Centre for Advanced Engineering
University of Canterbury

Our Waste: Our Responsibility

Towards Sustainable Waste Management in New Zealand

PROJECT OVERVIEW

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University of Canterbury
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Disclaimer

It will be noted that the authorship of this document has been attributed to the many individuals and organisations who have been involved in its production. While all sections have been subject to review and final editing, the opinions expressed remain those of the authors responsible and do not necessarily reflect the views of the Centre for Advanced Engineering.

Centre for Advanced Engineering

Establishment

The Centre for Advanced Engineering was founded in May 1987 to mark the centenary of the School of Engineering at the University of Canterbury. It was established by means of an appeal fund launched in conjunction with the centennial celebrations. To date, approximately $2.3 million has been raised, contributed by 150 corporate donors and 450 individual donors. The earnings from this capital sum are used to run the Centre and fund its activities.

Objective

The objective of the Centre is to enhance engineering knowledge within New Zealand in identified areas judged to be of national importance, and to engage in technology transfer of the latest research information available from overseas. The Centre is not concerned with basic engineering research, but more with the application of research findings to engineering problems.

This objective is achieved for each major project by bringing together a selected group of practising and research engineers and experts in the particular field from both within New Zealand and overseas to:

- consolidate existing knowledge
- study advanced techniques
- develop approaches to particular problems in engineering and technology
- promote excellence in engineering
- disseminate findings through documentation and public seminars.

The Centre thus creates for each project a unique forum that facilitates co-operation among industry, the engineering profession and university research engineers.

Function

The Centre is controlled by a Board of Directors comprising representatives from industry, the engineering profession and the University of Canterbury, chaired by Mr Peter Menzies.

The Board selects the title of each project undertaken by the Centre and approves the level of funding. A Steering Committee is appointed, initially to carry out detailed planning for the project and then to provide overall direction. The Steering Committee then appoints Task Group Leaders and a Project Manager.

Detailed work on the project is carried out on a voluntary basis by the members appointed to each Task Group. The Centre arranges to bring to New Zealand, at the appropriate time, several Visiting Fellows who work with Task Group members and contribute to the project the latest available information from overseas.

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Contents

1. INTRODUCTION

1.1 Project Selection

In recognition of an increasing environmental awareness in New Zealand, the Centre for Advanced Engineering chose waste management as the theme of its second major project. It was considered appropriate for the engineering profession, in particular, to take a leading role in efforts to improve the environment, and committing the Centre to this project was seen as a significant step in that direction.

The general purpose of the Waste Management Project is to contribute to the better management of wastes in New Zealand.

Better waste management means not only appropriate management of wastes already produced, but, more importantly, aims to avoid or reduce wastes at their source. Better waste management in this sense means less wasting of resources and minimising the risk of pollution arising from wastes.

The word "better" is used because there needs to be increased progress towards the goal of sustainable management of wastes.

The aim of society to move towards sustainable management is reflected in the Resource Management Act 1991, which has sustainable management of natural and physical resources as its main goal.

The project addresses some key technical, engineering and scientific matters which along with social, environmental and economic information, are required in order to develop appropriate solutions to waste management issues.

1.2 Scope

A Steering Committee comprising many of the leading people working in the waste management field was established in August 1990. The Steering Committee selected four topics considered to be of national importance in the field of waste management:

- Waste Minimisation Practices
- Hazardous Waste: Appropriate Technologies for New Zealand
- Landfill Engineering Guidelines
- Waste Management in Relation to Water Supplies

The topics chosen address important matters that in the past have not always received adequate attention in New Zealand. For example, considerable effort has been put into recycling waste materials, but there has been little guidance or visible

examples of waste reduction at the source. Similarly, knowledge of appropriate technologies for treatment of hazardous wastes remains uncertain and needs to be much better understood in the New Zealand context.

Smaller landfills, with few exceptions, remain little better than dumps and the big strides in landfill practices made overseas in the last five to ten years continue to be poorly understood or applied here.

The protection of drinking water supplies has been threatened by poor understanding of diffuse, multiple sources of pollution and how wastes, discharged to land or air, can affect water. The separate control regimes for air, water and land that existed until October 1991 did not allow a full examination of the cross-media effects of pollution.

A more detailed outline of each topic, as well as a summary of the findings, is outlined in later chapters of this overview report.

Because waste management in New Zealand is inextricably linked with Maori values, risk to the economy, the environment and public aspirations, the importance of these concerns needs to be recognised. In order to effectively address these vital issues, contributors were sought to provide insights into these issues, which apply to all aspects of waste management.

1.3 Project Organisation

The organisational structure of the project is shown in Figure 1.

Significant planning steps were as follows:

- A Steering Committee, set up in August 1990, decided the topics and the scope of the project.
- Four overseas Visiting Fellows were selected, each a recognised leader in their particular field.
- Task Groups, each with a leader, worked on each topic on a voluntary basis.
- Preliminary reports were prepared by each Task Group and were sent to and reviewed by the Visiting Fellow associated with each group.
- A three-day Workshop in November 1991 was attended by the Visiting Fellows and many project participants. Task Group reports were discussed, changes agreed and conclusions and recommendations formulated. The Workshop, which was a highlight of the Project, provided a forum where a very active interchange of ideas and opinions occurred.
- The preparation of the Overview and Project Reports followed.

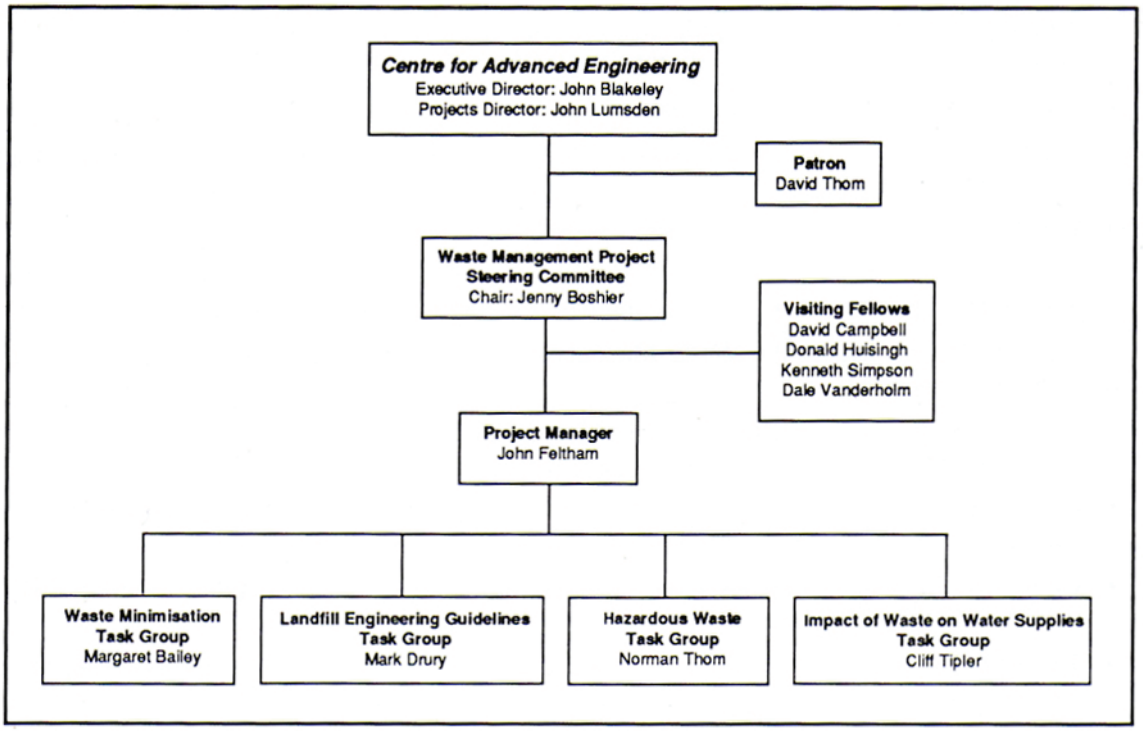

Figure 1: Project Organisation Chart

1.4 Report Structure

The work of the project is published in two volumes: a Project Overview and a Project Report, entitled ***"Our Waste: Our Responsibility"***.

Overview

The overview is intended to convey the essential elements of the Waste Management Project to a wider audience. This document consists of a brief outline of the more important aspects of the project together with a short summary of the work of each of the Task Groups and concludes with a commentary on future directions for waste management in New Zealand.

Project Report

The Project Report presents the work of the project in detail and is organised as follows:

Part 1 - Common Themes in Waste Management

The information in Part 1 is applicable to all four of the topics chosen and has, for the most part, been provided by the contributing authors. The themes covered are: Maori concerns, risk assessment, legislative framework, and public participation, all in relation to waste management.

Part 2 - Waste Minimisation Practices

This topic brings together case studies of waste minimisation practices from different sectors of the economy: the domestic, community, commercial, industrial and primary sectors.

Part 3 - Hazardous Wastes

Because there are many possible ways of managing hazardous wastes, this topic assesses those technologies considered appropriate for New Zealand.

Part 4 - Landfill Engineering Guidelines

There are no recognised guidelines currently available for the siting, design, operation and after-care of landfills in New Zealand. Such guidelines are presented in this section.

Part 5 - Waste Management and Water Supplies

The potential in New Zealand for a link between these two subjects is examined. Waste management practices that minimise the risk of polluting water supplies are recommended.

1.5 Achievements

The general objectives of the Centre for Advanced Engineering have been achieved for this project in the following ways:

Technology Transfer

The first achievement of the project is technology transfer, which can refer to the new application of an existing technology, or the exchange of knowledge between people and countries.

The Waste Management Project has provided a means for technology transfer by bringing together people who have interest in and knowledge of the subject, and providing the opportunity for them to work together.

The chance to bring overseas experts to New Zealand as Visiting Fellows has also provided a means of achieving technology transfer at an international level.

Consolidate Knowledge

The second achievement of the project has been to consolidate the sum of knowledge in New Zealand on the selected topics within the field of waste management, and to enhance these, where appropriate, with up-to-date trends and practices from overseas.

This has been done through the establishment of Task Groups whose members were selected for their knowledge of the topics under study. The Task Groups were set up to bring together existing information, and to identify and attempt to fill any gaps in available information through research and input from the Visiting Fellows.

Dissemination

The third achievement of the project is the dissemination of the knowledge gained during the project. The nature of the project, and the teamwork involved, means that over 100 key people now have a greater understanding of the topics and, furthermore, have a network of contacts to assist them in the future.

The main vehicles for dissemination of the project findings are this Project Overview and the Project Report, which contains detailed information on each of the four waste management topics.

Seminars to disseminate the Project's findings and recommendations are also planned.

2. AN INTEGRATED APPROACH

2.1 Principles of Waste Management

We all discard quantities of so-called rubbish that represents real waste in the form of wasted materials and wasted energy, and in the process create waste disposal problems to be passed on to future generations.

Discussion of the underlying principles of waste management has never ranked highly in New Zealand. It is only recently (since 1991) that the Ministry for the Environment, the department responsible for the government's environmental policy, has produced a discussion document that suggests waste management solutions should reflect, as nearly as possible:

- natural processes of breakdown and renewal;
- life-cycle approaches which consider all aspects of resource use, waste generation, storage, transport, treatment and disposal;
- waste management strategies that work towards longer-term goals, rather than simply addressing the immediate needs.

The four topics chosen for the Waste Management Project illustrate the integrated nature of waste management and also reflect features in the life-cycle of materials.

- Waste minimisation practices are concerned with raw materials, their conversion to products, and opportunities for reducing or preventing the wastes that thereby arise.
- Hazardous waste treatment is one of the more important steps that need to be taken before wastes can be safely reused or sent for disposal.
- Good landfill design and operation are the keys to waste disposal that minimise risks to present and future generations.
- The study of wastes in relation to water supplies highlights how wastes returning to the environment may cause pollution that could threaten public health.

2.2 Waste Minimisation - Always First

In the pursuit of sustainable management of wastes, one view is that the ultimate goal should be total waste prevention. That goal may be unattainable but preventive options should always be the first priority.

The long-term storage of wastes is becoming more expensive and difficult and this, together with increasingly more stringent treatment requirements, makes the commonsense advantages of waste minimisation more obvious.

Waste minimisation practices, when implemented, will lead to the disposal of less waste. This can be achieved through implementing the three Rs:

- Reduce
- Reuse
- Recycle

The emphasis in this project is on the reduction of waste at source, especially during production, since this is clearly seen as the first option. However, a broader view of waste minimisation would encompass the whole life-cycle of products and the many opportunities for waste minimisation that arise at various stages of product life.

Where source reduction has been implemented to its fullest extent, or when information on implementation has been unavailable, "reuse" should be given priority as the next best option.

Only if wastes cannot be reduced or reused should the "recycle" option be considered.

Disposal of less waste has a direct impact on the other three topics in this project.

2.3 Treatment of Wastes and Disposal of Residues

There will always be a continuing need to dispose of some wastes while recognising that the amount of wastes produced can be minimised. The intent and effort must then be to treat wastes and dispose of residues in such ways that any risks to the environment are within acceptable limits.

Two of the Waste Management Project's topics focus on treatment and disposal of residues: Hazardous Waste — Appropriate Technologies for New Zealand and Landfill Engineering Guidelines.

These topics are closely related because landfills should be considered as inescapably; physical, chemical and biological reactors that provide on-going treatment of wastes. If properly designed and operated, landfills can also play a useful role in the treatment of suitable hazardous wastes. Landfills need to be viewed, therefore, both as treatment facilities as well as places of disposal.

Disposal is a term that must be used with care. Placing wastes in storage, including containment landfills where segregation of wastes and exclusion of water are intended to prevent any chemical or biological action occurring, is not disposal; it is simply storage. Someone in the future will have to decide what to do with wastes so stored, as the containment cannot last forever.

Disposal inevitably means the ultimate return of substances to the environment. What we can and should do is convert substances that can harm the environment into ones that do not. This means returning substances to the environment at rates that enable assimilative processes in nature to work without adverse effects. It is convenient to call the substances that are finally disposed of after treatment, residues.

The appropriate treatment of hazardous waste is a part of the necessary process of creating less harmful residues, and together with properly conducted landfilling, can control what, how and where residues are returned to the environment.

2.4 The Return of Residues to the Environment

The return of the residues originating from treated wastes to the environment will involve all media: water, air and land. These residues will arise from chemical and biochemical reactions that are changing wastes into forms compatible with their return to the environment for ultimate disposal.

The residues may arise from activities that include chemical treatment plants, anaerobic bioreactions in landfills, aerobic composting, incineration, and the biological treatment of liquid materials including farm and other agricultural wastes. Other residues may enter water, either directly or indirectly, via the land. Soils are capable of retaining and changing some residues and provide residue disposal too, but the principle of not overloading natural soil ecosystems must be respected.

The topic of Waste Management in Relation to Water Supplies looks at one aspect of the return of residues to the environment, with a special focus on the protection of drinking-water supplies and hence on human health.

The emphasis on protecting human health from residues arising from wastes raises a different issue from those discussed above: namely, the microbiological safety of water supplies.

Chemical residues that may enter drinking water and be consumed over a lifetime are important also, especially if they are among those identified as being of health concern in the New Zealand Drinking Water Standards.

However, microbiological safety is always of the most acute concern because water supply systems can rapidly spread disease-causing organisms, or pathogens, to everyone served by the supply, and so potentially infect populations.

Pathogens are not residues formed during the treatment of wastes; they are present from human and some animal sources in the wastes, generally liquid sewage wastes and sludge. Pathogens do not necessarily have a harmful effect on the natural environment but are only of concern if people or, in some cases, animals are exposed to them in quantities and circumstances that might cause disease.

In the context of the safe return of residues to the environment, the presence of pathogens is of special concern for human health and provides an example of wastes that have not been changed fully into residues that are safe in all circumstances. Special care to avoid such occurrences is necessary where drinking water supplies may be placed at risk.

3. COMMON THEMES IN WASTE MANAGEMENT

Although the Waste Management Project has concentrated on some key technical aspects, links with the wider community have also been recognised. The information provided by the contributing authors, and found in Part 1 of the Project Report, is summarised in the following sections.

3.1 Maori Interests

An important aspect of any waste management project is to take into account the concerns and ideas of Maori people, the tangata whenua. The imperative for so doing stems primarily from Article 2 of the Treaty of Waitangi but also from the requirements of Section 8 and Section 6(e) of the Resource Management Act 1991. The guiding principle of this legislation is sustainable management of natural and physical resources, a concept that is not new to the Maori people who have traditionally practised it. There is a clear duty stated in the Resource Management Act 1991 to consult with Maori and to consider Maori interests.

Maori interests in respect of waste management are concerned with protection of natural, physical and spiritual resources. The Waitangi Tribunal was set up to hear claims of actions or inactions by the Crown that were declared as being prejudicial to Maori interests and to make recommendations to Government for remedy.

The Tribunal has heard claims on the effects of sewage and industrial waste on the natural resources of particular Maori tribal groups. Waste management projects have the potential to alter the environment, affecting not only a localised area but sometimes a wider region and more than one community.

Not only do Maori people want to be consulted about proposed actions or plans concerning waste management but, more importantly, they prefer to take a proactive role in influencing the outcome of a project or plan. In the past, Maori people have felt that not enough attention has been paid to their holistic regard of the environment.

It is not possible to adequately detail Maori concerns with waste management projects in a document such as this. The concerns of the tangata whenua in each locality will not be identical, but will reflect the richness of tribal and family history and tradition as kaitiaki (guardians) of their environment.

It is important that those working in the waste management field accept Maori values as a valid system of guiding principles in the management of wastes. It is incumbent on them to recognise the importance of the Treaty of Waitangi to

tangata whenua and to set up appropriate means of dialogue and consultation. Without proper attention to these factors, progress will be slow.

The presentation of Maori interests and values relating to waste management at the Project Workshop, held in November 1991, was unexpectedly enhanced by Professor Donald Huisingh, one of the Visiting Fellows. Professor Huisingh, who is part Sioux Indian, reminded the audience that values from thousands of years of human existence are being rediscovered, and that we must "tune in" to these age-old appropriate technologies. Examples of this are seen in ecosystem management, and the widespread use of plant extracts in medicine.

3.2 Risk Assessment

A risk is the chance of some undesired event arising from some source of hazard and the effect of that event, and the possible extent of the consequences, for people and the environment.

In other words risk has two major components; a probability of occurrence and also a consequence, which has magnitude of loss or perhaps gain.

Risk assessment has two main components:

- Risk Estimation: the identification and estimation of the probability and magnitude of the consequences of a hazardous event.
- Risk Evaluation: the determination of the significance or value of the estimated risks to those people concerned with or affected by the decision.

Risk assessment should always be followed by risk management. The risk management stage consists of decision-making with the aim of reducing, eliminating or controlling the risk.

The use of risk assessment techniques in waste management, as in some other disciplines, is still relatively new. Sometimes the best that can be done is to identify the hazards and seek means of reducing or mitigating them.

A precautionary approach in the face of uncertainty is clearly wise, and single lines of defence against hazards should not be relied upon. An example of such an approach is the concept of "multiple barriers" to the contamination of water supplies, employing not only treatment and disinfection but careful protection of water sources and experienced management and monitoring.

Whatever the approach to assessing risks, three issues are always present. Who estimates the risk; who evaluates what it means to society; and what is an acceptable level of risk and to whom?

The answers to such questions, and several others, need to be more clearly understood by experts, who have the task of risk estimation; decision makers, who have the function of evaluating risk; and society in general, which must decide on what level of risk is acceptable.

These and other questions are addressed in Part 1 of the Project Report in a chapter on perception and assessment of risk. Risk assessment is also specifically

referred to in Part 3 of the Project Report on hazardous wastes and will be inherent in all aspects of waste management, from the siting of landfills to the protection of water supplies. A requirement to apply a risk assessment approach is also embodied in the Resource Management Act 1991 through the meaning of "effect" (Section 3).

An example to illustrate the usefulness of the technique of risk communication is presented in Part I of the Project Report.

3.3 Legislative Framework

In New Zealand there is no one piece of legislation that provides a comprehensive framework for waste management.

The Local Government Act 1974 has provisions which enable (but do not require) local authorities to establish and operate water supplies; sewage collection, treatment and disposal facilities; and to collect and dispose of refuse.

Under the Health Act 1956 it is the duty of every local authority to promote and conserve the public health within its district. This includes the provision of waterworks, sanitary works, provision of facilities for the collection of refuse, control of offensive trades and control of nuisance.

The Resource Management Act 1991, although not providing for waste management planning specifically, does have a number of mechanisms that encourage this activity. Regional Councils must prepare a regional policy statement to provide an overview of the resource management issues of the region. These issues should include waste management.

The role of city and district councils in waste management relates to the use, development or protection of land and associated natural and physical resources (Section 31). This, together with a requirement to have a district plan, should encourage district and city councils to make proper provision for waste management.

There are many other Acts that are relevant to waste management issues. For example, hazardous substances are presently managed by eight different agencies through more than 15 separate pieces of legislation.

The legislative framework for each of the four topics of this project is outlined in relevant chapters of the Project Report.

3.4 Public Participation

Planning for waste management facilities usually requires that an assessment of environmental effects be submitted with an application for a resource consent.

The first stage in any process to assess the environmental effects of a waste management facility is consultation. An initial consultation with all the

stakeholders should assist in identifying the significant issues likely to be of concern. Consultation with tangata whenua (the Maori people of the area) is a necessary part of the process.

The Resource Management Act 1991 does not require an applicant for a resource consent to undertake consultation, but it does raise the issue in the Fourth Schedule as a matter that should be included in an assessment of effects on the environment.

In a recent High Court decision Mr Justice McGechan made the following points about consultation (Air New Zealand Ltd. and Ors. *versus* Wellington International Airport):

- *consultation must be a reality, not a charade;*
- *the party consulted must be adequately informed;*
- *the party obliged to consult must have an open mind and be ready to change; and finally,*
- *sufficient time must be allowed.*

A chapter on the importance and practice of public participation can be found in Part I of the Project Report.

4. WASTE MINIMISATION PRACTICES: REPORT SUMMARY

4.1 Objectives

The Task Group on Waste Minimisation Practices sought ways to reduce waste with the following mission:

To identify and describe management practices and technologies that will minimise the production of wastes in New Zealand, and suggest means for their implementation.

To fulfil its mission the Task Group set itself a number of detailed objectives and the results of this work are to be found in Part 2 of the Project Report.

Information was obtained about techniques that have already been used in New Zealand. A number of case studies were chosen as models to show how waste prevention and minimisation practices have already been implemented. When information could not be obtained about New Zealand practices, references were made to suitable overseas technologies and waste management practices.

4.2 Report Outline

Waste-Producing Activities

Official New Zealand statistics provide information about the relative importance of various activities to the economy. Data on wastes generated from such activities were obtained from a national compilation of regional waste surveys. This information was used to decide on those waste-generating activities to be investigated for any potential to reduce wastes.

Activities in New Zealand were divided into five general sectors, using chapter headings of the New Zealand Official 1990 Year Book:

- primary
- industry
- commercial
- community
- domestic

Part of the problem in moving towards waste prevention and minimisation is the way the New Zealand economy operates. The Task Group considered how to achieve the so called "greening" of the market economy. The existing market includes a host of hidden cost subsidies that tend to support disposal (what the hierarchy of principles for waste management describes as the *"option of last resort"*)

rather than prevention of waste. Market pricing deficiencies need to be addressed before expecting broad adoption of waste prevention and minimisation practices.

Primary Sector

The primary sector is a major feature of the New Zealand economy, producing the largest part of our export earnings. Both the meat processing and dairy industries have made some progress in reducing their wastes and at the same time obtaining added value from by-products.

A meat processing case study considered the savings that could be achieved for a lamb and beef export works by screening wastewaters to recover protein and fat materials.

A major case study examined the dairy industry from grass to ship. The overall process was considered to be:

grass cow shed tanker factory store ship

The purpose of waste reduction in the dairy industry is to turn a maximum amount of grass into milk and then into saleable product. This can be achieved by carrying out mass balances on the stage-by-stage basis shown above to identify inputs, desirable outputs, wastage and waste materials.

The dairy processing industry has an advantage in that all components of the wholemilk can be converted into saleable product. Waste prevention and minimisation principles can be applied at both the processing and packaging stages. To ensure that there is no contamination or damage in getting the product to market, container specifications must be adequate.

Forestry, an increasingly important sector in New Zealand, is one where further work on waste prevention and minimisation is needed to consider the use of wood wastes during production and milling. Examples where the pulp and paper industry has reduced its wastes are given.

Fishing and fish-processing wastes are being reused for fishmeal and as animal food. One innovative use studied was the co-composting of sawdust and fish waste to produce a fish-based compost for sale in 50 litre bags.

Residues from growing and packing fruits and vegetables is an increasing problem. The kiwifruit industry rejects huge quantities of substandard fruit each year. The dumping of reject fruit has resulted in significant pollution incidents. Continued investigation is needed to ensure that this valuable resource is better utilised, in particular for making by-products.

Industrial Sector

The industry sector includes those making a substantial contribution to the domestic economy, as well as those that produce exports. Manufacturing industries include both large and small industries. Many of the wastes produced by this sector have the potential to be hazardous if not disposed correctly. Incentives to reduce wastes are often greatest in this sector, and research and development

has produced appropriate clean technologies. Waste audits have shown that there are substantial monetary savings to be made by minimising industrial waste.

Energy conservation opportunities are, quite properly, often connected with waste reduction. New Zealand's consumption of energy per unit of GDP is much higher than many other industrialised countries, reflecting the need to consider energy efficiency measures as well as waste prevention and minimisation. Case studies have been produced by the Energy Management Demonstration Programme of the Ministry of Commerce.

One area of waste prevention and minimisation that is often forgotten is emissions to air, especially fugitive emissions. Information on means of estimating and eliminating these wastes is provided.

Four case studies from different industry sectors are presented:

- Waste reduction in the gold-mining industry;
- Dust losses from a cement kiln;
- A small electroplater;
- A dry cleaning business.

Information on waste prevention and minimisation in the steel and tin can industries, machinery repair, surface-coating, solvent-using, printing and dry-cleaning industries is presented.

Commercial Sector

The commercial sector covers a wide variety of activities, most of which affect every one of us in daily life. This sector is a major producer of wastes, especially paper. Two case studies of waste reduction in an office complex and in a large office building are presented to indicate that significant savings in paper use and waste disposal costs are achievable.

Information about waste prevention and minimisation practices were obtained for parts of the transport, communications, and banking sectors. Tourism is one area in which the production of wastes must surely be closely managed if the *"clean, green"* image promoted by New Zealand exporters is to be maintained.

Community Sector

The community sector provides those services required by a complex modern society. This is another sector that is not usually targeted for waste reduction. Organisations making up this sector often have special needs for waste disposal.

Information on waste prevention and minimisation practices for central and local government offices, defence establishments, health services, education institutions, a prison and recreational facilities was obtained.

A case study examined the conserving of food resources during a hui (a Maori social gathering) and another looked at the Eco-school Project being implemented at Ashhurst Primary School.

Domestic Sector

The domestic sector is one where people can make an individual contribution to reducing wastes.

Case studies of three flats and two homes where the residents tried to reduce their waste and become environmentally conscious buyers are presented. The amount of waste prevention and minimisation varied greatly.

A garden case study showed that unwanted garden material could be reused rather than being sent to the tip.

4.3 Conclusions and Recommendations

- The information gathered showed clearly that some individuals, social groups, companies and organisations are beginning to institute waste reduction measures. However, many more are not, often because of lack of knowledge about what to do, what it will cost and how to get started.
- The management of waste needs to be given a higher priority. Waste prevention and minimisation are essential practices for New Zealand if we are to achieve sustainability as required by the Resource Management Act 1991. These concepts warrant promotion and encouragement because they contain elements of wise use of resources, environmental protection and economic benefit. Guiding cultural and ethical principles should also be developed that incorporate the philosophies and values of the tangata whenua of the country.
- The full implementation of waste prevention and minimisation practices will require a major change in societal values and attitudes. Such fundamental change will need to be the subject of debate and discussion within New Zealand society. One of the most effective means of finding and imple-menting solutions which will lead to sustainability is the concept of cleaner production.
- Two major recommendations are proposed in order to facilitate this change in attitude and to move towards the implementation of solutions. These are concerned with the setting up of a Cleaner Production Foundation. Such a facility is considered necessary to provide New Zealanders with the tools to work simultaneously towards the goals of economic and environmental sustainability. The concept of cleaner production is discussed further in Chapter 8 of this Overview and mechanisms aimed at implementing the recommendations are being investigated.

5. HAZARDOUS WASTE - APPROPRIATE TECHNOLOGIES FOR NEW ZEALAND: REPORT SUMMARY

5.1 Objectives

A major issue of environmental concern shared by most countries throughout the world is the management of hazardous waste. The more industrialised countries in North America, Europe and Asia, particularly, are recognising the magnitude of the problem and are adopting control measures.

The objective of the Task Group on Hazardous Waste - Appropriate Technologies for New Zealand was:

To collectively indicate ways in which hazardous waste management programmes appropriate for New Zealand can be developed and resource requirements identified.

To fulfil its objective the Task Group identified a number of topics requiring specific study in the New Zealand context, and the results of this work are to be found in Part 3 of the Project Report. Part 3 is designed to stimulate thinking on local hazardous waste problems and encourage an informed approach to their management. It is not intended to act as a Code of Practice itself, but should provide a good basis from which such codes and hazardous waste management plans could be developed.

5.2 Report Outline

Hazardous Waste Management

The management of hazardous wastes should be considered in the context of waste management as a whole. The work of the Task Group should therefore be read and considered in conjunction with all parts of the Project Report. It cannot be taken in isolation, as it has been written with the expectation that the reader will have also considered aspects of waste minimisation, possible effects on groundwater quality and the requirements for landfilling, in specific cases.

Indications of Hazardous Wastes in New Zealand

The collection of information on hazardous wastes in New Zealand was attempted through regional waste surveys prompted by the Department of Health in the 1980s. As a starting point for the work of the Task Group, the Centre for Advanced Engineering commissioned the reappraisal and reclassification of the data on a common and national basis consistent with the OECD system.

Indications from the reclassified data, notwithstanding reservations about its reliability, were that some 100,000 tonnes of potentially hazardous wastes are produced annually in New Zealand. The amount was assessed by the Task Group to be in line with quantities that could be expected, based on experience from, for example, some Canadian provinces.

Definition and Classification

The presence of a toxic substance in a waste may, or may not, make the material a hazardous waste. The form and concentration of the toxic substance in the waste determines how hazardous the waste will be in terms of human health and the environment. The Resource Management Act 1991 stresses the importance of the environmental effects and, given this emphasis, it would seem appropriate for New Zealand to adopt an approach to hazardous wastes that identifies those that are potentially hazardous by the quantities and states of the toxic substances they contain.

The Task Group has developed detailed guidance on the identification of waste hazards, and a system of definition and classification for use in the proper identification of wastes in surveys, storage and transportation, and prior to treatment and disposal. The guidance will complement the national system for waste surveys being promoted by the Ministry for the Environment.

Treatment Processes and Technologies

Treatment has been defined by the Task Group as any physical, chemical or biological change applied to a waste material prior to ultimate disposal in order to reduce any potentially harmful impact on the environment.

The range of known treatment processes of hazardous wastes is extensive. The Task Group aimed to identify processes and technologies available worldwide and to note those that are presently available in New Zealand and are applicable to the New Zealand waste stream.

The guidance embraces 21 physical treatment processes, 6 processes of fixation or stabilisation, 13 groups of chemical treatment, and 6 biological processes. These are described and set out in tables against the types of wastes so that the treatment options may be readily examined.

Some hazardous waste disposal methods are already required, or have been recommended, in New Zealand for 11 commonly arising waste types. Requirements or guidance is presented in Acts, Regulations, Waste Management Guides, reports of the National Environmental Chemistry and Acoustics Laboratory (NECAL), National Radiation Laboratory (NRL) reports, and a New Zealand Standard. Part 3 of the Project Report summarises these.

The Task Group concluded that for each particular hazardous waste situation the most suitable treatment option will depend on many factors such as location and volume of the waste, the distance from treatment facilities, economic factors, environmental health and safety factors, performance factors, regulations, bylaws and community aspirations.

All the potential treatment methods should be identified, including thermal processes and land treatment methods, and all necessary information should be obtained about those processes. With that information and the factors set out above, a balanced decision should be sought making use of a team approach using all the available expertise. Paramount should be the search for a treatment and disposal option that avoids both short- and long-term adverse environmental effects.

It was noted by the Task Group that many of the technologies discussed are, or have been, used in New Zealand to treat hazardous wastes.

Incineration and Other Thermal Processes

Thermal processes treat wastes by the controlled application of heat in order to convert the wastes into less hazardous forms. It is applicable to most organic and/or combustible wastes. The process is not generally applicable to metal-containing wastes as the metal will not be destroyed by this (or any other) process. For some wastes, incineration may be the only or preferred treatment option, but only under strictly defined conditions and with the use of suitable facilities.

The Task Group also identified classes of wastes for which incineration may be applicable and has described the critical parameters necessary to ensure complete combustion. The merits of mobile versus fixed installations were considered.

The Task Group examined thermal treatment processes that are practicable in some existing installations in New Zealand such as industrial boilers that could accept small amounts of selected hazardous wastes. The Task Group concluded that cement kilns technically provide quite suitable conditions, with minor modifications, for the destruction of many of the hazardous wastes produced in New Zealand for which there are otherwise no present alternatives for destruction.

There are a number of other thermal treatment processes including molten glass (vitrification) and plasma systems, and the usefulness of these in the New Zealand context is outlined.

The Task Group concluded that:

- The most suitable immediate approach for the destruction of those wastes in New Zealand where the use of thermal processes is regarded as appropriate would be to make maximum use of existing facilities such as industrial furnaces and cement kilns.
- Special facilities may be needed for small quantities of the more difficult wastes but the capital and operational costs that would be involved hardly seem justified. These wastes should be securely stored if overseas disposal becomes no longer acceptable.
- A full environmental risk assessment is required for specific proposals. These may incorporate trial burns.
- A detailed monitoring programme incorporating continuous and batch testing of emissions, ambient environmental effects, quality control and auditing must be established and performed during waste destruction operations.

- Extra effort will be required to gain public support and acceptance of the use of thermal processes for hazardous waste disposal.

Land Treatment, Disposal and Containment of Hazardous Wastes

Land treatment and disposal of hazardous wastes encompasses a number of processes including land farms, controlled co-disposal in municipal landfills, surface impoundments, sub-surface disposal, and containment facilities.

The extent to which treatment is provided by such systems varies. For example, land farms utilise the surface soils to detoxify, immobilise and degrade wastes through natural biological, chemical, and physical processes. The remediation of soils at contaminated sites is a similar process.

Co-disposal uses the same natural processes but within the confines of carefully designed and managed municipal landfills. Here the wastes are selected and combined in a controlled and balanced way with domestic and similar wastes within a municipal landfill so that natural attenuation processes are not overwhelmed and are able to provide treatment of the hazardous wastes.

The Task Group paid particular attention to co-disposal and has set out in Part 3 of the Project Report detailed guidelines for co-disposal in New Zealand.

In contrast to co-disposal, hazardous waste containment facilities (HWCFs) aim to segregate wastes to prevent any processes taking place. The emphasis is on storage in a containment without change to the contents. Some intractable wastes, ones for which there is presently no available treatment or means of disposal, may have to be placed in HWCFs but the imposition of strict after-care in perpetuity is a serious problem that will be exacerbated if the containment begins to fail with age. Guidance on suitable wastes, site selection, design, operation and after-care is offered.

Warehousing and Storage of Hazardous Waste

Warehousing and storage of hazardous waste may arise during all operations after generation and before ultimate disposal. Management practices, risk assessment and risk reduction are applied to eliminate foreseeable incidents that could cause injury or damage, and minimise impacts if incidents do occur. The principles of safe storage, management practices, risk management and community awareness have been considered by the Task Group and a comprehensive check-list developed.

Emergency Preparedness

The purpose of the chapter on emergency preparedness is to provide guidelines and reference information to enable codes of practice and emergency plans to be prepared in a form suitable for particular industries, regions, districts or communities.

Topics include the essential features of an emergency plan, emergency teams, alarm initiation, on and off-site emergencies, outside help and mutual aid, protection of records, communication with the public and the media, and the relationship with emergency services.

5.3 Conclusions and Recommendations

- The highest achievable goal in the management of potentially hazardous wastes is the elimination of the production of such wastes, or reduction in the quantity or hazardous characteristics of those that are unavoidable.
- The OECD system of waste classification is appropriate for adoption and use in this country, with minor modification.
- Progress in the management of these wastes requires consistent definitions and an established system for waste tracking and recording.
- There is a range of established treatment and disposal options that can appropriately be used for the management of hazardous wastes arising locally.
- The potential for major incidents involving these wastes, and the effects from any such incidents, can be minimised by good management, anticipation and proper pre-planning.
- Certain hazardous wastes can be satisfactorily disposed in an appropriately designed and operated landfill.
- Suitable storage facilities need to be provided for those hazardous wastes for which there are no appropriate means of disposal presently available.
- Existing thermal facilities should be considered, subject to the necessary environmental requirements, for the incineration of those wastes where such methods are suitable.

6. LANDFILL ENGINEERING GUIDELINES: REPORT SUMMARY

6.1 Objectives

The main objective of the Task Group on Landfill Engineering Guidelines was:

To provide comprehensive guidelines on the disposal of wastes in landfills for the use and benefit of planners, designers, operators and regulators.

In achieving this objective the guidelines aim to:

- Detail key processes, procedures and best practices for the development and use of landfill sites to ensure that all relevant and essential components and issues have been adequately addressed for all types of landfill.
- Assist in, but not substitute for, the process of developing the site-specific design, operation and management criteria necessary to obtain and comply with all required consents and approvals, and related conditions.

These guidelines are not a substitute for the engagement of personnel with the necessary expertise and experience essential for the correct development, operation and management of all types of landfill — new, existing or closed.

This work is reported in detail in Part 4 of the Project Report.

6.2 Report Outline

Integrated Waste Management

The philosophy of integrated waste management is based on the hierarchical principles of waste minimisation, reuse, recycling, and resource recovery prior to the disposal of final waste residues.

Although waste minimisation will increasingly reduce the amount of wastes requiring disposal it will not eliminate the need for landfills. Landfills will continue to be an essential component of any integrated waste management plan in the foreseeable future.

Key Landfill Factors

In preparing the Landfill Engineering Guidelines it became clear to the Task Group that landfill issues pivot around five key factors: waste composition and definition; landfill processes; waste retention; process control; and monitoring.

A landfill should be considered as an active, complex, waste treatment bio-reactor, not merely a waste storage site. Waste materials in landfills undergo natural changes involving a mix of biological, physical and chemical processes. The complex processes are controllable and need to be managed during the operational life of the landfill.

The waste, which is the feedstock of the processes, needs to be characterised in a way that is helpful to the management of both the anticipated landfill process activity and the emission products being formed. Hence, the most suitable future approach could be to classify wastes as biodegradable, inorganic, inert, and so on. Such characterisation is different to the traditional approach which has focused on the source of wastes, such as domestic or industrial.

The processes of degradation produce landfill gas and leachate, both of which have potential environmental impacts. Retention of the waste and leachate are necessary until they have changed from being in their most concentrated state to one where controlled release into the environment is possible without lowering environmental quality. Landfill gas needs to be managed for safety reasons and/or collected for use as a fuel.

Monitoring is integral to good landfill practice. The need to be certain that systems are working as designed is paramount to the integrity of any landfill.

Landfill Sizing

Acceptance of the five key factors outlined above will accelerate the already evident trend towards fewer, but larger, landfills by taking advantage of economies of scale. The optimum size that determines economic viability depends on many factors including the population and its distribution within a locality.

Integrated Waste Management Facilities

The Task Group foresees an increasing trend towards facilities that provide at one site the means of disposal for all wastes generated within a region. Such an integrated facility could include recycling, composting waste, by-product manufacture, incineration, and landfill for unusable residues.

Performance Standards

Stringent performance standards are recommended by the Task Group for all landfills, whether or not they accept hazardous wastes. This advice is based on several important factors including the inevitable presence of hazardous materials in domestic wastes, and indications from current research that degradation products from conventional community landfills, and from landfills used for controlled co-disposal of hazardous wastes, do not differ in their potential to cause environmental impact.

Landfills and Legislation

The legislative framework by which landfills are governed is very complex, even after the passing of the Resource Management Act 1991. Part 1 of the Project Report considers the legislation in relation to waste management in general, and Part 4 includes greater detail of the legal requirements pertaining to landfills.

Landfill Siting

The success of any landfill rests heavily on the planning and preparation carried out before any landfill is constructed and used.

The technical arguments of site selection and siting criteria must be constantly balanced with economic and social aspects. This may mean that although all site options being considered may exhibit satisfactory engineering qualities, public perception and other values may ultimately be the deciding factors in determining which sites are acceptable.

Part 4 of the Project Report sets out guidelines on the site selection process, technical and non-technical investigations, economic assessments, and a range of siting criteria.

Landfill Design

Five key factors affecting landfill issues have been outlined above. The first of these affecting the design of a landfill is the nature of the waste that will be accepted. That, in turn, leads to the anticipated process activity in the landfill and the emission products that will occur.

A primary objective of the design process is to protect the environment around the landfill. The design should ensure that the landfill operates as a controlled reactor in which the complex processes already outlined are optimised so that the final residues are rendered benign to the surrounding environment.

Specific design considerations to achieve the required outcomes range across many factors including the control of access to the site, final use and landform, site capacity and staging of development, water control and water balance to promote desired reactions, leachate generation and systems for its management, leachate retention and liner systems, landfill gas, cover systems, stability and settlement, closure, after-care and monitoring. These matters are fully considered in Part 4 of the Project Report.

Operation

Operational guidelines applicable to the New Zealand situation have been prepared by the Task Group for modern, state-of-the-art, medium to large-scale landfill sites, which can be utilised for controlled co-disposal.

Key management elements of operation include a management plan and the clear identification of responsibilities.

Factors relevant to competent operation include a raft of control measures to categorise wastes entering the site (to promote the desired treatment processes), the exclusion of certain wastes, co-disposal loading rates and burial techniques, cover, water and leachate control, gas control, systems maintenance, monitoring, records, health and safety procedures, and the maintenance of nuisance-free site conditions and good access.

Access on site roads must be available in all weather. To minimise nuisance and undesirable environmental degradation from a landfill site, consideration and good operation is needed to provide screen planting and bunding, and the control of litter, dust, pests, noise, birds and fire.

After-care requires a closure plan with control and monitoring, post-closure maintenance, and registration of the site in the Hazards Register with the local authority.

Existing Landfills

Guidance has been provided by the Task Group on existing landfills with the aim of establishing what, if any, adverse effects are being caused, and whether or not the site should be closed, or is able to be upgraded to acceptable standards.

An evaluation process is suggested to assess existing landfill sites, their management and operation, the processes at work, and the types and quantities of wastes at the site. Identification of the shortcomings should lead to decisions on whether to remediate part or the whole of the site, or whether to close the site. Depending on the degree of environmental degradation being caused by an existing site, any of the available options may involve significant works.

Closed Landfills

There may be a large number of closed sites in any particular region. Some may have been closed for such a time that they pose no potential impact to the environment, while others may be of great concern. A screening process is suggested to focus investigations on the sites of greater concern. Evaluation is similar to that for existing sites.

6.3 Conclusions and Recommendations

- Landfills are, and will continue to be, an essential component of an integrated waste management plan. All wastes directed to landfills for disposal should have first been subjected to waste minimisation, reuse, recycling and resource recovery practices.
- The guidelines developed are applicable to all landfills whether they are small rural landfills or large metropolitan landfills.
- The siting of landfills requires careful examination of many parameters to establish all the potential impacts that such a facility could have on the

surrounding physical and social environment. The deciding factors in site selection may well be the expectations and resources of the affected community.

- The design of a landfill should ensure that it operates as a controlled reactor in which biological, biochemical and physical-chemical interactions are optimised in assisting the degradation and stabilisation of wastes.
- Integrated waste management facilities, with the capability of disposing of all wastes generated within a region, should be considered.
- Public participation is essential from an early stage in the decision-making process for a new landfill.
- Existing landfills should be assessed for adverse effects on the environment and appropriate action taken.
- Any modern, well-managed, community landfill can be considered for the co-disposal of certain hazardous wastes.
- Operation and management of a landfill requires a substantial commitment of resources to achieve the required standard.
- The minimum time period for after-care of a landfill site is 30 years.

7. WASTE MANAGEMENT IN RELATION TO WATER SUPPLIES: REPORT SUMMARY

7.1 Objectives

Waste management is becoming a major focal point in New Zealand. The environmental consequences of mismanagement are now socially unacceptable. The return of residues to the environment can affect both land and water resources if not managed appropriately.

Waste management is not only concerned with protecting natural resources, it is also concerned with protecting and promoting public health. One important linkage between public health and waste management is water that is used as a water supply source. Thus, this work has examined the management of wastes as it could affect existing or potential water supplies.

The scope of the work was to examine the impacts of various waste management practices on water supplies. The focus was restricted to examining impacts on water only insofar as they affect the potential of that water to be used for future human consumption.

The objective of this work was:

To identify and describe waste management practices and technologies that will ensure that the quality of New Zealand's water supply sources are protected and, where necessary, enhanced.

This work is described in detail in Part 5 of the Project Report.

7.2 Report Outline

Seven topics were selected that were considered to be the main areas of concern throughout New Zealand. Topics were selected to cover a range of impacts on both surface and groundwater supplies.

Domestic Sewage

The first waste sector covered is domestic sewage. As there is considerable information already available on the treatment and disposal of such wastes in general, this chapter concentrates on small community and on-site disposal systems. This is particularly relevant considering the many small inland towns and localised residences that are located within water supply catchments for other communities.

Landfill Leachate

Leachate from landfills is the second topic covered. Whilst landfills should ideally be located outside water supply catchments, there are many examples in New Zealand where this is not the case. Thus the potential exists for impacts on the quality of groundwater, in particular, at many localities throughout the country. This chapter provides an essential linkage with the work on Landfill Engineering Guidelines (Part 4).

Agricultural Waste

As New Zealand relies heavily on the primary production sector for its economic survival, agricultural wastes are addressed in two chapters. The first covers the major point sources of agricultural wastes, such as those associated with feedlots, piggeries, dairy sheds and silage pits. The second examines non-point source agricultural wastes, on which very little work has been done in New Zealand to date, and the impacts the many diverse practices involved have on the quality of our water supplies.

Primary Processing

Waste management in the primary processing industries is examined in depth in two chapters covering meat and dairy processing. Due to the intensive nature of the production processes in the former, meat processing plants are acknowledged as one of the major waste producers in the country. The nature of wastes from the dairy industry, another major export earner, are more varied due to to the many different ways in which dairy products are processed.

Hazardous Wastes and Pesticides

The final chapter addresses hazardous materials and pesticides, the wastes from which pose a very high risk to human health. A number of different hazardous wastes and pesticides are considered together with their impacts on water supplies and human health, and an essential linkage to Part 3: Hazardous Wastes, is thus provided.

Impact on Water Supplies

Each chapter discusses the characteristics of wastes, their potential to impact on water supply sources, the technologies available for their treatment and disposal and, finally, limitations in the current technologies or practices identified.

Where possible, case studies have been used to demonstrate the potential of wastes to impact adversely on water supplies or, alternatively, the potential of technologies to protect water sources.

7.3 Conclusions and Recommendations

- The major risks to the integrity of New Zealand's water supply sources arise from either toxic substances or pathogenic organisms.
- There are many examples of waste management practices that have the potential to discharge large quantities of nitrates (predominantly) into groundwater aquifers. Current technologies are adequate to minimise the effects of nitrate contamination from point source discharges. However, because of our diverse rural economy, current agronomic practices present a greater risk to groundwater supplies from nitrate contamination. Part 5 of the Project Report discusses the need for greater awareness of how nitrate nitrogen affects our water supplies.
- Other toxic substances which may arise through the use or abuse of hazardous chemicals also present a risk to water supplies. The work of the Task Group demonstrates a need for preventative measures to protect water supplies. Education and forward planning are proposed to minimise the risk to water supplies.
- Pathogenic organisms within domestic sewage are known to cause infections in humans. There is little understanding of the fate of many pathogenic organisms contained within wastes once discharged into the environment.
- It is noted that current technology relies on the use of indicator organisms that signal when a water supply may be unfit for human consumption. The use of such indicator organisms may not, in fact, offer the degree of protection that society expects.
- There is also little available technology in relation to cross-species infections from various organisms. This has been identified as an area in need of future research.

Part 5 of the Project Report has been written to provide an up-to-date overview of waste management issues in relation to water supply. It provides sufficient background material to enable professionals working in this area to make informed decisions relating to waste management.

While Part 5 is not a state-of-the-art technical review of waste treatment technologies, it does provide an overview of current problems and technologies in the New Zealand context.

It is essential to remember that this is only a part of the whole. This part must be read in conjunction with the work on Waste Minimisation, Landfill Practices, and Hazardous Waste Technologies.

8. TOWARDS SUSTAINABLE WASTE MANAGEMENT

8.1 From Pollution Control to Pollution Prevention

The Centre for Advanced Engineering believes it is important to emphasise what is arguably the most important outcome from this project. This is the realisation that there is an increasing trend amongst the developed countries of the world away from pollution control, or so called *"end-of-pipe solutions"* involving treatment of the problem, towards pollution prevention through waste reduction at the source, reuse and recycling.

The argument for this approach is so compelling that it seems obvious and yet it is not yet widely advocated in this country. Most significantly, it is extremely relevant to New Zealand's Resource Management Act 1991, which sets new standards in the efforts to achieve a sustainable future.

Throughout the project the centrality of waste minimisation to the whole subject of waste management thus emerged as a strong theme that underpinned work on the three other topics.

Much of the impetus for this emphasis on waste minimisation came from Professor Donald Huisingh, one of the Visiting Fellows, from Erasmus University in the Netherlands.

In Europe it has been demonstrated that many companies were wasting raw materials and generating unwanted side products because they were often unaware that improvements in product design and industrial processes could mean not only that less waste was produced, but that significant economic benefits were also possible.

Many of the companies that took part in demonstration projects in the Netherlands and Sweden already had excellent environmental records. These companies were able to make further substantial savings in materials and energy and thus gained a competitive edge within their industry sector.

Most benefit can be obtained from waste minimisation because of the flow-through effects on materials management, waste disposal costs, and energy costs.

Cleaner Production

Embracing the principles of waste minimisation within a wider concept is the ultimate ideal of clean production, and the road towards this goal is "Cleaner Production". Formulated under the auspices of UNEP in May, 1989, it has been defined as:

> ***"The conceptual and procedural approach to production that demands that all phases of the life-cycle of a product or of a process should be addressed with the objective of prevention or minimisation of short and long-term risks to humans and to the environment."***

It is significant that the inherent inadequacies of placing sole reliance upon pollution controls to achieve environmental protection are now being recognised by governmental and industrial leaders. This is leading towards the fostering of a more integrated and preventative approach to environmental protection and the concept of Cleaner Production provides a major contribution towards this objective.

Among the principal recommendations of the Waste Management Project therefore are:

- that an independent Cleaner Production Centre/Foundation be established to facilitate a change in attitude and to move towards the implementation of solutions; and,
- that the New Zealand Government should:
  - develop policies designed to promote Cleaner Production concepts as a first priority for all organisations;
  - foster the development of an effective network of information and educational opportunities about all aspects of Cleaner Production.

The establishment of a Centre or Foundation to promote waste minimisation through Cleaner Production should be considered in the wider context of the overall efficient use of resources, including raw materials and energy.

The intended purpose of such a facility would be not to replace present sector based initiatives in this area, but rather to provide an umbrella organisation that would encourage such initiatives, and promote the concepts and provide educational opportunities to a wider audience. In this respect it is considered fundamentally important that the Centre/Foundation should be independent of any particular sector group; government, commercial or otherwise.

8.2 The Waste Market

It is essential that in the restructuring of the economy and the continuing drive towards increased efficiency and growth, the avoidance of environmental cost is given appropriate recognition.

In the normal course of events, in order to bring about a change in a regime, agreement on a set of objectives would be followed by development of the means to achieve them. In the case of waste management, if New Zealand as a country sets goals for waste prevention and minimisation, the means of implementing these goals is unlikely to be straightforward.

As noted in the Project Report, the existing waste market in New Zealand is far from perfect. The failure of waste producers (including households) to pay the real cost of waste disposal is considered the greatest single barrier to waste prevention and minimisation.

For example, charges for the disposal of wastes to landfill need to include the cost of pollution monitoring, leachate collection and treatment, capital costs of the replacement landfill, landfill gas control, and the closure costs associated with the landfill site. As long as there is no clear market price signal that reflects the true life-cycle costs of disposal as compared to reduction, reuse and recycling, no minimisation scheme is likely to achieve its full potential.

Throughout most of New Zealand the ratepayer effectively subsidises waste producers. Moreover, the costs to the community and the environment from poor waste management practices are not directly accounted for.

New Zealand's efforts to date in waste management have been totally supply driven. For example, local authorities have tended to respond by providing bigger and bigger holes to bury an ever growing amount of rubbish. This has exacerbated natural resource depletion.

If positive environmental outcomes are to be achieved, a new way of managing waste needs to be accepted. Firstly, production of wastes should be avoided wherever possible so that the demand for "bigger holes" is reduced. All reusable and recyclable products should be carefully separated. Organic material should be returned to the earth. Hazardous wastes, if not completely avoidable, should be minimised. Whatever residual wastes are left following full implementation of these principles should be treated where necessary and properly disposed so as not to disadvantage future generations. Such a waste management system can only be achieved if **all people** participate.

The trend in waste management then seems likely for it to become increasingly driven by the end-users or consumers. There are several design principles for end-use demand management programmes.

- *A guiding design strategy is to directly link the programme to the resource consumer. The more the proposed programme is relevant to the activities of the end-use consumer, the more successful the project will be.*
- *Consumers must be provided with comprehensive information on the total life-cycle costs of a product and the direct and indirect consequences of using that product.*
- *Programmes must have a "human scale". Each individual must be able to identify directly with the desired outcomes of the programme and know that they are capable of making a positive contribution.*
- *Positive consumer behaviour needs to be effectively reinforced so that change becomes permanent.*
- *Programmes must be measurable. It is essential to establish a statistical baseline at the beginning so that success or failure can be measured against that baseline.*

As the dominant reliance is placed on end use/consumer actions in demand-side programmes, it is imperative that the "market place" is free of hidden distortions. Barriers to the effective operation of the market must be identified and redressed.

The challenge for those with a legislative responsibility in this area will be to provide the appropriate market signals.

8.3 Data on Waste Generation

A general lack of data on the quantities and composition of waste generated presently hampers all efforts at waste management. Without a clear idea of how much waste is produced, what it contains and from which sources, it is difficult to set priorities for waste management. Since hazardous waste management options can have high capital costs, proper knowledge of the quantities involved is desirable before deciding on the most appropriate treatment method. And so it goes on. It is difficult to decide on the best landfill design without having a good idea of the composition of municipal waste.

Officials at both central, regional and local government levels need waste generation data in order to be able to make proper waste management decisions. Accurate data on waste generation rates and waste composition are essential for the development of proper waste management practices in New Zealand and the mechanisms for obtaining this information should be established as a first priority.

8.4 Final Comments

A unique and important feature of the Waste Management Project has been the wide involvement of engineers, scientists and others in key positions with local authorities and services companies. The project team comprised some of the top people in New Zealand working in the field of waste management.

While the project makes no pretence at providing the answers to all waste management issues in New Zealand, the reports produced by the four Task Groups represent the best information on those topics studied, presently available in New Zealand. This work has been further enhanced by the significant input from the four Visiting Fellows and overseas review by several other recognised authorities.

Apart from the obvious thrust towards waste minimisation/reduction and cleaner production outlined above, it is hoped that in many other areas the reports will give readers, and particularly those with a responsibility in the field of waste management, cause to re-think their attitudes and understanding of this very complex subject.

The views and opinions expressed are, of course, those of the authors responsible and while these have been subject to considerable review, it is expected that there will be some readers who may disagree with some of the findings. Such cases will clearly highlight the need for continuing discussion and debate in these areas.

In the drive towards the sustainable management of wastes in New Zealand, there are some fundamental issues that need to be addressed. Such matters include the future management of the 300 (approx.) dump sites currently being used around

the country. In the new era of increasing environmental awareness, residual wastes (after reduction, reuse and recycling) must be disposed in a modern landfill, which will be considered a treatment facility in its own right. Presently used landfills will in many cases need improved management measures to prevent future degradation of the environment.

There also remains in New Zealand a legacy of existing hazardous wastes and the deficiencies in the present system of hazardous substance management. This project has gone some way towards both supporting the use of a classification system for hazardous wastes and indicating appropriate tech-nologies for their treatment. The matter of dealing with existing stockpiles of hazardous wastes though, some of which may not be readily identifiable, remains. Until there is willingness and public support to use either suitable existing facilities such as industrial furnaces and cement kilns, or provide new special dedicated facilities for disposal, the problems cannot be solved.

These waste management issues, and of course others, must be faced as New Zealand moves towards environmental sustainability – an essential goal if the country is to maintain its ***clean, green*** image. The importance of this, and its increasing relevance in terms of world trade and the international competitiveness of our products, should not be underestimated.

9. APPENDICES

9.1 PROJECT PERSONNEL

Steering Committee

Mr D A Thom, KRTA Limited, *Patron*
Mrs J A Boshier, Office of the Parliamentary Commissioner for the Environment, *Chairman*
Mr R Bauld, Auckland Regional Council
Mr J P Blakeley, CAE, University of Canterbury
Mr J Bradley, Royds Garden Ltd., Dunedin
Mr J H Feltham, Environmental Health Consultant, *Proj Mgr*
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Mr A Petley, NZ Chemical Industry Council
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Task Groups

Waste Minimisation Practices:

Many people contributed to the work of this group. This list contains the names of those who had a co-ordinating role or who made significant contributions to the work. The full list can be found in Part 2 of the Project Report.

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Hazardous Waste: Appropriate Technologies for New Zealand

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Landfill Engineering Guidelines

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Mr G Fox, Department of Health
Mr P Higgs, Thames-Coromandel Dist. Council
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Waste Management in Relation to Water Supplies

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Visiting Fellows

Professor Donald Huisingh (Waste Minimisation)

Professor Huisingh is Professor of Environmental Sciences at Erasmus University in Rotterdam, The Netherlands. After graduating with a B.S. degree from the University of Minnesota he completed a Doctor of Philosophy degree at the University of Wisconsin in 1965.
His primary research focus has been on the development of policies, concepts and technologies that can be utilized by governments and industries to help them change their focus from reliance upon "end-of-pipe" pollution controls toward the integrated and more sustainable approaches of pollution prevention and waste minimisation.
Since June 1987, Professor Huisingh has lived in Europe, working in The Netherlands, Sweden, Denmark, Norway, West Germany, Austria, Italy, France, England and Finland, on several experiments designed to develop effective methodologies for the wide-spread implementation of the preventative approaches to environmental quality improvement.

Mr Kenneth J Simpson (Hazardous Waste)
Mr Simpson is President and Chief Executive Officer of the Alberta Special Waste Management Corporation, based in Edmonton, Alberta, Canada.
He has a wide range of experience in Municipal Engineering, contracting, civic government and consulting both in Canada and overseas. He was Head of Waste Management for the Alberta Department of Environment prior to 1984 and during that time, Alberta carried out a successful selection process for a special waste site.

Mr David J V Campbell (Landfills)
Mr Campbell is Head of the Landfill Research and Management Section, Environmental Safety Centre, Harwell Laboratory, UK. In this position Mr Campbell directs the UK Department of Environment and Department of Energy sponsored research programmes, and provides a consultancy service on landfill waste management. The Landfill Research and Management Section is a leading authority on the treatment and commercial exploitation of landfill gas and Mr Campbell is recognised internationally as an expert in this area of work. He has been a leading member of peer group reviews in the formulation of guidance and advice documents on Landfill Practice and the Control of Landfill Gas carried out by the UK Department of the Environment.

Dr Dale H Vanderholm (Impacts of Waste on Water Supplies)
Dr Vanderholm is the Associate Dean for Agricultural Research and Associate Director of the Nebraska Agricultural Experiment Station at the University of Nebraska-Lincoln, U.S.A. Prior to taking this position in 1983, he was Assistant Director of the Illinois Agricultural Experiment Station and Professor of Agricultural Engineering at the University of Illinois.
He is a registered Professional Engineer and was involved in water quality and waste management research and education while a faculty member at Iowa State University and the University of Illinois.

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