aims of central government and underpinning those aspirations. The offer of support on an issue with time or money was also found to be an effective mechanism.

Ministry officials perceived that difficulties normally related to the different perspectives that central and regional government came from and these were generally resolved by discussion to work through the issues.

Regional council officers found it difficult to work between ministries as there was little cooperation between the different ministries and that they were more interested in protecting their domains. In trying to work with differing agencies with their different requirements, there was no unified approach to managing the incompatibilities. For some the approach was to let the central government agencies reach agreement and manage the results while others tried to be proactive by attempting to identify the problems and endeavour to achieve alignment between the agencies. It was clear that a 'whole of government' approach (Cabinet Office Wellington, 2008) was not being brought into effect.

To improve the situation and the ability to work more productively with central government the following were suggested by regional council officers.

- One point of contact who spreads the message.
- Better communication within and between government departments.
- Clear guidance on responsibilities in central government.
- Names tagged to responsibilities.

For the suggested solutions to eventuate government departments will need to accept that better support can be given to their ministers when stakeholders are given clearer channels of communication.

6.8.6.2 Territorial Authorities

Over 70% of territorial authorities have adopted zero waste targets (Zero Waste, 2009). Table 6.13 summarises the numbers of district and city councils that have adopted zero waste targets. This enabled ascertainment of

whether councils that are proactive in trying to reduce waste to zero, also show potential for integration by grouping the departments together under one "headship".

Table 6.13. "Zero Waste" Councils

Parameter	**City Councils**	**District Councils**
Number of councils by type (percentage by council type)	6 (40%)	30 (52%)
Population coverage	40%	53%
Number in Upper Quartile of Population	2	8
Number in Lower Quartile of Population	2	13
Urban (percentage by council type)	2 (25%)	3 (60%)
Rural (percentage by council type)	4 (57%)	27 (50%)

"Urban" city councils are those in which there is a cluster of city councils and "rural" city councils are those that are found in singular entities. The proximity of councils can influence surrounding councils and thus it was possible to investigate if the difference in the type of council had an influence on whether they adopted 'zero waste' policies. The percentage by type is a percentage of those types of councils throughout New Zealand. The population coverage is represented as the percentage of the population covered by that council type in New Zealand. This was done to ascertain whether the "Zero Waste" councils were similar in number of the sector being considered.

The city councils that have elected to become "Zero Waste" councils are evenly spread between the population quartiles. By comparing the percentage by type of the rural and urban city councils it can be seen that the urban city councils have a lower representation than the rural ones. The district councils that have adopted "zero waste", however, are evenly split between urban and rural in terms of the sectoral percentage. Geographically, the "Zero Waste" councils are generally located on the East Coast of the North Island and the central portion of the South Island. These geographical regions surround the Opotiki District Council in the North Island and Christchurch City Council in the South Island. Both of these councils have been very proactive in the zero waste movement.

An examination of how the territorial authorities collaborate showed that the comments that were applicable to regional councils were also applicable to district councils. In addition, the resourcing of the territorial authorities by local ratepayers, particularly the less populated ones, meant that there were conflicting demands placed on them. There was a perception that central government has devolved responsibility to territorial authorities but has not provided greater financial resources to accomplish the obligations, which increased the pressure on territorial authorities.

From a central government perspective, as autonomous agencies, each territorial authority could manage issues as they saw fit, which meant that a national consensus on issues was very difficult to achieve when adoption by councils was needed.

Ministry officials commented that there were a number of measures that could be taken to make the relationship work better.

- The provision of best practice guidance.
- Secondments between both organisations for specific projects to gain a better appreciation of the other's working context.
- Communicate the commonplace realities better.
- Avoid repetition of projects through good communication and the exchange of information.

Under the Waste Minimisation Act (2008) territorial authorities have greater financial resources to undertake waste minimisation programmes. Along with the greater resources is the expectation that there will be improved outcomes. For greater efficiencies to occur, central government will need to be show leadership and better communication.

6.8.7 Regional Councils and Territorial Authorities

Cooperation between regional and territorial authorities has had mixed success in New Zealand. In Canterbury, five territorial authorities – Christchurch City Council, and Selwyn, Ashburton, Hurunui and Waimakariri district councils – own 50% of Transwaste Canterbury, the owners of the Kate Valley Landfill. The other half is owned by Canterbury Waste Services, a

subsidiary of Transpacific NZ (Controller and Auditor General, 2001). All ten Canterbury territorial authorities plus the regional council are members of the Canterbury Waste Joint Standing Committee that enabled a regional waste strategy.

In other regions, like the Auckland region, the territorial authority waste officers meet on a frequent basis, but waste coordination is not carried through to the coordination of the services. In Auckland's situation, this has resulted in two joint collection initiatives: North Shore & Waitakere Cities and another one for Manukau & Auckland Cities. The other three territorial authorities organise their own collections.

In surveying the councils on the best ways to approach each other, both the regionally well-coordinated and the regionally independent ones gave the same responses. The development of personal relationships through being open and transparent led to the development of joint strategies through a yearly planning process, and stressing cooperative approaches and the provision of joint funding for schemes have proven to be successful approaches. Overall, patience and an ongoing education about what each other were doing also added to the effectiveness.

Overseas models have shown that cooperation is necessary and can be encouraged through the application of drivers. In Nova Scotia, Wagener and Arnold (2008) found that the municipalities decided to cooperate with each other in producing and delivering waste management plans. The driver for cooperation was that each municipality could not afford to construct new landfills and centralised material recovery facilities that would meet new standards that the province introduced. By cooperating, municipalities in regions could pool their resources and thus meet the new requirements.

In New Zealand, the potential for cooperation is built into the Waste Minimisation Act (2008) where section 45 allows for joint waste management and minimisation plans between any numbers of territorial authorities.

6.8.8 Regional Councils and Community Groups

When local territorial authorities (regional, district and city councils) want to do anything that affects the community, under the Local Government Act (2002) they are required to go through a consultation process as described in the Act. As well as consultation, some regional councils survey their communities to get feedback from the communities on specific issues. Environment Waikato surveyed their community in 2006 about waste issues (Environment Waikato, 2006). The results of the survey showed that people ranked waste disposal as second to water quality as the most important issue facing the region. Almost half the people thought that waste services had improved over the previous five years, 30% suggested that it had remained the same and 20% thought it had got worse. The ones who thought it got worse were principally in those areas where there had been a decrease in recycling services. This feedback provided information on the services that the regional council needed to support the expansion of resource efficiency programmes in the region in the 2008-09 year (Environment Waikato, 2008).

Community groups in the waste sector were often under financed, so the regional councils found that providing financial assistance for projects enabled effective interactions between the parties. To facilitate the interaction, regional councils that provided assistance in handling bureaucratic processes with which community groups were unfamiliar, achieved a strengthening relationship. The regional council officers found it was also important to take the time to sit and actively listen to the community groups.

The difficulties in the relationship between regional council officers the regional council and the community groups were the high expectations of the community groups for assistance and that the councils can't meet those expectations.

6.8.9 Territorial Authorities and Community Groups

Territorial Authorities sought to deliver joint programmes with community groups as an effective approach. They used the community groups' areas of expertise and applied it to other areas by integrating into existing programmes. The territorial authorities also sought key linkages to deliver

similar programmes that the parties had been involved in already. The difficulties encountered by the territorial authorities were that in some areas there was not a strong base of people to support it. It was in those relatively small communities that the community groups flourished.

Community groups encountered difficulties with the big waste companies, which were able to undercut the community groups through their buying power. The response from territorial authorities was to often go for the cheapest tender and not take into account social factors like local employment and local processing (e.g. Waiheke Island in Auckland City's area (ACC, 2009)).

6.9 Integration of Agents in Waste Management

The environmental image of New Zealand is a substantial driver of the value New Zealand can get for its goods and services. A study carried out by the MfE (2001) concluded that the clean, green image was worth between hundreds of millions and billions of dollars from such sectors as dairy, tourism, organics and meat. To protect such an important reputation requires cooperation between the different parties involved in developing it. Part of the reputation is derived from adequately dealing with waste issues.

When waste occurs different parties are affected depending on the sort of wastes that are emitted. The effects can be local (e.g. the neighbours with dust) through to global (e.g. unsustainable practices impacting on market viability and even a country's reputation).

The government is able to activate various policy options to drive change, in this case to reduce waste and increase resource efficiency. The preference of government has been to work with business in a cooperative, voluntary manner. When this has failed then the government has resorted to legislative provisions. In the case of waste, the legislative provisions of the Waste Minimisation Act (2008) provide for financial assistance in behaviour change and product stewardship to devolve responsibility for specific waste generation up the supply chain so that everyone, including the producers, have a responsibility in the end-of-life products and their role to minimise the

waste generated. The development of waste legislation resulted in advocacy from all sectors of the waste community

6.9.1 The Waste Minimisation Act (2008) Legislative Development Process

The power of self-organisation of a system is a strong leverage point for a system (Meadows, 1997). The development of new legislation that added structures and changed feedback loops in an endeavour to cause behaviour change had the potential to be very divisive and reactionary between the various agents.

Local government appealed to the government for legislation to provide for ongoing funding for waste minimisation; community groups had called for legislation for many years for funding and controls on waste products; business wanted legislation to support voluntary product stewardship schemes and central government was moved into action on sustainability through reaction in New Zealand to international events like the production of the Stern Review on the Economics of Climate Change (Stern, 2006) and The Inconvenient Truth (Gore, 2006).

The development of the Waste Minimisation Act (2008) illustrates how the integration of various agents produced a piece of legislation that was acceptable to all political parties and workable for government (both local and central), business and the community. The process for development of the legislation took 2⅓ years of concentrated effort.

6.9.1.1 The Initial Driver

The impetus for the government to support waste legislation was a court case brought by Carter Holt Harvey against the combined territories of Waitakere City, North Shore City, Rodney District and Christchurch City councils (Ministry of Justice, 2006 and 2007). The defendants had proposed a bylaw that applied a levy on waste generated in their areas and had provisions for data collection on waste to landfill as well as recycled and recovered materials. The verdict from the legal processes was that neither the levy nor

the licensing provisions were within the provisions of the Local Government Act (2002).

6.9.1.2 The Waste Minimisation Solids Bill

The government was motivated by public opinion to provide adequately for ongoing waste reduction. As a consequence of public opinion and the result of the court case, the government decided to support legislation that focused on waste. On 4 May 2006 a Green Party bill, the Waste Minimisation (Solids) Bill, was pulled out of the ballot. The Bill proposed to (Parliamentary Counsel Office, 2006):

- set up an authority to administer waste management and minimisation in New Zealand;
- set up waste control authorities to manage waste operations locally;
- provide for prohibition of disposal of certain wastes to landfill;
- provide for a levy on waste to landfill;
- provide for extended producer responsibility for goods on the New Zealand market;
- require organisations to formulate waste management plans;
- require central government agencies to take environmental factors into account when procuring goods and services; and
- require government departments to report their resource use, waste generation and management.

6.9.1.3 Public Input

With the support of the government, the Bill was sent to the Local Government and Environment Select Committee, made up of four Labour Members of Parliament, three National members and one Green Party member. The Select Committee appointed the MfE and the Parliamentary Commissioner for the Environment as advisors. Prior to this Bill, the Department of Internal Affairs, under the Local Government Act (2002) were responsible for waste at territorial authority level. The move to the Ministry for the Environment was a significant change in responsibilities.

The Select Committee called for submissions to the Bill from all sectors of New Zealand society. A total of 315 written submissions were received from local government, business, community groups and individuals, many of whom requested to also make oral submissions. Analysis of the submissions showed that local government generally wanted more control over business waste; business did not want the government to have provisions for compulsory product stewardship or levying and the community sector wanted even wider provisions to encourage behaviour change.

6.9.1.4 Development of Government Policy

The submissions were used by the MfE officials to draft a government policy paper. To provide an integrated approach from government, engagement through a consultation process was initiated with those government departments that may have been affected by the proposed legislation: the Treasury, the Department of Prime Minister and Cabinet, the Ministry of Economic Development, the New Zealand Customs Service, the Department of Internal Affairs, the Department of Building and Housing, the State Services Commission, the Inland Revenue Department, the Ministry of Transport, Te Puni Kōkiri, the Ministry of Justice, the Ministry of Foreign Affairs and Trade, and the Ministry of Agriculture and Forestry for consultation (Ministry for the Environment, 2007). The consultation was also an opportunity for affected departments to inform their ministers on the content and implications for their portfolios.

Concurrently, the MfE produced regulatory impact statements (RIS) to provide a summary of the key information on how the proposed option was the best one (The Treasury, 2007). The information included the following (MfE, 2007d,e).

- A summary of the current situation.
- A summary of the need for government action including the costs and benefits of the status quo.
- Alternative options with details on costs and benefits of each including financial, social, cultural, health, and environmental outcomes.

- The preferred option including a risk assessment, steps to minimise compliance costs and the impact on current regulations.
- The process for implementation and review of the proposed legislation.
- A summary of who was consulted and the key feedback.

The consultation and RIS processes ensured that some rigour was applied to the policy process. The provision of a full cost accounting process that covered not only financial but also social, cultural, health, and environmental aspects ideally provided a holistic approach.

Examination of the RISs (MfE, 2007 d,e) shows a strong bias to the financial costs and benefits, some indicators of social acceptance of some of the proposed measures, but little mention of cultural and health benefits. The environmental benefits were phrased around the vague notion of better use of resources. Risks were only referred to in a very qualitative sense. For example (MfE, 2007e) "*There is a risk that some councils will divert general council funds for waste minimisation projects into other projects when 'per capita' revenue starts reaching them*".

The lack of detailed analysis was due to a combination of factors.

- Government had already made a commitment to waste minimisation legislation so the threshold for acceptance at cabinet level was much lower.
- There was a lack of data to support the case.
- There was a very tight time schedule to produce the material.

Cabinet had the power to lower the threshold for acceptance of RISs, but then had collective responsibility for the consequences, which on this occasion Cabinet did take. One of the reasons for the ready acceptance was the second point which reinforced the case for legislation that contained provisions for data collection. This point was also supported by reviews completed by the Ministry (MfE, 2007b) and the OECD (OECD, 2007).

6.9.1.5 Development of the Supplementary Order Paper

The Cabinet Policy Committee considered the policy paper and RISs before being approved by the full cabinet on 17 May 2007. The approval of the policy enabled the Ministry to proceed to give drafting instructions to the Parliamentary Counsel Office to draft a Supplementary Order Paper that amended the Waste Minimisation (Solids) Bill.

Concurrent with the development of the Supplementary Order Paper, the Select Committee resolved to gain a better understanding of the New Zealand waste industry through targeted business, community and local government input via a series of site visits. The visits enabled more public participation in the legislative process and the Select Committee gained an appreciation of the complexity of the waste industry.

The Supplementary Order Paper was presented to the Select Committee on 20 September 2007 (New Zealand Parliament, 2007), which then put it out for public submissions. This time 125 submissions were received and the Committee heard oral submissions in January and February 2008.

The submissions that were received were largely along the lines that the submitters took on the original Bill. All agreed that the framework proposal that allowed for subsequent regulations to drive the direction was an improvement on the highly prescriptive nature of the original Bill – but then disagreed which portions needed further amendment following positions that had been taken incipiently.

An additional faction emerged from the local government sector. The Supplementary Order Paper prescribed that 50% of the revenue from the levy is allocated to territorial authorities. Regional councils submitted that they should receive funding since many of them were involved in waste activities, even though the Local Government Act (2002) allocated waste responsibilities to territorial authorities. Upon investigation it was found that regional councils engaged variably in waste around the country and hence a unified case could not be made. However, territorial authorities were able to pool their allocations given under the Act and could assume responsibility as a region.

6.9.1.5.1 Changes to the Waste Minimisation (Solids) Bill

All sections of the original Bill were changed through the Supplementary Order Paper. The high level changes to the original Bill are shown in Table 6.14.

Table 6.14. Changes between the original Waste Minimisation (Solids) Bill and the Supplementary Order Paper

Original Bill	**Supplementary Order Paper**
Waste Minimisation Authority	Waste Advisory Board
Waste Control Authorities	Role taken by Territorial Authorities
Prohibitions for disposal of wastes	Incorporated into the Product Stewardship provisions
Waste Disposal Levy	Waste Disposal Levy
Extended Producer Responsibility	Product Stewardship
Organisational Waste Management Plans	Omitted
Public Procurement Policy	Omitted
Public Reporting	Omitted
Sub sections	Reporting an monitoring provisions
Sub sections	Enforcement and offences

Under the changes proposed in the Supplementary Order Paper, the roles of the agents changed considerably. The changes produced a reduction in the proposed bureaucracy levels, and focused on increased integration of agents and media while enhancing cooperation between local government and the business sector.

The Waste Minimisation Authority was to have been a separate bureaucracy set up as an autonomous crown entity under the proposed Bill (similar to the Environmental Risk Management Agency), with decision-making powers and the ability to carry out operations but was changed to the Waste Advisory Board that would provide independent advice to the Minister for the Environment. The Waste Minimisation Authority would have had a single focus and would not provide an integrated approach with the rest of the work that the Ministry was engaged in. It was recognised that the waste work under

this legislation had overlaps with the work on water, air, environmental reporting and local government. Thus, the control of the Act was best placed within the Ministry, which would have the added benefit of being more efficient financially (Local Government and Environment Committee, 2008).

The Waste Control Authorities were removed since the functions were already carried out by territorial authorities and an added bureaucracy would serve no useful purpose. Likewise the omission of organisational waste management plans acknowledged that the bureaucracy needed to monitor these would be significant but contained no imperative to change behaviour (Local Government and Environment Committee, 2008).

Public procurement and public reporting were omitted as it was identified that central government was already engaged in these activities and legislation would not add any benefit (Local Government and Environment Committee, 2008).

The change from extended producer responsibility to product stewardship signified a change in emphasis from the single responsibility of the producer to manage the end-of-life effects to the acknowledgement that the whole customer chain has a responsibility for those effects, preferably achieved through voluntary initiatives. In the event of non-compliance with voluntary initiatives, or even those that become mandatory through regulation, the government is able to initiate regulations under the Waste Minimisation Act (2008) that require products to come under a product stewardship scheme.

The role of voluntary programmes, particularly in product stewardship is undergoing transition. Whereas the MfE was a signatory to the 2004 Packaging Accord (PackNZ, 2004), the change in role for the Ministry to responsibility for accreditation and monitoring of product stewardship schemes under the Waste Minimisation Act (2008) meant that it could no longer be a partner for anything that succeeds the 2004 Accord.

The only provision that was largely unchanged was the Waste Disposal Levy. This was set at $10 per tonne (plus GST) to have minimal effect on business (averaging $57 per year per business) but would provide a pool of money

(estimated at $32 million per annum) to undertake waste minimisation projects. The minimal effect on business contributed to the support from the Ministry of Economic Development for the legislation – a very influential agent from the government's perspective.

The focus on the use of the levy went from setting up organisational waste management plans in the original Bill to supporting waste minimisation in territorial authorities (50% of the levy) and supporting other waste minimisation projects through a contestable fund (the other 50% minus administration costs). The Select Committee were adamant that the levy should be confined to waste minimisation and not go into the Consolidated Fund – with the possibility of erosion of the funds available for waste minimisation over the duration of the Act. Treasury officials had opposed hypothecation on the grounds that it committed the government to future directions of spending, but this did not change the Select Committee's recommendation.

The definition of waste provided the most contention between the various agents. MfE officials provided no definition of waste in the Supplementary Order Paper which meant that a definition relied on a concept of what was waste. This position drew on the Australian experience of the difficulty of creating a definition that was appropriately balanced. The submission process identified that a definition of waste was needed. The available choices were a narrow definition as determined by the Carter Holt Harvey court case (Ministry of Justice, 2007), or a wide definition that could be narrowed in each part of the legislation. The Select Committee opted for a wide definition of waste (Local Government and Environment Committee, 2008).

"waste *means any thing that has been disposed of or discarded; or is no longer required for its original purpose and, but for commercial or other waste minimisation activities, would be disposed of or discarded; and includes a type of waste that is defined by its composition or source (for example, organic waste, electronic waste, or construction and demolition waste)*".

This definition facilitated territorial authorities to acquire information about recycled and recovered materials in their areas through a licensing system provided for in Part 4 of the Act. The definition antagonised industry because

they did not trust the territorial authorities to not use the information for commercial gain. In addition, the scrap metal recycling industry was concerned that if scrap metal was classed as waste it would face trade restrictions on the international market. Political lobbying by the scrap metal recyclers resulted in a changed definition for waste that removed the phrase "*or is no longer required for its original purpose and, but for commercial or other waste minimisation activities, would be disposed of or discarded"* with a new term of 'diverted material'. A new definition of 'diverted material' (*any thing that is no longer required for its original purpose and, but for commercial or other waste minimisation activities, would be disposed of or discarded* (Waste Minimisation Act, 2008)) allayed the concerns of the recyclers because of the effect it had on local authorities.

The balance of power changed such that territorial authorities were no longer able to collect information about recycled and recovered materials in their territories but they were still able to fulfil their obligations under the Act, though some local authorities (e.g. Waitakere City Council) disputed this.

The enactment of the Waste Minimisation Act in 2008 provided the conclusion to an unorthodox process of passing legislation in New Zealand. It was unorthodox in that it was the result of a Member's bill that was supported by the government and finally gained unanimous support from all parties in Parliament.

6.10 The Precautionary Principle

The positions adopted by various agents in negotiations are influenced by factors, an important environmental one being the Precautionary Principle. The Precautionary Principle as set out in Principle 15 of Agenda 21 (1992), states:

"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation".

This has been interpreted widely as in, for example, the New Zealand Waste Strategy (Ministry for the Environment, 2002) as:

"…action must sometimes be taken in the face of scientific uncertainty, especially where there are threats of serious or irreversible environmental, social or economic damage".

Knowledge of the Precautionary Principle by the various agents and its applicability were mixed.

Among central government politicians there was an understanding about the Precautionary Principle, but a philosophical difference on how it should be applied. A senior Labour party politician felt that people would apply it if there were clear environmental impacts demonstrated and a senior National party politician felt that the best motivation to achieve the best outcomes was provided by giving the right pricing signals.

The four local government politicians interviewed understood the concept of the Precautionary Principle. They thought that information alone was not sufficient motivation to apply the principle. Philosophically, information should be sufficient, but in practice they found that did not happen. This was thought to be because the difficulty for business was that applying the Precautionary Principle could affect financial aspects of the business in the short term. While this may be true for small businesses that had so much to contend with as well as delivering their product or service, larger businesses (like Fonterra – see below) need to have a sophisticated perspective on the longer term.

The 11 council waste minimisation officers generally did understand the precautionary principle though one had not heard of the principle. When it came to whether the people could be persuaded to apply the principle through information alone, the responses were more mixed. 36% responded no, 55% responded that there were some occasions when information was sufficient (e.g. for hazardous substances – maybe, but not for waste, or that after having a bad experience it was easier to get a response) and the remaining 9% thought that, from an internal perspective, councils were legally obliged to follow this approach and so they complied.

The council waste minimisation officers did not feel that information alone was sufficient to persuade people to apply the precautionary principle. In addition to information, the mechanisms suggested ranged from the soft approach of

repetitive messaging and reinforcement until it became second nature to do it which also included making it relevant to the individual's situation, through to applying pressure through business mechanisms (e.g. insurance and financial (dis)incentives).

Fonterra environmental managers and managers were asked whether they had heard of the precautionary principle. Only three environmental managers (16%) and one manager (3%) had heard of it. When the concept was subsequently explained to the others they indicated that were applying the Precautionary Principle or that it was just common sense. All of those who had heard of it previously described versions of the above statement, indicating that they knew the concept.

While everyone agreed that information was crucial to the process of applying the precautionary principle, it was generally agreed that information alone was not sufficient to cause change but it was crucial to have it. A lot of the motivation comes from whether the people are prepared to change. One comment was made that a lot of people don't care, but another comment said that if things are approached in the right way people are more apt to make a change. An example was provided by one manager of giving farmers a tangible experience.

Pasture burn from effluent used to be a problem. The use of copper sulfate in the effluent killed bacteria and reduced the effect of pasture burn. Farmers were cautious about the effects of the process and it wasn't until trails worked that they accepted it and now it is widely used. It was also felt by another respondent that a continual reminder highlighting environmental issues through television programming would produce beneficial results.

6.11 Conclusions

The integration of the various agents, central government, local government, business and the community, is critical in the move towards sustainable waste management.

Different agents come from different perspectives which can enrich the path forward and the ability to communicate between them is the foundation to

achieve success. The path to integration of agents is a long term process. Fonterra managers and environmental managers noted that it is useful for regular dialogue to happen between agents as it builds a platform of the understanding of how each organisation operates and the direction each is going.

Further to communication is to adopt a cooperative approach between parties as the best mechanism to enable agents from different perspectives to work together. Fonterra found that bringing people together enables them to feel part of the solution and that their views count when true participation is conducted. In addition, a recognition and understanding of how the different parties operated and the constraints that they had was necessary to gain an insight into the best way to work together and how each could add value to the work of the other. Cooperation can also be very useful in providing direction and support for action.

When issues arose it was useful for both parties to consider how these issues could be overcome to the benefit of both. Fonterra observed that to be able to engage at this level involves transparency and the development of trust between the parties in the relationship. Engagement at the appropriate level between organisations was also a positive way to resolve issues (e.g. manager to manager).

In addition to effective communication to build a relationship it is necessary invest in continuity planning. Continuity can be achieved by having more than one person working on a project, provide for succession planning and by having a *good* document management system. Other measures that can help continuity include the provision of best practice guidance and secondments between organisations.

Where trust had developed in a relationship, Fonterra found that a failure was seen as an opportunity for improvement, regardless of any legal measures that may have been undertaken. To reduce the occurrence of failure required the provision of good systems, in which case the dysfunction tended to be due to human causes rather than systemic ones.

The legislative framework for waste management in New Zealand requires agents to work towards an integrative approach, and to consult with their communities in a meaningful way. The days of agents being able to work in isolation and prescribe how they run their territories are rapidly closing.

From a government perspective in working with business, the relationship often started at achieving compliance. Once a business accepted that it had to meet compliance (whether through supportive or adversarial means), the offer of information and tools to help the business out of non-compliance started to build a better working relationship. Once compliancy was achieved, providing support and an advisory service for efforts to go beyond compliance was a very useful mechanism to encourage the business to go beyond the bare minimum standards.

Engagement with community groups presented similar opportunities to dealing with governmental organisations. Cooperation was seen to be a key element. Major differences between governmental parties and community groups occurred in two areas: commitment and knowledge. Fonterra detected that many people who were part of community groups had definite positions on issues, but often had limited technical knowledge. One way Fonterra observed to get through the difficulty was to work with representatives of the community groups to get them to understand the technical issues so that they could convey these to the wider audience.

From a council perspective, there is no obvious relationship between population size or type of council and the potential for integration, except that smaller district councils are better poised in that they have more overlap in the headship of their waste units. The local councils that have been proactively involved in Zero Waste have been generally those situated away from urban centres.

The waste management plans and the structures of local councils suggest that most are not looking at integrating waste management beyond solid waste. Even in the area of solid waste, the accent has been on diversion by recycling alone, rather than in conjunction with waste reduction at source. It

appears that up until now local councils have interpreted integration in a very narrow sense. However, the message has been given by the government that they must broaden their thinking.

For progress to be made, staff need to feel that they matter and their viewpoint is taken into account. Over the years, the change from confrontation to consultation in Fonterra has resulted in greater productivity and less downtime.

Behaviour change takes time and effort. A systems approach to effect a behaviour change is one that is evident from the enactment of the Waste Minimisation Act (2008). The cycle of paying a levy when landfilling waste to receiving money to undertake waste minimisation programmes provides a direct reinforcement cycle.

Direct reinforcement is an important part of the leadership that is needed to achieve a change in waste behaviour. Various agents have roles in leadership. The government leads through providing the long term vision and the tools to carry the vision out on a macro scale. Regional councils and territorial authorities provide leadership through translating national initiatives into local outcomes. Business provides leadership through adopting best practice. Within business leadership must come from the top – chief executives determine the direction and the success of any programme by either championing it or letting it wither. Fonterra recognised that setting up processes within the business planning cycle that require assessment of waste issues is one way of embedding waste issues into a company's psyche. This also gives an integrated approach with a consistent message that each sector reinforces the others.

To take an integrated approach means that a step into the unknown is needed. Taking this step means taking the associated risks and applying the Precautionary Principle. The precautionary principle is one that is well understood across the New Zealand scene, including Fonterra, and one that is applied at various levels. It is a constant balancing act between action and inaction and each situation is unique. Assistance in reaching an appropriate

answer is provided through the use of a risk management matrix, but this requires expertise in dealing with similar situations.

The needs for agents to become better positioned to implement integration of waste management are:

- Politicians who are motivated to lead the way;
- Education for the next generation to grow up with the message that waste is not acceptable;
- Time for the changes to show results;
- Stability of employment so that those who are willing to experiment creatively and from an informed position, are not penalised if everything does not bear instant fruit, and
- Rewards and recognition for those who succeed.

The key to an integrated approach is to get the various agents working in the same direction, even when not all of the outcomes are evident and the path to reach the known outcomes is uncertain. This can only be achieved through a cooperative approach and trust between the parties.

Chapter 7: Conclusions

7.1 Purpose

The purpose of this chapter is to draw conclusions which come from answering the questions posed in Section 7.2. The context includes a restatement of the research questions and answers to those questions arising from the thesis proper. Following this is a further set of conclusions (7.3) which demonstrate the contribution to knowledge made by this thesis.

7.2 Context

The management of waste has been an issue since humans started living in settlements. Ancient civilisations deposited their wastes outside the settlement boundaries. Some of the earliest records show that cities like Mahenjo-Daro in the Indus Valley had an organised solid waste collection system over 4000 years ago to reduce the problems of odour and disease (Vesilund et al., 2002). Organised sewage disposal can also be observed from the same period in Crete (Vesilund et al., 2002) and air pollution was an issue over 700 years ago in London (Molak, 1997). The progression of waste management started with personal health issues (Ponting, 1991) and progressed to community health issues (e.g. landfill proliferation and sewage treatment odours)

Where regulation impinged on a waste disposal activity, some organisations changed disposal routes (e.g. landfill disposal to incineration) (Clayton and Radcliffe, 1991) which reinforces the belief that waste management issues are inter-related and need an integrated approach. Turner and Powell (1991) observed that the simplest form of integration is through utilisation of a waste management hierarchy; a framework that can be used to optimise disposal and diversion options as well as in the design phase of new waste management programmes as defined by UNEP (1996).

Integrated waste management has occurred using a single medium. Examples include solid waste (McDougall et al.(1991), Thornloe et al. (1997) and Evans and Seadon (2003)), aqueous waste (McDonough and Stewart (1971) and Downing et al. (2002)) and atmospheric emissions (Oshita et al.

(1993) and Defra (2005)). Multi-media integrated waste management was introduced by Dow Chemical Company in the 1930's (Calvin et al., 1988) and was adopted by the European Union with the Integrated Pollution Prevention and Control Directive (1996) (Council Directive 96/61/EC), The multi-media approach has been extended to energy (Amundsen, 2000) with the acknowledgement that working with energy requires a different expertise than the other three media. Management of wastes through a life cycle approach (integrated chain management) lends itself to a multimedia approach (De Groene and Hermans, 1998).

The application of voluntary, informational, legislative and economic tools to implement an integrated waste management approach requires the adoption of a framework that is flexible enough to allow for changing needs during the lifetime of an integrated waste management programme (Robèrt et al., 2002).

The role of agents in integrated waste management is fundamental to success. Government (central and local), business and the community come from different perspectives and thus have different drivers. The drivers (economic factors, political, socio-cultural and technological (Stone, 2003b) operate in combination which provides a greater momentum for change. Overall responsibility lay with the government (Elkington, 1997), but identification and inclusion of stakeholders are important aspects for an integrated waste management system. Common stakeholders include: governments, investors, managers and users (represented by communities or community organisations) (Chua et al., 1992).

Integrated waste management requires the participation of all sectors utilising appropriate tools in a way that allows for changing circumstances. An example of an integrated waste management system that grew in an unplanned manner is Karlundborg (Denmark) (Chertow, 2000). This thesis takes the process one step further.

The thesis has addressed the question "Can integrated waste management contribute to sustainability, and if so, how"? The response was approached through the focus on systems methodology and the integration of processes

through the waste management hierarchy, tools and agents arising from the other six primary research questions raised in Chapter 1. These six primary research questions and their answers are summarised below and then further elaborated in the following section 7.3.

Question: What does integrated waste management mean in different societal contexts?

Answer: Analysis of literature shows that elements of integrated waste management exist, but the conscious integration of media, agents and tools to improve waste management has not occurred.

Historically the management of waste has been through single waste steams without consideration of cross-media effects. The advantage of the clarity achieved through managing a single waste stream disguises the need for contemplation of the restrictions of the approach. This single stream approach enables the transfer of waste from one medium to another to be seen as a solution to a waste issue.

The adoption of a multi-media approach highlights the problems of waste which encourages examination of the actual sources of waste in the life cycle of a product and methods to improve resource efficiency.

Integration of waste streams increases the complexity of the situation so a systems approach that enables adoption of a long-term, global perspective is an appropriate methodology.

Evidence of integration that has occurred includes the following.

- Multi-media approaches have resulted in more cost effective waste management options and the emergence of previously unknown solutions. For example, Fonterra's reuse of cow water in which it is used to preheat raw milk (Chapter 4).
- An integrated approach enables cross subsidisation of some parts of the operation that are a liability, but overall still deliver a profit. Dealing with the waste from each part of an operation benefits by considering it in context with linked processes and accordingly provided

reinforcement to the process. During development of Fonterra's recycling programme some recycled materials were initially subsidised by revenue generating materials (e.g. dirty cheese wrap subsidised by cardboard) until a return for the cheese wrap was found.

- A range of tools are appropriate in any given situation to maximise the benefits of waste management. The application of the tools will change as the life-cycle of the producer changes. The tools can provide integration of systems and processes. This can be demonstrated by Fonterra which uses an amalgam of tools for environmental product development (Table 5.23) grouped into tools that: shift to a systems focus, develop products with a reduced environmental impact, improve the environmental performance of the business and improve the triple bottom line sustainability performance of the business.
- The integration of authorities simplifies the process and allows consistent messaging. A societal change is signified by regulatory change, which encourages further societal change in a continuing spiral. This is evidenced by the passage of the RMA (1991) and the subsequent changes in the quality of waste discharges from Fonterra sites (Chapter 5).
- Agents are more responsive to voluntary approaches, which are powerful motivators when supported with the portent of mandating tools (e.g. legislation). Identification and inclusion of appropriate stakeholders is important to success of the implementation of tools. The Dairying and Clean Streams Accord to promote sustainable farming in New Zealand is an example where Fonterra has voluntarily worked with the government and regional councils to improve fresh water stream quality throughout New Zealand (Chapter 5).

Integrated waste management is a pathway to sustainability. To move towards sustainability requires an approach that integrates processes that are components of a bigger, more complex picture – a systems approach.

Question: How does a systems approach assist the movement to a sustainable waste management system?

Answer: The traditional approach to waste management is to treat it separately to the production cycle and only consider change when duress is applied. The easiest path that minimises the effort needed to demonstrate change is to adopt a reductionist, single stream approach. Such a narrow approach is inadequate to achieve a sustainable outcome because its implementation typically includes elements that take a very narrow focus.

- When a waste is identified the solution is to concentrate on the individual problems rather than the efficiency of the whole waste management system. As wastes are classified Fonterra seeks a solution to divert each one or make it less concentrated.
- The focus on the short term solutions rather than sustainable ones results from concentration on individual problems. The consequence of the focus is that waste management becomes a series of unrelated actions that lack cohesion and may weaken the system.
- Solutions that invoke irreversible actions are often taken as those solutions seek to correct the immediate problem rather than choosing mechanisms to manage emergent consequences from any procedures. For example, Auckland City introduced waste bins for domestic collection that increased capacity six-fold and did not anticipate that disposal quantities would increase.
- The desire to achieve a quick solution produces a misunderstanding of the time taken for effects of interventions to show. As a consequence stronger actions are implemented resulting in an overshoot to the desired results as the original intercessions take effect. This is demonstrated by the New Zealand Waste Strategy targets having two reviews within four years of adoption.
- Each intervention has side effects. A reductionist, single stream approach often ignores or underestimates the side effects from intervention. In the 1990s Fonterra's predecessors reduced milk packaging by replacing reusable glass bottles with HDPE bottles and waxed cardboard containers. Public backlash forced the company to

set up a recycling scheme for the HDPE, which was shipped overseas for processing, but the waxed cardboard still goes to landfill.

- There is a focus on collection and analysis of inappropriate data. Data collection and analysis is an important tool to measure progress, but the choice of data needs to be relevant and sensitive to indicate trends. For example, Fonterra collects a wide range of data on wastewater discharges and reports it on frequencies that range from daily to annually as shown in Table 5.5.
- To achieve a quick result there is a reliance on linear projections from contemporary events. Short term changes are not good indicators of long term trends in waste management. This is demonstrated by projections used by the Ministry for the Environment for waste quantity trends in New Zealand where a five year interpolation shows a 4.2% increase, a ten year interpolation showed no change and a 25 year interpolation showed an average 6.2% increase per annum.

A waste management system is an example of a complex adaptive system and accordingly a systems approach to waste management will produce a waste management system with the characteristics below.

- Negative feedback loops dominate positive feedback loops. The advantage of negative feedback is that is provides elements of self monitoring and self-regulation, thus providing a degree of control over the system whereas positive feedback drives the overall direction of the system. For example, Fonterra has many resource consents in New Zealand that allow for discharge of wastewater onto farmland, rather than polluting rivers or the ocean (positive feedback). However, restrictions on individual parameters like BOD force Fonterra to treat wastewater or utilise components more effectively before discharge (negative feedback).
- The robustness of the system does not depend on physical growth. The dependence on physical growth is not sustainable since the aim of modern waste management is to reduce the quantities of waste. Modern methods of waste management rely on better utilisation of materials to provide value added products. For example, Fonterra has

a long term byproducts industry built from utilising milk wastes more effectively as shown in Table 5.24.

- The focus is on processes, not products. Societal pressures and economic markets advantage changes in end-of-life usage of wastes and thus targeting products is an inflexible focal point. Fonterra collects solid waste and recyclable materials in the same manner, but they go to different endpoints.
- All components of the system (products, functions and organisational structures) are adaptable and multi-purpose. The allowance for integration of components enables the most efficient usage of resources. For example, Fonterra uses waste hot gases in heat exchangers to preheat incoming milk.
- Waste is eliminated through diversion and reduction at source. The recognition of waste as a resource opens up the market for further development and provides pressure for more efficient use of those resources. This is demonstrated by Fonterra which has a long term commitment to waste reduction as shown in Table 5.24.
- Symbiotic relationships are utilised to the communal advantage of all parties. Symbiotic relationships enable a system to operate and allows for the 'win-win' outcomes that enhance those relationships and build trust among the participants. An example of this is the relationship between regional councils and Fonterra where in many cases the relationship goes beyond compliance. Fonterra benefits through lower compliance costs and a larger number of marketable products, and the region has cleaner waterways.
- System components utilise feedback for planning to model biological systems. Modelling biological systems requires that resources are used efficiently and within the carrying capacity of the system – both for extraction and end-of-life processes.
- Leverage points are employed to effect system change. Judicious use of leverage can be used to accelerate desirable change in a waste management system resulting in a more sustainable system.

A systems approach to metamorphose to a sustainable waste management system utilises leverage points with increasing strength going down the list.

- By changing the parameters of the waste management system, the system can be made more effective. The measurement of parameters is most effective when used to corroborate evidence from one of the other leverage mechanisms below. For example, by measuring waste quantities and looking for ways to reduce the amount going to landfill, Fonterra discovered that large quantities of recyclable material that could provide an income stream were ending up at landfills. Diversion reduced the costs of landfilling and provided other income streams.
- The alteration of material flows and stocks increases perception of the system's impediments and limitations. Alteration allows for adjustment of the waste management system to provide the least strain on the system and therefore increase efficiency. This can be demonstrated by Fonterra's Operations Journey programme (Chapter 5) where one of the components is to de-bottleneck plants to increase the efficiency of the production process.
- Application of negative feedback loops moderates uncontrolled growth and future collapse of the waste management system. Negative feedback loops provide a degree of self monitoring and self regulation as noted above, which requires less interference to the system from the system designer and consequently smaller overshoots. For example, negative feedback loops from water quality measurements are used by Fonterra to adjust their processes to achieve optimal product manufacture.
- Induce positive feedback loops to provide the overall direction to the waste management system. When the positive feedback loops are unchecked (by negative feedback) the result is destruction of the system. For example the glass recycling situation in New Zealand (Chapter 3) and Fonterra's role as a member of the Packaging Council.
- The acquisition of new, relevant parameter information monitors trends and increases the accountability that can be attributed to individuals or groups. This can be demonstrated by Fonterra's measurement of their solid waste and the subsequent introduction of a recycling scheme.

- Alteration of the scope, boundaries or liberty of the waste management system alters the basic rules of the system. The rule-maker thus has significant power over the waste management system and provides the direction of the system. An example of scope change is the Auckland City Council's 50% reduction of mobile garbage bin size that resulted in an instantaneous increase in recycling and 33% reduction in waste quantities.
- Permit self organisation of the waste management system. The power of self organisation enables the system to create whole new structures and behaviours and to change any aspect in the above points. This can be shown by Fonterra which decided to implement a solid waste recycling scheme and the change in behaviour throughout the company as sites bought into the scheme (Chapter 4).
- Set goals that are resilient and adaptable to changing circumstances. For example, a goal of waste reduction isolates the system from the production system, but a goal of resource efficiency includes the whole production system and the supply chain through to the end-of life phase. For example, Fonterra's eco-efficiency standard provides a comprehensive set of goals that go beyond waste reduction (Chapter 5).
- Alteration of the waste management system model can be accomplished by the system designers. While remaining within the set paradigm, the ability to adjust all the preceding leverage points provides a powerful mechanism to achieve change. This is demonstrated by the adoption of the New Zealand Waste Strategy (2002) published by Ministry for the Environment that had an overall goal of "*moving towards zero waste and a sustainable New Zealand*". This continues to set the path, seven years after adoption.
- Adoption of a new model that achieves a more sustainable waste management system is reliant on the ability of advocates to realise that a new system model may be superior to achieve desired progress. For example, Fonterra was influenced by a member of the New Zealand Business Council for Sustainable Development to change its paradigm

from cheapest large scale production to *sustainable* cheapest large scale production.

Question: How can a waste management hierarchy be used to manage waste in an integrated manner?

Answer: A waste management hierarchy provides a convenient guide to options for a holistic approach to waste management. Part of the evaluation of options requires a consideration of the environmental, social and economic impacts of the product or service. The use of a waste management hierarchy can highlight the benefits and detriments of choosing various options.

- Operation at the pollution prevention level of the hierarchy (prevent and reduce) involves exertion to modify behaviour but it produces better resource efficiency and greater durability of products. The diversion of waste materials from wastewater to products by Fonterra is an example of operating at the pollution prevention level.
- Diversion (reuse, recycle and recover) is often easier to implement, has lower commencement costs and produces an income stream. All of these factors are conducive to management cooperation and have been successfully applied at Fonterra across the media (Chapter 4).
- Organisations implementing environmental impact reduction commence application of the waste management hierarchy on the medium that provides the greatest driver for efficiency. The descending scale of priorities for Fonterra are those that firstly had the greatest legal and cost impacts and secondly the potential for long term reputational change, particularly if adverse.
- Positive feedback from the results of initiatives generates enthusiasm to expand to other media and finally recognise approaches that manage cross-media benefits. Collaborative processes that involve recognised expertise are favoured for developing solutions as are replication of proven results. The Fonterra experience was that when a target of 75% diversion for solid waste was reached, senior management saw the benefit of striving for a 90% diversion rate.

A waste management hierarchy is a useful tool to provide a framework to investigate solutions in conjunction with other tools.

Question: How are tools used to manage waste in an integrated manner?

Answer: An integrated suite of tools provides an indispensable element to effectively manage waste. The conventional approach to waste management is to move from management of careless dumping to treatment or containment before the introduction of recycling and undertaking reduction of wastes at source.

Development of tools is dependent on an amalgamation of approaches.

- Policy direction and legislative tools are formulated by government in consultation with stakeholders to build consensus (e.g. The New Zealand Waste Strategy (2002)). For waste the policy framework customarily commences with a voluntary approach incorporating informational and educational tools. This starts to build consensus in the population. Where these approaches are insufficient to achieve the desired behaviour changes legislative tools fulfil the gap (e.g. the Waste Minimisation Act (2008)).
- Tools that enhance financial performance or mitigate financial disincentives are preferred by industry. Voluntary mechanisms are favoured by Fonterra (e.g. membership of the Packaging Accord) as they either enable Fonterra to develop tools that are tailored to their needs or allow them to procrastinate.
- Business tools to handle waste management issues frequently start with identification of desired changes and targets of at an elementary level and increase in complexity as experience is gained. For example, Fonterra focused on wastewater diversion for a long time before applying the principles to solid waste and air emissions.
- As complexity increases more sophisticated tools that provide for an integrated approach (e.g. the ISO 14001 Environmental Management System) provide a framework to which other tools are utilised as the need arises.

- Tools are exercised at different times in the lifecycle of a programme. System tools to define the scope and direction are often used at the beginning of a programme and tools to measure or mitigate waste management issues are used as appropriate throughout the life of a project as demonstrated by Fonterra (Table 5.23).
- Results are often reported in absolutes without any context to the physical, societal or environmental conditions. These conditions can change quite significantly with small changes in distance. A contextual approach has the subsequent effect of moving a business's accent from product sales to service provision.

Question: How do agents coordinate to manage waste in an integrated manner?

Answer: The process to integration of agents is a continual mechanism which is enhanced by a number of behaviour characteristics on the part of central government, local government, business and community agents.

- The mandate to engage in a process to manage waste in a more integrated manner must originate with the chief executive. This was the experience with Fonterra.
- The ability to communicate between the agents and within agent organisations is the foundation to progress. For example, Fonterra interviewees rated inclusiveness and openness top of their list in effective approaches to engage the community (Table 6.12).
- Behaviour change takes resources. Regular dialogue constructs a bond that leads to an understanding of positions and directions for each agent.
- A cooperative approach that is inclusive enables agents to contribute at an early stage of a project to achieve more robust solutions and build support for those solutions. This is exemplified by Fonterra interviewees who put cooperation with central and local government, and the community as vital to make progress (Chapter 6).
- Dealing transparently when managing issues and looking for mutually beneficial solutions (win-win solutions).

- Engagement at the proper level between organisations. This was experienced by Fonterra interviewees who noted that senior managers should engage with senor people at Ministries and the Board should engage with Ministers for the greatest effectiveness.
- Build resilience in the relationship by adopting a plan for continuity in the event of personnel changes through team involvement, document management, best practice guidance and secondments between organisations. The lack of continuity was most often levelled at central and local government who do not seem to be able to adapt to the high turnovers experienced in those organisations. Fonterra, who had more of an internal change in positions, did not experience the same level of criticism from other organisations.
- The provision of good systems so that failure is not inbuilt. For example, Fonterra built in significant reporting, measurement and monitoring systems to warn of actual or impending failure (Chapter 5)
- When failure occurs use it as a mutual opportunity for improvement. This is demonstrated by responses from regional council officers who noted that Fonterra were proactive at reporting incidents and reacted quickly to clean up the situation as well as determine the root cause so that steps could be taken to ensure that repetition did not occur.

In addition to the common elements for agents to successfully integrate waste management, agents have targeted methods to enhance relationships.

- The local government-business relationship often starts at achieving regulatory compliance; potentially an adversarial process. The offer of information and tools proves to be successful and once compliance is achieved support to go beyond compliance is efficacious. This has been the experience with Fonterra.
- The provision of technical knowledge and working with representatives of community groups to assist their understanding proves to be successful by Fonterra as community groups often have determined positions on issues but limited technical knowledge.

- Cooperation across waste streams and work priorities in central and local government produce mutual benefits and enhance resource efficiency.
- The cascading effect from central government to Fonterra is most productive when each agent utilises their appropriate level of influence.
- Central government provides the long term vision (e.g. New Zealand Waste Strategy (2002)) and tools to act nationally (e.g. Waste Minimisation Act (2008)).
- Local government translate countrywide initiatives into local impacts.
- Fonterra adopts best practice to align with local and national initiatives.

7.3 Conclusions and the Contribution to Knowledge

The primary question addressed in the thesis was “Can integrated waste management contribute to sustainability, and if so, how”?

In its simplest form sustainability refers to an ecological balance through avoidance of the depletion of natural resources (Oxford, 1995). The implication from this definition is that sustainability has time and space dimensions. Sustainability is something that will continue for a period of time and at one or more locations (where locations can be local or societal (e.g. countries or continents)). Closely related to sustainability is the concept of sustainable development which is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987). Within the definition are two key concepts: the needs of the world’s poor which should have priority and the limitations of technology and social organisation to adequately service the environment’s ability to meet present and future needs (World Commission on Environment and Development, 1987).

Approaches to sustainability can develop from a bottom-up process, a top-down process or a combination of both. A bottom-up process follows a community’s lead whereas a top-down process imposes a government’s desires. A combination allows for the government to set a framework that

determines the direction and the community to adapt that framework to meet its needs.

An integrated waste management approach provides the flexibility to manage the complexity that comprises a modern waste management system. In its simplest form, an integrated waste management approach consists of a framework based around a waste management hierarchy. As experience develops and conditions change due to community, business or political pressures, an integrated waste management system adapts to encompass a multimedia approach. A range of tools provided through an integrated approach enables the system to adapt to changing circumstances in the political, business and community subsystems.

The purpose of an integrated waste management system is to eliminate waste by improving resource efficiency and taking a life cycle management approach. The utilisation of an integrated set of tools enables the waste management system to focus on the system processes to increase resource efficiency (e.g. reduction and reuse of materials), not necessarily the fabrication of new products. As a waste management system matures opportunities for large changes present themselves through what Kuhn (1996) describes as a scientific revolution. These are often brought about by a community that demands action to reduce the environmental impact of waste. At such times the system responds by changing the system model as a whole or altering the system within the set paradigm. An integrated waste management system toolbox provides a variety of tools that enable change at the system level as well as at the very smallest subsystems. The application of tools requires the knowledge and skills of agents to be able to apply the appropriate tools.

Successful integrated approaches to waste management require agents to work together in a coordinated manner. Central and local government agents need to be able to gather feedback from politicians, business and the community to enable construction of policy frameworks and informational/educational campaigns to effectively manage waste. Business needs to effectively use tools to implement an integrated approach that aligns

with community needs, government requirements and international best practice. The community provides the voice to signal the overall direction in waste management. All three sectors need to work together in a cooperative, transparent manner to reach the best solutions for resource efficiency.

Successful integrated approaches require understanding and strategic leadership at a senior level within any organisation. Applying a systems approach to waste management requires an increased level of competence on the part of management and the establishment of transdisciplinary teams (teams with different skills and knowledge but using the same approach to work on projects).

An examination of current practices in this thesis, internationally and in New Zealand by central government, local government and Fonterra, has demonstrated that there is a considerable gap between the present sporadic integration of waste management and a fully operating integrated waste management system that leads to a more sustainable society. The thesis provides a way forward to improve resource efficiency through an integrated approach to waste management.

Finally, a systems based exploration into integrated waste management reveals the systemic nature of the New Zealand waste sector. This intuitively suggests that a systems approach would be beneficial when working in this environment. Yet, attempts to treat the sector as systemic are rare and have even been deliberately resisted by those charged with leadership in this area. Herein lies an important future research topic – what are the long term implications of these actions?

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