Management of Hazardous Waste

Towards Sustainable Waste Management in New Zealand

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Foreword

Although considerable concern has been expressed regarding shortcomings in the management of hazardous waste in New Zealand, the processes involved in determining an appropriate policy and legislative structure had not been finalised at the time of compiling this document. A nationally-accepted definition of what does or does not constitute a hazardous waste, for example, is still to be resolved by consultative processes.

The Ministry for the Environment's Hazardous Waste Programme has stimulated detailed consideration of the issues involved by releasing a discussion paper outlining a series of options and calling for comments and suggestions. Responses have been received and analysed and possible directions are beginning to emerge.

The development of the regulations and protocols necessary for the implementation of the Hazardous Substances and New Organisms Act 1996, which will have some influence on the future management of some hazardous waste, is expected to be completed in 2000.

The availability of treatment technologies appropriate for hazardous waste arising in New Zealand has markedly improved in recent time, while attitudes to the acceptability of practices such as co-disposal have changed, particularly in developed countries.

It is therefore considered timely to revisit *Appropriate Technologies for the Management of Hazardous Waste in New Zealand*, which formed Part 3 of the Centre for Advanced Engineering (CAE) report *Our Waste: Our Responsibility* (published in 1992). The opportunity is also being taken to publish this new edition as a stand-alone document to allow ease of periodical updating.

The objective of this project has been to bring together information relating to current legislation and good practice, which should be of assistance to all involved in the generation, lifecycle management, treatment and disposal of hazardous waste in New Zealand. The document brings together the findings and recommendations of Task Group members and contributors based on their individual specialised experience. It should not be regarded as a statement of the policies of those agencies of central, regional or local government with the statutory responsibility for hazardous waste management. The intention is more to provide information and to stimulate discussion on the issues involved and thus promote a more informed response to proposed reforms as these are developed. This should assist with the eventual introduction of a more practical, effective and enforceable system for the management of hazardous waste in New Zealand.

It is recognised that further review and updating of this document may be necessary when the outcome of the Ministry for the Environment's Hazardous Waste Programme is reflected in revised legislation and improvement of hazardous waste management practices.

Developing this document has required a substantial amount of collective effort, particularly by those identified in Appendix 1. This effort is gratefully acknowledged.

Norman Thom
Task Group Leader

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Chapter Overview

Chapter 1 - Introduction presents a brief description of the purpose of this document, an introduction to New Zealand's legislative framework for managing hazardous waste and an overview of the studies and reports published since 1992 that deal with New Zealand hazardous waste management issues.

Chapter 2 - The New Zealand Hazardous Waste Definition is a summary of the work undertaken so far on developing a New Zealand-specific definition for hazardous waste, and presents an up-to-date proposed definition.

Chapter 3 - Hazardous Waste and Risk provides an introduction to the principles of risk management, with a particular emphasis on the risks presented by hazardous waste.

Chapter 4 - Managing Hazardous Waste addresses a variety of factors important in hazardous waste management. The chapter commences with a description of the waste hierarchy, and goes on to outline the principles of Cleaner Production and references for accessing further information on this topic. Waste audits are covered briefly and general issues of importance in hazardous waste management are introduced.

Chapter 5 - Treatment Processes and Technologies is an up-to-date description of treatment processes for hazardous waste, including reference to some new and developing technologies. Information is provided about the availability of these treatment methods in New Zealand.

Chapter 6 - Thermal Processes provides an overview of thermal treatment processes for hazardous waste and associated issues such as environmental effects and costs.

Chapter 7 - Land Treatment, Disposal and Containment of Hazardous Waste describes the options for land treatment and the limitations of the disposal of hazardous waste to landfills in New Zealand.

Chapter 8 - Warehousing and Storage of Hazardous Waste delivers a guide to the general principles for storing hazardous waste and practical information on management issues such as segregation of waste, safety procedures and identification and recording of hazardous waste.

Chapter 9 - Emergency Preparedness discusses the need to be prepared for emergencies arising from the handling of hazardous waste and outlines steps to be taken towards developing emergency plans.

Chapter 10 - The Transport of Hazardous Waste provides a description of applicable legal requirements including labelling, documentation, segregation and the responsibilities of those involved in the transport of dangerous goods and waste.

The document also contains a comprehensive glossary, references and a bibliography for further reading grouped according to chapters.

Chapter 1
Introduction

1.1 Objectives and scope

This document provides those with an interest in the management of hazardous waste with up-to-date information in the following areas:

- New Zealand legislation and regulations addressing hazardous waste;
- initiatives and programmes at central and local government level involving hazardous waste;
- general treatment and disposal processes and storage considerations;
- transport issues; and
- emergencies involving hazardous waste.

The document is a resource compiling New Zealand-specific information related to hazardous waste (e.g. the legislative framework) as well as providing more general information (e.g. on treatment methods). It aims to assist the reader with forming an understanding of the special requirements and care necessary when handling or dealing with this type of waste, and the need to practice due diligence. While it is acknowledged that liquid trade waste and air emissions may also have hazardous constituents, it is beyond the scope of this document to address these waste types in detail.

It is important to note that this document describes current practices and concerns related to hazardous waste, thus providing a 'snapshot' of hazardous waste issues. The information and references presented here are intended to serve as a background to enable the reader to research their own specific needs. It is not a guideline, nor does it provide definitive answers to specific problems.

1.2 Background

This document represents a revision and update of *Part 3: Hazardous Waste: Appropriate Technologies for New Zealand* in *Our Waste - Our Responsibility* (Centre for Advanced Engineering, 1992)[1] . Since the publication of the *CAE 1992 Report*, hazardous waste management as an issue has risen in prominence and become a focus of concern. A number of studies and reports have been released within the last three years alone, and the Ministry for the Environment (MfE) established a Hazardous Waste Programme (HWP) in 1997.

Hazardous waste management continues to be one of the major environmental issues in most parts of the world, including New Zealand. Most industrialised countries have strict rules and regulations in this area, with certain key features common to most of them (refer section1.2). In contrast, New Zealand is characterised by a much less robust management system for hazardous waste (refer section1.3). As a result, it can be difficult to access information on hazardous waste. This document was compiled to assist with this task and provide references for further study.

1.3 Hazardous waste management in the international context

In 1996, the review panel of the Organisation for Economic Co-operation and Development (OECD) undertook an investigation into New Zealand's management of environmental issues, including waste management. The resulting document, entitled *Environmental Performance Review: New Zealand* (OECD, 1996), noted that "New Zealand lacks comprehensive legislation dealing specifically with both waste and hazardous waste … as a result, waste issues are poorly analysed and, in many cases, disregarded." (OECD, 1996, page 183). The report goes on to recommend "specific legislation for the control, treatment and disposal of hazardous waste, [to] take steps to facilitate the siting of dedicated treatment facilities within the country and negotiate disposal agreements with other OECD countries, as need be." (ibid., page 183).

A recent study commissioned by MfE (*A Review of Overseas Approaches to the Management and Landfilling of Hazardous Waste*, Environment and Business Group, 1997) investigated the hazardous waste management approaches of five industrialised

1 For the remainder of this document, this report will be referred to as the *CAE 1992 Report*.

countries (Australia, Canada, Denmark, Germany and the USA). While each system reflected individual needs and political preferences, there were also a number of elements common to all systems:

- a clear definition for hazardous waste;
- comprehensive policies at government level addressing waste and hazardous waste;
- dedicated legislation and/or regulations for waste and hazardous waste;
- the implementation of the waste management hierarchy;
- the application of the user/polluter pays principle;
- minimum performance requirements for the siting, design and operation of hazardous waste facilities;
- registration and/or licensing of hazardous waste facilities;
- tracking of hazardous waste movements;
- reporting to regulatory authorities;
- exemptions for generators of small quantities of hazardous waste; and
- increasing emphasis on self-monitoring by industry and decreased involvement of regulatory agencies.

As all or most of these policy elements are commonly found in the hazardous waste management frameworks of the countries investigated, it is likely that they are key factors for the development and implementation of a successful hazardous waste management strategy.

1.4 Hazardous waste management in New Zealand

The status of hazardous waste management in New Zealand is dictated by legislation, which sets the framework for implementing rules and regulations and allocates responsibilities to regulatory authorities. With the introduction of the Resource Management Act 1991 (RMA), environmental legislation has undergone considerable change and has affected the ways in which hazardous waste is managed. This section describes current relevant legislation and provides an overview of the studies and reports on hazardous waste management in New Zealand that have been published since the release of the *CAE 1992 Report*.

1.4.1 The regulatory framework for hazardous waste management in New Zealand

Hazardous waste management in New Zealand is predominantly governed by three Acts of Parliament, although other legislation such as the Land Transport Act 1998 are also relevant. The effects-based and decentralised nature of the RMA in particular has led to divergent approaches to hazardous waste management throughout New Zealand, with the result that no clear and nationally applicable standards prevail. This is expressed by the different conditions under which waste facilities operate in different parts of the country. The following is a brief overview of the major legislation affecting hazardous waste management in New Zealand. Other relevant legislation includes the Health Act 1956, the Health and Safety in Employment Act 1992, and various regulations. A detailed description of applicable legislation and regulations is provided in Appendix 2.

The Resource Management Act 1991 (RMA)

The purpose of the RMA is to promote the sustainable management of natural and physical resources. Section 5 (2) defines sustainable management as managing the use, development and protection of these resources while safeguarding the life-supporting capacity of air, water, soil and ecosystems and avoiding, remedying or mitigating any adverse effects of activities on the environment. Matters of national importance are addressed in Section 6 of the Act, other matters to be considered (such as the efficient use and development of natural and physical resources and the intrinsic value of ecosystems) are addressed in Section 7, while Section 8 requires that the principles of the Treaty of Waitangi are taken into account.

Implementation of the RMA rests predominantly with local government. Sections 30 and 31 respectively describe the functions of regional councils (RCs) and territorial authorities (TAs). In the context of hazardous waste management, RCs are responsible for controlling the discharge of ‘contaminants’[2] to the environment (Section 15), while TAs have primary responsibility for land use matters.

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[2] The definition of contaminant in Section 2 of the RMA is sufficiently broad to cover waste, including hazardous waste:

“Contaminant includes any substance (including gases, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat:

(a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of water, or

(b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged.”

In practice, these provisions mean that:

- Any facility that discharges contaminants to the environment, including hazardous waste or the by-products of handling or treating such waste (e.g. odour, leachate, stack emissions, effluent) will require a resource consent from the RC or unitary authority[3] unless a regional plan exists that specifically permits the activity. A land use consent from the relevant TA may also be required.
- This does not apply to facilities that discharge contaminants to the sewer system. Such discharges are generally subject to trade waste by-laws adopted by TAs under the Local Government Act 1974. Only the discharge from a sewage treatment plant requires a resource consent from the RC/unitary authority[4] .
- There are no nationally applicable minimum standards specifying the conditions such a facility needs to comply with. Each regulatory authority is entitled to determine its own consent conditions relevant to individual circumstances.
- A facility that does not discharge any contaminants while storing, treating or otherwise handling hazardous substances or waste and therefore does not require resource consents from the RC/unitary authority, may however require a land use consent from the relevant TA under the District Plan[5] . As is the case with RCs, each TA has discretion with respect to the conditions it places on a land use consent.

As a result, the conditions under which a hazardous waste facility may operate vary between regions, and between districts as well. Any person involved in the development or operation of a facility must therefore liaise closely with their relevant consent authority, i.e. the city/district council (TA) and the regional council/ unitary authority.

The Local Government Act 1974 (LGA)

The LGA predominantly defines the powers and duties of TAs (Section 37T). It is Part XXXI of this Act that enables TAs to undertake the function of waste management, and confers on them a duty to encourage efficient waste management (Section 538) while having regard to environmental and economic costs and benefits for the district, and ensuring that the management of waste does not cause a nuisance or is injurious to health. Under Section 539, TAs are also required to adopt a waste management plan for their district to make provision for the collection, reduction, reuse, recycling, recovery, treatment or disposal of waste.

Section XXVIII of the LGA enables TAs to undertake trade waste disposal and to make bylaws regulating trade waste disposal.

The LGA therefore states quite clearly that city and district councils have primary responsibility for ensuring that waste (including hazardous waste) is managed appropriately in their own districts, regardless of whether it is solid or liquid. This is backed up by the provisions of the Health Act 1965, which states that local authorities are empowered and directed to cause regular inspection of [their] districts to ascertain the existence of any nuisance, or any conditions likely to be injurious to health or offensive, and to cause all proper steps to be taken to secure the abatement of such nuisance or the removal of such condition (Section 23 of the Health Act 1956). However, as defined by the LGA, waste and trade waste falls within the RMA definition of contaminants, and any discharges from facilities a TA may use to fulfil their LGA function requires a resource consent from the RC unless specified otherwise in a regional plan.

Although most of the provisions for waste management in the LGA relate to TAs, RCs are authorised under Section 37SB to fund, establish and manage sites for the regional disposal of hazardous waste.

The Hazardous Substances and New Organisms Act 1996 (HSNO)

Note that at the time of writing (January 2000) the hazardous substances component of HSNO has not come into force.

The main focus of this Act is the management of the life cycle (i.e. identification, packaging, storage, emergency preparedness, tracking, use and disposal) of imported and manufactured hazardous substances (and new organisms), with the aim of protecting the environment and health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms.

It does so by making provisions for the establishment of an Environmental Risk Management Authority (ERMA), which is charged with the assessment and approval (or decline) and sets controls on hazardous substances and new organisms for use and/or release in New Zealand. To do so, the ERMA relies on the HSNO

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3 A unitary authority fulfils the function of both a regional council and a territorial authority. “Unitary authority” means a territorial authority that, by virtue of section 37N (1) of the Local Government Act 1974, has the functions, duties, and powers of a regional council in respect of a region under its control.

4 Note that in a large part of the Auckland Region, the Trade Waste Bylaw (ARC, 1991) is administered by Watercare Services.

5 Note that District Plans are mandatory while regional plans are optional.

Regulations, which specify the thresholds below/above which a substance is classified as hazardous, as well as a range of controls applying throughout the life-cycle of these substances.

The HSNO Act requires that all hazardous substances are assessed and approved or declined by ERMA. If a hazardous substance is approved, ERMA is required to set controls on the management of the hazardous substance.

A substance is hazardous if it exceeds the threshold level set by HSNO Regulations. It is important to note that HSNO applies only to *manufactured or imported* hazardous substances. Regulations can also be set for by-products from the manufacture of a hazardous substance under Section 140 (although none have been written at the time of writing).

A set of regulations has been developed that will be used by ERMA as a '*tool box*' to select and apply controls to hazardous substances that are approved under the Act. The controls on hazardous substances are broadly divided into:

- controls on their hazardous properties (oxidising, flammable, toxic, etc.); and
- controls on their life cycle (packaging, identification, disposal, etc.).

The level of control placed on the substance is linked to the *hazard classification* of the hazardous substance. In other words, the more hazardous the classification, the greater the level of control. The Act allows ERMA some flexibility when setting controls; section 77(4) allows ERMA to vary the controls applying throughout the life-cycle of these substances, if appropriate.

The HSNO disposal regulations are likely to impact on the management of hazardous waste. Disposal of a hazardous substance is defined as "treating, discharging to the environment or exporting". The disposal regulations, if promulgated in their current form, will enable ERMA to set controls on disposal based on the assumption that landfills and sewage treatment facilities (among other methods of disposal) are considered to be *treatment*. Treatment will be defined in the regulations as reducing the hazard to below the HSNO threshold criteria.

In addition, the HSNO disposal regulations will allow ERMA to require that disposal of oxidising, flammable or explosive substances is managed to prevent explosion or fire. Substances with toxic and ecotoxic properties will only be allowed to be discharged to the environment if they do not exceed the environmental exposure limits set by the ERMA (this includes discharge *from* landfill and sewage treatment facilities).

The number of hazardous wastes covered by HSNO are unknown because the hazardous substances part of the HSNO Act has not been tested. Because only substances that are manufactured or imported (and some byproducts) are covered by the Act, the definition of "manufacture" dictates whether the hazardous waste is a hazardous substance and therefore must be approved and controlled under HSNO. The definition in the Oxford English Dictionary is "to bring material into a form *suitable for use*". This indicates that wastes that are created with no use value are unlikely to be subject to HSNO, even though they may be hazardous.

The Land Transport Act 1998 (LTA)

The LTA revokes the Transport Act 1962 and the Land Transport Act 1993. In 1993, the LTA introduced a system which provided the option for making a Rule, with regulatory status, for the land transport of dangerous goods. Consequently, the requirements for transporting dangerous goods are now enshrined in the *Land Transport Rule: Dangerous Goods 1999* (LTDG Rule 1999), which came into force on 3 May 1999. The New Zealand Standard *NZS 5433:1999 - Transport of Dangerous Goods on Land* is incorporated by reference in the LTDG Rule 1999. A detailed account of the requirements for dangerous goods transport is presented in Chapter 10.

The roles of government departments and regulatory authorities

Under the above legislation, several different authorities have responsibilities for hazardous waste:

- Ministry for the Environment (MfE) — national hazardous waste policy;
- Environmental Risk Management Authority (ERMA) — implementation of HSNO, including

Illegal dumping of hazardous waste

(Auckland Regional Council)

aspects concerning waste hazardous substances covered under this legislation;

- Regional Councils — responsibility for discharges of contaminants (including hazardous waste) to the environment under Section 15 of the RMA;
- Territorial Authorities — responsibility for land use issues associated with hazardous substances under Section 30 of the RMA; and
- Ministry of Health/Public Health providers — protection of public health and toxic substances management.

1.4.2 New Zealand hazardous waste management studies

Since the publication of the *CAE 1992 Report*, the profile of hazardous waste management has increased. This was further underlined by the changes brought about by the introduction of the RMA. In subsequent years, a number of studies provided further information on how hazardous waste is managed in New Zealand.

The Hazardous Waste Management Handbook

In 1994, the MfE responded to the need for guidance by publishing the *Hazardous Waste Management Handbook* (MfE, 1994), which was specifically designed to aid hazardous waste practitioners in local government. The handbook focuses on practical advice and collates much needed information ranging from waste classification lists to recycling opportunities. In its technical information, the handbook relies significantly on the *CAE 1992 Report*. The significance of this publication is not so much that it provides new information or data, but in its implicit recognition of the need to address hazardous waste management in an integrated and committed fashion.

The 1995 National Landfill Census

In 1995, the MfE carried out a postal survey of the regulatory agencies responsible for landfills and their operators to obtain baseline data on various aspects of landfill management in New Zealand. The survey also included a brief section on hazardous waste.

The response rate to the survey was high — 87% of those questioned returned the questionnaire, identifying 327 operational landfills. Information was obtained for 271 (83%) of those landfills.

211 landfills (79%) did not accept all types of waste. This generally referred to hazardous waste (in 92% of these cases) but could also mean waste that is not hazardous but difficult to handle. However, closer investigation of how landfill operators defined hazardous waste revealed a wide range of criteria used, ranging from the co-disposal criteria in the *CAE 1992 Report* to USEPA TCLP criteria to specific exclusions such as chemicals, pesticides, asbestos and hot ashes. It was noted that larger landfills were generally more aware of the need to manage hazardous waste, and better equipped to do so. Results also indicated that only 39 landfills (14%) utilised some sort of manifest system to identify potential hazardous waste entering their landfill.

The landfill census thus showed quite clearly that the inconsistency in which hazardous waste is defined resulted in such waste entering landfills throughout New Zealand, and that more than 20% of landfills covered in the survey did not even attempt to control the influx of hazardous waste. Nothing is known about the 56 (17%) landfills for which no information was obtained during the survey.

The Auckland Region Hazardous Waste Survey 1996

A detailed characterisation of hazardous waste issues was provided in the *Auckland Region Hazardous Waste Survey 1996* (Environment and Business Group & Auckland Regional Council, 1996). Unlike other waste surveys, this study focused exclusively on hazardous waste in the Auckland Region and attempted to establish a profile of waste generation, handling and final disposal. The major findings of this study can be summarised as follows:

- The lack of a nationally applicable, clear definition for hazardous waste resulted in the adoption of a waste definition specific to this survey. This definition included high strength organic waste such as food processing waste as these were considered a significant contaminant within the meaning of the RMA. As a result, the study’s findings may not be immediately comparable to other studies.
- The lack of legal requirements for waste generators to keep records, coupled with the lack of a clear definition, resulted in significant difficulties when obtaining data and affected the accuracy of the data that were obtained.
- The survey found that 97.7% of the hazardous wastes generated were in the form of liquids and were discharged to the trade waste sewer, not always in compliance with the trade waste bylaw. Only 1.9% were solids and 0.4% sludges.
- Approximately 99% of the waste was generated by

the manufacturing sector; only small amounts came from businesses in the Community, Social & Personal Services sector (0.24%) and the Transport, Storage & Communication sector (0.09%).

- More accurate data was obtained for the quantities of hazardous waste disposed of, as landfill operators and sewage treatment facilities are required to keep records for compliance with their resource consent conditions. Based on this information, it was estimated that 10% (9,535,787 tonnes) of the total sewage treated at the region's sewage treatment plants in 1995 were hazardous trade waste, and that 15% (110,605 tonnes) of all waste disposed of in landfills in 1995 was hazardous.
- The survey also found a notable lack of education and training among those involved in generating and handling hazardous waste.
- Many of those interviewed during the survey stated that better and clearer rules and regulations in hazardous waste management are needed.

Hazardous Waste Management Options for the Canterbury Region

In 1996, the Canterbury Regional Council investigated hazardous waste management in the Canterbury Region (*Regional Hazardous Waste Management Investigation*, Royds Consulting, 1996). Because of the limited time frame, the investigation was in the form of a desk-top study and derived its information predominantly from existing data sources and communication with those involved in the field. The findings were as follows:

- An estimated 25,000 tonnes of hazardous waste[6] was generated by the industrial, agricultural and household sectors in the region each year, 19,000 tonnes of which are thought to come from the Christchurch City area.
- The report estimated that 80% of this waste consists of materials at the lower end of the hazard scale, e.g. contaminated sewage sludge, contaminated soils and waste oil. Hazardous waste such as solvents, cyanides and metal waste is thought to comprise less than 5%.
- The majority of hazardous waste generated in the region is co-disposed in the Burwood landfill, which is due to close in 2001. Treatment methods tend to be limited to stabilisation prior to landfilling.
- No satisfactory disposal options exist for highly hazardous waste such as some types of unwanted agricultural chemicals, boron sludges, chlorinated solvent sludges, CFCs and oil or chemical containers.

The National Waste Data Report 1997

This report (MfE, 1997) collates information from a wide range of sources with the aim of generating a detailed picture of waste generation and disposal in New Zealand. The first of its kind, it highlights the inconsistent approaches to defining waste and, consequently, hazardous waste management throughout the country. It also notes that waste data are produced in an ad-hoc fashion and are, therefore, generally scarce and of questionable accuracy, especially with respect to hazardous waste.

Unlike the information presented in other sections of the report, which is presented as New Zealand wide data, the information on hazardous waste quantities generated and disposed of is too deficient to provide a coherent national picture. Information is presented in the form of case studies, with each information source being described separately.

The main data source for the hazardous waste chapter is the *Auckland Region Waste Survey 1996* (see above). Others sources cited are the *1995 National Landfill Census* (see above), data on hazardous waste generated in the Taranaki Region (extracted from the *Hazardous Waste Management Handbook*, MfE, 1994), a 1996 report on hazardous waste by the Otago Regional Council (Works Consultancy Services Ltd., 1996) and information covering the collection of unwanted agricultural chemicals by regional councils/unitary authorities, hazardous waste exports and contaminated site investigations and clean-up. Information on the latter projects is inconsistent in its scope and availability.

Hazardous Waste Management

This report was published by the Parliamentary Commissioner for the Environment (PCE) in 1998. In contrast to most other studies discussed, this report investigates the management framework for hazardous waste and its shortcomings, rather than quantifying waste generation and disposal or describing management issues. The report acknowledges and welcomes the establishment of the MfE Hazardous Waste Programme, and establishes a monitoring and auditing framework to enable the Parliamentary Commissioner to assess the programme's progress.

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[6] In the Canterbury study, hazardous waste is defined as unwanted material with the characteristics of a hazardous substance as defined by the HSNO Act. Ecotoxic waste was excluded, although sewage sludge from Christchurch City was included due to its perceived hazardous properties. It is predominantly because of the differences in definition that the quantities estimated in the Canterbury Region differ from those recorded in the Auckland Region.

The findings of the report can be summarised as follows:

- The report was prompted by concern within local authorities and the waste treatment/disposal industry about the history of poor management of hazardous waste in New Zealand.
- The management of hazardous waste in New Zealand has been carried out in a piecemeal fashion without any overall strategy or commitment to monitor and review the existing system.
- Specific issues identified are:
  - lack of data does not allow for a reliable assessment of risk from hazardous waste;
  - the mechanisms for collecting such data are inadequate;
  - the mechanisms for managing the risk (e.g. existence and access to treatment facilities, tracking of hazardous waste, etc.) are insufficient for the task; and
  - the reduction of waste and risk need to be a part of any management programme for hazardous waste.
- Although the issues have been acknowledged by the government and commitment was made to address them in the form of the Hazardous Waste Programme (HWP), the report states that the programme should also incorporate objectives aimed at minimising hazardous waste (waste reduction) and the effects on the environment and public health arising from the disposal of hazardous waste (risk reduction).

1.4.3 Conclusions

Since the publication of the *CAE 1992 Report*, interest in hazardous waste management has increased steadily, as is evidenced by the number of publications on various aspects of this area throughout the 1990s.

These reports show that many of the basic elements utilised by other countries to control this waste are not available or used in New Zealand. As a result, hazardous waste management in New Zealand is characterised by:

- inconsistencies between geographical areas due to different rules and regulations;
- high cost due to the lack of availability or access to appropriate hazardous waste facilities for those who wish to deal responsibly with their hazardous waste; and
- haphazardness due to a general lack of education and knowledge on the parts of generators, facility operators and regulators.

This has been recognised by the responsible authorities and initiatives are now in place to remedy the situation. This document represents one part of this undertaking in that it provides some of the technical information necessary to improve the level of knowledge and current hazardous waste management practices in New Zealand.

1.5 Future developments

In response to the intense interest in hazardous waste management issues in recent years, the MfE established the Hazardous Waste Programme (HWP) in September 1997. Funding to undertake this work was granted for three years, with the aim of improving the management of hazardous waste in New Zealand. Ongoing funding is uncertain.

The first publication of the Programme was a discussion paper entitled *Managing Hazardous Waste* (MfE, 1998). The document outlines the reasoning behind the HWP, discusses the nature of hazardous waste, including its environmental effects, and presents a brief overview of the way in which hazardous waste is currently managed in New Zealand. It describes the elements of an effective hazardous waste management framework and presents options for achieving an improved system in New Zealand, in the light of New Zealand's legislation. In essence, the Ministry aims at establishing a management system with three fundamental elements:

- a definition for hazardous waste;
- controls on the disposal of both solid and liquid hazardous waste[7]; and
- monitoring and enforcement of hazardous waste controls.

The document implies that any improvements to the existing management framework for hazardous waste will occur within the structure of the RMA, and cites the development of a National Environmental Standard as the logical option. Minor amendments to the RMA may be necessary to enable full regulatory impact to occur. The MfE also notes that an array of guidelines, educational tools and model bylaws will be needed to ensure the successful implementation of the new framework.

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7 The discussion paper notes that the discharge of gaseous hazardous waste to air will be addressed through a separate work programme.

Hazardous waste is also considered in the MfE Environmental Indicators Programme. The purpose of this programme is to develop and use indicators to measure and report how well the New Zealand environment is looked after.

The MfE's specific objective is the systematic measurement of the performance of its environmental policies and legislation, to better prioritise policy, improve decision making and report on the state of New Zealand's environmental assets. To this end, indicators are being developed in the following areas:

- air;
- biodiversity;
- energy;
- fresh Water;
- land;
- marine environment;
- ozone and climate change;
- transport; and
- waste, hazardous substances and toxic contaminants.

Chapter 2
The New Zealand Hazardous Waste Definition

2.1 Introduction

In 1998, the Ministry for the Environment (MfE) published a discussion paper on managing hazardous waste. This outlined several options for defining hazardous waste. Public submissions on the discussion paper broadly supported MfE's proposals and stressed the need for a definition of hazardous waste to underpin a national management framework for hazardous waste.

The Ministry subsequently embarked on a consultation process leading to the development of a New Zealand definition of hazardous waste. This process was and is based on both technical and public consultation, as shown in Figure 1.

As part of the consultation process, MfE commissioned a report to review relevant technical issues associated with definitions of hazardous waste, to provide an overview of overseas practices and to outline options for a New Zealand definition of hazardous waste (Environment and Business Group Ltd, 1999a). This report formed the basis for a series of five workshops that were held between 7 and 16 June 1999 in Auckland, New Plymouth, Wellington and Christchurch.

A wide range of stakeholders were represented in the workshops, ranging from hazardous waste generators to the waste management industry, local, regional and central government, health providers, tangata whenua, tertiary institutions and various NGO groups. Feedback from the workshop is presented in a separate report (Environment and Business Group Ltd, 1999b). Overall, workshop participants strongly supported the concept and validity of a nationally consistent definition of hazardous waste.

This chapter presents the proposed New Zealand definition of hazardous waste and an associated classification system, which was introduced for public input and discussion at the Waste Management Institute New Zealand Conference 1999. As the proposed definition was not complete at the time of publication of this document, modifications (especially with respect to the hazardous characteristics thresholds) are likely. Readers are advised to consult with the Ministry for the Environment concerning the most up-to-date status of this definition and its implementation.

2.2 Background and key principles of defining hazardous waste

2.2.1 Purpose

The purpose of a New Zealand definition of hazardous waste is to:

- enable appropriate life-cycle management of hazardous waste, with a focus on avoiding or minimising any adverse effects on human health and safety, ecosystems, property and other human values;
- help industry, regulators and the public to clearly establish whether or not a waste is hazardous;
- establish a clear reference point for hazardous waste within the context of relevant environmental law, resource consent hearings and the Environment Court; and
- assist the New Zealand Government with meeting national and international requirements and expectations related to the environmentally sound management of hazardous waste.

2.2.2 Requirements

In order to meet the above objectives, the following requirements apply:

- The hazardous waste definition must be New Zealand-specific and cover all hazardous waste streams generated in New Zealand.
- The definition must be compatible with relevant controls for hazardous substances under the Hazardous Substances and New Organisms Act 1996.
- The definition should be workable and user-friendly.
- The definition should be suitable to serve as the basis for monitoring hazardous waste.

- The definition should be suitable to enable consistent record-keeping to:
  - — evaluate the quantity and quality of hazardous waste generated in New Zealand;
  - — set hazardous waste management priorities;
  - — identify the need for storage, treatment and disposal facilities; and
  - — enable monitoring at the regional, national and international level.
- The development of a New Zealand hazardous waste definition should take into account established overseas practice. It should also consider international obligations or expectations such as reporting requirements under the Basel Convention and the OECD.

2.2.3 Key principles

Clarification of the term 'definition'

The primary purpose of a hazardous waste definition is to help users establish whether or not a waste is hazardous and therefore subject to the management controls for such waste. However, there may be confusion as to what the term 'hazardous waste definition' means in practice. In this context, it is important to clarify the following terms:

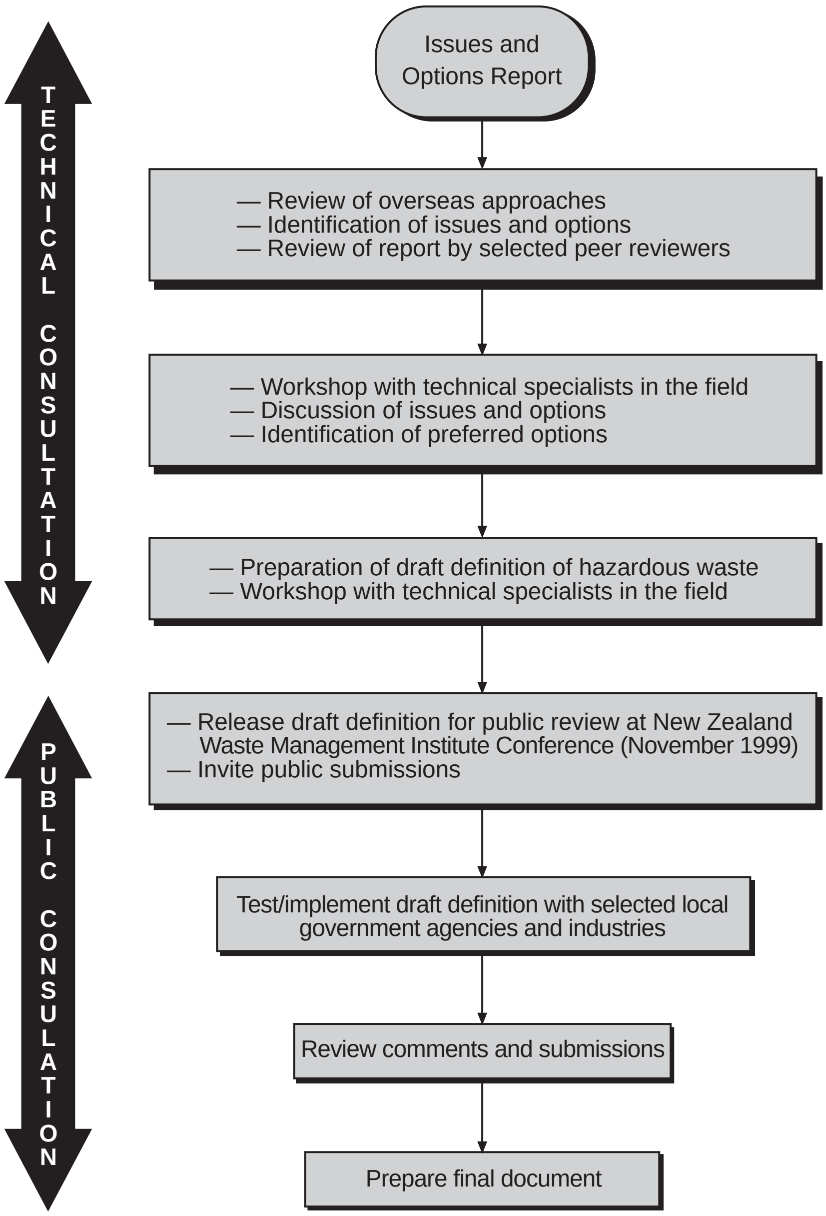

Figure 1: Consultation process for the development of the New Zealand hazardous waste definition

1 *Hazardous waste designation*: a mechanism that clearly designates a waste as hazardous so that appropriate controls can be applied.

2 *Hazardous waste classification*: a process by which hazardous waste is classified based on a series of waste codes or categories for record keeping and monitoring purposes.

For the purpose of the New Zealand definition of hazardous waste, the term 'definition' is applied only to the designation mechanism described in Point 1 above. However, it is also proposed to introduce a classification system that is intended to be an adjunct to the definition itself and to form the basis for a consistent record keeping and monitoring system.

It should also be noted that the definition does not address any issues, controls or standards relating to other aspects of the life-cycle management of hazardous waste (for example, treatment standards or landfill acceptance criteria). These matters will be addressed separately under MfE's Hazardous Waste Programme.

Key elements of the hazardous waste definition

Hazardous waste definitions are commonly based on the following key elements:

- An overriding definition of the term 'waste'. History has shown that with the growing availability of technologies for recovery and recycling, waste materials tend to become increasingly disguised as 'secondary raw materials' or 'recyclables' and consequently circumvent hazardous waste controls. However, as long as these materials are hazardous in terms of applicable thresholds, they need to be managed appropriately. It is therefore necessary to have a mechanism in place to capture all materials that constitute 'hazardous waste', irrespective of their final destination (W Code in Appendix 3).

- A series of hazardous characteristics and associated minimum thresholds above which waste is designated as hazardous. The 'bottom line' of any hazardous waste definition is whether a particular waste exceeds defined minimum hazardous characteristics thresholds. Hazardous characteristics cover properties such as flammability, corrosiveness, ecotoxicity etc. The 'minimum threshold', i.e. the minimum level below which a waste is no longer deemed to be hazardous, is a very important part of a hazardous waste definition. This has been demonstrated by overseas experience, where the use of hazardous characteristics without minimum thresholds has been shown to open the door to misinterpretation and abuse. In New Zealand, HSNO provides a clear regulatory specification for hazardous characteristics thresholds.

- A generic hazardous waste list that comprises a wide range of common hazardous waste types known to exceed minimum hazardous characteristics thresholds. A hazardous waste list is a tool that is used to quickly identify waste types commonly known to be hazardous, based on existing knowledge of the raw materials, processes or technologies involved, or existing testing data. Hazardous waste lists serve to 'flag' a particular waste as hazardous, so that appropriate life-cycle management measures can be applied as a precautionary measure. Hazardous waste lists normally describe a range of generic hazardous waste types based on typical processes and/or industries. Examples include waste cleaning solvents or sludge from the bottom of oil storage tanks. Hazardous waste lists usually contain codes that serve as unique identifiers.

Mechanisms

In order to ensure the appropriate use of the New Zealand definition of hazardous waste, the following mechanisms are required:

- *Hazardous waste listing and de-listing mechanisms*. Mechanisms to assign and remove waste types to the hazardous waste list. This process must be transparent so that all the listed waste types are widely acknowledged to be hazardous. In terms of compiling the initial list for the New Zealand hazardous waste definition, explanatory documentation will be prepared to justify the addition of every waste to the list.

- *Hazardous waste designation mechanism*. A mechanism to determine whether a waste is hazardous or not. This is effectively the mechanism that applies the hazardous waste definition to a particular waste in question.

- *Hazardous waste exemption mechanism*. A mechanism to demonstrate that a listed waste is not hazardous. As the presumption is that all listed waste types are hazardous, specific proof must be provided to demonstrate that this is not so. Proof will need to be provided against standard verification and testing requirements (refer Chapter 2.2.4).

- *Mixed/contaminated waste assessment mechanism*. A mechanism to assess mixed and contaminated hazardous waste.

Mixed and contaminated hazardous waste

A large proportion of hazardous waste generated in New Zealand is mixed or contaminated waste (for example, contaminated soils, sediment or equipment). This creates obvious problems with determining whether this waste is hazardous or not.

A hazardous waste definition can deal with mixed and contaminated hazardous waste in several ways:

- by listing the waste as a separate item on the hazardous waste list if the waste is well established as being hazardous (for example, contaminated equipment or absorbent material, contaminated soils and sediments, car shredder flock, cesspit waste, etc.);
- by applying mixture rules based on the fractional proportions of different hazardous waste types in a mixed waste; and/or
- through comprehensive biological or physico-chemical testing of the 'whole' mixed/contaminated waste.

2.2.4 Verification and testing requirements

Background

There are generally two scenarios where quantitative verification/testing of a particular waste will be necessary for identification purposes. Primarily, these fit in with the mechanisms listed above:

- to demonstrate that a waste is hazardous — this applies mainly in situations where a waste is not listed, but is suspected or known to be hazardous; and
- to demonstrate that a waste is not hazardous — this applies mainly in situations where a waste is listed, but is suspected or known not to be so.

It is noted that testing is required for most hazardous waste sometime during its life-cycle. However, these testing requirements will be specific to the stage of the life-cycle, for example for treatment or disposal purposes. This type of testing is not addressed here.

Testing requirements against applicable hazardous characteristics thresholds will be mostly based on HSNO regulations and guidelines. To a significant degree, these are still under development and will be incorporated into the New Zealand hazardous waste definition as they become available. However, while HSNO regulations and guidelines can be translated into a hazardous waste definition, special guidelines need to be developed to enable testing of mixed/contaminated hazardous waste against applicable hazardous thresholds.

Hazardous characteristics thresholds

HSNO hazardous characteristics thresholds have recently been described on a preliminary basis by the Environmental Risk Management Authority (ERMA, 1999). The thresholds defined under HSNO apply to six properties:

- explosiveness;
- flammability;
- capacity to oxidise;
- corrosiveness;
- toxicity; and
- ecotoxicity.

The H Code in Appendix 3 provides a listing of the hazardous substance characteristics for which thresholds have been established. While the application of HSNO thresholds to physical hazards is relatively straightforward, the thresholds for toxic and ecotoxic (i.e. biological) properties are quite complex. It may therefore be overly stringent to require hazardous waste to be tested against all biological thresholds specified by HSNO.

Guidance is currently being prepared by ERMA to determine when and which thresholds are appropriate. This guidance will need to be further considered in the development of the New Zealand hazardous waste definition when it becomes available.

Testing against biological thresholds

An important consideration in assessing hazardous waste against applicable biological thresholds is what process and testing regime to use. The following options exist:

- Direct biological testing of the waste. This involves submitting a 'whole' waste to tests against specified biological endpoints to characterise both toxicity or ecotoxicity of the waste, using standardised testing methods (still to be determined). Major disadvantages of this approach are cost, time requirements, and the potential complexity of tests as well as ethical considerations due to the involvement of living species. An advantage is that test results can be compared directly against critical endpoints (biological thresholds).
- Analytical characterisation of constituents. An easier way to assess hazardous waste is through analytical testing of priority constituents. Critical aspects are:
  - — which constituents need to be assessed?

— how can measured concentrations be evaluated against biological thresholds?

It is likely that the testing regime applied to hazardous waste would be based on a tiered system. In such a system, a standard set of priority constituents is tested first, with additional tests for other contaminants applied only if there is sufficient indication based on the knowledge of the type of waste in questions, its origins and history, the types of raw materials and processes involved, etc.

Evaluating analytical data of individual chemicals against applicable thresholds is a crucial consideration. A prerequisite for this approach is the availability of toxicity/ecotoxicity data on the individual constituents, which are analysed against respective endpoints. Another prerequisite is the availability of mixture rules that allow the assessment of hazardous waste containing more than one constituent.

2.2.5 Roles and responsibilities

The development and implementation of a hazardous waste definition raises important questions as to who will take on relevant responsibilities. Responsibilities will need to be defined, particularly in the area of maintaining the hazardous waste list (i.e. adding or removing hazardous waste to or from the list) or managing/approving exemptions from the list. Further discussion will be required in this respect.

While the role of regulatory agencies in the administration of the hazardous waste management framework has not yet been clarified, there are some responsibilities that apply to generators or holders of hazardous waste under the RMA. These include:

- identification of hazardous waste based on the New Zealand hazardous waste definition;
- application of appropriate management and life-cycle controls based on the nature and risks presented by the waste in question; and
- keeping of records based on the hazardous waste classification system.

2.2.6 Hazardous waste classification

The classification system

Hazardous waste classification systems form the basis for keeping records on and monitoring hazardous waste. They are designed to provide:

- Industry specific information, allowing industry groups to collect and evaluate industry-specific hazardous waste data for:
  - — identifying hazardous waste management priorities;
  - — identifying the need for waste management facilities; and
  - — developing industry codes of practice and/or standards.
- Company internal information, allowing the evaluation of hazardous waste data to enable implementation/monitoring of company hazardous waste management strategies, plans and budgets.
- Information on the generation, storage, treatment and disposal of hazardous waste in order to identify waste management priorities and the need for hazardous waste facilities, and to be able to meet reporting requirements at the regional, national and international level.

Even though not part of the hazardous waste definition as such, classification systems are normally based on the definition and are, therefore, closely associated with it. Additional codes (i.e. Codes 3, 4 and 5 in Appendix 3) assist with collecting life-cycle related information on a hazardous waste, such as where a waste originates from and where it is destined (for example, disposal, recycling or recovery). MfE's plans in respect of keeping records on, and monitoring, hazardous waste under the proposed RMA management framework are still under development. In particular, this relates to the types and minimum quantities of hazardous waste to which record-keeping requirements will apply.

Record keeping

Any record-keeping system has to be designed in a manner that enables the collection and collation of data for the purposes outlined above. The system has to be both functional and user friendly, and rationalise any bureaucracy and paper work to the maximum extent possible. It is desirable that in the long-term, electronic systems are made available to future users to enable a paper-free record keeping system.

2.2.7 Requirements of the Basel Convention

New Zealand is a signatory to the Basel Convention, an international treaty under which signatory countries are required to monitor and report on the transboundary movement of hazardous waste. Under this treaty, any individual or organisation involved in the import or export of hazardous waste is officially required to report this. In the case of New Zealand, reporting to the Ministry of Commerce is required.

The Basel Convention is based on a separate definition and classification system for hazardous waste. New Zealand is not required to use the Basel Convention hazardous waste definition and classification system at the national level – in fact only a few countries do so, because of inherent weaknesses of that system. However, any waste that is deemed to be hazardous under domestic legislation will need to be reported under the Basel Convention as well.

2.3 Proposed hazardous waste definition

2.3.1 Purpose

The purpose of the New Zealand definition of hazardous waste is to:

- enable appropriate life-cycle management of hazardous waste, with the primary focus on avoiding or minimising adverse effects on human health and safety, ecosystems, properties or other human values;
- help industry, regulators and the public clearly establish whether or not a waste is hazardous under the RMA;
- establish a clear legal reference point for hazardous waste within the context of relevant environmental law, resource consent hearings and the Environment Court; and
- assist the New Zealand Government with meeting national and international requirements and expectations related to the environmentally sound management of hazardous waste.

2.3.2 Definitions and terms

Waste

The term 'waste' is defined as any substance, material or object, in solid, liquid or gaseous form, that are:

- production and consumption residues not otherwise specified below;
- off-specification products;
- products whose date for appropriate use has expired;
- materials spilled, lost or having undergone other mishap, including any materials, equipment, etc. contaminated as a result of the mishap;
- materials contaminated or soiled as a result of planned actions (e.g. residues from cleaning operations, packing materials, containers, etc.);
- unusable parts (e.g. reject/exhausted batteries, exhausted catalysts, etc.);
- substances that no longer perform satisfactorily (e.g. contaminated acids, contaminated solvents, exhausted tempering salts, etc.);
- residues of industrial processes (e.g. slags, still bottoms, spent filters, etc.);
- residues from pollution abatement processes (e.g. scrubber sludges, baghouse dusts, spent filters, etc.);
- machining/finishing residues (e.g. lathe turnings, mill scales, etc.);
- residues from raw materials extraction and processing (e.g. mining residues, oil field slops, etc.);
- adulterated materials (e.g. oils contaminated with PCBs, etc.);
- any materials, substances or products whose use has been banned by law;
- products for which the original holder has no further use (e.g. agricultural, household, office, commercial and shop discards); and/or
- contaminated materials, substances or products resulting from remedial action with respect to land.

Hazardous waste

The term 'hazardous waste' is defined as:

- any waste that is listed in the L Code (New Zealand Hazardous Waste List) (Appendix 3[1]) and that exceeds applicable hazardous characteristics thresholds; or
- any other waste that exceeds applicable hazardous characteristics thresholds.

Hazardous characteristics thresholds

The term 'hazardous characteristics thresholds' is defined by:

- HSNO regulations defining thresholds for the following hazardous characteristics:
  - — explosiveness;
  - — flammability;

[1] It should be carefully noted that Appendix 3 has been taken from the draft listings available at the time of compiling this document. They have been included to illustrate likely content and format. It must be expected that changes to these will occur as a result of pilot trialing and reviews after general useage. The Ministry for the Environment, Wellington, should be contacted for current updated versions.

— a capacity to oxidise;

— toxicity (including chronic toxicity);

— corrosiveness;

— ecotoxicity with or without bioaccumulation.

- Land Transport Rule: Dangerous Goods 1999 and NZ Standard 5433: 1999 – Transport of Dangerous Goods on Land for infectious materials:

  — "Infectious substances are those substances known or reasonably expected to contain pathogens. Pathogens are defined as micro-organisms (including bacteria, viruses, rickettsia, parasites, fungi) or a recombinant micro-organism (hybrid or mutant) that are known or are reasonably expected to cause infectious disease in humans or animals".

- The Radiation Protection Act 1965 and Regulations 1982 for radioactive materials. Radioactive waste is any waste that is above the levels that are exempt under this legislation.

New Zealand hazardous waste list

The New Zealand hazardous waste list (L Code) incorporates narrative descriptions of hazardous waste types in New Zealand that are typically known to exceed hazardous characteristics thresholds. Therefore, any waste that is listed is deemed to be hazardous.

Holder

'Holder' means the legal owner of a hazardous waste at any stage during its life-cycle, including generators, transporters, storage, treatment and disposal operators.

Hazardous waste treatment

The term 'hazardous waste treatment' is defined as (refer Chapter 5.2):

> "Any physical, chemical or biological change applied to a waste material prior to its discharge or ultimate disposal, in order to reduce any potential adverse effects on:
>
> — the health and safety of the operators of subsequent processors of the waste, containers and conveying facilities including sewers pumping stations and the like; and
>
> — disposal processes such as a landfill or a waste water treatment plant, and/or the environment generally."

Hazardous waste disposal

The term 'hazardous waste disposal' is defined as:

> "Any sound and environmentally acceptable physical, chemical or biological process or change applied to a waste material to enable its final discharge, storage of deposition in line with any requirements specified under the Resource Management Act 1991 and Hazardous Substances and New Organisms Act 1996, and to minimise to an acceptable level any potential adverse effects on:
>
> — the health and safety of the operators of waste disposal facilities, containers, and storage and conveying facilities; and
>
> — the environment generally, including human health and safety, ecosystems, property and other human values.

2.3.3 Hazardous waste designation

The mechanism to determine whether a waste is hazardous is shown in Figure 2.

In designating a hazardous waste, the dilution and/or mixing of hazardous waste prior to treatment and/or disposal (refer Chapter 2.3.2) is not acceptable.

2.3.4 Listing and de-listing hazardous waste

The listing of a waste in the New Zealand hazardous waste list (L Code) is based on a weighted evaluation of the following considerations[2] :

- whether the waste exceeds minimum hazardous characteristics thresholds or not;
- existing knowledge of the hazardous characteristics of the waste, based on the raw materials, use or processes involved;
- overseas recognition of the waste as a hazardous waste (or not); and
- whether the waste is commonly generated in New Zealand.

The process to assign a waste to the hazardous waste list is shown in Figure 3.

The de-listing of a hazardous waste from the hazardous waste list, i.e. the permanent removal of a waste from the list, is expected to occur only rarely. The decision of whether to de-list a waste is based on the weighted consideration of the following criteria:

- whether the waste type has changed permanently in

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[2] The initial compilation of the hazardous waste list was based on extensive technical and public consultation. Explanations as to why certain waste types are placed on the list will be provided in a separate document, which is currently in preparation.

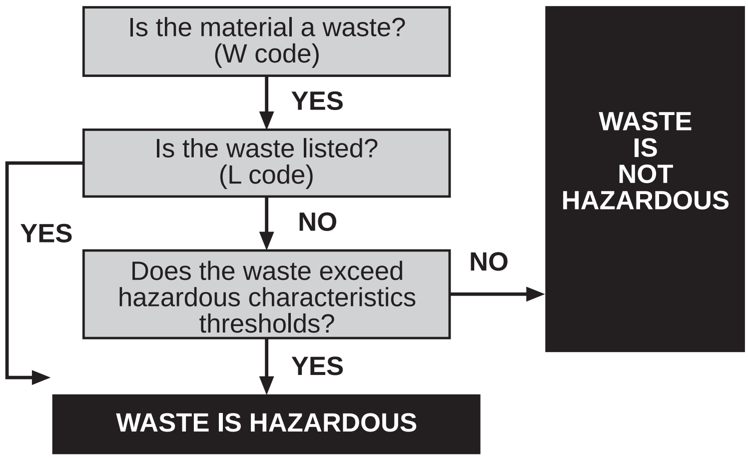


Figure 2: Hazardous waste designation

terms of the raw materials or processes/technologies employed;

- whether the waste has been removed from representative overseas lists also; and
- whether the waste's characteristics are typically below relevant thresholds.

The mechanism to de-list a hazardous waste is shown in Figure 4.

2.3.5 Exempting a waste from the hazardous waste list

A listed hazardous waste is exempt from the hazardous waste definition if it can be demonstrated on a case-by-case basis that the hazardous characteristics of the waste are below relevant thresholds. Proof of this must be furnished according to the verification and testing requirements outlined in Chapter 2.3.7. The exemption of waste types from the hazardous waste list based on dilution and/or mixing other than for the purposes of treatment (as defined in Chapter 2.3.2) is prohibited.

2.3.6 Designating mixed and contaminated hazardous waste

Mixed or contaminated waste is designated as hazardous based on the mechanism shown in Figure 5.

2.3.7 Verification and testing requirements

Available information to support this part of the hazardous waste definition is still incomplete. Provisions

Figure 3: Hazardous waste listing mechanism

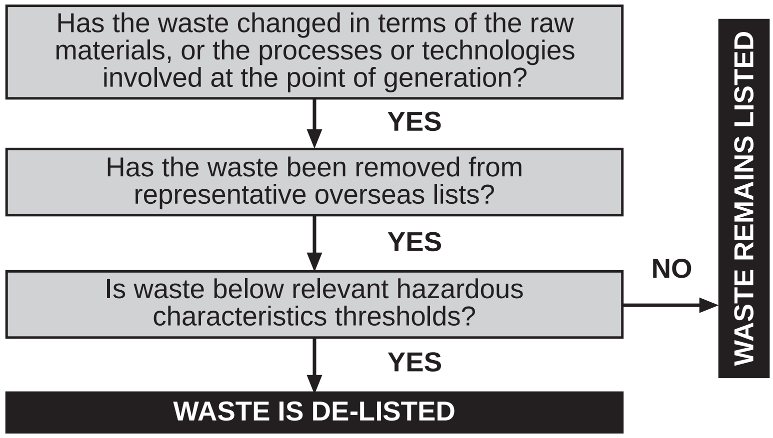


Figure 4: Hazardous waste de-listing mechanism

for verification and testing requirements will be inserted once they become available.

2.4 Proposed hazardous waste classification

2.4.1 Purpose

The hazardous waste classification provides the basis for record keeping and monitoring, and enables the generation of:

- industry-specific information for the purpose of identifying hazardous waste management priorities, determining the need for waste management facilities and developing industry codes of practice;
- company internal information for the purposes of monitoring waste and developing waste management plans; and
- information on the generation, storage, treatment and disposal of hazardous waste in order to identify waste management priorities and the need for hazardous waste facilities, and to be able to meet reporting requirements at the regional, national and international level.

2.4.2 Classification codes

The New Zealand hazardous waste classification is based on the hazardous waste definition, together with a series of codes to further characterise a waste in terms of its origin and its life-cycle. Therefore, the classification system consists of a series of codes. These are further described below.

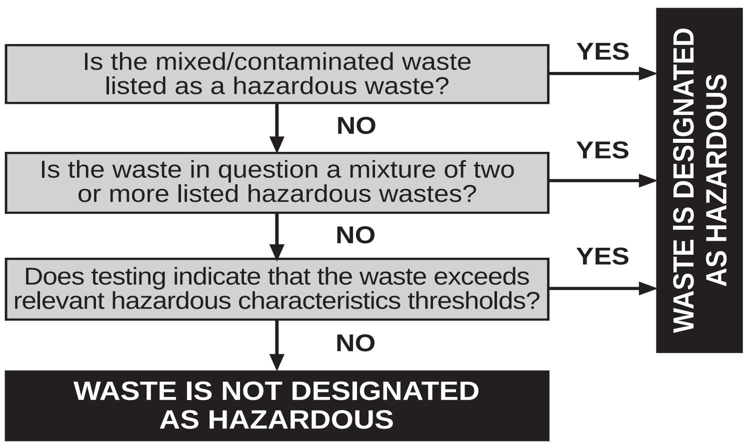


Figure 5: Assessment mechanisms for mixed and contaminated waste

CODE 1: The waste code (W Code)

The term ‘waste’ is defined as any substance, material or object in solid, liquid or gaseous form that meets the categories in the W Code (Appendix 3).

CODE 2: The New Zealand hazardous waste list (L Code)

The New Zealand hazardous waste list (L Code) incorporates narrative descriptions of hazardous waste generated in New Zealand that are typically known to exceed hazardous characteristics thresholds. Each listed hazardous waste is associated with a unique waste identification code that is used to code each waste (refer Appendix 3).

CODE 3: Hazardous characteristics thresholds (H Code)

Hazardous characteristics are defined by:

- relevant HSNO Regulations;
- the Land Transport Rule: Dangerous Goods 1999 and NZ Standard 5433: 1999 Transport of Dangerous Goods on Land for infectious substances; and
- the Radiation Protection Act 1965 and Regulations 1982 for radioactive materials.

Further detail is provided in the H Code in Appendix 3.

CODE 4: The industry classification code (ANZSIC Code)

The Australian and New Zealand Industry Classification (ANZSIC)is used as the basis for describing the source of a hazardous waste. This code will be used to the group title level, as shown in Appendix 3 (ANZSIC-Code).

CODE 5: Management code (D/R Code)

Depending on the final destination of the hazardous waste, a management code is allocated. The term ‘management’ in this context includes a range of activities, including reuse/recycling/recovery, storage, treatment and disposal options, as shown in Appendix 3 (D/R-Code). It should be noted that the presence of a hazardous waste on a site for more than 10 working days (for example for storage, treatment or disposal) represents an on-site hazardous waste activity and needs to be recorded as such.

2.4.3 Minimum threshold quantities

It is anticipated that record keeping will be limited to hazardous waste above minimum threshold quantities. These threshold quantities are still under development.

2.4.4 Requirements for record keeping

Record keeping requirements for hazardous waste will include:

- contact details of the current waste holder (including generators, transporters, and storage, treatment and disposal operators), comprising the organisation/individual name, street and postal address, telephone/fax and electronic details;
- hazardous waste description, including a narrative description of the waste, quantity, consistency, form, colour and odour, and UN Number/Classification (if the waste is a dangerous good for transportation purposes);
- hazardous waste classification based on the coding system described above;
- explanation of special handling instructions; and
- contact details of the destination waste holder (except for situations where the hazardous waste is handled/remains on site).

It is likely that special forms will be developed to enable consistent record-keeping and proof of transfer between two different hazardous waste holders. These forms will allow companies/organisations to establish an internal audit trail and a due diligence process for hazardous waste for which they are legally responsible. They will also enable the compilation of annual/biannual summary data for internal/external monitoring purposes.

The proposed record-keeping system will minimise the level of bureaucracy and paper use, and preferably be electronically based. It will complement similar record-keeping systems that must be maintained under HSNO and New Zealand land transport legislation.

Chapter 3
Hazardous Waste and Risk

3.1 Background

Hazardous waste is ubiquitous in industrialised countries. There is a wide range of activities that generate or otherwise involve hazardous waste in industry, commerce and households.

Hazardous waste typically does not remain at the place of generation. Rather, it is transferred to other places for storage, processing, treatment or final disposal. Hazardous waste therefore has a life-cycle that is characterised by changing locations, ownership and responsibilities.

Under normal operating and storage conditions, hazardous waste may be perfectly safe. However, accidents such as structural failures of containers or waste facilities, operational mistakes, transport accidents, human error, or even sabotage, can cause the release of hazardous waste to the environment. This can result in adverse environmental effects such as:

- acute and chronic exposure of people to toxins in air or water, including potable water sources;
- damage to property as a result of fire or explosion; and
- acute and chronic contamination of ecosystems.

The term ‘risk’ is commonly used to describe the potential for an adverse outcome from an unwanted event. The concept is used in a wide range of disciplines including finance, asset management, engineering design, environmental management and civil defence planning.

The overall concepts used to manage risks in these disciplines can easily be applied to hazardous waste, even though the actual methodologies vary according to the type of risk in question. This section provides a brief overview of the general concept of risk, associated definitions and an overview of the methodologies used.

3.2 Hazard and risk

The terms ‘hazard’ and ‘risk’ are often used interchangeably, but have the following distinct meanings:

- **Hazard:** Physical situations, processes and actions that have the potential to exert adverse effects on people, ecosystems, or the built environment.
- **Risk:** Represents the likelihood of specified consequences of a specific event on people, ecosystems, or the built environment (for example, damage to buildings, second-degree burns, hearing loss, fish kills, contamination of aquatic sediments, etc.).

It is not the presence of the hazard in itself, but the magnitude of risk it presents, which determines its significance. Therefore, if a hazard is well managed, it may never or only extremely rarely result in any adverse environmental effects.

3.3 The concept of risk

Irrespective of the application, the concept of risk is used to describe something adverse that may happen in the future, by asking the following questions:

- What can go wrong?
- How likely is it to happen?
- If it happens, what are the consequences?

In numerical terms, risk is estimated as the product of probability of an event occurring and the severity of the associated consequences:

RISK = PROBABILITY x CONSEQUENCES

Overall, the magnitude of risk is determined equally by probability and consequences. This means risks with a low probability of occurrence but high potential consequences can numerically equal other risks that may happen frequently but with low level consequences.

To reduce risks, either the likelihood or the magnitude of adverse effects can be addressed (or both). For example, by installing a roof and a sump at a hazardous waste drum storage facility, the probability of hazardous waste spills reaching the environment is reduced. Conversely, to reduce potential adverse effects of a hazardous waste spill from storage drums, the facility could be removed from sensitive environmental receptors. Both actions (joint or individually) would reduce the level of risk.

The above equation represents a very simplistic concept of risk. In reality, risk is often more complex and characterised by the probabilities of several contributing causes or several potential downstream consequences.

The term 'cumulative risk' is applied in situations where risks are additive either over space or time. For example, two neighbouring facilities that store waste flammable substances may present a combined cumulative off-site fire risk. Similarly, numerous small hazardous waste spills on a site may result in potentially cumulative long-term effects in the receiving environment.

3.4 Risks presented by hazardous waste

A typical life-cycle of a hazardous waste usually includes a significant number of steps, as described by the following example (Piasecki and Davis, 1987):

- process generation of the hazardous waste;
- on-site reuse or recovery;
- mixing with other by-products or waste streams;
- packaging in drums, tanks, transport vehicles or other containers;
- on-site storage: long-term or short-term;
- collection and initial transport;
- interim storage;
- mixing, repackaging, intermediate transport;
- initial processing (recycling, pre-treatment, blending;)
- repackaging and transport/transfer;
- final processing (incineration, treatment); and
- disposal of residue (landfill, retrievable storage).

Figure 6 provides an overview of the life-cycle of hazardous waste and potential adverse effects.

A common denominator in assessing the risks presented by hazardous waste are the inherent hazardous characteristics of the waste. A full understanding of these characteristics is therefore required based on the source of the waste, the raw materials and processes involved, as well as analytical testing.

Other than that, each step in the life-cycle of a hazardous waste presents specific risks that are defined by different circumstances, probabilities and potential consequences, and therefore need to be assessed on an individual basis. Examples of the different kinds of risk presented by hazardous waste that may need to be assessed include risks presented by:

- the transport of hazardous waste between a generator and a hazardous waste treatment facility;
- a fire in a hazardous waste storage facility to site workers and resident communities;
- stack emissions from the incineration of hazardous waste to surrounding communities and livestock;
- the disposal of hazardous waste incineration ash to groundwater quality and community health; and
- subsurface leachate from a contaminated site or a landfill to the ecological quality of a nearby estuary.

In line with the different types of risk that need to be assessed, the methodologies used can differ substantially, even though the underlying concept of risk remains the same.

3.5 Overview of risk management

The inherent concepts of risk management are the same, irrespective of the nature of the risk in question. Therefore, the same conceptual approach can be applied to the hazardous waste life-cycle. However, when reviewing overseas literature it is evident that the various terms used in risk management vary. A recent Australia/New Zealand risk management standard (Standards Australia and Standards New Zealand, AS/NZ 4360: 1999) provides a good reference point to develop a consistent terminology.

The standard describes the term risk management as "an iterative process consisting of well-defined steps, which, taken in sequence, support better decision-making by contributing a greater insight into risks and their impacts. The risk management process can be applied to any situation where an undesired or unexpected outcome could be significant or where opportunities are identified."

A simple illustration of conventional risk characterisation is provided in Figure 7, and the risk management process is outlined in Figure 8 and further described below. Figure 9 shows how this concept is applied to the case of hazardous waste.

3.5.1 Context

At the outset of risk management process, the context needs to be established. Context is determined partially by the nature, location, scale and time frame of the

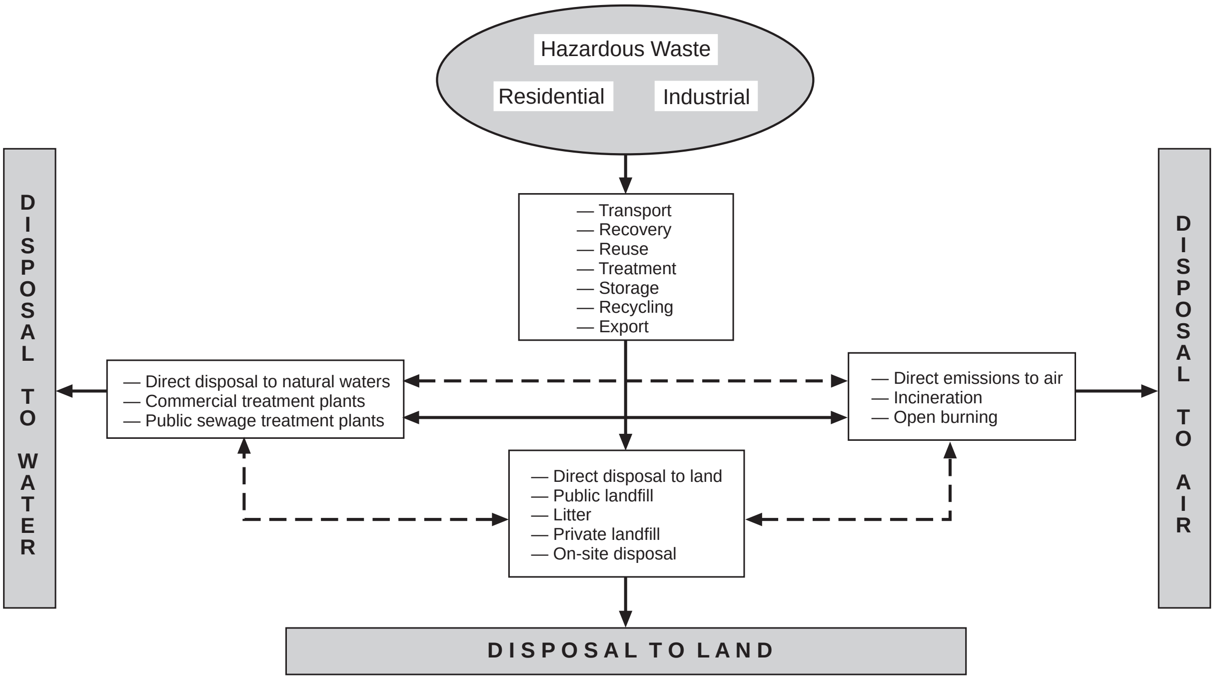


Figure 6: Life-cycle of hazardous waste

(Source: National Waste Data Report, MfE, 1997, with modifications)

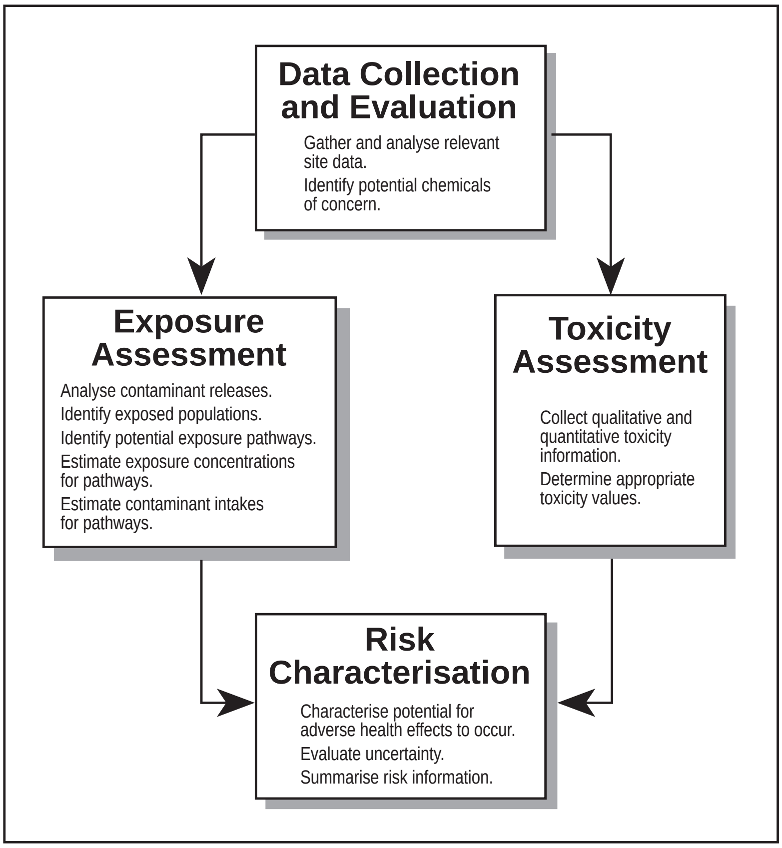


Figure 7: Risk characterisation

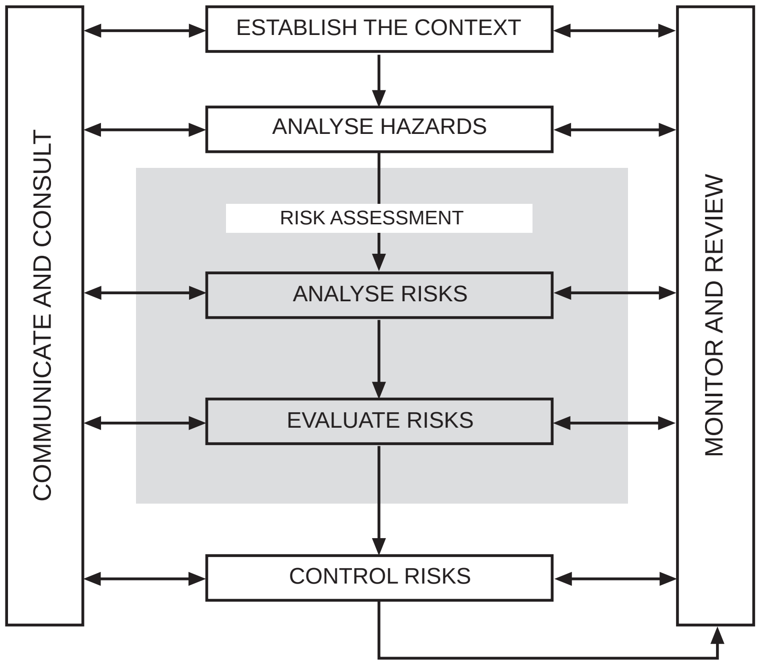


Figure 8: Conceptual overview of risk management

Source: AS/NZ 4360:1999 - Risk Management (with modifications)

activity in question. Other factors such as organisational structure and responsibilities as well as relationships with the external environment and relevant stakeholders also need to be considered.

Extensive information is also required about site-specific details and activities (for example treatment or transport), topography, climate, surface and groundwater characteristics, the sensitivity and density of local human populations, etc.

3.5.2 Hazard analysis

Hazard analysis comprises the systematic identification and description of hazards associated with a particular activity or location, that is, answering the question 'what can go wrong?'. Focus is placed on identifying events, situations, installations or activities with the potential for an accident with significant consequences. This could, for example, be sabotage of a hazardous waste storage facility, the transfer of hazardous waste between facilities, operational failure of an incinerator or a landfill, or human error in handling a hazardous waste.

Hazard analysis is often based on methods such as:

- site surveys or hazard audits;
- checklists;
- the use of maps, drawings or overlays;
- networks (a flow chart analysis of a problem that has been identified;
- matrix analysis (tables that evaluate hazards against possible failure modes and consequences); and
- hazard and operability analysis (HAZOP, a technique that is used to identify operational hazards thought an entire facility or process).

Suitable information sources for hazard analysis methods are discussed in Chapter 3.6.

3.5.3 Risk analysis

Risk analysis focuses on answering the questions 'how can it go wrong?' and 'what will be the consequences?' by estimating probabilities and assessing the potential consequence of each hazard within the context of existing or proposed control measures. An example of this is assessing the likelihood of landfill liner failure and the resulting escape of toxic leachate to potable groundwater resources, based on specified standards for liner thickness, permeability and construction standards.

This includes an assessment of:

- the nature and quantity of the hazardous waste involved;
- potential failure modes or accidents and associated probabilities;

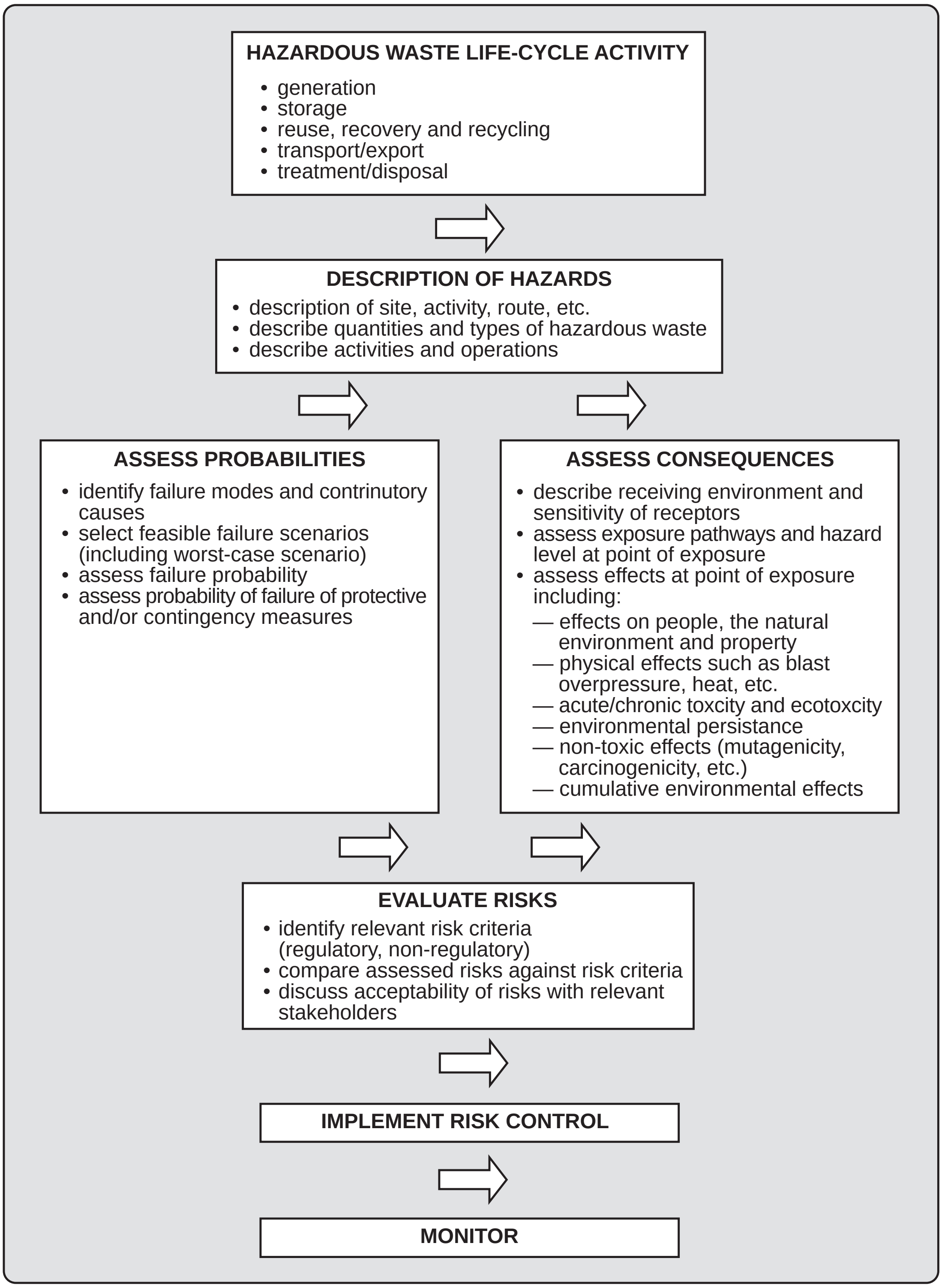


Figure 9: Risk management of hazardous waste

- the effectiveness of exposure pathways (for example, can the hazardous waste reach receptors such as sensitive ecological or human communities) and any protective measures that may have been installed or planned for; and
- the extent of consequences to the receptors.

A wide range of methods can be used for a risk analysis. They range from simple qualitative methods to highly sophisticated and technical quantitative methods that are based on complex models and computer software.

It is, however, beyond the scope of this document to provide such substantial detail, as the methodologies used for different types of hazardous waste and life-cycle scenarios are highly variable.

It is customary to begin with simple and qualitative methods to determine which risks are deemed to be significant and then move on to semi-quantitative and quantitative methods to assess the prioritised risks in greater detail. Risk assessment methods may include:

- site surveys and field studies;
- checklists and matrices, used together with a scoring system to estimate probabilities and consequences;
- fault and event trees (graphical flow charts to analyse the contributing events leading to an accident, or the resulting consequences);
- semi-quantitative and quantitative risk calculations;
- application of a range of standardised public health and environmental risk analysis models; and
- computer risk analysis software.

Suitable information sources are provided in Section 3.6.

3.5.4 Risk evaluation

Risk evaluation is the process that determines the significance and acceptability of risks. This requires the setting of 'bench marks' or risk criteria against which the acceptability of the risks is assessed. The selection of suitable risk criteria depends on the context of the risk concerned and a range of internal and external driving forces. Above all, the acceptability criteria selected must be both publicly and technically defensible.

External risk criteria may be driven by regulatory requirements (for example, a soil contaminant or air quality standard), or established Standards and Codes of Practice, as well as the perceptions of affected stakeholders. Internal risk criteria may be determined by available technology, asset management strategies and finances.

3.5.5 Risk control

If the identified risks have been assessed as unacceptable, appropriate measures for risk control (or risk treatment as per AS/NZ 4360: 1999) need to be identified and applied. The success of these measures is evaluated by feedback into the risk management process through ongoing monitoring and review.

3.5.6 Risk communication

Risk communication is a further important aspect of risk management. The benefits of good risk communication from an early point in the process cannot be stressed enough, as the availability of information to the community and the associated build-up of trust and goodwill may significantly change the perceptions of stakeholders and ultimately the acceptability of risks.

3.5.7 Uncertainty

Risk assessment also needs to consider the level of uncertainty that is attached to the results. As a general word of caution, any risk assessment is only as good as the underlying data employed, as well as the technical expertise and professional judgement that is applied.

The results, whether they are quantitative or qualitative, need to be interpreted and used with great care and within the appropriate context. Sensitivity analysis, that is, a check of the susceptibility of the risk methodology used to make changes in input variables, is an important method of assessing the reliability of the methodology used.

3.6 Information sources

It is beyond the scope of this document to go into the detail of the various methods and techniques used for the risk assessment of hazardous waste. However, there is a wide range of information available in the public domain that outlines relevant approaches to and methodologies for risk assessment.

Of importance in this context is the combined Australia and New Zealand Risk Standard (Standards Australia and Standards New Zealand, AS/NZ 4360: 1999) as well as the *Handbook of Environmental Risk Management* (Standards Australia, 1999). A document recently prepared for the Ministry for the Environment (MfE, 1999: *Assessment Guide for Hazardous Facilities*) provides an overview of risk assessment approaches for hazardous facilities, i.e. facilities involved in the storage, use, transport and disposal of hazardous substances. This document provides a tool box for both hazard and risk analysis, and outlines the general approaches taken for qualitative, semi-quantitative and quantitative risk assessment methods.

The United States Environmental Protection Agency (USEPA) has developed a large number of documents addressing a wide range of risk assessment methods, especially for the assessment of contaminated sites, hazardous waste disposal facilities and air emissions from hazardous waste incinerators. Further, the USEPA has published extensive information on acceptable public health and ecological exposure limits for a wide range of specific contaminants that can be used as benchmarks against which the acceptability of risks can be assessed.

Chapter 4
Managing Hazardous Waste

4.1 The Waste Management Hierarchy and its application to hazardous waste

In most industrialised countries, the Waste Management Hierarchy (sometimes called 'The 5 Rs') forms the basis of their waste management policies. The hierarchy describes the steps that need to be taken to manage waste as efficiently and cost-effectively as possible (Figure 10).in

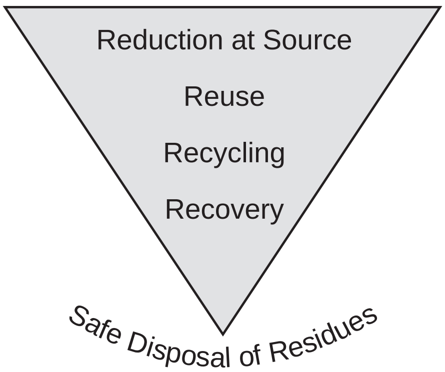


Figure 10: The Waste Management Hierarchy

- **Reduction** — minimising the generation of waste;
- **Reuse** — the use of a waste material in its current form;
- **Recycling** — the conversion or processing of a waste material into a new product or the raw material for a new product. This includes the process of composting;
- **Recovery** — the recovery of energy from waste; and
- **Residuals Disposal** — the disposal of waste that cannot be subjected to any of the above steps.

The Waste Management Hierarchy also applies to hazardous waste, which has the potential for considerable adverse environmental impacts. Waste reduction, which typically results in the least environmental and economic life-cycle costs because it requires little or no collection and processing of materials, is therefore particularly beneficial. It also produces significant benefits in terms of production efficiencies and use of resources.

Reuse, while often a viable option for non-hazardous waste, should be considered with caution when dealing with hazardous waste, as the waste may not be suitable for reuse due to the health and environmental effects associated with its repeated handling. Although similar concerns apply to the recycling of hazardous waste, this usually involves some kind of refining process (as is the case with the recycling of waste solvents and waste oil) which should be subject to quality control procedures. Some types of hazardous waste, for example waste oil due to its high calorific value, are also appropriate for use in a recovery process, provided that this does not result in adverse environmental impacts and is carefully controlled and monitored.

Despite the various options available, waste management is still generally approached from the bottom of the hierarchy — by far the majority of waste is disposed of in landfills, sometimes without appropriate treatment to render them non-hazardous. Consequently much more attention and resources need to be given to moving 'up' the hierarchy and adopting other, often more efficient ways, of managing hazardous waste. One of the key elements in this undertaking is the adoption of the principles of Cleaner Production (refer Chapter 4.2).

4.2 The principles of Cleaner Production

Much of the current thinking on environmental protection focuses on what to do with waste and emissions after they have been created. In contrast, it is the goal of Cleaner Production (CP) to avoid generating pollution and waste in the first place, which frequently cuts costs, reduces risks and identifies new opportunities. However, CP is also a concept that extends beyond the management of waste, and is therefore not restricted to the steps described in the Waste Management Hierarchy.

The United Nations Environment Programme (UNEP) has adopted the following definition:

> *"Cleaner Production is the continuous application of an integrated preventive*

environmental strategy applied to processes, products, and services to increase efficiency and reduce risks to humans and the environment."

The concept is therefore one of the basic building blocks of developing a sustainable approach to the use, management and development of resources. Applied specifically, CP means:

- **In production processes**, the conservation of raw materials and energy, elimination of toxic raw materials, and reduction of the quantity and toxicity of all emissions and waste before they leave the process.

- **With respect to products**, the reduction of negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal.

- **In relation to service delivery**, the elimination or reduction of adverse environmental impacts associated with the service and/or the products used to provide the service (for example, the use of non-polluting vehicles for courier delivery).

The successful implementation of CP policies and techniques requires changing attitudes and responsible environmental management. To this end, a wide range of tools may be used, from life-cycle analysis, training, education and voluntary agreements to environmental labelling, industry-specific environmental accreditation and financial incentives. Of particular importance in this respect is the implementation of an environmental management system (EMS) such as ISO 14001. This international standard was finalised in 1996 and superseded an earlier British Standard. While ISO 14001 covers the fundamentals of an EMS, a series of other related standards are in preparation that relate to environmental management and environmental performance. Under ISO 14001, organisations commit themselves to identify and manage significant environmental issues related to their activities and to comply with the law and other requirements.

It is beyond the scope of this document to explore Cleaner Production in detail. However, a wealth of information on this topic is available both on-line and in hard copy (refer Bibliography). One of the most versatile and useful sources is the United Nations Environment Programme's (UNEP) Cleaner Production Information Clearinghouse (*www.unepie.org/Cp2/home.html*). New Zealand specific information sources that may be of interest to the reader are listed below.

- **The CP Database.** A website providing information on CP in New Zealand, including case studies and links to other relevant sites, on *www.arc.govt.nz/cp/*

- **Cleaner Production Guide for Hospitals** (Opus International Consultants Ltd., 1997), which provides guidance for introducing CP techniques to the hospital environment.

- **Cleaner Production Guidelines for Institutions of Scientific Research and Technical Services** (Wellington City Council, 1997). This study focuses specifically on research institutions such as universities and provides advice on CP initiatives.

- **Cleaner Production Guidelines for the Water Transport Industry** (Wellington City Council, 1997) targets the shipping and port industries with advice for implementing CP programmes.

- **Cleaner Production Guide for the Food Service Industry** (Wellington City Council, 1996) offers advice for restaurants, cafes and related hospitality industry businesses.

- **Workplace Pride Wellington - An Information Package on Cleaner Production** (Wellington City Council, 1995) provides general CP information for businesses.

- **Cleaner Production and the Tourism Sector** (MfE, 1994) outlines CP case studies undertaken in the tourism sector in Rotorua.

- **The Cleaner Production Guidelines** (MfE, 1994). Aimed predominantly at local authorities, this document contains basic information about CP, advice on establishing programmes and a number of case studies.

- **Cleaner Production at Work** (MfE, 1993) provides examples of the application of CP techniques in a wide range of industries in New Zealand, using a case study approach.

4.3 Waste audits

4.3.1 Overview

It is a basic principle that one cannot manage what cannot be identified or measured. In order to effectively manage hazardous waste it is therefore necessary to obtain information on the types and quantities of waste produced by all processes within a given area of responsibility. This may be done as part of a waste auditing programme.

A waste audit may be defined as "a thorough account of the waste from an industry, a plant, a process, or a unit operation." (UNESCAP, 1994). It requires the derivation of a material balance for each part of the operation and should result in the identification of waste types, their origin, quantity, composition and potential for reduction.

According to another United Nations source (UNEP/UNIDO, 1991), a properly conducted waste audit should provide:

- identification of sources, quantities and types of waste being generated;
- information on unit operations, raw materials, products, water uses and waste;
- identification of process inefficiencies and areas of poor management;
- information allowing targets for waste reduction to be set;
- the development of cost effective waste management strategies;
- increased awareness in the workforce regarding the benefits of waste reduction;
- increased knowledge regarding the processes generally; and
- assistance with the general improvement of process efficiency.

Generally, a waste audit covers all types of waste (liquid, solid, gaseous, and in many cases energy) and is not restricted to those exhibiting hazardous characteristics. An audit should also lead to the development of a waste reduction action plan (Figure 11).

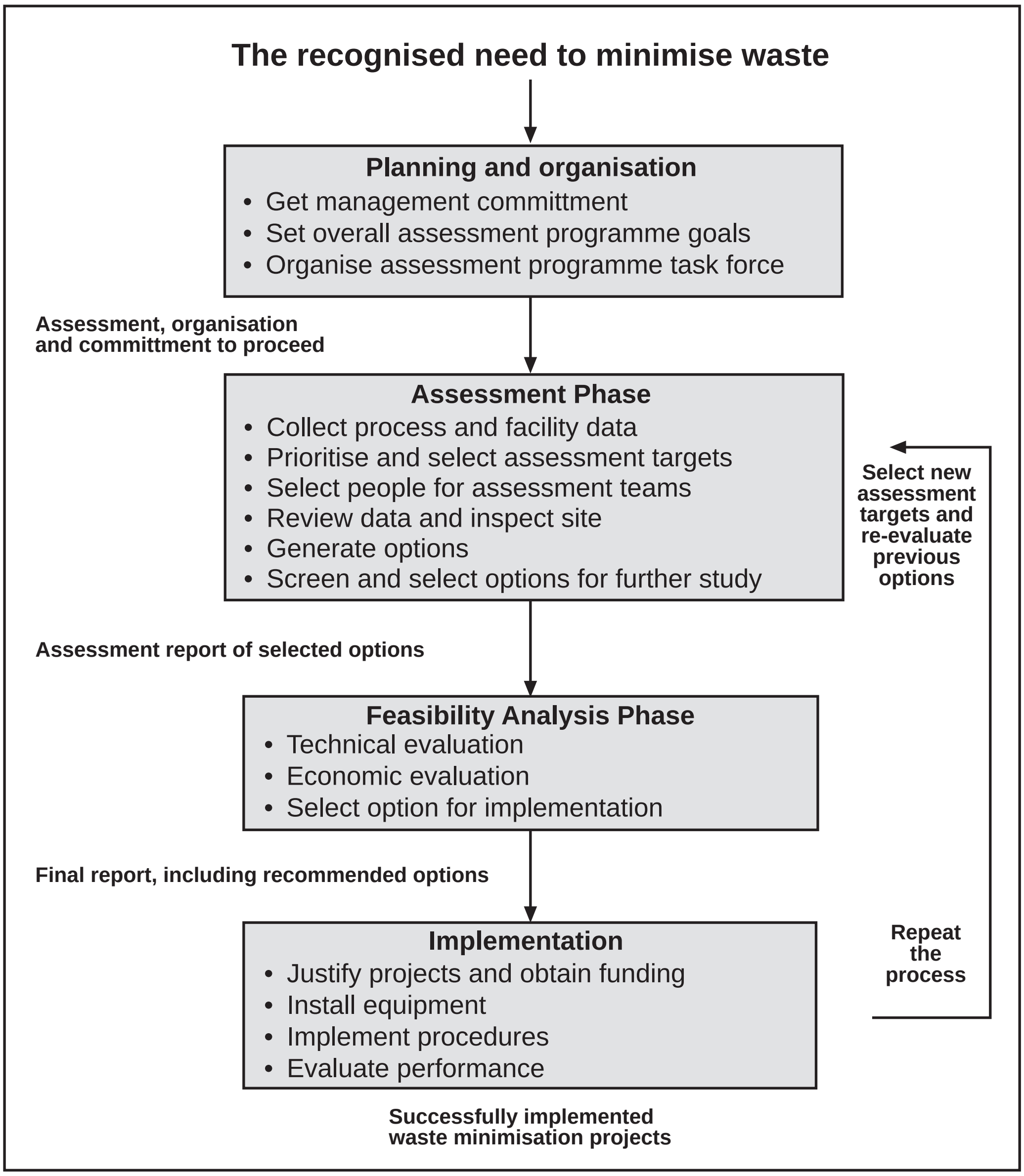


Figure 11: Overview of a waste reduction plan

The audit process can be broken up into three phases:

- **Phase 1:** Pre-assessment;
- **Phase 2:** Establishment of materials balance; and
- **Phase 3:** Information synthesis and establishment of waste reduction measures.

4.3.2 Phase 1: Pre-assessment

An effective waste audit requires:

- management commitment;
- staff involvement;
- establishment of clear objectives; and
- provision of resources to accomplish the objectives.

Following managerial commitment to the audit, an audit team needs to be established and provided with the necessary resources to carry out the task. The team usually comprises a leader and several members. Its actual size will be determined by time limitations, availability of staff and the size and complexity of the processes involved. Team members should be selected on the basis of their knowledge of waste auditing, the processes involved, the purchasing of raw materials and the marketing of products.

4.3.3 Phase 2: Establishment of materials balance

This phase divides the processes to be audited into unit activities, with a materials balance being prepared for each activity. The typical components of a materials balance are illustrated in Figure 12. Process and production documentation as well as the experience of the auditing team members are likely to be the primary sources of information, for example:

- process flow diagrams and layout plans;
- operating manuals;
- raw material specifications;
- product composition and batch sheets;
- production records, operating schedules and operator data logs;
- product and raw material inventory logs;
- Material Safety Data Sheets (MSDSs) for all materials and products involved;
- maintenance procedures and maintenance records;
- waste disposal charges; and
- resource consents and other regulatory documents relating to the processes.

Upon completion of this phase, each unit activity should have a materials balance which clearly shows how materials flow through the process and what waste is produced.

The MSDSs should assist by providing information on whether or not the waste is likely to be hazardous.

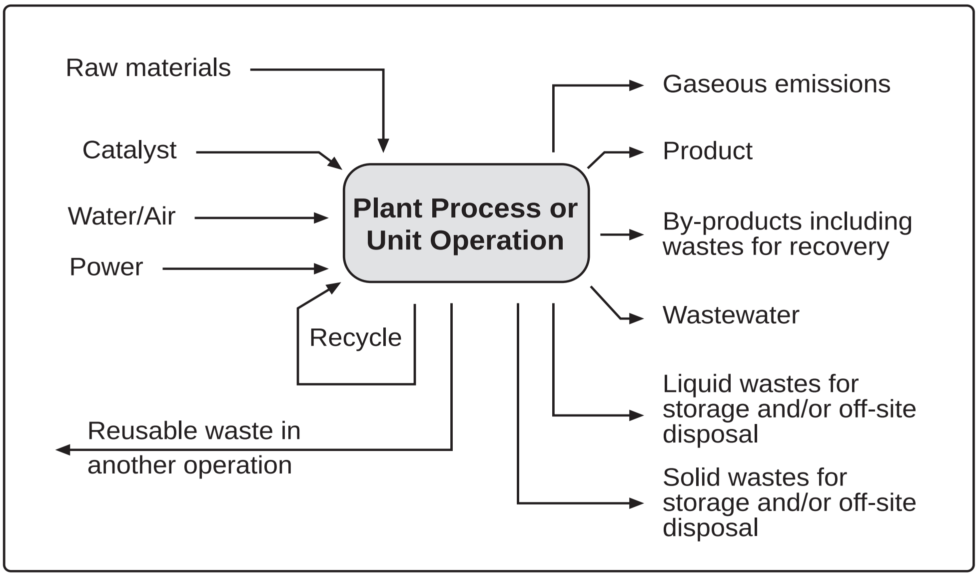


Figure 12: Typical components of a materials balance

4.3.4 Phase 3: Information synthesis and development of waste reduction measures

Evaluation of the information generated in Phase 2 should result in the development of waste reduction measures. Many of these can usually be implemented immediately and with little or no cost, for example:

- **the introduction of a materials inventory system** to minimise overstocking and stock deterioration;
- **quality control** at the time of material reception to ensure that incoming materials are not in leaking or unlabelled containers, and that material composition and quality are correct;
- **storage controls** to ensure that materials are appropriately segregated, spillages and leakage are minimised through adequate containment and a high standard of housekeeping is maintained (refer Chapter 8);
- **minimisation of materials transfer** on the site, including checks to ensure integrity of transfer lines and collection (and use) of materials drained from transfer lines;
- **establishment of a monitoring programme** to record emissions and waste from each unit;
- **implementation of a maintenance schedule** for all process equipment;
- **identification of cleaning and reuse and/or recycling procedures** to minimise the use of water or other cleaning agents and therefore the generation of waste; and
- **targeting the hazardous waste generated** by the different process and establishing methods to eliminate or reduce such waste.

Waste problems that cannot be solved by simple procedural adjustments or improvements in house-keeping practices will require substantial long-term change. In such cases, a comprehensive Cleaner Production programme (refer Chapter 4.1) should be initiated.

4.3.5 Waste audits — conclusions

A waste audit is an essential starting element in the development of a programme to effectively manage hazardous waste.

It provides for the identification, classification and quantification of the waste produced, and so creates opportunities for developing measures to reduce this waste, resulting in economic and environmental benefits.

4.4 General hazardous waste management issues

'Best practice' management of hazardous waste at all stages of its life cycle requires knowledge, information and attention to detail. A good overview of the different issues that need to be considered is provided by the US Treatment, Storage and Disposal Facilities (TSDF) Regulations (USEPA, 1997). These Regulations promote safe practices with respect to the handling of hazardous waste and avoiding the creation of contaminated sites. The Regulations apply both during operation and after closure of these facilities.

While not all requirements may be applicable to New Zealand activities, the principles on which these regulations are based provide guidance on hazardous waste management matters that should be addressed. They should be incorporated — together with Cleaner Production principles —into an environmental management plan or auditing/accreditation system (e.g. ISO 14001) (refer Chapter 4.2) for any hazardous waste facility. A brief outline of these principles is presented below:

- **Full understanding of waste composition and hazardous characteristics of the waste.** This includes procedures to ensure that waste despatched or received corresponds to the waste described in any accompanying documentation. Other approaches include the identification of waste analysis parameters, sampling methods and laboratory methods/specifications, defining the frequency of "spot tests" and establishing acceptance or rejection criteria.
- **Adequate site security.** There must be adequate provision to prevent accidental and unauthorised entry of people or livestock into the facility. This may be achieved through surveillance systems, artificial barriers such as gates and fences, and/or signs.
- **Regular site inspections.** Each facility should have a written inspection schedule addressing malfunctions, deterioration, operational errors, discharges, etc. Areas subject to spillages should be inspected daily. Results of inspections, observations and remedial actions should be recorded in a log.
- **Formal staff training.** Each staff member should have a written job description as well as having received training covering emergency procedures. Individual training records should be maintained and regularly reviewed.
- **Flammable, reactive and incompatible waste.**

Such waste necessitates special precautions that should be clearly documented and be part of staff training. Examples are protection from ignition sources, restrictions relating to smoking and the display of appropriate warning signs. Further information on incompatible hazardous waste types is provided in Appendix 4.

- **Siting of facilities.** The same precautions should be taken with siting as for any other facility involving a hazardous activity.
- **Construction quality assurance.** Following the construction of a facility for the generation, treatment, storage and/or disposal of hazardous waste, compliance with design criteria must be certified by an appropriately-qualified registered engineer.
- **Emergency planning and management.** A comprehensive system covering emergency prevention (e.g. spill prevention), emergency preparedness and emergency management should be developed, fully documented and be incorporated into staff training. Emergency management procedures should include contingency plans, emergency procedures and de-briefing processes (refer Chapter 9).
- **Waste tracking.** A waste tracking system allows any waste to be followed from the point of generation through intermediary stages to final disposal. It should incorporate manifests that accompany a specific waste load at any given time to enable identification of the waste and to provide evidence of its fate (refer Chapter 8).
- **Operational records.** Complete records of all waste generated or received, including dates, type and quantities of waste, methods of storage, transport, treatment and disposal of residues should be kept. These records should be cross-referenced to inspection reports, monitoring and analytical data and to incidents occurring which may lead to site contamination. Records should be kept for the full life of the facility, including any period of after-closure care.

4.5 New Zealand hazardous waste management initiatives

Apart from the recently established Hazardous Waste Programme which intends to investigate and improve the regulatory framework for hazardous waste management at Government level, there are few examples of successful government initiatives to manage hazardous waste. Of the three programmes outlined below, one was initiated by central government (waste oil), while the other two were organised by local government.

4.5.1 The Oil Recovery Programme

In 1996, the Ministry of the Environment (MfE), in conjunction with the Oil Industry Working Group[1] launched the Used Oil Recovery Programme. This initiative was a voluntary partnership programme between the government and the oil industry, with the goal of recovering used oil throughout New Zealand by launching relevant education programmes and providing a distribution and collection network. The collected oil was to be re-refined at the Dominion Oil Refinery in Auckland (which has since closed down), with any surplus being used as fuel for the Milburn cement kiln in Westport.

Early in 1999, MfE acknowledged that the Programme was not as successful as originally hoped, and announced its intention of developing a National Environmental Standard under the RMA to control the use and disposal of waste oil.

The current Ministry for the Environment work programme has three elements to it. These are:

- development, with the oil industry and other stakeholders, of a Code of Practice for the management of used oil;
- assessment of the environmental effects of particular forms of discharge, with a view to improving environmental controls; and
- consideration of options for enhancing the current Used Oil Recovery Programme.

4.5.2 Local government collection programmes for unwanted agricultural chemicals

The Taranaki Regional Council was the first local government authority to undertake a free collection of unwanted and redundant agricultural chemicals from the farms in its region . Taranaki's example was soon followed by other regional councils and unitary authorities[2], and by 1998 such collections had occurred in all but three regions in New Zealand.

1 This group comprises BP NZ Ltd, Caltex Oil (NZ) Ltd, Castrol NZ Ltd, Dominion Oil Refining Company, Milburn NZ Ltd and Shell NZ Ltd.

2 To date, the following councils have undertaken collections of unwanted agricultural chemicals: Auckland Regional Council; Environment Bay of Plenty; Environment Waikato; Gisborne District Council; Hawke's Bay Regional Council; Manawatu-Wanganui Regional Council; Marlborough District Council; Northland Regional Council; Otago Regional Council; Southland Regional Council; Taranaki Regional Council; and Tasman District Council.

The majority of the waste collected was either re-issued or treated for disposal within New Zealand. However, each council was left with a residue of agricultural chemical waste, such as organochlorine pesticides, for which no local treatment and disposal option exists. Consequently these materials remain in storage until the manner of their destruction is decided.

Some regional councils continue to offer drop-off facilities for unwanted agricultural chemicals. The following is an example of a large-scale and successful agricultural collection programme.

Storage of agricultural chemicals in a farm shed
(Haz-Tech Environmental Ltd)

Environment Waikato agrichemical collection

Following the example of the Taranaki and Northland Regional Councils, Environment Waikato initiated a collection of agricultural chemicals in its region in late 1991, for the following reasons:

- the risk that small on-farm stockpiles of hazardous waste present to the environment;
- the need to provide a non-regulatory, positive and cost-effective solution to the threat created by these stockpiles; and
- to fulfil Environment Waikato's function for integrated management of the region's natural and physical resources under Section 30 of the RMA.

Upon development of a management plan for the collection, Environment Waikato advertised for tenders to undertake the work, and collections began on a district by district basis in mid-1992 in the Waipa district. The collection was initially funded by Environment Waikato with contributions from territorial authorities. A small subsidy was received from the Sustainable Management Fund (SMF) towards the end of Phase One of the programme.

The collection in each district was preceded by intense advertising, and farmers were notified by mail of the collection times in their district. Registration with Environment Waikato was required to enable the contractor to develop an efficient pick-up schedule. In this manner, all districts within the Waikato region were covered by the collection, which was completed in December 1994. Over 62 tonnes of agrichemicals were collected from 1560 farms. At the completion of the programme, with the assistance of community surveys, Environment Waikato concluded the following:

- there was a likelihood that there would still be unwanted agrichemicals on farms that had missed or ignored the collection advertising;
- a community expectation had been created to the extent that the cancellation of the service would create risks of illegal dumping of hazardous waste, and on occasions this literally happened on Environment Waikato's doorstep; and
- territorial authorities (TAs) were the most appropriate agencies to continue providing collections with support from Environment Waikato to achieve economies of scale.

Environment Waikato therefore embarked on a partnership approach with territorial authorities to offer drop-off facilities where agrichemicals could be taken free of charge. In some cases (e.g. Hamilton City Council), these drop-off points also accept household hazardous waste (HHW), although this is done at the cost of the TA operating the facility.

To fulfil its role in the ongoing collection programme, Environment Waikato has provided:

- assistance with obtaining SMF grants from MfE for the establishment of hazardous waste collection depots;
- written guidelines for the management of these depots;
- training for TA staff and contractors from OSH and hazardous waste specialists; and
- long-term storage and disposal of the agrichemicals collected.

The drop-off facilities continue to operate in those districts where the TAs have agreed to collaborate with Environment Waikato (five TAs, with a further two TAs planning to establish drop-off points, out of a total of 11 TAs located in the Waikato region).

Collected chemicals are either:

- redistributed to other users;

- returned to their manufacturers;
- destroyed using existing New Zealand based technology; or
- stored pending identification and final disposal in New Zealand or overseas in accordance with the Basel Convention.

In Environment Waikato's experience only 25% of the chemicals received were not able to be identified and disposed of immediately.

At the end of 1999 all of the chemicals initially collected will have been disposed of safely and in accordance with New Zealand legislation and the requirements of the Basel Convention. Environment Waikato estimates that its ongoing cost of providing this collection programme will be $25,000 per annum.

4.5.3 Organochlorines

MfE has recently completed a major survey to determine background levels of organochlorines in our soils, rivers, estuaries, air, in food, and of the level of these contaminants in the New Zealand population.

MfE is currently developing an organochlorines management strategy (which is part of the broader hazardous waste management strategy). This is aimed at addressing five existing areas of risk:

- cumulative risk to human health;
- risk to food safety;
- cumulative environmental risk;
- site specific environmental risk; and
- economic risk to trade and tourism.

The public consultation phase on the draft organochlorines management strategy is expected to commence in April 2000. A key part of this strategy will be the development of national environmental standards (under the RMA) for controlling emissions of dioxins and PCBs.

4.5.4 Household Hazardous Waste (HHW) collection programmes

Separate collections of HHW, often by mobile units collecting directly from residents are a common element of waste management programmes in many European and North American states. Although this service is not offered in New Zealand, drop-off facilities for HHW and unwanted agricultural chemicals operate in many centres in the northern and central parts of the North Island. These are generally operated by regional councils or territorial authorities, or as a joint undertaking between the two.

An example of a HHW collection programme is provided by the scheme operating in the Auckland Region. Following on from its collection of agrichemicals in 1993/94, the Auckland Regional Council (ARC) entered into agreements with Wrightson Rural Services Ltd to provide drop-off facilities for agrichemicals in a similar manner to the arrangements operating in the Waikato Region. Informal arrangements were also made with some of the transfer stations in the region to collect HHW.

In 1998, the ARC upgraded the drop-off facilities for HHW and improved the management of the collection programme. There are now five transfer stations in the Auckland Region that provide a drop-off facility for HHW, and two further transfer stations are being considered. In addition, the ARC collaborated with the Auckland City council to provide a once-off, two-day collection of HHW for Waiheke Island residents.

During its first year of operation, the HHW drop-off facility network collected the following waste quantities:

- 60 tonnes of paint waste (82% of total waste);
- 12 tonnes of waste that was treated and disposed of (17% of total waste); and
- 1 tonne of waste destined for storage as no treatment and disposal options are available in New Zealand (1% of total waste).

Advertising for the drop-off facilities has been deliberately low-key during the first year to avoid overloading the facilities; despite this approach, usage of the drop-offs has increased steadily.

Chapter 5

Treatment Processes and Technologies

5.1 Introduction

This chapter briefly reviews hazardous waste treatment technologies established in New Zealand, and technologies commercially available in Australia, which are applicable to more difficult hazardous waste such as organochlorine-containing compounds. Those technologies not already operating in New Zealand have been included because of their accessibility and because, in at least two cases, resource consents for their establishment locally were being sought at the time this document was being compiled.

The fact that technologies are included in this review should not be taken as a recommendation or endorsement. Each process must be specifically evaluated on its ability to adequately treat the waste under consideration, and its ability to operate within the conditions of all resource consents required should be clearly established.

In conjunction with Chapters 6 (Thermal Processes) and 7 (Land Treatment, Disposal and Containment of Hazardous Waste), this chapter aims to assist in the identification of potential treatment methods for specific hazardous waste. However, it should be recognised that not all appropriate methods may have been discussed.

Further, it is recommended that once appropriate treatment methods are identified, issues such as likely environmental outcome, accessibility of the treatment facility, regulatory compliance, economics, reliability of performance, and health and safety implications are considered before a final decision is made.

5.2 Definition of treatment

Prior to any review of the methods available for the treatment of waste, it is pertinent to define the term 'treatment', as there may be many, quite diverse understandings of this concept. In the context of this document, 'treatment' is considered to be any process applied to a waste stream from the point of its generation to the point of disposal. It is therefore not limited to in-house or commercial waste treatment processes but also includes those operating within a waste water treatment plan, a landfill and/or an incinerator.

By implication, such a definition assumes that some preconditions have been met, e.g. that the principles of Cleaner Production have been applied before 'treatment' of the residual waste is considered.

Treatment can therefore be defined as:

> *"Any physical, chemical or biological change applied to a waste material prior to its discharge or ultimate disposal, in order to reduce any potential adverse effects on:*
>
> *— the health and safety of the operators of subsequent processors of the waste, containers and conveying facilities including sewers pumping stations and the like; and*
>
> *— disposal processes such as a landfill or a waste water treatment plant, and/or the environment generally."*

Treatment of hazardous waste prior to discharge to the sewer system or a landfill should address factors such as:

- the health and safety of workers and treatment plant operators;
- effects of the waste on pipework;
- the possibility of the waste adversely affecting the waste water treatment plant or landfill processes;
- the ability of the treatment plant or landfill to sufficiently reduce the hazardous characteristics of the waste so that any residual can be released into the environment without giving rise to adverse effects; and
- compatibility of the waste with any other waste being disposed of in a similar manner.

The choice of an appropriate method for treating a specific hazardous waste is influenced by a variety of factors, including:

- risks involved;
- quantities;
- concentrations;

- location;
- availability of appropriate treatment facilities; and
- relative cost in comparison with other acceptable methods for disposal.

The effectiveness of a given treatment process is dependent on the nature of the hazardous waste. In some instances, one treatment process may achieve the treatment efficiency desired, whereas in other cases, multiple treatment processes may be the only option. It should be noted that residues of treatment processes may themselves require particular care with respect to final disposal.

5.3 Waste composition and characteristics

To select appropriate treatment options for a specific hazardous waste, its composition, properties and characteristics must be clearly established. This data is also important for the production of a Material Data Safety Sheet (MSDS) which documents essential health, safety and environmental information specifically relating to the waste. In many cases all (or most) of the information required will not be immediately available from the waste generator. Commercial laboratories or the providers of special waste treatment should, however, be able to provide assistance.

The information required can be categorised as follows[1] :

- **Chemical composition**
  - — common name and origin of waste;
  - — hazardous organic or inorganic components;
  - — percent chemical composition — this should add up to 100 %;
  - — leachability data on components where available;
  - — pH; and
  - — BOD.
- **Physical properties**
  - — physical state e.g. solid, liquid or sludge;
  - — phases;
  - — total solids and or suspended solids;
  - — type of solids, e.g. organic, inorganic or mixed;
  - — specific gravity;
  - — viscosity;
  - — flash point;
  - — boiling point;
  - — freezing point;
  - — vapour pressure;
  - — calorific value;
  - — ash content;
  - — odour; and
  - — colour.
- **Hazardous properties**
  - — flammable;
  - — corrosive;
  - — reactive, including reactivity with water;
  - — explosive;
  - — radioactive;
  - — human toxicity — by inhalation, ingestion, or dermal contact; and
  - — ecotoxicity.
- **Information required by Regulations or Standards**
  - — HSNO requirements if it is a waste hazardous substance under that Act.
  - — Land Transport Rule: Dangerous Goods 1999 (e.g. UN number, proper shipping name, dangerous goods class, packing group, emergency procedure guide and dangerous goods declaration).
  - — HAZCHEM code.

1 It should be noted that the categories are provided for illustrative purposes and should not be regarded as complete, or that all items are required in every specific case.

5.4 Treatment methods available in New Zealand

The *CAE 1992 Report* gave particular consideration to treatment methods applicable to waste arising in New Zealand, and which were included in the compendium of treatment technologies for the treatment of hazardous waste published by the United States Environmental Protection Agency (USEPA) in 1987. Most of these technologies are still appropriate and are again briefly reviewed in this document.

As part of this review, a survey of waste treatment facilities offering services in New Zealand was undertaken. All commercial waste treatment processes advertising their services were identified. These were initially contacted by telephone to establish whether or not they were processing hazardous waste. All facilities treating hazardous waste agreed to participate in the survey, and two questionnaires were developed and posted to the participants. Overall, nine facilities operating in Auckland, Wellington and Christchurch were identified, as well as a small facility specialising in the treatment of waste arising from photographic processes, which operates in Dunedin. In addition, many waste generators have established in-house hazardous waste treatment facilities.

The first questionnaire sought details of:

- the companies;
- their location;
- the regions serviced;
- services provided;
- documentation required from the waste generator;
- treatment processes offered;
- documentation supplied to the waste generator after treatment and to disposers of any process residuals; and
- facilities available for recovery and recycling of waste or components.

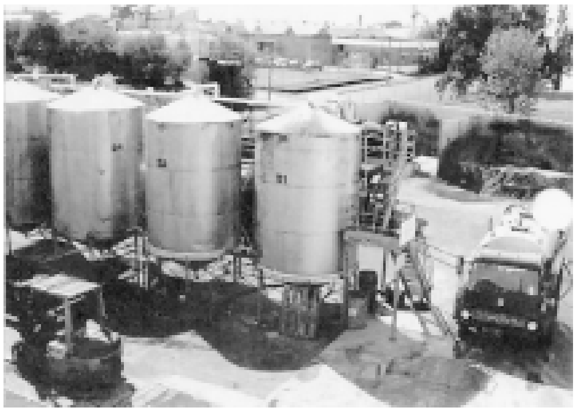
The second questionnaire covered each of the treatment processes indicated as available in the first. Information requested concerned:

- the type of process;
- description of waste treated and processes producing the waste;
- hazardous constituents in the waste;
- measure of effectiveness of the treatment process (e.g. encapsulation so as to comply with TCLP criteria, or chemical neutralisation or treatment to meet trade waste bylaws, etc.); and
- the residues from the process and their final disposal, and the consents obtained under the RMA.

All questionnaires were returned and were followed up further by visits or telephone calls to ensure consistency of interpretation. Participants also supplied throughput data for each of their treatment processes, but only on the understanding that this would be kept confidential and only used to confirm that the processes were on a commercial scale and operational.

Collectively, the results from the survey indicated that a range of physical, fixation/stabilisation, chemical and biological processes are being used to treat hazardous waste in New Zealand. All facility operators believed that they were in possession of the necessary resource consents, although this was not confirmed with the relevant regulatory authority.

The processes are briefly described below, together with the types of waste suitable for being treated in this manner. Some processes lead to the recovery of solvents, oils and heavy metals. Residues from treatment are discharged to sewers, or into landfills in compliance with local trade waste bylaws and landfill acceptance criteria. All faci lity operators stated that they operate a rigid manifest and documentation system.



Hazardous waste treatment plant
(ChemWaste Industries Ltd)

5.4.1 Physical treatment processes available in New Zealand

Sedimentation

A conventional separation process in which heavier solid particles settle by gravity. Suitable for solid materials heavier than water but not for emulsified oils. Residues may include sludges which themselves require further treatment.

Suitable for: Most waste liquids containing solids, but not emulsified oils.

Centrifugation

This is the separation of solids from liquid waste by rapidly rotating the waste mixture within a rigid vessel.

This technique is limited to dewatering sludges, separating oil from water and clarifying viscous gums and resins. The use of cloth or paper filters can improve separation efficiencies.

Suitable for: Sludges, oil/water mixtures, gums and resins.

Flocculation

A conventional treatment method in which flocculants are added to waste to enhance sedimentation or centrifugation processes by the formation of agglomerates. Primarily used for the precipitation of organics and inorganics.

Suitable for: Inorganics.

Oil/Water Separation

This may be considered for above or below ground applications:

- Separation of oil from waste water above ground - this is usually achieved by the use of separators with parallel plates to aid the coalescence of oil droplets; or
- Separation of oil lying on the surface of a water table below ground - achieved by the use of skimmers placed in wells or trenches.

Suitable for: Oils floating on water.

Dissolved Air Flotation

A conventional process in which a waste mixture is saturated with air (or other gases) to enhance the separation characteristics of the waste constituents. This technique is only applicable for waste with densities similar to water. Air emissions may result from this process.

Suitable for: Liquids with densities similar to water, oil, dye, engine reconditioning chemicals, proteins.

Heavy Media Separation

In this technique two solid materials with significantly differing densities are separated by placing them in a fluid of appropriate specific gravity so that the lighter solid floats and the heavier sinks. The separating material (heavy media) is often a suspension of magnetite in water, allowing the magnetite to be magnetically recovered for subsequent reuse. This technique is commonly used in the mining industry for the separation of ores from tailings.

Suitable for: Mining ores and tailings.

Evaporation

This involves the physical volatilisation of a liquid from a waste by application of energy (e.g. solar heating, steam heating, vacuum). Evaporation is often used to isolate the hazardous constituent into one of two phases, or to concentrate the waste, thus simplifying subsequent treatment. When the hazardous material is volatilised the technique is usually termed ‘stripping’.

Suitable for: Most waste containing solvents capable of evaporating.

Air Stripping

This technique removes volatiles from water or solids by passing air through the waste. The discharge of volatilised material to air must be controlled. It is useful for waste containing low concentrations of highly volatile organic compounds which have low water solubility.

Suitable for: Printing industry waste.

Steam Stripping

This is a well-established conventional technique in which steam is used to evaporate volatile organics from aqueous waste and separation is achieved by the application of continuous fractional distillation. Examples of applicable volatile organics include chlorinated hydrocarbons including high boiling point aromatics such as pentachlorophenol, aromatics such as xylene, ketones such as acetone or MEK, and alcohols such as methanol. Controls must be incorporated in the process to minimise discharges to the air.

Suitable for: Aqueous waste containing volatile organics.

Distillation

These processes, applied under vacuum or at atmospheric pressure, separate organic liquid mixtures by controlling temperature and pressure to selectively evaporate, then separately condense and collect the organic constituents of a waste. The purpose is either to reclaim reusable materials such as solvents, or to reduce waste volumes prior to further treatment.

Suitable for: Oils and solvents for recovery, waste from sheepskin/ tanning industries.

Soil flushing/Soil washing

Soil flushing involves the passing of extracting solvents (e.g. water, acids, bases, surfactants, oxidants, reductants, chelating agents) through soils in situ, and containing organic or inorganic contaminants using an injection/recirculation process. Soil washing involves similar treatment except that the soil is first excavated and treated on the surface in a soil washer.

Suitable for: Soils contaminated with extractable contaminants.

Chelation

In chelation, chemicals are added which bind to mainly metal contaminants in waste to make them more soluble and thus assist in their removal. The choice of the chelating agent depends on the metal involved.

Suitable for: Metals, particularly tin.

Liquid/liquid Extraction

In this process two liquids that are mutually soluble in each other are separated by the addition of a third liquid, which is only soluble in one. The resultant solvent/solute mixture is then separated, with the solvent being recovered for reuse. Techniques such as distillation or stripping may also be used for further purification and solvent recovery.

Suitable for: Liquid organic waste.

Supercritical Extraction

Above certain temperatures and pressures (the ‘critical’ points) the solvent properties of certain fluids are greatly enhanced. Both super critical water and carbon dioxide, for example, are excellent non-polar solvents for organics. Such properties provide more efficient and rapid extraction than other, conventional solvent extraction techniques.

Suitable for: Organics in aqueous waste.

Filtration

This is the conventional process of separating and removing suspended matter from a liquid by passing the liquid through a porous medium, such as a fibrous fabric (paper or cloth), a membrane, a screen or a bed of granular material. A wide variety of different types of filtration are used.

Suitable for: Suspended solids.

Carbon Adsorption

An adsorbent, generally activated charcoal, is used to adsorb organics from aqueous or gaseous waste streams. The adsorbent will require replacement or regeneration from time to time. It is not appropriate for use where suspended solids (above 50 ppm) or dissolved inorganics, oils and grease (above 10 ppm) are also present in the waste stream.

Suitable for: Volatile organics.

Reverse Osmosis

This process may be used to concentrate or to remove solvents. The waste stream is placed under pressure forcing solvent from the waste stream through a semi-permeable membrane, thus concentrating the waste. This technique can be used for the separation of inorganic or organic components of a solvent. The membrane must be compatible with the waste stream characteristics.

Suitable for: Liquid waste or sludges containing organic or inorganic contaminants.

Ion Exchange

Ion exchange is a well-known technique that involves passing the contaminated waste stream through ion exchange columns (anion or cation exchangers). The ions in the waste stream are adsorbed by the ion exchange beds releasing hydrogen ions or hydroxide ions in the process. The ion exchange columns are regenerated periodically by flushing with either concentrated acid or caustic, removing the adsorbed ions that can be further processed for recovery or reuse.

Suitable for: Inorganic contaminants such as plating metals.

Freezing and Crystallisation

In this process the solvent (e.g. water) is removed from a waste stream by freezing or crystallisation, leaving a more concentrated waste for further treatment

Suitable for: Aqueous waste.

5.4.2 Fixation/stabilisation processes

Lime-based Pozzolan Processes

In this method waste or contaminated soils are treated by the addition of large quantities of siliceous materials combined with a setting agent such as lime, cement or gypsum. The process results in a solidified, dewatered product.

Suitable for: Sludges and soils containing inorganic or organic contaminants.

Portland Cement Pozzolan Processes

This is a minor variation of the lime-based process above. The waste is mixed with Portland cement to incorporate the waste into the cement matrices.

Suitable for: Sludges and soils containing inorganic or organic contaminants.

Sorption

In this method contaminants in liquid waste are bound up in Pozzolan-type matrices by physical or chemical sorption, yielding a stabilised material that is easier to handle.

Suitable for: Metal sludges from aqueous waste streams.

5.4.3 Chemical treatment processes available in New Zealand

Neutralisation

Neutralisation is a common industrial process whereby the pH of a waste stream is adjusted to approximately neutral (pH 7) by the addition of acid or base to the waste. Neutralisation is used to treat acids and alkalis to eliminate or reduce their reactivity or corrosiveness. Compatibility of the waste and the treatment chemicals need to be ensured so that no hazardous compounds are produced during the process.

Suitable for: Acids and alkalis.

Chemical Precipitation

Chemical precipitation is the process commonly used to remove dissolved metals, oils or polymers from aqueous waste. The pH of the solution is adjusted to the point at which the material to be removed has its lowest solubility. Metals are often removed by the addition of lime, although sodium sulphide is also used to remove metals as their sulphide salts. Generally the metals are precipitated as a sludge which itself requires further treatment.

Suitable for: Dissolved metals, polymers and emulsified oils.

Chemical Hydrolysis

This is a common industrial process in which a bond in an organic molecule is broken thus allowing the molecule to become soluble in water. Hydrolysis can be achieved by adding chemicals (e.g. acids), by irradiation (e.g. photolysis), or biologically (e.g. by the use of enzymes). The resulting aqueous solution of the organic compounds can then be further treated.

Suitable for: Organic contaminants.

Ultraviolet Photolysis

Irradiation of certain hazardous waste in aqueous solutions initiates bond cleavage and oxidation of organic contaminants. The degradation of some organochlorine compounds and nitrates has been demonstrated successfully. The technique however, is dependent on the need for a transparent solvent and thus it does not work successfully in soils or in turbid or opaque solutions.

Suitable for: Organics, including some of the chlorinated forms, in aqueous solutions.

Chemical Oxidation and Reduction

These are conventional processes in which the oxidation state of a contaminant is changed in order to render it less hazardous, less mobile, change its solubility, stability, separability, or otherwise change it for further treatment, handling or disposal purposes. This change is usually effected by the addition of appropriate oxidising or reducing agents. Metals such as lead or mercury are often treated by this method. Hexavalent chromium is often reduced to the less toxic and mobile trivalent chromium by the use of ferrous sulphate or sodium metabisulphite.

Suitable for: Hazardous metals such as lead, mercury or chromium.

Oxidation by Hydrogen Peroxide

Hydrogen peroxide is a common oxidising agent which can be used to treat hazardous compounds such as some organotins and cyanides. Care must be taken as the reaction may be highly exothermic or reactive. Catalysts may be required to moderate the reaction.

Suitable for: Some hazardous organics, cyanides and for the removal of iron.

Ozonation

In this process ozone is used as an oxidising agent to treat organics (e.g. phenolics) and cyanides present in aqueous waste streams which contain less than 1% of hazardous oxidisable compounds. Ozone is usually produced by the high voltage ionisation of air. Sludges and solids are not readily treated by this method.

Suitable for: Waste containing organics or cyanides.

Alkaline Chlorination

This process uses chlorine to oxidise waste contaminants under alkaline conditions. It is widely used to treat free and complex cyanide containing waste, with the cyanide species being converted first to less toxic cyanates, which by reaction with further chlorine, break down to nitrogen, carbon dioxide and bicarbonates.

Suitable for: Cyanides.

Oxidation by Hypochlorite

This technique, which is widely used for swimming pool water disinfection, may also be used to treat hazardous waste containing cyanides and some organics. The oxidising agent commonly used is calcium hypochlorite. Extra care must be taken as hazardous chlorinated organics may be produced under some circumstances.

Suitable for: Some organics and cyanides.

Electrolytic Oxidation

This process may be used to treat high concentration (up to 10%) solutions of cyanide and metal salts. Electrodes are placed directly into the waste solution and an electrical current is applied. Metals that are present tend to collect on the cathode from which they can be recovered.

Suitable for: Solutions containing cyanides and metal salts.

5.4.4 Biological processes available in New Zealand

Aerobic Biological Treatment

Aerobic biological treatment is a conventional, widely-used technology for the treatment of aqueous waste contaminated with low levels of organics (BOD less than 10,000 mg/l). Environmental factors (e.g. nutrients, water, oxygen, carbon dioxide, pH, temperature) are controlled to maximise aerobic degradation of the waste.

Suitable for: Organics in aqueous solution.

Activated Sludge

This is a conventional and well-developed technology in which organic waste is mixed with micro-biologically active sludge in the presence of air and nutrients. Aerobic degradation occurs with the formation of additional sludge. The liquid effluent is separated in a clarifier and the sludge is either recirculated or sent to waste. Dilute (less than 1%) aqueous waste is usually treatable by this method, but this may not include some organic species and some heavy metals may poison the micro-organisms involved.

Suitable for: Some organics.

Rotating Biological Contactors

This technology uses rotating biological contactors to aerobically treat a variety of aqueous organic and inorganic contaminants. The waste stream comes in contact with a micro-biologically active film on the contactors and the rotation speed can be varied to achieve the optimum bacterial oxidation rate and waste contact time for waste degradation to occur. This technique is not suitable for the more intractable organics and microbes may be poisoned by some heavy metals and organics.

Suitable for: Alcohols, phenols, phthalates, cyanides and ammonia.

Bioreclamation

This process may be used to treat contaminated soils and groundwater *in situ* through the use of aerobic bacterial degradation. Nutrients and bacteria are introduced to the soil which is aerated to encourage decomposition of the contaminants. Site geology and hydrology may be restrictive factors.

Suitable for: Soils contaminated with organics such as petroleum hydrocarbons.

Anaerobic Digestion

This is the process widely used in municipal waste water treatment plants. Microbial degradation occurs in an oxygen-free environment, producing methane and carbon dioxide as by-products. The process is appropriate for treating aqueous waste containing low to moderate levels of organics, and can be more effective than aerobic processes. Stable, consistent operating conditions must be maintained. The methane gas produced can be collected and utilised for heating or power generation.

Suitable for: Organic contaminants in aqueous liquids.

5.5 Availability and accessibility of commercial treatment facilities

It appears that, collectively, the facilities identified by the survey (refer section 5.4) provide full national coverage for hazardous waste analyses, identification, collection, transport for treatment or storage of hazardous waste. Regular collections are also provided in areas away from the main centres in which the treatment processes are located. This can involve dedicated transportation of waste, over considerable distances in some cases, with associated cost implications. Costs could be moderated if appropriately managed local storage was made available so that small quantities from a range of generators could be combined for transportation.

Despite the assertions of the surveyed treatment facilities, waste generators may consider that access to appropriate treatment is limited, or that the services are too costly. Often, the quantity and type(s) of the waste to be treated as well as the location of the waste generator are important factors in determining the availability of the service. However, it is the responsibility of the hazardous waste generator to ensure that their waste is properly treated and disposed of so as to avoid adverse environmental effects (refer section 5.9).

5.6 Treatment options specified by central government agencies

The *CAE 1992 Report* outlined methods for the treatment of certain hazardous waste recommended by government agencies or required under specific regulations. These included waste containing asbestos, polychlorinated biphenyls (PCBs), copper chromium and arsenic contaminated sludges, leaded petrol sludges, electroplating waste, pesticides, acids and alkalis, tannery waste, resin and solvents, low level radioactive material and clinical waste.

It should be noted that all of these guidelines were developed prior to the enactment of the RMA and may therefore no longer be applicable. Before adopting any of the methods outlined in the *CAE 1992 Report* it is therefore recommended that the advice of the originating agency be sought and the appropriate regional council and city/district council be contacted to ensure acceptability of any discharges to the environment.

5.7 Other treatment facilities and technologies

Local hazardous waste surveys conducted to date and the review of technologies available for hazardous waste treatment indicate that facilities already exist in New Zealand for the treatment of most hazardous waste types. In addition to the commercial facilities outlined above, some hazardous waste generators have installed treatment processes specifically for their own waste. However, access to these processes is generally not available to other generators.

In the case of waste containing organochlorines such as PCBs, DDT, Aldrin, Dieldrin, etc., proposals for the use of existing thermal processes such as incineration in cement kilns (refer Chapter 6) have not received wide public support. These waste types either remain as contaminated soil *in situ*, or are stored prior to shipment overseas for destruction.

The current deficiency in technologies for the treatment of some hazardous waste arising in New Zealand therefore relates predominantly to organochlorine waste.

A similar situation existed in Australia in the early 1990s, which lead to the establishment of the Independent Panel on Intractable Waste. After widespread international review and considerable public consultation, the group released an assessment of the management options for such waste in 1992. Both in parallel with and subsequent to these activities, technologies to effectively treat organochlorine waste have been developed and are now operating commercially in Australia. In one case, part of the technology development was carried out in New Zealand.

Technologies relevant to New Zealand hazardous waste are briefly discussed below.

5.7.1 Technologies for organochlorine waste commercially available in Australia

Base Catalysed Dechlorination (BCD)

The BCD process in its original form was initially developed by USEPA researchers for the treatment of PCB-contaminated materials. These researchers held the international license for the process in the form that they developed it. Over the past decade the BCD process has undergone further development and enhancement, particularly in Australia where it is now operating commercially in several areas.

In its simplest form, BCD employs chemical nucleophilic substitution to replace each chlorine atom in a chlorinated organic compound with a hydrogen atom. The reaction is driven by a strong base (e.g. sodium hydroxide), a carbon catalyst and a suitable hydrogen donor, in an oxygen-free environment at temperatures of about 320˚C. The base and catalyst are added in a finely divided form and the hydrogen donor can be one of several commercially available paraffin oils.

For chlorinated waste in liquid form the reaction is carried out in a heat-jacketed stirred reactor vessel. It is a batch process operating at atmospheric pressure, with the reactor vessel purged with nitrogen for safety reasons after each batch is loaded. The mixture is agitated and heated over a period of several hours (4 to 6 hours). In that period moisture and low boiling volatiles in the reaction fluid are driven off from the reactor. These pass through a distillation column followed by a reflux condenser, then through an activated carbon adsorber which is vented to the air. The vented gases consist principally of the purge nitrogen and water vapour arising either from the water in the waste or resulting from the chemical reactions.

Other residues from the process consist of the paraffin oil with the hydrogenated organic in solution (in the case of PCBs the hydrogenated organic would be biphenyls), a filter cake made up of sodium chloride (common salt) and finely divided carbon, and water. The oil containing the hydrogenated organic is suitable either for reuse in the process or as a fuel in the heating furnace, the filter cake is acceptable in landfills without further treatment and the water resulting from the process can be discharged to local sewers. As a double check, testing for contaminants is carried out before discharge.

Destruction and removal efficiencies in excess of 99.999% can be expected in the treatment of PCBs and the processes are also effective in the destruction of other chlorinated organics, including those containing polychlorinated dibenzo dioxins.

Problems emerge in the operation of BCD processes if the organochlorine content of the waste is very high (e.g. above 10% for PCBs). The reaction products such as salt and carbon can build up in the reactor, making stirring difficult and impeding the reaction.

Further improvements have lead to the accelerated decomposition of organic halides/ base-catalysed decomposition (ADOX/BCD™) process which is also now operating commercially in Australia. These improvements were to the nature of the accelerants used and the accompanying chemical mechanism changes which occur. Benefits include faster reaction, no need for a special hydrogen donor, and the ability to process higher concentrations. The products of the reaction are simple salt and carbon. An organic accelerant is required but this is used in small quantities, and is commercially available at low cost. This modification to the BCD process results in a carbonisation process in which all organochlorine compounds are reduced to carbon and salt. Hydrocarbons are not formed as in the original BCD processes.

Trials in New Zealand during the development of the ADOX/BCD™ process illustrated its effectiveness for the treatment of a variety of organochlorine based pesticides and pentachlorophenols, including those containing polychlorinated dibenzodioxins. Data from these trials have been published in *Chemistry in NZ* (1998).

Suitable for: PCBs, hexachlorobenzene, chlorinated phenols, chlorinated pesticides.

Plasma Arc

Plasma is an ionised gas consisting of molecules, atoms, ions and electrons. It differs from the normal gaseous state because it is electrically conducting.

BCD reactor
(BCD Technologies Pty Ltd

ADOX-BCD process
(ADI Ltd)

Plasma is often referred to as the fourth state of matter, since with increasing temperature a material passes from solid, to liquid, to gas and finally becomes plasma. Gases become electrically conducting at temperatures in excess of 4,000˚C and in most industrial plasmas temperatures greater than 10,000˚C are attained. A plasma column is generated by the passage of an electric current between a cathode and an anode, through a gaseous medium. The hottest part of the plasma is the centre of the column where temperatures in excess of 20,000˚C are possible. Electric arc plasmas offer the advantage of very high temperature, high energy density and accurate, rapid control of the process; attributes which, if correctly applied, make this technology ideally suited for waste destruction applications.

The electric arc plasma processes operating commercially in Australia are in-flight plasma processes which means that the waste mixes directly with the plasma column. The essential core components of the system are the plasma torch, injection manifold, reaction chamber or flight tube, quench and scrubbing system, power supply and process control system.

The plasma torch is of segmented design using argon as the plasma gas. Argon is chosen because it has suitable thermodynamic properties and is inert. The argon plasma is generated by a direct current discharge between an anode and a cathode. At typical operating conditions the mean exit enthalpy of the plasma is about 11 Mj/kg at a mean exit temperature of 12,000˚C. The torch is nominally rated at 150 kW and has an electrical efficiency greater than 50%. Waste enters the torch through a specially designed manifold and instantly mixes with the plasma. The mixture temperature at this point varies between 3,000˚C and 5,000˚C, depending on feed rate and the chemical composition of the waste.

The waste is rapidly pyrolysed in the injection zone and the hot gases pass down the flight tube (a water cooled reaction chamber) undergoing further pyrolysis. As most of the hazardous waste applicable to this process contains little or no oxygen they have the potential to produce copious quantities of soot (carbon). Therefore, oxygen or some other suitable reactant gas is added at the manifold to ensure that all the carbon atoms in the waste are converted to carbon monoxide.

The hot gas at the bottom of the flight tube is typically carbon monoxide, hydrogen, hydrogen chloride and argon, together with small amounts of carbon mist, at approximately 1,500˚C. If this mixture is allowed to cool slowly to below 800˚C back reactions, resulting in the formation of unwanted compounds, including dioxins and furans, could occur. To avoid the chance of this happening the chemical composition is fixed at the bottom of the flight tube by rapid quenching with a direct spray of a cool, alkaline liquor.

After quenching, the cooled gas is scrubbed with alkaline liquor to neutralise hydrogen chloride and other acid gases. The gases then pass counter-currently up-packed columns down which flows fresh sodium hydroxide solution to remove the last traces of strong acid gases.

The off-gases from the packed column pass through an in stack flare and are then discharged to the atmosphere where the residual CO_2 and argon are dispersed. Gas composition is regularly monitored to ensure compliance with regulatory standards.

The power supply has been specifically designed for the process. It consists of a transformer/rectifier to convert 3 phase power into a current controlled DC output. It is designed for an electrical efficiency of at least 95% with provision for power correction from 150kW to 200 kW. A specialised starting device ignites the arc between the primary cathode and anode.

Process control is fully automated and allows for monitoring of 50 process parameters continuously. Data is logged and stored for future analysis. If pre-set levels are exceeded the system immediately shuts down. Start up from cold takes between 2 and 3 minutes and a normal shut down under 2 minutes.

The electric arc plasma process can either be operated as an integral part of an industrial process converting waste hazardous substances into process input materials, or as a stand alone waste treatment facility. Overall it is very compact, can be fitted into a shipping container, and it is therefore very transportable.

Very high destruction efficiencies (greater than 99.999%) can be achieved with this process. As a pyrolysis process it is very versatile for the destruction of mixed organic waste.

This process operates commercially in Australia under the trade name PLASCON™.

Suitable for: Liquid and gaseous waste including halons, CFCs, PCBs, pesticides and herbicides.

PLASCON™ (plasma arc) facility
(BCD Technologies Pty Ltd)

Gas-Phase Hydrogen Dechlorination

This process is based on the gas-phase thermo-chemical reaction of hydrogen with organic compounds. At temperatures exceeding 850˚C hydrogen reduces organic compounds forming methane gas. In the case of chlorinated organics the reduction products include methane and hydrogen chloride. The reaction is enhanced by the presence of water, which acts as a reducing agent and a source of hydrogen. The process is therefore highly suitable for the treatment of hazardous organic waste with a substantial water content.

In the process the waste is first preheated in a vaporiser using steam from a boiler. The resulting contaminated steam is then fed into a reactor vessel at a rate determined by the process control system, while the heated liquid waste from the vaporiser is discharged into the reactor through an atomising nozzle. Oily waste can also be metered into the reactor directly from drums with the heated liquid waste. Solid waste such as contaminated soil are decontaminated in a separate thermal desorption unit with the released contaminants entering the reactor through a separate port. Electrical equipment such as dismantled solvent-washed transformer cores and shredded capacitors are decontaminated in a sequencing batch vaporiser and the resulting thermally desorbed contaminants are swept into the reactor by hydrogen-rich hot recirculation gas. High strength volatile organic waste such as obsolete pesticides, warfare agents and industrial by products can also be processed in the sequencing batch vaporiser.

In the reactor the mixture of gases and vaporised liquids are heated as they swirl downwards past electric heating elements located around a central ceramic coated steel tube. Entrained grit is discharged from the bottom of the reactor while the gases pass up through the inside of the central tube. The retention time in the reactor is controlled to ensure that chemical reactions are complete.

Gases are then discharged to a scrubber where heat, water, fine particulates and acid gases are extracted. Effluent water from the scrubber is suitable for disposal to sewers after pH adjustment. The gas exiting the scrubber consists of a clean dry mixture of hydrogen, carbon monoxide, methane and other light hydrocarbons. Most of this gas is reheated and recirculated back to the reactor; any residual is used as a supplementary fuel for the steam boiler.

Process operation is completely automated and incorporates continuous monitoring and analyses of the gases exiting the scrubber. Up to ten compounds can be selected as indicators of destruction efficiency. In the event of pre-set levels being exceeded the process changes automatically to the recirculation mode thus stopping waste feed.

This process operates commercially in Australia under the name ECO LOGIC^{TM}.

Suitable for: Polycyclic aromatic hydrocarbons (PAHs), PCBs, chlorinated and non-chlorinated organics, contaminated soils and sediments.

Thermal Desorption

This is the process in which the waste substance or contaminated soil is heated to a temperature which is above the melting or boiling point of its hazardous constituents. Air or steam may be used to enhance desorption. The hazardous constituents are thus driven off in liquid or gaseous form and are subsequently destroyed by a secondary process such as incineration, plasma arc, BCD or gas phase dechlorination. A typical example of the use of this technology would be for the removal and destruction of petroleum hydrocarbons from soils.

Thermal desorber for the removal of PCBs from transformer bodies
(BCD Technologies Pty Ltd)

Suitable for: The desorption prior to treatment of volatile organics such as petroleum hydrocarbons.

A modification of this process, Enhanced Indirect Thermal Desorption (EIDT^{TM}), has been developed for ADI Ltd. This incorporates the mixing of chemical additives to contaminated soils prior to desorption. Pilot trials have indicated that this process alone is effective for the destruction of low concentrations of organochlorines such as pentachlorophenols and dioxins in soils. It may also be used in combination with other processes such as ADOX/BCD^{TM}

Suitable for: Soils etc. contaminated with organochlorine and organophosphorus compounds.

5.7.2 Plasma enhanced melting

Vitrification as a process for the stabilisation of hazardous waste, including radioactive waste, has been developed and demonstrated over a 20 year period.

Indirect thermal desorption (ITD) for contaminated soils
(ADI Ltd)

Plasma enhanced melting (PEM™) combines plasma and vitrification technology into a system which, it is claimed, can handle essentially any type of solid or liquid hazardous waste (apart from dilute aqueous solutions) and achieve high levels of destruction of organic contaminants. Hazardous elements are either incorporated into leach-resistant glass or recovered in a form suitable for recycling, depending on the waste composition and element volatility. Metallic iron, chromium, copper and nickel can be recovered from waste in ingot form.

The process chamber of the vitrifier is lined with three or more layers of high performance refractory and insulating materials to withstand high temperatures (1350˚C for the vitrified product) and to retain heat during idle periods. Energy is supplied to the process chamber in two forms; a DC arc plasma, and AC joule heating of the glass pool. The process can be operated in the non-enhanced mode by turning off the arc plasma.

The feed into the vitrifier is introduced into the plasma zone, where it is subject to temperatures in the range 3000˚C - 6000˚C, intense ultraviolet light and extremely reactive radicals including those produced from hydrogen, oxygen and hydroxyl groups. This results in extremely rapid and complete pyrolysis and steam reforming of the organic materials to produce hydrogen, carbon monoxide, carbon dioxide, hydrochloric acid and hydrogen sulphide. If any organic material escapes the plasma zone, it is pyrolised by the high temperature in the glass melt and chamber. Inorganic constituents either decompose into the vapour phase (relatively volatile elements) or are dissolved into and become part of the chemical structure of the melt. The strongly reducing conditions ensure that formation of dioxins at any stage, including the cooling of the off-gas, is effectively eliminated.

The endothermic plasma assisted synthesis gas reaction results in small off-gas volumes compared with other combustion processes. This facilitates gas cleaning and recovery of useful components. Hot off-gases from the vitrifier are initially water quenched (to less than 80˚C), scrubbed, and then pass through a mercury polishing unit before entering a catalytic process for the conversion of hydrogen sulphide to elemental sulphur. The cleaned gas is then available for use as a fuel or can be flared and released to the atmosphere. The scrubber solutions contain hydrochloric acid, metal particulates, and mercury condensed from the off-gas. After removal by filtration the particulates are distilled in a retort to recover mercury and the remaining particulates are returned to the vitrifier. The filtered solution is distilled to recover hydrochloric acid, and metals in solution are precipitated electrochemically.

Both the ingot metal and glass are tapped from the vitrifier periodically. The typical residence time for glass inside the vitrifier is 30 to 60 hours. Strong convection cells within the glass melt ensure good mixing. High temperatures and long residence time ensure destruction of organics.

Leachability of hazardous constituents from the glass have been shown to be very low; investigations to date by the developers indicate that ultra trace analytical techniques are required to establish true levels of hazardous constituent leachability.

Suitable for: Waste containing polycylic aromatics, chlorinated organics, heavy metals.

5.8 Evaluating new technologies

There are many other technologies in various stages of development in different parts of the world. Some of these may be appropriate for the treatment of hazardous waste and for the remediation of contaminated sites in New Zealand. It is suggested that the best way to keep up to date with and assess these technologies is by evaluating the reports issued by the USEPA's SITE (Superfund Innovative Technology Evaluation) programme which has been running since 1985. The SITE programme offers a mechanism for conducting joint technology demonstration/evaluation projects between the private sector, EPA and other US federal and state agencies. Its purpose is to demonstrate and verify field application of innovative remediation on actual hazardous waste.

The results of evaluations provide reliable engineering, performance and cost information for clean-up decision makers and technology vendors.

SITE programme evaluations on specific technologies are reported as Technology Profiles and these are published on a regular basis[2] .

5.9 Considerations for selecting appropriate treatment facilities

Apart from selecting a treatment process suitable for the waste type, a range of other factors must be taken

2 Further information about the SITE program can be obtained from the SITE Demonstration Program (MS-481), U.S. Environmental Protection Agency, 26 West ZML. King Drive, Cincinnati, OH 452268, USA OR through the USEPA home page: http//www.epa.gov

into account to ensure that treatment and disposal are undertaken according to best practice and result in as little adverse effect as possible. The following criteria should be considered by any hazardous waste generator seeking a treatment facility for their waste to ensure that they can comply with any legal obligations and demonstrate due diligence with respect to hazardous waste management issues. Although these criteria apply predominantly when selecting an off-site treatment facility, they may also be useful for waste generators that operate in-house/on-site treatment processes.

- **Regulatory compliance.** A hazardous waste treatment facility should have appropriate consents and other relevant permits and be prepared to supply evidence on request. This should include a land-use consent from the city/district council if required under the district plan, resource consents for discharges to the environment from the regional council and trade waste permits. A dangerous goods licence may also be necessary until the end of the transition period under the HSNO Act, as well as other licences such as those necessary for handling asbestos.

- **Company policies.** A reputable treatment facility should have an operational health and safety plan to comply with the Health and Safety in Employment (HSE) Act 1992 as well as contingency plans for emergencies.

- **Quality of advice.** The company should be able to provide expert advice on the best treatment process for any given waste, and be able to explain the process, including a description of the residues and their fate.

- **Waste tracking and acceptance procedures.** To ensure compliance with consent conditions and stable operation of treatment processes, the composition of the waste received for treatment must be known. To this end, the facility should have procedures in place that require the generator to provide data on waste composition and any other information about the waste that may be relevant. Alternatively, the facility should have access to a laboratory accredited by International Accreditation New Zealand which may be able to provide this information.

- **Reporting and invoicing procedures.** Once treatment has been completed, the waste generator should be supplied with a destruction certificate stating the treatment process and the method of final disposal of the treated waste and its residues. If a waste is stored because treatment is not available, regular reporting on the status of the waste should be forthcoming. Invoicing should be clear and relevant to the treatment undertaken.

- **ISO 14001 Certification.** Any facility that is ISO 14001 certified (or complies with a similar standard) is likely to offer a quality service and should be given preference.

5.10 Management of hazardous waste containers

Drums, containers and lining materials that have been used for containing hazardous materials, including waste, require proper management to reduce risks to public health and safety or to the environment. If hazardous residues are present, containers should be subject to strict controls until they have been thoroughly cleaned. A possible exception to the requirement for cleaning would be for containers being returned directly to suppliers for refilling. In this case, it is necessary to contact the supplier for advice.

5.10.1 Reuse and recycling

An established industry for the reconditioning of 200 l drums exists in many parts of New Zealand. However, drums that were used to contain hazardous materials must be cleaned adequately and the cleaning agent must be disposed of in compliance with relevant regulations, such as trade waste bylaws (for discharges of liquid waste and rinsewater to sewers).

Steel from drums is generally recyclable provided that the drums can be cleaned of any contamination. Operators of possible recycling processes should be contacted regarding acceptability. Adequate cleaning will be required before containers are despatched for recycling.

5.10.2 Disposal

Disposal of empty drums and other containers used for hazardous materials in landfills should only be considered if other options are not practical, and only after the drums have been thoroughly cleaned. Each drum should be punctured and crushed.

The regional council and/or landfill operator should be contacted to ascertain whether resource consent conditions for landfills allow the acceptance of empty hazardous waste containers.

Incineration of empty containers is not recommended, as some will release contaminants to air under conditions of incomplete combustion. The regional council must be contacted to establish relevant policies and rules concerning air emissions.

5.10.3 Removal of residues

Removal of residues from containers should preferably be carried out at the point of use, immediately after the container has been emptied. This prevents wastage and reduces the amount of contamination involved. The following briefly outlines acceptable cleaning processes:

Drain and triple rinse

The best way to decontaminate a container is by adopting a drain and rinse technique which should be performed as follows.

- Invert the container for at least 30 seconds, in the case of liquids after the stream has been reduced to a droplet form. With solids, removal by vibration or brushing may be necessary.
- A rack system may optimise the process for drums.
- If at all possible, reuse the extracted material for its intended original purpose. If this is not practicable, residues should be placed in a separate container for treatment and disposal.
- After draining, drums should be triple rinsed. This is done by adding rinsing solution (equivalent to about 20% of the drum volume) to the upright container, capping it, then shaking or rolling it to ensure that the rinsing solution thoroughly washes internal surfaces. Remove the cap, invert the container and let it drain as above. Repeat this rinsing process two times. Add the rinsate to the original product tank if possible; otherwise it should be placed into a separate container for treatment and proper disposal.

Pressure rinsing

After draining, opened containers are placed inverted in a tank and a pressure rinsing probe is inserted into each. The pressure rinse is operated for at least 30 seconds during which the container is twisted or rotated to ensure that all interior surfaces have been washed. The containers are then left to drain for at least another 30 seconds before removal. The rinsate is then reused or stored for treatment and disposal, as above.

Container liners

Disposable liners from hazardous materials containers should be removed and must be regarded as a hazardous waste. These must be treated and disposed in the same way as other hazardous waste from the substances involved.

Any other waste residues

All residues and waste arising from container handling, including spillages, must be managed as a hazardous waste.

5.11 Conclusions

This chapter has indicated why hazardous waste requires treatment and has identified various physical, fixation/stabilisation, chemical and biological treatment processes available in New Zealand.

Other treatment methods such as thermal processes (Chapter 6) and land treatment and disposal (Chapter 7) may also be appropriate in some circumstances.

At present, appropriate local treatment appears to be available for all hazardous waste types generated in New Zealand, except those containing persistent organochlorine compounds. Processes capable of treating these organochlorines are currently operating commercially in Australia. Technologies that may be appropriate for New Zealand have also been described briefly.

It is difficult to make recommendations on which technologies are most appropriate for a given hazardous waste because the selection of the most suitable option depends on many factors, such as the location and quantity of the waste, the distance to a treatment facility, economic considerations (cost and availability of technology, company philosophy and situation, operator training), as well as environmental, health and safety factors, performance factors, compliance with resource consent conditions, regulations and by-laws, and community aspirations. Possible treatment options for each type of waste by ANZECC Code, are provided in Appendix 5.

It is recommended that for a particular hazardous waste situation, the reader should identify potential hazardous waste treatment methods using this and other chapters and from the reference material. Information on the availability and cost should then be obtained from industries in New Zealand already using these technologies, from treatment technology suppliers, from the operators of commercial treatment facilities, and/or from the regulatory agencies responsible for hazardous waste management.

Regardless of the specific situation, the final outcome of any selected treatment and disposal option for a hazardous waste must avoid short and long-term adverse environmental effects arising during any stage of its life cycle, from generation through to the release into the environment of any resulting residues.

Chapter 6
Thermal Processes

6.1 Introduction

Thermal processes are those in which combustion or high temperatures are used to achieve physical and/or chemical treatment of hazardous waste. Plasma Arc and vitrification processes, which were reviewed in the previous chapter, are also examples of thermal processes. In the context of this chapter, the term ‘thermal process’ refers predominantly to incineration and the use of cement kilns. Large industrial furnaces in which combustion conditions are rigidly controlled may also be suitable for specific waste types.

Hazardous waste containing unsubstituted organics with a high energy content (calorific value), such as benzene, waste hydrocarbon oils etc., are particularly suitable because of the reduced requirement for additional energy inputs otherwise necessary for adequate destruction. Conversely, waste with a high water content or a significant non-combustible component are not suitable.

Incineration systems can be specifically designed to recover waste metals within the waste stream, although most do not have this specialised ability.

Highly explosive materials are not suitable for destruction in a confined incinerator, but have been historically disposed of in an open burn.

Thermal desorption of organic contaminants at lower temperature from soils, followed by high temperature incineration, is also a thermal process with application to contaminated sites.

6.2 Critical combustion control parameters

In order to achieve high destruction efficiency it is essential that the incinerator be designed and operated so as to provide adequate oxygen together with what is commonly referred to as the ‘three Ts of combustion’, namely temperature, turbulence, and time. The physical and/or chemical properties of the waste are also important. The relevance of each parameter is as follows:

- **Combustion air.** The provision of sufficient air, specifically oxygen, is essential to ensure complete combustion of the waste. The requirements for this vary, but typically 6% to 10% excess oxygen is considered desirable. Excess oxygen promotes the thermal oxidation process. For example, under stoichiometric conditions a temperature in excess of 1500˚C is necessary to ensure greater than 99.99% destruction of hydrogen cyanide, whereas in the presence of excess oxygen the cyanide radical readily converts to a cyanate radical and destruction occurs at temperatures less than 1000˚C. Too much excess air will, however, have a cooling effect on the system.
- **Temperature.** While for most waste combustion temperatures of 800˚C - 900˚C are adequate, contaminants with a high thermal stability such as dioxins require temperatures in excess of 1000˚C or higher.
- **Turbulence.** Good mixing of waste and oxygen achieved by turbulence in the hot combustion gases in the incinerator is essential for good combustion and efficient waste destruction.
- **Time.** A finite time is required for the complete combustion of any waste. This is referred to as the residence time and is typically between about 0.5 and 3 seconds. Waste with high thermal stability requires longer residence times.
- **Waste Properties.** Calorific value is important in determining the additional energy input needed to achieve the desired combustion conditions. Too much energy input may be just as undesirable as too little. The moisture content of the waste also needs to be considered, as valuable energy may be lost by the unnecessary conversion of water to steam. Finally, the physical form of the waste may be important, as this may have a significant effect on the efficiency of the heat transfer through the waste. Control over the feed mixture in conjunction with controlled operating parameters are important aspects in improving combustion and minimising emissions.

The above parameters are interdependent to some extent, but combustion temperature and residence time are especially so. The effective destruction of a particular waste may be achieved by different relationships between the two, e.g. 977˚C at 1 second residence time may be just as effective as 1000˚C at 0.5 seconds.

In any particular incinerator design, the overall aim is to achieve the most suitable combination of the above parameters. The extent to which this is achieved is indicated by a factor known as the Destruction and Removal Efficiency (DRE):

$$\text{DRE}\,(\%) = \left[\frac{(\text{Waste in} - \text{Waste out})}{(\text{Waste in})}\right] \text{x}\,100$$

A DRE of 99.99% ('4 nines') is considered adequate for most waste types, while a 99.9999% DRE ('6 nines') is recommended for highly toxic or environmentally persistent materials such as dioxins and PCBs.

6.3 Incinerator components

Incinerators generally consist of the following components:

- waste preparation and feeding facilities;
- combustion chamber(s);
- air pollution control systems; and
- residue and ash management systems.

6.3.1 Waste preparation and feeding

The feed method depends largely on the physical form of the waste.

- **Liquids** are normally pumped into the combustion chamber through nozzles or via specially designed atomising burners. Waste containing suspended particles may need to be screened so as to avoid clogging/blockage/erosion of the nozzle/atomiser openings. Blending of waste with other waste and/or solid or liquid fuels may also be carried out prior to feeding. This is usually done to adjust the calorific value of the mix, but could also be undertaken to adjust the concentration of specific components.
- **Sludges** can be fed to the incinerator by means of suitable pumps. Water-cooled lances may be required to ensure that the material is fed directly into or near the combustion zone.
- **Bulk solids** may require shredding so as to meet the requirements of the feed mechanism. Feed may be by way of rams, gravity feed, air-lock feeders, vibratory or screw feeders, or belt-feed systems. Containerised waste is typically gravity or ram fed.

In some cases the screening or separation of one or more waste components may assist the combustion process or reduce environmental effects. In other cases, mixing and blending of the waste prior to charging can be beneficial.

6.3.2 Combustion chambers

The combustion chamber is the 'heart' of an incineration system, and most are classified according to their combustion chamber design. Generally the following three types, each having different design and operating characteristics, and each applicable to specific waste types, are commonly used for hazardous waste destruction:

- liquid injection;
- rotary kiln; and
- fixed hearth.

Liquid injection

This is only suitable for pumpable liquid waste. The units usually consist of simple refractory-lined cylinders equipped with one or more waste burners. Liquid waste is injected into the chamber by means of an injection or atomising nozzle. The droplets are burned in suspension. In general, the smaller the droplets the more effective the system will be.

Effective atomisation is essential for achieving high destruction efficiencies. The orientation and placement of the burner(s) and the waste injection nozzles can be used to promote the required turbulent conditions (e.g. radial or tangential firing). Special burner designs (swirl or vortex) are also used.

Rotary kiln

Rotary kilns are versatile, and therefore popular, as they can be used for most types of waste. The rotary kiln is usually a refractory-lined cylinder, mounted on a slight incline. Rotation of the kiln, typically 1 to 5 revolutions per minute, induces the movement of the waste through the unit, as well as assisting in mixing. Waste feed can be either co-current or counter-current with the combustion gas flow, and residence time of the solids in the kiln can be in excess of 1 hour.

The primary processes in a rotary kiln are: gasification

and partial destruction of the waste by volatilisation, destructive distillation, and partial combustion. An afterburner system is required for complete waste destruction. This is normally provided as a separate chamber connected to the discharge end of the kiln. This unit is fired with auxiliary fuel and essentially functions in the same way as a liquid injection system. It is not uncommon to dispose of liquid waste by direct injection into the afterburner.

Fixed hearth

Fixed-hearth units are normally used to burn waste with a high volatiles content. The hearth in such units is generally stepped and waste is moved along and down the steps by means of a series of mechanical rams. The primary chamber, or first stage, generally operates under controlled air conditions and a secondary combustion stage is needed to complete the combustion process.

The waste is loaded into the primary combustion chamber by means of a mechanical ram and undergoes partial destruction through the combined effect of volatilisation, destructive distillation, and partial combustion. Adjacent to the discharge end, the residual fixed combustible material is burned under localised excess air conditions, resulting in residual ash with less than 5% combustible material.

Off-gases from the primary chamber are mixed with additional combustion air at the entrance to the second stage (secondary chamber). This mixture is ignited and combustion completed with the assistance of additional burners where necessary.

The 'controlled air' process aims to control the rate of the combustion reactions and the accompanying turbulence, which has the effect of minimising the entrainment and carry-over of particulates. It also provides a more economical method for achieving the required after-burning temperature and residence time.

6.4 Environmental impacts

Incinerators give rise to gaseous emissions, liquid effluent, and a solid residue. Each of these need to be controlled to minimise any adverse environmental effects.

6.4.1 Gaseous Emissions

Gases exit from the secondary combustion zone at temperatures in excess of 1000˚C and must be cooled.

Two factors influence cooling system selection:

- the 'de novo' synthesis of dioxins, which takes place in the 200˚C to 400˚C range, requires that temperatures be rapidly lowered through this critical temperature range; and
- the potential presence of acid gases and the need to avoid their condensation.

These considerations have resulted in the incorporation of a waste heat boiler, or to a lesser extent a wet quench scrubber as prime cooling methods.

The acid content of the flue gas must be controlled. This is generally achieved by the use of an alkaline medium, with calcium hydroxide being the most economic option, although other alkaline mediums such as sodium hydroxide, sodium carbonate, magnesium hydroxide and ammonia may also be used. Generally this is done by dry injection of the alkaline medium into the gas stream, as a slurry in a spray drier, or directly in a wet scrubber.

The emission of particulates and any injected adsorbents must be controlled and generally this is done by the use of fabric filters. Further cooling of the gas stream is incorporated to condense and collect highly volatile heavy metals.

Finally, an induced draft (I/D) fan and a heating device raise gas temperature and reduce relative humidity prior to the cleaned gases being released to atmosphere from a chimney stack designed to achieve the required dispersion of residual emissions.

The design of the emission control system depends on local statutory emission limits applied to the incinerator. Internationally, the move seems to be towards the dry/wet systems described above. These vary in configuration.

The two examples illustrated in Figures 13 and 14 below illustrate current international best practice. Performance to be expected from each are also compared with European Union emission limits for hazardous waste incinerators; such limits are also appropriate for consideration in New Zealand.

6.4.2 Products of Incomplete Combustion (PICs)

The complete combustion of organic substances consisting solely of carbon and hydrogen results in the formation of carbon dioxide and water. In reality waste contains a number of other constituents.

Incineration will produce significant amounts of PICs if one or more of the following conditions exist:

- inadequate combustion temperature;
- insufficient oxygen supply;
- poor turbulence; and
- inadequate retention time.

The most common PICs, which may occur in significant concentrations, are carbon monoxide and other products of incomplete combustion such as volatile organic compounds (VOCs), including polycyclic aromatics hydrocarbons (PAHs). Visible smoke and odours may also occur.

The presence of halogens, such as chlorine or fluorine, will result in the formation of acid gases (refer section 6.4.3) and trace amounts of highly toxic compounds such as the polychlorinated dibenzo dioxins and furans. An indication of likely emission rates can be obtained from publications such as *US National Emission of Dioxins from Hazardous Waste Incinerators* (Cudahy and Rigo, 1998).

An incinerator can however be designed and operated to minimise PICs. Guidance is given in *Proposed Maximum Achievable Control Technologies for Hazardous Waste Combustion* (USEPA, 1996).

6.4.3 Other gaseous emissions

Any toxic heavy metals present in the waste will generally be converted into the corresponding metal oxide or salts. These will either form part of the ash or be carried off as particulates in the gas stream. Other more volatile metals such as mercury, arsenic, cadmium and selenium may be carried off as gases.

Acid gases such as hydrogen chloride and hydrogen fluoride result from halogens in the waste, and sulphur will give rise to sulphur dioxide and sulphur trioxide.

Varying amounts of fine particulates and fly ash will be generated and control measures such as bag filters must be incorporated.

6.4.4 Solid residues and ash

Most inorganic components of hazardous waste are incombustible and hence will not be removed by the incineration process. These will tend to accumulate in the combustion chamber as bottom ash, or in the bag filters as fly ash, requiring periodical removal and controlled disposal.

Incinerator ash is generally alkaline and contains significant amounts of the incombustible components from the waste, particularly toxic heavy metals.

Ash and residual solids are generally landfilled once leaching tests such as the TCLP (refer Chapter 7) have illustrated their acceptability. If the leaching criteria is not met physical treatment such as encapsulation (refer Chapter 5) may be required before disposal.

6.4.5 Liquid effluents

Incinerators incorporating quenching or wet scrubbing systems will also produce liquid effluents. These may be minimised by recirculation or spray drying within the incineration process. Otherwise treatment facilities to remove contaminants to meet local discharge limits will be required.

6.5 Examples of incinerator configuration and performance

The following two examples are based on current best international practice:

- The units (Figure 13) are arranged in the following series.
  - — Rotary incinerator;
  - — Waste heat boiler;
  - — Electrostatic precipitator;
  - — Spray drier;
  - — Pulverised coke injection system;
  - — Reverse pulse fabric filter;
  - — Two stage co- and contraflow scrubber system;
  - — Droplet and mist eliminator;
  - — Heat exchanger to reheat the off-gas;
  - — I/D fan; and
  - — Discharge stack.

Zero liquid effluent is promoted by sending the blowdown liquor from the twin scrubbing towers to an interim storage area and dosing the effluent with calcium hydroxide to a pre-set concentration. The dosed liquor then forms the alkaline slurry, which is sprayed into the spray drier. This action flashes off the water content. Any entrained or dissolved solids from the scrubber and the spray drier products of the reaction are collected as a dry residue at the base of the spray drier or in the fabric filter immediately downstream of the spray drier.

- The units in Configuration 2 (Figure 14) are arranged as follows:
  - — Fixed hearth controlled air incinerator;
  - — Waste heat boiler;
  - — Calcium hydroxide and activated carbon injection system;
  - — Reverse pulse fabric filter;
  - — Quench cooler;
  - — Packed tower wet scrubber;
  - — I/D fan;
  - — Heat exchanger to reheat the off-gas; and
  - — Discharge stack.

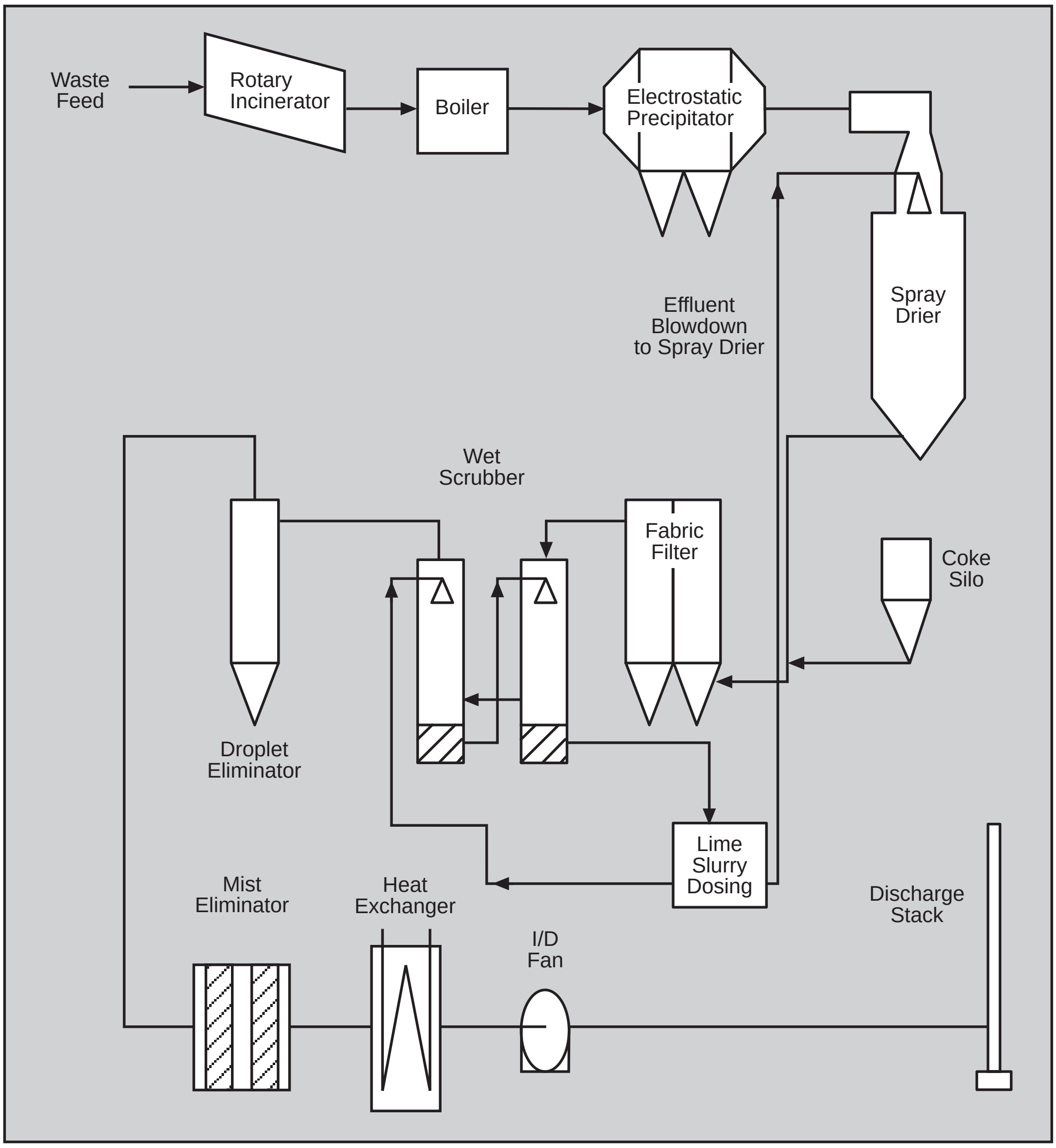


Figure 13: Configuration 1 - Dry/wet emission control system

Liquid effluent is managed by feeding the scrubber blowdown into an interim storage tank. The collected liquor is used to quench-cool the hot ash as it is ejected from the incinerator. The water content is flashed off and re-entrained in the incinerator off-gas flow while any dried residuals are left entrained in the bottom ash.

The performance of these two systems is shown in Table 1.

6.6 Mobile versus fixed installations

Hazardous waste incinerators may be permanently installed in one location or be designed for mobility to enable relocation. Mobile plants are made up of a number of skid-mounted units which can be uncoupled and transported to a new site.

Some of the possible advantages of a mobile unit are:

- transport of hazardous waste is minimised;
- waste can be treated at or near the place of generation; and
- improved community acceptance because of the limited time period on the site and the restriction to treatment of local waste.

The possible disadvantages are:

- ‘short term’ may be equated with ‘makeshift’;
- the costs, risks, and time associated with applying for multiple resource consents;

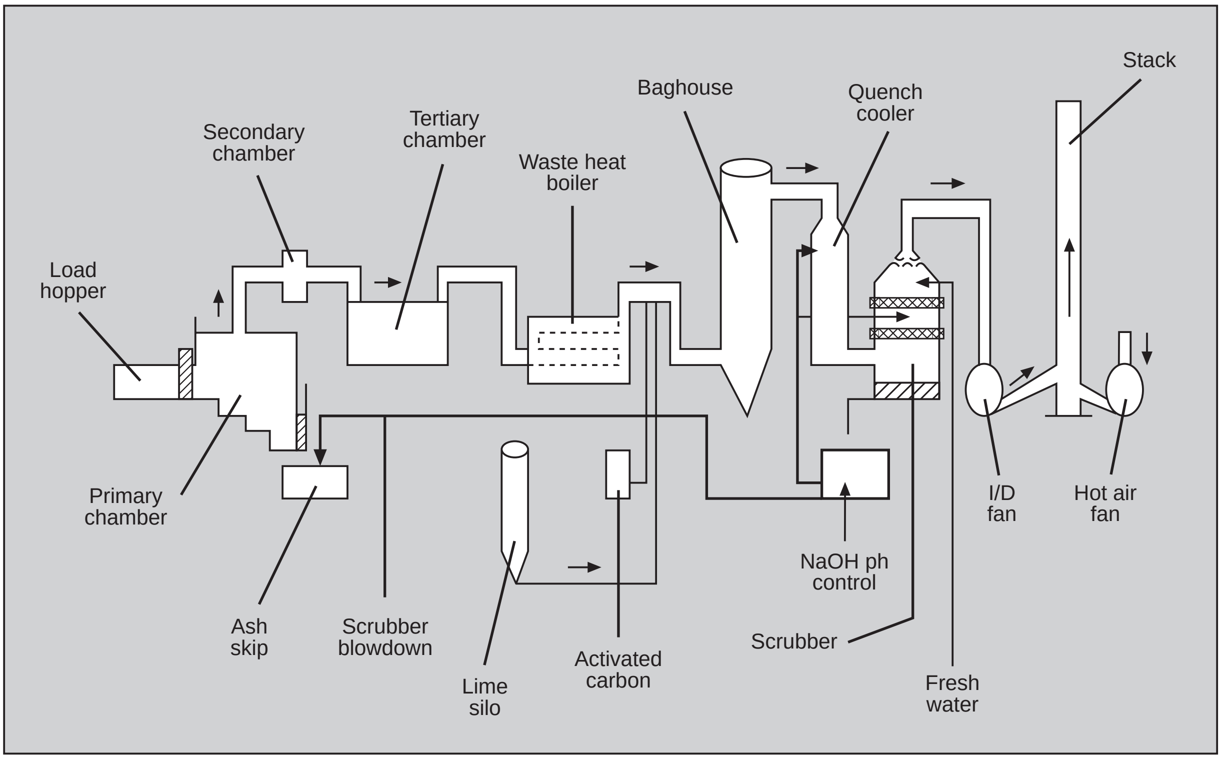


Figure 14: Configuration 2 - Dry/wet emission control system

- increased plant down-time and resultant increase in operational costs because of regular dismantling and re-assembly; and
- requirement of operating staff to constantly relocate.

6.7 Types of hazardous waste incinerated in New Zealand

A survey conducted for the Ministry for the Environment (Woodward Clyde, 1998) indicated that five

Pollutant	Units	EU Limit	Configuration 1	Configuration 2
Particulates	mg/m^3	10	<1	<1
HCl	mg/m^3	10	3.7	1.8
HF	mg/m^3	1	0.2	<0.5
CO	mg/m^3	50	-	0.68
SO_2	mg/m^3	50	43.3	12.5
Volatile organics	mg/m^3	10	-	0.9
Hg	µg/m^3	50	<7	42
Cd + Tl	µg/m^3	50	-	1.2
Heavy metals[1]	µg/m^3	500	-	37
Dioxins TEQ[2]	ng/m^3	0.1	<0.01	<0.01

All values are expressed as being measured at 0°C, 1 atmosphere pressure, a dry gas basis, and at 11% excess oxygen. The plants incinerate different hazardous waste types. [1] Heavy metals equal the sum of: Sb+As+Pb+Cr+Co+Cu+Mn+V+Sn. [2] TEQ=Toxic equivalents of 2378 TCDD as assessed by the international method.

Table 1: Performance of emission control system examples compared to European Union (EU) requirements for hazardous waste incinerators

units were disposing 77% of the waste currently incinerated in New Zealand. These were of fixed hearth design with separate conditioning and after burning chambers, primarily designed to burn solid waste. There is at least one other 'in house' incinerator used for the destruction of residues from a chemical process.

In general, hazardous waste incineration is currently limited to medical, clinical and quarantine type waste. Incinerators are also used for secure documents and the disposal of other controlled goods and substances.

Even though well designed and operated high temperature incineration, particularly of hazardous waste principally containing unsubstituted organic compounds, can achieve adequate treatment without giving rise to significant adverse environmental effects, generally there is little public support for these processes.

6.8 Low temperature thermal desorption

(See also section 5.7.1.). Pilot trials carried out by the USEPA (Thurnau and Manning, 1996) illustrated that contaminated soils containing organics such as hydrocarbons, some chlorinated compounds, PAHs and heavy metals could be effectively treated in conventional rotary kiln incinerators at lower temperatures. Temperatures less than 1000˚C, and lower gas velocities were severe enough to volatilise off the organics but mild enough to retain the metal species in the soils. The organics were then destroyed in the secondary combustion chamber with overall DREs in excess of 99.99%. A significant reduction of heavy metal emissions was also illustrated.

6.9 Emission monitoring

Overseas, hazardous waste incinerators are required to install an array of continuous monitoring and recording equipment. This equipment falls into two categories:

- incinerator process monitoring; and
- gaseous emission monitoring.

6.9.1 Incinerator process monitoring

Generally, the following parameters are required to be monitored and recorded on a continuous basis:

- primary chamber temperature;
- afterburner outlet temperature;
- afterburner outlet oxygen; and
- carbon monoxide concentrations.

Residence time is normally determined using an accepted computer-modelling procedure prior to the incinerator design being finalised. In some instances, actual residence time may be verified by measuring the actual residence time of a tracer gas. In New Zealand, ^{137}Xe has been used for this purpose.

6.9.2 Monitoring of gaseous emissions

The following parameters should be monitored and recorded on a continuous basis:

- particulate emissions;
- volatile organic carbon emissions;
- hydrogen chloride;
- hydrogen fluoride;
- sulphur dioxide;
- stack outlet temperature;
- stack moisture content; and
- stack pressure.

Depending on individual circumstances and measurement techniques used, some of the above parameters may be excluded. Measurement of nitrogen oxides on a continuous basis may also be required. Regular periodic emission tests to assess the discharge of mercury, cadmium, thallium and a range of heavy metals should also be performed.

Emission monitoring requirements should be carefully considered as availability of reliable, accurate, user friendly, and cost-effective instruments is often very limited.

6.9.3 Trial burns

Trial burns may be used to verify the actual performance capability of the equipment. These trials may be conducted using limited quantities of the specific waste or by using surrogate materials. Chemicals such as toluene and carbon tetrachloride have been used as surrogates.

6.10 Use of cement kilns for the destruction of hazardous waste

The use of cement kilns for the disposal of waste as alternative fuel is widely-practised overseas (Mournunghan, 1989), and has also been demonstrated in this country (Holden et al, 1983; Gossman, 1996). This practice may have benefits such as:

- reducing the use of non-renewable fossil fuels such as coal, and reducing the associated environmental impacts of coal mining;

- maximising the recovery of energy from waste – the energy is used directly in the kiln for clinker production; and
- maximising the recovery of the non-combustible part of the waste – the inorganic component (ash or slag) substitutes for raw materials in the cement, thus eliminating the need for its disposal.

Waste lubricating oils, for example, can be used as supplementary fuels in cement kilns. The oil is combusted, releasing energy, and is destroyed, while the inorganic constituents combine with the raw materials in the kiln and leave as part of the cement. Any heavy metals end up bound in concrete that has the same environmental and construction properties as concrete made entirely from fossil fuels.

Typical operating parameters for cement kilns in New Zealand include:

- kiln gas temperatures of 2400˚C at the firing end of the kiln;
- material residence time of at least 30 minutes at 800˚C - 1400˚C;
- an alkaline environment;
- oxidising conditions;
- encapsulation of foreign metallic and non metallic elements;
- efficient particle capture (>99.9%); and
- negative process pressures, eliminating gas leakage from the kiln.

Limitations on waste constituents may be imposed by operational requirements of the kiln, particularly the chlorine and sulphur content of any waste feed. In some kiln systems excess chlorine or sulphur can cause blockages. Product specifications may also limit the content of any heavy metals as these may affect the performance of the cement produced. These limitations would need to be set on the basis of the total material fed to the kiln, including coal.

In normal kiln configuration, liquid or powdered solid waste could be injected into the firing end with little modification. Additional equipment would be required, however, for sludges or solids.

Most of the safety and monitoring equipment required for a waste incinerator already exists on a modern cement kiln. Furthermore, because the cement kiln is a large manufacturing unit with high heat capacity, a significant change in kiln temperature for a brief time is not possible.

Cement kiln systems are capable of achieving high destruction and removal efficiencies (DREs), compared to other destruction methods. Generally, cement kilns are tested for the DREs of Principal Organic Hazardous Constituents (POHCs), in a trial burn. Table 2 illustrates examples of the effectiveness of destruction of common organics in cement kilns.

Studies on the performance of incinerators and other forms of thermal destruction focus on emissions of dioxins and furans (PCDDs and PCDFs). Testing of these emissions from cement kilns in New Zealand (Gossman, 1996) gave results of less than 0.1 ng/m3 (Environmental Toxicology International, 1992).

In 1992, UNEP recommended the use of cement kilns for the destruction of CFCs. Trials in Japan (Ueno et al, 1997) illustrated that during a 13 day continuous operation CFC11, CFC12 and CFC113 were treated with a destruction efficiency of 99.99% and emission testing illustrated that HF and HCl were retained in the cement and that no chlorinated organics, including dioxins or furans were generated.

In summary, cement kilns may be technically suitable, with minor modifications, for the destruction of hazardous waste produced in New Zealand. Furthermore, this process is available locally and will not require high capital outlay. However, conversion of a cement kiln to accept hazardous waste would require facilities

Country	**Compound**	**Results**
USA	Carbon tetrachloride	>99.999%
USA	Trichlorobenzene	>99.995%
NZ	Tetrachloroethylene	>99.999985%
Carbon tetrachloride and trichlorobenzene values sourced from *All Fired Up*, Environmental Toxicology International, 1992. Tetrachloroethylene values sourced from *Used Oil Test Burn Report*, Gossman Consulting Inc,1996.		

Table 2: DREs from trial burns in cement kilns

for the handling and storing of waste and, in general, minor alterations to monitoring equipment. Resource consents will also be required.

6.11 Conclusions

Thermal processes such as incinerators, cement kilns and some large industrial furnaces can offer opportunities for the effective destruction of a range of hazardous waste, particularly those containing hazardous organic constituents. Each situation must be carefully evaluated to ensure that the appropriate combustion conditions will be achieved and that formation of secondary contaminants such as the dioxins and other products of incomplete combustion is avoided.

A specific environmental risk assessment involving the proposed facility, feedstock waste and residuals produced should be performed for each situation, together with other evaluations necessary to obtain appropriate resource consents.

Chapter 7
Land Treatment, Disposal and Containment of Hazardous Waste

7.1 Introduction

Land treatment and disposal techniques are among the final components in the waste management hierarchy discussed in Chapter 4. All such techniques require a risk management approach to ensure that their adoption does not result in adverse effects on public health or the environment generally, either in the short or long term. The physical, chemical and biological processes involved can occur over long periods of time, reinforcing the fact that the avoidance of adverse effects requires continued dedicated monitoring.

Land treatment and disposal encompass the processes listed below, with the more relevant being described in later sections of this chapter.

- **Land treatment.** Landfarming entails the mixing of solid waste/sludges into the top surface of soils, usually by ploughing. The assimilative capacity of the soil is used to detoxify, immobilise and degrade some or all of the waste through the biological and chemical degradation of organic constituents and the immobilisation of inorganic constituents. The use of biological processes (bioremediation) by way of soil heaps and treatment beds, particularly for contaminated soils, may also be considered land treatment. This form of treatment is more controlled and contained than landfarming.

- **Phytoremediation.** This involves the use of plants (grasses, shrubs and trees) to treat contaminated solid waste or sludges. The plants and the root-associated microbes can work in ways similar to those involved in land treatment. Phytoremediation is a new technology, and to date has mainly been used in field trials. It is most commonly applied to heavy metals, solvents, explosives (e.g. TNT), and petroleum waste (Schnoor, 1997). This technology is not discussed further in this document.

- **Hazardous Waste (In-Ground) Containment Facilities.** An in-ground hazardous waste containment facility (HWCF) is designed, constructed, operated and maintained for the specific purpose of providing permanent containment of hazardous waste. As such, it can be regarded as a long term, in-ground, storage facility.

  A brief review of HWCFs is included solely because there is one such facility installed in this country. It is a private facility that provides containment for waste previously produced by a chemical manufacturing process. It incorporates a system for solution mining or leachate recirculation that allows above ground aerobic destruction of mobile contaminants over time.

- **Disposal of hazardous waste with municipal solid waste in landfills.** Chemical, physical, biochemical and biological processes operate in managed landfills for the disposal of municipal solid waste (MSW) that are capable of attenuating, to some degree, the hazardous characteristics of certain types of waste. Detailed evaluation in specific cases is needed to ensure that adverse environmental effects do not arise from the interaction of the hazardous waste types with the containment system or from the leachate generated.

- **Surface impoundments.** These are primarily regarded as storage facilities, providing little or no treatment, where aqueous waste or sludges are placed in pits, ponds or lagoons. The practice allows settling of solids and perhaps some biological degradation prior to the discharge or evaporation of effluent. If the settled solids are not removed it constitutes disposal to land.

- **Subsurface disposal.** There are three forms of subsurface disposal:

  — deep well injections;

  — disposal via mine shafts; and

  — deep burial.

Surface impoundments and subsurface disposal are not considered further in this document as it is considered that there is little potential for application in New Zealand. If practised, the surface impoundments would require careful containment and recognition of the potential for discharges to air. Subsurface disposal would also require site specific evaluation of possible environmental effects.

7.2 Land treatment

7.2.1 Overview

Indiscriminate disposal of waste to land is not land treatment. Land treatment has been used widely for municipal waste water sludges (biosolids), other sludges and hazardous waste. Over the last 25 years, considerable progress has been made in:

- understanding the fundamentals that affect the performance;
- defining suitable design and operating requirements; and
- using the technology for the treatment of hazardous waste (La Grega et al., 1994).

Land treatment of hazardous waste is a managed process using a dynamic system consisting of the soil, the atmosphere and biological species existing at the site. It involves the controlled application of a waste on to or into the soil surface to maximise biological, physical and chemical reactions. In the aerobic soil horizon, it results in the biological and chemical degradation of amenable organic waste constituents and the immobilisation of certain inorganic waste constituents.

The waste applied can be liquids, sludges or solids. Since the probability exists that waste constituents or by-products can be transmitted to groundwater as leachate and to surface waters by erosion and leachate interflow, as well as being emitted as gases, land treatment must be designed to minimise the potential for such transmissions and losses.

The advantages claimed for land treatment are that the application can be repeated safely at frequent intervals and has low initial and operational costs as well as low energy consumption. However, the operation has to be managed well to avoid the creation of a contaminated site.

7.2.2 Processes involved

The degradation of organics results from the action of indigenous microbes and other biological forms such as protozoa, mites and earthworms. Volatile constituents and gases from biological and chemical reactions are emitted to the atmosphere. Major chemical reactions include adsorption, precipitation, ion exchange and gas transfer. The soils also function as the sink for immobile, non-degradable waste and waste by-products. Mobile constituents will move with water percolating through the site.

To achieve adequate biodegradation, sufficient nutrients must be available in the soil. Nitrogen, phosphorus or potassium may need to be added to the soil if the hazardous waste is deficient in these elements. Following each application, the organics will be degraded. The organic degradation or loss is normally approximated by a first order rate reaction and the relative degradation rate identified in terms of a half life (i.e. the time required for the concentration of an organic to decrease by half). The rate of degradation will depend on temperature and the biodegradability of the organic constituents.

Climatic conditions, experience and soil monitoring to identify the concentration of waste constituents in the soil of a treatment site will determine the frequency of waste applications. Application rates are limited by the amount of material that can be easily applied and incorporated and that will not inhibit the micro-organisms involved in the biodegradation.

Atmospheric conditions affect the reactions in the soil by controlling the water content and temperature of the soil. Surface winds increase the release of volatile compounds, CO_2 and other gaseous by-products from the soil. The wind also affects the moisture content and heat balance of the soil. Solar radiation can enhance photo-oxidation of waste constituents exposed at the soil surface and acts to improve the heat balance.

7.2.3 Siting and operating parameters

Proper site selection and evaluation is essential to sound system design and management. The climatic conditions, soil and hydrogeological characteristics need detailed identification. A variety of soil types have been used successfully. Permeable and tillable soils such as loams, sandy loams or clay loams are best. The treatment zone is the active part of the soil horizon above the groundwater table, in which the degradation, transformation and immobilisation of the applied waste will occur. In the United States, the maximum depth of the treatment zone is defined as no more than 1.5 m below the initial soil surface and more than 1 m above the seasonal high water table.

Biodegradation is maximised by regular soil tilling, the addition of nutrients and soil moisture control. The effects of mechanical tillage include:

- better soil aeration (to ensure sufficient oxygen supply for microbial growth);
- dispersal of contaminant aggregates such as tar balls; and
- the even distribution of the contaminant through

the soil volume to improve contact between the soil organisms and the contaminants.

Run-on (of water) must be diverted to avoid excess water entering the site, anaerobic or ponding conditions, erosion or increased contaminated run-off that may require treatment. Surface run-off from the site must be collected, monitored and analysed to identify proper treatment and disposal methods.

For each waste that is applied to the treatment zone, it needs to be demonstrated prior to the application that the hazardous constituents in the waste can be completely degraded, transformed or immobilised. The soil and waste mix should be analysed periodically for conventional parameters such as pH, BOD, COD, suspended solids and nutrients, and those constituents that cause the waste to be classified as hazardous. Records of the application dates, rates, quantities, types and location of the applied waste types must be kept.

Monitoring is required to detect migration of the applied waste and waste by-products. This should include soil cores and soil pore water samples as well as groundwater monitoring around the site. The number of samples to be taken and analysed depends on:

- the hazardous waste constituents expected to migrate;
- soil type and permeability;
- climatic conditions; and
- waste application and frequency.

7.2.4 Waste suitable for land treatment

Land treatment can result in the neutralisation of waste with high or low pH values and in the conversion of some inorganic constituents to a less mobile or toxic form. However, land treatment is best used for waste that is biologically degradable or chemically stabilised. Examples of waste types that have been land treated successfully are organic waste from organic chemical, petroleum refining, textile, pharmaceutical and wood preserving industries.

7.2.5 Acceptability

Although land treatment is a technique that appears to have been used successfully in the United States and Europe, it has not been exploited to the same extent in New Zealand except for the disposal of sewage effluent and sewage sludge on land (Ministry of Health, 1992). However, the process is generally accepted for the treatment of contaminated sites, and there have been successful remediations of sites contaminated with hazardous waste, particularly organics.

Land farms are useful for certain waste types, provided that loading rates and residue build-up are controlled. In particular, residues of heavy metals must be accounted for and managed. The end use of the land is also an important consideration, as very few land farms are ever returned to full agricultural production.

7.2.6 Bioremediation of soils contaminated by hazardous organic waste

Bioremediation is the use of living organisms to clean up environments that have become contaminated by chemical compounds, by selectively enhancing the processes that occur in land treatment. This process requires careful monitoring and control. There are two main sources of appropriate micro-organisms to degrade organic contaminants in soil:

- enhancing the growth of organisms already present in the soil on the specific site; and
- adding selected organisms to the soil in the form of inoculum.

The main types of systems used are as follows.

- **Treatment Beds.** Contaminated soil is remediated in beds with plastic or clay liners to prevent leaching. Perforated piping below the beds is used to collect leachates that can be recycled through the beds. To increase soil temperatures, the beds may be enclosed in a force-ventilated plastic film greenhouse fitted with activated carbon filters or other absorbents (e.g. peat, compost, soil or saw dust) to trap volatiles. Moisture, nutrients and inoculum can be added by a spray system.
- **Soil Heaps.** These are used to remediate excavated soil where space is limited for landfarming or bed treatment. The soil is heaped into a stockpile to which nutrients and inoculum are added. The pile can be covered with plastic tarpaulins and fitted with ventilation piping to aerate the heap. Volatiles can be trapped by passing the ventilated air through filters.

7.3 Hazardous waste (in-ground) containment facilities (HWCFs)

7.3.1 Overview

HWCFs have been used in the past to accommodate a range of waste unsuitable, even with pre-treatment, for disposal in MSW landfills, primarily due to the fact that appropriate hazard reduction or stabilisation of the waste could not be achieved. A HWCF is a system designed to provide long-term land storage to prevent the hazardous constituents in the waste from being released to the outside environment, and to minimise the effects of the outside environment on the contents of the facility.

HWCFs are also known as 'dedicated hazardous waste landfills', 'land storage facilities' or 'hazardous waste landfills' (refer *CAE Landfill Guidelines*, 2000). As a result of significant and well-publicised problems with old and abandoned sites such as Love Canal (USA) and Malkins Bank (UK), many countries have introduced stringent operating and design standards for HWCFs.

A site is selected for, among other criteria, its natural containment properties and then engineered to isolate the waste as far as possible from the environment. In most cases this isolation is achieved by the use of multi-liners using synthetic or engineered materials. Synthetic liners have finite life and all liner systems allow some liquid to pass through them, but providing they have not been punctured during placement of waste into the facility, leakage should be minimal.

In recent times it has been acknowledged that HWCFs do not act to reduce the hazardous characteristics of the waste they contain, and that they require designation, management and monitoring indefinitely. As a result, their use does not receive widespread support. In addition, they must be constructed and operated to standards that generally exceed those specified for other types of landfills.

7.3.2 Design considerations

The primary consideration for a HWCF is containment of the deposited waste and the avoidance of adverse effects on local ground/surface water and air quality.

In certain situations, leachate recirculation may be appropriate for HWCFs. Recirculation can provide for above ground treatment which may be of assistance in stabilising the waste within the expected life time of the containment facilities.

Figure 15 illustrates a typical sectional view of a HWCF. The main features, starting with the top cap, are:

- the contained waste;
- a layer of permeable material to protect the liner systems;
- the primary leachate collection system;
- a composite containment liner consisting of a thick geomembrane or a clay or bentonite mat substitute;
- a secondary leachate collection/detection system;
- a composite secondary geomembrane or clay or bentonite substitute; and
- the primary leachate leakage detection system underlying the facility.

It should be noted that the double liner systems extend up the sides of the containment facility. Each leachate collection system includes a network of pipes, sumps, submersible pumps and piping to the surface of the facility and discharge into collection tanks. Adequate provision must be made for inspection and maintenance of these systems.

Construction of double-liner systems of this type is a complex operation involving detailed testing of the liner systems (including field testing) and close coordination with equipment and material suppliers. Quality assurance provisions for both materials and workmanship must be detailed and the construction process certified to ensure compliance with design plans.

7.3.3 After-care and end use

Because of the long-term containment function of a HWCF, detailed closure and post-closure management plans must be prepared and implemented. These plans should specify the frequency schedules for inspection of:

- facilities;
- systems for pumping recirculating and treating leachate;
- leakage monitoring drains;
- sampling;
- analyses; and
- the reporting of monitoring results.

Land use and discharge consents applicable to the facility are likely to determine a post-closure period, which would probably be activated by conditions requiring regular review of the consent. The hazards from a HWCF will remain undiminished with time, and may increase as the containment structure ages. In practical terms therefore, the post-closure period should be perpetual, or until the site is remediated, either by decontamination through treatment, or by the excavation and removal of the hazardous waste. Financial provision in the form of bonds or trust funds should be

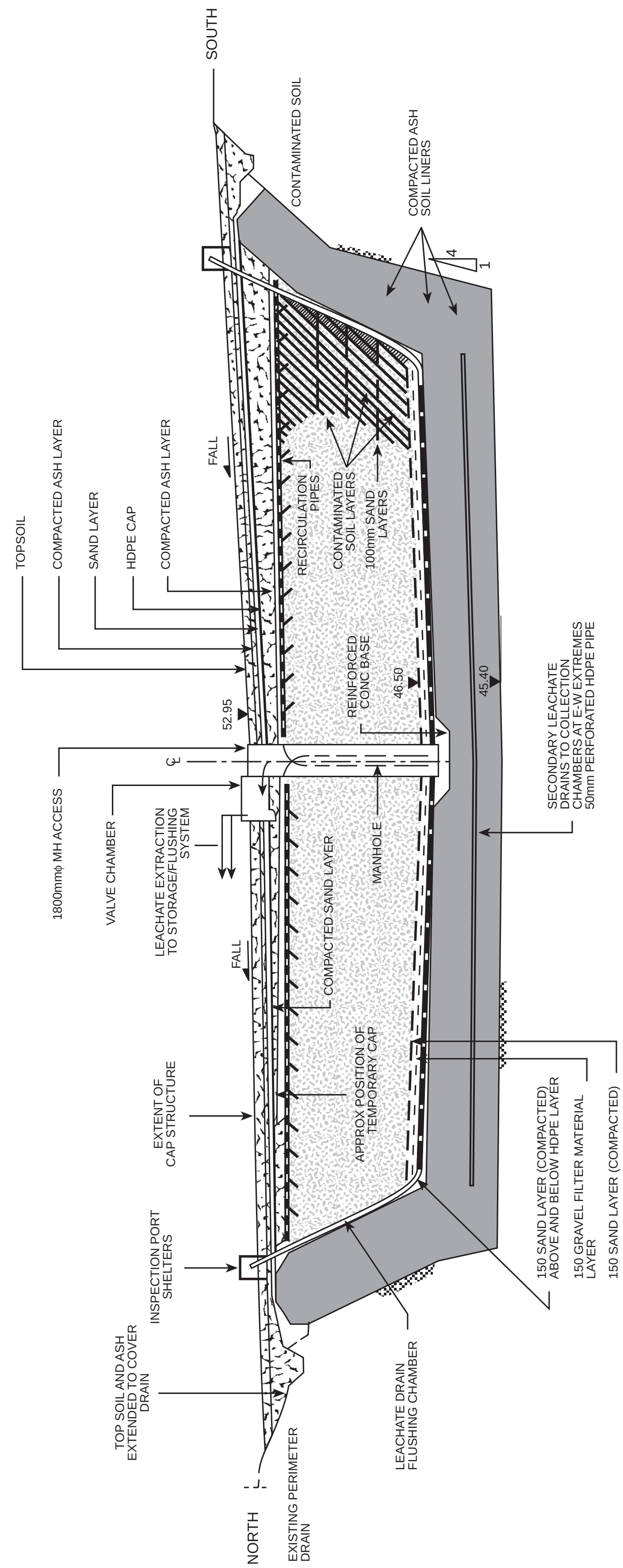


Figure 15: Cross-section of a hazardous waste containment facility

established to ensure that adequate after-care can be adequately resourced.

As the post-closure care period for a HWCF cannot be established with any certainty, it is difficult to determine appropriate future uses for the site. Such future uses are likely to be limited unless complete remediation measures have been implemented.

7.3.4 Applicability of HWCFs for hazardous waste arising in New Zealand

This method of land disposal requires a high degree of technical management over an indefinite period of time. Unless remediation measures are incorporated, it results in a perpetually contaminated site that relies on the ongoing integrity of its containment systems to ensure that exposure to contaminants is restricted, and wider contamination of land, ground and surface waters and air does not occur over time. Ongoing responsibilities for the site and for resourcing monitoring and management need to be carefully considered.

Alternative methods for satisfactorily treating and disposing the types of hazardous waste arising in New Zealand, as discussed in previous chapters, are available. Although an application for consents for a HWCF may be legal and successful under the risk-based approach of the RMA, the use of HWCFs is not considered to be an acceptable New Zealand industry practice by this Task Group.

7.4 Disposal of hazardous waste with MSW in landfills

7.4.1 Overview

The processes occurring within a municipal refuse landfill result in the biological and chemical degradation of amenable organic waste constituents, the immobilisation of certain inorganic waste constituents and the mobilisation of others. With limited addition of small quantities of some types of hazardous waste into well-designed and operated MSW landfills, the same reactions are likely to occur, and attenuation of contaminants may prevent the adverse environmental effects that may otherwise result. There are, however, uncertainties about the extent of the reactions and the degree of attenuation that will actually occur and consequently the extent of contamination of leachate. These uncertainties imply a risk associated with the disposal of hazardous waste into MSW landfills.

It must be recognised that all landfills receive hazardous waste to a greater or lesser extent. Waste analysis surveys conducted to date indicate that normal municipal waste streams contain hazardous waste arising from households and small commercial activities. These, and the decomposition of the organic component of the MSW waste stream also place demands on the attenuation capacity of the landfill processes and containment facilities.

Land disposal of hazardous waste has become less acceptable world-wide. This is due to the many poor practices in the past involving the indiscriminate disposal of hazardous waste with little regard to the selection of waste type or the assimilative capacity of the surrounding material. As a result, there is a perception that any form of land disposal is simply legitimised dumping of hazardous waste and the probability of contamination arising is unacceptably high.

Co-disposal, or the joint disposal of hazardous waste with municipal solid waste in landfills, initially gained a degree of support. This followed detailed investigations into landfill processes, conducted particularly in the United Kingdom, which indicated that co-disposal could be an acceptable practice providing it was undertaken in a managed and informed manner. The *CAE 1992 Report* provided recommendations on how co-disposal could be used for some of the hazardous waste arising in New Zealand. However, it was emphasised that these processes should be controlled and balanced. The intention was that the degree of management and monitoring that would be put into place at a co-disposal landfill would be similar to that of any other industrial or commercial biochemical process.

In many cases, these recommendations were found to be too complex and prescriptive. Few, if any, of the local landfill operators adopted the recommendations, and concern relating to the indiscriminate disposal of hazardous waste in landfills continues. Furthermore, the standard of siting, design and monitoring of New Zealand landfills is such that co-disposal as currently practised can no longer be justified. It is also worthy of note that the European Parliament has recently rejected co-disposal as an acceptable method for the disposal of hazardous waste within the European Community, as it was not convinced that the actual practice achieved the desired level of environmental protection.

Chapter 5 provides an outline of processes available locally for treating hazardous waste, demonstrating that facilities currently exist for all waste types except those containing organochlorines. The availability of these facilities means that the common practice of landfilling of untreated hazardous is no longer the only option. It must also be recognised that the land disposal of hazardous waste is not necessarily the cheapest option for society as the costs for transport and treatment of this waste must be compared against those for remedial measures, which may be required if inappropriate disposal measures are adopted.

For all of these reasons, the landfilling of hazardous waste, without treatment to a non-hazardous state, cannot be recommended in almost all circumstances. In addition, it is considered that it would be prudent to reduce, to the extent practicable, the hazardous waste entering municipal solid waste landfills from households and small commercial activities.

Because of the contentious nature of hazardous waste disposal into landfills, it is worthwhile to discuss the unusual circumstances under which the practice can be considered acceptable in more detail. One such circumstance would be an emergency situation. During emergencies, the disposal of hazardous waste to landfills may be considered a more acceptable practice than the other options available at the time (e.g. direct discharge to a water course). The principles reflected in Section 330 of the Resource Management Act may be of some use in providing a framework for implementing just such exceptional cases.

Even in such emergency situations, co-disposal can only be considered if:

- the hazardous waste conforms with the guidance given in Appendix 6;
- the site is properly selected, designed and operated; and
- an appropriate and thorough risk assessment is conducted for the particular situation.

7.4.2 Determining hazardous waste acceptability in MSW landfills

Acceptance criteria for MSW landfills, including the appropriate use of leaching criteria such as that determined by tests such as the USEPA's Toxicity Characteristics Leaching Procedure (TCLP), are discussed in Chapter 5 of the *CAE Landfill Guidelines*, 2000. As a general guide, the following considerations apply.

- Liquid hazardous waste (even if in containers) should not be accepted into a municipal solid waste landfill.
- Hazardous waste that has been treated to render it non-hazardous may be disposed in municipal solid waste landfills, provided it complies with relevant TCLP criteria.
- Hazardous waste containers must be thoroughly cleaned before being disposed of in a landfill (refer section 5.10).
- Some special waste types are sometimes classified as hazardous, although they do not generally present a hazard in a municipal solid waste landfill if managed properly. An examples is asbestos waste. Although asbestos-containing material may be harmful to human health, it does not present a hazard in the landfill provided it has received adequate burial.

7.4.3 MSW landfill site selection, design and operation

The disposal of small quantities of hazardous waste in extraordinary situations such as those described above is only acceptable at some MSW landfills. The requirements for such landfills should be regarded as being even more restrictive than those described in the *CAE Landfill Guidelines 2000* for the disposal of municipal solid waste. The following aspects are essential:

- siting in a low risk location;
- a high standard of engineered containment;
- a high standard of leachate collection and treatment;
- a rigorous monitoring system;
- a landfill management plan (with special regard to site access, safety, record keeping, and waste inspection); and
- specially trained operators.

7.4.4 Effects-based case-specific risk assessment

The recommendations of this Task Group that, as a general rule, untreated hazardous waste should not be disposed in MSW landfills, may be regarded by some landfill operators or consent authorities as too restrictive when considering the effects-based approach of the RMA. In such cases it is incumbent on proposers to clearly illustrate that an alternative approach would be appropriate.

A thorough, case-specific risk assessment would be required and this would need to cover all situations likely to arise during the complete life cycle of the landfill involved.

The initial step in such a risk assessment is a hazard identification process that requires an understanding of the nature of each waste, impurities, by-products, likely degradation products, and the potential effects of these substances on health and the environment. This should be followed by a quantified estimate of the contamination levels that could be transmitted to the environment, exposure pathways, potential effects of such exposures, including the identification of the most sensitive species appropriate to the site, and the acceptability of the resultant risk.

Most of the chemical, physical and biological processes occurring in landfills are not well characterised and little quantitative information is available. However, it is known that the extent of decomposition and stabilisation in a landfill depends on many factors, such as the:

- composition of the waste;
- degree of compaction;
- moisture content;
- rate of water movement;
- temperature; and
- presence of inhibiting materials.

In general, the rates of chemical and biological reactions increase with temperature and the amount of moisture present until an upper limit is reached. Because of the number of these interrelated influences, it is difficult to define the conditions that will exist in any landfill or location within a landfill at any particular time. It should be accepted that the processes required to achieve complete stabilisation in a MSW landfill will take considerable time; at least 30 to 50 years or more.

Any risk assessment must therefore achieve the following objectives:

- management of the risk of adverse environmental effects in terms of discharges to air, land and water;
- protection of the health and safety of landfill operators and the neighbouring community;
- protection of the biochemical processes within the landfill;
- avoidance of deleterious effects on the landfill containment structures;
- avoidance of reactions between waste types that result in the release of uncontrollable quantities of energy or toxic by-products; and
- management of the landfill in terms of it being a contaminated site.

The following factors should be taken into account:

- the nature of the hazard presented by the constituent;
- the concentration of the constituent in the waste and the extent of treatment to convert the constituent into a stable and relatively non-leachable form;
- the degree to which the waste is contained to prevent the release of the material;
- the potential of the constituent or any degradation product to migrate from the waste to the environment under plausible types of mismanagement to which the waste could be subjected;
- the potential for the constituent or any harmful degradation product of the constituent to degrade into non-harmful constituents and the rate of likely degradation;
- the degree to which the constituent, or any degradation product of the constituent, bioaccumulates in ecosystems; and
- the quantities of such waste generated on a regional basis or likely to come to the particular site.

7.5 Conclusions

Land treatment and the utilisation of the physical, chemical and biological processes involved will continue to be a management option for waste in New Zealand. If landfilled, hazardous waste should have undergone one or more treatment processes to remove or reduce the hazard(s) posed by the waste.

Co-disposal, or the joint disposal of untreated hazardous waste with municipal solid waste in landfills, can no longer be supported in other than exceptional circumstances. While it is recognised that attenuating processes do occur in well operated MSW landfills, these processes are difficult to identify and quantify. In all situations where hazardous waste is land treated or disposed to landfill a case specific risk evaluation must be carried out to illustrate that adverse environmental effects will not arise at any stage during the lifecycle of the disposal process.

Chapter 8
Warehousing and Storage of Hazardous Waste

8.1 Introduction

This chapter provides advice on the warehousing and storage of hazardous waste to ensure protection of the health and safety of people in the work place and the general public, as well as the protection of the environment and property.

In general, good warehousing practices involve:

- setting management plans and objectives;
- carrying out hazard identification;
- implementing risk reduction programmes; and
- supporting a community awareness programme.

Guidance is also provided on sorting, repackaging and handling waste.

Warehousing and storage covers all operations that hazardous waste undergoes after generation and before treatment and/or ultimate disposal, except for transport (refer Chapter 10), i.e. the handling, packaging, repacking, care, custody and transfer of hazardous waste. Particular reference is made to the operation of transfer stations, depots and landfill reception areas.

Management practices, the use of risk assessments and risk reduction activities are designed to:

- eliminate incidents that could result in injury to people or damage to the environment; and
- minimise the impact of such incidents if they should occur.

To this end, information is provided on warehouse management, record keeping, security, waste storage and segregation, repackaging and handling unknown waste, risk management practices and community consultation. A checklist is included to assist with the assessment of individual sites.

Although the recommended procedures have no legal status, they represent good practice. Failure to implement or follow them may result in serious contravention of the RMA, the HSNO Act or Health and Safety in Employment Act 1992 (HSE) (refer Chapter 1 and Appendix 2).

Figure 16 provides a graphic representation of these acts and their relationship with hazardous substances management.

The intersection of the circles shows how controls can exist for a particular substance under both Acts, in which case the more stringent controls apply.

8.2 General principles of storage

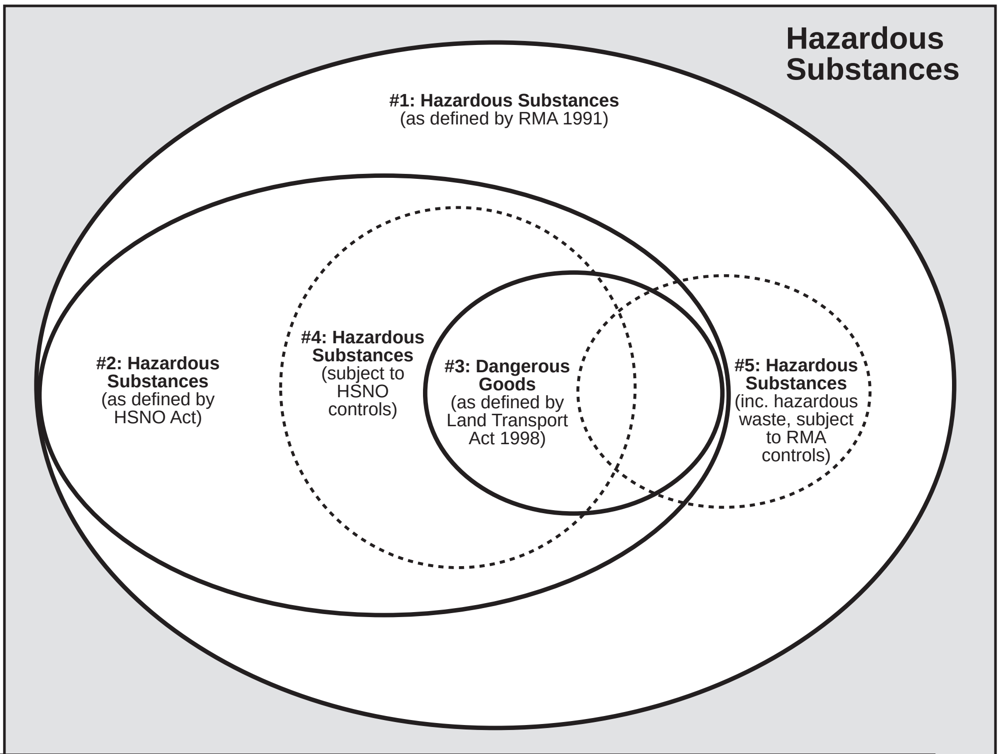
It is essential for the proper management of a facility to ensure that the hazardous properties of stored hazardous waste are clearly understood by all staff. These may be physical (e.g. fumes), chemical (e.g. corrosive) or biological (e.g. poisonous effects from swallowing, breathing or skin contact).

To ensure the safe storage of waste with hazardous characteristics, adequate procedures need to be developed consistent with good practice. Also, contingency planning for potentially adverse events such as broken containers, storage of incompatible substances, spills etc., should be in place. Information about the physical, chemical and biological properties of products and their quantities is needed to assess the risk.

The following factors should be considered:

- **Relevant Regulations or Codes of Practice.** The storage of hazardous substances, including hazardous waste, is generally covered by the RMA and the HSNO Act and its Regulations. The latter has replaced a number of other Acts[1], which also made provisions governing the storage of hazardous substances. The HSNO Act is still in its transition period, which is currently scheduled to expire on 1 January 2001.
- **Construction of the facility.** Hazardous waste

1 The Dangerous Goods Act 1974 and associated Regulations, the Explosives Act 1957, the Pesticides Act 1979 and the Toxic Substances Act 1979 including its Regulations.



#1 The large bold circle represents the *total* set of hazardous substances, as defined by the RMA
#2 The smaller bold circle represents the hazardous substances defined by the HSNO Act.
#3 The smallest bold circle represents "dangerous goods" as defined by the Land Transport Act 1998.
#4 The large dotted circle represents those substances for which controls have been developed under the HSNO Act.
#5 The small dotted circle represents those substances (usually hazardous waste) for which controls will be developed under the RMA.

Figure 16: Hazardous Substances Legislative Framework
(Adapted from the NZ Chemical Industry Council)

storage facilities must comply with the Building Act 1991 and the Building Code. The relevant clauses of this Code are shown in Table 3. Key requirements include bunding to contain the entire contents of the facility, an impermeable base suitable for the materials stored, isolation from ignition sources (use of intrinsically safe electrical systems), ventilation (static or active), and adequate security.

- **Signage.** Information on chemical classes and incompatible chemicals must be displayed clearly in the receiving area, as must the procedures for receiving chemicals and the emergency procedures. Storage areas for each class of chemical must be clearly identified, preferably in compliance with a relevant standard such as the NZCIC Code of Practice on Warning Signs for Premises Storing Hazardous Substances. The whole of the hazardous waste storage site must be designated a no smoking area.
- **Security.** It is necessary to ensure the security of storage sites, especially after hours. This includes adequate fencing, an intruder alarm and fire alarms monitored by a security firm or the fire service. Smoke and heat detectors within are essential, and sprinkler systems or other fire suppressing systems should be considered.
- **Inspection of incoming waste** to ensure that information is complete and packaging is appropriate, must be undertaken.
- **Separation of incompatible substances** by approved segregation devices, or approved separation distances, is good practice. The segregation requirements of the Land Transport Rule: Dangerous Goods 1999 (LTRDG) and the NZS5433:1999

NZBC Clause	Subject	Contents
F 3	Hazardous Substances and Processes	• Access restrictions • Protection of services • Protected ignition sources • Type of construction • Ventilation and control of escapes • Surface finishes
F 6	Lighting for Emergency	• Illumination of escape routes • Signage
F 7	Warning Systems	• Fire alarms • Smoke and heat detectors
F 8	Signs	• Escape routes • Emergency related safety features • Potential hazards

Table 3: Relevant Clauses of the Building Code

- Transport of Dangerous Goods on Land provide suitable guidance and as a matter of good practice should be followed even for such substances not covered by these documents.

- **Traceable control procedures** for the inspection, receipt, shipping, handling, storage, and security during storage of waste should be in place.

- **Training and certification** of persons involved in the handling and storage of hazardous waste is essential. Training records should be kept and refresher courses given.

- **Adequate fire-fighting equipment** and materials required to contain or neutralise spills should be kept on site and be easily accessible. Employees need to be trained in the procedures to be followed in the event of a fire or other emergency such as spill.

- **Waste data,** particularly those relating to containment, neutralisation and behaviour under fire conditions must be provided. This involves correct labelling, an MSDS and signage (e.g. the Hazchem Code). Where required (e.g. by the Land Transport: Dangerous Goods), UN Numbers and the correct waste identification code must be shown. Staff should be trained in understanding and interpreting MSDSs.

- **Packaging** should comply with relevant legislative requirements, e.g. the HSNO Regulations and/or the Land Transport Rule: Dangerous Goods 1999 where applicable. This should be regarded as a minimum requirement for good practice.

- **An up-to-date emergency plan** for the site, covering all potential incidents and addressing the extent to which community services will be involved, must be developed and maintained (refer Chapter 9).

- **Provision of suitable storage.** Premises that generate hazardous waste will generally also store other hazardous materials. Waste should be stored with the same level of security as products and raw materials, e.g. new oil and waste oil both need to be stored in secure bunded areas, protected from weather to minimise the risk of spillage. A facility should only receive waste which it can safely accommodate. For some highly hazardous waste, the generator may be better equipped to deal with the hazards present and the waste should remain with the generator.

- **Provision of any necessary special type of equipment**.

- **Effective control of ancillary operations** or other operations on the site which may have an impact on the storage of waste.

- **Hazardous waste should not be held in long term storage** where there is an appropriate treatment process/facility (refer Chapter 5) available.

A checklist addressing these issues is provided in

Appendix 7. This may be used to determine whether or not a particular warehouse (owned or contracted) is suitable for the storage of hazardous waste, for assisting in building a new facility, or for determining any necessary improvements to an existing warehouse and its management.

Accuracy in completing the checklist is necessary to help prevent accidents. A comprehensive list of the stored materials (or those intended to be stored) should complete the assessment.

Inappropriate storage of hazardous waste
(Auckland Regional Council)

8.3 Waste receipt

To handle very hazardous substances, a person will be required to hold a 'Certificate of Approval as a Handler' (CAH) under the HSNO Act. Operators must also be trained by a suitably-qualified person in the segregation of hazardous waste. If transporting hazardous waste, which also falls under the classification of 'Dangerous Good', drivers must have a licence endorsement according to the Land Transport Rule: Dangerous Goods 1999 (refer to Chapter 10).

The standard procedure for receipt of waste should be as follows:

- **Review applications from waste generator.** The application form needs to be tailored to the facility and can range from a simple declaration form to a multi-form manifest.
- **Staff must assist the waste generator in completing a hazardous waste declaration form** or similar document, stating the type of waste, quantity, source etc.
- **All containers must be inspected for leaks** and weaknesses, and contained if necessary. They must have suitable lids to prevent gas/fumes escaping. Spare containers and lids should be available at the site. Containers must be compatible with the waste type.
- **At transfer stations or landfills,** all general waste must be inspected by transfer station operators as it is tipped into the pit, or by landfill operators as it is placed at the face. This will ensure that potentially hazardous waste is identified and removed.
- **Operators must take care when handling unknown containers** recovered from the pit. Leaking containers must be placed in a secure container before being placed in the hazardous waste store.
- **All facility containers should be labelled before transfer to storage.** Labels should record date and place of delivery, type of waste and name of person delivering waste. This information must be recorded in a register, a copy of which is to be available on site, in a separate locked cabinet, to which the emergency services have a key. Trained staff must inspect the facility regularly and ensure that these chemicals are sorted and stored safely.
- **Stored material should be reviewed regularly** to identify reuse, treatment and disposal options.

8.4 Records and related procedures

A register of hazardous substances and waste must be kept and updated as waste arrives, with each container being given an identifying code. Alternatively, a record should be kept of the date, generator, waste type and storage location. This will allow the waste to be tracked to its final disposal.

The storage area must be regularly inspected by an independent auditor/supervisor and kept in a clean and tidy condition. Leaking or damaged containers must be recontained immediately.

Specific procedures must be prepared and maintained for the following:

- reviewing applications;
- receiving goods and checking manifests;
- recording waste details;
- handling of containers;
- emergency preparedness (spills/fire); and
- disposing of goods; and

- documenting the ultimate fate of all waste received.

Procedures must be clearly displayed and staff must confirm in writing that they understand and will comply with them. These procedures need to be reviewed regularly. A minimum recommended review period is one year.

8.5 Waste segregation

Waste should be stored in accordance with its inherent hazards; some waste may have more than one hazard, e.g. it may be flammable, toxic and ecotoxic. The classes listed below are based on the United Nations Recommendations on the Transport of Dangerous Goods (UNRTDG):

Class 1: Explosives

Class 2: Gases
- 2.1 Flammable gases
- 2.2 Non-flammable, non toxic gases
- 2.3 Toxic gases

Class 3: Flammable Liquids

Class 4: Flammable Solids
- 4.1 Flammable solids
- 4.2 Substances spontaneously combustible
- 4.3 Substances reacting with water emitting flammable gases

Class 5: Oxidising Substances and Organic Peroxides
- 5.1 Oxidising substances
- 5.2 Organic peroxides

Class 6: Toxic and Infectious Substances
- 6.1 Toxic substances
- 6.2 Infectious substances

Class 7: Radioactive Materials

Class 8: Corrosive Substances

Class 9: Miscellaneous Dangerous Substances and Articles

Under the Land Transport Rule: Dangerous Goods 1999, separation distances between these classes are now either zero, three metres, or classes cannot be loaded with each other at all depending on their compatibility. The NZS 5433:1999 - Transport of Dangerous Goods on Land (incorporated by reference in the LTRDG) provides comprehensive information on the classification, packaging, labelling, documentation and transport of dangerous goods. Information on waste types that are not compatible and should therefore be segregated accordingly is provided in Appendix 4.

Inappropriate storage of hazardous waste, showing lack of proper segregation
(Haz-Tech Environmental Ltd)

8.6 Waste handling

8.6.1 Sorting and repackaging

The following points should be considered when sorting and repackaging waste.

- The handling of waste must be kept to a minimum.
- The decanting of chemicals is not recommended. The decanting or repackaging of substances of known composition should only be undertaken by suitably trained and experienced staff.
- It is preferable to minimise additional contamination (i.e. rinse water, spill absorbents) by recontaining old containers within a new oversize container.
- Unidentified chemicals must be stored individually pending testing.
- If the waste is also a 'Dangerous Good', packaging must be in UN-approved containers, as set out in NZS 5433:1999.

8.6.2 Personal protective equipment

Personal protective equipment (PPE) appropriate to the hazardous nature of the waste is essential. PPE should include safety footwear, eye protection (gas-tight goggles or face screens or both), gloves, aprons and head protection where applicable. All PPE should be approved and/or certified to appropriate New Zealand or international standards.

When the load consists of substances which can emit toxic gases, vapours or mists, suitable breathing protection equipment should be provided such as a respirator with a canister appropriate to the gas concerned, or as required by the nature of the goods carried. This equipment must be carried on the vehicle for use in emergency situations as required in the Land Transport Rule: Dangerous Goods.

The following aspects are of importance.

- **Gloves** should be preferably gauntlet style in PVC, butyl or nitrile. They need to be checked regularly for cuts, tears or other damage. Barrier cream should be applied where necessary.
- **Eye protection** should ideally be a full face shield. However, on its own this will not provide protection from vapours. The visor will need to be replaced regularly.
- **Respiratory protection should match the different hazards represented.** Cartridge type respirators are preferred, with different types of cartridges available for different hazards. A sealed face mask with visor for eye protection may be necessary for some chemicals.
- **Chemical suits, overalls and splash aprons** are essential components of PPE.
- **Safety gum boots or similar work boots** are necessary. Overalls should remain outside boots rather than being tucked inside.

Other important equipment includes:

- **first aid equipment** including eye wash and emergency shower;
- **drum trolley(s);**
- **tools for opening tight drums;**
- **spill kit(s)** including absorbent material;
- **plastic containers/bins to re-contain** leaking or old containers;
- **adhesive or tie on labels.**

8.6.3 Personal hygiene

To avoid potential health risks when handling chemicals, staff should follow these procedures:

- **NEVER** touch your face when you have been handling products;
- **ALWAYS** wash your hands with soap and warm water at least twice before eating, smoking, touching your face, or going to the toilet;
- **NEVER** smoke in or near the hazardous waste area;
- **ENSURE** clothing is washed after handling chemicals;
- **WASH** spills off your skin immediately;
- **STOP WORK** and advise your supervisor if you feel unwell and get fresh air;
- **NEVER** work alone; and
- **ALWAYS** work in a well ventilated area.

8.7 Unidentified waste

The identification of unknown waste can be very costly and potentially dangerous. As much information as possible should be obtained before the waste is accepted. A laboratory should be retained for the identification of unknown waste. It is the responsibility of the waste generator to correctly identify, package, label and document the waste before transport elsewhere. Unqualified staff should not carry out any identification or even basic characterisation of potentially hazardous materials.

Under no circumstances should a container be opened intentionally for the purpose of smelling any product. However, obvious odours generated during the handling of containers or from samples taken for further tests should be noted.

Staff should adhere to the following procedures:

- **NEVER** open containers marked ‘explosive’ or ‘radioactive’;
- **NEVER** open containers with known reactive chemicals such as picric acid or substances that can combust on exposure to air or water (e.g. phosphorous, lithium, and sodium);
- **NEVER** smell the contents of any container;
- **NEVER** mix unknown chemicals; and
- **NEVER** taste chemicals.

8.8 Management practices

The organisation should have written policies, procedures and improvement plans for warehousing and storage. These should apply to all facilities and cover all operations on the site. Responsibilities for approving, communicating, implementing, reviewing and updating these documents should be clearly defined.

The key objectives are the achievement of minimum defined standards and continuous improvement.

To achieve this the organisation should:

- Maintain policies and procedures that meet or exceed all applicable laws, regulations and relevant New Zealand standards in letter and in spirit. Procedures must be clearly displayed and staff must confirm in writing that they understand and will comply with them. Procedures must be reviewed regularly, with a recommended minimum period of one year.
- Maintain records and quantitative measures of warehousing as well as storage incidents and reviews.
- Set specific targets for reduction of these incidents and for improvement in reviews.
- Work actively, alone or through selected organisations and, if possible, in consultation with other affected parties to assist government in developing public policies, legislation and regulations governing warehousing and storage.
- Maintain a system that identifies ownership, responsibility and status of hazardous waste through warehousing and storage operations.
- Not use facilities or engage in practices that do not meet the conditions outlined in this chapter.
- Be actively involved in procedures designed to minimise the generation of hazardous waste.
- Carry out regular audits of the operation (refer Chapter 8.11 and Appendix 7).

8.9 Risk management

The organisation should carry out a risk assessment of its warehousing and storage operations on a regular basis.

To achieve this, the organisation should:

- Maintain a review system that considers the hazards of each material or type of waste, the methods of containment (including pipelines) and the procedures involving handling and storage.
- Maintain a system that considers the likelihood of accidents or spillage and the resultant impact on humans and the environment.
- Maintain a system that will only allow new hazardous waste to be stored after a risk assessment has been completed.

The organisation should actively practice risk reduction by developing effective practices for those who warehouse and store hazardous waste, such as:

- ensuring appropriate and approved siting of all facilities;
- ensuring that security is provided at all facilities to prevent unauthorised access;
- maintaining a review system considering the integrity of all containment facilities, including storage tanks, pipelines, drums and other packaging, at least in accordance with regulatory requirements;
- ensuring that materials are appropriately segregated during storage;
- ensuring that all operations are covered by written, regularly updated procedures;
- ensuring that, as a minimum, all labelling is in accordance with regulatory requirements (refer Chapter 1);
- maintain a system that provides guidance and information in advance to any group that may be affected by the warehousing and storage of hazardous waste, including provisions to keep such information current;
- maintaining a system that regularly reviews the suitability of all facilities for their purpose;
- maintaining a system that reviews generator/contractor ability to meet this guideline;
- maintaining a system that ensures prompt and effective response to any incident (refer Chapter 9); and
- ensuring that organisation and contract staff are adequately trained in *all* operational matters (including safety, health and environmental matters) and that this training is formally reviewed.

8.10 Community awareness

Trends overseas suggest that the surrounding community should be taken into account in the design and operation of a storage facility and the formulation of Emergency Plans.

To this end, the organisation should:

- maintain a system that responds to any reasonable community request as to the type and quantity of hazardous waste in a storage facility;
- encourage the local community to have an under-

standing of the organisation's practices, especially those involving security and incident response;

- encourage the formation of neighbourhood consultative committees where deemed appropriate;
- maintain a system that, as a minimum, makes information on all reportable releases or loss of containment available to the public; and
- keep relevant agencies (e.g. fire service, civil defence) up-to-date on types of hazardous waste on-site and established emergency procedures.

When dealing with the community, seven rules of risk communication should be followed:

- accept and involve the public as a legitimate partner;
- plan carefully and evaluate your efforts;
- listen to the public's specific concerns;
- be honest, frank, and open;
- coordinate and collaborate with other credible sources;
- meet the needs of the media; and
- speak clearly and with compassion.

8.11 Audits

Internal safety, health and environmental protection (SH&E) audits of the whole warehousing operation that cover both equipment and procedures help to:

- ensure that objectives are understood by all concerned;
- ensure that deficiencies are uncovered; and
- stimulate safety awareness.

It is recommended that SH&E audits be carried out regularly and with management participation. It is important that management commitment to SH&E be demonstrated by acting promptly to correct any noted deficiencies. Records should be kept of audit findings and recommendations (refer Appendix 7).

Chapter 9
Emergency Preparedness

9.1 Introduction

This chapter presents guidelines and reference information to enable the preparation of emergency plans suitable for situations involving hazardous waste. The waste may be in existence prior to the emergency and hence may be either the source or be merely involved in the emergency, or they may be a product of the emergency.

Prompt, effective emergency response reduces accidental losses and the consequences of natural and man-made disasters. There is often not enough time during an emergency to decide who is in charge, consult outside agencies, identify sources of help, or train people for emergency response. These actions must be taken prior to the emergency.

An effective safety and health programme will first ensure that a general emergency plan exists that:

- establishes evacuation procedures;
- assigns responsibilities to specific individuals;
- provides for notification to outside agencies;
- establishes means of communication; and
- provides for in-house emergency response and prepares for other effective actions.

The next step is to customise the general emergency plan to specific emergency situations likely to occur. The principle of the 'critical few' should be applied when formulating customised emergency plans (i.e. develop plans first for those emergency situations that are most likely to occur and/or possess the greatest potential for loss).

Successful emergency preparedness is a comprehensive and systematic approach that is written down, critically tested and continually updated. This needs to consider air, sea and land as environments in which an emergency may occur and that may be affected by such an emergency.

This document principally focuses on land-based emergencies. Air emergencies are well covered by international regulations and guidelines. Similarly, management of waste dangerous goods and associated emergencies in the marine environment is covered by the International Maritime Dangerous Goods Code (IMDG Code) as well as domestic rules and regulations covering shipping.

Emergency plans are also required under the HSNO Regulations. Related aspects of emergency management such as evacuation plans are required under the Fire Safety and Evacuation of Buildings Regulations 1992 (for premises storing or handling hazardous substances).

This section recommends the use of both the Coordinated Incident Management System and the New Zealand Chemical Industry Council Code of Practice 'Emergency Preparedness', which have been extensively used as source material.

9.2 Emergency planning

9.2.1 Introduction

The key components of emergency management are:

- reduction of emergencies;
- readiness for emergencies;
- response to emergencies; and
- recovery from emergencies.

9.2.2 Leadership and administration

Effective leadership and simple administration are the keys to effective emergency response systems. Once an emergency coordinator has been appointed, he/she should appoint a deputy. Sectional wardens who ensure that the specific needs of individual departments are taken into account should also be appointed. All staff should be advised of these appointments.

A checklist to assess the effectiveness of an emergency preparedness system is provided in Appendix 8.

9.2.3 The emergency plan

A comprehensive written Emergency Plan provides for actions to be taken in all types of emergency conditions likely to occur (e.g. floods, storms, earthquakes, fires, explosions, chemical spills, chemical accidents, bomb threats, civil disturbances, sabotage, major accidents, equipment failures, structural failures, earth collapses and transport emergencies).

The plan should demonstrate that an assessment has been made to identify the types of probable emergencies, both general in nature (such as a fire, flood or cyclone) and specific to the site (a certain type of chemical spill), that could be expected to occur.

It should make adequate provision for the safety of people on the site. An evacuation plan should be part of the emergency plan and should include a description of the system used to alert staff that an evacuation is in progress, the designation of safe areas where employees, visitors, and others will report, and a "head-count" procedure to determine that everyone has been evacuated safely.

The plan should have layout sketches of the site buildings, departments, dangerous goods storage areas, bulk tanks, underground services, electricity, gas, water, sewage and trade waste. Material safety data sheets (MSDS) should also be available.

A model emergency plan, adapted from the Maritime Safety Authority Marine Oil Spill Contingency Plan is provided in Appendix 9. Example emergency procedures are provided in Appendix 10. These procedures should be simple, one-page documents which can be laminated and displayed together with an emergency contact list.

9.2.4 Principal features of an emergency plan

A comprehensive emergency plan includes the following:

- **an evacuation plan** to move people to predetermined safe areas;
- **clearly defined duties and responsibilities;**
- **details of the site**, the materials stored and hazards posed to people, assets and the environment;
- **plans showing services and sensitive areas;**
- **details of the response equipment** available on site and elsewhere, together with plans showing its location;
- **well documented, detailed instructions** for each building or area, that include fire, major chemical spill, toxic gas release, work shutdown and evacuation;
- **special fire-fighting procedures** to control fires in hazardous materials and controls for those hazardous materials, i.e., spill and waste water containment;
- **all clear and re-entry procedures**;
- **hazard assessment procedures** and designated levels of response;
- **notification procedures** for outside authorities;
- **communication authority** for the public and news media;
- **regular plan review dates**;
- **regular plan testing dates**; **and**
- **essential telephone numbers** (both office and after hours) including, but not limited to:

  — key company staff

  — fire, police, ambulance

  — local hospital emergency clinic

  — company doctor or nominated local general practitioner

  — Civil Defence

  — National Poisons Centre

  — government agencies, including designated HSNO authority

  —adjoining organisations

  — chemical spill clean-up services

  — electricity, gas, water authorities.

9.2.5 Emergency plan layout and administration

Ideally the plan should be loose leaf in a ring binder with all copies under a system of document control to prevent unauthorised copying. Each copy of the plan should be numbered.

The front of the plan should list all staff on the call-out roster and their telephone numbers. Many sites are open or fully-staffed only five days per week, or perhaps 60 out of 168 hours. If there is no full-time security, call-out telephone numbers at the building main gate or entrance are needed. A copy of the plan and an inventory of the hazardous substances on the site must be kept in a locked box at the entrance or in the sprinkler house (for buildings with sprinklers), together with a key in a break-glass box for the Fire Service if they are first to arrive after hours.

If there is a staffed security gatehouse, a copy of the plan and the hazardous substances inventory should be readily accessible and its location known to all relevant people. In the event of off-site emergencies, emergency response contact numbers should be visible or readily available to staff on the scene.

Site plans, specific departmental shutdown procedures and all other relevant material should be appended to the plan. To ensure that the whole document is easily readable, diagrams and flow charts should be used wherever possible. Coloured dividers are a useful means for quick reference.

9.2.6 Emergency teams

Emergency teams could include internal fire brigades, search and rescue teams and security teams. Under Section 28 (3) of the Fires Service Act 1976, the Fire Service is required to respond to hazardous substances emergencies and will also be on site. It should be noted that even in small facilities or transport incidents it has been shown that prompt and appropriate response to fires and other emergencies prior to the arrival of outside services greatly reduces the extent of loss.

An emergency team (or teams) should be established to handle basic emergencies. This may include staff in charge of the following areas:

- medical/first aid;
- environmental protection;
- transportation/food supply;
- maintenance, damage control and repairs;
- media communications; and
- security.

The size of the team(s) should be adequate to enable them to perform all designated functions, cover all shifts when the facility is in operation, and have sufficient staff so that absences (sick leave, holidays) will not affect performance.

In transport emergencies, the driver may be the only first line of response. In preparation for such situations, safe limits of the driver's actions must be defined.

Training of the team should include classroom and field training. A regular training schedule should be established to update the emergency team members' knowledge and skills. Training objectives should be developed on an annual basis and should list the subjects and dates of scheduled training. The local New Zealand Fire Service can assist in this exercise.

Regular drills, whether announced or not, are essential to ensure proper emergency preparedness as they allow participants to use and reinforce their training. Drill results should be carefully evaluated to determine the area(s) of training that need(s) to be emphasised in the future.

Where outside agencies (Fire Service, Regional Council, Police etc.) are included in teams, they should be fully involved in all emergency plan development and training exercises.

9.2.7 Alarm initiation

The alarm system must be documented, understood by all relevant parties, and routinely tested. Concise instructions should be visible at all alarm points.

Alarms are often automatically transmitted to emergency services like the Fire Service. Whether or not this is the case, or in an off-site emergency, procedures to be followed must be available to the coordinator. It is important that all staff understand alarm initiating procedures.

In a transport emergency, response is typically triggered verbally by a telephone call to the prearranged contact.

9.2.8 Emergency lighting and power

Emergency lighting and power sources should be available where needed throughout the site. Emergency lighting should be provided in all areas where staff might be working to allow safe evacuation from the area. Emergency power should be supplied to any area or process in which lack of power could cause fire, explosion, major process/equipment damage, or other losses.

9.2.9 Emergency equipment

As part of emergency planning, requirements for the following equipment should be investigated:

- detection systems for smoke, hydrocarbons and other hazardous substances;
- fire extinguishers, extinguishing systems (e.g. sprinklers or deluge) and fire-fighting equipment;
- other emergency and rescue equipment such as self-contained breathing apparatus (SCBA), emergency escape air packs, deluge showers and eye baths, emergency first-aid packs, stretcher and possibly rescue lines, ladders and other relevant tools and equipment; and
- spill kits and absorbent materials, booms, saline bags or other services protection, containers for collected spills, etc.

9.2.10 Emergency communications

Since many emergencies result in disruption of established methods of communication, plans should include alternative means of communication with key managers, company emergency teams, outside emergency organisations, employees, government officials and others as needed. Examples of alternative systems include courier systems, radio communication systems and separate back-up telephone systems (cellular phones).

9.2.11 First-aid training

As many people as possible should be trained in first-aid. People properly trained in first-aid have fewer accidents, and the consequences of on-the-job accidents will be lessened through prompt and appropriate first-aid care.

9.2.12 Off-site and transport emergencies

Where materials or waste is transported off-site, prevention and control of off-site emergencies must be considered. A substance considered non-hazardous under transport regulations may still present a significant threat to the environment if spilled, and such incidents may be subject to prosecution under the RMA.

Emergencies originating from the vehicle itself (e.g. brake fires) may develop into a major incident affecting the hazardous substance being carried if not adequately handled in the early stages. It should be noted that an emergency may occur in remote areas and at times of the day that impose special difficulties.

Provision of the following equipment should be considered:

- fire extinguishers, spill control equipment and tools;
- chemical suits, gloves, boots, face shields; and
- gas masks.

Systems appropriate for communicating emergency information need to be carefully considered, including the need for road markers or flares to alert other road users.

In the event of the driver of a vehicle becoming incapacitated, information about the load and other relevant instructions must be readily accessible to an untrained, casual bystander so that the first phase of emergency response can be undertaken.

In contrast to a site emergency, only one employee may initially be present during an off-site or transport emergency. Drivers should therefore receive first-aid training and vehicles should carry an emergency first-aid kit suitably stocked for the nature of the emergency likely to arise from the substances carried.

9.2.13 Organised outside help and mutual aid plans

Assistance from outside agencies and industries can be beneficial and, in many cases, is essential in controlling an emergency situation. Care should be taken to properly select, plan and maintain relations with services and industries that can be helpful. Activities to keep Police, Fire Departments and other such agencies informed of emergency needs should include:

- regular site visits by employees and emergency services staff;
- provision of site layouts, building floor plans, information about process and equipment hazards, chemicals/materials inventories, and transport routes to such agencies;
- joint training exercises with other company and emergency services staff; and
- participation in community emergency plans and drills.

As part of emergency preparedness it is advisable to contact immediate neighbours, or other companies handling similar materials, and set up a small group to discuss each others' likely emergencies and priority actions if and when problems occur.

9.2.14 Protection of vital records

Protection of vital records is an often overlooked aspect of emergency plans, even though their loss (due to fire or smoke damage) often proves very costly when organisations attempt to resume operations following an emergency.

In transport emergencies, the vital records are the manifest and emergency procedure guides for products (and vehicle). These must be carried separately from the product and in the most accessible location (e.g. cabin door).

Procedures to protect such records are an important emergency plan component.

9.2.15 Communicating with the public and media

Training of senior staff in media relations is advisable to ensure concise and effective communication. A company spokesperson and deputy should be designated in the emergency plan.

Procedure(s) for communicating with government agencies for evacuating the public must also be in writing and included in the emergency plan, and public safety in general should be addressed.

Procedures should clearly define:

- the situations that require notification and evacuation;
- specific individual(s) responsible for notifying the appropriate agencies;
- names, addresses and phone numbers of personnel to be notified; and
- time frames for fulfilling notification requirements.

9.2.16 Termination of an emergency

It is important to officially proclaim the termination of an emergency to allow return to normal operations. Procedures for emergency termination should be in place, and staff should know who is authorised to do so.

Each operating unit of the facility should identify the critical areas of operations which may have a major impact on the business if lost. Plans to bring operations back on-line as soon as possible following an emergency should be developed.

9.2.17 Post emergency investigations

An emergency may be followed by a statutory investigation, for example by the Department of Labour or the Ministry of Transport. Full cooperation must be given and evidence should be preserved. In particular, any post-emergency clean-up or repair should only be undertaken with the approval of the investigating officer.

Normally, a senior police officer is delegated to take charge of all aspects of the emergency that may later be subject to a coroner's inquiry.

In all emergency responses, regardless of size and severity, a debriefing should be conducted, with recommendations to improve facility operation and/or the emergency plan.

9.3 Emergency services

9.3.1 Government agencies

The New Zealand Police generally has a designated Emergency Service Commander who takes charge of an emergency situation. In the case of a hazardous substances emergency, this function is delegated to the Fire Service, although the Police retains overall responsibility for public safety. Appropriate staff from regional councils and territorial authorities as well as public health authorities may also assist on the scene. In many regions, this is facilitated by the Hazardous Substances Technical Liaison Committee, organised by the Fire Service.

Further details on the roles of the emergency services is provided in Appendix 11, along with a list of Fire Service Contacts.

9.3.2 Industry

In contrast to other industrialised countries, mutual aid services within private industry are limited in New Zealand. One of the few examples is the Petroleum Industry Emergency Action Committee (PIEAC), which was formed to serve the needs of its member companies (Mobil, Shell, Caltex and BP) in fire, spill and civil defence emergencies. The Committee maintains a network of strategically-located equipment and staff. Its response capability is only available to member companies, but is limited in the area of hazardous waste as it is not designed to handle non-petroleum based materials.

Some waste management service companies have facilities to assist in emergencies, but this capability is severely limited outside of New Zealand's largest cities.

9.3.3 Information systems

The effective handling of an emergency is greatly assisted in having appropriate information available in a timely fashion. When hazardous materials are involved the scope of data that may be necessary can be very extensive, including information needs relating to effects on human health and the environment. New Zealand information sources include the following.

- The Auckland Area Fire Service, which has a chemical response database, 'Chemdata' purchased from the United Kingdom Atomic Energy Authority (AEA). The information is made available to all Fire Service regions (refer Appendix 11).
- The National Poisons Centre has a large database in Dunedin. The centre is available on 03 - 474 7000 24 hours a day, seven days a week.
- The New Zealand Chemical Industry Council provides an 0800 'CHEMCALL' service, to which companies may subscribe. This service is provided 24 hours a day, seven days a week to assist companies with emergency response.

It should be noted that standard databases may be of limited use if the material involved is a hazardous waste.

Chapter 10
The Transport of Hazardous Waste

10.1 Introduction

This chapter presents an outline of the rules and requirements for the transport of dangerous goods, including hazardous waste, on land. It is based largely on the Land Transport Rule: Dangerous Goods 1999 (LTRDG) which came into force on 3 May 1999 together with NZS 5433:1999 Transport of Dangerous Goods on Land.

It should be noted that the Rule relates to dangerous goods only; many types of hazardous waste are not covered by this or indeed any other transport regulation. However, as unauthorised discharges of contaminants (including those arising from a transport emergency) are liable to prosecution under the RMA, a good practice approach dictates that the guidance provided by the Land Transport Rule should be followed even for those materials not covered by it. The following chapter is based on this assumption.

10.2 Dangerous goods classification and segregation

The classification system for dangerous goods used in the LTRDG (Table A: Properties and Classes of Dangerous Goods) is based on the United Nations Recommendations on the Transport of Dangerous Goods (refer Chapter 8). It provides considerable information on classification and segregation/storage of dangerous goods. Segregation is further addressed in Schedule 3 of the Rule.

Dangerous goods in limited quantities, with the total weight of waste and packaging which not exceeding 1,000 kg, and which otherwise comply with Section 2.3 of the Rule, may be transported without segregation of outer packages.

10.3 Requirements for labelling and documentation

10.3.1 Labelling and marking

Hazardous waste being transported must be labelled and marked to describe the type and quantity, and identify their risk to people, property and the environment.

Labels must be clearly displayed, durable and relevant to the materials being transported. Misleading/incorrect labels must be removed or covered before transport. Label designs must comply with specifications in at least one of the following:

- NZS5433:1999 - Transport of Dangerous Goods on Land.
- UN Recommendations on the Transport of Dangerous Goods.
- International Maritime Dangerous Goods Code.
- Technical Instructions for safe Transport of Dangerous Goods by Air.
- Dangerous Goods Regulations of the International Air Transport Association.

In addition, marking must include the proper shipping name and the UN number. Other useful guidelines such as the NZCIC Waste Identification Code are also available.

10.3.2 Dangerous Goods documentation

Dangerous goods transportation must be accompanied by documentation stored separately from the materials, e.g. in a prominent position in the cab of the transporting vehicle. This documentation must be in English, legible, on paper or similar material and clearly identifiable as a dangerous goods declaration. The Dangerous Goods Declaration must include:

- proper shipping name and technical name;
- class and division of dangerous goods;
- UN number;
- packing group if applicable; and
- other technical information needed to ensure safe transport.

The number and type of packages must be stated, as well as the total quantity of material, as measured by volume or mass. Details of the consignor, including contact details must be provided.

If a load contains goods from more than one location then a Schedule of Quantities on a separate page must be used.

Line haul vehicles must have a load plan showing location of all dangerous goods. This must be amended every time goods are loaded or unloaded.

If the dangerous goods are contained in a pre-packed freight container or vehicle, the transporter must carry a container/vehicle packing certificate which should state that:

- the container was clean and fit to receive goods;
- the goods are segregated properly;
- all packages have been inspected for damage;
- packages have been correctly loaded and secured; and
- all packages are appropriately marked and labelled.

The signature and details of the packer must be included in the certificate.

10.3.3 Hazardous waste manifests

All transport of hazardous waste should be covered by a waste manifest system that identifies the source of the waste and its intended fate. The form should provide for a 'chain of custody' record detailing information about the waste from its generation to final disposal. An example of a hazardous waste manifest is provided in Appendix E of the *CAE 1992 Report*.

10.3.4 Placards

Any vehicle transporting dangerous goods must display placards identifying the hazard, as appropriate to the nature of the dangerous goods.

The requirements for placarding are covered in Section 7 of the Land Transport Rule: Dangerous Goods 1999.

10.4 Transport procedures

10.4.1 General safety requirements

Dangerous goods must be loaded, secured, transported and unloaded safely so that packaging remains fit for the purpose, segregation is maintained and goods do not present hazard to people, property or the environment.

It is necessary to ensure that nothing on the vehicle will damage the goods. Vehicle design, construction and maintenance must comply with relevant regulatory authorities requirements.

Appropriate emergency equipment and documented procedures must be accessible at all times during transport.

If a vehicle in transit is parked for more than 18 hours in the same place, it must be in a truck depot and comply with the stopping/parking restrictions of other rules, enactments or bylaws.

10.4.2 Requirements for loading security

For a road vehicle of less than 3,500 kg gross mass, there is a requirement to use load restraints sufficient enough to withstand acceleration or deceleration that occurs during normal conditions of transport.

Road vehicles with greater than 3,500kg gross mass must comply with the Land Transport Safety Authority 'Truck Loading Code'.

Rail vehicles must use load restraints sufficient to withstand the acceleration and deceleration that occurs during shunting and main-power braking.

10.5 Emergency response

10.5.1 General

Emergency response information for all dangerous goods on the vehicle must be carried. It must be kept in the driver's cab in an accessible position (refer Chapter 9).

The transporter must be aware of the hazards associated with the load, as well as safe handling and storage procedures and emergency response information.

It is the responsibility of the consignor to supply emergency response information.

10.5.2 Safety equipment

Safety equipment appropriate to the type of waste being transported should be available on the vehicle and include:

- multi-purpose dry powder fire extinguisher (to be checked every six months for fitness of operation);
- PVC jacket and leggings;
- safety footwear and/or gumboots;
- gloves;
- suitable respirator;

- face shield;
- accident warning 'Zetka' triangle;
- first-aid kit; and
- emergency spill kit.

10.6 Responsibilities of shippers and operators

10.6.1 Responsibilities of consignor

The responsibilities of the consignor of dangerous goods include ensuring that:

- dangerous goods are packaged properly;
- goods are labelled and marked properly;
- documentation is provided;
- emergency response information is provided; and
- documentation is passed onto next person in the transport chain.

10.6.2 Responsibilities of loader

The loader of vehicles or containers used to transport dangerous goods must ensure that:

- there are no obvious defects in the condition of packaging, labelling and marking;
- the load plan or container or vehicle packing certificate is prepared;
- any special loading instructions are complied with;
- mixed loads are segregated;
- vehicle/freight containers are placarded where necessary;
- the vehicle is securely loaded;
- they have undergone appropriate training regarding dangerous goods; and
- documentation is passed onto next person in the transport chain.

10.6.3 Responsibilities of driver/ operator of road vehicle

The person driving the vehicle must ensure that:

- the vehicle is placarded;
- the load is secure and transport procedures are complied with;
- they have undergone appropriate training regarding dangerous goods;
- they hold a valid dangerous goods endorsement on their driver's licence;
- documentation carried and secured in the dangerous goods holder;
- documentation is made available to a dangerous goods officer or emergency services personnel if required;
- documentation is passed onto to next person in the transport chain;
- the schedule of quantities is amended to record the delivery/collection of dangerous goods; and
- the load plan amended to record any changes.

10.6.4 Responsibilities of driver/ operator of rail vehicle

The train or rail service vehicle must ensure that:

- they have undergone training specific to transport of dangerous goods;
- documentation is carried and secured in a dangerous goods holder;
- documentation is made available to any dangerous goods officer or emergency services personnel if required; and
- documentation is passed on to the next person in the transport chain.

10.6.5 Responsibilities of employers

The employer must ensure that employees carry out all activities related to the transport of dangerous goods in accordance with the Land Transport Rule: Dangerous Goods.

10.7 Training

10.7.1 General

People involved in any activity related to transporting hazardous substances must be able to demonstrate knowledge as to:

- hazards associated with dangerous goods;
- safe practice to activities they must carry out; and
- emergency procedures.

The employer must ensure staff are trained adequately to ensure carry out duties safely and satisfactorily, including:

- general awareness or familiarisation training;
- function specific training;
- safety training; and
- retraining as appropriate.

10.7.2 Driver training

Any person who drives a vehicle transporting dangerous goods must hold a dangerous goods endorsement on their driver's licence.

Any person who drives a rail service vehicle transporting dangerous goods must be trained in the hazards associated with dangerous goods, safe transport procedures and emergency procedures, in accordance with the requirements of the approved safety system.

Chapter 11
Conclusions

This document has provided an overview of the issues important to everyone who is involved with managing hazardous waste in New Zealand. Since the first CAE document addressing this issue was published in 1992, the legal, social and technological environment in which hazardous waste management takes place has changed significantly. It is the objective of this document to inform the reader of these changes, and to provide an up-to-the minute account of 'where it's at' when managing hazardous waste in New Zealand.

To this end, an overview of the most important laws is presented in Chapter 1, with a more in-depth account given in Appendix 2. For the first time, detailed information is presented on the proposed New Zealand hazardous waste definition under development by the Ministry for the Environment at the time of writing. Defining hazardous waste is a crucial first step on the road to developing an integrated management system spanning all aspects from generation to treatment and final disposal, and the material presented here should be able to assist readers in becoming familiar with the proposed definition.

The document also provides an introduction to risk management and its relationship to hazardous waste management (Chapter 3). Various aspects of the management process such as Cleaner Production, hazardous waste treatment, technical information on incineration, land treatment and disposal of hazardous waste to land, transport and emergency management complete the picture.

It must be stressed, however, that hazardous waste management in New Zealand is in a state of flux. The Minister for the Environment has recognised that hazardous waste needs to be better managed in the future, and to this end has established the Hazardous Waste Programme. Improving the management of this waste is a long-term undertaking, and it is probable that further revision of this document will be required. For now, readers have a compilation of facts and knowledge that will enable them to participate meaningfully in the discussions that lie ahead, to bring about a system for hazardous waste management in New Zealand acceptable to all — including our environment.

Abbreviations

AGCARM	New Zealand Association for Animal Health and Crop Protection (AGCARM Inc)
ANZECC	Australia and New Zealand Environment and Conservation Council
CAE	Centre for Advanced Engineering, University of Canterbury
CFCs	Chlorofluorocarbons
DRE	Destruction and Removal Efficiency
ERMA	Environmental Risk Management Authority
EU	European Union
HHW	Household Hazardous Waste
HSNO	Hazardous Substances and New Organisms Act 1996
HWP	Hazardous Waste Programme
LGA	Local Government Act 1974
LTRDG	Land Transport Rule: Dangerous Goods 1999
MEK	Methylethyl ketone
MfE	Ministry for the Environment
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
NZCIC	New Zealand Chemical Industry Council
NZHWIC	New Zealand Hazardous Waste Identification Code
OECD	Organisation for Economic Co-operation and Development
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated Biphenyls
PIC	Product of incomplete combustion
PPE	Personal Protective Equipment
RC	Regional Council
RMA	Resource Management Act 1991
TA	Territorial Authority
TCLP	Toxicity Characteristic Leaching Procedure
UN	United Nations
UNEP	United Nations Environment Programme

UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNIDO	United Nations Industrial Development Organisation
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds

Glossary

Basel Convention	The Basel Convention on the Control of the Transboundary Movement of Hazardous Waste and their Disposal, UNEP,1989. New Zealand is a signatory to this Convention.
Cleaner Production	The continuous application of an integrated preventative environmental strategy applied to processes, products, and services to increase efficiency and to reduce risks to humans and the environment.
Co-disposal	The disposal of hazardous waste, in a managed and informed manner, with normal municipal solid waste in a landfill.
Contaminant	Defined under the Resource Management Act 1991 as including any substance (including gases, liquids, solids and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy or heat: (a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of the water; or (b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged.
Dangerous Goods	Substances having the properties described in *Table A: Properties and classification of dangerous goods for land transport* of the Land Transport Rule: Dangerous Goods 1999, and includes packaging and empty containers that have not been cleaned after containing dangerous goods,
De-novo synthesis	The formation of a compound beyond the combustion zone in an incinerator or furnace. Usually applied to dioxins.
Dioxins	A group of 75 chemical compounds made up of two benzene rings joined by two oxygen atoms. The polychlorinated dibenzo dioxins (PCDDs) have one or more of their hydrogen atoms replaced by chlorine atoms.
Ecotoxic	Capable of causing ill health, injury or death, to any living organism.
Furans	A group of chemical compounds, closely related to the dioxins, but where the two benzene rings are only joined by one oxygen atom.
Halogens	A group of chemicals consisting of fluorine, chlorine, bromine, iodine and astatine.
Hazard	Physical situations, processes and actions which have the potential to exert adverse effects on people, ecosystems or the built environment.
Hazardous Characteristics	Inherent properties which make a substance, including a waste, hazardous, such as toxicity, ecotoxicity, reactivity, flammability, explosiveness or radioactivity.
Hazardous Constituents	The constituents in a waste that give rise to its hazardous characteristics.
Hazardous Substance	As defined by the Hazardous Substances and New Organisms Act 1996.
Hazardous Waste	Any waste that exhibits hazardous characteristics or otherwise has the potential to damage human, animal and other species.

HAZCHEM An identification code which indicates appropriate emergency action with respect to a dangerous good.

Intractable waste A hazardous waste for which no appropriate treatment method is nationally available. Such waste must be stored and is often shipped overseas for treatment.

Life cycle As applied to a hazardous waste is from the point of its generation to that of the release of any residual into the environment and includes all steps in between.

Material Safety Data Sheet A document providing information on various aspects of a chemical product, substance or preparation concerning safety, health and environmental protection. An MSDS supplies (for these aspects) basic knowledge of the chemical product and gives recommendations on protective measures and emergency actions. It is a means of transferring essential hazard information, including information on transport, handling and storage from the supplier of the product to the recipient.

Organochlorine An organic chemical compound containing chlorine.

PAHs Polycyclic Aromatic Hydrocarbons.

PCBs The group of chemicals known as polychlorinated biphenyls where chlorine has substituted hydrogen to varying extents.

Resource Consent A consent granted under the Resource Management Act 1991.

Risk A combination of the probability or frequency of occurrence of a defined hazard and the consequences of the occurrence.

Sludge Semi-liquid waste produced as a by-product of a process with a high water content and a consistency of soft mud.

Tracking The process of identifying movement (of a hazardous waste) over time from the point of its generation to that of final disposal of any residuals to the environment.

Trade Waste By-law The by-laws made under the Local Government Act 1974 to control the discharge of liquids waste into sewers.

Treatment Any physical, chemical or biological change applied to a waste material prior to its release into the environment.

Unitary Authority An authority exercising the powers of both a Regional Council and a Territorial Local Authority.

Waste Management Hierarchy A hierarchy for decision- making applied to the management of waste emphasising reduction, reuse, recycling, recovery and residuals management.

References

Chapter 1

Environment and Business Group and Auckland Regional Council, 1996. *Auckland Regional Hazardous Waste Survey*.

Environment and Business Group, 1997. *A Review of Overseas Approaches to the Management and Landfilling of Hazardous Waste*.

Ministry for the Environment, 1994. *The Hazardous Waste Management Handbook*.

Ministry for the Environment, 1995. *The 1995 National Landfill Census*.

Ministry for the Environment, 1997. *The National Waste Data Report*.

Ministry for the Environment, 1998. *Managing Hazardous Waste*.

Organisation for Economic Co-operation and Development, 1996. *Environmental Performance Review: New Zealand*.

Parliamentary Commissioner for the Environment, 1998. *Hazardous Waste Management*.

Royds Consulting, 1996. *Regional Hazardous Waste Management Investigation*. Prepared for the Canterbury Regional Council, Christchurch.

Chapter 2

Department of Statistics, 1996. *Australia and New Zealand Standard Industry Classification*.

Environment and Business Group Ltd, 1999a. *Towards a New Zealand Definition of Hazardous Waste — Issues and Options*. Prepared for the Ministry for the Environment, Wellington.

Environment and Business Group Ltd, 1999b. S*ummary of Comments from Five Workshops on the Development of a New Zealand Definition of Hazardous Waste*. Prepared for the Ministry for the Environment, Wellington.

Environment and Business Group, 1999. *Proposed New Zealand Hazardous Waste List — Issues and Options*. Prepared for the Ministry for the Environment, Wellington.

ERMA, 1999. *Interim Guide to the Specifications for Hazardous Thresholds under the HSNO Act*. Wellington , New Zealand.

Ministry for the Environment, 1998. *Managing Hazardous Waste — a Discussion Paper*.

UN, 1991. *Recommendations for the Transport of Dangerous Goods*, 10^{th} Edition. Geneva.

UNEP, 1989. *Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal*.

Chapter 3

Ministry for the Environment, 1997. *The National Waste Data Report.*

Ministry for the Environment, 1999. *Assessment Guide for Hazardous Facilities — a Resource for Local Authorities and Hazardous Facility Operators*. Prepared by Environment and Business Group Ltd and resources. Wellington, New Zealand.

Piasecki, BW and GA Davis, 1987. *America's Future in Toxic Waste Management — Lessons Learnt from Europe*. Quorum Books, New York.

Standards Australia 1999. *Environmental Risk Management Handbook*. In preparation.

Standards Australia and Standards New Zealand, 1995. *Risk Analysis of Technological Systems – Application Guide* (Interim Standard AS/NZS 3931:1995).

Standards Australia and Standards New Zealand, 1999. *AS/NZS 4360:1999 — Risk Management*.

Chapter 4

Environmental Protection Agency of Victoria, 1990. *Waste Audit Guidelines*, Publication No 277. Melbourne.

Environmental Protection Agency of Victoria, 1997. *Transport and Disposal of Empty Drums Containing Hazardous Compounds*, Publication No 344. Melbourne.

UNEP/UNIDO, 1991. *Audit and Reduction Manual for Industrial Emissions and Wastes*. Technical Report, Series No 7. UNEP, Industry and Environment Office, Paris.

UNESCAP, 1994. *Manual for Hazardous Waste Management*. United Nations, New York.

USEPA, 1988. *Waste Minimisation Opportunity Assessment Manual*, EPA/625/7 - 88/003.

USEPA, 1997. "Overview of the Treatment, Storage and Disposal Facility Regulations Under US RCRA - 40 CFR, Subpart A-E Parts 264/265". From: *Training Module USEPA 530-R-97-074 PB98 108 293*. USEPA, Cincinnati.

Chapter 5

Chemistry in New Zealand, 1998. "Environmental issues : destruction of organochlorine wastes". *Chem in NZ, Jnl of NZ Inst Chem, 62,4*, pp 11-13 July/Aug 1998.

Department of Health, 1986. *Waste Management Guide 02, Treatment and Disposal of Timber Preservative Wastes: Copper, Chromium and Arsenic*. Wellington.

Department of Health, 1988. *Safe Management of PCBs Code of Practice*. Wellington.

Department of Health, 1989. *Waste Management Guide 04, Electroplating Wastes*. Wellington.

Department of Health, 1991. *Waste Management Guide 05, Acid and Alkali Wastes*. Wellington.

Department of Health, 1991. *Waste Management Guide 06, Pesticides*. Wellington.

Independent Panel on Intractable Waste, 1992. *A Cleaner Australia*, Vols 1, 2 and 3. Sydney.

La Grega, MD, PL Buckingham and JC Evans (eds), 1994. *Hazardous Waste Management*, McGraw-Hill, New York.

NZ Government, 1983. *Asbestos Regulations*.

USEPA, 1996. *Superfund Innovative Technology Evaluation Program: Technology Profiles, EPA/540/R-97/502*, December 1996. 9th Edition. Office of Research and Development, Washington DC.

USEPA, 1987. *A Compendium of Technologies Used in the Treatment of Hazardous Wastes*, EPA/625/8-87/014.

Chapter 6

Cudahy, JJ and HG Rigo, 1998. "National dioxin emissions from hazardous waste combustors". *Journal Air & Waste Management Association 48*, pp 1107-1111.

Gossman Consulting Inc, 1996. *Used Oil Test Burn Report*.

Mournungham, RE, 1989. "Hazardous waste disposal in cement kilns: the American experience". *Proc Conf Singapore April 1989*. Pacific Basin Consortium For Hazardous Waste Research, East West Centre, Honolulu.

Thurnau, RC and JA Manning, 1996. "Low temperature desorption applications of a direct fired rotary kiln incinerator". *Journal Air & Waste Management Association 46*, pp 12-19.

Ueno H, et al, 1997. "Destruction of chlorofluorocarbons in a cement kiln". *Journal Air & Waste Management Association 47*, pp 1220-1223.

USEPA, 1991. *Burning of Hazardous Waste in Boilers and Industrial Furnaces*, Federal Register 40 CFR, Part 260, *et al*, Part III, Feb 21, (BIF Regs).

USEPA, 1996. *Proposed Maximum Achievable Control Technology for Hazardous Waste Combustion*. US Federal Register, 61.

Chapter 7

Australian and New Zealand Environment and Conservation Council (ANZECC), 1992. *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*. ANZECC, Canberra.

La Grega, MD, PL Buckingham and JC Evans (eds) 1994. *Hazardous Waste Management*. McGraw-Hill, New York.

Schnoor, JL, 1997. *Phytoremediation: Technology Evaluation Report*. E Series Report TE-9-01, Groundwater Remediation Technologies Analysis Center, Pittsburgh, PA, USA (www.gwrtac.org).

SCS-Wetherill Environmental, 1999. Waste Acceptance Criteria at Landfills. Prepared for the Ministry for the Environment.

Chapter 8

Australian Chemical Industry Council, 1992. *Warehousing and Storage Code of Practice*. Melbourne.

Building Industry Authority, 1992. *New Zealand Building Code*.

Canadian Chemical Producers' Association, 1989. *Distribution Code of Practice — Implementation Guide*. Ottawa, Ontario.

Department of Labour - OSH, 1994. *Approved Code of Practice for Managing Hazards to Prevent Major Industrial Accidents.*

New Zealand Chemical Industry Council, 1998. *The Responsible Care Management System*.

New Zealand Government, 1996. *Hazardous Substances and New Organisms Act, 1996*.

Standards New Zealand, 1999. *NZS 5433:1999 — Transport of Dangerous Goods on Land.*

United Nations Environment Programme, Industry and Environment Office, 1990. *Storage of Hazardous Materials — A Technical Guide for Safe Warehousing of Hazardous Material*s. Paris.

United Nations, 1997. *Recommendations on the Transport of Dangerous Goods: Model Regulation; Revision 10.*

USEPA - Office of Solid Waste and Emergency Response, 1999. *Risk Management Program Guidance for Warehouses (40 CFR Part 68)*. EPA 550-B-99-004.

Chapter 9

Auckland Regional Council Regional Planning, 1990. *Industry Emergency Planning Guidelines.*

Mears, CW, 1990. *In-Place Protection (Sheltering) During Hazardous Materials Incidents*. Auckland Fire Service, September 1990.

Environment Waikato, 1993. *Hazardous Substances Management in the Waikato Region*.

International Air Transport Association, 1992. *Dangerous Goods Regulations*.

International Maritime Organisation. *International Maritime Dangerous Goods Code*, Consolidated Amendment 29-98.

Maritime Safety Authority, 1998. *Model Site Marine Oil Spill Contingency Plan.*

New Zealand Chemical Industry Council, 1989. *Code of Practice on Warning Signs for Premises Storing Hazardous Substances.*

New Zealand Chemical Industry Council, 1991. *Code of Practice on Emergency Preparedness.*

New Zealand Chemical Industry Council, 1998. *The Responsible Care Management System.*

New Zealand Fire Service. *Manual of Operations* [FSM 8].

New Zealand Fires Service Commission, 1998. *The New Zealand Coordinated Incident Management System (CIMS).*

Parliamentary Commissioner for the Environment, 1991. *The Control of Marine Oil Pollution in New Zealand — A Review of the System.*

Standards New Zealand, 1999. NZS 5433:1999 - *Transport of Dangerous Goods on Land.*

Chapter 10

Land Transport Safety Authority, 1999. *Land Transport Rule: Dangerous Goods 1999.*

New Zealand Chemical Industry Council, 1990. *Waste Management Practice in New Zealand.*

New Zealand Government, 1996. H*azardous Substances and New Organisms Act, 1996.*

Standards New Zealand, 1999. *NZS 5433:1999 — Transport of Dangerous Goods on Land.*

United Nations, 1997. *Recommendations on the Transport of Dangerous Goods: Model Regulation*. 10th edition.

Bibliography

A: Websites of organisations relevant to hazardous waste management

Air & Waste Management Association, USA: www.awma.org

Environment Canada: www.ec.gc.ca

Environment Protection Authority Victoria, Australia: www.epa.vic.gov.au

Environment Protection Authority, New South Wales, Australia: www.epa.nsw.gov.au/

Environmental Organisation Web Directory: www.webdirectory.com/

Environmental Risk Management Authority, New Zealand: www.ermanz.govt.nz

Hazardous Substance Research Centers, USA: www.hsrc.org/

Ministry for the Environment, New Zealand: www.mfe.govt.nz

New Zealand Chemical Industry Council: www.nzcic.org.nz

Organisation for Economic Co-operation and Development (OECD): www.oecd.org/

RACHEL's (Remote Access Chemical Hazards Electronic Library)Hazardous Waste News: www.enviroweb.org/publications/rachel/index.htm

Society of Environmental Toxicology and Chemistry (SETAC): www.setac.org/

United Nations Environment Programme: www.unep.org

United States Environmental Protection Agency, Office of Solid Waste: www.epa.gov/osw/

United States Environmental Protection Agency: www.epa.gov

US Department of Energy, Office of Environmental Management: www.em.doe.gov/

B: Resources specific to the chapters in this document

Chapter 3 — Hazardous Waste and Risk

Calow, P (ed.), 1998. *Handbook of Environmental Risk Assessment and Management*. Blackwell Science, Osney Mead, Oxford UK.

Canadian Council of Ministers for the Environment, 1996. *A Framework for Ecological Risk Assessment: General Guidance.* Prepared by the National Contaminated Sites Remediation Program, Winnipeg, Manitoba, Canada.

Centre for Substances and Risk Assessment: www.rivm.nl/csr/index.html

Elms, D (ed), 1998. *Owning the Future – Integrated Risk Management in Practice*. Centre for Advanced Engineering, University of Canterbury, Christchurch, New Zealand.

Gough, J D, 1991. *Risk Communication: the Implications for Risk Management.* Centre for Resource Management, Lincoln University, Christchurch.

Pyle, E and JD Gough, 1991. *Environmental Risk Assessment for New Zealand.* Centre for Resource Management, Lincoln University, Christchurch.

Riskworld — News and views on risk assessment & management: www.riskworld.com/

The Royal Society, 1992. *Risk: Analysis, Perception and Management.* Report of a Royal Society Study Group. London.

Tweeddale, HM, 1992. *Balancing Quantitative and Non-quantitative Risk Assessment.* Australian Centre of Advanced Risk and Reliability Engineering Ltd, Dept. of Chemical Engineering, University of Sydney.

Tweeddale, H M, RF Cameron and SS Sylvester, 1992. *Some Experiences in Hazard Identification and Risk Short Listing*. Australian Centre of Advanced Risk and Reliability Engineering Ltd, Department of Chemical Engineering, University of Sydney.

USEPA 1996b. *Guidelines for Reproductive Toxicity Assessment*. EPA/630/R-96/009.

USEPA, 1989. *Risk Assessment Guidance for Superfund*. Volume I: *Human Health Evaluation Manual*. EPA/540/1-89/002.

USEPA, 1989. *Risk Assessment Guidance for Superfund*. Volume II: *Environmental Evaluation Manual*. EPA/540/1-89/001.

USEPA, 1991. *Guidelines for Developmental Toxicity Risk assessment*. Notice, Federal Register. EPA/600/FR-91/001.

USEPA, 1992. *Guidelines for Exposure Assessment*. Notice, Federal Register. EPA/600/z-92/001.

USEPA, 1994. *The Use of Benchmark Dose Approach in Health Risk Assessment*. EPA/630/R-94/007.

USEPA, 1995. *Exposure Factors Handbook*. EPA/600/P-95/002A.

USEPA, 1995. *Proposed Guidelines for Neurotoxicity Assessment*. Federal Register (52032-52056.

USEPA, 1996a. *Proposed Guidelines for Carcinogen Risk Rssessment*. Notice, Federal Register. EPA/600/P-92/003Ca.

USEPA, 1996c. *Proposed Guidelines for Ecological Risk Assessment*. United States Environmental Protection Agency. EPA/630/R-95/002B.

USEPA, 1998. *General Guidance for Risk Management programs (40 CFR Part 68)*. Office of Solid Waste and Emergency Response EPA 550-B-98-003.

Chapter 4 — Managing Hazardous Waste

Canadian Centre for Pollution Prevention (C2P2): www.c2p2.sarnia.com/

Clark, JH (ed.), 1995. *Chemistry of Waste Minimisation*. Chapman and Hall, Glasgow.

Higgins, TE (ed.), 1995. *Pollution Prevention Handbook*. Lewis , New York, 1995.

Toolbook for financing energy efficiency and pollution prevention technology: www.oit.doe.gov/toolbook/

USEPA's Green Chemistry Programme: www.epa.gov/greenchenistry

Woodside, G, 1993. *Hazardous Materials and Hazardous Waste Management — A Technical Guide*. John Wiley & Sons, London.

Chapter 5 — Treatment Processes and Technologies

Air & Waste Management Association, 1992. *Bioremediation: The State of Practice in Hazardous Waste Remediation Operations*. Pittsburgh USA.

Freeman, H and EF Harris (eds), 1995. *Hazardous Waste Remediation: Innovative Technologies*. Technomic Publishing Co, Lancaster PA,USA.

Lewis, RA & G Subklew (eds), 1995. *Challenges and Innovations in the Management of Hazardous Waste*. Air & Waste Management Association, Pittsburgh USA.

USEPA, 1991. *Handbook of Stabilization Technologies for RCRA Corrective Actions*. EPA/625/6-91/026.

USEPA, 1998. *Handbook of Advanced Photochemical Oxidation Processes*.

EPA/625/R-98/004.

USEPA, 1995. *Accessing the Federal Government Site Remediation Technology Programs and Initiatives*. EPA/542/B-95/006

USEPA, 1999. *Technology Profiles*, Volumes 1 – 3. Tenth Edition. EPA/540/9-99/500a-c

Chapter 6 —Thermal Processes

Cheremisinoff, PN, 1992. *Waste Incineration Handbook.* Butterworth-Heinemann, Oxford UK.

Cudahy, JJ and HG Rigo, 1998. "National dioxin emissions from hazardous waste combustors". *Jnl Air & Waste Mngt Assoc., 48*, 1107-1111, 1998.

Mantus, EK, 1992. *All Fired Up: Burning of Hazardous Waste in Cement Kilns*. Environmental Toxicology International Inc, Seattle.

USEPA, 1996. *Proposed Maximum Achievable Control Technology for Hazardous Waste Combustion*. US Federal Register, 61.

Chapter 7 — Land Treatment, Disposal and Containment of Hazardous Waste

Air & Waste Management Association, 1992. *Bioventing and Vapour Extraction : Uses and Applications in Remediation Operations*. Pittsburgh USA.

Air & Waste Management Association, 1993. *Innovative Thermal Treatment Technologies: Uses and Applications*. Pittsburgh USA.

Andersen, W.C. (ed.), 1993. *Innovative Site Remediation Technologies.* Vol 6. American Academy of Env. Engineers, Maryland USA.

Centre for Advanced Engineering, 2000. *Landfill Guidelines*. University of Canterbury, Christchurch.

Ministry of Health, 1992. *Public Health Guidelines for the Safe Use of Sewage Effluent and Sewage Sludge on Land*. Wellington.

La Grega, M.D. et al, 1994. *Hazardous Waste Management*. McGraw-Hill, New York.

NATO, 1998. *Evaluation of Demonstrated and Emerging Technologies for the Treatment and Cleanup of Contaminated Land and Groundwater*. Phase II Vols I, II and III and Phase III Vols I and II NATO/CCMS, Brussels, Belgium.

USEPA, 1995. *Accessing Federal Data Bases for Contaminated Site Clean-up Technologies.* 4th Edition. EPA542-B-95-005.

Chapter 10 — Transport

USA Department of Transportation Office of Hazardous Materials Safety: hazmat.dot.gov/

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Appendix 2: New Zealand Legislation Relevant to Hazardous Waste Management

The regulatory framework for hazardous waste management

Unlike the majority of industrialised countries, New Zealand does not have dedicated waste legislation. Consequently, waste and hazardous waste management is regulated by a number of laws and regulations, as summarised (in alphabetical order) below.

Legislation

1. The Agricultural Compounds and Veterinary Medicines Act 1997

This Act is administered by the Ministry for Food and Fibre (previously Agriculture). It was enacted to prevent or manage risks associated with the use of agricultural compounds, to ensure that the use of compounds does not result in breaches of domestic food residue standards and to ensure the provision of sufficient customer information about agricultural compounds (Section 4). The Act incorporates the definition of 'hazardous substances' as given in the HSNO Act, and any agricultural compounds which are also hazardous substances require the approval of the ERMA before they can be registered in New Zealand (Section 21(5)).

2. The Building Act 1991

The Building Act covers issues associated with the construction, design and fire protection of buildings and specifies the functions and powers of the Building Industry Authority and territorial local authorities (city/district councils). It provides for the safe storage of hazardous substances to prevent their release into the environment in the case of fire (Section 6(2)(c). The Building Code and 'approved documents' provide means of compliance with the requirements of the Act (refer Building Code, under Regulations, Standards and Other Relevant Documents below).

3. The Fire Service Act 1975

This Act deals with matters relating to the structure, function and funding of the New Zealand Fire Service. Under this Act, incidents involving hazardous substances are considered to be emergencies that are attended by the Fire Service. Of interest is Section 17N, which stipulates that the National (Fire Service) Commander shall provide for cooperation with territorial local authorities and regional councils, with special reference to hazardous substances emergencies.

4. The Hazardous Substances and New Organisms Act 1996 (HSNO)

This is the major legislation controlling the import, manufacture, use and handling of hazardous substances in New Zealand. It was enacted on 10 June 1996, and has repealed a host of other laws[1] in order to streamline the legislation covering hazardous substances. Section 14 of the Act establishes the Environmental Risk Management Authority (ERMA), to undertake the assessment of hazardous substances and new organisms. ERMA's functions include advising the Minister for the Environment on matters related to the Act and monitoring the effect of the Act.

HSNO's purpose, as stated in Section 4 of the Act, is "to protect the environment, and health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms". The Act sets up a regime for the assessment of hazardous substances and new organisms in order to enable a decision to be made as to whether or not approval should be granted for the **importation or manufacture** of hazardous substances, and the importation, manufacture, development, field testing and release of new organisms.

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1 The Explosives Act 1957, Dangerous Goods Act 1974, Toxic Substances Act 1979, a substantial part of the Pesticides Act 1979 and parts of other legislation.

The HSNO Act specifies that a precautionary approach should be adopted with respect to the management of hazardous substances (Section 7), and is essentially risk-based (rather than being prescriptive). Its aim is to provide for the management of hazardous substances throughout their life cycle, including packaging, identification, tracking, emergency management and disposal. In the context of the HSNO Act, disposal is defined as meaning:

- treating the (hazardous) substance in such a way that it is no longer a hazardous substance; or
- discharging the substance into the environment as waste; or
- exporting the substance as waste from New Zealand.

Under HSNO, the ERMA is the central government agency responsible for establishing and administering core conditions for the management of all hazardous substances and new organisms, although the Act is enforced by a number of different agencies such as the Customs Department (import of hazardous substances and new organisms), the Labour Department (in the workplace), Land Transport Safety and the Police (transport) and the TAs for anything else. These agencies may also delegate their enforcement functions to each other.

A transitional period for existing hazardous substances is provided for in the Act, which ensures that controls contained in repealed legislation (such as the Toxic Substances Regulations) remain in force until the HSNO Regulations are completed and fully operational. It is currently intended that this period will expire on 1 January 2001. However, in a recently proposed amendment to the HSNO Act, an extension of this transition period has been put forward. This would provide for the transition period to last three years from the date of commencement of the hazardous substances provisions of the Act, with a provision for extension of a further two years. The reason for this extension is to enable the orderly transfer of existing hazardous substances to the new regime, which is a complex and lengthy task.

5. The Health Act 1956

Responsibilities of Central Government

Section 3A of the Health Act 1956 provides the Ministry of Health with the function of improving, promoting and protecting public health, and to this end establishes a Public Health group within the Ministry (Section 3E).

The Public Health Authorities, on behalf of the Minister of Health, administer and enforce the Health Act in regard to any issues beyond local concerns and assume an audit function with respect to the work carried out by the local environmental health officers. The Public Health Authorities also appoint Health Protection Officers who enforce Toxic Substances Regulations for Classes 6 (Toxic Substances), 7 (Radioactive Substances) and 8 (Corrosives).

Section 122 of the Act […] is amended by the HSNO Act, which adds a new subsection (6) which requires the Minister of Health to consult with ERMA about the contents of the above mentioned regulations and to take into account ERMA’s submission before recommending the making of any regulations under Sections 117 and 119 relating to hazardous substances as defined by HSNO.

Responsibilities of Local Government

The Act empowers territorial authorities (TAs) to control nuisances, offensive trades, and the handling and storage of noxious substances (Sections 25, 29 and Third Schedule), which may include hazardous wastes. The TAs are required to appoint Environmental Health Officers but are also given wide powers to establish bylaws to control these matters (Section 117 (2)). Section 119 authorises regulations providing for the control (including disposal) of noxious substances.

To carry out their duties under the Act, every local authority is empowered and directed to:

- appoint Environmental Health Officers;
- cause regular inspection of its district to be made to ascertain the existence of any nuisance, or any conditions likely to be injurious to health or offensive;
- cause all proper steps to be taken to secure the abatement of such nuisance or the removal of such condition; and
- make bylaws for the protection of public health, including for the purpose of regulating the handling and storage

of noxious substances or goods which are, or are likely to become, offensive.

The nuisances with which the Act is concerned are largely those relating to lack of sanitation or unhealthy working conditions. The latter are now also controlled by the Health and Safety in Employment Act 1992.

6. The Health and Safety in Employment Act 1992 (HSE)

This Act, administered by the Occupational Safety and Health Division of the Department of Labour (OSH), addresses the responsibilities of employers with respect to the identification and elimination of hazards and the protection of workers from hazards. The Act's objective is to provide for the prevention of harm to employees at work, and it does so by:

- promoting excellence in health and safety management by employers;
- prescribing, and imposing on employers and others, duties in relation to the prevention of harm to employees; and
- providing for the making of regulations and the development of codes of practice relating to hazards to employees.

7. The Local Government Act 1974 (LGA)

The LGA is the key legislation defining the purpose, structure, function and duties of local government in New Zealand. It therefore provides a framework for the efficient and effective operation of local government and the services they deliver, rather than setting a regulatory framework.

Parts XXVIII (Trade Wastes) and XXXI (Refuse Collection and Disposal) are of relevance to hazardous waste management.

Responsibilities of Territorial Authorities

Territorial authorities have the functions, duties and powers set out in Section 37T of the LGA, namely those conferred by the LGA or any other public Act, and any local Act applying to a particular territorial authority.

Part XXXI enables territorial authorities to undertake the function of waste management. In the context of waste management by territorial authorities 'disposal' means the final deposit of waste on land set apart for the purpose (by implication, landfills). It is the duty of every territorial authority to encourage efficient waste management (Section 538), and in doing so to:

(a) have regard to environmental and economic costs and benefits for the district; and

(b) ensure that the management of waste does not cause a nuisance or be injurious to health.

Territorial authorities are required to adopt a waste management plan to make provision for the collection and reduction, reuse, recycling, recovery, treatment or disposal of waste in the district (Section 539). They are permitted to make grants to encourage the reduction, reuse, recycling, recovery, treatment or disposal of waste (Section 543) and allocate the costs incurred in the implementation of a waste management plan in such a way as they consider will effectively and appropriately promote the objectives of the plan (including in a way that establishes economic incentives and disincentives) (Section 544).

Subject to the RMA and the Health Act, Part XXVIII authorises TAs to undertake trade waste disposal (by discharging waste into sewers) and to make bylaws regulating the disposal of trade wastes. Bylaws may be made, *inter alia*, requiring any specified constituent of the trade waste to be reduced to a prescribed level before discharge, and determining the maximum quantity of trade wastes that may be discharged from trade premises on any one day without the consent of the territorial authority.

'Trade wastes' is defined as "any liquid [...] that is or may be discharged from trade premises in the course of any trade or industrial process or operation but does not include condensing water, surface water, or domestic sewage" (Section 489). For the purposes of Part XXVIII 'waste' is defined as including "any matter that, when added to or mixed with any natural water will contaminate the water so as to change the physical or chemical condition thereof in such a manner as to:

(a) make the water unclean, noxious, or impure; or

(b) be detrimental to the health, safety, or welfare of persons using the water; or

(c) render the water undrinkable to farm animals; or

(d) be poisonous or harmful to animals, birds, or fish around or in the water.

'Waste', as defined above, appears to fall completely within the meaning of 'contaminant' in the RMA and therefore the discharge of any waste (and any trade waste) to the environment will be subject to Section 15 of the RMA. A TA may refuse to allow trade waste of any type or class to be disposed of through its sewers if it is of the opinion that waste of that type or class is not suitable for discharge into the territorial authority's system (Section 490(3)).

Charges for the treatment or reception or disposal of trade wastes are to be in accordance with a scale of charges prescribed by the territorial authority by special order (Section 494). They may not exceed the amount of costs reasonably expected to be incurred in treating, receiving or disposing of an equivalent amount of domestic sewage of an equivalent strength and may be made only in respect of the amount by which the trade wastes discharged from a premises exceeds the amount of domestic sewage that would normally be discharged from other premises having substantially the same rateable value. Presumably any trade wastes disposed of through the sewer receive the same treatment, if any, that domestic sewage receives, in which case the charging regime appears to be adequate to enable local authorities to recover their costs.

Responsibilities of Regional Councils

As set out in Section 37 SB, regional councils are authorised to fund, establish and manage sites for the regional disposal of hazardous waste. This recognises that it may not necessarily be practical or efficient to establish sites in every district.

8. The Land Transport Act 1998 (LTA)

The LTA revokes the Transport Act 1962 and the Land Transport Act 1993. In 1993, the LTA introduced a system which provided the option for making a Rule, with regulatory status, for the land transport of hazardous goods. Consequently, the requirements for transporting dangerous goods are now enshrined in the *Land Transport Rule: Dangerous Goods 1999* (LTDG Rule 1999), which came into force on 3 May 1999. The New Zealand Standard *NZS 5433: 1999 - Transport of Dangerous Goods on Land* is incorporated by reference in the LTDG Rule 1999.

9. The Radiation Protection Act 1965

This Act is administered by the Ministry of Health. It governs any issues related to radioactive substances and equipment using these substances, such as X-Ray machines, including the disposal of radioactive wastes. The National Radiation Laboratory in Christchurch is the principal agency implementing this Act and providing advice and information on these matters.

Radioactive substances are purposefully excluded form the HSNO Act and remain under the control of the Radiation Protection Act. Sections 14 and 15 of the Radiation Protection Regulations 1982/72 provide for the disposal of waste products and containers.

10. The Resource Management Act 1991 (RMA)

It is the purpose of the RMA (Section 5) to promote the sustainable management of natural and physical resources. As defined by Section 5 (2), 'sustainable management' requires the safeguarding of the life-supporting capacity of air, water, soil and ecosystems. The RMA does not define the term 'hazardous waste', but provides the following definitions for the terms 'hazardous substance' and 'waste':

- hazardous substance includes, but is not limited to, any substance defined in Section 2 of the Hazardous Substances and New Organisms Act 1996 as a hazardous substance; and
- waste or other matter means materials and substances of any kind, form, or description.

Responsibilities of Central Government

The Minister for the Environment may appoint a board of inquiry to inquire into and report on a proposed national policy statement (Section 46). In determining whether it is desirable to prepare a national policy statement, the Minister may have regard to a number of matters, including:

- New Zealand's interests and obligations in maintaining or enhancing aspects of the national or global environment; and
- anything which affects or potentially affects more than one region.

National environmental standards (Section 43) may be used to prescribe technical standards for the use, development, and protection of natural and physical resources and methods for implementing such standards. Standards may be made in respect of contaminants such as hazardous wastes. To date, no national environmental standards have been prescribed. Section 360(1)(h) enables regulations to be made exempting discharges of contaminants from the operation of Section 15 (which prohibits discharges unless they are expressly allowed by a rule in a plan, a resource consent or regulations). The making of national environmental standards is subject to a public process (Section 44).

Responsibilities of Local Government

The RMA authorises regional councils to prepare regional policy statements (RPS) (Section 60) and regional plans (Section 65); and district councils to prepare district plans (Section 73). Regional policy statements are to contain the objectives they seek to achieve, the policies and methods supporting the objectives, reasons for adopting the objectives, policies and methods, and the environmental results anticipated from the implementation of the policies and methods. Regional plans and district plans are to fulfil similar requirements but may also contain rules which prohibit, regulate or allow activities. District plans may not be inconsistent with the relevant RPS or regional plan.

Regional councils have the functions set out in Section 30, which include:

- the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the natural and physical resources of the region (Section 30(1)(a));
- control of the dumping and incineration of waste or other matter and the dumping of ships, aircraft, and offshore installations (Section 30(1)(d)(iva));
- the control of the use of land for the purpose of the prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances (Section 30(1)(c)(v)); and
- the control of discharges of contaminants into, or onto land, air, or water and discharges of water into water (Section 30(1)(f)).

The definition of 'contaminant'[2] is wide enough to cover any hazardous substance, including waste which may be hazardous.

Territorial authorities have the functions set out in Section 31, including the control of any actual or potential effects of the use, development, or protection of land, including for the purpose of [...] the prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances (Section 31(b)).

There appears to be no real difference between the functions of regional councils and territorial authorities in relation to hazardous wastes. Wording similar to that used in Sections 30(1(c)(v) and 31((b) is used in the context of the control of natural hazards, so that Section 30 empowers regional councils to control the use of land for the avoidance or mitigation of natural hazards and Section 31 similarly empowers territorial authorities to control *the effects* of the use of land for the avoidance or mitigation of natural hazards. In considering the relative jurisdictions of regional councils and territorial authorities over natural hazards, the Court of Appeal has acknowledged that they may have overlapping jurisdiction, but noted that territorial authorities' power to make rules is subject to Section 75(2) of the RMA which provides that a district plan shall not be inconsistent with the applicable regional plan.[3] The Court observed that it was difficult to see how a territorial authority could control the effects of a use of land without regulating the use itself.

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[2] 'Contaminant' is defined in Section 2 as including "any substance (including gases, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself of in combination with the same, similar, or other substances, energy, or heat:
(a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or
(b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged.

[3] *Application by Canterbury Regional Council* [1995] NZRMA 452.

Notwithstanding this overlap in jurisdiction, Section 62(1)h clarifies the situation by enabling the regional council to provide which local authority shall have responsibility within its area for controlling the use of land for the prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances, and failing any allocation of responsibility in the RPS provides that the regional council retains primary responsibility for the hazard or hazardous substance. However, this situation has been changed by the HSNO Act, which amends the RMA so that the default position is that territorial authorities are primarily responsible for the hazardous substance.

In 1997, new provisions were inserted into the RMA to address marine pollution. They empower regional councils to regulate the dumping or incineration of waste in the coastal marine area (Section 15A), and the Governor-General in Council to make regulations allowing discharges of harmful substances from ships or off-shore installations into the coastal marine area (Section 15B). Section 15C prohibits the dumping or storing of radioactive waste or other matter in the coastal marine area. These provisions are intended to correspond to the marine protection rules to be made under the Maritime Transport Act 1994, which apply beyond the coastal marine area.

Regulations, Standards and Other Relevant Documents

Regulations

Asbestos Regulations 1983/70

Section 27 of this Regulation provides for the disposal of asbestos-containing materials. It prescribes that asbestos destined for disposal is to be kept in closed containers that are impermeable to asbestos dust and are conspicuously marked with a warning. Paragraph (2) requires asbestos waste to be dampened and disposed of in a place approved by the Medical Officer of Health and covered with not less than 25 cm of earth, or in any other manner approved by an inspector.

Building Code

Of particular relevance to hazardous waste management are the following sections:

- F3 (Hazardous Substances and Processes), providing for
  - access restrictions
  - protection of services
  - protected ignition sources
  - type of construction
  - ventilation and control of escapes
  - surface finishes
- F6 (Lighting for Emergency), providing for
  - illumination of escape routes
  - signage
- F7 (Warning Systems), providing for
  - fire alarms
  - smoke and heat detectors
- F8 (Signs), providing for
  - escape routes
  - emergency related safety features

— potential hazards.

Fumigation Regulations 1967

Pesticides Regulations 1983

Toxic Substances Regulations 1983

Standards

NZS 5417: 1986 - Specification for Transportation Labels for Hazardous Substances

NZS 8409: 1995 - Agrichemical Users Code of Practice

NZS 9201: 1995 - General Model Bylaws (Trade Wastes, Chapter 23P)

NZS 5433: 1999 - Transport of Dangerous Goods on Land

AS/NZS 4452: 1997 - Storage and Handling of Toxic Substances

AS/NZS 3816: 1998- Management of Clinical and Related Wastes

AS/NZS 3833: 1998 - Storage and Handling of Mixed Classes of Dangerous Goods in Packages and IBCs

Codes of Practice

Ministry of Health, 1988: Code of Practice for the Safe Management of PCBs.

National Radiation Laboratory, 1996: Code of Safe Practice for the Use of Unsealed Radioactive Materials.

OSH, 1988: Hazardous Goods Storage Facilities - A code of practice for the design and construction of static storage facilities, including static tanks, pipelines and pumping systems for storage and transferral of hazardous goods in bulk.

OSH, 1994: Code of Practice for the Safe Use of Timber Preservatives and Antisapstain Chemicals

OSH, 1995: Code of Practice for the Transportation and Disposal of Petroleum Storage Tanks and Related Wastes

OSH, 1997: Approved Code of Practice for the Management of Substances Hazardous to Health in the Place of Work

Guidelines

Environment Waikato, 1996: Collecting Hazardous Waste - A Guideline for Local Authorities

Ministry of Health, 1986: Waste Management Guide 02 - Treatment and Disposal for Timber Preservative Wastes: Copper, Chromium & Arsenic

Ministry of Health, 1988: Waste Management Guide 03 - Leaded Petrol Sludges: Treatment and Disposal

Ministry of Health, 1989: Waste Management Guide 04 - Electroplating Wastes

Ministry of Health, 1991: Waste Management Guide 05 - Acid and Alkali Wastes

Ministry of Health, 1991: Waste Management Guide 06 - Pesticide Wastes

Ministry of Health, 1997: Asbestos Management Guideline

OSH, 1992: Practical Guidelines for the Safe Use of Organic Solvents

OSH, 1994: Health and Safety Guidelines on the Cleanup of Contaminated Sites

OSH, 1995: Guidelines for the Management and Removal of Asbestos

OSH, 1995: Guidelines for the Management of Lead-based Paint

OSH, 1996: Guidelines for the Safe Use of Chemicals in Electroplating and Related Industries

OSH, 1997: Guidelines for the Safe Handling of Cytotoxic Drugs and Related Wastes

Other

NZCIC: Responsible Care Management System.

NZCIC: Warning Signs for Premises Storing Hazardous Substances

NZCIC: Handling Small Spills of Hazardous Substances

Appendix 3: New Zealand Hazardous Waste Definition Codes

N.B. These listings are provided for indicative purposes only. Before using, please contact the Ministry for the Environment, Wellington, for the current updated version.

Code 1: Reasons why materials become waste (W Code)

W1	Production and consumption residues not otherwise specified below
W2	Off-specification products
W3	Products whose date for appropriate use has expired
W4	Materials spilled, lost or having undergone other mishap, including any materials, equipment etc. contaminated as a result of the mishap
W5	Materials contaminated or soiled as a result of planned actions (e.g. residues from cleaning operations, packing materials, containers etc.)
W6	Unusable parts (e.g. reject/exhausted batteries, exhausted catalysts etc.)
W7	Substances which no longer perform satisfactorily (e.g. contaminated acids, contaminated solvents, exhausted tempering salts etc.)
W8	Residues of industrial processes (e.g. slags, still bottoms, spent filters etc.)
W9	Residues from pollution abatement processes (e.g. scrubber sludges, baghouse dusts, spent filters etc.)
W10	Machining/finishing residues (e.g. lathe turnings, mill scales etc.)
W11	Residues from raw materials extraction and processing (e.g. mining residues, oil field slops etc.)
W12	Adulterated materials (e.g. oils contaminated with PCBs etc.)
W13	Any materials, substances or products whose use has been banned by law
W14	Products for which the holder has no further use (e.g. agricultural, household, office, commercial and shop discards)
W15	Contaminated materials, substances or products resulting from remedial action with respect to land

Code 2: The New Zealand hazardous waste list (L Code)

Waste Code	**Description**	**Waste Code**	**Hazardous wastes covered by list**
0 1	**Waste resulting from exploration, mining and further treatment of minerals and quarrying**	**01 01**	**Waste from further physical and chemical processing of metalliferrous minerals (including tailings and red mud from alumina production)**
		01 01 01	Waste from further physical and chemical processing of metalliferrous minerals (including tailings and red mud from alumina production)
		01 02	**Drilling muds (including oil-containing muds)**
		01 02 01	Drilling muds (including oil-containing muds)

Waste Code	Description	Waste Code	Hazardous wastes covered by list
0 2	**Waste from agricultural, horticultural, hunting, fishing and aquaculture primary production, food preparation and processing**	**02 01**	**Agrochemical wastes**
		02 01 01	Inorganic, organo-metallic agrochemicals
		02 01 02	Organo-phosphorus agrochemicals
		02 01 03	Nitrogen containing agrochemicals
		02 01 04	Halogenated (including chlorinated) agrochemicals
		02 01 05	Sulphur containing agrochemicals
		02 01 06	Mixed pesticide residue
		02 01 07	Catalysts from fertiliser production
0 3	**Wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture**	**03 01**	**Wood preservation wastes**
		03 01 01	Non-halogenated organic wood preservatives
		03 01 02	Organo-chlorinated wood preservatives
		03 01 03	Organo-metallic wood preservatives
		03 01 04	Copper-chrome-arsenic
		03 01 05	Inorganic wood preservatives
		03 01 06	Treated timber
		03 02	**Wastes from pulp, paper and cardboard production and processing (including black liquor treatment wastes, bleaching sludges from hypochlorite, chlorine and other processes and de-inking sludges)**
		03 02 01	Dregs and clean liquor sludges (from black liquor treatment)
		03 02 02	Bleaching sludges from hypochlorite and chlorine processes
		03 02 03	Bleaching sludges from other bleaching processes
		03 02 04	De-inking sludge from paper re-cycling
0 4	**Wastes from the leather and textile industries**	**04 01**	**Wastes from the leather industry**
		04 01 01	Tanning liquor containing chromium
		04 01 02	Tanning sludges containing chromium
		04 01 03	Liming waste
		04 01 04	Degreasing wastes containing solvents without a liquid phase
		04 02 05	Dye stuffs and pigments
		04 02	**Wastes from the textile industry**
		04 02 01	Halogenated wastes from dressing and finishing
		04 02 02	Dye stuffs and pigments
0 5	**Wastes from petroleum refining, natural gas purification**	**05 01**	**Oily sludges and solid wastes**
		05 01 01	Sludges from on-site effluent treatment
		05 01 02	Tank bottom sludges
		05 01 03	Acid alkyl sludges
		05 01 04	Waste from the cleanup of oil spills
		05 01 05	Sludges from plant, equipment and maintenance operations
		05 01 06	Acid tars

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		05 01 07	Other tars
		05 02	**Spent catalysts**
		05 02 01	Spent catalysts containing precious metals
		05 03	**Spent filter clays**
		05 03 01	Spent filter clays
		05 04	**Waste from the pyrolytic treatment of coal**
		05 04 01	Acid tars
		05 04 02	Other tars
		05 05	**Waste from natural gas purification**
		05 05 01	Sludges containing mercury
		05 06	**Wastes from oil regeneration**
		05 06 01	Spent filter clays
		05 06 02	Acid tars
		05 06 03	Other tars
		05 06 04	Aqueous liquid waste from oil regeneration
0 6	**Wastes from inorganic chemical processing**	**06 01**	**Waste acid solutions**
		06 01 01	Sulphuric acid and sulphurous acid
		06 01 02	Hydrochloric acid
		06 01 03	Hydrofluoric acid
		06 01 04	Phosphoric and phosphorus acid
		06 01 05	Nitric acid and nitrous acid
		06 02	**Alkaline solutions**
		06 02 01	Calcium hydroxide
		06 02 02	Sodium hydroxide
		06 02 03	Ammonia
		06 03	**Waste salts and their solution**
		06 03 01	Salts and solutions containing cyanides
		06 04	**Metal containing wastes**
		06 04 01	Metallic salts (except 06 03)
		06 04 02	Wastes containing arsenic
		06 04 03	Wastes containing mercury
		06 04 04	Wastes containing heavy metals
		06 05	**Wastes from halogen chemical processing**
		06 05 01	Wastes containing asbestos from electrolysis
		06 05 02	Activated carbon from chlorine production
		06 06	**Wastes from other inorganic chemical processes**
		06 06 01	Inorganic agrochemicals, biocides and wood preserving agents
		06 06 02	Spent activated carbon (except 06 07 02)
		06 07	**Sludges from on-site treatment**
		06 07 01	Sludges from on-site treatment
0 7	**Wastes from organic chemical processing**	**07 01**	**Waste from the manufacture, formulatio supply and use (MFSU) of basic organic chemicals**
		07 01 01	Aqueous washing liquids and mother liquors
		07 01 02	Sludges from on-site effluent treatment
		07 01 03	Organic halogenated solvents, washing liquids and mother liquors

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		07 01 04	Other organic solvents, washing liquids and mother liquors
		07 01 05	Spent catalysts containing metals
		07 01 06	Halogenated still bottoms and reaction residues
		07 01 07	Other still bottoms and reaction residues
		07 01 08	Halogenated filter cakes, spent absorbents
		07 01 09	Other filter cakes, spent absorbents
		07 02	**Waste from the MFSU of plastics, synthetic rubber and manmade fibres**
		07 02 01 - 99	As in 07 01 01-99
		07 03	**Waste from the MFSU of organic dyes and pigments (excluding 06 11 00)**
		07 03 01 - 99	As in 07 01 01-99
		07 04	**Waste from the MFSU of organic agrichemicals (except 02 01 05)**
		07 04 01 - 99	As in 07 01 01-99
		07 05	**Waste from the MFSU of pharmaceutical**
		07 05 01 - 99	As in 07 01 01-99
		07 06	**Waste from the MFSU of fats, grease, soaps, detergents, disinfectants and cosmetics**
		07 06 01 - 99	As in 07 01 01-99
		07 07	**Waste from the MSFU of fine chemicals and chemical products and chemical products not otherwise specified**
		07 07 01 - 99	As in 07 01 01-99
0 8	**Wastes from the manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks**	**08 01**	**Waste from MFSU of paint and varnish**
		08 01 01	Waste from paints and varnishes containing halogenated solvents
		08 01 02	Waste from paints and varnishes containing non-halogenated solvents
		08 01 03	Waste from water-based paints and varnishes
		08 01 04	Sludges from paint or varnish removal containing halogenated solvents
		08 01 05	Sludges from paint or varnish removal containing non-halogenated solvents
		08 01 06	Aqueous sludges containing paint and varnishes
		08 02	**Waste from MFSU of printing inks**
		08 02 01	Waste from inks containing halogenated solvents
		08 02 02	Waste from inks containing non - halogenated solvents
		08 02 03	Waste from water-based inks
		08 02 04	Sludges from inks containing halogenated solvents

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		08 02 05	Sludges from inks containing non - halogenated solvents
		08 02 06	Aqueous sludges containing ink
		08 03	**Wastes from MFSU of adhesive and sealants (including waster proofing products)**
		08 03 01	Waste from adhesives and sealants containing halogenated solvents
		08 03 02	Waste from adhesives and sealants containing non-halogenated solvents
		08 03 03	Waste from water-based adhesives and sealants
		08 03 04	Sludges from adhesives and sealants containing halogenated solvents
		08 03 05	Sludges from adhesives and sealants containing non-halogenated solvents
		08 03 06	Aqueous sludges containing adhesives and sealants
0 9	**Wastes from the photographic industry**	**09 01**	**Wastes from the photographic industry**
		09 01 01	Waste based developer and activator solutions
		09 01 02	Waste based offset plate developer solutions
		09 01 03	Solvent based developer solutions
		09 01 04	Fixer solutions
		09 01 05	Bleach solutions and bleach fixer solutions
		09 01 06	Waste containing silver from on-site treatment of photographic waste
1 0	**Inorganic wastes from thermal processes**	**10 01**	**Wastes from power station and other combustion plants (except 19)**
		10 01 01	Bottom and fly ash
		10 01 02	Sulphur containing waste from gas treatment
		10 02	**Wastes from aluminium thermal metallurgy**
		10 02 01	Tars and other carbon containing wastes from anode manufacture
		10 02 02	Skimmings
		10 02 03	Primary smelting slags/white drosses
		10 02 04	Spent pot lining
		10 02 05	Salt slags from secondary smelting
		10 02 06	Black drosses from secondary smelting
		10 02 07	Waste from treatment of salt slags and black drosses treatment
		10 02 08	Solid wastes from gas treatment
		10 03	**Wastes from lead thermal metallurgy**
		10 04	**Waste from zinc thermal metallurgy**
		10 05	**Waste from copper metallurgy**
1 1	**Inorganic waste with metals from metal treatment and the coating of metals, non-ferrous hydrometallurgy**	**11 01**	**Liquid wastes and sludges from metal treatment and coating of metals (e.g. galvanic processes, zinc coating processes, pickling processes, etching phosphatising, alkaline degreasing)**
		11 01 01	Cyanidic (alkaline) wastes containing heavy metals other than chromium
		11 01 02	Cyanidic (alkaline) wastes which do not contain heavy metals

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		11 01 03	Cyanide free wastes containing chromium
		11 01 04	Cyanide-free wastes not containing chromium
		11 01 05	Acidic picking solutions
		11 01 06	Acids not otherwise specified
		11 01 07	Alkalis not otherwise specified
		11 01 08	Phosphatising sludges
		11 02	**Wastes and sludges from non-ferrous hydrometallurgical processes**
		11 02 01	Sludges from zinc metallurgy (including jarosite, geothite)
		11 03	**Sludges and solids from tempering processes**
		11 03 01	Wastes containing cyanide
1 2	**Wastes from shaping and surface treatment of metals and plastics**	**12 01**	**Wastes from shaping (including forging, welding, pressing, drawing, turning cutting and filing)**
		12 01 01	Waste machining oils containing halogens (not emulsified)
		12 01 02	Waste machining oils free of halogens (not emulsified)
		12 01 02	Waste machining emulsions containing halogens
		12 01 04	Waste machining emulsions free of halogens
		12 01 05	Synthetic machining oils
		12 01 06	Machining sludges
		12 01 07	Spent waxes and fats
		12 02	**Wastes from water and stream degreasing processes (except 11)**
		12 02 01	Aqueous washing liquids
		12 02 02	Steam degreasing wastes
1 3	**Oil wastes (except edible oils, and oils listed under 05 and 12)**	**13 01**	**Waste hydraulic oils and brake fluids**
		13 01 01	Hydraulic oils containing PCBs or PCTs
		13 01 02	Other chlorinated hydraulic oils (not emulsions)
		13 01 03	Non-chlorinated hydraulic oils (not emulsions)
		13 01 04	Chlorinated emulsions
		13 01 05	Non-chlorinated emulsions
		13 01 06	Hydraulic oils containing only mineral oils
		13 01 07	Other hydraulic oils
		13 01 08	Brake fluids
		13 01 09	Oil filters
		13 02	**Waste engine, gear and lubricating oils**
		13 02 01	Chlorinated engine, gear and lubricating oils
		13 02 02	Non-chlorinated engine, gear and lubricating oils
		13 02 03	Other machine, gear and lubrication oils
		13 03	**Waste insulating and heat transmission oils and other liquids**
		13 03 01	Insulating or heat transmission oils and other liquids containing PCBs or PCTs
		13 03 02	Other chlorinated insulating and heat transmission oils and other liquids

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		13 03 03	Non-chlorinated insulating and heat transmission oils and other liquids
		13 03 04	Synthetic insulating and heat transmission oils and other liquids
		13 03 05	Mineral insulating and heat transmission oils
		13 04	**Bilge oils**
		13 04 01	Bilge oils from inland navigation
		13 04 02	Bilge oils from jetty sewers
		13 04 03	Bilge oils from other navigation
		13 05	**Oil/water separator contents**
		13 05 01	Oil/water separator liquids
		13 05 02	Oil/water separator sludges
		13 05 03	Interceptor sludges
		13 05 04	Desalter sludges or emissions
		13 05 05	Other emulsions
		13 05 06	Other oil wastes.
14	**Wastes from organic substances employed as solvents (except waste listed under 07 and 08)**	**14 01**	**Wastes from metal degreasing and machinery maintenance**
		14 01 01	Chlorofluorocarbons
		14 01 02	Other halogenated solvents and solvent mixtures
		14 01 03	Other solvents and solvent mixtures
		14 01 04	Aqueous solvent mixes containing halogens
		14 01 05	Aqueous solvent mixes free of halogens
		14 01 06	Sludges or solid wastes containing halogenated solvents
		14 01 07	Sludges or solid wastes free of halogenated solvents
		14 02	**Wastes from textile cleaning and degreasing of natural products**
		14 02 01	Halogenated solvents and solvent mixtures
		14 02 02	Solvent and organic liquids free of halogenated solvents
		14 02 03	Sludges or solid wastes containing halogenated solvents
		14 02 04	Sludges or solid wastes containing other solvents
		14 03	**Wastes from the electronic industry**
		14 03 01	Chlorofluorocarbons
		14 03 02	Other halogenated solvents
		14 03 03	Solvents and solvent mixtures free of halogenated solvents
		14 03 04	Sludges or solid wastes containing halogenated solvents
		14 03 05	Sludges or solid wastes containing other solvents
		14 04	**Wastes from coolants, foam/aerosol propellants**
		14 04 01	Chlorofluorocarbons
		14 04 02	Other halogenated solvents and solvent mixes
		14 04 03	Other solvents and solvent mixtures

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		14 04 04	Sludges or solid wastes containing halogenated solvents
		14 04 05	Sludges or solid wastes containing other solvents
		14 05	**Wastes from solvent and coolant recovery (still bottoms)**
		14 05 01	Chlorofluorocarbons
		14 05 02	Other halogenated solvents and solvent mixes
		14 05 03	Other solvents and solvent mixtures
		14 05 04	Sludges or solid wastes containing halogenated solvents
		14 05 05	Sludges or solid wastes containing other solvents
15	**Containers, packaging, absorbents, wiping cloths, filter materials and protective clothing not otherwise specified**	**15 01**	**Containers and packaging**
		15 01 01	Contaminated packaging materials and containers
		15 02	**Absorbents, filter materials, wiping clothes and protective clothing**
		15 02 01	Contaminated absorbents and filters, cleaning materials and protective clothing
16	**Waste not otherwise specified in this catalogue**	**16 01**	**End-of-life vehicles including catalysts (containing metals or not)**
		16 01 01	Car shredder flock
		16 02	**Discarded equipment and shredder residues**
		16 02 01	Transformers and capacitors containing PCBs or PCTs
		16 03	**Waste reactive chemicals**
		16 03 01	Waste oxidisers
		16 03 02	Waste solid flammables
		16 04	**Waste explosives**
		16 04 01	Waste ammunition
		16 04 02	Fireworks wastes
		16 04 03	Other waste explosives
		16 05	**Chemicals and gases in containers**
		16 05 01	Industrial gases in high pressure cylinders, LPG containers and industrial aerosol containers (including halons)
		16 05 02	Other waste containing inorganic chemicals e.g. lab chemicals not otherwise specified, fire extinguishing powders
		16 05 03	Other waste containing organic chemicals e.g. lab chemicals not otherwise specified
		16 06	**Batteries and accumulators**
		16 06 01	Lead batteries
		16 06 02	Ni-Cd batteries
		16 06 03	Mercury dry cells
		16 06 04	Alkaline batteries
		16 06 05	Other batteries and accumulators
		16 06 06	Electrolyte from batteries and accumulators
		16 07	**Waste from transport and storage tank cleaning (except 05 and 12)**

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		16 07 01	Waste from marine transport tank cleaning containing chemicals
		16 07 02	Waste from marine transport tank cleaning containing oil
		16 07 03	Waste from railway and road transport tank cleaning containing oil
		16 07 04	Waste from railway and road transport tank cleaning containing chemicals
		16 07 05	Waste from storage tank cleaning containing chemicals
		16 07 06	Waste from storage tank cleaning containing oil
1 7	**Construction and demolition waste (including road construction)**	**17 01**	**Concrete, bricks, tiles and ceramics and gypsum based materials**
		17 01 01	Contaminated concrete, bricks, tiles and ceramics and asbestos based materials
		17 02	**Wood, glass and plastics**
		17 02 01	Contaminated timber, glass and plastics
		17 03	**Asphalt, tar and tarred products**
		17 03 01	Asphalt containing tar
		17 03 02	Tar and tar products
		17 04	**Soil and dredging spoil**
		17 04 01	Contaminated soil, excavation materials and dredging spoils
		17 05	**Insulation materials**
		17 05 01	Insulation materials containing asbestos
		17 05 02	Other insulation materials which are contaminated
1 8	**Wastes from human and animals and health care and/or related research (excluding kitchen and restaurant wastes which do not arise from immediate health care)**	**18 01**	**Waste from natal care, diagnosis, treatment or prevention of diseases in humans and animals**
		18 01 01	Sharps
		18 01 02	Body parts and organs including blood bags and blood preserves
		18 01 03	Other wastes whose collection and disposal is subject to special requirements in view of the prevention of infection
		18 01 04	Discarded chemicals and medicines
		18 01 05	Cytostatic agents
		18 02	**Waste from research, diagnosis, treatment or prevention of disease involving animals**
		18 02 01	Sharps
		18 02 02	Other wastes whose collection and disposal is subject to special requirements in view of the prevention of infection
		18 02 03	Discarded chemicals and medicines
1 9	**Wastes from waste treatment facilities, off-site waste water treatment plants and the water industry**	**19 01**	**Wastes from the incineration or pyrolysis of municipal and similar commercial, industrial and institutional waste**
		19 01 01	Bottom ash or slag
		19 01 02	Fly ash
		19 01 03	Boiler dust

Waste Code	Description	Waste Code	Hazardous wastes covered by list
		19 01 04	Filter cake from gas treatment
		19 01 05	Aqueous liquid waste from gas treatment and other aqueous liquid wastes
		19 01 06	Solid waste from gas treatment
		19 01 07	Fly ash from hazardous waste incineration facilities
		19 01 08	Drosses from hazardous waste incineration facilities
		19 01 09	Spent catalysts
		19 01 10	Spent activated carbon from flue gas treatment
		19 02	**Waste from the treatment of stormwater**
		19 02 01	Sludges from the treatment of stormwater, including cess pit waste
		19 03	**Vitrified wastes and wastes from vitrification**
		19 03 01	Fly ash and other flue gas treatment wastes
		19 03 02	Non vitrified solid phase
		19 04	**Landfill leachate**
		19 04 01	Landfill leachate
		19 05	**Wastes from waste treatment plants not otherwise specified**
		19 05 01	Grease and oil mixture from oil/waste water separation
		19 05 02	Sludges from the treatment of industrial wastes
20	**Other hazardous waste (commercial, industrial and institutional) or waste hazardous substances collected as separate fractions.**	**20 01**	**Other hazardous waste (commercial, industrial and institutional) or waste hazardous substances generated and/or collected as separate fractions.**
		20 01 01	Paints, inks, adhesives and resins (non - solidified)
		20 01 02	Solvents
		20 01 03	Acids
		20 01 04	Alkalines
		20 01 05	Lead paint from paint removal activities
		20 01 06	Agrichemicals
		20 01 07	Fluorescent tubes and other mercury containing wastes
		20 01 08	Detergents
		20 01 09	Medicines
		20 01 10	Batteries
		20 01 11	Aerosols
		20 01 12	Equipment containing chloroflurocarbons
		20 01 13	Electronic equipment (e.g. printed circuit board)
		20 01 14	Photographic chemicals

Code 3: Hazardous characteristics thresholds (H Code)

All hazardous characteristics codes are based on the Hazardous Substances and New Organisms Act 1996 and associated regulations, with exception of code H6.2 (infectious characteristics), which is based on the Land Transport Rule: Dangerous Goods 1999 and NZ Standard 5433: 1999 – Transport of Dangerous Goods on Land) and H7 (radioactive characteristics), which is based on the Radiation Protection Act 1965 and Radiation Protection Regulations 1982.

Code	Characteristics
H1.1	Substances and articles presenting a mass explosion hazard
H1.2	Substances and articles presenting a projection but not a mass explosion hazard
H1.3	Substances and articles presenting a fire and minor blast/projection hazard, but not a mass explosion hazard
H1.4	Substances and articles presenting no significant hazard, but a minor fire or projection hazard
H1.5	Very insensitive substances which have a mass explosion hazard
H1.6	Extremely insensitive articles which do not have a mass explosion hazard
H2.1	Flammable gases
H3	Flammable liquid
H4.1a	Flammable solids
H4.1b	Self-reactive flammable solids
H4.1c	Desensitised explosive and related substances
H4.2	Substances liable to spontaneous combustion, pyrophoric and self-heating substances
H4.3	Substances which in contact with water emit flammable gases
H5.1	Inorganic oxidisers (including gases)
H5.2	Organic oxidisers
H6.1	Acutely toxic (through oral, dermal, gas, vapour or gas/mist exposure)
H6.2	Infectious materials as defined by Land Transport Rule: Dangerous Goods 1999 and NZ Standard 5433: 1999 – Transport of Dangerous Goods on Land for infectious materials.
H6.3	Biological corrosive or skin irritant
H6.4	Skin irritant
H6.5	Respiratory sensitisation
H6.6	Mutagen
H6.7	Carcinogen
H6.8	Reproductive/developmental toxicity
H6.9	Target organ systemic toxicity
H7	Radioactivity above the levels which are exempt under Radiation Protection Act 1965 and Regulations 1982
H8	Metallic corrosive
H9.1	Aquatic ecotoxicity
H9.2	Soil ecotoxicity
H9.3	Vertebrate ecotoxicity
H9.4	Invertebrate ecotoxicity

Code 4: Australia and New Zealand Standard Industry Classification code (ANZSIC Code)

A Agriculture, Forestry and Fishing
- **A01** Agriculture
  - A011 Horticulture and Fruit Growing
  - A012 Grain, Sheep and Beef Cattle Farming
  - A013 Dairy Cattle Farming
  - A014 Poultry Farming
  - A015 Other Livestock Farming
  - A016 Other Crop Growing
- **A02** Services to Agriculture; Hunting and Trapping
  - A021 Services to Agriculture
  - A022 Hunting and Trapping
- **A03** Forestry and Logging
  - A030 Forestry and logging
- **A04** Commercial Fishing
  - A041 Marine Fishing
  - A042 Aquaculture

B Mining
- **B11** Coal Mining
  - B110 Coal Mining
- **B12** Oil and Gas Extraction
  - B120 Oil and Gas Extraction
- **B13** Metal ore Mining
  - B131 Metal Ore Mining
- **B14** Other Mining
  - B141 Construction Material Mining
  - B142 Mining nec
- **B15** Services to Mining
  - B151 Exploration
  - B152 Other Mining

C Manufacturing
- **C21** Food, Beverage and Tobacco
  - C211 Meat and Meat Product Manufacturing
  - C212 Dairy Product Manufacturing
  - C213 Fruit and Vegetable Processing
  - C214 Oil and Fat Manufacturing
  - C215 Flour Mill and Cereal Food Manufacturing
  - C216 Bakery Product Manufacturing
  - C217 Other Food Manufacturing
  - C218 Beverage and Malt Manufacturing
  - C219 Tobacco Product Manufacturing
- **C22** Textile, Clothing, Footwear and Leather Manufacturing
  - C221 Textile, Fibre, Yarn and Woven Fabric Manufacturing
  - C222 Textile Product Manufacturing
  - C223 Knitting Mills
  - C224 Clothing Manufacturing
  - C225 Footwear Manufacturing
  - C226 Leather and Leather Product Manufacturing
- **C23** Wood and Paper Product Manufacturing
  - C231 Log Sawmilling and Timber Dressing
  - C232 Other Wood Product Manufacturing
  - C233 Paper and Paper Product Manufacturing
- **C24** Printing, Publishing and Recorded Media
  - C241 Printing and Services to Printing
  - C242 Publishing
  - C243 Recorded Media Manufacturing and Publishing

C25 Petroleum, Coal, Chemical & Associated Product Manufacturing
C251 Petroleum Refining
C252 Petroleum and Coal Product Manufacturing nec
C253 Basic Chemical Manufacturing
C254 Other Chemical Product Manufacturing
C255 Rubber Product Manufacturing
C256 Plastic Product Manufacturing
C26 Non-Metallic Mineral Product Manufacturing
C261 Glass and Glass Product Manufacturing
C262 Ceramic Manufacturing
C263 Cement, Lime, Plaster and Concrete Product Manufacturing
C264 Non-Metallic Mineral Product Manufacturing nec
C27 Metal Product Manufacturing
C271 Iron and Steel Manufacturing
C272 Basic Non-Ferrous Metal Manufacturing
C273 Non-Ferrous Basic Metal Product Manufacturing
C274 Structural Metal Product Manufacturing
C275 Sheet Metal Product Manufacturing
C276 Fabricated Metal Product Manufacturing
C28 Machinery and Equipment Manufacturing
C281 Motor Vehicle and Part Manufacturing
C282 Other Transport Equipment Manufacturing
C283 Photographic and Scientific Equipment Manufacturing
C284 Electronic Equipment Manufacturing
C285 Electrical Equipment and Appliance Manufacturing
C286 Industrial Machinery and Equipment Manufacturing
C29 Other Manufacturing
C291 Prefabricated Building Manufacturing
C292 Furniture Manufacturing
C294 Other Manufacturing
D Electricity, Gas and Water Supply
D36 Electricity and Gas Supply
D361 Electricity Supply
D362 Gas Supply
D37 Water Supply, Sewerage and Drainage Services
D370 Water Supply, Sewerage and Drainage Services
E Construction
E41 General Construction
E411 Building Construction
E412 Non-Building Construction
E42 Construction Trade Services
E421 Site Preparation Services
E422 Building Structure Services
E423 Installation Trade Services
E424 Building Completion Services
E425 Other Construction Services
F Wholesale Trade
F45 Basic Material Wholesaling
F451 Farm Produce Wholesaling
F452 Mineral, Metal and Chemical Wholesaling
F453 Builders Supplies Wholesaling
F46 Machinery and Motor Vehicle Wholesaling
F461 Machinery and Equipment Wholesaling
F462 Motor Vehicle Wholesaling
F47 Personal and Household Good Wholesaling
F471 Food, Drink and Tobacco Wholesaling
F472 Textile, Clothing and Footwear Wholesaling
F473 Household Good Wholesaling
F479 Other Wholesaling

G Retail Trade
- **G51** Food Retailing
  - G511 Supermarket and Grocery Stores
  - G512 Specialised Food Retailing
- **G52** Personal and Household Good Retailing
  - G521 Department Stores
  - G522 Clothing and Soft Good Retailing
  - G523 Furniture, Houseware and Appliance Retailing
  - G524 Recreational Good Retailing
  - G525 Other Personal and Household Good Retailing
  - G526 Household Equipment Repair Services
- **G53** Motor Vehicle Retailing and Services
  - G531 Motor Vehicle Retailing
  - G532 Motor Vehicle Services

H Accommodation, Cafes and Restaurants
- **H57** Accommodation, Cafes and Restaurants
  - H571 Accommodation
  - H572 Pubs, Taverns and Bars
  - H573 Cafes and Restaurants
  - H574 Clubs (Hospitality)

I Transport and Storage
- **I61** Road Transport
  - I611 Road Freight Transport
  - I612 Road Passenger Transport
- **I62** Rail Transport
  - I620 Rail Transport
- **I63** Water Transport
  - I630 Water Transport
- **I64** Air and Space Transport
  - I640 Air and Space Transport
- **I65** Other Transport
  - I650 Other Transport
- **I66** Services to Transport
  - I661 Services to Road Transport
  - I662 Services to Water Transport
  - I663 Services to Air Transport
  - I664 Other Services to Transport
- I**67** Storage
  - I670 Storage

J Communication Services
- **J71** Communication Services
  - J711 Postal and Courier Services
  - J712 Telecommunication Services

K Finance and Insurance
- **K73** Finance
  - K731 Central Bank
  - K732 Deposit Taking Financiers
  - K733 Other Financiers
  - K734 Financial Asset Investors
- **K74** Insurance
  - K741 Life Insurance and Superannuation Funds
  - K742 Other Insurance
- **K75** Services to Finance and Insurance
  - K751 Services to Finance and Investment
  - K752 Services to Insurance

L Property and Business Services
- **L77** Property Services
  - L771 Property Operators and Developers

L772 Real Estate Agents
L773 Non-Financial Asset Investors
L774 Machinery and Equipment Hiring and Leasing
L78 Business Services
L781 Scientific Research
L782 Technical Services
L783 Computer Services
L784 Legal and Accounting Services
L785 Marketing and Business Management Services
L786 Other Business Services
M Government Administration and Defence
M81 Government Administration
M811 Government Administration
M812 Justice
M813 Foreign Government Representation
M82 Defence
M820 Defence
N Education
N84 Education
N841 Preschool Education
N842 School Education
N843 Post School Education
N844 Other Education
O Health and Community Services
O86 Health Services
O861 Hospitals and Nursing Homes
O862 Medical and Dental Services
O863 Other Health Services
O864 Veterinary Services
O87 Community Services
O871 Child Care Services
O872 Community Care Services
P Cultural and Recreational Services
P91 Motion Picture, Radio and Television Services
P911 Film and Video Services
P912 Radio and Television Services
P92 Libraries, Museums and the Arts
P921 Libraries
P922 Museums
P923 Parks and Gardens
P924 Arts
P925 Services to the Arts
P93 Sport and Recreation
P931 Sport
P932 Gambling Services
P933 Other Recreation Services
Q Personal and Other Services
Q95 Personal Services
Q951 Personal and Household Goods Hiring
Q952 Other Personal Services
Q96 Other Services
Q961 Religious Organisations
Q962 Interest Groups
Q963 Public Order and Safety Services
Q97 Private Households Employing Staff
Q970 Private Households Employing Staff

Code 5: Management code (D/R Code)

Operations which do not lead to the possibility of resource recovery, recycling, reclamation, direct re- use or alternative uses	
D1	Deposit into or onto land (e.g. landfill etc.)
D2	Land treatment (e.g. biodegradation of liquid or sludgy discards in soils etc.)
D3	Deep injection (e.g. injection of pumpable discards into wells, salt domes or naturally occurring repositories etc.)
D4	Surface impoundment (e.g. placement of liquid or sludge discards into pits, ponds or lagoons etc.)
D5	Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated from one another and the environment etc.)
D6	Release into a water body except seas/oceans
D7	Release into seas/oceans including sea-bed insertion
D8	Biological treatment not specified
D9	Physico-chemical treatment not specified elsewhere
D10	Incineration on land
D11	Incineration at sea
D12	Permanent storage (e.g. emplacement of containers in a mine etc.)
D13	Blending or mixing prior to submission to any of the above operations
D14	Repackaging prior to submission to any of the above operations
D15	Storage pending any of the above operations

Operations which may lead to resource recovery, recycling, reclamation, direct re-use or alternative uses	
R1	Use as a fuel (other than in direct incineration) or other means to generate energy
R2	Solvent reclamation/regeneration
R3	Recycling/reclamation of organic substances which are not used as solvents
R4	Recycling/reclamation of metals and metal compounds
R5	Recycling/reclamation of other inorganic materials
R6	Regeneration of acids or bases
R7	Recovery of components used for pollution abatement
R8	Recovery of components from catalysts
R9	Used oil re-refining or other re-uses of previously used oil
R10	Land treatment resulting in benefit to agriculture or ecological improvement
R11	Uses of residual materials obtained from any of the operations numbered R1-R10
R12	Exchange of wastes for submission to any of the operations numbered R1- R11
R13	Accumulation of material intended for any operation numbered R1- R11
R14	Recycling/reconditioning/laundering of drums

Appendix 4: Incompatible Hazardous Waste Types

Waste streams from Group A should not be stored, mixed or treated with waste streams from Group B for the reasons indicated[1] .

Mixing of the following waste streams may result in violent reactions where heat is generated

Group A	Group B
Acetylene sludge	Acid sludge
Alkaline caustic liquids	Acid and water
Alkaline cleaners	Battery acid
Alkaline corrosive liquids	Chemical cleaners
Alkaline battery fluid	Electrolyte acid
Caustic waste water	Etching acid, liquid or solvent
Lime sludge and corrosive alkalis	Liquid cleaning compounds
Lime wastewater	Pickling liquors
Lime and water	Other corrosive acids
Spent caustics	Sludge acid
	Spent mixed acid
	Spent sulphuric acid

Mixing of the following waste streams may result in the release of toxic substances in the case of fire or explosion

Group A	Group B
Asbestos waste	Cleaning solvents
Beryllium waste	Data-processing liquid
Unrinsed pesticide containers	Obsolete explosives
Waste pesticides	Petroleum waste
	Refinery waste
	Retrograde explosives
	Solvents
	Waste oil
	Flammable and explosive wastes

Mixing of the following waste streams may result in fire and/or explosion, and/or the generation of flammable hydrogen gas

Group A	Group B
Aluminium	Acetylene sludge
Beryllium	Acid and water
Calcium	Acid sludge
lithium	Alkaline battery fluid
Magnesium	Alkaline caustic liquids
Potassium	Alkaline cleaners
Sodium	Alkaline corrosive liquids
Zinc powder	Battery acid
Other reactive metals and metal hydrides	Caustic waste water
	Chemical cleaners
	Electrolyte acid

[1] Derived from: UNESCAP, 1994: Manual for Hazardous Waste Management Volume 1 (Reference Text), pp 107 - 109. UN, New York.

	Etching acid, liquid or solvent
	Lime and water
	Lime sludge and corrosive alkalis
	Lime wastewater
	Liquid cleaning compounds
	Other corrosive acids
	Pickling liquors
	Sludge acid
	Spent caustics
	Spent mixed acid
	Spent sulphuric acid

Mixing of the following waste streams may result in fire, explosion or heat generation, and/or the generation of flammable or toxic gases

Group A	**Group B**
Alcohols	Acetylene sludge
Water	Acid and water
	Acid sludge
	Alkaline battery fluid
	Alkaline caustic liquids
	Alkaline cleaners
	Alkaline corrosive liquids
	Battery acid
	Calcium
	Caustic waste water
	Chemical cleaners
	Electrolyte acid
	Etching acid, liquid or solvent
	Lime and water
	Lime sludge and corrosive alkalis
	Lime wastewater
	Liquid cleaning compounds
	Lithium
	Metal hydrides
	Other corrosive acids
	Other water-reactive waste
	Pickling liquors
	Potassium
	Sludge acid
	SO_2CL_2, $SOCl_2$, PCl_3, CH_3SiCl_3
	Sodium
	Spent caustics
	Spent mixed acid
	Spent sulphuric acid

Mixing of the following waste streams may result in fire, explosion and/or violent reactions

Group A	**Group B**
Alcohols	Acetylene sludge
Aldehydes	Acid and water
Halogenated hydrocarbons	Acid sludge
Nitrated hydrocarbons and/or other reactive organic compounds and solvents	Alkaline battery fluid
Unsaturated hydrocarbons	Alkaline caustic liquids
	Alkaline cleaners
	Alkaline corrosive liquids
	Aluminium
	Battery acid

Beryllium
Calcium
Caustic waste water
Chemical cleaners
Electrolyte acid
Etching acid, liquid or solvent
Lime and water
Lime sludge and corrosive alkalis
Lime wastewater
Liquid cleaning compounds
Lithium
Magnesium
Other corrosive acids
Other reactive metals and metal hydrides
Pickling liquors
Potassium
Sludge acid
Sodium
Spent caustics
Spent mixed acid
Spent sulphuric acid
Zinc powder

Mixing of the following waste streams may result in the generation of toxic hydrogen cyanide or hydrogen sulphide gas

Group A
Spent cyanide solutions
Spent sulphide solutions

Group B
Acid sludge
Acid and water
Battery acid
Chemical cleaners
Electrolyte acid
Etching acid, liquid or solvent
Liquid cleaning compounds
Pickling liquors
Other corrosive acids
Sludge acid
Spent mixed acid
Spent sulphuric acid

Mixing of the following waste streams may result in fire, explosion and/or other violent reactions

Group A
Chlorates and other strong oxidisers
Chlorine
Chlorites
Chromic acid
Hypochlorites
Nitrates
Nitric acid (fuming)
Perchlorates
Permangantes
Peroxides

Group B
Acetic acid and other organic acids
Acetylene sludge
Acid and water
Acid sludge
Alcohols
Aldehydes
Alkaline battery fluid
Alkaline caustic liquids
Alkaline cleaners
Alkaline corrosive liquids
Battery acid
Caustic waste water
Chemical cleaners
Cleaning solvents
Concentrated mineral acids
Data-processing liquid
Electrolyte acid

Etching acid, liquid or solvent
Flammable and explosive wastes
Halogenated hydrocarbons
Lime and water
Lime sludge and corrosive alkalis
Lime wastewater
Liquid cleaning compounds
Nitrated hydrocarbons and/or other reactive organic compounds and solvents
Obsolete explosives
Other corrosive acids
Other flammable and combustible wastes
Petroleum waste
Pickling liquors
Refinery waste
Retrograde explosives
Sludge acid
Solvents
Spent caustics
Spent mixed acid
Spent sulphuric acid
Unsaturated hydrocarbons
Waste oil

Appendix 5: Treatment Options for Specific Hazardous Waste Types

The numbering and terminology used in this Appendix are generally consistent with the ANZECC classification system and refer in the first instance to untreated wastes. As the system contains both waste types and constituents, more than one category may be applicable to a particular waste and therefore all categories need to be checked.

For those more familiar with the OECD/Basel classification system, Tables 3.2 and pages 185 to 187 of the *CAE 1992 Report* should be consulted, recognising that commercial technologies for the treatment of organochlorine wastes have been included in this revision.

Treatment process are coded as follows:

Code	Type of Treatment	Chapter Reference
B	Biological processes	Chapter 5.3.4
C	Chemical processes	Chapter 5.3.3
F	Fixation/Stabilisation	Chapter 5.3.2
N	Further specific information on hazardous constituents required	
O	Other available technologies	Chapter 5.3.5
P	Physical processes	Chapter 5.3.1
R	It may be practical to recover the waste substance as a usable product	
T	Thermal processes	Chapter 6

It should be noted that in most cases a combination of the processes indicated may be required to destroy the waste, or render it acceptable for discharge to a sewer or to meet landfill acceptance criteria.

WASTE TYPES	POSSIBLE TREATMENT
Cyanides, surface treatment and heat treatment wastes	
A100	Cyanide containing waste from treatment of metals B, C, P
A110	Cyanide containing waste from heat treatment and tempering B, C, P
A120	Complex cyanides B, C, P
A130	Other cyanides B, C, P
Acids	
B100	Sulphuric acid C, R
B110	Hydrochloric acid C, R
B120	Nitric acid C, R
B130	Phosphoric acid C, R
B140	Chromic acid C, R
B150	Hydrofluoric acid C, R
B160	Sulphuric/hydrochloric acid mixtures C
B170	Other mixed acids C
B180	Organic acids C, R

WASTE TYPES	POSSIBLE TREATMENT
Alkalis	
C100	Caustic soda, potash, alkaline cleaners C
C110	Ammonium hydroxide C
C120	Waste lime and cement F, P
C130	Lime/caustic neutralised wastes containing metallic constituents F, P
C140	Other (hazardous substances must be specified) N
Inorganic chemicals	
D100	Metal carbonyls C, F, T
D110	Inorganic fluoride compounds C, P
D120	Mercury C, F, P, R
D121	Equipment and articles containing mercury C, F, P, R
D130	Arseni C, arsenic compounds C, F, P, R
D140	Chromium and chromium compounds C, F, P, R
D141	Tannery wastes containing chromium C, F, P, R
D150	Cadmium, cadmium compounds C, F
D160	Beryllium, beryllium compounds C, F
D170	Antimony, antimony compounds C, F, P
D180	Thallium, thallium compounds C, F, P
D190	Copper, copper compounds C, F, P, R
D200	Cobalt, cobalt compounds C, F, P
D210	Nickel, nickel compounds C, F, P
D220	Lead, lead compounds C, F, P
D230	Zinc compounds C, F, P
D240	Selenium, selenium compounds C, F, P
D250	Tellurium, tellurium compounds C, F, P
D260	Silver compounds C, P, R
D261	Photographic waste containing silver C, P, R
D270	Vanadium, vanadium compounds F, P
D280	Alkali metals C, P
D290	Barium, barium compounds P
D310	Boro N, boron compounds C, P
D320	Inorganic non-metallic phosphorus compounds C, P
D330	Inorganic sulphur containing compounds C, P
D340	Other inorganic compounds and complexes N
Reactive chemicals	
E100	Oxidising agents C
E110	Reducing agents C
E120	Explosives T
E130	Highly reactive chemicals C, N

WASTE TYPES	POSSIBLE TREATMENT
Paints, lacquers, varnishes, inks, dyes, pigments, adhesives	
F200	Uncured adhesives or resins C, F, P, T
Organic solvents	
G100	Ethers P, T, R
G110	Non-halogenated (FP>61ºC), n.o.s. P, T, R
G120	Non-halogenated (FP<61ºC), n.o.s. P, T, R
G130	Halogenated (FP>61ºC), n.o.s. O, P, T, R
G140	Halogenated (FP<61ºC), n.o.s. O, P, T, R
G150	Halogenated n.o.s. O, P, T, R
G160	Wastes from the production and formulation of organic solvents P, T
G170	Solvent recovery residues C, F
G180	Others (hazardous substances must be specified) N
Pesticides	
H100	Inorganic C, organometallic pesticides C, P
H110	Organophosphorus pesticides B, C, F, P, T
H120	Nitrogen-containing pesticides B, C, T
H130	Halogen-containing pesticides B, O, T
H140	Sulphur-containing pesticides B, C, P, T
H150	Mixed pesticide residues N
H160	Copper-chrome-arsenic (CCA) C, F, P
H170	Other inorganic wood preserving compounds N
H180	Organic wood preserving compounds N
Oils, hydrocarbons, emulsions	
J100	Waste mineral oils unfit for their original intended use (lubricating, hydraulic) T, R
J110	Waste hydrocarbons T, R
J120	Waste oils/water, hydrocarbon/water mixtures, emulsions (mainly oil and or hydrocarbons, i.e. >50%) P, T, R
J130	Waste oils/water, hydrocarbon/water mixtures, emulsions (mainly water, i.e. >50%) P, T, R
J140	Transformer fluids (excluding PCBs) P, T
J150	Other (cutting, soluble oils) P, T
J160	Tars and tarry residues (including tarry residues arising from refining and any pyrolytic treatment) P, T
Putrescible, organic wastes	
K100	Liquid animal effluent (poultry and fish processing) B, P
K150	Liquid vegetable oils and derivatives B, P, T, R
K170	Liquid animal oils and derivatives B, P, T, R
K180	Abattoir effluent B, P
K200	Food processing effluent B, P

WASTE TYPES	POSSIBLE TREATMENT
Industrial wash waters, effluents	
L100	Truck, machinery wash water with or without detergents B, P
L101	Car wash water with or without detergents B, P
L110	Boiler blowdown sludges C, F
L120	Cooling tower wash water C, B, P
L130	Fire wastewater C, B, P
L140	Textile effluent C, B, P
L150	Other industrial plant washdown water N
Organic chemicals	
M100	Polychlorinated biphenyls (PCBs) and/or polyterphenyl (PCTs) and/or polybrominated biphenyls (PBBs) O
M110	Equipment containing PCBs and/or PCTs and/or PBBs O, P, T
M120	Solvents and materials contaminated with PCBs and/or PCTs and/or PBBs O, P
M130	Non-halogenated (non-solvent) n.o.s P, T
M140	Heterocyclic organic compounds P, T
M150	Phenols, phenol derivatives including chlorophenols B, C, O
M160	Halogenated compounds n.o.s. O
M170	Any congener of poly-chlorinated dibenzo-furan O
M180	Any congener of poly-chlorinated dibenzo-p-dioxin O
M190	Organic phosphorus compounds C, F
M200	Organic sulphur compounds C, F
M210	Organic cyanides B, C, P, T
M220	Organic isocyanates C
M230	Amines and other nitrogen compounds (aliphatic) C, T
M240	Amines and other nitrogen compounds (aromatic) C, T
M250	Liquid surfactants and detergents B, C, P
M260	Highly odorous (e.g. mercaptans, acrylates) C, T
M270	Methacrylate compounds C, T
M280	Other (hazardous substances must be specified) N
Clinical and pharmaceutical wastes	
R100	Infectious substances C, P, T
R110	Pathogenic substances C, P, T
R130	Cytotoxic substances C, P, T
Miscellaneous	
T100	Waste chemical substances arising from research and development or teaching activities, which are not identified N
Solid/sludge requiring special handling	
N100	Drums which have contained hazardous substances (and which have been triple-rinsed) N

WASTE TYPES	POSSIBLE TREATMENT
N110	Containers and bags which have contained hazardous substances (hazardous substances must be specified) N
N120	Contaminated soils (hazardous substances must be specified) N
N130	Spent catalysts (contaminants must be specified) N
N140	Fire debris N
N150	Fly ash N
N160	Encapsulated wastes N
N170	Chemically fixed wastes N
N180	Solidified or polymerised wastes N
N190	Ion-exchange column residues N
N200	Industrial waste treatment sludges and residues n.o.s. N
N210	Residues from pollution control operations N
N220	Asbestos [1] N
N230	Synthetic mineral fibres N
Clinical and pharmaceutical wastes [2]	
R120	Pharmaceuticals and residues C, F, T
R140	Wastes from the production and preparation of pharmaceutical products C, F, T
Miscellaneous	
T120	Scrubber sludge N
T130	Photographic chemicals which do not contain silver C, F, P
T140	Inert sludges/slurries (eg. clay, ceramic suspensions) F, P
T150	Used tyres/tyre wastes T
T190	Other (hazardous substances must be specified) N

1 Refer to Asbestos Regulations 1983

2 Some clinical wastes such as non-shar P, non-infectious and non-pathological wastes may be able to be landfilled (Department of Health)

Appendix 6: Waste Classification for Landfill Disposal

NOTES: Numbering and terminology used are generally consistent with the ANZECC classification system and refer in Section A to untreated wastes. As the system contains both waste types and constituents more than one category may be applicable to a particular waste and therefore all categories need to be checked to determine whether landfill disposal may be appropriate.

A Waste Prohibited from Landfills

1 Characteristics

H1	Explosives
H2	Gases
H3	Flammable liquids
H4.1	Flammable solids
H4.2	Substances or wastes liable to spontaneous combustion
H4.3	Substances or wastes, which in contact with water emit flammable gases
H5.1	Oxidising substances
H5.2	Organic peroxides
H6.2	Infectious substances
H7	Radioactive materials[1]
H8	Corrosives
H10	Liberation of toxic gases in contact with air or water
H13	Capable, by any means after disposal, of yielding another material, eg. leachate, which possess any of the above characteristics

2 Waste types

Cyanides, surface treatment and heat treatment wastes

A100	Cyanide containing waste from treatment of metals
A110	Cyanide containing waste from heat treatment and tempering
A120	Complexed cyanides
A130	Other cyanides

Acids

B100	Sulphuric acid
B110	Hydrochloric acid
B120	Nitric acid
B130	Phosphoric acid

[1] Some radioactive wastes may be able to be landfilled (refer Guidelines for Disposal of Radioactive Substances – National Radiation Laboratory).

B140	Chromic acid
B150	Hydrofluoric acid
B160	Sulphuric/hydrochloric acid mixtures
B170	Other mixed acids
B180	Organic acids

Alkalis

C100	Caustic soda, potash, alkaline cleaners
C110	Ammonium hydroxide
C140	Other (hazardous substances must be specified)

Inorganic chemicals

D100	Metal carbonyls
D120	Mercury
D280	Alkali metals
D330	Sulphur

Reactive chemicals

E100	Oxidising agents
E110	Reducing agents
E120	Explosives
E130	Highly reactive chemicals

Paints, lacquers, varnishes, inks, dyes, pigments, adhesives

F200	Uncured adhesives or resins

Organic solvents

G100	Ethers
G110	Non-halogenated (FP>61˚C), n.o.s.
G120	Non-halogenated (FP<61˚C), n.o.s.
G130	Halogenated (FP>61˚C), n.o.s.
G140	Halogenated (FP<61˚C), n.o.s.
G150	Halogenated n.o.s.
G160	Wastes from the production and formulation of organic solvents
G180	Others (hazardous substances must be specified)

Pesticides

H100	Inorganic, organometallic pesticides
H110	Organophosphorus pesticides
H120	Nitrogen-containing pesticides
H130	Halogen-containing pesticides
H140	Sulphur-containing pesticides
H150	Mixed pesticide residues
H160	Copper-chrome-arsenic (CCA)
H170	Other inorganic wood preserving compounds

H180 Organic wood preserving compounds

Oils, hydrocarbons, emulsions

J100 Waste mineral oils unfit for their original intended use (lubricating, hydraulic)

J110 Waste hydrocarbons

J120 Waste oils/water, hydrocarbon/water mixtures, emulsions (mainly oil and or hydrocarbons, i.e. >50%)

J130 Waste oils/water, hydrocarbon/water mixtures, emulsions (mainly water, i.e. >50%)

J140 Transformer fluids (excluding PCBs)

J150 Other (cutting, soluble oils)

J160 Tars and tarry residues (including tarry residues arising from refining and any pyrolytic treatment)

Putrescible, organic wastes

K100 Liquid animal effluent (poultry and fish processing)

K150 Liquid vegetable oils and derivatives

K170 Liquid animal oils and derivatives

K180 Abattoir effluent

K200 Food processing effluent

Industrial wash water, effluents

L100 Truck, machinery wash water with or without detergents

L101 Car wash water with or without detergents

L120 Cooling tower wash water

L130 Fire wastewater

L140 Textile effluent

L150 Other industrial plant washdown water

Organic chemicals

M100 Polychlorinated biphenyls (PCBs) and/or polyterphenyl (PCTs) and/or polybrominated biphenyls (PBBs)

M110 Equipment containing PCBs and/or PCTs and/or PBBs

M120 Solvents and materials contaminated with PCBs and/or PCTs and/or PBBs

M150 Phenols, phenol derivatives including chlorophenols

M160 Halogenated compounds n.o.s.

M170 Any congener of poly-chlorinated dibenzo-furan

M180 Any congener of poly-chlorinated dibenzo-p-dioxin

M210 Organic cyanides

M250 Liquid surfactants and detergents

Clinical and pharmaceutical wastes

R100 Infectious substances

R110 Pathogenic substances

R130 Cytotoxic substances

Miscellaneous

T100 Waste chemical substances arising from research and development or teaching activities, which are not identified.

B Wastes possibly acceptable for municipal landfill disposal — solids and sludges

Note: All hazardous wastes should be pre-treated to meet Landfill Acceptance Criteria.

1 Characteristics

H6.1	Poisonous substances
H11	Toxic substances (chronic or delayed effects)
H12	Eco-toxic

2 Waste types

Alkalis

C120	Waste lime and cement
C130	Lime/caustic neutralised wastes containing metallic constituents

Inorganic chemicals

D110	Inorganic fluoride compounds
D120	Mercury compounds
D121	Equipment and articles containing mercury
D130	Arsenic, arsenic compounds
D140	Chromium, chromium compounds
D141	Tannery wastes containing chromium
D150	Cadmium, cadmium compounds
D160	Beryllium, beryllium compounds
D170	Antimony, antimony compounds
D180	Thallium, thallium compounds
D190	Copper compounds
D200	Cobalt, cobalt compounds
D210	Nickel, nickel compounds
D220	Lead, lead compounds
D230	Zinc compounds
D240	Selenium, selenium compounds
D250	Tellurium, tellurium compounds
D260	Silver compounds
D261	Photographic waste containing silver
D270	Vanadium, vanadium compounds
D280	Alkali metal containing compounds
D290	Barium, barium compounds
D310	Boron, boron compounds
D320	Inorganic non-metallic phosphorus compounds
D330	Inorganic sulphur containing compounds
D340	Other inorganic compounds and complexes

Putrescible, organic wastes

K100	Animal residues (poultry and fish processing wastes)
K101	Scallop processing residues

K120	Grease interceptor trap waste – domestic
K130	Bacterial sludge (septic tank)
K132	Sewage sludge and residues
K140	Tannery wastes not containing chromium
K150	Vegetable oil derivatives
K160	Vegetable wastes
K170	Animal oil derivatives (eg. tallow)
K180	Abattoir residues
K190	Wool scouring wastes

Organic chemicals

M130	Non-halogenated (non-solvent) n.o.s.
M140	Heterocyclic organic compounds
M190	Organic phosphorus compounds
M200	Organic sulphur compounds
M220	Organic isocyanates
M230	Amines and other nitrogen compounds (aliphatic)
M240	Amines and other nitrogen compounds (aromatic)
M250	Surfactants and detergents
M260	Highly odorous (eg. mercaptans, acrylate)
M270	Methacrylate compounds
M280	Other (hazardous substances must be specified)

Solid/sludge requiring special handling

N100	Drums which have contained hazardous substances (and which have been triple-rinsed)
N110	Containers and bags which have contained hazardous substances (hazardous substances must be specified)
N120	Contaminated soils (hazardous substances must be specified)
N130	Spent catalysts (contaminants must be specified)
N140	Fire debris
N150	Fly ash
N160	Encapsulated wastes
N170	Chemically fixed wastes
N180	Solidified or polymerised wastes
N190	Ion-exchange column residues
N200	Industrial waste treatment sludges and residues n.o.s.
N210	Residues from pollution control operations
N220	Asbestos[2]
N230	Synthetic mineral fibres

Clinical and pharmaceutical wastes[3]

R120	Pharmaceuticals and residues

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2 Refer to Asbestos Regulations 1983.

3 Some clinical wastes such as non-sharp, non-infectious and non-pathological (non-cytotoxic) wastes may be able to be landfilled (Department of Health)

R140 Wastes from the production and preparation of pharmaceutical products

Miscellaneous

T120 Scrubber sludge

T130 Photographic chemicals which do not contain silver

T140 Inert sludges/slurries (eg. clay, ceramic suspensions)

T150 Used tyres/tyre wastes

T190 Other (hazardous substances must be specified)

Appendix 7: Storage Facility Checklist

1. Location and Buildings

1.1 Legal Requirements

- Does the storage facility have a resource consent under the Resource Management Act? Is one required?
- Does the facility fulfil requirements of the Building Code regarding:
  - — construction materials and surface finishes?
  - — internal fire break walls, fire alarms, and smoke and heat detectors?
  - — ventilation?
  - — access restrictions and escape routes?
  - — signage?
- Is there sufficient light? Is it properly positioned? Refer to the Building Code, Clause F6.
- Are sufficient emergency exits provided? Do they conform to the Building Code, Clause F8?
- Is the warehouse fitted with a lightning conductor?
- If any office or amenity accommodation exists in the warehouse structure:
  - — is it adequately segregated from the store?
  - — does it have an exit other than through the warehouse?

1.2 Emergency Prevention

- If the warehouse is heated, is the heating source located away from the storage area? Is the direct heating of products avoided?
- Is waste stored at a safe distance from light fittings and electrical equipment.
- Is the warehouse bunding sufficient to contain any release?
- Are all vents above bunding height?
- What additional system for containment of firefighting water exists:
  - — none.
  - — underground retention pit.
  - — external containment wall.
  - — other (describe).

2. Warehouse Administration

2.1 Management

- Is there a defined management structure with clear areas of responsibility?
- Do these responsibilities include:
  - — receipt and dispatch of goods?
  - — occupational health and safety?
  - — industrial hygiene and safety?
  - — maintaining suitable storage conditions?
  - — security?

— protection of the environment?

— emergency procedure plans?

- Are all staff adequately trained concerning:

— knowledge of product hazards?

— safe operating procedures?

— emergency procedures?

2.2 Procedures

- Is a supervisor present during receipt and dispatch of all goods to check documents, package integrity, etc.?
- Are Material Safety Data Sheets (MSDS) available for materials stored? Are they accessible?
- Are inventory records kept up-to-date? Do they guarantee knowledge of the quantity and location of the stored materials at any time?
- Is an outline of the storage plan of the materials in each warehouse kept up-to-date?
- Are all non-routine maintenance or construction activities authorised in writing?
- Are the requirements on use and charging of forklift trucks satisfied?

2.3 Housekeeping Practices

- Is the warehouse divided into distinct and separate storage bays?
- Are passageways clearly marked and accessible?
- Does the arrangement for block storage comply with storage plan recommendations?
- Are inspection aisles kept free?
- Are the racks used in the warehouse non-combustible?
- Are container labels visible?
- Does waste segregation or separation within the premises satisfy requirements?
- Are damaged containers marked and segregated?

2.4 Security

- Does the warehouse have adequate precautions against arson and burglary and vandalism?
- Do these precautions include:

— alarm systems?

— burglar-proof gates and windows?

— fenced-in premises?

— a 24-hour guard service?

— perimeter lighting?

- If any product is stored outside the warehouse, are conditions satisfactory regarding:

— security?

— weather protection?

— access for firefighting?

3. Hygiene and Personal Safety

- Are standards of hygiene and housekeeping adequate?
- Are personnel issued with work clothes and protective gloves? Are these routinely worn when handling products?
- Does protective equipment exist on the premises for handling spills?
- Are adequate first-aid materials and facilities provided? Are staff familiar with their use?

4. Fire, Spills, and Environmental Protection

- Is there a plan of how to deal with emergencies?
- Are absorbent material and other spill equipment available?
- Is there a fire plan showing positions of all firefighting equipment?
- Is the prohibition of smoking rigidly enforced in the warehouse?
- Are forklift trucks operating in warehouses with flammable goods properly protected from generating sparks?
- Does the number and type of fire extinguishers, hydrants and hose lines satisfy requirements?
- Does the warehouse have automatic protection such as sprinklers or smoke detectors?
- Are fire alarms automatically linked to the fire brigade?
- Has this been agreed with the local fire brigade and/or the designated authority under the HSNO Act, 1996?
- Are personnel trained in firefighting?
- Is a fire drill regularly practised in cooperation with the local fire brigade?

Appendix 8: Emergency Preparedness Checklist

This checklist has been adapted from the NZ Chemical Industry Council Code of Practice for Emergency Preparedness.

1. Do you have an Emergency Plan?
2. Have you appointed a coordinator to develop and administer your Emergency Plan?
3. Do you have departmental or sectional co-ordinators appointed to assist in the development and administration of the emergency programme within their areas of the organisation?

Does your Plan include:

4. Evacuation of people to predetermined areas of safety?
5. Well documented, detailed instructions for each department, building or area, that include fire, work shut-down and other emergency procedures?
6. The control of hazardous materials?
7. The removal or protection of vital equipment and materials?
8. The designation of a central control area?
9. A search and rescue plan?
10. All clear and re-entry procedure?
11. Procedures to notify personnel of emergencies and to define their participation?
12. Are all essential emergency services, telephone numbers and addresses such as hospitals, doctors, poison control centres, fire departments, ambulances, etc. known and listed?
13. Have special fire-fighting procedures been developed to control fires where hazardous materials exist?
14. Do you have at least four training drills and evacuations annually such as work shut-downs, fire drills and emergency tests?
15. Have special fire-fighting procedures been developed to control fires where hazardous materials exist?
16. Has the presence of all hazardous materials been made known to fire units which would respond to the organisation in the event of an emergency?
17. Has a survey been made to determine the adequacy of procedures and absorbent materials to control hazardous materials spills?
18. Do you have adequate environmental pollution controls to deal with hazardous chemical spills, i.e., site bunding/ containment?
19. Is there a programme for proper colour-coding and labelling of master control valves, switches and other shut-off controls on site?
20. Are appropriate personnel familiar with the location and shut-down procedures of all master controls?
21. Is emergency lighting and power adequate and does it meet or exceed legislative requirements where applicable?

Has a systematic survey of all facilities been made within the past three years to identify the need for:

22. Fire extinguishers, extinguishing systems and fire-fighting equipment?
23. Detection systems for hazards such as smoke, hydrocarbons and other toxic substances, to detect and report emergency situations?

24. Other emergency and rescue equipment, such as supplied air respirators, emergency escape air packs, eye baths and showers, blankets, stretchers and other rescue equipment indicated by local exposures?
25. Is there an emergency team (or teams) to respond to emergency situations?
26. Are objectives established for training and drills of the emergency team(s)?
27. Do at least 10% of operating employees on each work shift hold a current, recognised first-aid certificate?
28. Is there a person (or persons) qualified in first-aid available during all working hours?
29. Do you have procedures to inform and liaise with fire service, police, civil defence, local hospital, local council and government agencies on emergency needs and plans?
30. Do you have mutual aid agreements with outside organisations to provide personnel and equipment in the event of an emergency?
31. Have you identified and taken action to safeguard vital records?
32. Have you got a written plan for restoration of your business following a major property damage emergency?
33. Do you have alternative communication systems available in case of interruption of normal systems in emergencies?
34. Do you have a media communications procedure with an appointed spokesperson?
35. Do you have a procedure to ensure evacuation of both on-site and off-site personnel (adjacent areas to an emergency) endorsed by Fire and Police departments?

ACTION IS REQUIRED IF LESS THAN 20 OF THE ABOVE QUESTIONS ARE ANSWERED WITH 'YES'.

Appendix 9: Model Site Emergency Plan

This plan has been adapted from the Maritime Safety Authority Model Site Marine Oil Spill Contingency Plan.

NOTE: In the following model plan, words in *italics* are instructions to the plan author. Normal text should be inserted into the plan as they appear, or in like kind. [Square brackets] are places where the plan author should place names, etc. specific to this plan.

1. Purpose and Policy

The purpose of this document is to describe in detail the systems whereby there is a planned response in place in case of any emergencies that relate to the spillage of hazardous substances or waste, or other emergency situations, from the [name] site/operation that is liable to be a health and safety risk and/or pollute the environment.

The [name] site is subject to the provisions of the Resource Management Act 1991 and Health & Safety in Employment Act 1992, and is therefore advised to have in place a site plan for response to any incident which occurs on or from this site. This is to ensure to that the risk to personnel is reduced as far as possible, and incident can be immediately and effectively contained within the site or within a defined boundary adjacent to the site, as agreed with the regional council.

To meet its responsibilities the [company name] has prepared this site emergency incident contingency plan.

1.1 Title

This document may be cited as the [company name] Site Emergency Plan.

1.2 Safety

NOTE: The safety of people overrides all other considerations.

In the event of an emergency, all sources of ignition must be shut down and the area checked for flammable vapours before deploying any machinery in the area. Operations in conditions which endanger personnel must be suspended until conditions improve.

NO CLEAN-UP OF ANY AREA IS TO COMMENCE UNTIL IT HAS BEEN DETERMINED SAFE TO DO SO.

"Safe to do so" means each person must make a judgement based upon their training and experience in coping with the situation faced.

Personnel involved in a clean-up must be appropriately trained and issued with the appropriate protective clothing and safety equipment.

Refer to relevant parts of the company's health and safety plan and insert a section here detailing the various measures in place to be used to protect personnel during a spill and the ensuing response.

Where necessary an evacuation plan must prepared and inserted here.

1.3 Responsibilities

The following positions within [the company] have the responsibilities for putting the plan into action as and when required, as noted:

All personnel have a duty to respond initially to an emergency by raising the alarm, warning other personnel on site, and standing by in a safe location until instructed to take part in the clean-up exercise if needed.

Note here all other company personnel who are involved in the response structure, such as:

- *the site manager;*
- *the person who was responsible for preparing this plan and who puts it into effect in the event of an emergency;*
- *the environmental and health and safety manager(s) for the company; and*
- *any other person who would have a role to play in an emergency, other than the on-the-ground personnel who carry out the manual tasks involved in the clean-up.*

2. Description of the Company Site

Insert here a detailed description of the company site identifying likely routes for release to surrounding environments (e.g. stormwater drains, waterbodies etc.). A map/plan of the site should be included in Appendix 1. You should also include the following points where relevant:

- *the location to which the plans applies. The "site" is the area of land for which the plan makes provision and sets up response procedures;*
- *coastal access points (from the site and public access) including roads and other vehicle access; and*
- *any other specific information about the site and its environs which will be of use in the response to a spill or other emergency.*

2.1 Sensitive Environments

Sensitive environments within the company's vicinity such as rivers or waterways, beaches, mangrove areas, wetlands, agricultural land, culturally-sensitive areas, parks, etc., should be listed so that in the event of an emergency, protection can be considered. Sensitive sites should be given priority if possible. These should also be included in the map in Appendix 1.

In most instances your regional council will have prepared detailed inventories of such sites and these should form the basis of the information included within this plan. Some judgement will be required as to the level of detail and coverage included — seek assistance from your regional council to do this.

2.2 Characteristic Substances Stored at the Site

Provide as much detail as you can which might be of assistance in an emergency, such as chemical types, flash points, any incompatibilities, and any available health and safety information. Material safety data sheets should be included as an appendix to the plan.

2.3 Potential Spill Sources and Risks

This plan needs to identify the specific scenarios that this site contingency plan will cover.

NOTE: Do not include those scenarios that are beyond the scope of this plan, including those circumstances, as agreed with the regional council, when a regional response will be undertaken.

The risks consequent on each scenario will need to be identified. A list of all the areas where there is the potential for overflows, spillage of product, etc. should be placed in this section. An assessment must be made of the likely magnitude of different types of emergency incidents. Your regional council can assist with this.

Allow for all types of release scenarios, including:

- *handling accidents;*
- *damaged containers;*
- *unstable storage;*
- *vandalism;*
- *chemical reaction;*
- *flooding;*
- *fire; and*

- *natural hazards (earthquakes. major storms etc.).*

2.4 Preventative Measures in Place

A list or description of preventative measures that are in place at the company's site should be inserted here. These could include special security and alarm systems, bunding of storage areas, spill kits, stormwater drains directed to separators, saline bags for placing over drains, etc. It should be noted that emergency response requirements could well be lessened if the regional council considered that sufficient preventative measures had been put in place.

2.5 Training

A commitment to training all staff to be conscious of their responsibilities in relation to adverse incidents should be stated, and specific training for emergency response should be undertaken regularly. You will need to list here all personnel on site who can be called upon in an emergency response, their contact numbers, and their level of training and/or special expertise (e.g. first aider, spill kit user, boom operator, digger driver, etc.).

2.6 Response Organisation

In the event of an incident occurring a reporting procedure should be adopted for:

- *staff to management;*
- *management to regional council;*
- *Fire Service (if necessary); and*
- *Police (if necessary).*

A list of relevant phone numbers and personnel to contact should be included in Appendix 5.

You will need to set out, preferably in diagram form, the lines of communication from the discoverer of an incident to all relevant people. An example is set out below. Further advice on assessing the severity of an incident can be obtained from the Incident Potential Matrix produced by the Shell International Petroleum Company.

It may be appropriate to categorise incidents as follows:

Type A: An incident which can be contained before it leaves the store or site and can be cleaned up by the company or its contractors within the scope of this plan, or an accident in which there were no serious injuries or on-going risk to personnel.

Type B: An incident which leaves the site, but can still be contained and cleaned up by the company or its contractors within the scope of this plan, or where minor injury has occurred and there is an ongoing minor threat to personnel.

Regional Response: An incident which cannot be contained and leaves the site or threatens to do so, and cannot be cleaned up without significant external resources. There is or may be a threat to personnel and local resources and/or response is beyond the scope of this plan and should be under the control of outside authorities.

3. Equipment and Operators

It is recognised that spill response may require equipment and/or operators rapidly. The [..........]Regional Council must be informed immediately.

3.1 Equipment Available on Site

Insert a list of equipment available for containment and clean-up held on site should be recorded (Refer Appendix 2).

3.2 Equipment Available Elsewhere

Insert a list of equipment available for containment and clean-up held off site (Refer Appendix 3).

3.3 Operators and Other Assistance Available

Note here the sources of equipment, personnel and relevant operators (e.g. contractor/digger companies, vacuum *truck operators) which could be used in a clean-up operation. Include a detailed list of equipment, call-out numbers and names in Appendix 4.*

4. Response Procedures

Detail what you can/will do in each of the scenarios set out in 2.3 above. Some of the questions you may need to ask for assessing the adequacy of your contingency plan are:

- *Has there been a realistic assessment of the nature and size of the possible threat, and of the resources most at risk, bearing in mind the type of substance stored and the probable movement of any incident?*
- *Has the process for notification of the regional council been established?*
- *In the event of a significant emergency , has the process by which outside agencies take control of the response function been established and recognised in the plan?*
- *Have priorities for protection been agreed, taking into account the viability of the various protection and clean-up options?*
- *Has a strategy for protecting and cleaning the various areas been agreed and clearly explained?*
- *Has the necessary organisation been outlined and the responsibilities of all those involved been clearly stated with no "grey areas" — will all who have a task to perform be aware of what is expected of them? In particular, are company responders aware of their role and responsibilities in the event of outside agencies taking control of the emergency response?*
- *Are the levels of equipment, materials and manpower immediately available sufficient to deal with the size of emergency planned for? If not, have back-up resources been identified?*
- *Have temporary storage sites and final disposal routes for collected spilled substance been identified?*
- *Are the alerting and initial evaluation procedures fully explained as well as arrangements for continual review of the progress and effectiveness of the clean-up operation?*
- *Have the arrangement for ensuring effective communication during the response been described?*
- *Have all aspects of the plan been tested and nothing significant found lacking?*

4.1 Immediate Response

The **person who discovers** the emergency situation will first:

- determine whether it is a result of an incident which occurred some time ago, or is still occurring; and
- identify the type of substance released and, if possible, obtain a sample;

It is of utmost importance, once an emergency has been reported, to ensure the safety of all staff. In the event of an emergency, attempt to isolate the source and limit or contain the release , taking safety into consideration. If safe to do so, take immediate steps to limit the size of the release by shutting down pumps, closing valves, or taking whatever other action is appropriate.

He/she will then report it to their supervisor or the person nominated to respond to emergency incidents [name/ position in company] on [phone number/ extension/pager] or the company telephone operator [phone].

The **supervisor** or the person nominated to respond to incidents will then:

- have the incident evaluated by [name/ position in company].
- notify the [……….] Regional Council (Phone……….) and will follow this, as soon as practicable, with a fax of the same details. (Fax……….).

NOTE: What constitutes a notifiable incident should be agreed between the company and the regional council or other emergency services.

Fill in an emergency incident notification report form as set out in Appendix 6.

Undertake other action as required by the plan.

NOTE: Where appropriate, e.g. for larger sites, it will be necessary to detail in an appendix the specific roles of all *key personnel involved in response, as well as provide forms for pollution notification, spill evaluating, etc. This should be discussed with your regional council.*

4.2 Category of Incidents

All incidents will be evaluated as soon as possible by [state name/position in company] and categorised progressively as type A or type B or regional response, as defined on in Section 2.6 above.

4.3 Procedure Following Incident Evaluation

Once an incident has been evaluated, the [company's emergency response coordinator name/ position in company/ phone or extension or pager number] is to be notified. In his absence, his/her deputy is to be notified [name/position in company/phone or extension or pager number].

The emergency response coordinator will proceed immediately to the emergency response room [location] and take command of the response operation according to the procedures set out in 4.4, 4.5 and 4.6 below. Any or all of the response procedures set out in Section 4.0 above may be used by the response coordinator, who has responsibility for action on behalf of the company in the event of a type A or type B incident.

NOTE: For smaller and/or mobile sources, there may be no emergency response room. Note other/alternatives.

4.4 Procedures for a Type A Incident

Once an incident has been categorised Type A, the emergency response coordinator is to supervise the following actions:

- carry out procedures to ensure safety of staff and the public. If appropriate, notify Fire Service and Police and initiate evacuation procedures;
- take any safe steps to prevent further discharge at the source of the event;
- mobilise appropriate equipment and personnel to commence containment and clean-up;
- advise the [……….] Regional Council, on phone [………] fax [……….] *(subject to regional council agreement on need to advise see 4.1 above);*
- notify neighbouring properties and landowners of the incident; and
- supervise clean-up operations in such a manner as to ensure no or minimal environmental damage.

4.5 Procedures for a Type B Incident

Once an incident has been categorised type B, the emergency response coordinator is to supervise the following actions:

- carry out procedures to ensure safety of staff and the public. If appropriate, notify Fire Service and Police and initiate evacuation procedures;
- take any safe steps to prevent further discharge at the source of the incident;
- advise the [……….] Regional Council, on phone [………] fax [……….];
- notify neighbouring properties and landowners of the emergency;
- mobilise appropriate equipment and personnel to commence containment and clean-up (it should be noted that equipment from other sources is available for use and this is listed in Appendix 3); and
- supervise clean-up operations in such a manner as to minimise any environmental damage.

Clean-up should be completed so that the area affected is returned as near as possible to its natural state prior to the incident.

The [……….] Regional Council will attend the response and monitor the cleanup. The regional on-scene commander may take control of the response, if they consider it to be appropriate, or if asked to do so by the site emergency response coordinator.

4.6 Procedures for an Incident Requiring a Regional Response

If an emergency situation and containment and/ or clean-up operation is determined to be beyond the capability of the site response system, the regional council should be notified as soon as possible on phone [……….] fax [……….]

NOTE: In some instances the regional council or other emergency services may classify the incident as requiring a regional response and take control of the situation and/or clean-up.

Once an incident has been declared to be under the control of outside authorities, management of the company should:

- carry out procedures to ensure safety of staff and the public. If appropriate, notify Fire Service and Police and initiate evacuation procedures;
- take any safe steps to prevent further discharge at the source of the incident;
- notify neighbouring properties and landowners of the incident;
- take any safe steps to deal with the incident (as directed by the regional on-scene commander) until outside help arrives; and
- assist the outside authority with personnel and equipment to undertake any response and clean-up operations until completed.

You will need to be quite specific in setting out all of the above procedures, particularly for larger, more complex sites, including step-by-step instructions for all personnel involved in the response/clean-up operation. Flow charts are a very useful way of showing this information.

For smaller events or simple sites, emergency procedures can be displayed as simple one page documents. Examples are given in Appendix 10 in the next section.

IT IS ESSENTIAL THAT ALL PERSONNEL INVOLVED KNOW EXACTLY WHAT THEY ARE TO DO, WHO TO NOTIFY/REPORT TO, ETC.

5. Media Releases

The only person who is authorised to make public statements, via the media or not, is [name/ position in company].

6. Debriefing

After the clean-up has been completed a debriefing involving all personnel concerned with the incident should be carried out, and a report with recommendations compiled to the [……….] Regional Council. It is the responsibility of [state name/position in company] to arrange and organise a debriefing and review of the plan (Refer 8.0 below).

NOTE: The regional council or emergency services may wish to be involved in the debriefing and should be invited.

7. Points to Consider

It is recognised and probable that any incident may be part of a fire or similar emergency and that Fire Service and Police would supervise the event probably by appointing a commander. In this case, any clean-up operation undertaken would be subordinate to that agency.

8. Document Review

This document must be reviewed not less than once every twelve months to check the currency and completeness of the information contained in it. The next review is due in [……….]. This document must also be reviewed after its use in response to an emergency incident.

NOTE: The regional council may need to approve any significant amendments to this plan, and may wish to be involved therefore in its review.

9. Plan Testing

This plan must be fully tested not less than once every twelve months, with individual components of the plan being tested as necessary. Tests are due before [………] and [……….]. Any modification that would increase the effectiveness of the plan must be made.

10. Appendices

Appendix 1: Map of Site

Show site and its relationship to all sensitive sites/environs, drains, waterways, etc.

Appendix 2: List of Equipment Available On-site

Note all equipment, where it is stored, who has access to it (plus 24 hour phone numbers), and any special requirements for its use (e.g. "Can only be operated by [name]", or "can only use following approval from Regional Council." (All contact people and their contact details (phone numbers, pagers, e-mail etc.) should be checked and updated regularly.)

Appendix 3: List of Equipment Available Elsewhere

Include location of equipment, 24 hour contacts of people who can get access to it, and the list of equipment available. Note any special requirements for its use - e.g. "can only be operated by [name]" where necessary. (All contact people and their contact details (phone numbers, pagers, e-mail etc.) should be checked and updated regularly.)

Appendix 4: List of Operators

List operators who can assist in a clean-up, such as sucker/tanker truck firms, earthworks contractors, any firms experienced in hazardous substance clean-up or who may have equipment to assist. (All contact people and their contact details (phone numbers, pagers, e-mail etc.) should be checked and updated regularly.)

Appendix 5: Telephone Numbers of Other Organisations

National Poisons Centre: (03) 474 7000 (Urgent) - 24 hour phone.

NZ Fire Service

Ambulance

Police

[……….] District Council [contact name and telephone number]

[……….] Area Health Board [contact name and telephone number]

[……….] Hospital [contact name and telephone number]

[……….] Port company [contact name and telephone number]

Department of Conservation [contact name and telephone number]

Department of Labour, OSH [contact name and telephone number]

Civil Defence [contact name and telephone number]

(All contact people and their contact details (phone numbers, pagers, e-mail etc.) should be checked and updated regularly.)

Appendix 6: Pollution Report and Incident Forms

As discussed and agreed with the [……….] Regional Council.

Appendix 10: Example Emergency Procedures

These procedures have been adapted from Environment Waikato “Hazardous Substances Management in the Waikato Region”)

These procedures are intended to be examples of instructions which can be laminated and displayed at appropriate places around the storage facility. The Emergency Plan should contain such instructions, which should be concise and easy to read.

SAFETY OF PEOPLE IS MOST IMPORTANT DURING ANY EMERGENCY

1. Hazardous Waste Store - Hazard Identification

The events most likely to cause emergencies at the hazardous waste store are as follows:

- fire/explosion in the hazardous waste store, in the building housing the hazardous waste store, or nearby buildings;
- chemical spills/reactions within the store;
- chemical spills or staff injury while handling hazardous waste; and
- flooding of the hazardous waste store.

Other emergency events that are considered to be of very low risk include:

- earthquakes; and
- other natural hazards — e.g. tornadoes.

2. Risk Reduction and Emergency Procedures

Through care and good management the risks of emergency events occurring can be reduced or eliminated.

2.1 Fire/Explosion in the Hazardous Waste Store or Neighbouring Buildings

Possible causes of this hazard include:

- vandalism;
- sparks igniting flammable gases/fumes;
- reactions between incompatible chemicals;
- smoking in or near the store; and/or
- spontaneous combustion of flammable gases at flash point concentrations.

2.1.1 Emergency Procedures

In the case of a fire in the hazardous waste store the following procedures shall be carried out:

- Sound the alarm and dial 111 for Fire Service.
- Advise the operator of:
  - — company name;
  - — location (suburb, street, nearest intersecting street to relevant site entry);
  - — type of emergency;
  - — casualties;
  - — assistance required;

— telephone contact number; and

— name of caller.

- If the fire is in its initial stages personnel may attempt to extinguish the fire or remove the source. This should only be attempted if protective clothing (including full face respirator) is worn, and if it can be done with no additional danger to persons or property.
- Customers and staff must be evacuated to at least 200 metres from the facility.
- Fire Service must be provided with hazardous waste store inventory records, plan etc. Copy to be held nearby but separate from the store.
- Ensure that any liquid used to control the fire (or spilt during the event) is contained. Drain covers and absorbent materials are to be stored nearby.
- Notify the local Council.
- Place a temporary bund of sand or absorbent material around any stormwater drains.
- Assist the emergency services as necessary.

2.2 Chemical Spills/Reactions in or near the Store

Possible causes include:

- accidents/carelessness when handling chemicals;
- damaged, weak or inappropriate containers;
- unstable stacking of containers; and/or
- vandalism.

Steps to eliminate or minimise risks include:

- Provide security monitoring for the site and buildings after hours.
- Minimise handling of chemicals.
- Repackage leaking chemicals into new UN approved containers. Transfer the label details across to the new container.
- Staff must be trained in safe handling and spill containment procedures.
- Containers should not be stacked unless unavoidable. If containers must be stacked, only use stacking containers designed for that purpose. Consider using shelves with steel mesh covers to stop containers falling.
- Spill kits for the various chemical types should be provided and maintained in easily accessible positions both within the store and adjacent to it.
- Check labels and/or test chemicals to ensure that the container is appropriate for its contents, i.e. acids not in metal tins.
- Place all containers in bunded areas and/or in plastic trays large enough to hold the entire contents of the container if it leaks.
- A drum of dry sand or absorbent material must be available to isolate any spills outside of the bunded area and to block off exit points such as stormwater drains.

2.2.1 Emergency Procedures

- Assess the scale of the spill.
- Identify chemicals involved, refer to the label, MSDS or other information sources. Check for any special handling instructions.
- Minor Spills — i.e. only a few containers. Use clay granules and spill kits to clean up the mess. The contaminated absorbent material must be treated as hazardous waste and be placed in sealed containers for disposal. The container must be labelled and recorded in the system noting the details of the contaminant.
- Major Spills — Isolate the spill using dry sand or spill booms. Move other containers away from the spill site

and either pump the spilled liquid into new containers or use absorbent materials to soak up the spilt liquid. Dispose of any contaminated material as hazardous waste.

- Ensure that any nearby stormwater drains are isolated with temporary bunds of dry sand or absorbent materials.
- For very large spills or for dangerous or reacting chemicals (i.e. spills which pose a risk to public) call in the appropriate emergency authorities. Follow procedures for fires and explosions as appropriate.
- If any liquid enters stormwater system or any neighbouring streams notify the local territorial authority and the regional council.
- Always wear protective clothing (gloves, overalls, eye protection) when handling chemicals.
- Avoid breathing any fumes. Wear appropriate respirators.
- All contaminated equipment must be placed in sealed containers and held for disposal as hazardous waste.
- Any floor staining or slight residue unable to be absorbed can be washed with detergents or solvents and the liquid retained for disposal. Ensure compatibility before applying detergent or solvent.
- If the spill occurred outside the storage facility and soil has been contaminated, the contaminated soil must be removed and held until a suitable disposal method can be identified.

2.3 Staff Injury While Handling Hazardous Waste

Possible causes include:

- unlabelled or mislabelled waste;
- damaged, weak or inappropriate containers;
- chemical reaction between incompatible chemicals;
- inhalation of toxic or narcotic fumes (e.g. solvents); and/or
- contact with corrosive or toxic on-contact chemicals.

Steps to minimise risks include:

- Minimise handling of chemicals.
- Staff must be trained in safe handling and spill containment procedures and be familiar with the risks that the chemical may pose.
- Containers should be visually examined before they are moved. If containers look fragile, the substance should be repackaged in UN approved hazardous goods containers and all label details transferred to the new container.
- Working and storage areas must be well ventilated.
- All chemicals must be identified on receipt. The contact details of the person they came from should be noted.
- Unknown chemicals should be treated as extremely hazardous until proven otherwise.
- Unknown chemicals should be characterised using an experienced laboratory.
- Staff must be provided with all necessary protective equipment and trained in its use.
- Staff must be aware of where first aid equipment is kept and the use of the equipment.

2.3.1 Emergency Procedures

- Immediately wash the affected skin area, use the emergency shower and/or eyewash as appropriate.
- Remove affected clothing immediately.
- Check MSDS, labels and other chemical data (if available) for any specific first aid instructions.
- If the chemical is known to be toxic through skin contact and no first aid information is available consult a doctor immediately.
- If there is any redness of skin, swelling, rash or itchiness, etc. Consult a doctor.
- If the staff member exhibits symptoms such as nausea and there is reason to believe that fumes may have been the cause, immediately cease work in the store. If the symptoms continue consult a doctor. Do not resume work in the facility until medical approval has been received.

2.4 Flooding of Hazardous Waste Store

Possible causes include:

- blockage of stormwater drains during heavy rain;
- strong winds driving rain into store; and/or
- vandalism.

Steps to eliminate or minimise risks include:

- Ensure regular clearing of stormwater drains.
- Ensure security of both store and overall site, especially after hours.
- Make sure staff, including after hours security staff, know to keep an eye on the Hazardous Waste Store and who to call in an emergency.
- All containers in store should be waterproof.
- A bund around the store will assist keeping water out as well as in.

2.4.1 Emergency Procedures

- Eliminate cause of flooding if possible.
- Ascertain if any chemicals have leaked into the water.
- Wear gloves, gumboots and waterproof overalls when in contact with water, treat as if contaminated.
- Extract flood water from the store, do not discharge to stormwater as it will most likely be contaminated.
- Water must be disposed of as hazardous waste through a suitable waste disposal facility.
- Notify the territorial authority and the regional council if the contaminated water has entered the stormwater system or nearby streams.

Appendix 11: Role of Emergency Services and Fire Service Contacts

1 Role of the Emergency Incident Coordinator

The Emergency Incident Coordinator has responsibility for the incident scene, rendering the incident safe and liaison with the other emergency services. Under Part IX of the HSNO Act, for a hazardous substance or fire incident, the Emergency Incident Coordinator is either the commanding Police or Fire Officer, at the scene. Traditionally, this has been delegated to the Chief Fire Officer.

2 Telecom Emergency 111 Service

All 111 emergency calls are received by the Telecom operator who will connect the call to the service requested. The service receiving the 111 call automatically advises the other emergency services.

3 Role of the Fire Service

Duties:

- prevent fires and promote fire safety;
- suppress and extinguish fires;
- stabilise or render safe hazardous substance emergencies; and
- render assistance when life and property are at risk from fires and dangers other than fires, using firefighting resources.

The authority for the above is contained in the Fire Services Act 1975.

In carrying out the above duties, the Fire Service attending an incident scene involving hazardous substances, will take action as deemed appropriate. This may include contacting some of the following where necessary:

- the owners of any vehicles or premises affected so that they can attend the scene to assist and advise on safety procedures, including methods for clean up and disposal;
- Police;
- St John Ambulance;
- Ministry of Transport, Traffic Department;
- Local and Regional Authorities (e.g. regarding dangerous goods, refuse collection and water supply); and/or
- Occupational Safety & Health (OSH).

4 Role of the Police

Traditionally, for a hazardous substance emergency, the Police have had a response role to control the incident danger area from traffic and onlookers and to provide site security. If requested by the Emergency incident Coordinator, the Police may assist in any necessary evacuation. Other duties of the Police during an emergency (where applicable) are:

- preservation of life and recovery of injured;
- reconciliation of survivors;
- accounting of deceased;
- establishing culpability; and
- inquests.

5 St John Ambulance Association

The purpose of the St John Ambulance Association is to respond to a call for assistance and assume responsibility for pre-hospital care of patients. The Ambulance Service will notify the hospital of the incident. The St John Ambulance Association has developed plans for multi-casualty incidents.

6 Police Traffic Safety Service

For a hazardous substance emergency the Police, if requested to help (by the Emergency Incident Coordinator), may co-ordinate all transport access routes to and from the area to effect safe movement of traffic.

7 Role of Emergency Management and Civil Defence

When incidents occur on a scale too great to be dealt with by normal emergency services, then a community response known as Emergency Management and Civil Defence is required.

The local Emergency Management and Civil Defence will, on receipt of information that an incident has occurred:

- confer with the emergency services on the scene;
- if appropriate, declare a Civil Defence Emergency for the area affected; and
- activate the local Emergency Management and Civil Defence headquarters.

8 New Zealand Fire Service Contacts — by Area

Regional Commander Northland Fire Region 5 Mansfield Terrace WHANGAREI PH: (09) 438 - 9199	Regional Commander Western Fire Region PO BOX 148 PALMERSTON NORTH PH: (06) 356 - 5222	Regional Commander Auckland Fire Region PO BOX 68 444 AUCKLAND PH: (09) 302 -5114
Regional Commander Arapawa Fire Region PO BOX 9346 WELLINGTON PH: (04) 383 - 9100	Regional Commander Bay-Waikato Fire Region PO BOX 341 TAURANGA PH: (07) 571 2703	Regional Commander Transalpine Fire Region PO BOX 13 747 CHRISTCHURCH PH: (03) 371 3600
Regional Commander Eastern Fire Region PO BOX 4122 NAPIER PH: (06) 835 - 2114	Regional Commander Southern Fire Region PO BOX 341 DUNEDIN PH: (03) 474 - 0709	

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This publication is a revised and updated version of "Hazardous Wastes: Appropriate Technologies for New Zealand" originally included as Part 3 in *Our Waste: Our Responsibility*, published by the Centre for Advanced Engineering in 1992.

Since 1992, hazardous waste management, as an issue, has risen in prominence and become a focus of concern. A number of studies and reports have been released within the last three years alone, and the Ministry for the Environment (MfE) established a Hazardous Waste Programme (HWP) in 1997.

Updated information is provided on:

- New Zealand legislation and regulations addressing hazardous waste;
- initiatives and programmes at central and local government level involving hazardous waste;
- general treatment and disposal processes and storage considerations;
- transport issues; and
- emergencies involving hazardous waste.

The document is, thus, a resource compiling specific information related to management of hazardous waste (in New Zealand), as well as providing more general information. It aims to assist the reader to form an understanding of the special requirements and care necessary when handling or dealing with this type of waste, and the need to practice due diligence.

It is important to note that this publication describes current practices and concerns related to hazardous waste, thus providing a 'snapshot' of hazardous waste issues. The information and references presented here are intended to serve as a background to enable the reader to research their own specific needs.

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