THE UNIVERSITY OF ADELAIDE

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Master of Engineering Science Thesis

REGIONAL HAZARDOUS WASTE MANAGEMENT SYSTEMS

Stephen Moore
January 1995

Awarded 1995

STUDENT'S DECLARATION

This work contains no material which has been accepted for the award of any other degree of diploma in any university of other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give my consent to this copy of my thesis, when deposited in the University Library , being available - for loan and photocopying.

SIGNED : - DATE : 24. 1. 95

REGIONAL HAZARDOUS WASTE MANAGEMENT SYSTEMS

KEYWORDS :

hazardous waste, systems, policy, classification, databases, South Australia

ABSTRACT :

In the early 1980s it was recognised that poor management of hazardous wastes from industry was leading to significant environmental degradation, particularly contamination of unconfined aquifers. In Europe, North America and then in Australia, it was recognised that separate systems were required to properly manage hazardous waste generation, transport, treatment and disposal.

This MEngSc thesis, after reviewing developments in Australia, proposes a comprehensive system for the management of hazardous waste in an industrial region (such as a State, or an industrial region such as the Hunter Valley in NSW). This system is outlined in Part A of the report. Important components of the system described in this part include guiding principles, generation and classification, manifest procedures, waste minimisation, treatment, and treatment residue management. The importance of the manifest system, and the database of information compiled by it, in linking all components of the system together is emphasised.

Part B of the report examines in detail three aspects of the regional system which are of fundamental importance to the successful implementation of the whole system , namely; guiding principles (policy), classification systems, and hazardous waste databases. The importance of designing an unambiguous classification system so that the database based on it will be reliable is highlighted. The use of the database in assisting in the implementation, control and ongoing development of the hazardous waste system is discussed.

Part C of the report illustrates the implementation of the system described in Parts A and B by way of a case study, based on a review and recommendations for upgrading of the hazardous waste management system in South Australia.

REFERENCE :

Moore, S. J. 1994, 'Regional Hazardous Waste Management Systems', Master of Engineering Science Thesis, Department of Civil & Environmental Engineering, University of Adelaide,

SUPERVISOR :

Professor R. F. Warner, Department of Civil and Environmental Engineering, University of Adelaide

REGIONAL HAZARDOUS WASTE MANAGEMENT SYSTEMS

CONTENTS

PART C : CASE STUDY : SOUTH AUSTRALIA

LIST OF FIGURES

PART A

PART B

PART C

LIST OF TABLES

PART A

PART B

PART C

ACKNOWLEDGMENTS

The author's experience in the field of hazardous waste management was largely gained while working for Maunsell Pty Ltd, where the author was awarded a Miles Birkett Fellowship for study of international trends in solid and hazardous waste management, and was given the opportunity of working on a range of hazardous waste management studies in Australia. Particular thanks are due to Philip Fargher, Michael Worrall and Donald Macleod for their guidance, assistance and advice over nearly 10 years.

The author is grateful to the SAWMC for allowing use of the study prepared for them as a case study in this thesis., and particularly to Max Harvey for critical comment, and Geoff Sclare for extraction of data from the SA manifest database.

Part B of the thesis, in which selected topics in hazardous waste are developed was to some extent assisted by the needs of the National Waste Database project in the hazardous waste field. The National Waste Database is a project in the Waste Minimisation Program of the CRC for Waste Management and Pollution Control Ltd., which has been established and supported under the Australian Governments Cooperative Research Centres Program. The project is funded by the Commonwealth EPA and the CRC for Waste Management and Pollution Control Ltd. The Database will hopefully provide answers to some of the problems raised in Part B. The author appreciates the assistance and critical comments of Ms Shin-Yu Tu , research assistant on the project, whose contributions have been cited in the references to joint papers with the author.

The author owes a debt of gratitude to Prof Warner, whose systematic approach to problem formulation, analysis and design has provided a model for this work and now in the author's teaching in this and other subjects.

GLOSSARY OF TERMS

Basel Convention :	A United Nations convention controlling the transfrontier movement of hazardous waste, Australia is a signatory to this convention.
Composting :	The controlled biological decomposition of organic solid waste materials under aerobic conditions. Composting can be accomplished in windrows, static piles, and enclosed vessels. (Tchobanoglous, 1993)
Flux :	Rate of flow of materials across a given area in a given time, mass/unit area (regional boundary area)/unit time
Goods :	Movable property, merchandise, wares (OxfordEnglishDictionary)
Halon :	A stable chlorinated hydrocarbon used to blanket fires to prevent oxygen from maintaining combustion; an important greenhouse gas, now being phased out of use.
Kerbside recycling :	System of recycling where the generator segregates wastes according to material type and places them in containers on the kerbside for separate collection. Normally refers to Domestic Waste.
Manifest system:	A procedure with a set of documents that tracks the movement of waste from the point of generation to storage and disposal sites; enable the regulatory authority to track the movement of waste after it leaves a generators site.
Materials :	Matter from which thing is made, elements, constituent parts (OED)

MRF :	Facility for separating commingled collected recyclables into their material types.
MSW :	Municipal Solid Waste, solid non-hazardous waste arising from urban sources, including residences, commercial and industrial facilities.
Process :	Series of operations to achieve a particular end
Recycling :	Separating a given material type (eg glass) from the waste stream and processing it so that it may be used again as a useful material for products which may or may not be similar to the original. (adapted from Tchobanoglous, 1993)
Reuse :	The use of a waste material or product more than once.
Superfund	A common term for CERCLA, the legislation and program in the USA which aims to remediate contaminated land from past poor waste disposal practices.
Waste :	A material or product with a negative value to its current owner in its current location.
Waste Composition :	The component material types, by % or weight, in a waste stream.
Waste Classification :	A system to enable the unique identification of a waste stream and the composition of material types in that waste stream, so that comparable data may be collected from different regions.

Waste Designation : A legal definition embodied in legislation that prescribes a material or product as being a waste for that particular jurisdiction.

Waste Management System : An interrelated set of hardware (capital facilities) and software (regulations, economic conditions, cultural values) that determines the occurrence, transformation and ultimate fate of waste materials.

Waste Stream : The total weight of wastes arising from a particular source (either a principal or secondary source) in a particular region in a given time.

ABBREVIATIONS

AEC	Australian Environment Council (forerunner of ANZECC)
ABS	Australian Bureau of Statistics
AGSM	Australian Graduate School of Management
ANZEC	Australian New Zealand Environment Council
ANZECC	Australian New Zealand Environment & Conservation Council
ANZSIC	Australian New Zealand Standard Industrial Classification
API	American Petroleum Institute
ASIC	Australian Standard Industrial Code
BAT	Best Available Technology
BDAT	Best Demonstrated Available Technology
BOD	Biological Oxygen Demand
CEPA	Commonwealth Environment Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act, US EPA
CFR	Code of Federal Regulations (USA)
CFCs	Chlorofluorocarbons
CRCWMPC	Cooperative Research Centre for Waste Management & Pollution Control
DEP	Department of Environment & Planning
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPA	Environment Protection Authority
ESD	Ecologically Sustainable Development
EQI	Environmental Quality Index
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GIS	Geographic Information System
HCB	Hexachlorobenzene

HDPE	High Density Polyethylene
Ind. Panel	Independent Panel on Intractable Waste
IGAE	Intergovernmental Agreement on the Environment
IWIC	International Waste Identification Code
Joint Taskforce	Joint Taskforce on Intractable Waste
LDPE	Low Density Polyethylene
MRF	Materials Recovery Facility
NPI	National Pollutant Inventory
NWD	National Waste Database
OECD	Organisation for Economic Cooperation and Development
OH&S	Occupational Health & Safety
PCBs	Poly chlorinated Bi Phenyls
PET	Polyethylene Terephthalate
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act, US EPA
SWWG	Scheduled Wastes Working Group
TCLP	Toxicity Characteristic Leaching Procedure
TQM	Total Quality Management
UNCED	United Nations Conference on Environment & Development
UNEP	United Nations Environment Program
UNIDO	United Nations Industrial Development Organisation
WCED	World Commission on Environment & Development
WHO	World Health Organisation
WMA of NSW	Waste Management Authority of NSW

PREFACE

Aim and Approach

The aim of this MEngSc project report is to provide a background document and set of guidelines, for use by professionals involved in the establishment of hazardous waste management systems, in regions in which there are currently poor controls in place. The approach taken to achieve this aim has been to :

- provide a general overview of an ideal comprehensive hazardous waste management system, so that the general context of the more detailed treatment of particular topics, and the application to a case study, can be better appreciated. Part A of the report provides this overview of the total system, introduces the reader to basic concepts and attempts to highlight the inter-relationships among different system components.

- provide detailed examination of, and guidance on, some of the fundamental foundations for a good regional hazardous waste management system; including guiding principles for policy formulation, waste classification, waste tracking (manifest procedures), and databases which can monitor and guide the development and implementation of more efficient regional systems. Unless these fundamentals are in place, resources devoted to the more visible components of the management system, such as treatment and disposal facilities, are likely to be misplaced. Emphasis has therefore been placed on these "front end " components of the regional system in the aspects chosen for detailed treatment in Part B of the report.

- provide a case study, based on a review of hazardous wastes in South Australia, which illustrates how the principles outlined in Part A, and selectively developed in detail in Part B, can be applied in practice. South Australia's hazardous waste system was sufficiently developed by 1990 to enable data to be obtained and used to quantitatively describe existing practice and trends, and to identify specific areas that could be improved. The primary aim of this report is for use by environmental scientists and engineers in regions in which there are no dedicated hazardous waste systems in place; the South Australian case study illustrates that the principles can be implemented, and that periodic reviews can assist in the progress towards an ideal system.

- provide reference documents necessary for an understanding of the detailed treatment of selected topics in part B of the report. The Appendices referred to in Part C of the report consist of more readily available material from the South Australian Waste Management Commission (now absorbed into the new EPA), and have not been provided with this report. They are available from the author on request.

Background to the Preparation of this Thesis

This thesis is based on the author's professional involvement in a range of hazardous waste investigations as a consultant employed by Maunsell Pty Ltd, and as a senior lecturer in the School of Civil Engineering at the University of NSW. The investigations were substantially undertaken by the author (generally 80 - 90 % of the professional time input, with junior supporting engineers and more recently research assistants, providing assistance with data compilation and spreadsheet development under the author's supervision), and the author was the project leader in all cases. Significant among these investigations with Maunsell were :

- Hazardous Waste Incineration Study for the Melbourne and Metropolitan Board of Works (1986) which introduced the author to the field of hazardous waste management (the author was responsible for four of the five volumes of this report, with Lurgi preparing the preliminary process design volume).

- Hazardous Waste Management Review for the SAWMC (1990).

- Consultant to the Joint Taskforce on Intractable Wastes (1988 and again in 1990). The Taskforce consisted of four full time engineers and scientists who undertook most of the work in three Taskforce reports. The author prepared Appendix A10 : Hazardous Waste Classification Systems, Manifest Systems and Definition of Intractable Waste in the Preliminary Report (Phase 1), and was largely responsible (with data compilation /analysis support from an environmental scientist in Maunsell) for the report " Designation of Non-BAT (Best Available Technology) Waste Survey in NSW" to the Taskforce, which was reported in the Phase 3 Taskforce report and subsequently in a paper by Moore and Chelliah (1992).

- An audit of the capacity of off-site hazardous waste treatment facilities in Melbourne for the Victorian EPA, undertaken solely by the author.

- Project leader for the Hunter Regional Liquid Waste Treatment Plant EIS. The author supervised the estimates of waste generation for the preliminary design of the Plant, gave general direction to the preparation of the EIS and acted as an interface between the proponent (Cleanaway), the process designers (BHP Engineering), the EIS writer (a Maunsell environmental scientist) and the public (arranged by Corporate Impacts consulting to Cleanaway on these issues).

Since November 1990 the author has been a senior lecturer in the School of Civil Engineering at the University of NSW, responsible for the coordination of, and a significant part of the lecturing in , a graduate coursework masters degree in waste management, which includes a subject on hazardous waste management. The author is now project leader for the establishment of a National Waste Database, being undertaken by the CRC for Waste Management & Pollution Control for the Commonwealth EPA, and is assisted in this by two full time and one part time research assistants.

This report has been developed around the experience gained from these investigations, and from an eight week study tour in 1987 supported by a Miles Birkett fellowship provided by Maunsell. The particular influences on sections in the report, and the extent to which the author believes the work to be original contributions are outlined in the remainder of this section.

Part C is taken from the report to the South Australian Waste Management Commission (see Foreword to this part) and has been modified to a minor extent only. The report is readily available from the Commission, and the author understands that it has been reprinted a number of times. The author wrote the report, had assistance from junior engineers in Maunsell with spreadsheets and it was typed by others. Critical comment on drafts were provided by the Commission (see Acknowledgments above).

An hazardous waste management system had developed in South Australia from about 1980, and the author's work in 1989 - 90 was the first thorough review of the effectiveness of the system. The author believes that this review was the first in Australia to extract data from a manifest database for the purpose of analysing waste generation and management trends, and to use this as a basis for developing and monitoring improvements to the system. Previously (and still predominantly today) manifest databases are used by Authorities for the tracking of individual tanker loads of hazardous waste. The author's work for the South Australian Waste Management Commission, the Joint Taskforce on Intractable Waste and Cleanaway (Hunter Valley treatment plant EIS) were the first in Australia to use Australian data for the analysis of existing systems and for the prediction of waste quantities in regions in which no manifest system was in place. The Victorian EPA and their consultants introduced the method of relating production employees in different industries to predict waste generation, but this was on the basis of Canadian data in the early 1980s before Australian data was available. The Australian data on hazardous waste generation related to population was first reported by the author, and the discussion on how these two sources of information can be applied was introduced by the author.

The author believes that the introduction of an explicit systems analysis framework for the description, analysis and design of improvements (even though this was in a simple format as illustrated in Figure 1.2) to the South Australian hazardous waste system, was an original contribution. It enabled a clearer understanding of the relationships among the components, and facilitated the design and implementation of improvements.

Part A was primarily prepared for this report and as a background reading document. It has been used in the author's teaching in subjects involving hazardous waste as a background reading document. It has been included as a background reading document for a unit prepared by the author for the MBT (Master of Business and Technolgy) open learning subject on Environmental Management offered by the Graduate School of Engineering (GSE), at the University of NSW (copyright of the open learning unit is owned by the GSE, but this does not include the background reading document).

Part A provides a general overview of a preferred system for managing hazardous waste in a region. The content of this part is largely based on literature reviews of material in the various sections, but the data presented on waste generation in Australia was first developed by the Author in the SAWMC study. The author believes that the presentation of the various options for waste residue management in the framework shown in Table 1.2 to be an original contribution. The author also believes that the systems framework and the drawing together of the various components described in Part A in an Australian context to be an original contribution (the exception to this could be the Industrial Waste Strategy prepared by the Victorian EPA (Vic.EPA, 1985) although the author believes the approach to be somewhat different and with less emphasis on the use of the manifest database as a controlling instrument).

Part B consists of three chapters with :

- **Chapter 1** being prepared for this thesis. The author would like to obtain some critical reviews from colleagues and to use it as a discussion paper in the anticipated follow up work foreshadowed in the Precautionary Principle conference. No commitments in this regard have yet been made. The chapter is based on a literature review of emerging environmental management policies and guidelines, mostly pertaining to Ecologically Sustainable

Development. The author believes that the application of the emerging principles to the field of hazardous waste management as presented in Section 1.3 and 1.4 to be original contributions.

- Chapter 2 and 3 have been developed from lecture overheads prepared by the author for teaching in a graduate subject on hazardous waste management. The chapters go to greater depth than is covered in class.

  Chapter 2 on hazardous waste classification has been used as a submission (written by the author) to an ANZECC working group developing new guidelines for a national hazardous waste classification and manifest system, and the final part of Chapter 2 refers to a draft from this working group. Parts of Chapter 2 (excluding reference to the developing Australian system which is still in draft form) have been included as a chapter in a book prepared for a short course by the Soils Society (Moore & Tu, 1993). Shin-Yu Tu is a research assistant on the National Waste Database project providing support on the hazardous waste data compilation and analysis aspects.

  Chapter 2 is based on a literature review of Australian and overseas approaches to hazardous waste classification, but the author believes the critique and application of these international approaches to the Australian system to be an original contribution.

  Chapter 3 was written for this thesis. Section 3.2.2 was taken from the submission to the ANZECC working group, the tables and diagrams have been taken from various reports and papers written by th author, and Section 3.5 has been taken from part of a paper written by the author (Moore & Tu, 1993a) in which the data and tables were prepared by Shin-Yu Tu. The other parts of the chapter have not been used for other purposes. The chapter has been based on reviews of manifest systems and the databases arising from them in Australia (largely by discussions with Waste Authorities) and the use of employee based models to predict hazardous waste has been reported in the literature (Monahan, 1989). The author believes that original contributions have been made in the following areas in this chapter :

- the extraction of data from waste manifest databases for the purpose of reviewing trends, to develop modifications to the management system, and to present population and employee based waste generation factors based on Australian experience (the author wrote a specification for staff in the SAWMC and the WMA of NSW to extract this data from their databases).
- the critique of the proposal for a national manifest system, with suggestions for improvements,
- the succinct formulation of the employee based model by Equation (2) has not been seen by the author in the literature.
- the use of production employees sampled as a ratio of total employees in the region, to scale up questionnaire survey results has not been seen by the author in the literature.
- the suggested hazardous waste indices derived from a national hazardous waste database are believed to be original, at least in the Australian context. The proposal for a national waste database was developed by the author and Bert van den Broek from the then WMA of NSW. The author was responsible for the hazardous waste component, and both were responsible for the solid waste component (municipal refuse) of the proposal which is now being undertaken with the author as project leader.

Future Development of the Topic

Provided it does not infringe any copyright or other rules of the University of Adelaide, the author intends to build of the work presented in this report in two ways :

1. To develop additional chapters in Part B to include separate chapters on those components of an hazardous waste management system not yet covered in detail, namely; waste minimisation/clean production, integrated off-site treatment, and residue management. It is intended that this would then provide a comprehensive set of

background readings for graduate and undergraduate students taking subjects involving hazardous waste management.

2 Hazardous waste management is an important part of the emerging field of clean production and the broader field of environmental management systems for industrial complexes and regions. This report identifies some areas where hazardous waste management interfaces with these broader environmental management issues. The author views the field of environmental management systems as being in a similar stage of development to Environmental Impact Assessment when legislation was introduced in the mid 1970s, namely broad general concepts without the tools and procedures to enable the concepts to be implemented in a manner that matched the ideals of the concepts. In PhD studies, the author intends to :

- Develop a framework for an Environmental Management System that can be applied by industry and government to achieve ESD in an industrial region.

- Develop tools to facilitate implementation of the Environmental Mangement System in a region.

PART A

INTRODUCTION & OVERVIEW OF HAZARDOUS WASTE MANAGEMENT SYSTEMS

1 INTRODUCTION TO HAZARDOUS WASTE MANAGEMENT

1.1 Introduction

1.1.1 Scope

This introductory chapter, Part A of the report, provides an overview of the management of hazardous wastes, with particular reference to Australian conditions. After providing a generalised definition of hazardous wastes, the system that has been developed to manage them in Australia is outlined. General conclusions are then made on the current status of hazardous waste management in Australia, and probable future trends are discussed.

The main body of the report in Part B provides a more detailed treatment of selected major components of a regional hazardous waste management system. A critical analysis of existing general practice is provided. Part C of the report illustrates the application of the principles detailed in

Part A and Part B to the State of South Australia as a case study. Supporting documentation in the form of legislation, guidelines etc is provided in the Appendices.

1.1.2 Roles and Responsibilities of Various Organisations in the Management of Hazardous Waste

In addition to Regulatory bodies at the Commonwealth, State and Local Government levels, there have been a series of ad-hoc taskforces formed through-out the 1980s to the current day, to address specific issues related to hazardous waste. The issues associated with intractable waste (a sub-set of hazardous waste) have received particular attention. A series of reports have been produced and are referred to extensively throughout this report, especially those to which the author was a contributor. The roles of these groups are outlined below in the hope that confusion between them will be minimised.

Following the release of the 1983 AEC report (Maunsell, 1983) on the Management and Disposal of Hazardous Industrial Waste in Australia, in which a major recommendation was to establish a high temperature incinerator, a number of State government organisations and one private company attempted to establish a National High Temperature Incinerator. All these individual attempts failed, and in 1987 the first of a series of joint inter-governmental taskforces was formed. In chronological order of formation these were :

- September 1987 : Joint Taskforce on Intractable Waste (often shortened to "Joint Taskforce"), composed of four independent members and reporting to the Ministers for the Environment in Victoria, NSW and the Commonwealth. It produced three major reports, with the Phase 3 report being published in September 1990.

- January 1991 : Independent Panel on Intractable Waste (shortened to "Independent Panel"), composed of four independent members, again reporting to the governments of Victoria, NSW and the Commonwealth. Their brief was to review the recommendations of the

Joint Taskforce and to oversee the EIS for a preferred management method for intractable waste. Their final report was submitted in November 1992. The recommendations in this report were essentially to stockpile intractable wastes (henceforth to be called "Scheduled Wastes") until alternative , non - incineration, treatment technologies could be demonstrated to be effective.

- December 1992 : The Scheduled Wastes Working Group (SWWG) was formed to coordinate and oversee the implementation of the Independent Panel's recommendations. This Group is composed of EPA representatives from NSW, Victoria and the Commonwealth, and representatives from trade union and community based organisations. It is currently active and is likely to have a life of up to a decade.

These organisations will be referred to by their abbreviated names throughout this report.

1.2 What Are Hazardous Wastes?

1.2.1 Background

Concern over the management of hazardous wastes first arose in the 1970s when it was discovered that drinking water supplies drawn from unconfined aquifers, largely in North America, were being contaminated by uncontrolled dumping of industrial wastes in landfills and impoundments. How was this situation allowed to develop?

Increasingly stringent air and surface water discharge standards developed in the 1960s led to the introduction of improved air pollution and water pollution control technology in industry. These treatment plants removed contaminants from emissions to the atmosphere and surface waters (either via the sewerage system or by direct means) and concentrated them in sludges and dusts. These residues were then dumped in solid waste landfills or surface impoundments, either on the site of the generator or, more often, at offsite facilities. These facilities had little control on the nature of residues being accepted and provided little security against leakage to groundwaters. As a result, leachate from these facilities migrated to groundwater and eventually appeared in wells extracting water for town supplies.

Two responses occurred as a result of the discovery of the environmental impacts of the uncontrolled disposal of industrial wastes:

- Programs to clean up contamination from past activities, such as the Superfund program in the USA.

- Development of comprehensive systems to properly manage industrial wastes so that the ongoing generation of wastes would not continue to degrade environments, particularly groundwaters.

This chapter is primarily concerned with the development of comprehensive management systems. However, there are overlaps with contaminated site remediation and these will be briefly discussed. Contaminated site remediation has developed into a field in its own right because of the often complex mixtures of contaminants that arose from the uncontrolled disposal of wastes.

1.2.2 General Definitions of Hazardous Waste

Exclusionary Definitions

In general terms, hazardous wastes can be defined on an exclusionary basis i.e. they are wastes which are excluded from being disposed of to conventional waste management systems of:

- Municipal solid waste landfills, and

- Sewerage systems.

These conventional systems often have discharge acceptance criteria (trade waste discharge criteria for sewers, and lists of excluded wastes for municipal solid waste landfills) and hence any wastes which are not allowed to be disposed by these routes become, by this definition, hazardous wastes. In some countries (Canada, U.K.), these wastes are known as 'Special Wastes', which avoids the problem of whether they are actually hazardous or not.

While the exclusionary basis is logically comprehensive, it is a difficult means for Regulators to employ in controlling the generation and fate of hazardous wastes. While this exclusionary definition was used in the U.K. for a time, it is not now generally used in practice. It remains, however, a useful concept to aid in the appreciation of where hazardous wastes fit in the overall picture of waste management.

Inclusionary Definitions

Inclusionary definitions seek to define hazardous wastes by providing criteria or an inclusionary list which, if wastes satisfy these, designates them as hazardous wastes. There are three types of inclusionary definitions:

- Generic definitions
- Constituent definitions
- Characteristic's definitions

Most Regulatory agencies in Australia use a combination of the first two, the US EPA and the Basel Convention (CFR40 and UNEP, respectively) use a combination of all three. The draft proposal for designation of non-BAT wastes in N.S.W. uses a combination of all three along the lines of the Basel Convention (Joint Taskforce on Intractable Wastes, Phase 3 report, 1990).

Generic definitions are based on a description of the process from which the waste arises; for instance, sludge from the bottom of oil storage tanks, distillation bottoms from solvent recovery plants.

Constituent definitions designate wastes as hazardous if they contain measurable concentrations of certain hazardous compounds; for instance, wastes which contain arsenic, or chlorinated solvents, or lead. In Australia the concentration or mass load of a constituent is not often employed in the definition - whether or not the concentration of a constituent is of concern is left to the judgement of the Regulator. North American and European practice is to include the concentration and mass of the constituent that makes the waste hazardous. The inclusion of concentrations and mass of constituents is now being employed in the N.S.W. Chemical Control Orders for chemical wastes and the definition of intractable waste (see discussion below).

Wastes can also be designated as hazardous if they exhibit one or more of the following **hazardous characteristics:**

- Toxicity
- Flammability
- Reactivity
- Corrosivity.

The tests for determining each of these characteristics are not yet fully developed. Tests for toxicity characteristics are subject to the greatest debate (Francis et al, 1989). The test gaining acceptance in Australia is the US EPA Toxicity Characteristic Leaching Procedure (TCLP), which designates a waste as hazardous if the leachate from the waste has concentrations of toxic constituents greater than 100 times that allowed in drinking water.

While most inclusionary definitions are simple lists with a combination of the above three approaches, (e.g., the Scheduled Wastes Definition) the latest definitions developed for the Basel Convention and the non-BAT waste designation (Joint Taskforce on Intractable Waste, Phase 3 report, 1990) follow a more rigorous rationale; namely:

a waste is designated as a non-BAT hazardous waste if it is contained in a generic list of wastes, or contains one or more constituents of concern at concentrations and mass above threshold levels, and the generator has failed to demonstrate that the waste does not exhibit any of the four hazardous characteristics.

This designation allows the generator to *de-List* his waste by demonstrating that it does not exhibit, according to standard agreed tests, any hazardous characteristics. Dilution of constituents to achieve this state is not allowed. However, there are practical difficulties which would mean that few generators would attempt to de-List their wastes.

1.2.3 Broad Categories within Hazardous Wastes

The Australian understanding of hazardous wastes generally follows counterpart definitions of hazardous or special wastes in other OECD countries. Australian waste management and environmental authorities have, however, developed two categories within hazardous wastes which are not used overseas, and which have arisen because of the particular characteristics of the Australian waste management system. The terms *non-BAT wastes* and *intractable wastes* and their relationship to hazardous wastes are illustrated in Figure 1.1. - they are both sub-sets of hazardous wastes, and intractable wastes are a subset of non-BAT wastes. The term "scheduled wastes" now replaces intractable wastes and "non - BAT" wastes are currently not identified as a separate category of hazardous wastes.

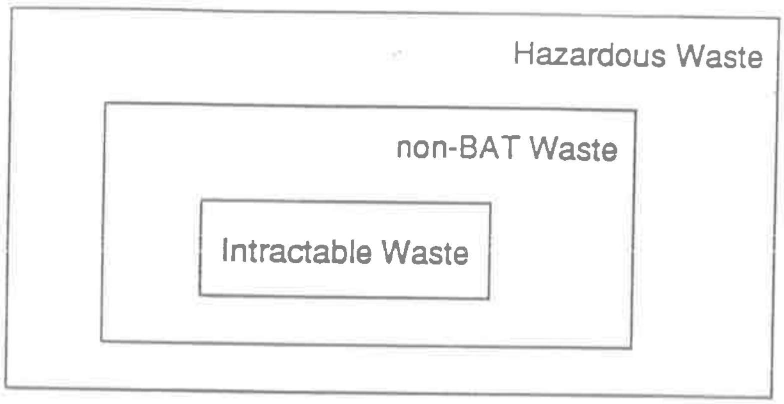


Figure 1.1 : Relationship among Intractable, non-BAT and Hazardous Waste

A Plating and Heat Treatment

	Classification	Category Number
Discarded plating wastes	Poisonous	01
Discarded heat treatment wastes	Poisonous	02
Complexed cyanides	Poisonous	03
Other cyanide wastes	Poisonous	04

B Acids

	Classification	Category Number
Sulphuric acid	Corrosive	05
Hydrochloric acid	Corrosive	06
Nitric acid	Corrosive	07
Phosphoric acid	Corrosive	08
Chromic acid	Corrosive	09
Hydrofluoric acid	Corrosive	10
Sulphuric hydrochloric acid mixtures	Corrosive	11
Other mixed acids	Corrosive	12
Organic acids	Corrosive	13

C Alkalis

	Classification	Category Number
Caustic Soda, Potash, Alkaline Cleaners, Ammonium Hydroxide	Corrosive	14
Lime Slurries, Cement Slurries (not containing metal sludges)	Pollutant	15
Neutralised metal wastes	Poisonous	16
Other alkaline wastes	Corrosive	17

D Inorganic Chemicals

	Classification	Category Number
Non toxic salts (eg sodium calcium chloride)	Pollutant	18
Arsenic and arsenic compounds	Poisonous	19
Boron compounds	Poisonous	20
Cadmium and cadmium compounds	Poisonous	21
Chromium and chromium compounds	Poisonous	22
Lead compounds	Poisonous	23
Mercury and mercuric compounds, mercury containing equipment	Poisonous	24
Other inorganic salts and complexes (including Zn, Fe, Ni etc)	Poisonous	25

E. Reactive Chemicals

	Classification	Category Number
Oxidising agents (eg peroxides)	Oxidising agent	26
Reducing agents	Poisonous	27
Explosives and unstable chemicals	Explosive	28
Water reactive chemicals	Dangerous when wet	29

F. Paints, Resins, Inks, Dyes, Adhesives, Organic sludges

	Classification	Category Number
Aqueous based (non combustible/non-flammable vapours)	Poisonous/Pollutant	30
Solvent based FP > 61 °C	Flammable/Poisonous	31
Aqueous based containing solvents	Flammable/Poisonous	32
Solvent based FP < 61 °C	Flammable/Poisonous	33
Residues	Flammable/Poisonous	34
Others		35

G. Organic Solvents

	Classification	Category Number
Non halogenated FP > 61 °C	Flammable	36
Non halogenated FP < 61 °C	Flammable	37
Halogenated FP > 61 °C	Flammable/Poisonous	38
Halogenated FP < 61 °C	Flammable/Poisonous	39
Halogenated (non-combustible/non-flammable vapours)	Poisonous	40
Organic solvent/water mixtures	Flammable/Poisonous	41

H. Pesticides

	Classification	Category Number
Inorganic, organo-metallic pesticides	Flammable/Poisonous	42
Organo phosphorous	Flammable/Poisonous	43
Nitrogen containing pesticides	Flammable/Poisonous	44
Halogen containing pesticides	Flammable/Poisonous	45
Sulphur containing pesticides	Flammable/Poisonous	46
Biological pesticides	Poisonous	47

J. Waste Oil

	Classification	Category Number
Contaminated oils (lubricating, hydraulic)	Pollutant	48
Oil/water mixtures (mainly water, eg cutting oils, soluble oils etc)	Pollutant	49
Water/oil sludge (high sludge content)	Pollutant	50

K. Textile

	Classification	Category Number
Tannery wastes	Poisonous/Pollutant	51
Wool scouring wastes	Pollutant	52
Textile washwaters	Pollutant	53

L. Putrescible/Organic Wastes

	Classification	Category Number
Animal effluent and residues (abbatoir wastes)	Pollutant	54
Grease trap waste — domestic	Pollutant	55
Grease trap waste — industrial	Pollutant	56
Bacterial sludge (septic tank)	Pollutant/Infectious	57
Vegetable oils and tallow derivatives	Pollutant	58
Vegetable waste — sludges	Pollutant	59
Animal oils	Pollutant	60

M. Washwaters

	Classification	Category Number
Truck, machinery washwaters with or without detergents	Poisonous	61
Other industrial washwaters	Poisonous	62

N. Inert Wastes

	Classification	Category Number
Inert sludges/slurries eg clay ceramic suspensions	Pollutant	63

P. Organic Chemicals

	Classification	Category Number
Non-halogenated hydrocarbons (non-solvent)	Flammable/Poisonous	64
Bituminous materials and tars	Flammable	65
Highly odorous	Flammable/Poisonous	66
Pharmaceuticals and residues	Poisonous	67
Surfactants and detergents	Pollutant	68
Polychlorinated, halogenated organics (non-solvent)	Poisonous	69
Other		70

Q. Bags, Containers

	Classification	Category Number
Containers and bags which have contained hazardous substances (hazardous substance to be specified)	Poisonous	71

R. Immobilised Wastes, Inert Wastes

	Classification	Category Number
Encapsulated Wastes	Pollutant	72
Chemically fixed wastes	Pollutant	73
Solidified or polymerised wastes	Pollutant	74
Inert solids (Asbestos, etc)	Poisonous	75

S. Miscellaneous

	Classification	Category Number
Contaminated soils (must specify contaminant, eg cyanide, PCB, etc)	Poisonous	76
Clinical and related wastes	Infectious	77
Other, eg bulky demolition		78
Inorganic dusty wastes		79
Organic dusty wastes		80
Security & Customs		81
Synthetic Mineral Fibres		82
Clinical & Related (diverted WWI)		83
Quarantine waste (diverted WWI)		84

Table 1.1 : AEC Classification System

(Source : WMA of NSW)

Non-BAT wastes (non-Best Available Technology wastes) are those hazardous wastes currently being treated and disposed of by other than Best Available Technology. They are largely hazardous organic wastes being disposed of to landfill and for which Best Available Technology would be incineration or equally acceptable technology. In most cases the hazardous characteristics of these wastes are such that Authorities are allowing land disposal to continue pending the availability of incineration treatment capacity. However, more stringent requirements are placed on a sub-set of non-BAT wastes, the so called *scheduled wastes*.

Scheduled wastes are hazardous wastes for which there is no currently available treatment capacity available in Australia, and whose toxic characteristics are of such concern that interim disposal to landfill is prohibited. The only management options for scheduled wastes are secure storage pending the commissioning of the national high temperature incinerator or shipment to approved high temperature incineration in the U.K. Examples of scheduled wastes include PCBs, DDT and other organochlorine pesticides, HCB residues from plastics manufacture, and, more recently, CFCs.

1.2.4 Hazardous Waste Classification Systems

The discussion above has outlined how hazardous wastes are defined or designated, i.e. a means whereby the wastes so identified can legally be required to be controlled by the hazardous waste management system. A separate concept is that of classification systems which are used to categorise hazardous wastes to facilitate data collection and their management. Classification systems tend to be coarser than designations and are easier to apply in practice.

In summary, designation methods determine whether or not a waste is hazardous; once it is determined to be hazardous, the hazardous waste classification system tends to be used to identify the waste, collect statistics on its occurrence, and to track its movement.

The preferred classification system is that developed by the Australian Environment Council (now the Australian and New Zealand Environment and Conservation Council, ANZECC), as shown in Table 1.1. It has now been adopted in South Australia, Victoria and in Sydney by the former Waste Management Authority of N.S.W. and the new EPA. A draft report indicates that Tasmania is also likely to adopt the AEC standard (Tasmanian DEP, 1991). Brisbane and Western Australia have simplified versions which can be converted to the AEC system if required.

Currently (February 1994), ANZECC are revising the 1986 version of the Hazardous Waste Classification system as part of the process of introducing a National Manifest system into Australia in 1994. The revised system is based on the 1986 version, with some additional entries and the introduction of a more flexible code numbering system. A detailed discussion of this new system is provided in Part B of this report.

1.3 Hazardous Waste Management Systems

The system which has evolved to manage hazardous wastes is illustrated in Figure 1.2. Its structure will be described in this section and salient features of each functional element will be described in the remainder of this chapter. The functional elements are:

- Guiding Principles
- Waste Designation & Classification systems, enabling the generation of hazardous waste to be licensed and monitored
- Waste Minimisation programs
- Waste Transfer and Transport
- Offsite Treatment Facilities

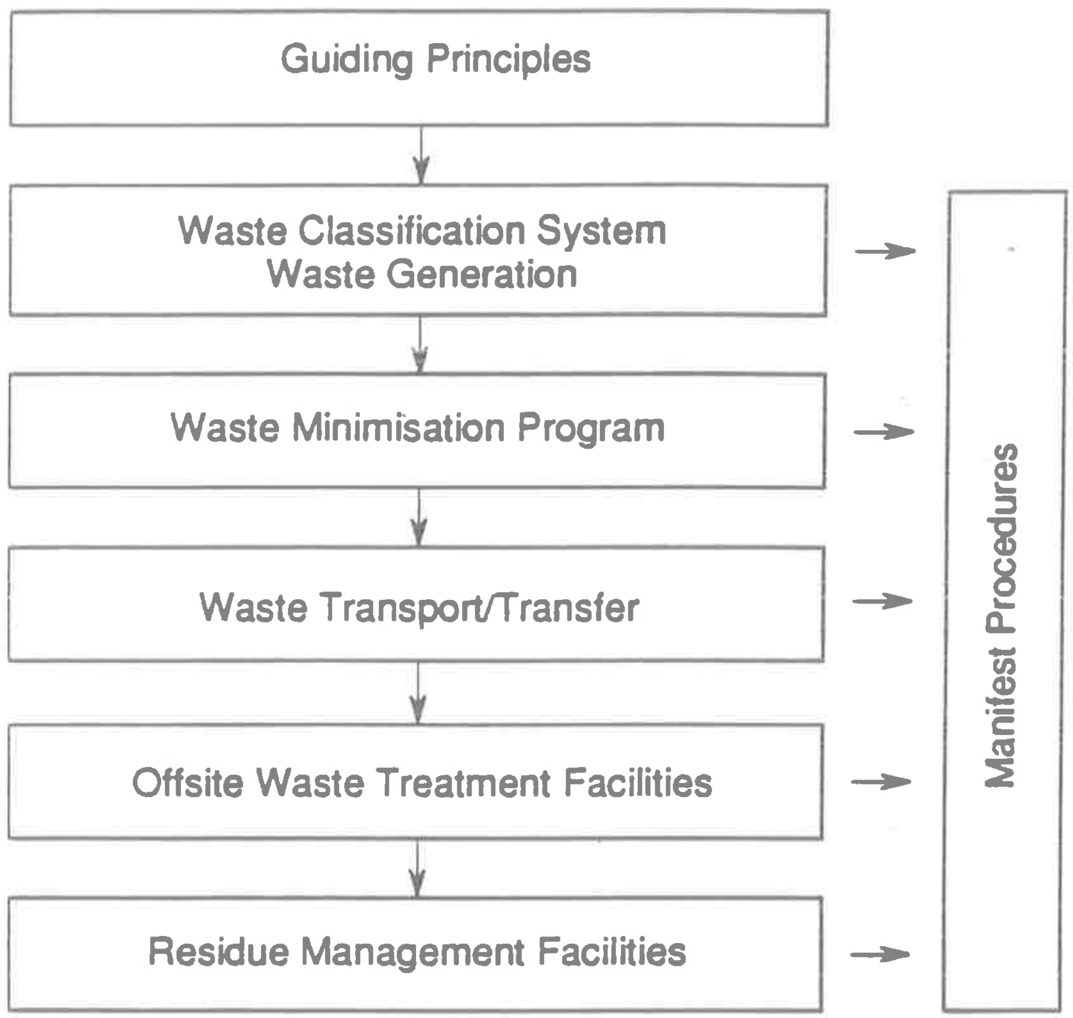


Figure 1.2 : Hazardous Waste Management System

(Source : Moore et al, 1991)

- Residue Management Facilities

- Manifest Procedures

Guiding principles or policy statements provide the unifying direction for the development of procedures and facilities in each of the functional elements. The primary guiding principle is the *preferred hierarchy of waste management*, whereby wastes are minimised if possible, or treated before final landfill disposal, where they do arise.

Waste designation and classification systems are required to differentiate hazardous wastes from other types of waste (such as sewage, municipal solid waste etc.) so that generators of these wastes can be licensed and the fate of the wastes can be controlled by the manifest procedures.
Waste minimisation programs will consist of incentives and penalties at both the regional and individual industry level to enable real progress to be made towards the guiding principle of the preferred hierarchy of waste management. Successful waste minimisation programs reduce the reliance on treatment and disposal facilities and minimise potential long term environmental liabilities associated with waste disposal.

Waste that cannot be minimised, treated and disposed of at the site of the generator must be transported by a regulated transport system, that may include transfer stations to achieve transport economies.

Offsite treatment facilities provide centralised, integrated regional treatment capacity for those wastes which cannot be treated by generators at the site where they arise.

Residue management facilities are required to dispose of the solid residues arising from on-site and off-site treatment plants. Liquid effluents are generally treated to a level where they can be reused, be disposed to sewer, or be disposed by evaporation to the atmosphere.

Manifest procedures involve a system of documents which follow the waste from the point of generation to the final disposal location, and provide a record that the requirements of each functional element have been complied with. The manifest procedure is the thread that ties the functional elements together under the direction of the Guiding Principles.

This system has evolved in Australia over the past decade. Prior to the 1980s the only functional elements in place were those of poorly controlled transport and residue disposal. Other functional elements gradually evolved, usually in a series of improvements and not with the benefit of the fully articulated system outlined in this section. Off-site treatment facilities were developed, then classification systems and manifest procedures, then guiding principles and minimisation programs; off-site treatment plants were then improved, designation documents made more sophisticated, and penalties for failing to comply with manifest procedures increased.

Hence the development of the hazardous waste management system has not been the result of implementation of a considered solution to a problem - it has evolved in a series of stages over a decade. This evolution is not complete, as there are deficiencies and associated needs for developments in most of the functional elements. However, the system as it now stands (where it is implemented) is a great improvement on that which existed a decade ago. It is developed to an extent that regions in Australia which do not have fully implemented hazardous waste systems should be able to establish them in a much shorter period than a decade. This will require implementation of the system in a rational order as indicated by the arrows in Figure 1.2. - a procedure apparently not being followed in some regions that are currently in the process of implementing a hazardous waste management system.

1.4 Guiding Principles

Principles which have been developed to guide the development of systems to manage hazardous waste include:

- adoption of the preferred hierarchy of waste management;
- adoption of a multi-media approach in setting emission standards for various contaminants to the environment;
- adoption of policies in relation to the effects of hazardous waste treatment and disposal on ozone depletion and the greenhouse effect;
- adoption of the polluter pays principle.

These principles are described in detail in the remainder of this section. While most of them appear obvious, there are no regions in Australia which have hazardous waste management systems which are wholly consistent with these principles.

1.4.1 Preferred Hierarchy of Waste Management

Adoption of the preferred hierarchy of waste management requires that incentives and penalties are in place to force the use of the following practices in order of decreasing priority:

- waste avoidance or elimination
- waste minimisation or reduction
- waste recycling and reuse
- waste treatment, to convert wastes to non-hazardous residues
- landfill disposal of these non-hazardous residues

The first three practices are collectively called waste minimisation. This principle has formally been adopted in Victoria (Victorian EPA, 1985) and N.S.W. (WMA of N.S.W., 1990), and by the Commonwealth (CEPA, 1992).

1.4.2 Multi-media Approach to Emission Standard Setting

To date, in most countries, emission standards have been set for one environmental media, such as the atmosphere, without full examination of the implications for the impact on other environmental media, such as waters and soils. There is a need to coordinate the setting of standards for all environmental media so that the best overall environmental protection is achieved. Similarly, the introduction of technology to control emission of contaminants to one medium (e.g. baghouses for heavy metal contaminated dusts) needs to consider the impact on other media and to provide a comprehensive system for management of these contaminants so that the mere transfer from one medium to another (e.g. soil, waterbodies) is avoided.

There are two approaches which can be employed in this regard:

- Consider the impact on other environmental media when setting emission standards, and modify standards for other media as appropriate, through a more integrated approach to licensing and control.

- Establish regulations for the control of individual chemicals, having regard for their fate when released to the environment and their impacts when contained in various media. This is a rational, but complex and expensive exercise and to date has only been undertaken for a small number of chemicals in some countries (e.g. dioxin, PCBs in Ontario, Canada). The former SPCC of N.S.W. (now the EPA) has adopted this approach for certain chemicals through *Chemical Control Orders* under the Environmentally Hazardous Chemicals Act, 1985. This Act takes precedence over the control of these chemicals by other legislation. To date aluminium smelter wastes, dioxin contaminated waste, asbestos wastes, organochlorine pesticide wastes, organotin wastes and PCBs have Chemical Control Orders regulating their management.

Recent work undertaken by the Joint Taskforce on Intractable Waste (Joint Taskforce, Phase 3 report, 1990) and discussion papers on the formation of the proposed EPA in N.S.W. indicate that it is possible that integrated site-based licences may supersede the current practice of separate issue of air, water and land based emission licences.

1.4.3 Ozone Depletion and Greenhouse Effect

The control of CFCs and halons needs to include guidelines for the disposal of CFCs currently in use. The Joint Taskforce on Intractable Waste has included CFCs and halons in their designation of intractable wastes and it was intended that these materials in N.S.W. and Victoria be disposed of by high temperature incineration.

The development of detailed policy for the control of the greenhouse gases methane and carbon dioxide, should include controls on these gases arising from hazardous (and solid) waste treatment and disposal. For instance, the following measures should be considered:

- Methane arising from anaerobic decomposition of organic wastes should be:
  - collected and be utilised for energy production where the generation exceeds a certain level;
  - collected and flared to produce CO_2 where the generation rate is at a lower level;
  - allowed to disperse to the atmosphere where the generation rate is small.

- Incineration of waste organics should have energy recovery and utilisation where the rate of CO_2 production exceeds a certain level.

1.4.4 Polluter Pays Principle

While this principle is often cited as being the policy for a particular region, examination of the practice often shows that it is not being implemented. *Polluter Pays* requires the waste generator to pay the full cost of treating and disposing of his waste. There are often subsidies inherent in current waste management costs in Australia because:

- there is little differentiation in costing different types of waste. Until recently it was common to see all liquid aqueous based wastes charged the same rate for disposal, and in many cases this cost was less than would be required for Best Available Treatment of that waste. This meant that the more toxic and difficult to treat wastes were being subsidised by other waste types or, the full cost was being externalised by leading to a decline in environmental quality. The cost of redressing this decline in environmental quality being externalised to future generations. This was largely the situation prior to the mid-1980s, and it is only since 1990 that differential charging for treatment based on toxicity and difficulty of treatment has become more widespread.

- the cost of landfill disposal of solid residues is too low. There are few secure landfills, by world standards, available and even the more secure landfills tend to charge at rates which are much lower than the replacement cost of the landfill.

If the polluter pays principle is to be adopted, there is a need to calculate the full cost of treating each waste type and to impose that full cost on the generator. This will avoid undesirable externalisation of this cost and provide a greater incentive to minimise waste generation. The Bureau of Industry Economics is now undertaking an investigation to assess the full costs of landfill disposal, and has released a preliminary findings report (BIE, 1993)

1.5 Generation and Classification of Hazardous Wastes

1.5.1 Manifest Record Methods

The topic of designation and classification of hazardous wastes has been covered above. Once a designation has been agreed to and included in Regulations, generators of hazardous waste can be licensed and monitoring of hazardous waste types and quantities can be commenced. This is normally undertaken through analysis of manifest records, using the classification system as the basis for the various types of waste. This is fundamental to the design of a comprehensive management system.

Provided the manifest procedures are adhered to, analysis of its database is the best method to determine the quantities of various types of hazardous waste being generated in a region. Difficulties can arise if:

- poor training is provided to the people responsible for completing the manifest forms, resulting in incorrect classification of hazardous waste types;

- the procedures are avoided. A series of media exposés on illegal hazardous waste dumping lead to a 50% increase in the quantity of hazardous waste being tracked by the manifest procedures in Sydney in mid 1990. It is very unlikely that this was caused by a real increase in the generation of hazardous waste.

The above difficulties point to an important concept: the hazardous waste management system is only (can only be) interested in those wastes caught in the manifest procedure net. The system cannot deal with illegally collected and disposed of hazardous wastes - if the Regulatory system has failed to identify and catch them in the manifest procedural net, then they are of little interest to the normal operation of the system; by definition, they will not be known. However, this does not mean that no allowance should be made for them. Illegally disposed of hazardous waste, to sewers, stormwater or the land, can give rise to large quantities of what will be, on detection, hazardous waste.

1.5.2 Other Methods

If a manifest system has not been operating in a region where a hazardous waste management system is proposed, then alternative means of determining waste arisings are required. These methods include:

- simple models relating hazardous waste generation to population;

- more complex models relating hazardous waste generation to the industrial profile of a region. This profile is usually quantified by examining the number of production employees in various industry types and relating this to generation of various waste types.

- surveys of major waste generators and scaling up from samples by statistical means. This final method, while commonly employed, does not often yield reliable results because of the usually poor data on wastes held by generators in a region where no manifest procedures exist.

Limited experience in Australia indicates that the models based on industrial profiles of a region are reasonable predictors where a sufficiently large region is examined (Joint Taskforce, Phase 3 report, 1990).

1.5.3 Typical Quantities of Hazardous Waste

Examination of manifest data and predictions from models show the following typical hazardous waste generation rates in Australia:

- Sydney, Melbourne : 100 ML/yr
- Adelaide : 40-50 ML/yr
- Hunter Region : 30-40 ML/yr.

In terms of volume, major types of liquid hazardous wastes are:

- acids
- alkalis
- organic sludges
- oily wastes
- putrescible organic sludges (grease traps)

This is illustrated in Figure 1.3, which has normalised the generation of hazardous waste in Australian cities to that arising from an equivalent 1 million people in each city.

1.6 Manifest Procedures

Figure 1.4 illustrates the operation of the manifest form for tracking the life of hazardous wastes from *cradle to grave* - the point of generation to the final treatment and disposal facility.
The manifest form consists of four parts:

- Part A, and Part D : completed by the waste generator
- Part B : completed by the collection vehicle driver
- Part C : completed by the treatment and disposal facility, with the fully completed form sent to the Waste Authority

Each party retains a carbon copy for their records. The Waste Authority compares the completed Parts A, B, and C with the initial part D to ensure that the waste has been appropriately managed. If

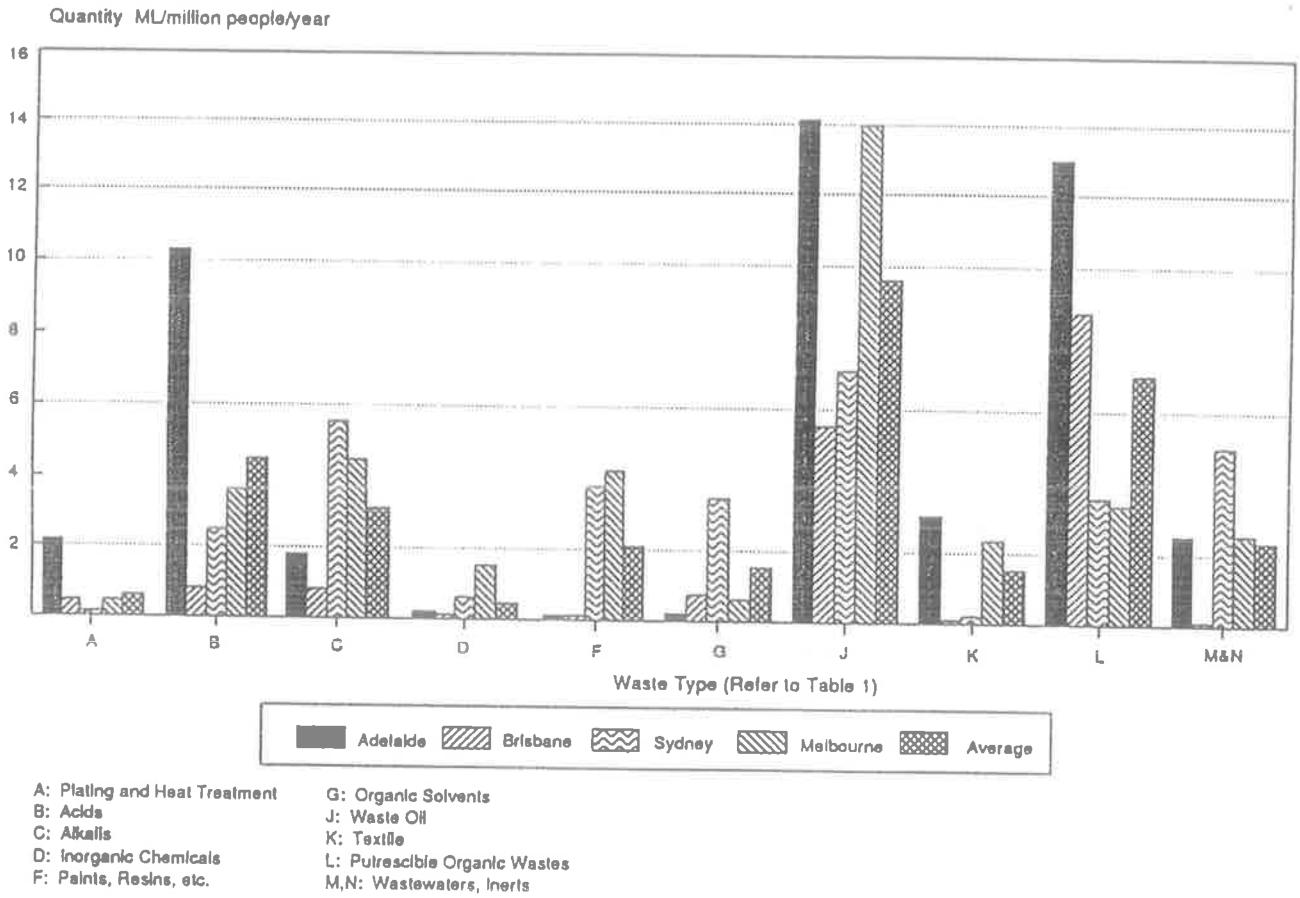


Figure 1.3 : Comparison of Hazardous Waste Generation in Australian Cities

(Source : Joint Taskforce on Intractable Waste, 1990, prepared by the author)

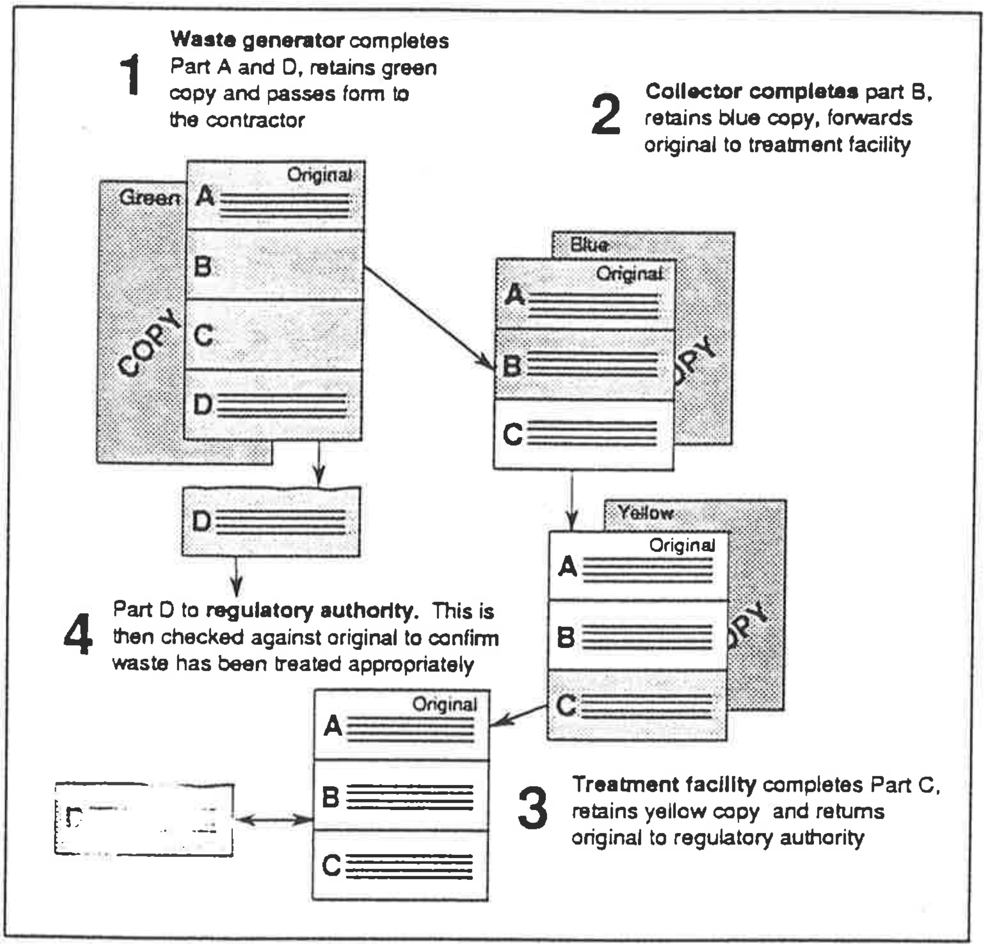


Figure 1.4 : Manifest Form Operation

(Source : Maunsell, 1991)Figure 1.5 : AEC Manifest Form Guideline

Parts A, B and C do not reach the Waste Authority, then an "alarm" is raised and investigations instituted to determine the fate of the load of waste.

Information supplied on the manifest form is outlined in Figure 1.5. This information is recorded in a computer database, such as dBase III or IV, and a variety of summaries of this data can be obtained. In particular it can be used to calibrate the unit production models used to predict hazardous waste generation in regions which do not yet have manifest systems.

The major potential point of weakness in the manifest procedure is the initial completion of Part A and D of the form. If the generator fails to become licensed, or fails to appreciate that one of his waste streams is hazardous, then the chain will not commence and the tracking procedure can be avoided. Adequate resources in the Waste Authority are required to establish the licensing and manifest procedure, and then to train generators in its use.

1.7 Waste Minimisation

1.7.1 Definition

As outlined in the section on - Guiding Principles, waste minimisation is a generic term encompassing:

- Waste elimination or avoidance
- Waste reduction or minimisation
- Waste reuse and recycling

Waste minimisation is the preferred method of managing wastes to achieve the broader

Australian Manifest for Movement of Hazardous Wastes

NAME AND ADDRESS OF WASTE AUTHORITY IN STATE / TERRITORY WHERE WASTE IS GENERATED / STORED

GENERATOR / STORER

1 Name of Generator / Storer
Business Address ....
....
Phone No: Business Hours ....After Hours ....

2 Generator's / Storer's Licence No. (if applicable)

3 Location where waste generated

4 Storage site prior to transport

5 Date of proposed transport

6 Transporter (Name) ....
(Address) ....
....

7 Name of Disposer / Storer to receive consignment ....
Disposal / Storage site address ....

8 Description of Waste

9 Additional description of waste

10 Coded Waste Description	LIST 1	LIST 2	LIST 3	LIST 4	LIST 5

11 Quantity
..............................(m³) / (kg)

12 UN Packaging No.
....

13 Generator's / Storer's Safety and Handling Instructions for Waste

14 Packaging method

15 I declare that the above waste is accurately described and is in a proper condition for transport in accordance with the Australian Dangerous Goods Code.
Name .... Signature ....
Date ....

TRANS-PORTER

16 I acknowledge the receipt of the waste consignment described above.
Name .... Signature ....
Date ....

DISPOSER / STORER

17 I declare that the waste consignment described above has been received.
Name .... Signature .... Date ....
Date of disposal .... Method of disposal (see List 5) ....
Disposers Licence No ....

18 Specify any discrepancy between waste described and waste received.
Name Storer / Disposer .... Signature .... Date ....

COPY ROUTING

GENERATOR	TRANSPORTER	DISPOSER / STORER
Pink to Authority	Yellow - retain	Blue to Authority
White - retain		Green - retain

Figure 1.5 : AEC Manifest Form Guideline

(AEC, 1986)

environmental objectives of (ANZECC, 1989):

- *reduced hazard to human health from the generation of toxic wastes;*
- *preventing environmental degradation caused by the unnecessary release of waste materials;*
- *promotion of more efficient use of scarce natural resources;*
- *reduced need for waste disposal facilities and reduction in waste disposal costs;*
- *cost savings to industry by adoption of processes with reduced waste disposal and raw material costs.*

1.7.2 Major issues for the Implementation of Waste Minimisation

Successful implementation of waste minimisation requires more than the availability of economically attractive techniques and technologies, although these are a necessary part. Studies of the reasons behind the slow implementation of waste minimisation (Huisingh, 1989; Hirschhorn, 1991) emphasise 'software' issues as being more important than the availability of the technological 'hardware'. A waste minimisation program must include an integrated strategy composed of (Vigneswaran and Moore, 1992):

- Access to information on the most appropriate techniques and technologies for minimising waste from various industrial processes.
- An attractive economic environment for investment in waste minimisation techniques and technologies. This includes appropriate evaluation and allocation of full waste disposal costs from existing operations and full assessment of benefits from implementation of waste minimisation.

- An appropriate environmental management plan (Moore et al, 1991) which includes corporate commitment to waste minimisation, incentives and penalties to encourage its implementation by all departments in a company and appropriate organisational structure, reporting system and resources to enable implementation of a waste minimisation program.

An outline of how to address these issues in preparing a waste minimisation program is provided in the remainder of this section.

1.7.3 Waste Minimisation Techniques and Technologies

Compendia of waste minimisation techniques and technologies, often illustrated by case studies, are now being developed and provide reasonable access to information on appropriate hardware. For example (Overcash, 1986; Inform, 1985). More recently, computer databases of case studies and technologies have been established which provide easy access to users from industry (USEPA, 1989).

Waste minimisation techniques are of two main types; source reduction techniques and recycling techniques. These are illustrated in Figure 1.6 and are treated in some depth in publications by the USEPA, UNEP and Australian Waste and Environment Authorities (Freeman, 1990; UNEP/UNIDO, 1991, WMA of NSW, 1990).

Waste minimisation technologies normally refer to on-site and offsite recycling technologies. The 'Source reduction' approach is largely composed of techniques (Figure 1.6), with any application of technology largely being a modification to existing process technology, rather than a new generic waste minimisation technology. The Recycling approach, however, has a number of technologies which enable resources to be recovered from waste streams and then be returned to the process, or be used in another process.

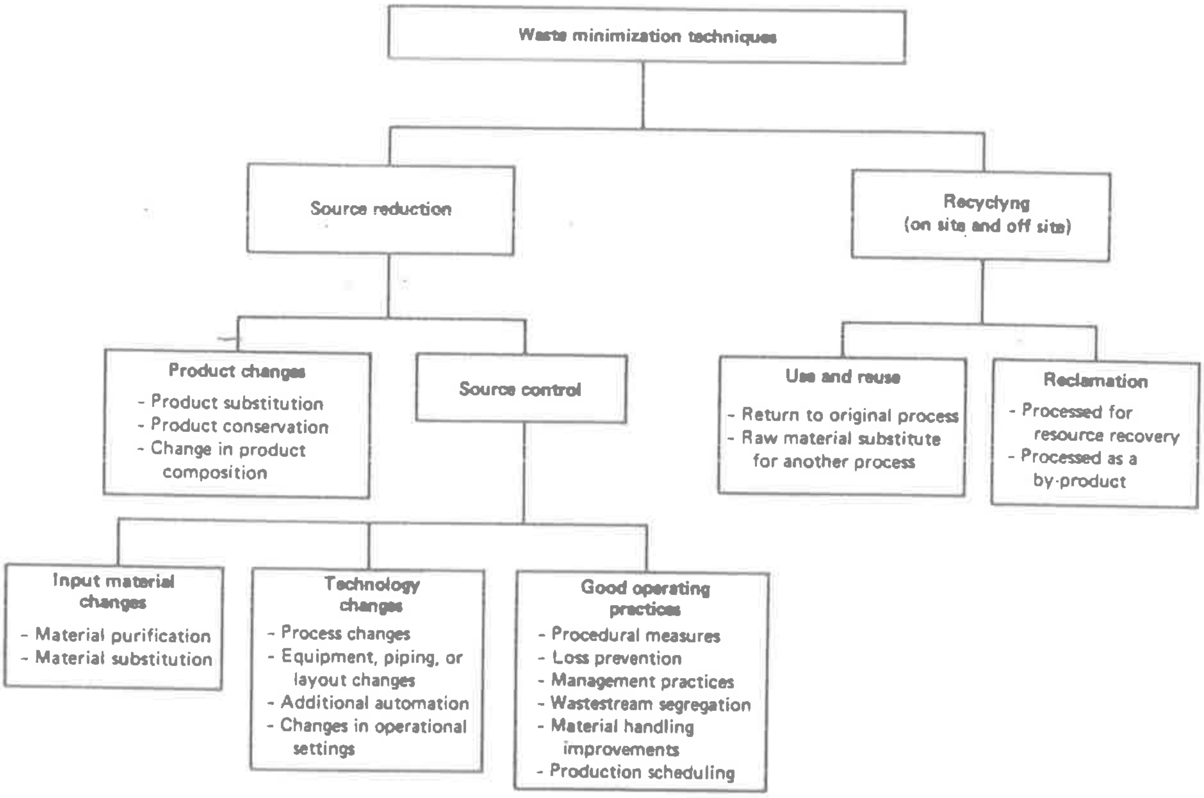


Figure 1.6 : Waste Minimisation Techniques

(Source : Freeman, 1990)

These technologies are, therefore, largely separation technologies; important among them are:

- Membranes, from reverse osmosis through to microfiltration
- Gravity separation technologies, including settling, enhanced settling, centrifugation.
- Dissolved air flotation
- Screens, sieves and plate and frame filter presses
- Distillation
- Electrolytic recovery
- Ion exchange

1.7.4 Regional Programs

Regional waste minimisation programs established by waste and environment authorities can provide strong incentives for the implementation of waste minimisation by waste generators. Programs need to be designed to suit local regional circumstances.

Common elements of regional programs are listed below:

- Economic incentives:
    - ensure the *polluter pays* principle is enforced through full costing of waste management services provided by regional authorities;
    - ensure penalties for environmental offences are sufficiently high to provide a real disincentive to avoid legal waste management systems; (For instance as in the jail terms, $million fines and personal liability provisions of the NSW Environmental Offences and Penalties Act, 1991).
    - introduction of deposit legislation for selected wastes (for example waste oil, batteries);

- taxation measures, such as a levy on waste disposal to fund tax incentives (for example 150% deductions used for R & D expenditure) for waste minimisation;
- soft loans for purchase of waste minimisation technology;
- grants for waste minimisation research and development.

♦ Regulatory incentives:

- increase generator's liability for his waste, even after passing to a third party's control;
- manifest form declarations that all reasonable efforts to minimise waste have been undertaken (as required in the USA);
- the setting of targets for industries as a whole, and individual companies to attain. Targets should be based on benchmarks of best international practice, and, at least initially, are often voluntarily adopted by industry;
- planning approval requirements.

♦ Information, education and promotion:

- Waste Authority managed waste exchange services
- industry seminars
- awards
- central information and advisory services, including publication of successful programs in newsletters.
- inclusion of waste minimisation topics in training courses at the undergraduate and professional level

1.7.5 Industry Programs

In addition to an *external* environment which encourages waste minimisation, there is a need to establish a strong support for waste minimisation within the 'internal' company environment.

A company program should include (Vigneswaran and Moore, 1992):

- A strong and visible commitment by the highest levels in the company to waste minimisation

- Recognition that all functions in a company have a role in the waste minimisation strategy, and explicit definition of these roles and responsibilities is required.

- Development of a staged implementation strategy, which will often include the following steps:

    1 conduct of an environmental review of the company, for instance, as done in BHP (Scaife, 1991);
    2 preparation of an (outline) company Environmental Management Plan (Moore et al, 1991);
    3 conduct of waste audits on high priority areas of operations (UNEP/UNIDO, 1991);
    4 undertake audits of companies supplying goods and services to the company;
    5 refine and develop a waste minimisation program, which after raising awareness in the environmental review (1. above), will follow on to (Hirschhorn, 1991):
        - data collection and feedback to waste generators
        - access of information and conduct of detailed feasibility studies
        - conduct of research and development on the more intractable waste streams;
    6 include waste minimisation techniques in company training programs.

A philosophy of continuous improvement, as is being applied to all business activities in companies which adopt Total Quality Management (TQM) (AGSM, 1989) will ensure that the above six point strategy will be dynamic and adaptive to changing needs for products, and the stringency of environmental regulations. TQM methods are likely to be important tools in implementing the waste minimisation strategy.

1.8 Hazardous Waste Treatment

1.8.1 Onsite versus offsite treatment

Treatment of hazardous waste may be undertaken at the site of the generator, or at a shared offsite facility managed by another organisation. In most OECD countries the majority of hazardous waste, by volume, is treated on the generator's site and the majority of this is undertaken by a relatively small number of large generators. Data are not available in Australia, but a similar situation is likely to occur - the few large companies will manage most of their wastes onsite and the many small companies (in total representing a minor part of total waste volumes) will rely on offsite treatment facilities.

It is important to recognise this typical pattern when designing hazardous waste management systems. It is inconsistent to demand very high standards of offsite treatment facilities and to neglect the licensing and regulation of onsite facilities.

There are two significant trends occurring in the onsite treatment of hazardous wastes:

- onsite treatment facilities are increasingly being modified and designed to be complementary to waste minimisation facilities, particularly in the area of recycling by by-product recovery. The trend is illustrated by the schematics in Figure 1.7.

- There is an increasing trend to reduce reliance on offsite treatment facilities, particularly by larger companies, in order to reduce their liability associated with transport hazards, and poor offsite treatment and disposal by others.

Onsite treatment systems use waste minimisation technologies and the unit processes involved in integrated offsite treatment plants, and will not be described separately in this section.

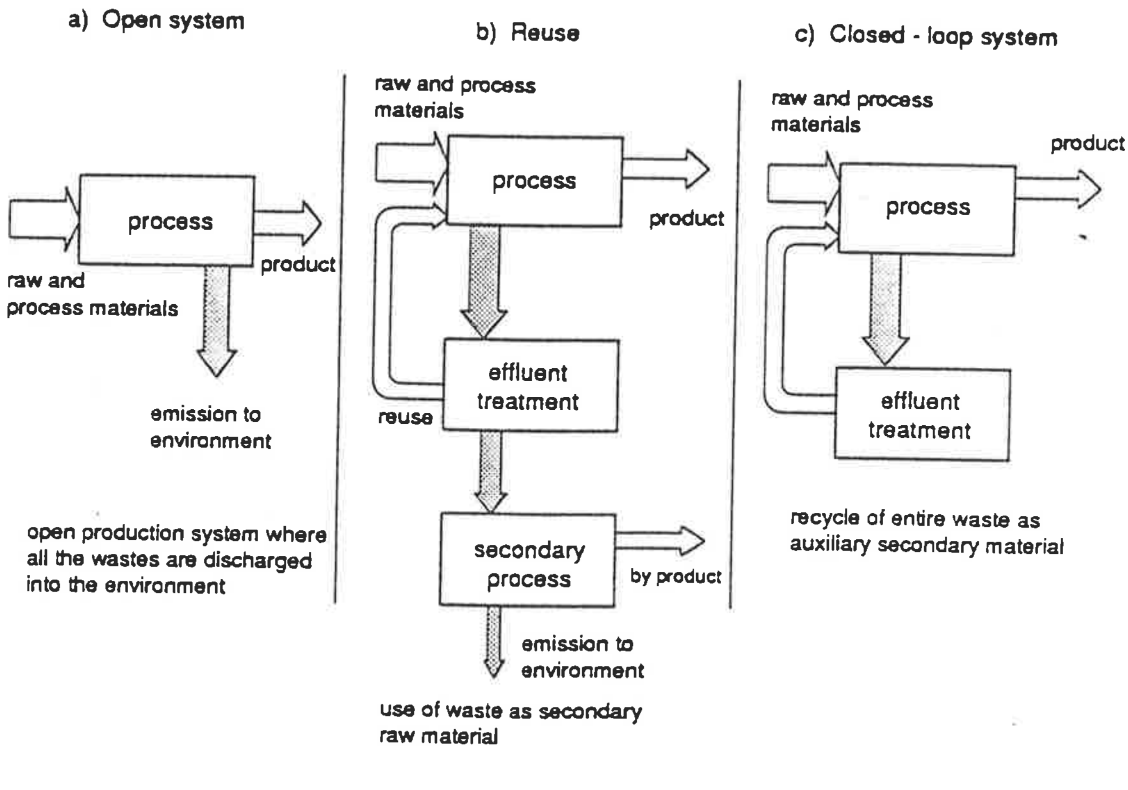


Figure 1.7 : Onsite Treatment Concepts, with trend from open to closed loop systems

(Source : Vigneswaran et al, 1989)

Offsite treatment facilities play an important part in regional hazardous waste management systems (Figure 1.2):

- They provide high standard facilities for small generators who are unable to provide onsite treatment because of lack of space, capital and operating expertise.

- They provide facilities for wastes which are difficult to treat and which require equipment and expertise that even large companies find difficult to provide. These wastes, while often small in volume, are often highly toxic and therefore are significant; they include the intractable waste stream.

- They enable economies of scale and synergistic benefits to be derived. Wastes of one type can be stored until there is sufficient volume to treat them economically and some wastes (such as waste acids) can be used to treat other wastes (such as alkalis by neutralisation, and by 'cracking' oily water emulsion prior to gravity separation).

The remainder of this section provides a broad outline of a typical offsite treatment plant. Details of individual unit processes can be found in standard chemical engineering handbooks (for example Freeman, 1989).

1.8.2 Integrated Offsite Regional Treatment Facilities.

Integrated offsite hazardous waste treatment facilities to serve the needs of industrial regions were commissioned in Australia in the late 1980s. Examples include:

- the WMA of NSW's Aqueous Waste Treatment Plant at Lidcombe, serving Sydney;

- four private sector aqueous waste treatment plants serving Melbourne;

- National Waste Company's industrial liquid waste treatment plant in Wingfield, serving Adelaide.

Further plants are in the planning and design phase, the most recent being the Envirogard plant for Newcastle.

A generic flowsheet for an integrated treatment plant is shown in Figure 1.8. It illustrates current consensus on Best Available Technology (BAT) for the treatment of the various hazardous waste streams. BAT has been defined in some detail in recent legislation from the USEPA (USEPA, 1990), and is in accord with that illustrated in Figure 1.8.

Waste streams can be broadly divided into two main groups, the inorganics and the organics.
The inorganics include acids, alkalis and heavy metal bearing wastes and are treated by physical/chemical processes such as neutralisation/precipitation to concentrate the toxic constituent into a sludge. The neutralised effluent can then be disposed to sewer or be reused in an industrial process. The inorganic stream is usually a greater volume than the organics and is a relatively simple waste to treat. Reactive wastes are usually a very small component of the inorganic waste stream.

The organics include waste oils and oily waters, solvents, organic chemicals, biological process sludges (including septic tank sludges) and grease trap wastes. Main treatment processes include separation (gravity, membranes) to recover valuable materials, and biological treatment and incineration to convert organics to carbon dioxide and water. The intractable wastes are all organic and currently require high temperature incineration treatment in the UK, as Australian facilities are still (after more than a decade) in the planning stage.

The regional offsite facilities are *integrated* in that they generally accept all types of waste and aim to achieve process operating advantages by using the waste stream of one process as a raw material for another in the facility.

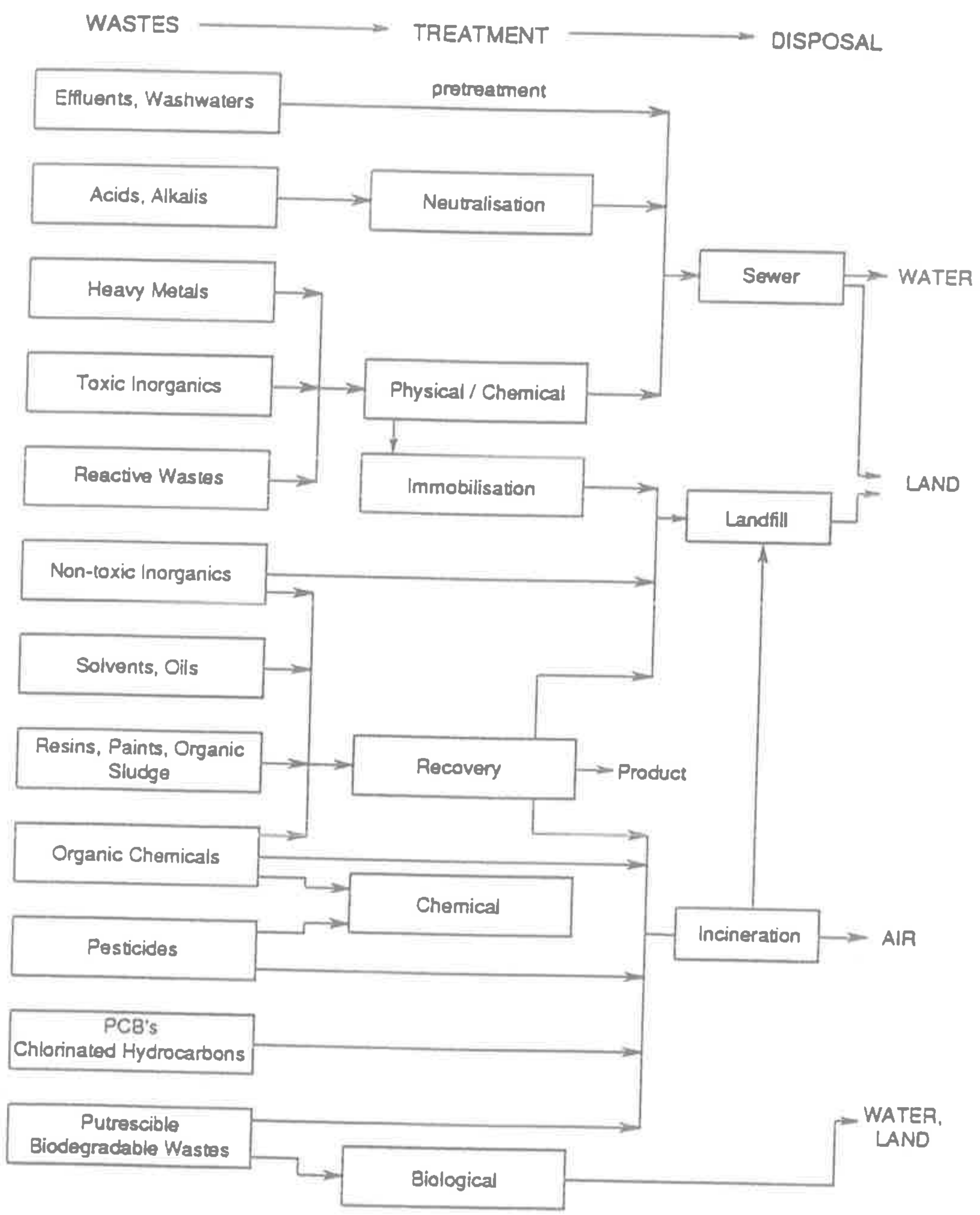


Figure 1.8 : Generic Schematic of an Integrated Hazardous Waste Treatment Facility

(Source : Victorian EPA, 1985a)

For example:

- waste heat for enhanced separation of fats and oils;
- neutralisation to treat acid gas scrubber effluents from incineration;
- effluent from aqueous waste streams as cooling water for incineration;
- recovered oil and solvents as fuel for incinerating low calorific value wastes.

Emissions from the integrated facilities consists of gaseous, liquid and solid treatment products. Gaseous emissions are largely CO_2 and H_2O, with some trace organic and inorganic constituents, and are dispersed to the atmosphere. Liquid effluents are largely salty neutralised water with low levels of organic and heavy metal constituents which are normally disposed to sewer after passing Trade Waste acceptance criteria and procedures.

Solid emissions consist of treatment sludges with high concentration of heavy metals. Their management is described in the Section on Residue Management.

1.9 Residue Management

1.9.1 Introduction

As noted above, residues from onsite and offsite treatment plants consist of gaseous, liquid and solid residues. Management of gaseous and liquid emissions will be briefly discussed before concentrating on solid residue management.

Gaseous emissions arise from two types of sources:

- Stack emissions, where gaseous end products of treatment processes are deliberately dispersed to the atmosphere. These are predominantly from combustion processes and consist largely of CO_2, H_2O and NO_x with trace concentrations of heavy metals and toxic organics. The toxic organics arise from uncombusted wastes, from products of incomplete combustion or from reformation products in the post combustion zones of the incineration/air pollution control device system. (Doig, 1991).

- Fugitive emissions, arising from leaks of gaseous wastes from storage tanks and process streams. These are of particular importance from an occupational health viewpoint, but can sometimes also be more significant than stack emissions to residents in the vicinity of treatment facilities. Fugitive emissions are managed by designing storage and process units to contain and minimise leaks, or to capture leaks and recycle or treat them prior to discharge. Onsite monitoring will be required to ensure OH&S standards for employees are being achieved.

Treated liquid effluents are disposed of by:

- recycling onsite, for washdown purposes, cooling and gaseous emission scrubber water;

- recycling to industrial users in the vicinity of the treatment plant;

- disposal to sewer.

Compliance with Trade Waste Discharge criteria for disposal of effluent to sewer can take two forms:

- either, the effluent is monitored continuously where possible (for example pH) or is subject to routine sampling where laboratory analysis (for example heavy metals) is required. Trade Waste charges and penalties are applied after the results are known.

- Or, treated effluent is discharged to an *effluent batch tank*, typically 100-500 kL capacity, and stored until the results of analytical tests are known. These Trade Waste acceptance tests include pH, heavy metals, some toxic organics, ammonia and a biological inhibition test. The last test can take 2-3 days to complete. On passing the screening tests, an officer from the Water Authority releases the effluent to the sewer. Two or preferably three batch tanks are therefore required.

1.9.2 Solid Residue Management

All hazardous waste management systems will produce residues from treatment plants and wastes that require ultimate disposal. Conventionally, this has been to secure landfill. However, there are a range of options that are being developed worldwide for the management of solid residues arising from hazardous waste treatment processes. Other than the need to minimise the demand on these facilities through waste minimisation, there is no clear consensus on the best approach. Solutions being developed result from a complex interaction of legal, political, social and historical reasons as much as the physical environment predominating in any one country.

The approaches being developed can be described in relation to two factors:

- The nature of the repository, namely:
    - Municipal Solid Waste (MSW) landfill
    - double lines secure landfill
    - above ground vault/storage
    - geologically stable mine space

- burial below pavements, above groundwater influences
- a clean fill area

- The treatment or management of the residues themselves:

  - treatment to immobilise contaminants;
  - segregation of residues, treatment to a form that will facilitate future recovery, and storage in a manner that will facilitate future recovery;
  - no segregation of residues, and no special treatment to immobilise hazardous constituents in the residue.

Selected combinations of these two factors produce the range of approaches that are currently being developed worldwide. These are illustrated in Table 1.2.

Criteria needs to be developed to enable the preferred option to be selected. Possible criteria could include:

- simplicity and flexibility, facilitating future recovery of hazardous constituents;

- maximum security, with low risk of contaminants being released to the environment.

These criteria are not compatible; one or the other needs to be applied for any particular waste residue type. A conscious decision needs to be made when designing facilities for the management of solid residues arising from waste treatment plants.

Ultimate Repository	Residue Treatment		
	Immobilisation of Contaminants A	Not Fixed	
		Segregated & Retrievable B	Mixed C
1 MSW Landfill	X		
2 Double lined secure landfill	X	X	X
3 Above ground vault/storage		X	
4 Geologically stable mines space	X	X	X
5 Burial below pavements, above groundwater	X		
6 Clean fill	X		
X Feasible option			

Table 1.2 : Treatment Residue Repository Options

(Source : Moore et al, 1991)

1.10 Conclusions

The proper management of hazardous waste in a region requires a systems approach which:

- clearly defines the objectives and outcomes required through a set of consistent guiding principles;

- defines the elements in the system and requires that these elements be designed to meet the defined objectives;

- appreciates the interactions among system elements, particularly that neglect or alteration of one element will influence the design and operation of all other elements;

- enables the system elements to be developed in a rational manner, recognising that resource constraints will not enable an ideal system to be immediately realised.

- The design of the management system should recognise that the environment and need that it is designed to satisfy are dynamic, namely:

- economic conditions change;
- the state of knowledge of the environment and anthropogenic influences on it will change and improve;

- community perceptions will change.

The hazardous waste system will therefore need to be able to respond to these changes. Flexibility should be incorporated into all procedures and facilities, where possible.

While the above conclusions are almost trivial from a systems analysis viewpoint, examination of the development of hazardous waste management practices over the past decade indicate they have not always been applied.

PART B

DEVELOPMENT OF SELECTED ASPECTS OF A MODEL HAZARDOUS WASTE MANAGEMENT SYSTEM

1 GUIDING PRINCIPLES FOR HAZARDOUS WASTE MANAGEMENT

1.1 Introduction

1.1.1 Background to the development of existing guiding principles

A description of current and developing guiding principles for the management of hazardous wastes is provided in Part A of this report. From the pollution control and treatment emphasis of the 1970s and early 1980s, there developed the current dominant guiding principle of the preferred hierarchy of waste management, which has now been adopted by most waste and environmental regulatory authorities in Australia.

While the principle of minimising waste[1] in preference to treating it to inert residues and disposing of it in landfills is widely espoused, the degree to which authorities implement the principle is constrained[2] by various limits on regulatory powers and political will, and to some extent is unknown. Inevitably, it will never be possible to satisfy all segments of the community that the correct or optimum 'balance' between waste minimisation, and waste treatment and disposal has been achieved. Because such an optimum will change over time, and because our current methods of monitoring the achievement of stated targets is poor, it is somewhat fruitless arguing about the precise description of the optimum mix of waste minimisation/treatment. What is important, however, is the establishment of an agreed framework within which the debate can occur, in the hope that more informed and accountable decisions can be made.

From the late 1980s, a series of environmental issues arose, and strategies were developed to deal with these issues; a number of these have implications for hazardous waste management. However, the implications for hazardous waste have not been well defined, nor have they been explicitly integrated into the newly established waste minimisation paradigm by waste and environmental authorities. Important strategies that have been developed at the National level, in response to International concerns and agreements to which Australia is a signatory, include :

- Greenhouse Strategy (ANZEC, 1990)
- Ecologically Sustainable Development Strategy (ESD Working Groups, 1991)

[1] Waste minimisation is used as a generic term to include waste avoidance or elimination, waste reduction or minimisation and waste recycling. In this discussion waste minimisation should be seen in this broader context.
[2] The author is not suggesting that there is anything improper in this. In a democratic society, there must be curbs on regulatory authority in "zero sum game " areas, and it is the job of politicians to judge what is an appropriate level of political will in areas which will produce perceived benefits to some sectors and disadvantages to others.

Other environmental principles which have been developing in the 1980's and which may influence the management of hazardous waste include :

- the polluter pays principle
- development of multi-media emission standards to replace separate emission regulations covering air, water and soils.

The implications of these policies (with the exception of ESD) for hazardous waste management are described in Part A of this report. This review will not repeat this discussion, but will concentrate on the most recent ESD documents, before drawing together recommendations at the end of this chapter.

1.1.2 Basic Aims of Waste Management

Brunner (pers. comm., 1993) starts from the premise that there are two fundamental aims in waste management, from which derivative strategies and detailed principles can be developed; namely :

1. Resource conservation
2. Environmental protection

These aims, in turn, arise from the basic statement of ecologically sustainable development, " to meet the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1990).

These two aims draw our attention back to what all waste strategies should be trying to achieve; and they can assist in answering questions such as, ' how far do we go in minimising waste before we treat the next tonne, and then dispose of the next tonne to landfill ?'. The preferred hierarchy of waste management offers no answers here, and implies that there is no end to, or limits on, the effort that should be expended on minimising that marginal tonne of waste. These two fundamental aims remind us that it is possible to consume more resources in attempting to reduce waste materials below certain levels, and that some waste minimisation (especially recycling) schemes can result in nett environmental quality degradation.

This chapter will review the guiding principles for hazardous waste management by starting from these two fundamental aims, and then consider the application of ESD principles, and the other emerging principles listed above, to hazardous waste management. If appropriate, a more comprehensive and integrated restatement of detailed guiding principles, which take account of these recent developments in broader environmental management policy areas, will be attempted.

1.2 ESD Principles

1.2.1 Background

The World Commission on Environment and Development, under the chair of Gro Harlem Brundtland, released their report "Our Common Future" in March 1987 (WCED, 1990). The concept of ecologically sustainable development (ESD), which is the subject of this report, gained widespread exposure and credibility through the publication of the book and its sponsorship by the United Nations General Assembly. The Australian government responded to its publication by engaging the Commission for the Future to write a paper on *A Sustainable Future for Australia*, which was subsequently included as a preface in an Australian edition of *Our Common Future* (WCED, 1990).

In June 1990, the ESD working groups process commenced with the publication of a Discussion Paper by the Commonwealth (Dept of the Prime Minister and Cabinet, 1990), followed by the establishment of nine industry sector working groups under three chairs. The sector working groups were :

1. Agriculture
2. Forest Use

3. Energy Production
4. Energy Use
5. Fisheries
6. Manufacturing
7. Mining
8. Tourism
9. Transport

The working groups were composed of a broad cross-section of interests from government, industry, trade unions and community based groups, and final drafts and final reports were released between August and December 1991 (ESD Working Groups, 1991a, 1991b). In addition, the three chairs prepared supplementary reports on cross or inter-sectoral issues and greenhouse issues (ESD Working Groups Chairs, 1992). In December 1992 the Council of Australian Governments issued a communique at their meeting in Perth (Prime Minister, 1992) endorsing the National Strategy for Ecologically Sustainable Development and agreeing that ' future development of policies and programs should take place within the framework of the ESD Strategy and the Intergovernmental Agreement of the Environment (IGAE, 1992)' .

The current status of implementation of ESD in government decision making, and the monitoring and reporting on the commitments made in the IGAE and the Perth communique, are not clear. NSW has included aspects of ESD principles into the new Environment Protection Act (1992). The remainder of the discussion in this section will assume that the major thrust of the recommendations in the final Working Group reports will be adopted by governments in the next three years; the implication of these recommendations for hazardous waste management will be examined.

1.2.2 Outline of ESD principles

A variety of principles have been developed from the basic general definition of ESD by a range of organisations. The six ESD principles discussed in the ESD Working Group Chairs' report on

Intersectoral Issues (ESD Working Group Chairs, 1992) have been adopted as being representative of the scope and content of these various approaches and, in summary, are :

1. **Intergenerational Equity**, normally stated as the fundamental definition of ESD, namely that ' the current generation should not compromise the ability of future generations to meet their needs in material and non-material terms '.

2. **Intragenerational Equity** : the distributional effects of development on the allocation of benefits and costs needs to be considered, both in the introduction of economic growth policies and projects, and in policies aimed at other aspects of ESD (such as reducing greenhouse gas emissions by increasing fuel costs). The chairs argue that ESD requires these distributional aspects to be explicitly addressed as an integral part of new economic growth policies; rather than employing one set of instruments to increase overall growth in GDP (tax, interest rates, microeconomic reform etc) and another to come in later to ' fix up ' the distributional effects, essentially social welfare subsidies and measures. Intragenerational equity also has an international dimension, and this was a particular focus of the Brundtland report.

3. **Conservation of Biodiversity** : one of the four goals outlined in the Prime Minister's brief for the ESD Working Groups was ' the protection of biological diversity and the maintenance of ecological processes and systems.'. Biological diversity encompasses three levels (ESD Working Group Chairs, 1992) :

    - genetic diversity - the total range of genetic information contained in the genes of all living things
    - species diversity - the variety of species of organisms on earth
    - ecosystem diversity - the variety of habitats, biotic communities, and ecological processes and interactions that characterise the biosphere.'

Changes in biodiversity have been a feature of geological time frames, as indicated by the geological record. However, when the rate of change can be measured in time frames of decades, there is concern that the natural capacity of ecosystems to respond may be exceeded. If this occurs, then the benefits and values associated with biodiversity may be threatened; these include (ESD Working Groups Chairs, 1992) :

- consumptive use values
- non-consumptive use values (watershed protection, soil formation etc)
- productive use values (harvesting of natural resources)
- retention of options
- existence rig. .s[3]

The Working Groups Chairs recommend that ESD policies should aim to prevent further loss of biological diversity and that strategies and plans, down to the level of identifying areas that should be conserved or specially managed in order to achieve this aim, should be prepared.

4 **The Precautionary Principle** (or Dealing Cautiously with risk) : There are a number of definitions of the precautionary principle, and it is perhaps the most poorly developed of the principles. The Working Groups Chairs view it in terms of ensuring a correct balance between environmental capital and human -made capital, and that in arriving at this balance there is an "acceptance of the need for dealing cautiously with risk" and that there is a need to bring this into the decision making process. The recommendations of the Chairs for this principle indicate that they believe that improved risk assessment techniques and the incorporation of them into decision making processes will satisfy this principle.

A conference (Institute of Environmental Studies, 1993) on the precautionary principle highlighted the current developing nature of this principle, with a range of perspectives

[3]refer to the work of Peter Singer (1993) for a detailed outline of the argument in favour of the view that all species have a right to exist, independent of anthropocentric views.

provided in the Proceedings. The definition now commonly adopted in Australia is that agreed to in the IGAE (1992):

"Where there are threats of serious or irreversible environmental damage, lack of full scientific knowledge should not be used as a reason for postponing measures to prevent environmental degradation.

In the application of the precautionary principle public and private decisions should be guided by :

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and

(ii) an assessment of the risk weighted consequences of various options."

The major difference in interpretation of this principle at the conference (as perceived by the author) can be expressed by the following two views :

(i) that the precautionary principle had already been in place in decision making for some years, and that conventional risk assessment techniques could be applied to enable rational decisions to be made.

or (ii) that the precautionary principle was fundamentally new and different in that it shifted the onus of proof away from the environment onto the developer[4], and that conventional risk assessment techniques were unsuited to problems in which the precautionary principle had to be applied because, by definition, there was lack of scientific knowledge about the risks.

[4]In conventional environmental impact assessment the developer can use the argument "there is no evidence to suggest that emission of this substance into that environment will cause harm" - it may be relatively easy to make this assertion when there is little data available, and it will be difficult for environmental groups or EPAs, arguing on behalf of the environment, to demonstrate that the emission will cause harm. If there is a possibility of serious or irreversible damage (note, however, that these terms have not been defined in an operational manner (Harding & Fisher, 1993)) then application of the Precautionary Principle makes it incumbent on the developer to prove a much more difficult hypothesis; that after emission of the substance the integrity of the receiving environment will be maintained, i.e. to prove that it will **not** cause harm.

These questions of interpretation, and subsequent development into operational strategies, will be the subject of follow - up seminars (Harding, pers comm, 1993), where it is hoped that application to specific sectors and case studies may yield some clarification of the issues involved.

5 **Global Issues** : The Brundtland report (WCED, 1991) had a particular focus on the relationship between underdevelopment and threats to global environmental sustainability, concluding that without growth and development, environmental problems in underdeveloped countries, which have global implications, could not be addressed. The Chairs of the ESD Working Groups refer to the need for Australia to address this nexus in our overseas aid program, and then concentrate their discussion on two aspects of global issues :

- International agreements and obligations in the environmental area as well as the influence of trade agreements on global environmental issues.
- the global and cross-border dimension of some environmental problems, particularly greenhouse gas emissions , ozone depleting substances, biodiversity (rainforest destruction) and some emerging issues in waste management.

While Australia often contributes a relatively small total contribution to environmental problems with a global dimension, the per capita contribution is often high (for instance greenhouse gas emissions), because of the structure of the Australian economy. Allocation of emission reduction quantities among countries with different economies (whose economies in turn are linked with other apparently less polluting economies) is a complex question. The Chairs recognise that exporting ecologically unsustainable industries to other countries is not a solution, and suggest that market based instruments should be considered in most efficiently achieving global targets for emission reduction, e. g. it may be more efficient for Australia to pay for enhancement of coal fired power generation efficiency in China, than to further improve efficiencies in Australia, to meet Australian CO_2 reduction quotas.

6 **Economic Diversity/Resilience** : the Chairs define this principle as economies which 'are sufficiently strong to withstand short-term fluctuations and sufficiently flexible to adapt effectively to longer-term structural change without compromising their ability to contribute to sustained improvements in material and non-material aspects of community welfare.'

The impact of climate change will be lessened if there is resilience in the economy, but the Chairs recognise that the Australian economy must essentially be adaptive to overseas economic changes and our choices will be limited . Important implications of moving towards a more resilient economy within a framework constrained by ESD principles are :

- the need to add value to our primary products to improve economic resilience will need to account for the associated resource consumption and pollution potential,
- the need to conserve and manage natural resources, which are the mainstay of the Australian economy,
- the need to accommodate climate change impacts on the economy,
- the opportunities that may arise if market developments caused by the introduction of ESD principles can be anticipated.

An examination of these six separately presented principles indicates that there is overlap and relationships among them. The precautionary principle for instance, can be applied in conjunction with conservation of biodiversity, and intergenerational equity is intimately related to biodiversity, global issues and the development of a resilient economy. In applying these principles, the National Strategy for ESD (reported in Harding & Fisher, 1993) states that ' no objective or principle should predominate over others. A balanced approach is required that takes into account all these objectives and principles to pursue the goal of ESD.'

1.3 Application of ESD Principles to Hazardous Waste Management

This section provides an ESD perspective on how hazardous waste should be managed, and examines :

- how well past and current hazardous waste management practices in Australia satisfy these ESD principles,
- how well the preferred hierarchy of waste management (waste minimisation) satisfies ESD principles - is application of the guiding principle of waste minimisation sufficient in itself ?

The recommendations of the ESD Working Group on Manufacturing in their final report(ESD Working Group - Manufacturing, 1991b) are included where appropriate, as this is the Final Report containing most of the references to hazardous waste.[5]

1.3.1 Intergenerational Equity

Application of this ESD principle to hazardous waste would lead to the requirement that all hazardous waste produced by this generation be managed in such a way that the next generation (taken as 30 years from now) incurs no liability by way of environmental quality degradation and/or the cost of remediating environmentally degraded assets. Switzerland has formally adopted this goal into their objectives for waste management set by the Swiss Federal Commission on Waste Management (BUS, 1986 reported in Brunner, 1988), namely that ' wastes shall be treated in Switzerland (i.e. no export is allowed), and the treatment shall produce materials which can either be reused or landfilled without long term implications. ....(the term given to wastes so treated being) "final storage (quality)" ' (Brunner, 1988). The principle could be extended to state that we should try to leave future generations with potential assets from our waste management systems rather than potential liabilities. In this regard, the establishment of monofils to accept waste treatment residues high in potentially

[5]From the author's perspective, it is surprising that waste management was not considered in more detail as an intersectoral issue. No comments could be found in the Intersectoral Issues Report on the reasons for selection of the issues.

valuable materials, could provide future generations with an asset when markets and technologies change (Brunner, 1992)[6].

It is apparent that past management of hazardous waste has not satisfied the ESD principle of intergenerational equity. The current generation is now expending resources on the remediation of contaminated soil and groundwater caused by the poorly managed disposal of hazardous waste by a previous generation. The previous generation gained the benefit of the production and consumption of goods associated with this hazardous waste, but did not pay the full cost of environmentally acceptable disposal of the waste; the "bill", with considerable "interest" (ie it is often much more expensive to treat and manage waste contaminated soil and groundwater than to treat the original smaller volume raw waste), is now being paid by this generation.[7] While current hazardous waste management practices have improved dramatically from common practice 30 years ago, there are still significant regions in Australia with no formal comprehensive control system in place (for example, the Illawarra and the Hunter).

Current Australian practice includes the landfilling of waste residues that would certainly not meet the Swiss 'final storage quality' criteria, and it is conceivable that hazardous waste being landfilled today will need remediation treatment by a future generation. US practice is to only landfill hazardous waste in 'secure landfills' after certain leaching test criteria have been met. The security being provided by double layer HDPE liners underlain with compacted clay.(Fluet et al, 1992). The Swiss have rejected this approach on the basis that the liners can only be guaranteed for 30 -40 years, after which time the next generation may well be faced with expensive and ongoing remedial activities (Brunner, pers comm., 1993). There is also some debate in the USA on the appropriateness of this approach for the long term (Lee & Jones-Lee, 1993). Australian leaching criteria for landfill acceptance of waste are not as stringent as those of the USEPA, and our secure landfills would not meet the specifications set

[6]This concept is also hinted at in the ESD Working Group on Manufacturing Final Report (1991, p162) for materials in the municipal waste stream, but the concept could more easily be applied to hazardous waste treatment residues.

[7]It is interesting to note that the National Accounts count this environmental remediation expenditure as a positive contribution to GDP(Waugh, 1993). The Commonwealth Discussion paper (Dept of PM & Cabinet, 1990, p18) refers to the possibility of including environmental resource degradation as a liability in the National Accounts, but concludes that "the complexities involved would appear to preclude the National Accounts from forming the basis of any approach to ecologically sustainable development in Australia in the short to medium term." The author could not find any discussion of this concept in the Working Groups' and the Chairs' final reports.

for such landfills in the USA. While it could be argued that Australian (with the exception of cases like Perth) groundwater is not as vulnerable to leachate contamination as American groundwaters, and therefore that lower standards could be argued for, the author is unaware of any detailed assessment of our landfilling guidelines that would indicate that this ESD principle is being satisfied.

The principle of the preferred hierarchy of waste management (simplified to 'waste minimisation') is certainly consistent with the intergenerational equity principle. Waste that is not produced at all will not pose any threat to future generations, and waste treatment residues disposed to landfill would be the least preferred from this perspective because there remains some possibility, with many residues currently being produced, that some future additional treatment may be required (the actual attainment of final storage quality has been somewhat elusive).

1.3.2 Intragenerational Equity

The principle of intragenerational equity applied to hazardous waste would require the costs and benefits of the management system to be equitably shared among individuals in the community.

Past poor management of hazardous waste by indiscriminate dumping and landfilling or lagooning has created contaminated sites with local environmental problems of contaminated groundwater, soils and air. This has provided benefits to parts of the community (through artificially low waste disposal costs) and obviously placed very high costs on individuals and small sections of the community affected by the contaminated site. In parts of Australia with no manifest system and with other components of the management system (refer Part A) missing, there is still a possibility of the ongoing creation of contaminated sites. Where site identification procedures are poorly implemented or non-existent, there remains the possibility of individuals and localised communities bearing the cost and health burden of these practices. This is obviously not satisfying the intragenerational equity ESD principle.

In regions where a comprehensive hazardous waste management system has been introduced, there are still difficulties with the implementation of this principle. Adequate centralised waste treatment and disposal facilities benefit the whole community by protecting the environment, but they need to be located in a localised area, with associated costs of increased waste tanker traffic and the potential for localised environmental and health impacts if the treatment plant fails. These costs are born by a small number of individuals in the community, and it is this issue which makes the siting of new treatment and disposal so difficult. If this ESD principle is to be implemented, a means of arriving at a more equitable distribution of the costs needs to be developed. In newly industrialising countries, the principle can be accommodated by having the treatment and possibly the disposal facility located within the industrial estate, which is normally separate from the residential areas, thereby enabling the benefits and costs to be born by the one group, with the whole community receiving a benefit. This is more problematic in cities, including most Australian cities, with dispersed industries and a legacy of poor planning that allowed residential areas to be located adjacent to industrial areas.

Waste minimisation satisfies this ESD principle because minimisation at the point of generation means that the waste does not need to be transported, treated and disposed of in a different part of the region. However, onsite treatment and disposal, or treatment and disposal within the bounds of an industrial estate would also meet this ESD objective.

1.3.3 Conservation of Biodiversity

Implementation of the biodiversity principle would require that the management of hazardous wastes not impact on species and ecosystem diversity. This could require routing of hazardous waste truck movements to avoid sensitive areas within regions, and the establishment of emission standards that would not impact on ecosystems. This latter task would require the setting of emission standards on the basis of ecotoxicology approaches, an approach which is rarely adopted because of the cost and uncertainties involved (refer to the discussion at the end of this section). There are currently practical limits on the extent to which this principle can be applied to waste management therefore. The ESD Working Group final report on manufacturing (1991, p166) comments that biodiversity requires consideration of ecosystem conservation as well as pollution control, and that overall (including presumably associated waste management) 'the direct impacts of manufacturing industry on biodiversity and ecological integrity are low compared to other industry sectors.'

Past poor hazardous waste management has led to the destruction of some ecosystems (Lake Bonny in South Australia and the emerging revelations on waste disposal in the former Soviet Union for example). It is unknown whether this has also led to a reduction in species and ecosystem diversity, as the extent and nature of our ecological resources are poorly defined (as indicated by the Intersectoral Report's recommendations on biodiversity, which include 'monitoring requirements and mechanisms to measure whether the full range of biodiversity is being conserved' (ESD Working Groups Chairs, 1991, p35))

Current good practice in treating and disposing of hazardous waste requires that emission standards are adhered to. These emission standards are usually based on what Best Available Technology can achieve. Conventional risk analysis usually indicates that the risk to human health from these emission levels are very low, and relatively low compared with other similarly calculated risks to health from anthropogenic sources (this should not be interpreted to mean that these risks levels are "acceptable", a relevant and complex issue not dealt with in this report[8].) However, ecotoxicology has not yet been able to confidently provide acceptable emission standards for the host of substances contained in waste emissions to the environment (Baccini & Brunner, 1991), and there are consequently limits to the practical implementation of this principle in the area of hazardous wastes.

Waste minimisation is consistent with the biodiversity principle as it will limit the potential for adverse impact on ecosystems and species from the residual emissions from treatment of wastes that would otherwise have occurred. Because of the difficulties associated with setting acceptable ecotoxicologically based emission standards, the highest achievable point in the hierarchy would best satisfy this principle. Alternate emission setting standard methods based on materials flux analysis

[8]Refer to McDonell,(1991) and Wynne (1987)for a discussion on risk in the field of hazardous waste. For further reading refer to Beck (1992)

(Baccini & Brunner, 1991) may be of some assistance in overcoming the shortcomings of ecotoxicology in the medium term (refer to the concluding discussion in this chapter)

1.3.4 The Precautionary Principle

As noted in Section 1.2, there is debate about the interpretation of the Precautionary Principle, and there will be difficulties in operationalising it, because of the political judgements required in the determination of what is a 'serious' threat and how 'irreversible' damage can be identified. If it is accepted that the Principle does shift the onus of proof to the proponent, and because of the present state of the art of toxicology, implementation of the Precautionary Principle in the hazardous waste field would tend to require the adoption of the 'Swiss option' described in Section 1.3.1. Conversion of wastes to final storage quality residues and 'safe' air emissions would avoid any damage to the environment (regardless of whether the potential damage was actually serious or irreversible), and it would be the lowest risk option for existing wastes requiring disposal. If practicable (using the IGAE wording), ongoing generation of wastes should be minimised in preference to being treated to final storage quality residues, because this would entail lowest risk, and would therefore better satisfy the Principle as stated by the IGAE.

The current method of managing existing Scheduled wastes in Australia is not in accordance with this principle. Currently, scheduled wastes are being stockpiled awaiting removal of an export moratorium or the establishment of non-incineration treatment facilities, which are still in the developmental stage for the type and form of wastes in question. There is a serious threat that the stockpiles could be encompassed by a fire from adjoining sites, resulting in certain environmental damage (its reversibility being unknown). The risk associated with continued indefinite storage is likely to be greater than treatment in high temperature incineration.[9] The recommendation of the Joint Taskforce on Intractable Waste was to incinerate existing stockpiles and phase out the production of the small ongoing stream within the 10 year life of the incinerator. This recommendation is consistent with the

[9] This is based on the authors experience with risk analysis of integrated treatment plants, where the highest risk process is usually the storage facility, see Vic EPA (1985)

Principle, but has been superseded by recommendations of the Independent Panel on Intractable Waste which recommended that wastes should be stored until non-incineration technologies could be developed to treat them.

The Manufacturing Working Group recommended in favour of the establishment of a high temperature incinerator in accordance with the Joint Taskforce recommendation (ESD Working Groups - Manufacturing, 1991b)

1.3.5 Global Issues

Management of hazardous waste should include consideration of the following ESD global issues :

- Complying with international agreements on the transport of hazardous waste across borders, such as the Basel Convention (see Appendix II). Australia is a signatory to the Basel Convention and OECD agreements and complies with the requirements of them.
- Treating hazardous organic wastes in such a way as to minimise greenhouse gas emissions in a region. This would imply that landfilling of organic hazardous waste, with the potential for release of hydrocarbons to the atmosphere, would not be preferred, and that incineration to CO_2 with energy recovery would be. Currently a relatively high proportion of hazardous organic wastes are disposed to landfill. The Joint Taskforce (1990) recommended that these wastes should be sent to the proposed high temperature incinerator, but this is now not possible under the current recommendations of the Independent Panel (1992).
- Ozone depleting substances such as CFCs and halons being taken out of service would normally be considered waste, and high temperature incineration treatment would have ensured these materials could not be released into the upper atmosphere. The Joint Taskforce (1990) made such a recommendation, but again this has been superseded by the Independent Panel (1992) recommendations, and the subsequent work of the Scheduled Wastes Working Group where CFCs and halons are no longer included as a scheduled

(intractable) waste, but are dealt with under separate legislation arising from the Montreal Convention. (ANZECC, 1992)

- The acceptability of achieving hazardous waste management goals by moving chemical processes that produce the waste to another region of country, needs to be considered in the context of global issues; in some cases a nett deterioration may result. The author is not aware of any agreements that cover this aspect. A related issue is the potential for some importing countries to place trade restrictions on goods produced by processes or in regions that do not have adequate (equal to standards in the importing country) hazardous waste management systems in place. The situation with the freeing up of GATT is uncertain, but it is possible that such practices which would be regarded as complying with the ESD global issues principle, may be regarded as a restrictive trade practice under GATT, and Section 92 of the Australian Constitution (controlling interstate trade)

Waste minimisation is again consistent with the global issues principles of ESD. Minimising waste at the point of generation avoids the potential downstream environmental problems with a global dimension. This is conditional on 'real' waste minimisation being achieved, rather than merely achieving local waste minimisation by relocating waste generating processes to other regions and then importing finished goods for incorporation into the final product.

1.3.6 Economic Diversity/Resilience

One outcome of moving towards a more resilient and diverse economy by adding value to our natural resources would be the potential for generating larger quantities of hazardous wastes associated with these processes. However, introduction of these industries into the Australian economy at this time would have the advantage of being able to incorporate the latest low waste (clean production) technologies. Hence economic growth and improvement in living standards may be able to be achieved with relatively low associated waste production.

Waste minimisation is therefore a complementary approach for the economic resilience principle in Australia.

1.4 Conclusions and Recommendations

1.4.1 Conclusions

The examination of the application of ESD principles to hazardous waste management in Section 1.3 has shown that in most cases the guiding principle of the preferred hierarchy of waste management is consistent with, or complementary to, the six ESD principles. However, this does not necessarily mean that the preferred hierarchy is a sufficient principle. While it is consistent with most ESD principles, the possible reservations with using it by itself to guide waste management are :

- other approaches may equally satisfy the ESD principle (refer to the above discussion on intragenerational equity),
- other approaches, possibly in combination with the preferred hierarchy, may better satisfy ESD principles and the basic aims of resource conservation and environmental protection,
- the preferred hierarchy is not an operational principle. It does not prescribe what is the optimum mix of minimisation, treatment and disposal, and provides, by itself, no means of determining such a mix. This means there is a danger that everyone can subscribe to it, while having there own private interpretation of what it translates to in practice - this then leads to irreconcilable conflict situations.[10]
- there is potential for misuse of the preferred hierarchy if it is used for particular waste streams and regions in isolation of impacts beyond narrowly defined system boundaries. Waste minimisation can easily be achieved, for example, by :
    - relocating waste generating processes to other regions,

[10]Such situations can be observed in almost all debates related to the development of regional waste strategies and individual treatment and disposal facilities.

- expending relatively large material and energy resources to achieve high waste recycling levels for particular waste materials, possibly creating other wastes in other parts of the system.

i.e. local waste minimisation gains satisfying particular ESD principles may be achieved at the expense of other ESD principles and the basic objectives of resource conservation and environmental protection.

To overcome some of these reservations it is necessary to expand waste minimisation to the broader concept of clean(er)[11] production. Clean production is defined by the UNEP Industry and Environment Office (Baas et al 1990, p19, quoted in Jackson , 1993) as :

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

A clean production approach aims to ensure that all aspects of waste generation from all product life cycle stages are fully accounted for, and that a comprehensive consideration of the environmental protection and resource conservation costs and benefits of a range of waste management systems are considered before choosing an optimum. Clean production provides a good summation of the application of ESD principles to the field of hazardous waste management. However, there are currently problems with the practical application of both ESD principles and clean production approaches to hazardous waste management because their are a number of areas in both that require application tools to be developed. The discussion on the application of ESD principles indicates that in nearly all cases there is a need to develop means by which the general principles can be applied to guide the detailed development of design criteria for the various components of a hazardous waste management system, as well as system optimisation itself. In only a limited number of cases have countries such as Switzerland explicitly developed waste management guidelines which directly address some of the ESD principles such as intergenerational equity. Clean production also requires the development of basic tools, such as standard procedures for life cycle analysis.

[11] There is some debate over the correct term to use. UNEP prefers 'cleaner' while other authors, having regard for thermodynamic constraints, make strong arguments in favour of 'clean' (Jackson, 1993).

As discussed in Section 1.3.3, current regulatory standards for hazardous waste facilities are often based on what the Best Available Technology can achieve. This is explicitly stated in the background documentation for current USEPA RCRA regulations for specifying the quality of residues that are allowed to be disposed of to landfill (USEPA, 1990). This approach is not based on ESD principles, other than perhaps the precautionary principle. These standards do not provide any information on whether the biodiversity principle, the core of the environmental protection objective, is being satisfied. The ESD Working Group on Manufacturing (1991b, p 158) recommend 'that targets in the form of guidelines based on ESD principles be set for waste reduction .....' . However the report provides no guidance on how the ESD principles are to be applied to produce some numbers which can be used as targets. There is therefore a need to develop alternative approaches that are consistent with ESD.

The Scheduled Wastes Working Group is currently developing standards for a number of hazardous organochlorin wastes using an ecotoxicological approach (ANZECC, 1992), namely, through the development of 'management plans and (the threshold values) are to be determined in the context of a full assessment of environmental, economic and social impacts, including a risk based assessment of potential adverse effects on human health and the environment that may result from the uncontrolled release of waste containing the specified chemical to the environment. Such an assessment is to consider the nature and form of contaminants, and properties such as persistence, bioaccumulation, toxicity, biodegradability, mobility and solubility.' This is a difficult, expensive, and lengthy approach likely to involve considerable debate because of the range of assumptions that are required to be made in the risk based models. The approach has been used in the more limited setting of clean-up standards for contaminated land on specific sites, and for setting a more general environmental standard for dioxin in Canada described in a 450 page document for one substance(Ontario Ministry of the Environment, 1985). However, for synthetic substances the author is unaware of any alternate approach and it is consistent with biodiversity, and some would argue with the precautionary principle.

An alternate approach for waste substances that are naturally occurring (largely inorganics such as lead, cadmium, mercury etc) is that based on materials flux analysis developed by Baccini & Brunner (1991). In this approach the anthropogenic flux of a contaminant into a region is compared with the natural geogenic flux, and a pragmatic limit of say 10% of the geogenic load is set as an acceptable standard unlikely to cause harm to ecosystems. The method has been applied with some success in Switzerland and has the advantages of :

- being relatively fast and inexpensive once some basic data has been compiled
- being very open and 'transparent' in its approach and therefore likely to be more generally accepted. The decision on the allowable % of the geogenic load being guided by information on the natural variation in geogenic loads from one year to the next, and ultimately being made by the political process.(Moore & Tu, 1993);
- providing a clear perspective on the origin of important anthropogenic loads in the region and therefore where resources may be most effectively used to achieve the stated objective. (note that in the studies undertaken to date the anthropogenic loads have been 100 -200% of geogenic loads, clearly unsustainable in the medium term).

Moore and Tu (1993) introduce the concept of an environmental quality index for all hazardous wastes generated in a region, which attempts to relate the quantity of waste generated with the regional capacity to manage these wastes, as determined by load based regulations developed by the above approaches. The regional demand being derived from reports expected to be generated by the National Waste Database.

The problem of allocating the regional capacity amongst current and possibly additional future generators of hazardous wastes is essentially an economics problem, and standard and developing systems analysis and economics tools , should be able to be used in its solution. For instance, trading in rights to hazardous waste index units may lead to an efficient allocation of the regional capacity, and simulation may be able to model the effects of different waste strategies on reducing the demand for regional environmental capacity.

In summary, the conclusions that can be drawn from the discussion in this chapter are :

- The preferred hierarchy of waste management on its own is not sufficient to account for all the issues raised by ESD requirements.
- Cleaner production is a more comprehensive approach and better satisfies the requirements of ESD.
- There is still substantial developmental work to be undertaken to turn these broad guiding principles into practical design guidelines for individual hazardous waste system components such as landfills and treatment processes, as well as for overall system design to answer questions on the appropriate mix of minimisation treatment and disposal in a particular region.
- ESD based regulatory standards for hazardous waste residue emissions to the environment, and a means of designing an efficient system of distributing the environmental capacity so derived, need to be developed.

1.4.2 Recommendations

The following approach is recommended as a way to progress towards more detailed operational guidelines for hazardous waste management that are consistent with all ESD principles.

1. Establish the basic objectives of waste management as resource conservation and environmental protection. These are at the heart of ESD and need to be clearly restated to set waste management on a firm foundation. Use these basic objectives as a reference point for the development of more specific guidelines outlined below.
2. Translate each of the general ESD principles into clearly stated principles for hazardous waste management. The discussion in this chapter has attempted to begin this development. For example, the Swiss policy of managing hazardous waste within Switzerland in such a way that only final storage quality residues are passed onto the next generation in 30 years is a translation of the intergenerational (and to some extent the intragenerational) equity ESD

principle into a hazardous waste principle. Clean production may be a useful principle to apply to fully satisfy a number of ESD requirements.

3. Develop design guidelines for hazardous waste systems and their components, revising established guidelines where appropriate, that can operationalise the principles developed by (2) and which satisfy (or allow measurement of achievement of) the basic objectives defined in (1).

4. Develop approaches to (and numbers for, where appropriate) the setting of regulatory standards in regions, that are consistent with ESD principles and the hazardous waste principles derived from them. This will enable the hazardous waste system designed in concept in accordance with (3) to be designed in detail. A combination of ecotoxicology based and the newly developing materials flux method approach may provide the best approach here.

5 Develop simulation models to predict the environmental outcome of alternative hazardous waste system designs, and apply environmental economics techniques and conventional regulatory approaches to achieve implementation in the most efficient manner.

The author will attempt to address these recommendations as part of ongoing studies of regional environmental management systems.

2. DESIGNATION & CLASSIFICATION OF HAZARDOUS WASTES

2.1 Introduction

Fundamental to the management of hazardous waste is the need for an adequate definition to provide bounds to the problem. The task of providing an adequate definition is not straight forward because of *"the tremendous scope of adverse human and environmental effects which may be caused by an almost boundless list of environmental contaminants. Against this background, almost any definition will seem simplistic and inadequate"* (Hrudey, 1985).

However, nothing can be achieved until a workable definition is agreed to.

Currently (1994), there are significant changes occurring in the administration of environmental controls in a number of States and at the Federal level. This includes extending the geographic extent of control over hazardous waste and the revision (or design of) hazardous waste regulations. A thorough appreciation of the background to current classification systems and a critical review of them is essential for the design of new and more comprehensive systems.

With this in mind, this chapter aims to:

- In Section 2.2 : provide an introduction to the concepts of designation of hazardous waste verses classification of hazardous waste, and the importance of understanding the roles of these two concepts.

- In Section 2.3 : provide a review of the Basel Convention systems of designation and classification of hazardous waste, as Australia is a signatory to the Basel Convention.

- In Section 2.4 : provide a review of the OECD documents on designation and classification of hazardous waste; this being the other international system which must be taken account of in designing a system for Australia.

- In Section 2.5 : a critical examination of the proposed ANZECC classification system is provided, including :
  - application of the concepts of designation and classification in an Australian context
  - potential implementation problems with the proposed system
  - problems of translation between the Australian and Basel Convention systems
  - matters of detail in the formulation of the ANZECC classification system.

- In Section 2.6 : a suggested list of issues for further discussion in ANZECC fora is provided.

2.2 Designation and Classification of Hazardous Waste

Designation of a waste as a hazardous waste refers to the regulatory procedure that legally determines that a particular waste is caught in the hazardous waste control system for a particular region; it is normally written in Regulations under an Act controlling the management of wastes. Classification of hazardous wastes is the system that facilitates the monitoring of wastes after they have been caught in the hazardous waste control system by the designation procedure. The approaches to designation and classification systems are reviewed in the following section before this distinction is revisited in more detail. (Wynne, 1987).

Three approaches, and sometimes a mixture of these approaches, have been used in the development of designation and classification systems, namely:

- generalised definitions
- exclusionary definitions
- inclusionary definitions.

The application of these approaches to designation and classification systems are explained in this section.

2.2.1 Hazardous Waste Designation Systems

Generalised Definitions

Generalised definitions are often provided in legislation and guidelines on hazardous waste management. They are important in providing a succinct description of the scope of the legislation/guidelines, but have limited immediate usefulness for the administration of hazardous waste systems or the conduct of research and development. They must be interpreted in order to build up a workable list of wastes which are hazardous.

"A hazardous waste is thus defined as any waste, excluding domestic and radioactive waste which, because of its quantity, physical, chemical or infectious characteristics, can cause significant hazards to human health or the environment when improperly treated, stored, transported or disposed" (WHO, 1987).

"Hazardous waste means a solid waste, or combination of solid wastes which, because of its quantity, concentration or physical, chemical or infectious characteristics, may:

(a)cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or
(b)pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed" (US. Act 94/580, 21 Oct., 1976).

"Hazardous waste means waste that requires special precautions in its storage, collection, transportation, treatment or disposal, to prevent damage to persons or property and includes explosive, flammable, volatile, radioactive, toxic and pathological waste" (Ministry of the Environment, Ontario, 1983).

"Hazardous waste means any waste other than radioactive waste considered as hazardous or legally defined as hazardous in the country where it is situated or through which it is conveyed, because of the potential risk to man or the environment likely to result from an accident or from improper transport or disposal." (OECD, 1990)

From these examples, it can be seen that generalised definitions of hazardous waste consist of one or more of the following components:

Hazardous waste is a waste, which:

- may adversely affect human health

- may adversely affect other living organisms

- may damage property.

Exclusionary Definitions

In general terms, hazardous wastes can be defined on an exclusionary basis i.e. they are wastes which are excluded from being disposed of to conventional waste management systems of:

- Municipal solid waste landfills, and

- Sewerage systems.

These conventional systems often have discharge acceptance criteria (trade waste discharge criteria for sewers, and lists of excluded wastes for municipal solid waste landfills) and hence any wastes which are not allowed to be disposed by these routes become, by this definition, hazardous wastes. In some countries (Canada, U.K.), these wastes are known as 'Special Wastes', which avoids the problem of whether they are actually hazardous or not.

While the exclusionary basis is logically comprehensive, it is a difficult means for Regulators to employ in controlling the generation and fate of hazardous wastes. While this exclusionary definition was used in the U.K. for a time, it is not now generally used in practice. It remains, however, a useful concept to aid in the appreciation of where hazardous wastes fit in the overall picture of waste management.

Inclusionary Definitions or Designation

Inclusionary definitions seek to define hazardous wastes by providing criteria or an inclusionary list which, if wastes satisfy these, designates them as hazardous wastes.

There are three types of inclusionary definitions:

- Generic definitions
- Constituent definitions
- Characteristic's definitions

Most Regulatory agencies in Australia use a combination of the first two, the US EPA (CFR40, 1990) and the Basel Convention (UNEP, 1989) use a combination of all three. The draft proposal for designation of non-BAT wastes in N.S.W. used a combination of all three along the lines of the Basel Convention (Joint Taskforce on Intractable Wastes, Phase 3 report).

Generic definitions are based on a description of the process from which the waste arises; for instance, sludge from the bottom of oil storage tanks, and distillation bottoms from solvent recovery plants.

Constituent definitions designate wastes as hazardous if they contain measurable concentrations of certain hazardous compounds. For instance, wastes which contain arsenic, or chlorinated solvents, or lead. In Australia the concentration or mass load of a constituent is not often employed in the definition - whether or not the concentration of a constituent is of concern is left to the judgement of the Regulator. North American and European practice is to include the concentration and mass of the constituent that makes the waste hazardous. The inclusion of concentrations and mass of constituents is now being employed in the N.S.W. Chemical Control Orders for chemical wastes and the definition of Scheduled (formerly intractable) Waste.

Wastes can also be designated as hazardous if they exhibit one or more of the following **hazardous characteristics:**

- Toxicity
- Flammability
- Reactivity
- Corrosivity.

The tests for determining each of these characteristics are not yet fully developed. Tests for toxicity characteristics are subject to the greatest debate (Francis et al, 1989). The test gaining acceptance in Australia is the US EPA Toxicity Characteristic Leaching Procedure (TCLP), which, in Australia, designates a waste as hazardous if the leachate from the waste has concentrations of toxic constituents greater than 100 times that allowed in drinking water. Standards Australia is modifying this test for an Australian Standard which is likely to become a component of a number of Australian regulations defining hazardous waste.

While most inclusionary definitions are simple lists with a combination of the above three approaches, the latest definitions developed for the Basel Convention and the non-BAT waste designation (Joint Taskforce on Intractable Waste, Phase 3 report) follow a more rigorous rationale; namely:

a waste is designated as a non-BAT hazardous waste if it is contained in a generic list of wastes, or contains one or more constituents of concern at concentrations and mass above threshold levels, and the generator has failed to demonstrate that the waste does not exhibit any of the four hazardous characteristics.

This designation allows the generators to *de-List* their wastes by demonstrating that they do not exhibit, according to standard agreed tests, any hazardous characteristics. Dilution of constituents to achieve this state is not allowed. However, there are practical difficulties which would mean that few generators would attempt to de-List their wastes.

2.2.2 Hazardous Waste Classification Systems

The discussion above has outlined how hazardous wastes are defined or designated, i.e. a means whereby the wastes so identified can legally be required to be controlled by the hazardous waste management system. A separate concept is that of classification systems which are used to categorise hazardous wastes to facilitate data collection and their management. Classification systems are sometimes coarser than designations and are often easier to apply in practice, and sometimes contain additional useful information not required for the legal purposes of the designation system. However they can also be derived from, or incorporate, the designation lists and criteria.

In summary, designation methods determine whether or not a waste is hazardous; once it is determined to be hazardous, the hazardous waste classification system tends to be used to identify the waste, collect statistics on its occurrence, provide additional information on the waste's characteristics to assist in its management, and to track its movement.

The classification system developed by the Australian Environment Council in 1986 (now the Australian and New Zealand Environment and Conservation Council, ANZECC), as shown in Table 2.1, has now been adopted in South Australia, Victoria and in Sydney by the former Waste Management Authority of N.S.W. and the new EPA. A draft report indicates that Tasmania is also likely to adopt the AEC standard (Tasmanian DEP, 1991). Brisbane and Western Australia have simplified versions which can be converted to the AEC system if required.

2.3 Basel Convention

2.3.1 Hazardous Waste Designation

The Basel Convention designation of hazardous waste, for the purpose of defining those wastes subject to the Convention, is provided in Article 1 of the Convention :

1. The following wastes that are subject to transboundary movements shall be "hazardous wastes" for the purposes of this Convention :

(a) Wastes that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III; and

Table 2.1 : AEC Hazardous Waste Classification System

Hazardous Waste Type

Plating and Heat Treatment	
1.	Discarded plating solutions
2.	Discarded heat treatment solutions
3.	Complexed cyanides
4.	Other cyanide solutions
Acids	
5.	Sulphuric acid
6.	Hydrochloric acid
7.	Nitric acid
8.	Phosphoric acid
9.	Chromic acid
10.	Hydrofluoric acid
11.	Sulphuric/hydrochloric acid mixtures
12.	Other mixed acids
13.	Organic acids
Alkalis	
14.	Caustic Soda, Potash, Alkaline Cleaners, Ammonium Hydroxide
15.	Lime Slurries, Cement Slurries (not containing metal sludges)
16.	Lime neutralised metal sludges
17.	Other sludges
Inorganic Chemicals	
18.	Non toxic salts (eg sodium, calcium chlorides)
19.	Arsenic and arsenic compounds
20.	Boron compounds
21.	Cadmium and cadmium compounds
22.	Chromium and chromium compounds
23.	Lead compounds
24.	Mercury and mercuric compounds, mercury containing equipment
25.	Other inorganic salts and complexes
Reactive Chemicals	
26.	Oxidising agents
27.	Reducing agents
28.	Explosives and unstable chemicals
29.	Highly reactive chemicals
Paints, Resins, Inks, Dyes, Adhesives, Organic sludges	
30.	Aqueous based (non combustible/non-flammable vapours)
31.	Solvent based FP>61°C (combustible)
32.	Aqueous based (flammable vapours)
33.	Solvent based FP<61°C (flammable)
34.	Paint residues
35.	Cured adhesives or resins
Organic solvents	
36.	Non-halogenated FP>61°C (combustible)
37.	Non-halogenated FP<61°C (flammable)

Table 2.1 : AEC Hazardous Waste Classification System

Hazardous Waste Type (continued...)

38.	Halogenated FP>61°C (combustible)
39.	Halogenated FP<61°C (flammable)
40.	Halogenated (non combustible/non flammable vapours)
41.	Others
Pesticides	
42.	Inorganic, organo-metallic pesticides
43.	Organo phosphorous
44.	Nitrogen containing pesticides
45.	Halogen containing pesticides
46.	Sulphur containing pesticides
47.	Biological pesticides
Waste oil	
48.	Contaminanted oils (lubricating, hydraulic)
49.	Oil/water mixtures (mainly oil) (cutting oils, soluble oils)
50.	Water/oil sludge, (mainly water)
Textile	
51.	Tannery wastes
52.	Wool scouring wastes
53.	Textile washwaters
Putrescible/Organic wastes	
54.	Animal effluent and residues (abbatoir wastes)
55.	Grease trap waste - domestic
56.	Grease trap waste - industrial
57.	Bacterial sludge (septic tank)
58.	Vegetable oils and tallow derivatives
59.	Vegetable waste - sludges
60.	Animal oils
Washwaters	
61.	Truck, machinery washwaters with or without detergents
62.	Other industrial washwaters
Inert Wastes	
63.	Inert sludges/slurries eg. clay, ceramic suspensions
Organic Chemicals	
64.	Non-halogenated aliphatics (non solvent)
65.	Non-halogenated aromatics and phenolics (non solvent)
66.	Highly odourous
67.	Pharmaceuticals and residues
68.	Surfactants and detergents
69.	Polychlorinated, halogenated organics (non solvent)
70.	Other
Bags, Containers	
71.	Containers and bags which have contained hazardous substances (hazardous substance to be specified)
Immobilised Wastes, Inert Wastes	
72.	Encapsulated wastes
73.	Chemically fixed wastes
74.	Solidified or polymerised wastes
75.	Inert solids
Miscellaneous	
76.	Contaminated soils (must specify contaminant, eg, cyanide, PCB etc)
77.	Pathogenic wastes
78.	Other

(b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import or transit.

Annex I and Annex III are provided in Appendix II. Annex I is made up of two parts :

- "Waste streams" which largely follow the generic approach described above, and
- "Wastes having as constituents" which follows the constituent approach described above.

Annex III is a list of hazardous characteristics, the third approach described Section 2.1.3.

2.3.2 Hazardous Waste Classification

The Basel Convention requires the completion of two forms that are similar in intent to the conventional waste manifest four docket system, and requires waste classification information to be provided in those forms, namely :

- Information to be Provided on Notification :
  - "Y" number (part of the designation system from Annex I, refer Appendix II)
  - Physical description (liquid, sludge, solid)
  - UN Number (the UN code number for waste dangerous goods, per List 2 of the 1986 AEC Guidelines)
  - Composition (nature, eg toxicity, and concentration of the most hazardous components)
  - "H" Code number from Annex III, refer Appendix II
  - Method of disposal, per Annex IV, refer Appendix II

This information is essentially a six field classification system.

- Information to be Provided on the Movement Document :
  - "Y" number from Annex I
  - Physical state of the waste
  - UN Number
  - "H" Code number from Annex III

  ie a four field classification system which is a derivative of the classification system used for the Notification document.

It can be seen that the Basel Convention classification system (even though it is not explicitly described as such) has used most of the designation system, and added fields to it, to provide more information about the waste in a convenient form that facilitates the management of the waste, particularly in the case of a spill.

2.4 OECD Monograph No 34

2.4.1 Hazardous Waste Designation

For the purposes of the OECD Decision on Transfrontier Movement of Hazardous Waste, wastes are designated as hazardous wastes if they appear in a Core List or are defined as such by member country legislation, namely :

> *For the purposes of this Decision* (Decision on transfrontier movements of hazardous waste, C(88) 90 (final)) *those wastes which belong to any of the categories described in Table Y shall be controlled unless such wastes do not possess any of the hazardous characteristics listed in Table 5*; and
> *all other wastes which are considered to be or are legally defined as hazardous wastes in the Member country from which these wastes are exported or in the Member country into which these wastes are imported.*

The Core List, or Table Y is provided in Appendix III and can be seen to be very similar to , but not exactly the same as, Annex I from the Basel Convention. Table 5 in the OECD monograph is similar to Annex III in the Basel Convention, and is provided in Appendix III.

2.4.2 Hazardous Waste Classification

The OECD Decision is explicit in providing a separate complete characterisation of hazardous wastes to assist in their management after the waste has been caught within the controls of the Decision. The International Waste Identification Code (IWIC) consists of :

- *Table 1* : One or two descriptors from the table of "reasons why materials are intended for disposal" - this is a very general generic type approach to classifying waste. Refer Appendix III.
- *Table 2* : One descriptor from the table of disposal and recycling operations. Details of the location of the disposal facility would be provided on transport documents, the main use of this field in the classification system would be in extracting information from a database on the fate of different types of hazardous wastes, and to track trends over time. Refer Appendix III.
- *Table 3* : One descriptor from the list of generic types of hazardous wastes, with a prefix of L (liquid), P (sludge) or S (solid). The first 17 of these are the same as Table "Y" used in the designation and for the Basel Convention; the remaining 23 are additional generic waste descriptors that are suggested for use provided they also contain constituents of concern as listed in Table 4 of the OECD monograph. Refer Appendix III.
- *Table 4* : Zero to three hazardous constituents in order of decreasing concern. This list is more extensive than the Basel Convention. Refer Appendix III.
- *Table 5* : One or two descriptors of hazard characteristics from this table, which is similar to Annex III from the Basel Convention. *Table 5* is also used in the designation of hazardous wastes. Refer Appendix III.

- *Table 6* : One of the activities generating the waste should be selected from this table of Standard Industry Codes. Refer Appendix III.

The IWIC can be conveniently expressed in a single line with double oblique line field separators :

Q----+----//D,R----//L,P,S----//C----+----+----//H----+----//A----

This provides a very comprehensive characterisation of the waste and facilitates monitoring and management of the waste once it is designated as a hazardous waste under the Decision. It can be seen that the designation system is incorporated into the classification system.

2.5 Proposed ANZECC Hazardous Waste Classification

2.5.1 Designation of Hazardous Waste

The responsibility for designating wastes as hazardous wastes in Regulations under Acts governing the management of hazardous wastes lays with the States; for example, South Australia's SAWMC Act has regulations containing Schedule 2, the Prescribed Waste list (refer Table 2.2) which defines those wastes to be controlled in South Australia by the hazardous waste provisions of the Act (licensing of generators, manifest procedures etc). Victoria also has a Prescribed Waste List, and NSW has Chemical Control Orders under the Environmentally Hazardous Chemicals Act as well as guidelines under the Waste Disposal Act based on an exclusionary approach to defining hazardous wastes.

However, as noted in the ANZECC Background paper (Part B, Section 2.3) , *"development of an efficient control procedure for cross border movements requires a clear delineation of the waste streams to be controlled"* i.e., a designation system defining those wastes required to follow the

Table 2.2 : South Australian Prescribed Waste List

Acids and acidic solutions

Adhesives (excluding solid inert polymeric materials)

Alkali metals and alkaline earth metals

Alkalis and alkaline solutions

Antimony and antimony compounds and solutions

Arsenic and arsenic compounds and solutions

Asbestos

Barium compounds and solutions

Beryllium and beryllium compounds

Boron and boron compounds

Cadmium and cadmium compounds and solutions

Calcium carbide

Carbon disulphide

Carcinogens, teratogens and mutagens

Chlorates

Chromium compounds and solutions

Copper compounds and solutions

Cyanides or cyanide solutions and cyanide complexes

Cytotoxic wastes

Dangerous substances within the meaning of the *Dangerous Substances Act, 1979*

Distillation residues

Fluoride compounds

Halogens

Heterocyclic organic compounds containing oxygen, nitrogen or sulphur

Hydrocarbons and their oxygen, nitrogen and sulphur compounds (excluding oils)

Infectious waste, being—

- *(a)* animal carcasses or matter produced in the course of scientific research;
- *(b)* human tissue, bone, organs, foetuses, blood or blood products;
- *(c)* used syringes, needles or surgical instruments;
- *(d)* any other waste that is contaminated with pathogens and that is produced in the course of the practice of medicine (including pathology), dentistry or veterinary science

Isocyanate compounds (excluding solid inert polymeric materials)

Laboratory chemicals

Lead compounds and solutions

Lime sludges or slurries

Manganese compounds

Mercaptans

Mercury compounds and equipment containing mercury

Metal finishing effluent and residues

Nickel compounds and solutions

Nitrates

Oil refinery waste

Organic halogen compounds (excluding solid inert polymeric materials)

Organic phosphates

Organic solvents

Organometallic residues

Oxidizing agents

Table 2.2 : South Australian Prescribed Waste List

(continued....)

Paint sludges and residues
Perchlorates
Peroxides
Pesticides (including herbicides and fungicides)
Pharmaceutical wastes and residues
Phenolic compounds (excluding solid inert polymeric materials)
Phosphorus and its compounds
Polychlorinated biphenyls
Poisons within the meaning of the *Drugs Act, 1908*
Reactive chemicals
Reducing agents
Selenium and selenium compounds and solutions
Silver compounds and solutions
Solvent recovery residues
Sulphides and sulphide solutions
Surfactants
Thallium and thallium compounds and solutions
Timber preservative residues
Vanadium compounds
Zinc compounds and solutions

National Manifest procedures is required. This does not appear to be provided in the Background paper. Options for an ANZECC national hazardous waste designation could include :

- A designation system based on the Basel Convention and OECD approach; for instance, a waste is a hazardous waste if:

  (a) it is contained in List 1 - Hazardous Waste Type, or it contains constituents listed in List 2 - Waste Constituents/Contaminants at levels regarded by the Responsible Authority to make the waste hazardous, and the generator has failed to demonstrate that the waste does not exhibit any of the hazardous characteristics listed in List 6. (This requires separate definition of "waste" and "Responsible Authority"). Refer Appendix I for Lists 1, 2 and 6 in proposed ANZECC system.

  or

  (b) wastes not included in (a) but are defined as hazardous waste by the legislation in the State where the waste is generated, through which it passes, or in which it is disposed. (This may be difficult in some States which do not include such definitions in legislation, and may lead to problems with Section 92 of the Constitution, precluding barriers to trade between States ? Refer discussion in Section 2.5.3)

- Use of existing State designations only; for instance :

  wastes are hazardous wastes if they are so defined by the legislation in the State where the waste is generated, through which it passes, or in which it is disposed. (Refer comments above)

2.5.2 Classification of Hazardous Waste

The general approach proposed by the ANZECC Classification system (Appendix I) closely follows the OECD model, with the following six fields used to fully characterise hazardous wastes on the Waste Transport Certificate :

- List 1 : Hazardous Waste Type is derived from List 3 of the 1986 AEC classification system (Table 2.1), with some changes, some additions and with a more flexible numbering system. The approach adopted is a combination of the generic, constituent and hazard characteristic approaches.

- List 2 : Waste Constituents/Contaminants is derived from List 5 of the 1986 AEC classification system, with "None of the below" removed from the earlier version, and with constituents listed in no apparent order. There appears to be space for up to four constituents on the manifest form, but the guidelines do not specify how many should be included and the order, if any , in which they should be entered. It is unclear what generators should enter if they do not know the constituents in the waste (use 27 Other ?)

- List 3 : Industry from which waste originates, uses the ASIC industry classification to identify the industry of origin for the waste. The ASIC system is compatible with the SIC system used by OECD. Some codes have been omitted and an examination of Sydney manifest data indicates that these industries do produce hazardous waste; these industry groups are :
    - 24 Clothing and Footwear
    - 33 Other Machinery

- List 4 : Disposal / Treatment Options generally follows the OECD Table 2, but uses slightly different terms and code numbers. OECD and UNEP use a "D" prefix for disposal options and an "R" for recycling; ANZECC uses the "R" prefix but not the "D". The manifest form uses simplified direct descriptions of disposal route for the generator and the fully coded List 4 for the treater to complete.

- List 5 : is the UN number and description for waste dangerous goods, and is the same as List 2 in the 1986 AEC version.(Appendix IV)

- List 6 : Hazardous Characteristics is taken from the Basel Convention Annex III, and is similar to the OECD Table 5. It supersedes List 1 from the 1986 AEC version, removing some characteristics, adding others and providing more detailed descriptions of the characteristics. It omits an important footnote included in both the OECD and the UNEP versions; namely, that objective tests to define quantitatively certain hazards do not yet exist, and that other tests have only been developed for pure chemicals and materials - their applicability to wastes may be open to question.

The proposed ANZECC Classification system implicit from the Part A of the Background paper and the layout of the Manifest form is therefore :

annn//nnnnnn//nnnn//nn//nnnn//Hnn

where "a" is an alphabetical letter and "n" is a numeral, with each List separated by a "//".

The Background section of Part A of the Background Paper states that the classification system is List 1 only. While this is the main list, and provides the most useful information on characteristics of the waste, international practice is to regard the whole six lists as fields for a comprehensive classification system - a comparison of quantities of wastes on the basis of one list only will not provide the same level of detail and meaning as one based on a number of lists.

Lists 1,2,3,5, and 6 can be entered directly into the manifest database by the data entry operator by reading the codes from Part 5, and list 4 from Part 7 of the Waste Transport Certificate. In order to enter data on the disposal route, the operator will have to check the ticked box in part 3 of the Certificate and translate it to a number from List 4. Manual checking by the regulatory agency would be too difficult. Having regard for the requirement for the generator to be able to understand five lists and enter the correct codes into the Certificate (this should not be difficult after the first time), and the increased use of data entry bureaus to key in data, sometimes using overseas companies, it is considered that the use of ticked boxes for disposal operation will lead to more data errors, than a direct entry of the appropriate List 4 code into an additional box in part 5 of the Certificate. This would then enable the Regulator to check that the treatment intended by the generator was undertaken by the treatment facility, and to follow up discrepancies if appropriate.

2.5.3 Possible Implementation and Interpretation Problems with the ANZECC Classification system.

List 1, Hazardous Waste Types, contains all three approaches to classifying hazardous waste, ie the generic (eg A100, A110), constituent (eg., A120, A130) and hazardous characteristic (e.g., E100, E110) approaches. There is usually only one code selected from this List, but because of the three approaches used, it is possible to classify the one waste in a number of correct , different ways. For example, arsenic used for termite treatment could be classified as D130 : Arsenic, arsenic compounds; or as H180 : Other inorganic wood preserving compounds; nickel hydroxide sludge could be classified as C120 : Lime neutralised wastes containing metallic constituents, or as D210 : Nickel, nickel compounds.

When there are no detailed guidelines on use of the Lists, it is possible (as may well happen with the current AEC system in use in Sydney, Victoria, and SA) for different regions to be classifying the one waste type in a number of ways. This makes comparison among regions via the National Waste Database very difficult - there is always doubt on the true variation among regions, i.e., how much of the variation can simply be accounted for by different methods of use of the List 1.

Most of the problems in using List 1 can be overcome by eliminating the duplication that exists with Lists 2 and 6. As both Lists 2 and 6 are part of the six field classification system (if this broader international definition of Classification is accepted) there will be no loss of detail. Examples include (this is not exhaustive) :

- A120 and A130 could be eliminated in favour of covering this aspect in List 2, using Code 8
- B100 to B180 Acids could be eliminated in favour of a more extensive list in List 2 using Code 18

- C100 and C110 could be moved to List 2 under Code 19 (using sub-numbers for more detail), but C120 and C130 should remain in List 1, as they are consistent with the generic approach.
- D100, D110, D120, D130, D140, D150 etc should be moved to List 2, but D121, D141 should remain in List 1.
- E100, E110, 130 should be moved to List 6. E120, if it refers to the chemicals in commercially produced explosives should remain in List 1, but if it refers to the hazardous characteristic, it should also be moved to List 6 for consistency.

2.5.4 Possible Problems of Translation to and from the Basel Convention and OECD systems

The major potential problem arises from the mixture of approaches in List 1 of the ANZECC system. If Australian classifiers of waste choose a category from List 1 that is not from the generic approach (even though it is often possible for them to do so), there may not be an equivalent from the "Y" list of the Basel Convention or the Core List of the OECD Decision. For example, if a nickel hydroxide sludge was classified in Australia as D210, then the ANZECC Background paper indicates that there is no Basel Convention equivalent (and no OECD equivalent). However, if the waste had been classified as C130, then the ANZECC Background paper indicates an equivalent of Y35 in the Basel Convention "Y" table (and Code 26 from the similar, but more comprehensive Table 3 in the OECD system).

Again, these potential problems could be avoided if List 1 of the ANZECC system adopted a fully generic approach and moved the constituent categories into List 2, and the hazardous characteristics into List 6.

2.5.5 Matters of Detail in the ANZECC Classification System.

The following matters could be considered in the finalisation of the ANZECC classification system; they are listed in order of appearance in the Background paper, and not in order of priority. General issues relating to the Classification System for hazardous wastes have been treated in some detail. The following points relate to some details in this area:

- There are advantages in maintaining the structural arrangement of the OECD and Basel Convention systems as they provide clearer delineation among waste types in ANZECC List 1 and avoid duplication between List 1, and Lists 2 and 6. The *content* of each list can be modified to suit Australian industries, but there is no advantage in altering the structure of the classification system. The major advantage of the proposed ANZECC system is its similarity to the previous AEC system, and therefore will be more familiar to some users and may (having regard for the difficulties in interpreting some categories) enable easier comparison between past waste generation and future waste generation in Australia. (paragraph 2 , page 2 under Background) The remaining points are addressed to the proposed ANZECC structure; if it is reorganised then some of the matters raised may still be relevant, but for a different list.

- List 4 on Disposal/Treatment options is not included in Part 5 of the Manifest form proposed. (Paragraph 3, page 2 under Background) There are good arguments in favour of including it in Part 5 of the Manifest form; refer discussion in Section 5.2 above.

- In general, the Lists 1 to 6 require some detailed guidance notes, including examples, so that they are interpreted and applied in a uniform manner around Australia.

- "M for mixed loads" is ambiguous; it could mean mixtures of solids and liquids, in a drum for example; or, it could mean a tanker has collected a mixture of loads, acids and oily water for example. The distinction between sludges and liquids also needs to be defined (1% solids concentration ?).

- The major waste types should have a one letter prefix, e.g., Paints, Lacquers, etc should be prefixed with an "F", to enable a shorthand description of groups of waste types to be used in graphs, reports etc.

- Inorganic chemicals are listed in order of importance. The importance of the constituent will also be related to it concentration, total mass and environmental availability. It would be too costly and difficult to account for these matters, so the accompanying guidance notes should provide the basis on which the constituents were listed, and note that rigorous prioritizing of constituents is not required in completing the Manifest.

- While the ANZECC List 1 does not have equivalents in the Basel Convention "Y" table, some of ANZECCs List 1 categories do have equivalents in other lists in the Basel Convention and the OECD systems (e.g., D270 is C2 in OECD Table 4).

- "G170 : Solvent recovery residues" (ANZECC list 1) is better placed as equivalent to "Y11 : Waste tarry residues arising from refining, distillation and any pyrolytic treatment." (Basel Convention Annex I). If Y1 to Y18 is taken as the generic approach list, and Y19 to 45 as a separate constituent list; and the ANZECC lists 1 and 2 are similarly kept as generic and constituent lists respectively, then this sort of potential anomaly would not arise. A detailed check of the whole translation has not been undertaken in this review.

- If the Inorganic chemical list is priority ordered , then the constituents in List 2 should be similarly ordered, and, as argued above, all constituent descriptions should be moved into an expanded List 2.

- An "unknown" code 28 could be included in List 2.

- 2400 Clothing and Footwear, and 3300 Other machinery should be added to List 3.

- List 4 : consider including prefix "D" for treatment type 1 to 15 as in the Basel Convention, and provide a definition of the various treatment types in the Guidance notes, e.g., what is the detailed distinction between 1 Landfill and 5 Specifically engineered landfill.

- List 6 : Consider including at least in the Guidance notes, the note included in the Basel Convention *"The potential hazards posed by certain types of wastes are not yet fully documented; tests to .....".* Also include in the Guidance notes the agreed standards for determining each of the hazardous characteristics defined to date, and provide comments on testing protocol development e.g., for toxicity, refer to the Draft Australian Standard leaching protocol (Standards Australia, 1992)and the work in the CRC for Waste Management and Pollution Control Ltd.(CRCWMPC, 1993 in progress).

2.6 Suggested Issues for further Discussion by ANZECC

A number of issues have been raised in Section 5 of this discussion paper. In summary, the issues suggested for further discussion in ANZECC fora are :

- The need to change the approach for List 1 to an exclusively generic approach to reduce confusion in applying the List in Australia and to facilitate translation to Basel Convention and OECD systems.

- Make the ANZECC hazardous waste classification an explicit six field system with one or a specified number of codes for each field taken from the six Lists.

- Develop detailed guidelines on use of the ANZECC designation and classification systems, providing numerous examples, so that they may be uniformly applied.

- Obtain a number of practitioners views on translation of the ANZECC classification system to the Basel Convention and the OECD systems. Resolve differences through a Delphi technique or via an independent arbitrator.

- Consider the list of suggestions for improvements to the details of the classification system, provided in Section 2.5.5 of this discussion paper.

3 HAZARDOUS WASTE DATABASES AND THEIR APPLICATIONS

3.1 Introduction

As indicated in Figure 1.2 (Part A), Manifest Procedures tie all other components of the hazardous waste system together. Without a well designed and enforced manifest procedure, investment in facilities in other components is likely to be under-utilised. This chapter describes the design and operation of manifest systems in some detail, and then looks at the development of an hazardous waste database that can be established from the completed manifest forms. The uses that this database can be put to in the field of environmental management are then explored.

Much of the content of this section is based on the author's work in consulting for the Joint Taskforce on Intractable Waste, and as leader of the National Waste Database project, undertaken for the CRC for Waste Management & Pollution Control, and funded by the Commonwealth EPA; reference is made to publications where appropriate. Details of the National Waste Database project are provided in Appendix V.

In many cases the analysis has been of a preliminary nature only, because of the limited data currently available, and problems with the integrity of existing data. The National Waste Database will attempt to resolve these problems over the next two years, and the ideas outlined in the final sections of this chapter will be pursued in greater depth in follow-up studies to be undertaken by the author.

3.2 Manifest Procedures

There are two major aims of manifest procedures :

- The first and most important, at least in the initial stages of establishment of a hazardous waste control system in a region, is to track the movement of all waste that leaves a generator's site for off-site treatment and disposal facilities.

- The second aim, which increases in significance as the hazardous waste control system matures, is to provide data for a database which can be interrogated by managers of the system to provide information on trends in the management of waste types from industries, particularly on whether waste minimisation is being effective.

The way in which the design and operation of manifest systems influences the successful achievement of these aims is described in the remainder of this section. Some discussion is provided on the establishment and usefulness of the manifest database in this section, largely as it relates to operation of the manifest procedure in achieving its first aim. More wide ranging discussion on the database is provided in Section 3.3.

3.2.1 Design and Operation of Manifest Procedures

The operation of the manifest procedure is illustrated in Figure 3.1 and examples of existing manifest forms are provided in Figure 3.2 (the AEC recommendation) and Figure 3.3 (from South Australia).

A critical examination of the operation of the existing manifest procedure in various States is provided in the remainder of this section. An outline and critique of the proposed changes to the AEC system by the current review by ANZECC are provided in Section 3.2.2 below. Important issues that need to be considered in the design of new manifest procedures are then summarised in Section 3.2.3

Operation of the manifest procedure follows the steps outlined below :

1. The generator becomes licensed by the EPA (or similar body) to generate certain waste types, usually as part of the development approval process for new facilities, and is issued with a licensed premises number. In some jurisdictions (e.g. Sydney) the EPA inspects the plant and determines with the generator, the appropriate waste classification for wastes arising from the process; if the process and /or waste stream changes, then the generator applies for new conditions for their licence. In other jurisdictions, the generator decides on the appropriate classification for their wastes.

2. When the waste storage sump is scheduled for pump out, the generator fills in **Part A and Part D** of the manifest form (Figure 3.1) and retains a carbon copy of both (or only Part A). Part D is torn off and sent within seven days to the EPA as a record that waste has left the site. The original of Part A is forwarded-on intact with the remainder of the form to the transporter. Both Parts (A + B + C) and Part D have the same unique Notice Number, which uniquely identifies that particular load of liquid waste. The typical information provided in Part A is listed in the South Australian form in Figure 3.3, and generally consists of :

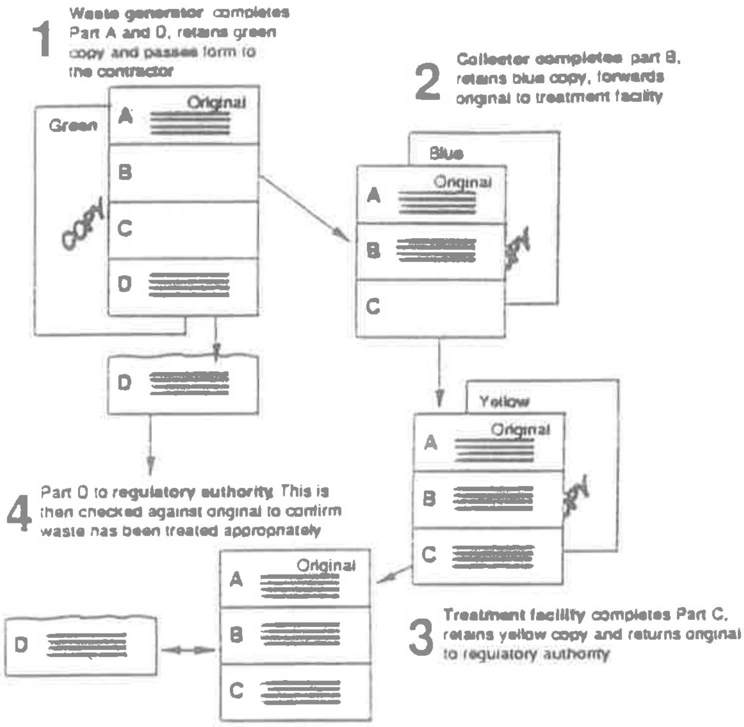


Figure 3.1 : Operation of Manifest Procedure

(Source : Maunsell, 1991)

AUSTRALIAN MANIFEST FOR MOVEMENT OF HAZARDOUS WASTES

NAME AND ADDRESS OF WASTE AUTHORITY IN STATE/TERRITORY WHERE WASTE IS GENERATED/ STORED

GENERATOR/STORER

1. Name of Generator/Storer
Business Address ....
....
Phone No: Business Hours .... After Hours ....

2. Generator's/Storer's Licence No. (if applicable)

3. Location where waste generated

4. Storage site prior to transport

5. Date of proposed transport

6. Transporter (Name) ....
(Address) ....
....

7. Name of Disposer/Storer to receive consignment ....
Disposal/Storage site address ....

8. Description of Waste

9. Additional description of waste

10. Coded Waste Description	LIST 1	LIST 2	LIST 3	LIST 4	LIST 5

11. Quantity .... (m³) (KG)

12. UN Packaging No. ....

13. Generator's/Storer's Safety and Handling instructions for Waste

14. Packaging method

15. I declare that the above waste is accurately described and is in a proper condition for transport in accordance with the Australian Dangerous Goods Code.
Name .... Signature ....
Date ....

TRANSPORTER

16. I acknowledge the receipt of the waste consignment described above.
Name .... Signature ....
Date ....

DISPOSER/STORER

17. I declare that the waste consignment described above has been received.
Name .... Signature .... Date ....
Date of disposal .... Method of disposal (see List 5) .... Disposers Licence No ......

18. Specify any discrepancy between waste described and waste received.
Name Storer/Disposer .... Signature .... Date ....

COPY ROUTING

GENERATOR	TRANSPORTER	DISPOSER/STORER
Pink to Authority	Yellow - retain	Blue to Authority
White - retain		Green - retain

Figure 3.2 : AEC Manifest Form

NOTICE NUMBER 33517

Waste Disposal Notice

WASTE CODE NO

A — This Section to be completed by the Generator or the Storer of the waste

NAME ....

ADDRESS ....

LICENCE No. ....

DESCRIPTION OF WASTE ....

.... pH. = ...

AMOUNT OF WASTE (Tonnes/KL/M³) ....

Toxic ☐ Corrosive ☐ Inflammable ☐ Highly Reactive ☐ Infectious ☐

INTENDED DISPOSAL ROUTE Recycling ☐ Landfill ☐ Incineration ☐

Storage ☐ Chem./Phys. Treatment ☐ Immobilisation ☐ Evaporation ☐ Other ☐

NOMINATED DISPOSAL SITE ....

I hereby declare that the above consignment is accurately described and is in proper condition for transport.

Signature .... Name .... Date ....

B — To be completed by the transporter of the waste.

NAME OF LICENSEE ....

ADDRESS ....

....

LICENCE NUMBER .... VEHICLE REGISTRATION No. ....

I hereby acknowledge receipt of the above mentioned waste for transport.

Signature .... Name .... Date ....

C — To be completed by the Depot receiving the waste.

NAME OF DEPOT ....

ADDRESS ....

....

LICENCE NUMBER ....

I hereby declare I have received the above waste.

Signature .... Name .... Date ....

Complete the Section of this Notice that applies to you.
The copies are distributed as follows:

Green — Kept by the waste generator.
Yellow — Kept by Depot.
Blue — Kept by Transporter.
White — Returned to SAWMC by the Depot within 7 days of receipt.

D — IS THE RESPONSIBILITY OF THE ASTE GENERATOR TO REMOVE HIS PORTION AND RETURN IT TO HE S.A. WASTE MANAGEMENT OMMISSION WITHIN 7 DAYS OF ISPATCH OF THE WASTE.

SOUTH AUSTRALIAN WASTE MANAGEMENT COMMISSION
G.P.O. BOX 2607, ADELAIDE, S.A., 5001

WASTE DISPOSAL ADVICE

NOTICE NUMBER 33517

NAME ....

ADDRESS ....

LICENSED WASTE TRANSPORTER ....

BRIEF DESCRIPTION OF WASTE ....

Figure 3.3 : SAWMC Manifest Form

- **Generator's Name and Address** (including postcode) : Some jurisdictions use the company's registered office address. This reduces the usefulness of data collected, as there may be cases where the one company may have a number of facilities. If it is desired to undertake an analysis of the data collected to determine the origin of waste types by sub-region, then a query of the database by postcode would indicate that the CBD is a major hazardous waste generating region. It is therefore preferable to use the premise's address and to separately licence each premise.

- **Licence Number** : the licence number will be related to more detailed data in a database which will give details of the licence conditions, including in some jurisdictions, the types and quantities of hazardous wastes that are permitted to be generated in any one year. In such regions it would be possible to do a routine check in the database to ensure that only licensed waste types are being removed from the premises. Some form of auditing of the procedure would also be required (see discussion in Section 3.2.3 below).

- **Waste Code Numbers** : These are taken from the AEC hazardous waste classification system, and vary from one to six fields; with the AEC guideline recommending six (including the UN Packaging Number) and the South Australian form requiring three. These fields in total provide the full description of the waste type, including all relevant attributes (refer the discussion in Section 2.5.2, Part B on this aspect). As discussed in Section 2 (Part B), the integrity of the waste type data supplied to a database is dependent on the quality assurance measures in place at this point. At one extreme, there will be poor confidence in the data if an uncontrolled number of untrained operators at the generator's premise fill in the manifest form. However, if the EPA determines the appropriate waste type for each premises, and if only a limited number of responsible operators are designated for each premise, then confidence in the data will be high. If different approaches are used in different regions then inter-region comparisons must be undertaken with caution.

- The **Waste quantity** is required, and may be reported as volume (m^3 or KL) or mass (t). In South Australia it is assumed that all liquid hazardous wastes have a specific gravity of 1.0, which is reasonable for most wastes which are aqueous based and where measuring equipment would be no more accurate than +/- 5 %. Sydney has a weighbridge at its major off-site treatment plant and therefore uses mass, the most reliable method. Victoria allows generators to choose the unit, and volume and mass are entered separately into the database. If volume as measured by a dip-stick or a pitot tube is used, then random checks on nett weight of the tanker should be undertaken by the generator to guard against possible fraud, or by the EPA to protect the integrity of the data.

- **Intended waste treatment and disposal method** is included in the South Australian, but not the AEC form. There is some debate on whether the generator or the treatment plant should specify treatment method. In Australia, where prime responsibility would reside with the Treatment Plant operator for any environmental damage caused by their operation, this information should probably be entered by the treatment plant. The generator still has a duty of care to ensure that their waste is being properly managed by contracted parties (Moore & Worrall, 1992), and an auditing system covering this aspect should be in place if generators want to demonstrate "due diligence". The information enables useful summaries to be made on the use of different treatment methods over time.

3. The transporter completes **Part B** of the form, providing their name, address, licence number and vehicle registration number. The transporter retains a carbon copy of Part A and B of the manifest form for their own record. When entered into a database, the regulator can routinely check that the transporter is only carting waste types for which the vehicle is appropriately equipped (via the licence number and associated conditions). For certain types of waste, such as grease trap pump-outs, the transporter can be licensed as an accredited agent, and can

complete a simplified manifest form on behalf of the generator. This is a pragmatic response on the part of regulators to the problem of form completion when generators are unavailable, as is usually the case for fast food outlets and restaurants (commonly serviced early in the morning to avoid odour nuisance to customers). Care must be taken when analysing data from manifest databases, as the grease trap waste is often in a separate database.

4 The transporter arrives at the treatment plant, gets their nett weight recorded, and parks while a short routine "finger print " analysis of a sample of the waste is undertaken. This normally consists of simple tests such as pH, colour, odour, flash point and reactivity with the existing contents of the storage tank into which the tanker contents will be discharged. A sample is stored for later detailed analysis in case the load is subsequently suspected of containing material that upsets the treatment processes. If the waste appears to be as described on the manifest form, the load is discharged into the receivals facility and the treatment plant completes the manifest form, **Part C**. The treatment plant records that they have accepted the waste, insert their licence number and sometimes specify the type of treatment provided to the waste. The treatment plant retains a carbon copy of Parts A, B and C for their own records, and sends the original on to the EPA.

5 The EPA routinely inserts selected data from Part D of all forms and, separately and independently, from Parts A, B and C into a manifest database. Sydney uses a mainframe computer (Digital) with associated database software, while Victoria and South Australia use Foxpro and dBASE III+, respectively, running on PCs. Manual matching of Parts D and (A + B + C) would be too cumbersome, as a regulator would typically process tens to hundreds of thousands of forms each year.

Data is fed into the database each month, often by a Bureau, and a report is generated on all those forms with Part D in the system, but without the corresponding Parts A, B and C. Inspectors then investigate these missing forms to determine whether prosecution is necessary.

Approximately 1% of forms do not have matching parts (Pers. comm., David Cook, Vic EPA, July 1992), and subsequent follow up of these results in a small number of illegal practices being uncovered (most can be traced to forms not being posted in to the EPA, or going missing in the mail system - as can be demonstrated by the carbon copies held by the various parties). Other reports as described above are generated to check that various licence conditions are being met. The primary purpose to date has been the monitoring of the movement of individual tanker loads of waste from generation to final disposal, to ensure that appropriate management is occurring.

3.2.2 Proposed ANZECC Establishment of a National Hazardous Waste Manifest System

Appendix I provides a copy of an ANZECC Background Paper on a draft proposal to establish a revised Hazardous Waste Classification system and to establish a National Manifest Procedure, which would enable hazardous wastes to be transported easily from one State to another for treatment or recovery. It is proposed to introduce one form design (with individual State information on EPA addresses etc) and to arrange for appropriate notification of relevant authorities to ensure that proper control occurs on the interstate movement of hazardous waste.

With the above understanding of the manifest procedures, the reader should now study Appendix I, (starting from the page headed "Part B : Prior Notification of Inter-state Movements of Wastes") before proceeding to the next part of this Section.

A commentary on the proposal in Appendix I follows (ongoing deliberations by the ANZECC committee may make some of these comments obsolete for current versions of the proposal, and for the final version). General comments are provided on the issue of prior notification/approval and then a series of more detailed comments on the Manifest form itself are provided in point form.

"Waste" and "Hazardous waste" have different meanings in State legislation; "waste" can include urban solid waste for instance. Hazardous waste should be used where this is intended, and waste should be reserved for occasions when all wastes are intended.

The warning that *"it is important that approval mechanisms do not impose an undue administrative burden on industry or agencies* " is fully supported. An analysis of the EC system in the late 1980s (Bartels et al, 1989a), showed that EC directives at that time required, for instance, a flow of 101 documents for a single consignment of waste to travel from Italy through Austria, West Germany, and Belgium on its way to Great Britain ! The result was that there was very poor compliance even as late as 1988, well after the Seveso fiasco and attempts to stop future recurrences of highly toxic waste becoming "lost".

The recommendations by Bartels et al (Bartels et al, 1989a; Bartels et al, 1989b) to overcome the inadequacies of the manual paper document system is included the establishment of a sophisticated central computer with on-line access by all parties to the transhipment exercise, with electronic mail essentially replacing the paper forms. Prior notification and relevant approvals by each responsible authority was to be done directly through access to the central computer, with parties having legitimate interest to information being able to track the notifications, approvals and actual movement of the waste through the various jurisdictions. Aggregated output from the database on the generation and treatment of hazardous waste from EC countries would be provided to the OECD proposed database TOXWASTE. Inquiries have been made on the current status of these databases, and detailed discussions will be held between Bartels and the author in April 1994 as part of the National Waste Database project.

It unlikely that the volume of hazardous waste transport between Australian States could warrant a sophisticated central computerised system as proposed for Europe, especially if it is in fact decided to go for prior notification only (and not also a prior approval system which the EC at that time had to use ; the post 1992 situation in this regard is unknown). However, an hypothetical shipment of, say PCBs, from WA, through SA and NSW to Queensland for treatment, should be undertaken to ensure that the manual paper documentation system is not too unwieldy, and can in fact keep pace with the shipment. The author undertook such an exercise with a group of graduate students at the University of NSW and found that, even with all relevant parties sitting at the same table (and not in separate offices in different States), it took some time to effect one hypothetical movement of PCBs. It is recommended that a number of hypotheticals be worked through and be documented as examples for the use of regulators and others involved in the process.

Legal opinion should be sought, if not already done so, on the application of Section 92 of the Constitution to the movement of hazardous wastes between States. Although Scheduled Wastes are likely to be managed by uniform methods around Australia, some States may have different approaches to managing other particular hazardous wastes. Even after harmonisation of *approaches* to hazardous waste management via the IGAE, there may be legitimate differences of degree between States, or differences in timing of phasing in of regulations. For instance, if State A introduces a Regulation requiring all solvent wastes to be recycled or disposed of by high temperature incineration, and a generator in State A wishes to dispose of solvent wastes (at a lower cost) in State B by solidification or disposal to secure landfill (which is legal in State B), would State A or B be able to prevent this (they may both have legitimate reasons for wishing to) ?

In another case, if a generator in State C generates a waste that is not designated as hazardous waste in State C, and the generator wishes to dispose of the waste in State D where it is designated as hazardous, what are the requirements for licensing of the generator and manifest procedures (State C may not wish to be involved, can State D essentially run it's Manifest system in another State ?) These problems would be overcome if States moved to uniform designation of all hazardous wastes, but the first case of one State wishing to impose more stringent regulation of those agreed hazardous wastes would remain. This could be accommodated if prior approval was allowed to be required.

Part B of the Background paper recommends in favour of a prior notification only. However, under 4 Implementation, the paper recommends, *"... each jurisdiction needs treatment/disposal/storage* *facilities to only accept interstate consignments of waste where an identification number has been given by the regulatory authority in the receiving State."*, and this would essentially be the generators "licence" number. If the receiving State *must* provide the generator with an identification number (which would be a generators licence number in if the generator was in the receiving State), then the system is essentially one of prior notification. If, however, the receiving State wishes to retain the right **not** to issue an identification number (as it could do in its own State, if for instance the generator did not comply with certain waste minimisation criteria), then the system is essentially one of prior approval. It is possible that States may not wish to give up their sovereignty in this matter.

In summary, as noted by the Background paper, the issues of prior notification and prior approval are complex, and there is a danger that the hypothetical problems that need to be resolved will be used as an excuse to delay implementation of the National Manifest system. It is strongly suggested that a trial system be implemented for a one or two year period and that it be reviewed at the end of the period in order to fine tune the procedure (or change from prior notification to prior approval if appropriate) .

Comments on matters of detail in relation to the Manifest procedure are :

- 5 (a) : include the six field hazardous waste identification code in the information to be provided with the Notification form.

- 5 (e) : can the receiving State refuse acceptance of the hazardous waste at this point ? If so, under what conditions without infringing Section 92 of the Constitution.

- Appendix 2, Explanatory notes on the Proposed manifest, Part A, paragraph 6 : the inclusion of postcode of the generating facility will be of great assistance in mapping regional generation of hazardous waste.

- Paragraph 7, 8 op. cit. : the roles and responsibilities of the generator and the treater need to be clarified. Is the generator's responsibility ended on specifying a treatment method, and a licensed treatment facility, or does the generator have some responsibility to ensure that the specified treatment has in fact been undertaken ? Does the treater have any discretion to treat the waste according to the other wastes stored at the facility, and the availability of process capacity, provided discharge criteria are adhered to ? In a number, possibly the majority, of cases the treater will have better knowledge of appropriate treatment methods. What responsibility does the Regulatory agency have; for instance, to check that the treatment facility specified is licensed to accept a certain type of waste and has appropriate treatment capacity.

- Paragraph 10, op. cit. : how many constituents should be listed in the hazardous waste classification ?

- Operation of Manifest system : this appears to be well thought through and comprehensive. It is suggested that the system be trialed through a series of "games", with each party represented by a player, and with players deliberately making errors to check whether the system will detect and correct them. This game was played in some graduate waste management classes at UNSW, and with expansion to a series of hypotheticals, potential shortcomings of the system could be detected.

- Waste Transport Certificate : List 4, 5, and 6 should be inserted in parentheses as has been done for Lists 1, 2, and 3 so that there is no confusion as to which List to use. Descriptors for data entry should be the same as in the Lists, e.g., "Waste Code No" in Section 5 of the Waste Transport Certificate should be "Hazardous Waste Type" per List 1 heading.

3.2.3 Concluding Remarks on Design and Implementation of Manifest Procedures

It is incumbent on regulators to design and implement robust manifest procedures that actually fulfil the primary aim of tracking and ensuring hazardous wastes that are generated, follow the intended route to final disposal. In describing the general design and operation of manifest procedures, a number of potential "pit-falls" have been alluded to. The more important aspects that need to be accounted for in the design and implementation of manifest systems are summarised below.

Failure to initiate and follow manifest procedures :

The most obvious way of avoiding the manifest procedures is to fail to fill in the manifest form at the point of generation; either deliberately by collusion between the generator and the transporter (in which case the liquid waste may be disposed illegally to sewer or other disposal sites) or by the generator genuinely failing to appreciate that they are dealing with hazardous waste (in which case the waste may be disposed to the generator's sewer connection, or with urban solid waste to landfill). Comprehensive surveys and inspections by EPA officers and Water Board trade waste inspectors should avoid the latter reason - usually by inspection of all premises belonging to certain industry types that generally produce hazardous waste.

If collusion exists, then by definition the tracking system alone must fail in its objective. It will require additional procedures and measures to ensure that only a negligible number of generators have an (economic) incentive to continue with avoiding the control system. Sydney experienced dramatic increases in waste being controlled by the manifest system following the introduction of jail terms for directors and multi-million dollar fines for companies (the Environmental Offences and Penalties Act, 1989), and coinciding with an *expose* of illegal practice on current affairs television programs. Alternative, or additional, measures could be the introduction of similar practices to those already undertaken by the Taxation Department, namely :

- A requirement for certain types of industry with more than a certain number of employees to have independent professional waste audits undertaken which would provide an independent check on the manifest returns for those companies.

- A compulsory EPA environmental/waste audit of the largest 100 waste producers in a region or State.

- Random environmental/waste audits of smaller companies with well publicised prosecutions and sufficient penalties to minimise any economic incentive to avoid the manifest procedures.

As the cost of hazardous waste treatment and disposal continues to increase, the economic incentive to avoid the manifest procedure and associated high management cost will increase, so that increasing emphasis will need to be placed on these complementary measures.

EPA control verses self regulation

Two approaches to controlling hazardous wastes through manifest systems have emerged. At one end of the spectrum, self regulation is instituted, while at the other end direct EPA involvement is integrated into the procedure. The appropriate approach for any one region will be dependent on the resources made available to the EPA, the size and nature of industry, and the regional environment. In a region where the EPA has limited resources, where industry is dominated by single or large companies, and where the natural environment is not sensitive (or perhaps where decisions have been made to leave it in an already degraded state), then self regulation may be appropriate.

The advantages of having the EPA involved in the initial licensing, to a degree where an EPA officer specifies the type (and possibly quantity) of hazardous wastes that are permitted to be produced, and subsequently inspects the facility to ensure that conditions have not altered, are :

- there is a high degree of confidence in the data reported in the manifest system (or at least a high degree of consistency)

- the possibility of avoiding the inadvertent improper management of hazardous wastes through disposal to sewer or municipal waste landfill.
- if the industrial process does change and new or increased quantities of wastes are produced, then the manifest system will alert the regulator to this, and follow up action in the form of revision to licence conditions, fees structures and waste minimisation requirements can be initiated.

Four part versus five part manifest procedures

The system described in Section 3.2.1 is a five part procedure. In four part procedures, the Part D of the form does not exist and the EPA only knows about the hazardous waste load after it has successfully reached its final disposal location. This is essentially what happens with the "accredited agent" procedure commonly used for grease trap wastes. If it is also used for other types of wastes (which are of greater environmental concern), there is the potential for unscrupulous transporters to forge manifest forms, lure the generator into the belief that procedures are in order, and then illegally dispose of the waste and fail to submit the partially completed forms. The EPA would not have any way of checking against missing unique Notice numbers, as the forms would not have originated from the EPA office.

However, in regions where there are only a small number of large generators, and where the waste streams are well known to the EPA, and therefore the risk of fraud is low, such four part procedures may be appropriate.

Implementation of a national manifest system

Section 3.2.2 provides a detailed discussion of a proposed national manifest system, which will increasingly be required as specialised facilities to treat (especially) scheduled wastes become established in parts of Australia. Important aspects that will need to be included in any national system include :

- The need to develop an ANZECC designation of hazardous wastes which delineates those wastes required to follow the national manifest system for interstate transfers.
- Adopt a trial "prior notification" approach for operation of the national manifest system, because of the advantages of having simpler, but still relatively complex (compared to intrastate) procedures. Continuing discussions and investigations of the two approaches (prior notification and prior approval) and a review the procedures after one to two years should be undertaken.
- Use a game theory approach to trial the manifest system in an attempt to discover any inadequacies before it is used in practice.
- Consideration of the list of suggestions for improvements to the details of the manifest system, provided in Section 3.2.2 above, should be undertaken.

3.3 Hazardous Waste Databases

The operation of the manifest procedures in the way outlined in Section 3.2 enables a comprehensive database to be established on individual tanker loads of hazardous waste. In addition to the primary purpose of checking the route and fate of individual loads, the database can be used for regional hazardous waste management purposes by interpreting the data collected on the origin and fate of different types of hazardous waste (see Section 3.4 and 3.5). This section describes the structure and content of a typical manifest database and the proposed National Waste Database, which will be derived from the regional manifest databases.

3.3.1 Manifest Databases

The four entities ("tables" in ACCESS) in manifest databases are waste loads, generators, transporters and treatment/disposal facilities. Attributes ("fields" in ACCESS) for these entities are :

- **Waste Loads :**

  - generator by licence number (key field in ACCESS)
  - * date collected
  - * waste type
  - * ANZSIC industrial code to which generator belongs
  - * contaminants in the waste, usually allowing for three to be listed
  - * quantity of waste type, m^3 or tonne
  - transporter licence number
  - treatment/disposal site
  - * treatment/disposal method

- **Generator information :**

  - Licence number (key field in ACCESS)
  - Name
  - Address (preferably of the premises)
  - Waste types licensed to be generated

- **Transporter information :**

  - Licence number (key field in ACCESS)
  - Address
  - Vehicle registration numbers (in some regions individual vehicles rather than companies may be licensed)
  - Types of hazardous waste licensed to transport

- **Treatment/Disposal Facility**

  - Licence number (key field in ACCESS)
  - Name and address of facility
  - Licensed treatment processes
  - Waste types licensed to be treated

Standard reports from these manifest databases generally concentrate on the primary aim of manifest systems, to detect non-compliance with required procedures, and include :

- Report on the Notice numbers that have a Part D but no corresponding Part A, B and C in the database.
- Report on the vehicles transporting waste types for which they are unlicensed.
- Report on facilities that are accepting waste types for treatment for which they are unlicensed.
- Report on waste loads that are treated or disposed of by unacceptable methods.

In addition, reports can be generated to assist in the design and improvement of hazardous waste management in the region in which the manifest database operates. These reports could include :

- Monthly and annual generation of each waste type, to observe trends over time. If policy changes (such as pricing changes, legislative measures, and waste minimisation programs), are super-imposed on these trend analyses, then a qualitative assessment of the effect of these changes can be made.
- Monthly generation of a combination of waste types that require the same treatment process, for the design of regional off-site treatment plants. By closer examination of daily and weekly variation it is possible to derive peaking factors for the design of receivals facilities and treatment processes that need to be able to respond to such variation. As in many engineering fields, as the quantity declines the variability increases.

- Waste generation by waste type and industry type. Such reports provide an indication of the industries where waste minimisation resources are most likely to be effectively employed.

Examples of the above reports from the SAWMC manifest database, and their application to the design of management systems and treatment facilities in Adelaide, are provided in Part C of this report.

3.3.2 Proposed National Waste Database

The scope of the National Waste Database is outlined in Appendix V, and includes the establishment of a hazardous waste database module within the overall database (Moore et al, 1994), which will have the following structure ; entities will be hazardous waste loads and regions, with the following attributes (refer to the attributes marked with a "*" in Section 3.3.1) :

- Hazardous waste loads :
    - waste type (A : Plating wastes etc)
    - quantity generated, t/month
    - region in which generated, uniquely identified by Statistical Local Area, Statistical sub-division, statistical division and state (key field)
    - industry generating the waste type
    - contaminants in the waste type
    - type of treatment provided to the waste load

- Regional Information derived from ABS databases :
    - region, uniquely identified using ABS divisions described above(key field)
    - population

- employment

- ANZSIC industry types

The primary purpose of the National Waste Database in the hazardous waste field is to provide a means of monitoring the generation of hazardous wastes in regions, particularly the success of waste minimisation programs, and to be able to make inter-regional (and eventually international) comparisons. Reports that will be generated by the National Waste Database include :

- Waste generation by waste type and region (see Figure 3.4)

- Waste generation per employee in each ANZSIC industry code by waste type, region (see Table 3.1)

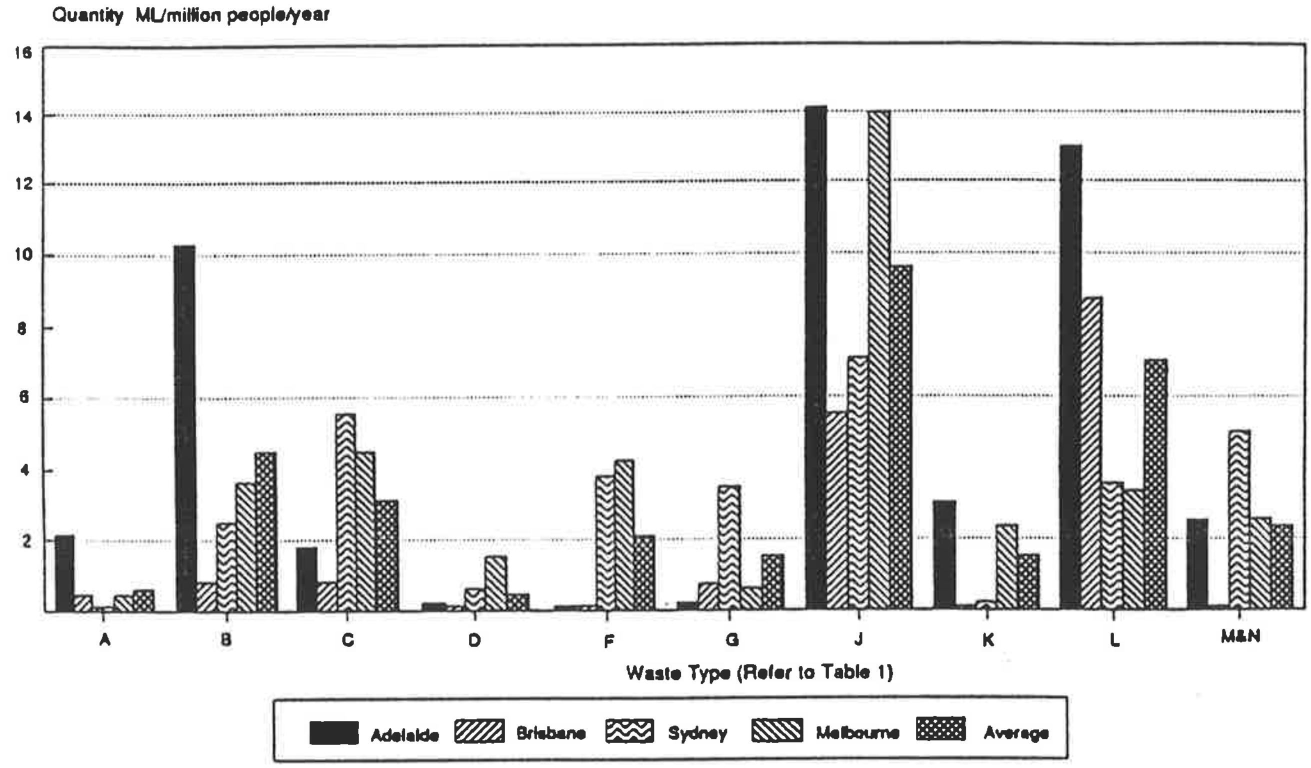
The use of these reports and others that may be derived from the National Waste Database for improvement of regional environmental management is explored in Section 3.5.

3.4 Estimates of Hazardous Waste Quantities in Regions with No Manifest System

Often a region will need to establish an hazardous waste management system in the absence of data on hazardous waste generation from a manifest database. It is common for manifest systems to be established some years after initial planning and establishment of facilities and programs has commenced [12], and therefore alternative methods of estimating and predicting hazardous waste generation quantities need to be used to enable the system components to be designed, at least to the preliminary stage until data from a manifest procedure becomes available.

This section describes three methods that can be used to provide estimates of hazardous waste generation in a region where there is no manifest procedures in place; consideration of future trends in

[12]The author would argue that a manifest system should be one of the first components introduced into a region in the process of establishing a hazardous waste management system. The cost is small, interim disposal facilities can be designated to receive hazardous waste (it is better to have all waste going to one confined location than to be dispersed with no control into the general environment) and, most importantly, real data can be collected from the region so that facilities can be more confidently designed.



A: Plating and Heat Treatment
B: Acids
C: Alkalis
D: Inorganic Chemicals
F: Paints, Resins, etc.
G: Organic Solvents
J: Waste Oil
K: Textile
L: Putrescible Organic Wastes
M,N: Wastewaters, Inerts

Figure 3.4 : Waste Generation per Million People by Waste Type

(Source : Joint Taskforce, 1990, prepared by the author)

Table 3.1 : Hazardous Waste Generation per Production Employee in each ANZSIC Industry Group

(Source : Moore & Chelliah, 1992)

UNIT RATES FOR SYDNEY HAZARDOUS WASTE GENERATION BASED ON WASTE MANAGEMENT AUTHORITY MANIFEST DATA
(Litres / Production Employee / year)

ASIC Index Code	Waste Type A	B	C	D	E	F	G	H	J	K	L	M&N	P	Q	Misc. R	Imm S
21	0.00	4.30	6.24	2.65	0.00	4.12	4.23	0.08	0.91	0.00	592.55	64.66	0.95	0.00	5.92	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	5.91	0.00	25.79	30.11	0.00	0.00	31.42	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.12	0.29	0.00	0.16	0.00	0.00	0.04	0.16	0.00	0.00	0.00
25	0.47	3.33	1.30	12.80	0.00	28.76	2.63	0.00	0.85	0.00	0.53	3.98	1.04	0.00	0.00	0.00
26	0.13	2.84	0.80	0.00	0.00	105.71	25.58	0.01	8.00	0.00	8.18	2.68	3.96	0.00	0.00	0.00
27	0.00	30.34	169.01	51.13	7.12	931.79	884.00	7.08	113.54	7.30	112.14	197.23	180.33	0.00	2.94	98.54
28	0.00	1.58	56.56	21.59	0.00	26.51	0.71	0.00	98.45	0.00	3.75	47.52	4.53	0.00	0.00	0.00
29	0.00	89.40	830.07	51.69	0.01	10.84	13.58	0.00	268.15	0.00	15.46	108.92	0.00	0.00	0.00	0.00
31	8.53	240.09	239.28	31.38	0.80	19.09	33.88	0.58	193.94	0.00	2.79	12.04	11.49	0.00	0.00	0.54
32	0.02	10.41	1.68	5.51	0.00	10.47	9.74	0.00	149.37	0.00	0.83	52.47	0.06	0.00	0.00	0.00
33	0.04	23.59	73.65	5.88	0.00	5.90	4.53	0.00	45.77	0.00	2.17	35.73	1.83	0.00	0.00	0.00
34	0.50	0.00	2.42	0.54	0.00	15.58	3.11	0.00	24.50	29.98	13.75	1.83	0.54	0.00	0.00	0.00
51 - 58	0.00	0.56	0.39	6.40	0.00	0.11	37.47	0.00	39.11	0.00	3.62	59.67	0.72	0.00	0.18	0.00
Other *	0.002	0.138	0.219	0.030	0.126	0.503	2.903	0.009	5.480	0.005	4.347	2.681	0.749	0.000	0.171	0.006

* - Unit rate based on Total Employees ie Litres / Employee / year

21	- Food, beverages, tobacco	A	- Plating/heat treat
23	- Textiles	B	- Acids
24	- Clothing, footware	C	- Alkalis
25	- Wood, wood products	D	- Inorganic wastes
26	- Paper products, printing	E	- Reactive wastes
27	- Chemicals, Petroleum, Coal	F	- Paints/resins etc.
28	- Non-metallic products	G	- Organic solvents
29	- Basic metal products	H	- Pesticides
31	- Fabricated metal products	J	- Waste Oils
32	- Transport equipment	K	- Textile wastes
33	- Other Machinery etc.	L	- Putrescible wastes
34	- Miscellaneous manufacturing	M&N	- Wastewaters
51-58	- Transport & Storage industry	P	- Organic Chem.
Other	- Other Service industries	Q	- Bags, Cont.
		R	- Miscellaneous
		S	- Immobilised

population growth, the economy, and waste management practices may enable the methods to be used to attempt prediction of future waste generation. The three methods are (Moore and Chelliah, 1992) :

- Population based models
- Production employee based models
- Questionnaire methods, supplemented with a production employee model

3.4.1 Population based models

Brisbane, Sydney, Melbourne and Adelaide have had manifest procedures in place since the mid 1980s and population based unit rates for the various waste types can be derived by dividing total regional waste quantity for each major waste type by regional population. This is provided in Figure 3.4 and Table 3.2 from Maunsell (1990) and Part C of this report.

Hazardous waste generation can be simply estimated by :

$$Q_i = p_i * P \qquad [1]$$

where :

Q_i = quantity of waste type i (from A to M&N), in KL/year

p_i = unit rate of waste generation for waste type i, KL/million people/year

P = population in the region, in millions

P is inserted into the equation in millions to reinforce the notion that the estimate is very coarse, and that estimates should not be quoted to more than two significant figures.

A judgement is required on the appropriate value of p_i to use. The generation of most hazardous waste types is related to the industrial profile of a region rather than population and it is only reasonable to use population based approaches if the region for which waste generation is being estimated has a similar industrial economy to the region from which p_i was derived. In most cases this will not be the case, and

Table 3.2 : Hazardous Waste Generation per Million People in Australian Cities

CITY	POPULATION (MILLIONS) (2)	WASTE TYPE A		B		C		D		F		G		J		K		L		M & N	
		Ml/yr	(1) Ml/m/yr																		
ADELAIDE	1.01	2.2	2.18	10.54	10.44		1.30	0.763	0.27	0.15	0.15	0.23	0.15	14.3	14.16	2.77	[illegible]	13.2	13.07	[illegible]	2.38
BRISBANE (4)	1.22	0.56	0.46	1.12	0.92	1.12	0.92		?		?	0.75	0.6	4.17	3.42		?	10.74	8.80		?
SYDNEY (5)	3.53	0.11	0.03	8.72	2.47	19.00	5.83	2.46	0.70	12.86	3.64	11.85	3.36	24.48	6.73	0.45	0.13	12.30	3.30	16.44	4.66
MELBOURNE (6)	2.96	1.52	0.55	10.54	3.59	12.38	11.35	3.87	1.31	12.66	4.28	1.6	0.54	41.26	13.94	6.53	2.23	9.76	3.30	7.29	2.46

NOTES

(1) ML waste generated/1 million people/yr

(2) 1988 Year Book, Bureau of Statistics

(3) Waste Types

Adelaide	Brisbane	Sydney	Melbourne
A Plating		Plating	A
B Acids	Acid Aali/ metal site 2794 kl/yr	Acids	B
C Alkalis		Alkalis	C
D Inorganic Chem.		Inorganic Chem	D
F Paints, org sludge		Paints resins etc.	F
G Organic Solvents	Solvent waste	Organic Solvents	G
J Waste Oil	Aqueous Oily Waste	oils/water mix	J
K Textile		Textile	K
L Pesticide	Biodeg. Aug & sludge waste	Putrescible Organic	L
M Wastewater		Wastewater	M
N Inert slurries		Inert	N

(4) W.E. Razzell, Brisbane

(5) E. Samuel, NS

(6) J. Hogan, Vic, EPA

therefore estimates based on population have to be used with caution. An exception to this may be grease trap waste (type L) and oily wastes (type J) which would be derived from service industries of restaurants and the transport industry respectively, which in turn would be expected to be correlated with population.

The author's experience with population models as reported in Moore & Chelliah (1990), Moore et al (1991), and Maunsell (1991), is that the population model provides a quick "ball park" figure for initial estimates which can then be used as a check against gross errors in the following two methods which involve a greater number of calculations. In many cases the estimates from the population model for waste types L and J will be used in preference to estimates derived from other methods.

3.4.2 Production employee based models

Historical background to the development of the model in Australia

Production employee based models attempt to overcome the deficiencies of the population model by relating hazardous waste generation to the industrial profile of a region as expressed by the number of production employees in various ANZSIC industry groups. The method was first introduced into Australia by Caldwell Connell Engineers (1985) in a study for the Victorian EPA. This "Desk Study of Industrial Waste Generation in Victoria" was based on Canadian industrial waste generation data prepared by Reid Crowther & Partners (1980). Subsequent data from manifest records indicated that, at least for total hazardous waste generation quantities, the production employee model was more reliable than questionnaire surveys, which significantly overestimated quantities (Monahan, 1989).

Since then the author has used the method in hazardous waste studies in South Australia (Maunsell, 1990), in NSW for non-BAT waste estimates (Joint Taskforce on Intractable Waste, 1990) and in the Hunter region for hazardous waste estimates (Maunsell, 1991). In South Australia the method was used to compare manifest records of waste generation with what might be expected if South Australia had a similar waste management system to Victoria/Canada (which at the time had higher charges and different treatment processes in place). The results of this comparison and the implications for policy development in South Australia are described in Part C of this report.

The application of the method in NSW used new data extracted from the manifest system for Sydney for these studies, by the Waste Management Authority of NSW. The most recent data available is presented in Table 3.1 (Moore & Chelliah, 1992) and is currently the only available production employee unit loads data derived from Australian experience. The National Waste Database project will obtain the data reported in Table 3.1 on a routine basis from every region with a manifest system and will report the data at least annually (Moore and Tu, 1993). In time, sufficient data will become available for statistical parameters describing the variability of these unit load factors to be determined. This will significantly enhance the usefulness and credibility of the method.

The production employee model method

The steps to follow in arriving at an estimate of hazardous waste generation in a region based on Sydney's experience from April 1989 - May 1990 is :

1. Decide on which table of unit waste production factors (quantity of each waste type produced by each production employee in each ANZSIC group) to use. Currently only the Canadian data modified for use in Victoria in 1985 and Sydney data for 1989 - 90 is available, and generally the latter will be more appropriate (Table 3.1)

2. Obtain the total number of employees in each ANZSIC industry type in each region (and sub-region if appropriate) to be studied. In NSW the ABS publication is "Manufacturing in NSW, 1986 - 87", ABS Cat No. 8207.1 or more recent update.

3. Apply a ratio of Production Employee/Total Employee to total employees in each industry in the region. Production employees are considered a better basis as they exclude office and warehouse employees that do not generate hazardous waste. This data has to be specially requested from ABS, and is presented in Table 3.3 for NSW as a whole in 1986 - 87.

4. Develop a spreadsheet to multiply unit waste production factors by the appropriate number of production employees; and then sum to obtain the total waste quantity of each waste type, i.e. :

MANUFACTURING ESTABLISHMENTS EMPLOYING FOUR OR MORE PERSONS: TYPE OF EMPLOYMENT BY INDUSTRY SUB-DIVISION, 1986-87 NEW SOUTH WALES.

ASIC code	Description	Administrative etc employees	Production and all other employees (P.E)	Total Employment (T. E)
21	Food, beverages, and tobacco	15,714	34,391	50,505
23	Textiles	2,483	6,952	9,435
24	Clothing and footwear	3,427	17,541	20,968
25	Wood, wood products, and furniture	6,125	16,611	22,736
26	Paper, paper products, printing, and publishing	16,833	20,493	37,326
27	Chemical, petroleum, and coal products	11,358	13,565	24,923
28	Non-metallic mineral products	3,727	9,289	13,016
29	Basic metal products	9,741	27,700	37,441
31	Fabricated metal products	9,987	24,791	34,778
32	Transport equipment	8,263	22,652	30,915
33	Other machinery	16,478	37,752	54,230
34	Miscellaneous manufacturing	5,932	15,619	21,551
	Total, manufacturing industries	*110,068*	*247,856*	*357,924*

Table 3.3 : Ratio of Production Employees to Total Employees

(Source : Australian Bureau of Statistics)

Region :				By :					Date :					
ANZSIC	Ratio	Employees								Waste Type A : Plating				
	PE/TE	Region 1		Region 2		Region 3		Total		Unit Rate	Waste Quantity, KL/Yr			
		Total Empl	Prod Empl	Total Empl	Prod Empl	Total Empl	Prod Empl	Total Empl	Prod Empl	UPE	Region 1	Region 2	Region 3	Total
21	a	b	=a*b	c	=a*c	d	=a*d	=b+c+d	=a(b+c+d)	f(A,21)	=f(a*b)	=f(a*c)	=f(a*d)	=f(A,21)a(b+c+d)
23														
24														
25														
26	From	From		From		From				From				
27	Table 3.3	ABS		ABS		ABS				Table 3.1				
28		Catalogue		Catalogue		Catalogue								
29														
31														
32														
33														
34														
Total											Sum	Sum	Sum	Sum

Table 3.4 : Guide to Establishment of a Spreadsheet for a Production Employee Model

$$Q_i = \sum_{j=21}^{34} f_{ij} * PE_j \qquad [2]$$

where : Q_i = KL/yr of waste type i (from A to Q)

f_{ij} = unit waste production factor for waste type i in industry j

PE_j = Production Employee in industry j (ANZSIC group 21 - 34 for manufacturing)

ANZSIC industry types normally of importance are listed in Table 3.1, as is an explanation of the letter abbreviations for major waste types. There is currently no justification in quoting waste types to the next finer level of detail (the 80 categories in the AEC classification system, refer Chapter 2, Part B)

A guide to establishing the spreadsheet is provided in Table 3.4, and the application of the method is illustrated in Part C of this report and in Moore & Chelliah (1992).

Concluding remarks on the interpretation of model results

A comparison of the results from the population model and the production employee model, using Sydney Waste Management Authority and Victorian EPA (modified Canadian data) for NSW regions outside of metropolitan Sydney[13] is provided in Figure 3.5. The comparison shows that the production employee method generally provides higher estimates for most waste types in the industrial regions of the Hunter and the Illawarra, while the low level of industrial activity in the remainder of NSW means that the population model (which has been derived from industrialised cities in Australia) provides higher estimates there. As discussed above, the population model provides higher estimates for oily wastes (type J) and grease trap wastes (type L) in most areas. In this study for the Joint Taskforce on

[13] It should be noted that as at March 1994, only the Sydney metropolitan area is covered by an hazardous waste manifest system in NSW.

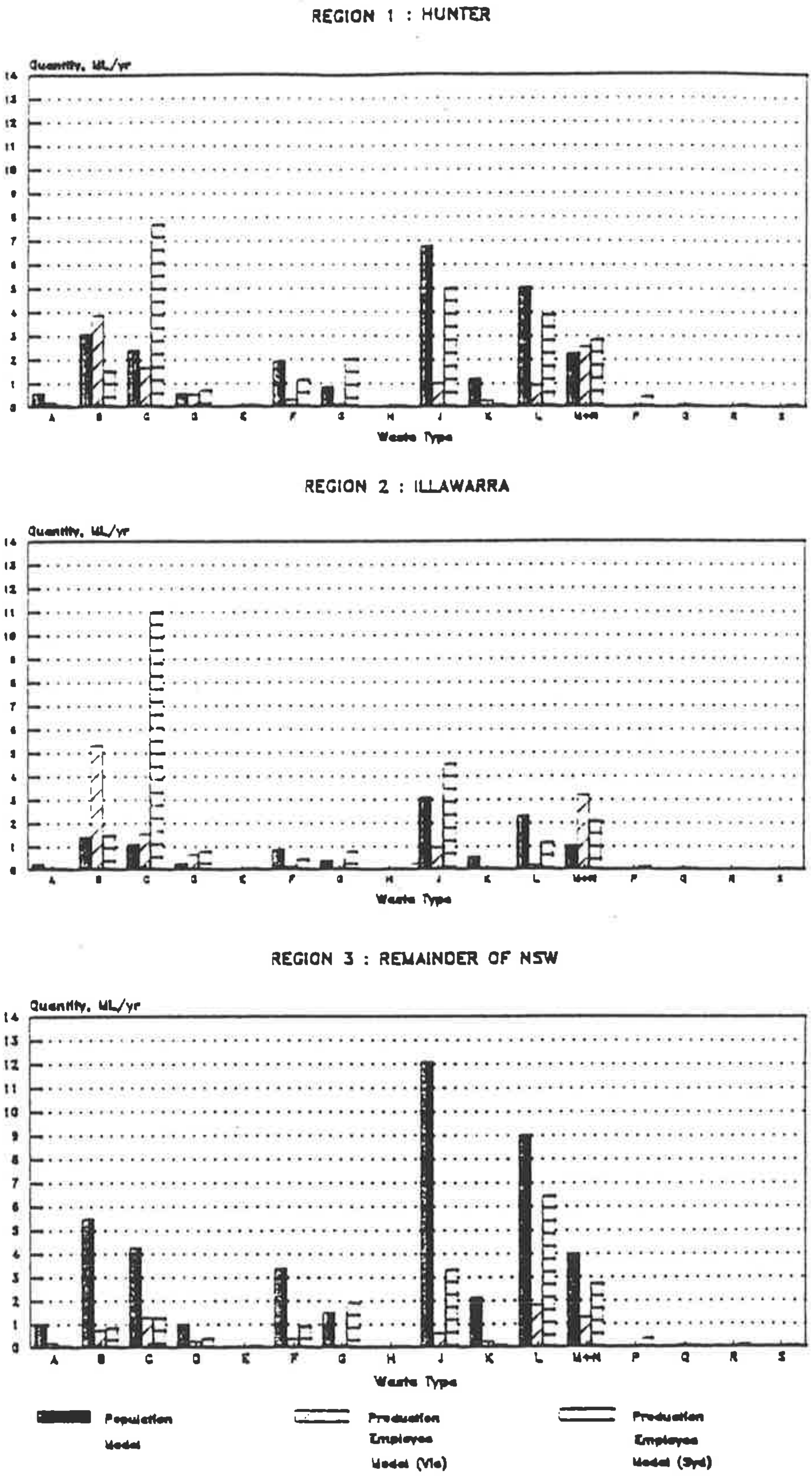


Figure 3.5 : Comparison of Desk Study Methods for Regions in NSW

(Source : Moore & Chelliah, 1992)

Intractable Waste, the production employee model using Sydney data was used for all wastes types with the exception of Type L and Type J where the population model estimates were taken into account.

It must be appreciated that, in using the unit factors derived from the Sydney manifest database, two major implicit assumptions are being made, namely :

- that the waste management system in existence in Sydney, with its registration of generators, manifest system, relatively strict sewer discharge standards and levels of enforcement, and relatively high off-site treatment costs[14] will tend to produce a particular outcome in terms of the type and quantity of hazardous waste requiring off-site treatment and disposal from a particular set of industries. These circumstances do not exist anywhere else in NSW, nor in the rest of Australia. Hence when an hazardous waste management system is implemented in a region it can be expected that initial generation rates will be higher than estimated. However, if a control system similar to Sydney's is introduced, then within a period of 5 years, the estimated figure should be reasonable. This initial high volume (if the manifest system is effectively implemented) must be able to be accommodated by the design of the system.

- that the make-up of the 2 digit ANZSIC industry groups in Sydney is similar to the region in which the method is being applied. Again this will rarely be the case. In the case illustrated in Figure 3.5 for instance, there are no integrated steelworks in Sydney it can therefore be anticipated that there will be some significant error in the estimates for the Hunter and the Illawarra where integrated steelworks are a major industry (and employer). All that can be done in these cases is to recognise the source of error, and to make judgements that may reduce the error. The use of targeted surveys, as described in the following section may provide some assistance here. Eventually, it is hoped that international standardisation in the waste classification field and the exchange of data among countries will enable larger databases to be established which will allow statistically meaningful data to be applied in regions where no manifest systems exist.

[14]High in Australian terms, North American and European costs are substantially higher than Australia.

3.4.3 Questionnaire Surveys

Introduction

The third and most expensive method of obtaining an estimate of hazardous waste generation in a region with no manifest system is to undertake a questionnaire survey of potential generators. While this method has a high credibility with community groups, politicians and some public agencies, the author's and the Victorian EPA's (Monahan, 1989) experience is that the results are less reliable than the desk study methods described above. In regions where there has been little environmental regulation, generators will not have records of waste generation to the level of detail required to design a hazardous waste management system. At best, the survey will reveal the generation of waste at a point in time, rarely will there be sufficient resources available to understand variation through-out the year, or from one year to the next.

It is therefore the author's opinion that questionnaire surveys are best used to answer specific questions arising from the desk studies, and to complement them rather than attempt to provide an alternative view or an independent check.

Design of Questionnaire Surveys

Having regard for the limitations of the data likely to be obtained in a survey, the following steps are suggested as the best means of obtaining the most meaningful results for usually limited budgets. The procedure is based on standard waste audit recommendations (Waste Management Authority of NSW, 1990) modified by the author's experience so that a whole region may be included in the survey rather than one facility. The focus of these surveys, like the desk study, is with wastes requiring treatment and disposal at an off-site facility, as the one of the main aims of these studies is to provide data for the preliminary design of these treatment plants.

1. Use ABS information and results from the desk studies to identify major industry types and major industrial waste generators in a region.

2. Select a number of facilities in each major (significant) industry group and attempt to obtain a uniform representation in each significant group; for instance, obtain a sample with at least 50 % (or 80% if resources allow) of production employees represented in each significant industry group (ie major industries in terms of employment as well as waste generating potential). The "80/20" rule will often apply in that it will be possible to sample 80 % of the facilities by only visiting 20 % of the premises; and similarly that 80% of the waste will be generated by 20 % of the premises. Care needs to be taken to consider whether it will be the same 20 % of premises in both cases[15].

3. Contact each facility to be surveyed by phone and follow-up letter and explain the purpose of the survey. If possible obtain supporting letters from local authorities, and attempt to provide assurances that confidentiality will be maintained. In this regard it is usually preferable to use professional consultants rather than staff from a public regulatory authority. Information that should be sort should include :

    - the number of production employees (so that scale up to the whole region can be undertaken)
    - details of discharge licences (to sewer and to surface waters, providing information on the waste streams produced and some indication of possible needs for off-site treatment facilities)
    - a process flow sheet of the facility (to identify waste producing unit processes)
    - waste removal records from contractors (particularly liquid wastes as this will give a total waste stream quantity, but probably not a detailed description)
    - production records (to obtain some idea of variation within the year, and from year to year)

[15] i.e., it is possible that the smaller premises in terms of employees will generate proportionately higher waste quantities. If this is the case, then a range of facility sizes should be included in the sample, and scale up to the whole region should include differential generation rates for different sized enterprises. However, having regard for the problems in obtaining reliable data it will rarely be possible to include this level of sophistication in the analysis.

- water usage over time (most hazardous wastes are aqueous based wastes; water usage can therefore give a good indication of waste generation quantities, as well as variability through-out the year)

- raw material usage (again related to waste generation and variation in waste generation)

- on-site waste treatment and disposal (this may avoid the need for off-site treatment; or it may be unacceptable and be closed down after the establishment of an off-site facility, or the on-site treatment process itself may give rise to waste residues requiring off-site treatment and disposal).

4. Visit the site of each facility contacted by letter, walk through the facility and obtain the information requested by letter while you are at the site. Try to confirm the data collected while you are at the site. Data collected in this personal manner is likely to be more reliable than poorly completed forms returned by mail. It is better to obtain good data from a small number of sites than a lot of data with poor reliability.

5. Scale up the survey results for the whole region on the basis of the production employees sampled; eg if 50 % of the production employees have been sampled in the survey then double the waste quantities to obtain an estimate for the whole region. In industries that have not been sampled, provide data from the desk studies.

3.4.4 Conclusions

In the absence of manifest systems there are three methods that can be used to estimate hazardous waste in a region for the purpose of planning a regional hazardous waste management system; two desk study methods and one survey method. The desk study methods are quick (one week) and inexpensive while the survey method can take up to 6 months and cost tens of thousands of dollars. In Australia, the author's experience and the experience of others is that the desk study methods, under certain conditions, are more reliable. However, surveys can be useful in obtaining targeted information not well modelled by the desk studies, and in improving public confidence in the results of the overall investigation.

In undertaking estimation of regional hazardous waste generation, the following points need to be recognised in interpreting the final output :

- Surveys typically overestimate the manifest data, in Victoria by a factor of 2.(100%)
- Manifest data itself for any one waste type can vary from one year to the next by up to 50% (refer Part C). Expectations of obtaining estimates within to less than within 30 % are therefore unrealistic.
- In applying desk study methods, the region being investigated needs to be large enough to overcome anomalies introduced by single major industries that may not have been well represented in the region from which the manifest derived unit factors were obtained. If there are large industries that are likely to bias the results, then special surveys need to be undertaken to obtain industry/region specific data to over-ride the model estimates.
- Resources spent on surveys should be limited, as it is better to use the money on early introduction of even a partial manifest system. Comprehensive surveys can take a year to complete. In the same time frame a partial trial manifest system covering major and representative industries can be introduced to collect "real" data - the waste quantities that will actually arise in the region when the full management system is introduced.
- Improved confidence in the unit factors used in the desk study methods will be achieved as the results from the National Waste Database become available.

3.5 Hazardous Waste Indices in Regional and Industrial Environmental Management Plans (Moore & Tu, 1993)

3.5.1 Introduction

Increased awareness of the need to maintain and enhance environmental quality has led to the development of processes such as the Ecologically Sustainable Development (ESD) consultations, and subsequently to a series of strategies to improve environmental quality. This section explores the potential for information on hazardous waste from manifest derived databases to be used as indices or indicators of environmental quality, which can be employed to monitor and improve performance in this area in individual industries and in industrial regions.

Government initiatives to improve environmental quality include :

- The Intergovernmental Agreement on the Environment (IGAE, 1992))
- State of the Environment Reporting
- The proposed National Pollutant Inventory (NPI)
- The National Waste Minimisation and Recycling Strategy (1992)

Industry has also initiated environmental improvement programs amongst various Industry Association members, sometimes in advance of government incentives. Important recent initiatives in the area of hazardous waste include :

- ACIC (Australian Chemical Industry Council) Responsible Care Program
- ACM (Australian Chamber of Manufactures) Best Practice Environmental Management Program

All of these programs have environmental improvement objectives and require, implicitly or explicitly, the development of environmental quality indices against which performance can be measured. It is important to develop rational measures so that benchmarks can be established and facilities can measure their improvement over time, against both their own and industry-wide standards.

Many areas of human activity demonstrate the power of monitoring and feedback in influencing behaviour towards desired ends, including the field of waste minimisation (Hirschhorn, 1991). This means that the establishment and monitoring of environmental quality indices itself is likely to result in improved performance, through simple actions of "paying attention" to the processes related to the environmental quality index, or in, in reverse terms, Eisenhower's words "the uninspected inevitably deteriorates".

The remainder of this section examines possible environmental quality indices which may be appropriate in the field of minimising the potential for environmental degradation from hazardous waste generation by industry, utilising information which will become available as the National Waste Database becomes established.

3.5.2 Unit Production Indices of Hazardous Waste Generation

Existing Practice

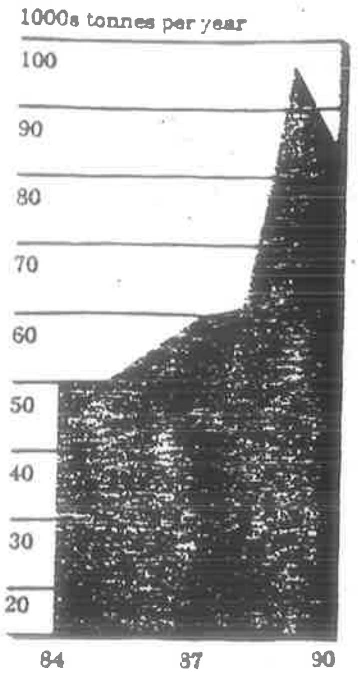
Currently, monitoring and reporting of hazardous waste generation consists of graphs of total waste generation in a region over time (Figure 3.6), or tables of major waste types (Table 3.5). Occasionally relationships between GDP and total hazardous waste generation are used to compare countries (Figure 3.7). These are very useful but coarse measures of trends in hazardous waste generation and do not readily enable detailed comparison among cities.

Table 3.5 : Quantityof Major Waste Types in Adelaide

(Source : SAWMC Annual Report, 1990/1991)

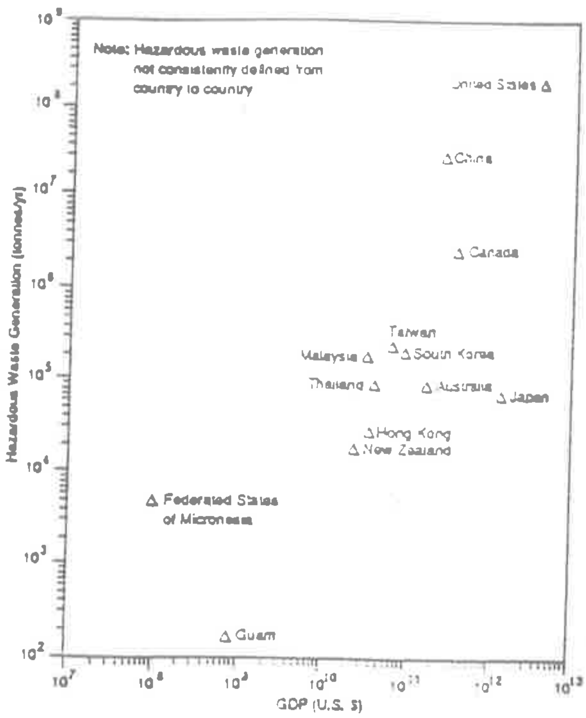
Waste Type	Quantity (Kilolitres) 1989	Quantity (Kilolitres) 1990
Plating & heat treatment	2228	1750
Acids	13043	6673
Alkalis	3520	3158
Inorganic chemicals	378	1170
Reactive chemicals	85	3
Paints, resins, inks, dyes etc.	435	869
Organic solvents	188	118
Pesticides washings	1112	304
Organic chemicals	390	818

The above quantities were the results of processing 8723 Waste Disposal Notices.



Generation of Hazardous Waste in Sydney
(Source : WMA of NSW Annual Report, 1990/1991)

Figure 3.6 : Waste Generation in a Region over time



Hazardous Waste Generation in the Pacific Basin
(Source : Pacific Basin Consortium for Hazardous Waste Research, 1990)

Figure 3.7 : GDP verses Hazardous Waste Generation

In Australia there have been only two isolated published analyses of the relationship between hazardous waste generation and what would be regarded as significantly related factors; the relationship between hazardous waste type generation and population in Australian cities in 1989 is illustrated in Figure 3.4 (Joint Taskforce on Intractable Waste, 1990), and the relationship between hazardous waste type generation and production employees in various ASIC industry groups in Sydney in 1990 is illustrated in Table 3.1 (Moore & Chelliah, 1992). They point to the potential to develop rational and meaningful indices of hazardous waste generation.

Objectives for Environmental Quality Indices for Hazardous Waste

Appropriate objectives for environmental quality indices for hazardous waste generation by industry would include :

- the ability to relate hazardous waste generation to causative factors such as population, production employees in different industry groups, value added in different industry groups, quantity of product in industry groups.

- the ability to set and monitor targets for generation of different waste types for individual industry groups, and to be able to establish benchmarks for individual facilities to aim for in those industry groups.

- the ability to develop quantitative criteria and possibly one index for an industry group or individual facility to aim for, ie to go beyond waste minimisation of total hazardous wastes in general terms towards rationally developed criteria which specify how much of each type of waste should be the target generation rate for each industry/facility.

Ideally there would be an "Environmental Quality Index (EQI) function" for hazardous waste minimisation which would allow individual facilities to determine which mix of reductions of the various waste type quantities per unit production would yield the best improvement in environmental quality (maximise the EQI function) for a given investment. Furthermore, if this EQI for hazardous waste minimisation was developed through industry/government/community consultation, industry would have the opportunity of arriving at an agreed outcome via a process developed by themselves which best met the varying constraints on individual facilities. This would avoid the problems which will inevitably be encountered in trying to implement blanket targets such as reducing all waste by 50% by a specified date.

Suggestions for Hazardous Waste Indices

By linking the hazardous waste generation module in the National Waste Database with the ASIC related information from ABS, it should be possible to derive the hazardous waste indices described below. The limitations of each are also outlined.

- *Annual quantity of each hazardous waste type per head of population in a region.* This is illustrated in Figure 3.4 and suffers from the limitation that most waste types will be related to industrial activity and will only indirectly be related to population. However, as discussed above some waste types such as oils, oily water and grease trap waste may show a stronger correlation to population than industrial activity in some regions.

- *Annual quantity of each waste type per production employee in each ASIC industry group.* An example of this is shown in Table 3.1, and similar tables for each year will be generated by standard reports from the National Waste Database for each region which adopts the ANZECC National Hazardous Waste Classification and Manifest system. Currently this is limited to Sydney, Victoria and South Australia, but should become more widespread from 1994.

The index suffers from not directly allowing for the influence of increased productivity, ie if waste generation remains constant, an increase in productivity would imply an increase in waste generation per production employee. This could be allowed for, if productivity could be reliably measured by ASIC industry group and an adjustment made back to an index year of, say 1990. A related issue is the trend over the past decade to privatisation, both in the private and public sector; contracting out of support and service functions may move employees out of the waste generating ASIC group into another group, again leading to an incorrect result of higher waste generation per production employee. Production employees rather total employees are used in an attempt to avoid this difficulty, but the extent to which this is successful is uncertain.

- *Quantity of each waste type per $value added in each ASIC industry group.* This measure would overcome the productivity complication of the above measure and would yield some interesting answers or part answers to questions such as :

  - which industry groups generate the lowest waste per $ of value added ? An EQI function for hazardous wastes would be a necessary precursor to satisfactorily answering this question.

  - if agreement on a sustainable level of anthropogenic emissions to the environment of a region could be agreed to (emissions arising from hazardous waste generation being one of a number), what mix of industries would be best suited to that region and what is the optimum economy which could be sustained ? ie given the normal range of constraints that determine a limited range of alternative industrial mixes which could be developed in a region (supply of resources and skilled labour and market demands etc), which particular mix provides the greatest contribution to the economy within the environmental constraints imposed by sustainable hazardous waste and other waste emissions.

- *Quantity of each waste type per unit of goods (or services?) produced by the ASIC industry group.* This measure would be one of the most useful as it directly removes the uncertainty associated with the productivity of employees (including how much overtime that each employee might work). Appropriate units of production such as tonnes of steel produced, tonnes of aluminium produced, number of vehicles (or an equivalent standard vehicle which would account for differences between types of vehicles) should be able to be decided upon with advice from Industry Associations. This measure would be of particular use to individual facilities in monitoring their performance against waste minimisation benchmarks, and for industry and government in setting and monitoring benchmarks.

Form of an Environmental Quality Index Function for Hazardous Waste Generation

As indicated in the preceding discussion, all waste types are not equivalent in terms of their potential to cause environmental harm and there is a need to develop a single index or function which can give an overall measure for a variety of combinations of waste types produced in a region by an industry group, or an individual facility. The need for such an overall index or measure has been expressed by some Environmental Managers (L. Sellick, Env. Man. BHP Steel, pers comm., 1992) and will be one of the topics pursued in subsequent studies by the author.

PART C

CASE STUDY : SOUTH AUSTRALIA

REGIONAL HAZARDOUS WASTE MANAGEMENT SYSTEMS
PART C : CASE STUDY : SOUTH AUSTRALIA

CONTENTS

APPENDICES (not supplied with this Thesis report)

1. BRIEF

2. REFERENCES

3. WASTE CLASSIFICATION

3.1 Prescribed Waste List
3.2 Primary Waste Code
3.3 Discussion on Hazardous Waste Definitions
3.4 Prescribed Wastes Monitored by SAWMC Waste Disposal Notice

4. LEGISLATION AND REGULATIONS

4.1 Other State and Commonwealth Legislation Applicable to S.A.
4.2 EWS Sewer Acceptance Criteria, Trade Waste Discharge Regulations
4.3 Waste Management Act, Regulations

5. STANDARD CONDITIONS OF LICENCE

6. GUIDELINES AND POLICY

6.1 National Guidelines on Waste Minimisation
6.2 Joint Taskforce on Intractable Waste Recommendations
6.3 Advisory Circular on Land Contamination
6.4 NH&MRC Draft Guidelines for the Rehabilitation of Contaminated Land
6.5 Example Site Selection Criteria

7. SAWMC TECHNICAL BULLETINS

8. US EPA EP TOXICITY TEST

9. TAFE HAZARDOUS WASTE TRANSPORT COURSE OUTLINE

FIGURES

TABLES

Foreword

This part of the thesis has been adapted from a study undertaken by the author while employed by Maunsell Pty Ltd, for the SAWMC. The whole of the report was written by the author, but it has benefited from comments and information supplied by the SAWMC, and in particular Mr Max Harvey from that organisation.

This part of the report illustrates the application of the concepts discussed in Parts A and B to conditions as they applied in South Australia in the late 1980s. This will serve as a useful guide to those wishing to implement a comprehensive hazardous waste management system in a region which has only recently commenced planning and introduction of systems to control hazardous waste.

SUMMARY

Background

The South Australian Waste Management Commission was formed in 1979 to manage the generation, transport, treatment and disposal of solid and hazardous wastes in South Australia. The system of management of hazardous wastes has developed over the past decade to a stage where the Minister for Environment and Planning has decided that it is now appropriate for a comprehensive review to be undertaken, with opportunities for input from the community throughout the review.

An Information Bulletin was widely circulated in late 1989 advising of the terms of reference of the Review, and inviting general comments. This report documents the outcome of the Review and is presented in the form of a detailed discussion paper with full supporting Appendices. It raises a series of issues and suggests options for resolving these issues. Community input will be invited, and solicited, and an analysis of responses will guide decisions to be made on the resolution of issues. A suggested approach to decision making is outlined in Section 5 of the report.

Definition of Hazardous Wastes

In general terms, hazardous wastes exhibit characteristics of corrosivity, flammability, explosivity or toxicity, including infectious potential. They mostly arise from industrial and commercial activity. One, or a number, of these characteristics makes these wastes unsuitable for disposal to the sewerage system or to municipal solid waste landfills. Special management systems must therefore be established to protect human health and the environment from the effects of improper disposal of these wastes.

Aim and Objectives of the Review

The aim of the Review is to assess the adequacy of the existing system for managing hazardous wastes in South Australia, and to outline issues that need to be resolved in order to provide South Australia with a comprehensive strategy for the future.

The objectives that were set to achieve this aim were:

- Describe the existing management system.
- Outline guiding principles for each component of an ideal system and assess the performance of the existing system against these principles.
- Suggest options for resolving identified issues, and suggest a decision making process and programme for implementation of agreed options.

The Existing hazardous Waste Management System

The existing management system is described and analysed in each of the following areas in Section 2 of the report:

- The hazardous waste classification system.
- Waste generation.
- Hazardous waste policy, legislation and guidelines.
- Waste minimisation.
- Hazardous waste treatment facilities.
- Hazardous waste treatment residue disposal facilities.

Conclusions are drawn on the quality and availability of data for description of the existing system, and on the general adequacy of it, with more specific identification of issues and possible solutions being the subject of the remainder of the report. Salient conclusions from this description of the existing system are summarised below.

Hazardous Waste Classification

A system which is easily administered and which is compatible with the national Australian Environment Council (AEC) has proven to be satisfactory, and should not be altered.

Waste Generation

The manifest system, which tracks the movement of waste from the generator to the ultimate disposal site, is well established and provides good control over hazardous waste movement. Manifest records are very well managed in a computer database, which provides ready access to individual records as well as aggregate trends.

Waste generation was reviewed using manifest records for Adelaide, a desk study method for the State, and comparison to records of waste generation interstate. This review concluded that:

- Adelaide is the dominant centre of hazardous waste generation; 50 megalitres of liquid waste are treated at offsite facilities each year, with the major waste types being acids, oily wastes, and grease trap wastes. The concentration of Commission resources and activities in Adelaide has been appropriate, but the reviews of regional centres should continue to be updated.

- Comparison of manifest data with desk study and interstate data show some apparent anomalies which should be investigated. Suggested explanations for these anomalies need to be tested. For example, plating and acid wastes appear to be higher than expected, while paint sludges appear to be lower.

- Over the past three years there has been a slight increase in waste generation quantities. This is now levelling off and beginning to decline for some waste types.

- Household hazardous waste collections and minimisation programmes are common overseas, and are now being introduced into Victoria. This experience will be useful in planning collection services for South Australia.

- A proactive programme of identifying sites contaminated with industrial waste from past poor practice has commenced, and planning procedures are being established to prevent inappropriate redevelopment of these sites. Victoria has taken similar action, by a different approach. Many OECD countries commenced this process 5-10 years ago and South Australia can use the experience gained in managing these sites.

- Data on the generation of hazardous wastes treated and disposed to land on the site of the generator are not of the same quality for wastes treated at offsite facilities (and therefore tracked by the manifest system).

Hazardous Waste Policy, Legislation & Guidelines

South Australian legislation and guidelines, together with appropriate national guidelines prepared by the NH&MRC and the ANZEC, provide a comprehensive coverage of most aspects of hazardous waste management. Some anomalies and deficiencies have been identified, and these are mostly in the process of being rectified; for example the post-closure management of waste facilities, and definitions of hazardous waste and waste generators.

As in most States of Australia, a number of government departments in S.A. have responsibilities relating to waste management, and there is the potential for inconsistency and lack of co-ordination.

However, this is largely overcome in S.A. because the Waste Management Act, administered by the SAWMC, supersedes the waste provisions of other acts, resulting in a consistent approach. In spite of this, the improvements that have been made to regulations and guidelines over the past decade have made the administration procedures associated with waste management appear complex and difficult to follow for users of the system. It is now appropriate to consider preparation of a Manual which will explain the administrative procedures by way of simple decision trees and explanatory notes.

Management of intractable wastes, a subset of hazardous wastes, has been the subject of extensive investigations by the Joint Taskforce on Intractable Wastes, an independent body established by the NSW, Victorian and Commonwealth governments. S.A. should consider managing intractable wastes (PCBs, organochlorine pesticides, etc.) in accordance with the Taskforce's recommendations; including, disposal of these wastes at the proposed Waste Management Authority of NSW's high temperature incinerator, and an investigation of non-BAT wastes (wastes being disposed of by other than Best Available Technology).

Waste Minimisation

Waste minimisation is the generic term for waste prevention, minimisation and recycling, which reduces the total quantity of hazardous wastes requiring treatment and disposal. It can be achieved through product substitution, alteration to input materials, alteration to process technology and modification of management of production processes. State sponsored waste minimisation activities in the hazardous waste field have been informal to date, largely because the Commission's resources have concentrated on implementing one of the most important elements in waste minimisation; namely, the establishment of modern treatment facilities charging associated treatment costs.

Victoria, and many OECD countries have introduced formal waste minimisation programmes at the State and Local Government level. It is now appropriate for South Australia to develop a programme.

Hazardous Waste Treatment Facilities

Offsite treatment facilities (i.e. treatment of waste off the site of the generator) consist of the National Waste Company liquid waste treatment plant and the proposed Waste Management Services plant. Together, these plants will provide sufficient capacity to treat most of Adelaide's hazardous wastes, with the possible exception of Type L, grease trap wastes. Currently, technology which would be considered Best Practical Means (cement stabilisation) is being used for treatment of organic wastes and treatment residues prior to disposal to a refuse landfill.

High temperature incineration of SA intractable wastes is undertaken in the UK, and some incineration of waste solvents and residues is undertaken in Melbourne.

The data available on quantities and types of wastes, treatment technology, and residue disposal at on-site treatment facilities, is not as comprehensive as that available through the manifest system for offsite plants, and it is therefore difficult to assess the adequacy of this component of the management of hazardous wastes in South Australia.

Hazardous Waste Treatment Residue Disposal

Liquid effluents arising from offsite treatment facilities in Adelaide are disposed to sewer by the well controlled means of an effluent batch tank which is monitored prior to discharge to sewer. Liquid effluents being disposed to land in Adelaide are being phased out, and liquid effluent discharges to sea from major on-site treatment facilities in regional centres will be reviewed as part of the introduction of proposed new marine discharge legislation.

Gaseous emissions from point sources such as stacks are controlled by the Clean Air Act. The need to control diffuse source emissions, such as fugitive emissions from treatment plants and evaporation losses from uncovered storage facilities should be reviewed.

Solid residues arising from current hazardous waste management activities are dealt with in the following manner:

Dry sludge and cement stabilised solids arising from the offsite treatment facilities in Adelaide are disposed of to a refuse landfill after passing a leaching test. This amounts to approximately 2000t/yr. This technology would be regarded as Best Practical Means at present.

Sludges from on-site treatment plants are disposed of to the off-site treatment plant (in Adelaide) or to on-site landfills (in the regions). The technology employed is not well documented.

Contaminated soils are contained on-site until appropriate treatment and disposal facilities can be identified.

There are no dedicated storage facilities for liquid and solid hazardous waste arising from chemical tanker spills or chemical warehouse fires.

Management of solid residues is a major area of concern and the options for improvement are dealt with in some detail in the Review.

Outline of an Ideal Hazardous Waste Management System

A comprehensive system for the management of hazardous waste will provide details on procedures and facilities for:

- Guiding Principles
- Waste Classification
- Waste Manifest Controls
- Waste Minimisation

- Treatment
- Residue Management

A number of achievements have been accomplished in each of the above sectors, in some cases making parts of South Australia's system equal to the best in Australia. These achievements are documented in the Review and, for brevity, will not be described in this summary.

Outstanding issues remaining and suggested options for their resolution, listed under each of the above sectors, are:

Guiding Principles for the management of hazardous waste in South Australia should include:

- Adoption of the preferred hierarchy of waste management (minimisation followed by treatment followed by land disposal).

- Adoption of a multi-media approach in setting emission standards for various contaminants being disposed to the environment.

- Adoption of the polluter pays principle.

- Development of policies in relation to the effects of hazardous waste management on ozone depletion (CFCs and halons disposal) and the greenhouse effect (methane and carbon dioxide emissions).

The Waste Classification system used by S.A. is compatible with those used in N.S.W. and Victoria. To enable comparisons to be made with waste generation overseas, S.A. should consider initiating, through the Australian and New Zealand Environment Council (ANZEC), an investigation to translate the ANZEC system (used by SA) to international classification systems.

Definitions of activities (Section 22 (1) of the Act) that can be regulated in the generation of hazardous waste should include all activities e.g. including demolition activities which could currently be interpreted as being excluded.

The **Manifest System** and Control of Hazardous Waste Generation could be improved through investigation of the following:

- improving co-ordination between the SAWMC and the E&WS controls, as suggested in the Review;
- surveying waste type F (paint sludges etc.) generators to ensure correct manifest procedures are being followed.
- reviewing the frequency of routine inspections (with a view to increasing them) by the SAWMC for hazardous waste being accidentally, negligently or illegally disposed of to refuse landfills;
- improving on-site waste treatment controls and database;
- extending the Waste Disposal Notice and Liquid Waste Form (manifest system) to regional centres;
- updating of regional surveys of hazardous waste generation;
- collecting comprehensive data from household hazardous waste collection days;
- consideration of controlling contaminated sites through the controls available for temporary hazardous waste storage facilities;

- designation of non-BAT wastes in S.A., estimates of quantities, and development of controls;

- revision of minor anomalous sections in various Acts, as identified in the Review,

- introduction of bonding or other financial guarantees on the various parties involved in hazardous waste management.

Develop a State sponsored **Waste Minimisation** programme through adoption of an integrated set of options suggested in the draft ANZEC guidelines, and elements of other overseas programmes described in the Review.

Improve **Hazardous Waste Treatment** in South Australia by:

- reviewing regional treatment facilities and designing appropriate systems for major and small generators;

- developing a policy on treatment and disposal of CFCs and halons;

- considering appropriate levels of redundancy for various treatment processes and means of achieving them;

- establishing emergency storage facilities for wastes from chemical tanker spills and chemical warehouse fires;

- preparing a plan for the management of intractable waste in the event of delays in the Waste Management Authority of NSW's facility and bans on the use of overseas facilities;

- reviewing on-site treatment plant adequacy to ensure consistency with off-site treatment facility standards;

- providing guidelines on what constitutes Best Practical Means (BPM) and Best Available Technology (BAT) for each waste type so that existing facilities can be upgraded and new facilities can be established within a clear framework;

- providing guidelines for contaminated land remediation which ensures consistency with the treatment standards required for on-going waste generation;

- reviewing treatment and disposal practices for asbestos, and encouraging research and development of alternative technologies if appropriate.

Outstanding issues requiring resolution in the area of Residue Management are:

- the need to establish a secure repository(s) system for short to medium term storage of residues awaiting treatment, and for the ultimate disposal or long term storage of solid residues from waste treatment processes;

- the need to include time limits (90 day) and bonding requirements in licence conditions for temporary waste storage depots;

- the need to consider effluent reuse from industrial waste treatment facilities where desirable, practical and economic;

- the need to develop monitoring standards (an odour assessment panel) to enable control of fugitive emissions from facilities.

Alternative Options for Improvement

In most of the elements of a hazardous waste management system, improvements can be made by selecting an appropriate set of options following investigation of those options. However, in the areas of hazardous waste treatment and residue disposal, selection among alternatives is required in order to achieve the improvements described in the preceding sections. These alternatives are outlined below.

- **Hazardous Waste Treatment**. Alternatives are provided in the Review for each of the following areas within the hazardous waste treatment component:

  - setting of standards,
  - establishment of emergency storage capacity,
  - upgrading, if appropriate, of regional and on-site treatment systems,
  - treatment of highly odorous wastes,
  - treatment of hazardous organic waste,
  - treatment and disposal of asbestos,
  - treatment and disposal of copper-chrome-arsenate (CCA) timber preserving wastes,
  - treatment of high ammonia wastes.

- **Residue Management**. The Review concludes that residue arisings requiring special management are likely to increase, in spite of any successes arising from waste minimisation programmes. This will largely be due to the expected increase in contaminated soil residues requiring management, for a period of 10 to 20 years. Long term solutions, as explained in the final part of this summary, are likely to take two to three years to establish. There is therefore a need to establish Best Practical Means interim solutions, which could either be:

  - continuing with disposal to refuse landfills provided leaching tests are passed or,

- temporary secure storage on government owned land currently being used for compatible land uses e.g. a well land-buffered, sewage treatment plant or refuse landfill.

Long term solutions will be comprised of two elements, each influencing the other; namely, the nature of the treatment and management of the solid residues themselves, and the nature of the repository. Residues can be:

- treated to immobilise contaminants, or
- segregated by contaminant type in a manner that will facilitate future recovery, or
- mixed and with no special treatment to immobilise contaminants.

The repository could be:

- a refuse landfill, or
- a double lined secure landfill, or
- above ground secure vault or `warehouse'
- geologically stable mined space, or
- burial below pavements, or
- a clean fill area.

Not all combinations of residue treatment and repository are feasible. The feasible options are illustrated in Table 4.1, and are described in detail in the Review.

Table 4.2 provides a preliminary assessment of the feasible options on the basis of the following criteria:

- type of barrier provided, and whether the barrier should be required (R), preferred (P), or not required (NR),

- number of barriers normally provided, as a measure of the security of the system,

- ability of the option to facilitate future recovery of contaminants, as a measure of flexibility in not foreclosing future options,

- simplicity of operation, as a measure of likely relative cost and reliability.

A decision has to be made, following assessment of community and government responses to the Review, on whether simplicity and flexibility is preferred or whether simplicity and security is preferred. Table 5-2 can then assist in evaluating the options to arrive at a preferred option.

No specific sites have yet been identified for a waste residue repository. The selection of an appropriate site, from a technical viewpoint, will need to be an interactive one between the characteristics of potential sites and the needs of the preferred residue management option(s), and vice versa. Site selection decision processes are described below but, regardless of the decision process chosen, it is likely that a number of sites will need to be evaluated. A set of criteria to facilitate this evaluation is provided in the Review. In summary, the criteria suggested are:

- preference for flood free flat land
- preference for appropriately zoned land, with potential for beneficial end-use
- avoidance of residential, high density, intensive agricultural regions
- preference for buffer within the site, (not necessarily quarantined)
- preference for good road access, services
- preference for access to appropriately skilled workforce
- preference for site geology and hydrogeology that enhances the safety of the facility
- avoidance of areas in proximity to sensitive landuses.

As part of the implementation procedure described below, socio-economic criteria will need to be developed. Costs and benefits will need to be clearly stated, and a decision process and site which meets the needs of the general community and is fair to local communities needs to be developed.

Implementation Procedure

The process by which these facilities and controls are introduced is critically important to their successful implementation.

The process adopted must firstly establish the need for facilities followed by selection of preferred technologies and sites by application of screening and evaluation criteria. Flexibility however must exist within the process to solicit or receive registrations of interest from individual Councils and companies, as appropriate, to provide possible sites for evaluation. Throughout the process the community must be kept informed.

Alternative decision processes are described in the Review, and one which combines points from the alternatives is suggested as a basis for discussion. Initial stages of information transfer and voluntary invitation by Councils to have their area assessed for the potential to site one of the facilities needed, progress to more detailed and site specific investigations. At a certain stage, Council, and the local community it represents, must agree to allow use of the site if the next stage of (expensive) investigations proves the site to be suitable; alternatives for decision makers in this regard are suggested.

The overall implementation procedure to provide South Australia with a comprehensive system of hazardous waste management should be:

- Release of this report for community comment.

- Assessment of comments and formation of a broadly representative Steering Committee to guide the implementation of the preferred strategy, including ongoing community consultation.

- Investigation, design and implementation of procedures, sites and facilities under the guidance of the Steering Committee, including formal EIS/planning procedures.

- Construction and ongoing monitoring of facilities, with an ongoing role for the Steering Committee and local communities as appropriate.

The time required to provide South Australia with a comprehensive hazardous waste management system will depend on the decision process chosen by the Steering Committee and government. It will be at least two to three years.

1 INTRODUCTION

1.1. Background

The South Australian Waste Management Commission (SAWMC, or the Commission) was formed in 1979. Its objectives are to (Section 7 (2) Waste Management Act, 1987):

- promote effective, efficient, safe and appropriate waste management policies and practices;
- reduce the generation of waste;
- conserve resources by means of recycling and re-use of waste and resource recovery;
- prevent or minimise impairment to the environment occurring through the management of waste;
- encourage the participation of local authorities and private enterprise in overcoming problems of waste management;
- provide an equitable basis for defraying the costs of waste management;
- conduct or assist research relevant to any of the above objectives.

Hazardous wastes are part of the waste stream under the control of the Commission, and in general terms, are those wastes which cannot be safely disposed to the sewerage system or to municipal solid waste (MSW) landfills.

The Commission has developed controls comprised of licensing, tracking and inspecting all components of the hazardous waste management system, namely:

- generators
- transporters
- treatment and disposal facilities

After a decade of operation, during which improvements have been continually introduced, the Minister for Environment and Planning has decided that it is now appropriate to undertake a comprehensive review of the existing arrangements for the management of hazardous wastes in South Australia. Following community comment on the review, a comprehensive strategy for the management of hazardous wastes in South Australia will be developed. This will be guided by a broadly represented Steering Committee, to be formed after comments on the review have been received.

This report presents the findings of the Review and is supported by the following documents:

- An introductory background paper prepared at the commencement of the Review, explaining the scope and study procedure.

- A summary document, essentially in line with the summary provided in this report, which is intended to have wide circulation and readership.

A comprehensive set of Appendices in a separate document, providing a ready reference to the major legislative and guidelines documents necessary to fully describe the existing system of hazardous waste management in South Australia. The Appendices are lengthy, are not required to appreciate the contents of the Review, and are expected to have limited circulation. They have not been included in this MEngSc thesis report.

1.2. Aims and Objectives

The aim of the Review is to assess the adequacy of the existing system for managing hazardous wastes in South Australia, and to outline issues that need to be resolved in order to provide South Australia with a comprehensive strategy for the future.

The objectives that were set to achieve this aim were:

- Describe, to the extent possible from available data, the existing hazardous waste management system, including regulations, procedures and facilities used to control the generation (and minimisation), storage, transport, treatment and disposal of hazardous wastes in South Australia.

- Outline a tentative ideal system, by way of Guiding Principles for each component of the system, and assess the performance of the existing system against these principles. This should be undertaken by identifying the achievements of the existing system and those issues requiring consideration, investigation or resolution before the ideal can be attained.

- Where a number of alternative options could resolve a particular issue, describe these options and list criteria which should be used to evaluate them. Final evaluation should await community responses to this Review.

- Discuss means of implementing the options required to resolve the identified issues, and suggest a decision process. The process to be adopted will be dependent on the analysis of community responses to the suggested approach.

1.3. Structure of the Review Report (Part C of this report)

The structure of this report generally follows the logic of the Review as guided by the objectives described above. Detailed analysis has generally been placed in an appendix, with the findings of the analysis being provided in the text of this report.

1.4. Acknowledgments

The Review has required the collation and assessment of a large amount of data from diverse sources, and the consideration of broad ranging issues. It could not have been completed without the willing assistance and encouragement throughout an extended period by staff of the Commission and the Engineering and Water Supply Department. Particular acknowledgment of the contributions to this Review by the following deserve special mention:

- Max Harvey, Chemical Engineer, SAWMC for overall management, contribution of ideas and critical appraisal of outline concepts and draft report sections as they were being developed.

- Geoff Sclare, SAWMC, for establishing the dBASE III manifest data-base and extracting the summaries of trends in waste generation used in the analysis of the existing system.

- Tony Catalano, Trades Waste Engineer, Engineering and Water Supply Department for discussions and information enabling the important aspect of trade waste discharges to sewer to be covered in the Review.

2 A REVIEW OF THE EXISTING HAZARDOUS WASTE MANAGEMENT SYSTEM IN SOUTH AUSTRALIA

2.1. Introduction

This section describes the existing system of facilities and management procedures for hazardous waste in South Australia. It provides an overview based on readily available information and comments on the adequacy of the information base. The review examines the components of a hazardous waste system as described in Part A of this report. Detailed discussion on the adequacy of the system is provided in Section 4.

2.2. Hazardous Waste Classification System

Hazardous wastes are defined as those wastes designated as Prescribed Waste in the Regulations to the Waste Management Act (Appendix 3.1). They are classified according to Waste Codes on the Waste Disposal Notice, namely:

- List A, B: UN Hazard Class, UN No. and description of Waste Dangerous Goods
- List C: The Primary Waste Code, describing the type of waste (Appendix 3.2)
- List D: Industry of Waste Origin
- List E: Waste Constituents
- Nature of toxic, corrosive, inflammable, reactive or infectious.

Hazard:

o	Intended Disposal Route:	storage, chemical/physical treatment; immobilisation; evaporation, other.

Details of List A, B, D and E are provided in Appendix 7. (Bulletin No. 4, Waste Disposal Notice).

In March 1986, the SAWMC introduced the Waste Disposal Notice, a multiple docket or manifest system to track and control the movement of prescribed waste. Licensed generators of prescribed waste must complete the docket for each load of prescribed waste removed from their premises.

In September 1988, the Commission introduced a simplified procedure, the Liquid Waste Form, to accompany loads of oily waste, greasetrap waste, inert sludges, and water based paint sludges. The Form sets out the nature and quantity of the waste load, the date of transport and disposal, the identity of the people involved in the operations and is completed by the waste transporter.

Data on hazardous waste monitored by the Waste Disposal Notice are entered into the Commission's database and can be extracted in summary form using the various waste codes described above.

A more detailed discussion on hazardous waste definitions and classification systems is provided in Appendix 3.3.

Hazardous wastes, for the purpose of this Review and in line with the responsibilities of the SAWMC, do not include radioactive wastes and wastes arising from mining activities. This is common practice throughout Australia and overseas, because these wastes are generally handled by separate management systems. It does not mean, however, that they are of less concern; indeed, worldwide, greater attention is now being paid to these wastes to ensure their management is consistent with improving industrial waste management standards.

2.3. Waste Generation

2.3.1. Introduction

In South Australia, hazardous waste generation is monitored by two systems:

- Waste stored, treated and disposed of at the site of generation is monitored by annual returns from generators of Prescribed Waste. Information provided in these returns includes:

  - Prescribed waste description
  - Waste form (solid, liquid or sludge)
  - Quantity produced (kL/yr)
  - Process resulting in generation of waste
  - Whether treated on-site or offsite
  - Details on how waste is treated and disposed of

- Waste collected by contract vehicles for offsite treatment and disposal is monitored by the hazardous wastes manifest system known as The Waste Disposal Notice (refer Section 2.2). The quantity, form and type of waste is tracked from generator to transporter to offsite treatment and disposal site and is recorded in the Commission's database. Monthly summaries of waste quantities, types and form can be extracted from the database.

There are three methods of assessing waste generation characteristics in a region:

- Analysis of data from manifest system records, generally regarded as the most reliable. A summary of the analysis of SA records is provided in Section 2.3.2.

- Desk studies which relate production of goods (as measured by production employees in various industry groups) to hazardous waste generation. These have had limited application in Australia, but those undertaken have shown good agreement with manifest data that subsequently became available (Victorian EPA, 1985). This method has been applied to South Australia and the results are presented in Section 2.3.3.

- Questionnaire surveys of the major wastes generators and selected examples of small generators. The results of these surveys, when compared to manifest data that subsequently became available, have been disappointing for general hazardous waste streams. They have been more useful for selected waste streams generated by identifiable industry sectors, e.g. PCBs arising from electricity generation and distribution. Questionnaire surveys have not been undertaken as part of this study. They may be useful if undertaken selectively to resolve questions arising from poor data from the above two methods, or to resolve apparent anomalies in the characteristics of SA waste generation.

The characteristics of the SA hazardous wastes stream derived from analysis of manifest records and the desk study method will be compared to waste stream profiles derived from manifest records in Brisbane, Sydney and Melbourne (Section 2.3.4) Conclusions on the pattern of waste generation in S.A. will then be drawn in Section 2.3.8.

2.3.2. Manifest Record Analysis

Appendix 3.4 provides a comprehensive summary of waste types (waste code), forms and quantities for the past two years, as extracted from the Waste Disposal Notice database. The information is provided in graphical form in the following figures:

Figure 2.1: Hazardous waste generation by Waste Category for 1987/88 and 1988/89.

Figure 2.2: Monthly generation of wastes in a number of groups of waste categories, namely:

- A, B, C, D representing wastes arising from metal finishing and plating
- F, representing organic wastes from manufacturing
- K, L, representing wastes from processing of agricultural products

Figure 2.3: - all categories

Examination of these graphs indicates:

- An increase in annual waste quantities recorded by the manifest system in most categories, and particularly for acids, alkalis and textile wastes.
- The dominance of the metal finishing and plating wastes type - categories A, B, and C, and acid wastes (type B) in particular. Wool scouring and tannery wastes are also a significant proportion of the total. This reflects the nature of Adelaide's industry. Waste oil is relatively low as this is not classified as a prescribed waste (due to its potential for recycling).
- Waste types A, B, C, and D show a general upward trend, with peak monthly generation rate variations related to the monthly generation rates. For generation rates in excess of 200kL/month (about 20 tanker loads) ratios of peak monthly: average monthly vary from 1.25 - 1.75. For generation rates less than 200kL/month ratios up to about 6 are observed. This information is important for treatment facility design.
- Waste type F (organic sludges, such as paint sludges) is highly variable on a month by month basis because of the relatively low generation rate of only 1-3 tanker loads (10-30 kL) per month.
- Waste type K (L - largely grease traps, monitored by the Liquid Waste Form system, completed by the tanker driver rather than the generator) has shown a gradual decline since a

peak in the September quarter of 1988. This is possibly due to increased charges and less frequent clean-outs, and does not necessarily imply illegal disposal.

- A combination of all waste types shows similar behaviour to waste types A, B, C and D because of the dominance of this group.

2.3.3. Desk Study - Unit Production Method

The Desk Study, Unit Production Method provides a model of hazardous waste generation based on the generation of waste being proportional to the number of production employees in various industry groups within a region (Victorian EPA, 1985). The unit waste generation load factors per production employee for ASIC (Australian Standard Industry Classification) industry groups are provided in Table 2.1. A comparison of the model predictions with Melbourne manifest records for 1986 and 1988 (Table 2.2) shows that, for most of the significant waste types, model predictions are within 50% and often within 30% of manifest record data. This is a reasonable degree of accuracy when the variation in the manifest data itself between 1986 and 1988 is considered.

Manifest data shows, relative to model predictions, high values for waste oil and solvents.

The production employee numbers in the various ASIC industry code groups in each of six regions in SA are presented in Table 2.3. When multiplied by the unit load factors in Table 2.1 these production employee numbers yield the output from the spreadsheet model presented in Table 2.4 and Figure 2.4; namely, annual quantities of each waste type for each region. A comparison between model data for Adelaide (Region 1 and 2) and manifest records is provided in Table 2.4 and illustrated graphically in Figure 2.5.

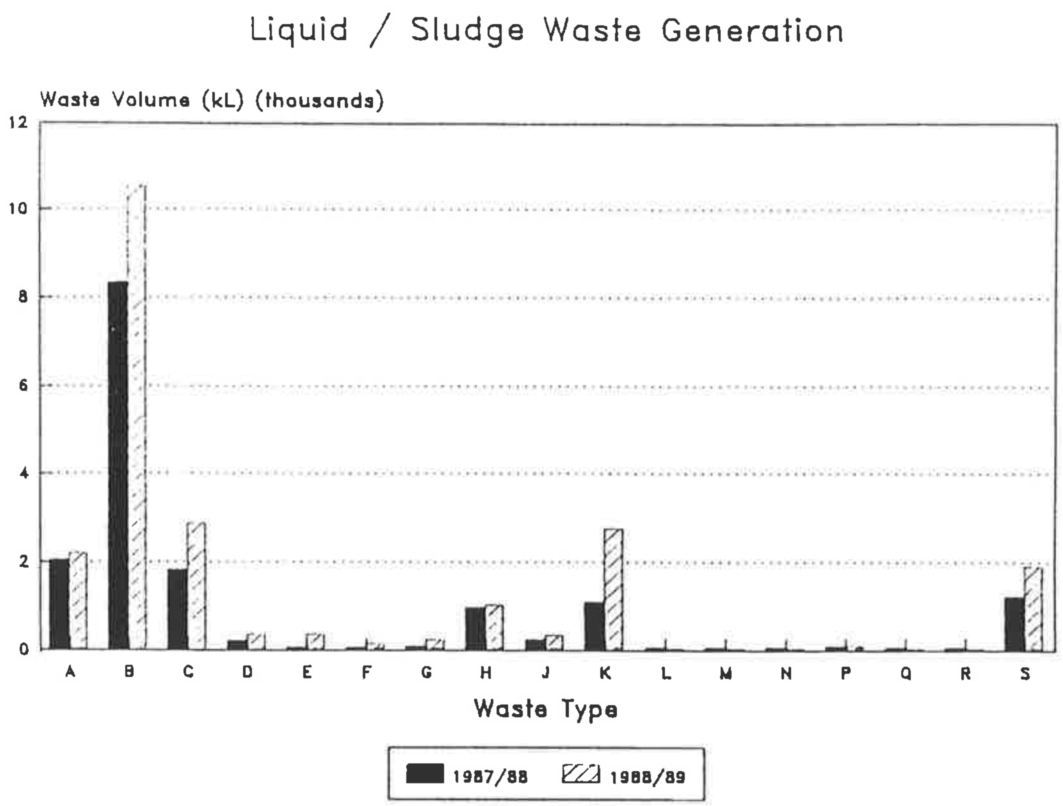


Figure 2.1 : Waste volume versus waste category (from Waste Disposal Notice Manifest

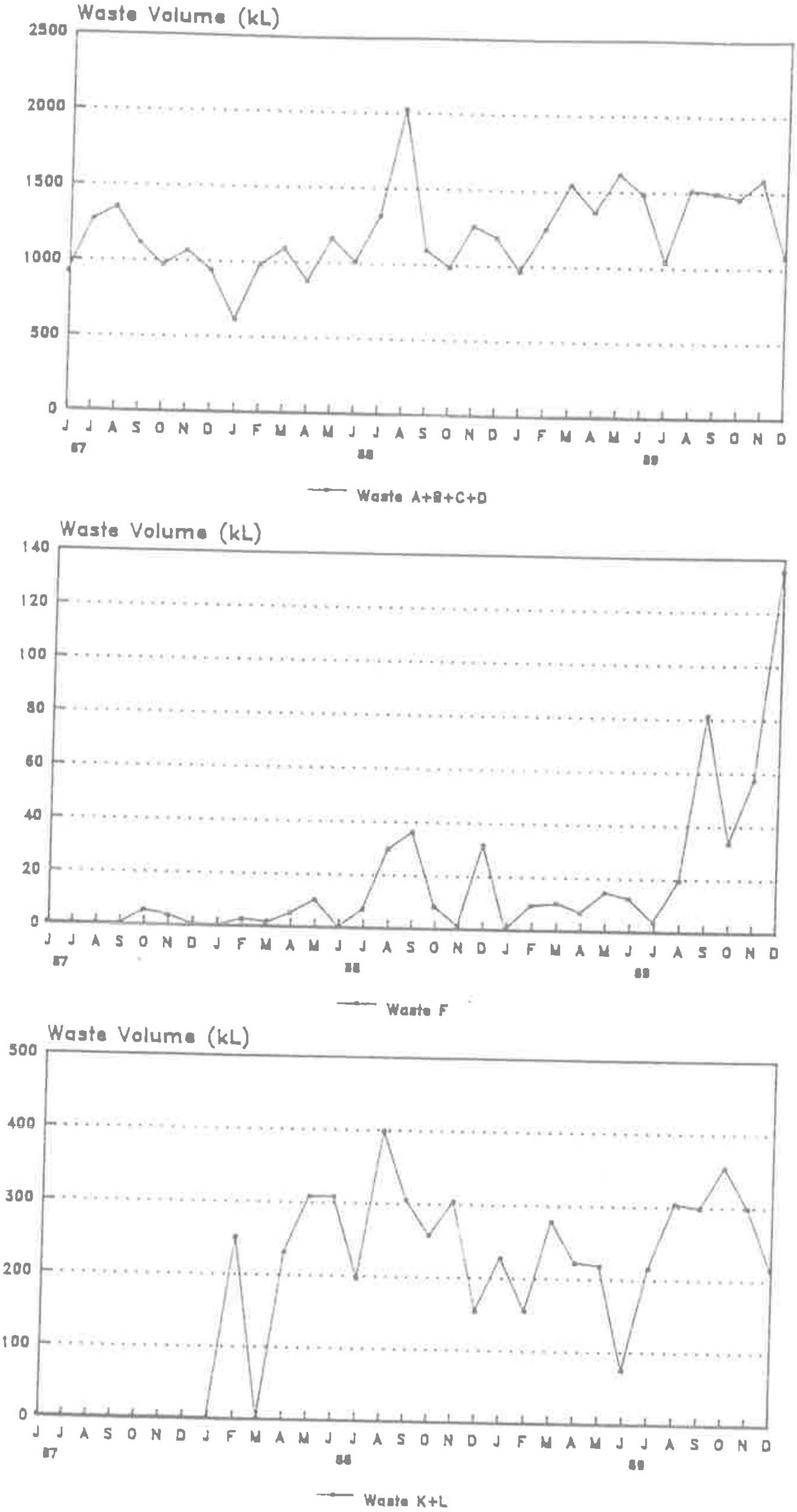


Figure 2.2 : Monthly waste generation variations

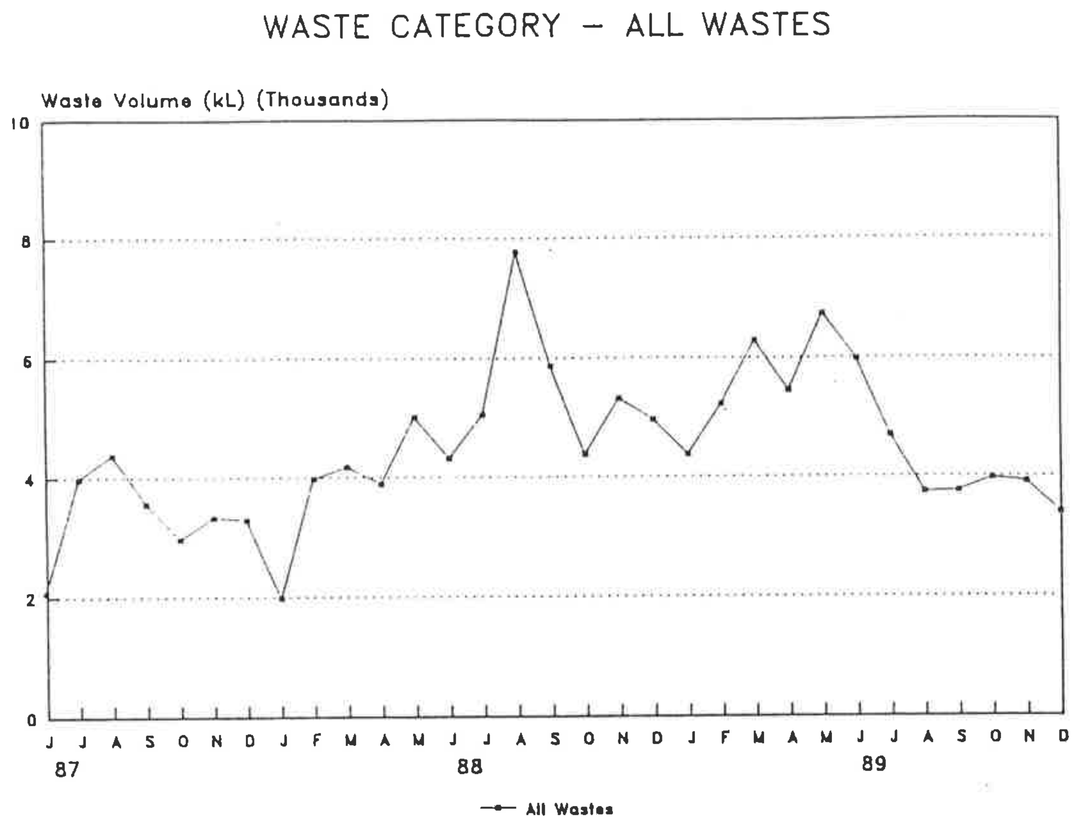


Figure 2.3 : Monthly waste generation variations, all waste

Salient points from the desk study are:

- The dominance of Adelaide over all other regions in all waste types. Adelaide has been the priority region to date and this analysis demonstrates that this is appropriate when allocating resources for inspections and manifest system management.

- There are three dominant groups of waste types:

  - inorganics, mostly acids and alkalis, with the contaminants of concern being heavy metals (Type A, B, C, D).

  - organic wastes, consisting of organic sludges of chemical and agricultural origin, and oily water (Types F, J, K, L).

  - inorganic, relatively inert washwaters and slurries (Types M, N).

- The validity and accuracy of model predictions for regions dominated by a small number of industries is suspect, and the results should only be used as initial general indicators which can guide more detailed surveys if appropriate.

In non-metropolitan regions, the major volumes of waste predicted by the model which would normally require off-site treatment and disposal are acids, alkalis and waste oil in Whyalla and Port Pirie; putrescible organic wastes in the South East and Murray Lands; and washwaters and inert wastes in all regions. As these wastes are generally produced by a small number of

TABLE 2.1: DERIVED UNIT LOAD FACTORS, LITRES PER PRODUCTION EMPLOYEE PER ANNUM

ITEM	21 FOOD BEVERAGES TOBACCO	23 TEXTILES	24 CLOTHING, FOOTWEAR	25 WOOD, WOOD PRODUCTS	26 PAPER PRINTING	27 CHEMICALS, PETROLEUM, COAL	28 NON-METALLIC PRODUCTS	29 BASIC METAL PRODUCTS	31 FABRICATED METAL PRODUCTS	32 TRANSPORT EQUIPMENT	33 OTHER MACHINERY ETC.	34 MISCELLANEOUS MANUFACTURING
PLATING/HEAT TREAT	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1	40.0	10.0	10.0	20.0
ACIDS	0.3	3.0	0.3	0.1	1.0	50.0	5.0	400.0	50.0	100.0	100.0	50.0
ALKALIS	100.0	5.0	0.1	3.0	6.0	200.0	50.0	100.0	50.0	10.0	20.0	30.0
INORGANIC WASTES	2.0	2.0	4.0	4.0	10.0	40.0	80.0	40.0	8.0	6.0	8.0	6.0
REACTIVE WASTES					4.0	8.0		2.0	2.0	2.0		2.0
PAINTS/RESINS ETC		5.0	10.0	20.0	20.0	20.0	10.0		20.0	10.0	20.0	100.0
ORGANIC SOLVENTS	2.0	3.0	2.0	2.0	5.0	7.0	0.1	1.0	5.0	3.0	1.0	6.0
PUTRESCIBLE WASTES	200.0	5.0	5.0	1.0	5.0	10.0				1.0	5.0	10.0
TEXTILE WASTES		200.0	20.0			10.0						15.0
OILS/OILY WASTES	10.0	60.0	30.0	10.0	10.0	80.0	10.0	60.0	30.0	60.0	30.0	30.0
CONTAM. CONTAINERS	2.0	2.0	1.0	2.0	2.0	20.0	1.0	2.0	3.0	2.0	10.0	10.0
INERT WASTES	10.0	10.0	20.0	20.0	50.0	200.0	400.0	200.0	40.0	30.0	40.0	30.0
ORGANIC CHEMICALS	0.2		0.1	0.1	0.2	2.0					0.1	0.2
PESTICIDES		0.1		0.1	0.1	10.0			0.1	0.2	1.0	0.1
TOTAL	326.7	295.3	92.7	62.6	113.6	657.3	556.3	805.1	248.1	234.2	245.1	309.2

SOURCE: VICTORIAN EPA, 1985

TABLE 2.2:
COMPARISON OF MODEL PREDICTIONS VS MANIFEST RECORDS
MELBOURNE

WASTE TYPE	MODEL PREDICTION kL/yr	MANIFEST RECORDS 1986 1988 kL/yr	RATIO MODEL: MANIFEST 1986 1988
A. PLATING	2,066	2,812 1,624	0.73 1.27
B. ACIDS	12,979	10,008 10,637	1.30 1.22
C. ALKALIS	8,379	18,851 12,875	0.44 0.65
D. INORGANIC CHEMICALS	2,452	2,823 3,868	0.87 0.63
E. REACTIVE CHEMICALS	313		-
F. PAINTS, ORG. SLUDGES	4,891	7,169 12,659	0.68 0.39
G. ORGANIC SOLVENTS (1)	699	193 1,603	3.62 0.44
H. PESTICIDES	141		-
J. WASTE OIL (1)	7,609	21,875 41,260	0.35 0.18
K. TEXTILE	2,586	2,962 6,529	0.87 0.40
L. PUTRESCIBLE ORGANIC WASTES	5,446 9,760	3,831	1.42 0.56
M,N WASHWATER/INERT WASTE	12,258	10,697 2,286 +	1.15 -
P ORGANIC CHEMICALS	39	941	-
Q. BAGS, CONTAINERS (2)	1,060	4,786	0.22 -

Notes (1) Highly dependent on crude oil price and availability of recycling facilities

(2) Unreliable, difficult to define quantity

TABLE 2.3: HAZARDOUS WASTE GENERATION MODEL - PRODUCTION EMPLOYEE DATA

STUDY AREA: SOUTH AUSTRALIA

ASIC Index Code	Ratio P.E / T.E	Employees													
		Region 1		Region 2		Region 3		Region 4		Region 5		Region 6		Total	
		Total	Prod	Total	Prod	Total	Prod	Total	Prod	Total	Prod	Total	Prod	Total	Prod
21	0.687	9075	6235	2784	1913	1783	1225	998	686	0	0	283	194	14923	10252
23	0.815	1929	1572	62	51	42	34	86	70	0	0	0	0	2119	1727
24	0.801	4081	3269	62	50	43	34	86	69	0	0	0	0	4272	3422
25	0.761	4627	3521	214	163	42	32	1982	1508	0	0	0	0	6865	5224
26	0.613	6041	3703	159	97	43	26	922	565	0	0	32	20	7197	4412
27	0.498	2040	1016	62	31	42	21	86	43	0	0	0	0	2230	1111
28	0.674	3074	2072	232	156	43	29	32	22	0	0	0	0	3381	2279
29	0.791	2125	1681	62	49	42	33	86	68	2398	1897	1453	1149	6166	4877
31	0.682	6630	4522	136	93	141	96	86	59	181	123	59	40	7233	4933
32	0.846	14558	12316	43	36	43	36	20	17	0	0	0	0	14664	12406
33	0.720	11675	8406	159	114	321	231	28	20	0	0	0	0	12183	8772
34	0.739	6752	4990	63	47	83	61	49	36	0	0	0	0	6947	5134
														88180	64548
TOTAL		72607	53302	4038	2800	2668	1860	4461	3162	2579	2020	1827	1404	88180	64548

NOTE : P.E - Production Employees
T.E - Total Employees

(SOURCE: Australian Bureau of Statistics)

AISC Index Code

21 - Food, beverages, tobacc
23 - Textiles
24 - Clothing, footware
25 - Wood, wood products
26 - Paper products, printin
27 - Chemicals, petroleum, c
28 - Non-metallic products
29 - Basic metal products
31 - Fabricated metal produc
32 - Transport equipment
33 - Other machinery etc.
34 - Miscellaneous manufactu

Region 1: Adelaide
Region 2: Outer Adelaide
Region 3: Murray Lands
Region 4: South East
Region 5: Whyalla
Region 6: Pirie

TABLE 2.4: HAZARDOUS WASTE GENERATION MODEL: OUTPUT SUMMARY

WASTE TYPE	WASTE QUANTITY kL / yr Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	TOTAL	Total for Region 1&2	Total 1988/89 Manifest
A. Plating Wastes	493.2	6.7	8.0	4.3	5.1	1.8	519.0	499.8	2199.4
B. Acids	3292.9	44.8	49.6	39.1	764.9	461.8	4653.1	3337.8	10540.6
C. Alkalis	1806.3	220.2	143.5	97.9	195.9	136.5	2600.3	2026.5	2881.5
D. Inorganic Chemicals	560.7	23.6	10.7	20.6	76.9	46.9	739.4	584.3	368.8
E. Reactive Chemicals	70.0	1.1	0.7	3.0	4.0	2.5	81.2	71.0	0.2
F. Paints, Organic Sludges	1106.8	17.3	15.4	48.9	2.5	1.2	1192.1	1124.1	154.8
G. Organic Solvents	156.2	6.1	4.2	8.5	2.5	1.8	179.4	162.3	239.3
H. Pesticides	22.9	0.5	0.5	0.7	0.0	0.0	24.5	23.3	1044.7
J. Waste Oil	1806.3	43.0	33.7	46.1	117.5	72.3	2118.9	1849.3	352.3
K. Textile	464.8	12.1	8.7	16.4	0.0	0.0	501.9	476.9	2765.5
L. Putrescible Org. Waste	1407.5	385.1	247.5	143.1	0.0	39.0	2222.2	1792.6	0.0
M,N. Wshwater, Inert Waste	2803.4	118.1	53.7	102.9	384.3	234.4	3696.8	2921.5	14.3
P. Organic Chemicals	6.5	0.5	0.3	0.5	0.0	0.0	7.9	7.0	116.6
Q. Bags, Containers	231.2	7.3	6.5	7.5	4.2	2.8	259.6	238.6	0.0
TOTAL	14228.7	886.4	583.1	539.3	1557.8	1001.0	18796.3	15115.1	20678.0

Region 1: Adelaide
Region 2: Outer Adelaide
Region 3: Murray Lands
Region 4: South East
Region 5: Whyalla
Region 6: Pirie

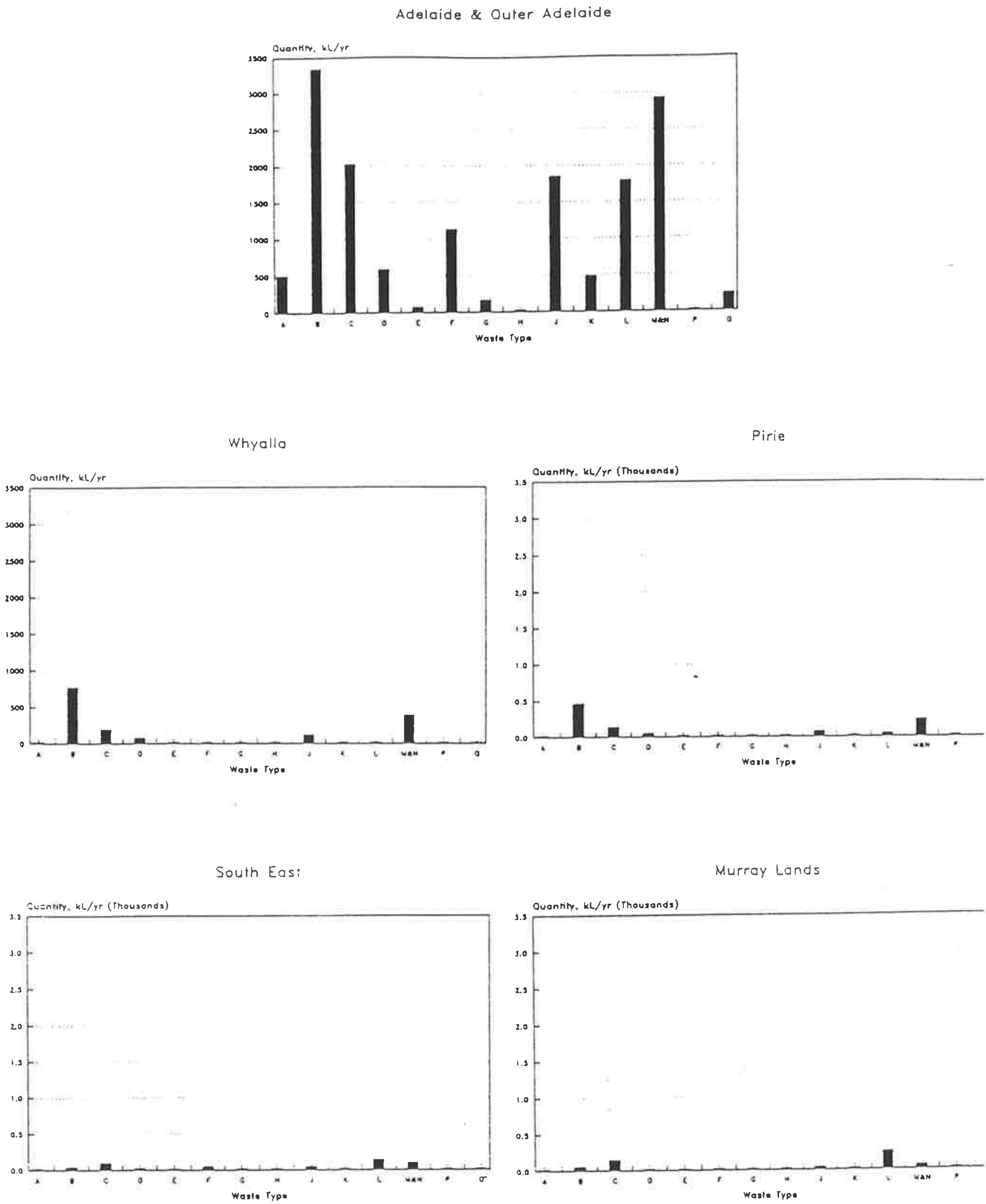
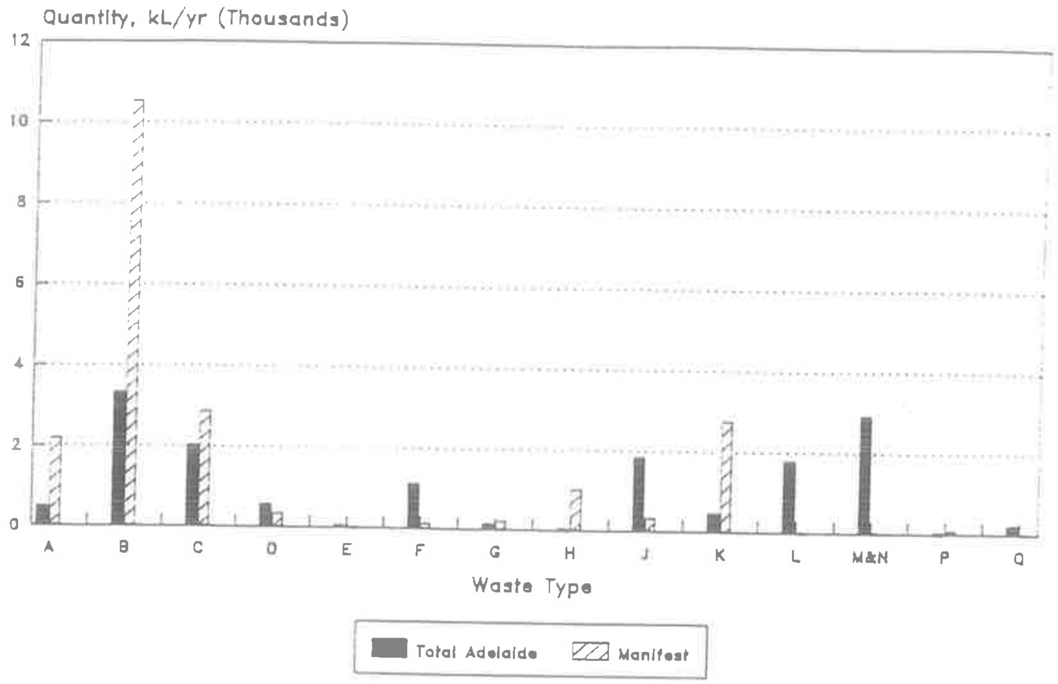


Figure 2.4 : Unit production method , regional waste generation predictions



Note : Manifest data from Waste Disposal Notice only .

Figure 2.5
Waste generation , unit production method
Adelaide & Outer Adelaide versus Manifest

large generators in these regions, possible strategies for their management could include:

- Treatment and disposal on the sites of the major generator (or on a site controlled by the major generator), with the capacity to enable smaller generators to use these facilities. This is a reasonable approach as many of the smaller generators would be in industries complimentary to the major industry in the region.

- Provision of a liquid waste transfer station in each region to enable the efficient transport of hazardous wastes to a centralised treatment facility in Adelaide. Storage could either be in 200L drums or tankers depending on the monthly volume generated in the region.

♦ Other than acids, oily wastes, putrescible sludges and washwaters, most other waste types can be expected to be relatively minor.

♦ Comparison of the desk study predictions with manifest recorded data (Figure 2.5) indicates:

- very high quantities of plating wastes (Type A) and acids (Type B) actually requiring off-site treatment compared with model predictions. This could be a reflection of relatively inexpensive off-site treatment costs until recent times.

- low volumes of paint and other chemical organic sludges (Type F) recorded compared with model predictions. This may indicate that paint waste minimisation techniques are being introduced within manufacturing industries; or, paint sludges are not being considered as hazardous by some generators and are being disposed of with solid commercial and industrial waste. Random inspections of large and small generators should be undertaken to confirm manifest data.

- Pesticide waste arisings (Type H) appear to be high compared with model predictions. This could indicate that there is the potential for waste minimisation through storage of tank washings for subsequent use as dilution water.

- As mentioned above, waste oils (Type J48) are not well covered by the manifest system because of the potential for recycling through use as kiln fuel and for dust suppression on rural roads. Oily water is controlled by the Liquid Waste Form. Commission estimates of about 14000 kL/yr are well above the model predictions of 2000 kL/yr, (a similar situation to Melbourne) and possibly reflect the current low demand for recycled oil because of low crude oil prices i.e. the model parameters were developed during a period of high oil prices and associated strong demand for recycled oil, conditions that do not currently hold.

- Manifest data for Textile wastes (Type K), largely wool scouring wastes, are much higher than model predictions; possibly indicating the potential for waste minimisation through dewatering at the site of major generators.

- Putrescible organic sludges (Type L), largely grease trap wastes, are monitored by the Liquid Waste from manifest system (Appendix 7). Commission estimates of 9000 - 13000kL/yr are well in excess of model predictions of slightly less than 2000 kL/yr. This can mostly be explained by the inability of the model to account for grease trap wastes arising from restaurants and septic tanks (which are not related to industrial production employee numbers). However the ratio of estimate : model prediction of 6.5 is far higher than for Melbourne, which is only 1.8 (Table 2.5).

- Commission estimates of wastewaters and inert slurries (M and N) of about 2500 kL/yr are in reasonable agreement with model predictions. The Liquid Waste Form manifest system generally monitors these waste arisings.

The desk study method is a useful tool in identifying areas which should be investigated in some detail to either search for wastes that may be avoiding the manifest system or which may have the potential of being reduced. It is also useful in assessing the facilities that may be required in regions not currently covered by the manifest procedure. These advantages have been demonstrated in the above discussion and the uncertainties identified will be addressed in later sections of this report.

2.3.4. Comparison with Interstate Waste Generation

A brief comparison between Adelaide and Melbourne has been made in the discussion in Section 2.3.3. This comparison had the advantage of using the common technique of the desk study based on industrial production employees to enable valid comparisons to be made, i.e. the different profile of industrial waste generators was taken into account in the comparison.

A coarser comparison between Adelaide, Brisbane, Sydney and Melbourne based only on population corrections, is provided in Table 2.5 and Figure 2.6. Salient points from this comparison are:

- **Plating Wastes (Type A)**: Adelaide's generation rate appears to be about four times that of Brisbane and Melbourne, and Sydney's appears to be very low. When the industrial profile of Melbourne and Adelaide are accounted for (Table 2.2 for Melbourne and Table 2.4 for Adelaide), Adelaide's recorded Plating Waste generation still appears to be greater than Melbourne by a factor of about 4. This could indicate some combination of the following:

  - better compliance with manifest procedures in Adelaide.

  - more off-site treatment in Adelaide, possibly because of, until recently, the relatively low cost of off-site treatment and disposal in Adelaide compared with other cities.

TABLE 2.5

COMPARISON OF HAZARDOUS WASTE GENERATION IN AUSTRALIAN CITIES

CITY	POPULATION (MILLIONS) (2)	A kl/yr	A (1) kl/m/yr	B	B	C	C	D	D	F	F
ADELAIDE	1.01	2.2	2.18	10.54	10.44		1.30	0.763	0.27	0.15	0.15
BRISBANE (4)	1.22	0.56	0.46	1.12	0.92	1.12	0.92		*		?
SYDNEY (5)	3.53	0.11	0.03	8.72	2.47	19.00	5.83	2.46	0.70	12.36	3.64
MELBOURNE (6)	2.96	1.62	0.55	10.64	3.59	12.88	4.35	3.87	1.31	12.56	4.28

CITY	G	G	J	J	K	K	L	L	M & N	M & N
ADELAIDE	0.23	0.15	14.3	14.16	2.77	2.74	13.2	13.07	2.4	2.38
BRISBANE (4)	0.75	0.6	4.17	3.42		*	10.74	8.80		*
SYDNEY (5)	11.85	3.36	24.48	6.73	0.45	0.13	12.30	3.30	16.44	4.66
MELBOURNE (6)	1.6	0.54	41.26	13.94	6.53	2.23	9.76	3.30	7.29	2.46

NOTES (1) kl waste generated/1 million people/yr

(2) 1988 Year Book, Bureau of Statistics

(3) Waste Types

Adelaide	Brisbane	Sydney	Melbourne
A Plating		Plating	A
B Acids	Acid Aali/ metal site 2794 kl/yr	Acids	B
C Alkalis		Alkalis	C
D Inorganic Chem.		Inorganic Chem	D
F Paints, org sludge		Paints resins etc.	F
G Organic Solvents	Solvent waste	Organic Solvents	G
J Waste Oil	Aqueous Oily Waste	oils/water mix	J
K Textile		Textile	K
L Pesticide	Biodeg. Aug & sludge waste	Putrescible Organic	L
M Wastewater		Wastewater	M
N Inert slurries		Inert	N

(4) W.E. Razzell, Brisbane

(5) E. Samual, NS

(6) J. Hogan, Vic, EPA

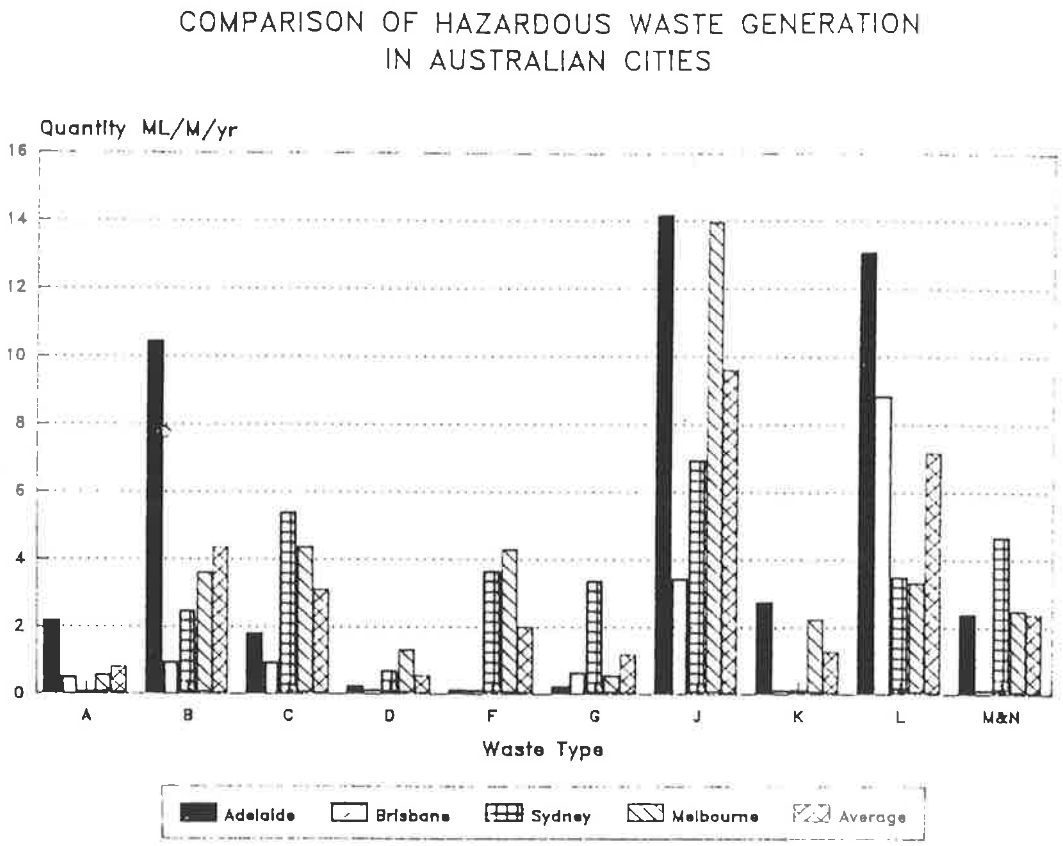


Figure 2.6 : Comparison of Hazwaste generation in Australian cities

- **Acids (Type B)**: Adelaide's generation rate is three to four times that of other cities. When the industrial profiles of Melbourne and Adelaide are taken into account (Table 2.2 and 2.4), Adelaide's acid wastes are still four times greater than what would be expected based on Melbourne's recorded waste generation. The reasons listed for plating wastes (type A) could also apply here.

- **Alkalis (Type C)**: alkali waste generation rates are about half those of Sydney and Melbourne and double those of Brisbane. Accounting for the industrial profiles of Adelaide and Melbourne, and using Melbourne as a basis, Adelaide's alkali wastes would be expected to be about 3600 kL/yr which is less than 30% above the recorded value of 2881 kL/yr. Therefore Adelaide's alkali waste generation rate appears to be consistent with expectations. It is unfortunate that the relative quantities of acids and alkalis in Adelaide are the reverse of interstate ratios, i.e. there is 3.7 times more acid than alkali, thereby requiring the purchase of additional lime to neutralise the high amount of waste acid.

- **Inorganic Chemicals (Type D)**: generation rates in Adelaide as measured by the manifest system are about 30-50% of the rates in Sydney and Melbourne. However, by taking the industrial profiles of Melbourne and Adelaide into account, the measured rate is within 20% of the expected rate based on Melbourne's generation rate.

- **Paints, resins, organic sludges (Type F)**: generation rates in Adelaide are only 4% of the rates in Sydney and Melbourne. After accounting for the variation in the industrial profile between Melbourne and Adelaide, the rate is still only 7% of what would be expected. Reasons could be postulated for this low rate, but they would be largely speculative and it would be more prudent to undertake some surveys in this area to try to explain the low generation rate. (Liquid waste form data to be included).

- **Organic solvents (Type G)**: waste generation is low in Adelaide compared to Brisbane, Sydney and Melbourne, and Sydney's rate appears to be far greater than other Australian cities. When the industrial profiles are accounted for, Adelaide's generation rate is about 65% of what would be expected based on Melbourne's records. Possible reasons for this are the availability of solvent recyclers in Adelaide and Albury and the proactive position taken by the Commission in encouraging major solvent waste generators to segregate their wastes and have them recycled to their economic benefit. This has achieved some success and could explain the relatively low values shown in the manifest records.

♦ **Waste Oils, oily water (Type J)**: now that waste oil is a waste in economic terms (owners of waste oil pay to have it removed from their premises), there is an argument for increasing controls on its movement. The large number of small diverse generators makes waste oil, like grease traps waste, difficult to monitor through conventional manifest procedures.

Waste oil generation rates in Adelaide are the same as for Melbourne and apparently higher than for Sydney and Brisbane. The reason for these differences could include:

- the availability of recycling facilities and outlets.
- the incidence of illegal disposal to sewers and landfill.

The waste stream is significant and should provide opportunities for waste minimisation, re-use and recycling.

♦ **Textile, tannery, wool scouring (Type K)**: wastes generation rates in Adelaide are about the same as Melbourne, with Sydney being very low. With recently introduced restrictions on grease disposal to sewer in Sydney, the quantities requiring offsite treatment and disposal could increase to the levels of Melbourne and Adelaide. When the industrial profiles of Melbourne and Adelaide are accounted for, based on Melbourne's generation, Adelaide recorded rates are about 2.3 times greater than expected. This may indicate the potential for waste minimisation in these industries, probably in the area of dewatering and water conservation and reuse.

- **Grease trap (Type L)**: wastes are monitored by the Liquid Waste Form. Estimates provided by the Commission are included in Table 2.5 and Figure 2.6, and waste generation rates appear to be much larger in Adelaide than Sydney and Melbourne, but about the same as in Brisbane. Grease trap wastes are more likely to be related to population than industrial profiles, and the difference between Adelaide and Sydney and Melbourne could be because of:

  - the manifest systems in Sydney and Melbourne not capturing all wastes generated;
  - higher incidence of illegal disposal to sewer and landfill in Sydney and Melbourne.

- **Washwaters and inert wastes (type M & N)**: generation rates are similar in Adelaide, Sydney and Melbourne (no data available for Brisbane), and are at about the level expected when the differing industrial profiles of Adelaide and Melbourne are accounted for.

2.3.5. Hazardous Waste Treated and/or Stored On-site

With rapidly escalating disposal charges, there is an emerging trend for producers to install on-site treatment facilities.

Coupled with more stringent control on the discharge of heavy metals to sewer, major producers of acid wastes and metal finishing wastes have established or are committed to the establishment of integrated waste treatment facilities. Four plants are now operating (G.H. Michell, Mitsubishi, Agchem and General Motors).

A number of wastes are generated within the State which have presented difficulties with regard to treatment and disposal.

- Timber preservative residues containing copper, chromium and arsenic were stored by the producer on site pending the establishment of suitable facilities within the State for treatment by fixation.

- Arsenical wastes arising from Pasminco-BHAS are stored in lined dams pending the development of a more suitable means of disposal or re-use.

- Wastes containing Polychlorinated biphenyls from electrical equipment is aggregated prior to shipment for destruction in the United Kingdom.

2.3.6. Household Hazardous Waste

Household hazardous waste consists of residues of hazardous materials used around the home; for example, pesticides, paint stripper, oven cleaner, pool acid and paint thinners. These wastes are currently managed by:

- Disposal with household refuse and ultimate disposal to refuse landfills.

- The householder phoning the SAWMC, who then give advice on appropriate handling, storage and disposal.

The Commission is currently establishing a receival/storage facility where householders may deposit small quantities of hazardous waste. Waste will be then sent to appropriate disposal facilities.

The Department of Agriculture has held an organochlorine pesticide recall and the 75 tonne of material received was disposed of to the ReChem high temperature incinerator in Wales. In December 1988 the use of a number of organochlorine chemicals for agricultural purposes was prohibited, and the Commission believes a further recall is warranted.

The Engineering and Water Supply Department, in the interests of protecting its sewerage system, has been planning to hold voluntary recall days in 1990.

Voluntary household chemical collection days have been held on a routine basis in Victoria and on a number of occasions in other States. The experience gained from these events has been made available to the Commission and will assist in the planning and operation of the household chemical receival/storage facility.

2.3.7. Contaminated Soils and Materials

Cabinet has given the Public and Environmental Health Division, South Australian Health Commission, responsibility for initial determination of whether a public health programme exists at a site and for assessing and advising on appropriate action.

The S.A. Health Commission provides the following service to owners of potentially contaminated sites:

- Initial site inspection search of site history, and identification of potential contaminants.

- Advice on testing programme and liaison with sampling/analytical team.

- Review of results, follow-up testing, assessment of contamination and preparation of a report to the owner and planning authorities.

An interdepartmental working group, chaired by the SAWMC's Chemical Engineer, is developing a government paper recommending policy and legislation for the management of contaminated sites. As an interim measure, a Planning Practice Circular (Appendix 6.3) is being developed for use by Councils, planners and consultants to make them aware of the need for Planning Authorities to be satisfied that land subject to rezoning or change of use, does not contain contaminated soil likely to create a hazard relative to the proposed use. Potentially contaminated sites should be referred to the SA Health Commission to enable them to undertake the service described above.

Current work being undertaken by the Commission concentrates on identifying potentially contaminated sites, namely:

- liquid waste depots
- waste disposal sites
- sites occupied by generators of prescribed waste (e.g. CCA wood treatment facilities)
- sites previously occupied by generators of prescribed waste, with the assistance of Councils, and concentrating on the older industrial areas between NE Road and Richmond Road.

To date some 40-50 sites have been identified and seven sites have been assessed by the Health Commission as being contaminated (at Albert Park, Mount Barker, five in the Bowden/Brompton area). Identified sites will be included in the Lands Department's Land Information System; this will provide information on possible contamination during Section 90 searches so that prospective purchasers of properties are aware of the possibility of clean-up costs that may be associated with change of use of the site.

In addition to the above activities, the SAWMC is contributing to an AEC project to develop National Guidelines for the Rehabilitation of Contaminated Sites, and the SA Health Commission is involved in a similar project managed by the NH&MRC. These guidelines will be taken into account in the development of policy, legislation and regulations in South Australia.

To date, most activities have been involved with the identification, characterisation and design of remedial methods for contaminated sites. Other than the Port Pirie lead contamination remediation, there has been limited site remediation involving treatment and disposal of contaminated material, either on-site or off-site. Actions have been limited to controls on site use. In line with experience interstate and overseas, this current phase is likely to move into a period when more active site remediation treatment and treatment residue disposal will predominate. This will require clear guidelines on clean-up criteria, controls on treatment facilities, and the provision of treatment and disposal facilities, all of which are currently only in the planning phase.

The quantities of material requiring on-site/off-site treatment and disposal are currently unknown, but should become available as the identification of potentially contaminated sites proceeds to completion. Victorian estimates of $1-3 million for a typical site clean-up lead to an estimate of $2 billion for total clean-up in that state. Melbourne is more industrialised than Adelaide and total clean-up costs for South Australian could be on order of magnitude lower than for Victoria.

2.3.8. Conclusions

This section has drawn on a diverse range of sources in an attempt to describe the pattern of hazardous waste generation in South Australia. Detailed discussion on each waste type has been provided and the main conclusions are repeated in summary form below:

- There is a general minor increase in the quantity of most waste types being recorded by the manifest system; less in some Eastern state centres where increases of 50% over 6 months have been recorded, following introduction of stronger legislation and closer public scrutiny. Waste quantities can be expected to decline as recent increases in waste treatment and disposal costs cause generators to upgrade on-site waste treatment. There is some evidence that this is now occurring and annual quantities could decline by 10% in 1990.

- Adelaide is the dominant centre for hazardous waste generation and should continue to be the focus of resources for the management of hazardous wastes. Other regional centres potentially produce significant quantities of certain waste types, and facilities and procedures should be formalised to manage these waste streams.

- Anomalies in the generation of certain waste types are apparent from an examination of various sources of data on hazardous waste generation, namely:

- plating wastes and acid wastes quantities are larger than expected.
- paint and other chemical organic sludges quantities are smaller than expected.
- oily wastes are a significant problem because of the large quantities and the large number of diverse generators. This problem is common to other states in Australia and nationally co-ordinated discussions through the AEC may be appropriate.
- Textile/tannery/wool scouring waste quantities appear to be larger than expected.

The reasons for these apparent anomalies are not clear and it is recommended that a survey of a range of generators be undertaken to explain the data obtained from the manifest records.

2.4. Hazardous Waste Policy, Legislation & Guidelines

2.4.1. Hazardous Waste Policy

The major statement of government policy is contained in the objectives of the Commission, namely to:

(a) promote effective, efficient, safe and appropriate waste management policies and practices;

(b) promote the reduction of waste generation;

(c) promote the conservation of resources by recycling and reuse of waste and resource recovery;

(d) prevent or minimise impairment to the environment through inappropriate methods of waste management;

(e) encourage the participation of local authorities and private enterprise in overcoming problems of waste management;

(f) provide an equitable basis for defraying the costs of waste management;

(g) conduct or assist research relevant to any of the above objectives.

There are no current formal agreements between South Australia and other states. The South Australian Government is however represented on the Australian Environment Council (AEC), and does consider guidelines produced by the AEC and the National Health and Medical Research Council in formulating policy and legislation in the hazardous waste area.

Hazardous wastes can be transported into South Australia from other states, and out of South Australia to treatment facilities in other states. These are considered on a case by case basis; currently:

- Infectious waste is transported from Victoria to South Australia for destruction by incineration.

- Hydrocarbon and chlorinated solvents are transported to Melbourne for incineration and recycling by licensed transporters who notify the Victorian EPA prior to shipment.

The Joint Taskforce on Intractable Waste, an initiative of the NSW, Victorian and Commonwealth Governments, has now completed two phases of a programme aimed at minimising and managing intractable waste, and at developing facilities in south-eastern Australia for its disposal. Its first report (Joint Taskforce on Intractable Waste, April 1988) made a number of recommendations which are relevant to South Australia. Preliminary discussions with Commission staff indicate that it is likely that the Commission will support a number of the recommendations of the Taskforce in an appropriate forum (such as the Australian Environment Council); these are detailed in Appendix 6.2.

In summary, the Commission should consider adopting the following policies:

(1) to manage intractable wastes in accordance with recommendations made by the Joint

Taskforce on Intractable Wastes and agreed to by the NSW, Victorian and Commonwealth Governments, and to dispose of intractable wastes arising in South Australia at the intractable waste treatment facility to be owned and operated by the Waste Management Authority of N.S.W.

(2) To investigate the technology used for non-BAT wastes (i.e. wastes being treated by other than Best Available Technology) in South Australia, to consider the environmental consequences, and to make decisions on whether this waste should also be directed to the intractable waste treatment facility. The conditions that may be placed on this by the WMA of NSW need to be considered in detail, as the facility may only be available for these wastes for a limited period, after which alternative facilities may need to be commissioned.

2.4.2. Legislation and Regulations

The Waste Management Act 1987 forms the core of controls on hazardous waste management in South Australia. The Act is complemented by a range of other legislation and administrative procedures. This section provides an overview of the relevant legislation

The Waste Management Act

The first comprehensive waste legislation in S.A. was the SA Waste Management Commission Act 1979, which, inter alia, provided for the establishment of the Waste Management Commission. This was designed to overcome the fragmented responsibilities of state and local authorities.

The legislation was strengthened in the Waste Management Act 1987. The Act empowers the Commission to control the production, storage, transport, treatment and disposal of wastes within S.A. The definition of wastes within the Act excludes legal discharges to sewer, gaseous discharges, smoke and wastes generated by mining and milling. These are covered by other legislation (see below).

The Act makes it an offence to produce, transport and deposit waste without authority. Such authority is conferred through a system of licences. These are required for transport of wastes for fee or reward, and/or operation of waste disposal depots. Licences are also required by producers of prescribed wastes as defined by Regulations promulgated under the Act.

The conditions of licence are designed to ensure that management of waste does not create:

- a nuisance or offensive condition
- a risk to health and safety
- damage to the environment

Breaches of licence may result in financial penalty, or a direction by an authorised officer to comply, or suspension or cancellation of licence. Standard conditions of licence are listed in Table 2.6 and provided in Appendix 5.

Two other sections of the Act are important in the context of hazardous waste. Firstly, the Commission itself may establish or operate a waste depot - provided that the criteria in the Act, including ministerial approval and public consultation, have been met. Secondly, section 15 of the Act provides for Waste Management Plans covering specified areas of S.A. These set out the measures considered necessary for proper waste management in the area. The Plans have their primary statutory force through the Planning Act 1982. The relevant planning authority is required to make decisions in accordance with the Waste Management Plans, which may be incorporated in the Area Development Plan.

The significance of this is that a Hazardous Waste Strategy could be defined and drafted as a Waste Management Plan. This would give planning force to any geographic constraints identified in the Strategy, such as specific land uses or siting requirements.

The Act is paramount to other legislation in matters concerning defined wastes with the exception of the following:

- Legal discharge to sewer (Sewerage Act 1929)
- Mining and associated milling wastes (Mining Act 1971)
- Radio-active wastes (Radiation Protection and Control Act 1982)
- Smoke or gaseous discharges (Clean Air Act 1984)

In addition, section 46 states that the Act "does not derogate from the Water Resources Act, 1976". In other words, a licence to produce, transport or dispose of waste does not entitle the holder to cause the pollution of ground or surface waters.

No other statutory interactions exist, apart from the previously mentioned provision for the incorporation of Waste Management Plans in Development Plans under the Planning Act 1982. There is, of course, an array of administrative procedures which provides for the practical implementation of overlapping statutes.

Other Legislation Applicable to Hazardous Waste Management

Options for hazardous waste management may be constrained by State and Commonwealth Legislation. A full listing of the statutory law is provided in Appendix 4.1. This includes application, relevant sections or regulations, and administering authorities.

The principle Acts are:

- Planning Act 1982: provides for Waste Management plans to be part of development plans governing land use; new waste management facilities require development approval and may require environmental impact assessment.

- Sewerage Act 1929: sets trade waste criteria governing the discharge of liquid wastes to sewers; non-complying wastes require alternative disposal or pre-treatment prior to discharge.

- Water Resources Act 1972: prohibits waste materials from being discharged or placed such that they come into contact with surface or underground waters; exceptions occur where an authorisation order is issued.

- Local Government Act 1974: duty of Councils to ensure proper collection and disposal of wastes; by-laws may be passed to cover landfill, air and water pollution and infectious diseases.

- Health Act 1935: provides generally for waste deposition and disposal, and for disposal of infectious material; many of the general provisions in the Act have been revoked or are effectively regulated by more recent statutes. These include the Waste Management Act 1987, Dangerous Substances Act 1979 and the Radiation Protection and Control Act 1982.

Table 2.7 shows the legislative framework and the areas of application.

Although many of the Acts have overlapping provisions, in practice there is effective co-operation between the administering authorities. Major overlaps are dealt with as follows:

- An illegal discharge to the sewer would be dealt with under the Sewerage Act 1929; but taking the same waste off site in a tanker, then illegally dumping, falls under the Waste Management Act 1987.

- The Local Government Act 1934 is generally accepted as covering non-hazardous wastes; where hazardous waste matters arise, the SA Waste Management Commission becomes involved.

- The keeping and handling of dangerous substances is governed by the Transport of Dangerous Goods Act; both the Act (administered by the Department of Labour) and Waste Management Licences issued by SAWMC use the same schedule of dangerous substances.

- Wastes which are burnt in an incinerator are regulated by SAWMC during transportation and when the residues are removed after burning; emissions from the incinerator are governed by the Clean Air Act 1984.

Areas in the legislative framework which cause some concern are:

(i) At present, there are occasional difficulties in distinguishing between a waste under the Waste Management Act, and a substance which may be covered by other Acts. Contaminated soils provide an example. This is a problem worldwide and there is no simple universal approach. A discussion on hazardous waste definitions is provided in Appendix 3.3, which concludes that the current classification system is appropriate.

(ii) the Petroleum Act 1940 has a section 64 which prohibits the disposal of waste oil, salt water or refuse on any land. Interpreted literally, petroleum generators covered by the Act are unable to dispose of waste at all. The section is currently under review by the Department of Mines and Energy.

(iii) Post-closure management of licensed depots: Currently licence holders can avoid responsibility for on-going management and remediation of contaminated areas around depots by simply handing in their licence and ceasing to become a licensed depot. There needs to be a legal requirement, possibly supported by some form of financial guarantee, to force licence holders to take responsibility for management of possible environmental damage after closure of their depot.

(iv) Currently, prosecution of responsible parties for illegal disposal of hazardous wastes requires the Commission to prove that in so disposing of the waste a nuisance or offensive condition, a risk to health or safety, or damage to the environment has occurred (Section 31, Waste Management Act, 1987). These conditions are not well defined and they are difficult to prove. This section should be modified to simplify interpretation and enforcement by:

- shifting the onus of proof to the polluter, as is the case with the recent NSW Penalties and Offences Act; and/or

- specifying that any unauthorised deposition of any Prescribed Waste is an offence, avoiding the need to prove that damage has been incurred.

(v) The definition of licensed generator in Section 22 (1) of the Act should be broadened to enable the control, licensing and prosecution of generators of prescribed waste where the generation arises from other activities (e.g. demolition, site excavation) as well as "an industrial or commercial process or a teaching or research activity".

Table 2.6
Standard Conditions of Licence

Waste Generation

- o General Conditions of Licence applying to Producers of Prescribed Waste.
- o Special Conditions of Licence applicable to Producers of Infectious Wastes.
- o Special Conditions of Licence applying to Producers of Acid and Alkali Waste.
- o Special Conditions of Licence for Producer of Asbestos Insulation Wastes.

Waste Transportation

- o General Conditions of Licence applying to the Transportation of Waste.
- o General Conditions of Licence applying to the Transportation of Waste including liquid and prescribed waste.
- o Special Conditions of Licence applicable to transporters of Infectious Waste.

Storage and Transfer Depots

- o General Conditions of Licence for solid waste Transfer Depot (Asbestos).
- o Special Conditions applicable to the storage of PCB waste.
- o General Conditions of Licence applying to Liquid Waste Depots (storage).

Treatment and Disposal Depots

- o General Conditions of Licence applying to Liquid Waste Depots (Evaporation Ponds).
- o Condition of Licence applying to Waste Depots (incineration).
- o Conditions of Licence applying to Liquid Waste Depots (treatment).
- o General Conditions of Licence applying to Liquid Waste Depots (Redistillation).
- o Solid Waste Landfill Depot - Special Conditions of Licence for disposal of asbestos waste.

Full copies of these Conditions of Licence are provided in Appendix 6.

Table 2.7
Legislation Influencing the Management of Hazardous Waste in South Australia

Waste Aspect	Component	Legislation
Generation	Dangerous substances	Agricultural Chemicals Act 1955
	Air pollution	Clean Air Act 1984 Local Government Act 1934
Handling and Storage	Dangerous substances	Dangerous Substances Act 1979 Agricultural Chemicals Act 1955 Health Act 1935 Waste Management Act 1987 Occupational Safety, Health and Welfare Act
'86		
	Infectious material	Health Act 1935 Waste Management Act 1987 Local Government Act 1934
	Radioactive material	Radiation Protection and Control Act 1982
	General wastes	Waste Management Act 1987 Local Government Act 1934 Water Resources Act 1972
Transport	Dangerous substances	Dangerous substances Act 1979 Waste Management Act 1987 Health Act 1935
	Infectious material	Health Act 1935 Waste Management Act 1987 Local Government Act 1934
	Radioactive material	Radiation Protection and Control Act 1982
	General wastes	Waste Management Act 1987 Local Government Act 1934
Recycling	General wastes	Waste Management Act 1987
Treatment	Criteria	Waste Management Act 1987 Sewerage Act 1929 Water Resources Act 1976
	Incineration	Clean Air Act 1984
	Air pollution	Clean Air Act 1984
	Infectious material	Health Act 1935 Waste Management Act 1987

Waste Aspect	Component	Legislation
	Treatment plants	Planning Act 1982 Waste Management Act 1987
	Water pollution	Water Resources Act 1972
	Environment	Environment Protection (Impact of Proposals) Act 1974
Disposal - Physical	Land	Waste Management Act 1987 Planning Act 1982 Petroleum Act 1940 Mining Act 1971 Health Act 1935 Local Govt Act 1934
	Environment	Environment Protection (Impact of
Proposals)		Act 1974
	Sea	Environment Protection (Sea Dumping) Act
1984		
		Harbours Act 1936
	Waters	Water Resources Act 1972 Local Govt Act 1934
	Sewer	Sewerage Act 1929 Health Act 1935 Dangerous Substances Act 1979 Local Government Act 1934
	Air	Clean Air Act 1984 Planning Act 1982 Local Government Act 1934 Environment Protection (Sea Dumping) Act
1984		
Disposal - substances	Dangerous substances	Waste Management Act 1987
	Radioactive material	Radiation Protection and Control Act 1982
	Pesticides	Occupational Safety, Health and Welfare Act 1986
Restoration 1984	Sea	Environment Protection (Sea Dumping) Act
	Land	Planning Act 1982 Mining Act 1971 Petroleum Act 1940
	Environment	Planning Act 1982

2.4.3. Guidelines

The Commission produces Technical Bulletins which provide not only general information, but also guidance on procedures to be followed by practitioners. Those of particular relevance to hazardous waste management are listed below and are provided in Appendix 7:

- o No. 1 Conditions of Licence for the Safe Handling, Transport, Storage and Disposal of Asbestos Waste.
- o No. 2 Conditions of Licence for the Storage and Transport of Waste Containing Polychlorinated biphenyl (PCB).
- o No. 3 Handling and Disposal of Wastes Containing PCB.
- o No. 4 The Waste Disposal Notice.
- o No. 5 Disposal of Asbestos Cement Wastes.
- o No. 6 Control of Production of Prescribed (i.e. Hazardous) Wastes.
- o No. 7 Disposal of Hazardous Wastes Arising from Laboratories.
- o No. 10 Disposal of Halogenated Hydrocarbon Solvent Waste.
- o No. 12 The Storage, Treatment, Transportation and Disposal of Putrescible Wastes from the Food Processing Industry.
- o No. 13 Disposal of Empty Pesticide Containers.
- o No. 14 Dangerous Goods - Requirements for the Transportation of Prescribed Wastes.
- o No. 15 Guidelines for the Storage, Transport and Disposal of Infectious Wastes Arising from Medical, Dental and Veterinary practices.
- o No. 16 The Liquid Waste Form.

National guidelines which influence the management of hazardous waste in South Australia include:

- o AEC National Guidelines for the management of Hazardous Wastes, Nov. 1986.

- o NH & MRC National Guidelines for the Management of Clinical and Related Wastes, 1988.

The AEC Guidelines provide guidance, to varying levels of detail, on:

- ♦ Polluter Pays Principle;
- ♦ Regulation of Generators, storers, treaters, transporters and disposers of hazardous waste;
- ♦ The waste classification system (detailed);
- ♦ National manifest system for tracking movement of hazardous wastes (detailed);
- ♦ International movement of hazardous wastes
- ♦ Operational guidelines;
- ♦ Site selection criteria for facilities;
- ♦ National high temperature incinerator;
- ♦ Waste exchange;
- ♦ Research and development.

The South Australian system complies with the guidelines in most areas of relevance to South Australia; exceptions are:

- ♦ Regulation of generators, transporters, treaters and disposers should include a requirement to carry indemnity insurance.

- ♦ Operation of a formal Waste Exchange with interchange of information with other States (informal advice on waste exchange is provided by Commission staff).

In relation to the AEC recommendation for a national manifest system for the tracking of interstate and international waste movements, the Commission's classification and manifest system and the states which interact with S.A. (Victoria and NSW) all now follow the AEC guidelines. S.A. intractable wastes, such as PCBs, are exported for treatment overseas through repackaging facilities interstate -

S.A. does not export waste directly.

A review of the management of clinical and related waste is being undertaken in parallel with this study and the NH & MRC Guidelines will be incorporated into the review. (S.A. Health Commission, April 1986; S.A. Health Commission, October 1989).

2.4.4. Conclusions

This overview of policy, legislation and guidelines indicates that a reasonably comprehensive framework exists for the management of hazardous waste in South Australia. Areas for improvement have been identified.

2.5. Waste Prevention, Minimisation and Recycling

2.5.1. Introduction

In the preferred hierarchy of waste management, waste prevention, minimisation and recycling have precedence over treatment and landfill, i.e. treatment and landfill should be employed only after opportunities for prevention, minimisation and recycling have been exhausted.

The first four objectives of the Commission can, in some cases, be satisfied through introduction of waste minimisation practices (the generic term for prevention, minimisation and recycling). The Commission will support the adoption of the Draft National Guidelines for Waste Minimisation in the AEC, and therefore waste minimisation will play an increasingly important role in hazardous waste management in S.A. in the future.

A detailed outline of waste minimisation approaches is provided in the Draft National Guidelines for Waste Minimisation (Appendix 6.1). In summary, waste minimisation results in reduced volumes and/or toxicity of hazardous wastes and in most cases subsequently means reduced demand on treatment facilities and secure landfills for the disposal of solid residues from treatment processes. Waste minimisation investigations consist of the conduct of a waste audit for a plant, followed by the identification of opportunities for waste minimisation through:

- product substitution
- alteration of input materials
- alteration of technology
- alteration of management of the production process

Technology changes may consist of process changes, equipment changes, changes to operation parameters and additional controls, and energy and water conservation. Management changes are often referred to as `housekeeping' and can consist of procedural measures (chemical control systems, waste audits, cost allocation procedures); loss prevention; waste segregation and personnel awareness programmes. A key factor in the success of waste minimisation programmes is the level of attention paid by senior management to the programme.

2.5.2. Waste Minimisation Activities in South Australia

To date, there has not been a major formal waste minimisation programme in South Australia. Reasons for this include:

- the lack of clear guidelines on what waste minimisation is, and what government role is appropriate and effective.

- the unsteady nature of the generation of hazardous wastes in South Australia in an environment of substantial increase in waste treatment charges, and the uncertainty over the effect these prices will have on waste generation volumes.

Informal and development activities have been undertaken, including:

- contributions by the Commission to national seminars on waste minimisation, leading to the development of the AEC Draft guidelines.

- informal advice to generators of hazardous waste on the potential to recycle their wastes e.g. solvents.

- monitoring the impact of price increases on generators wastes volumes.

- introduction of trade waste charging by the E&WS in some circumstances, and consideration by them of a broader application.

An illustration of the impact of increases in offsite waste treatment charges on waste volumes is provided in Figure 2.7. With the possible exception of wool scouring wastes (type K), there is not yet any discernible correlation. This may either be because of the lag that would be expected between a price rise and the commissioning of new equipment to reduce offsite waste treatment quantities and costs; or, it may indicate the insensitivity of waste volumes to changes in the current price range. Evidence for both these possibilities is available, and it is unlikely that a clear picture will emerge before the end of 1990.

In addition, introduction of trade waste charging (sewer disposal) could further complicate the trends in volumes of waste requiring off-site treatment. Discharges to sewer must comply with allowable discharge criteria, and therefore the introduction of charging could lead to:

- increased volumes of dilute untreated waste for off-site treatment if this is economic,

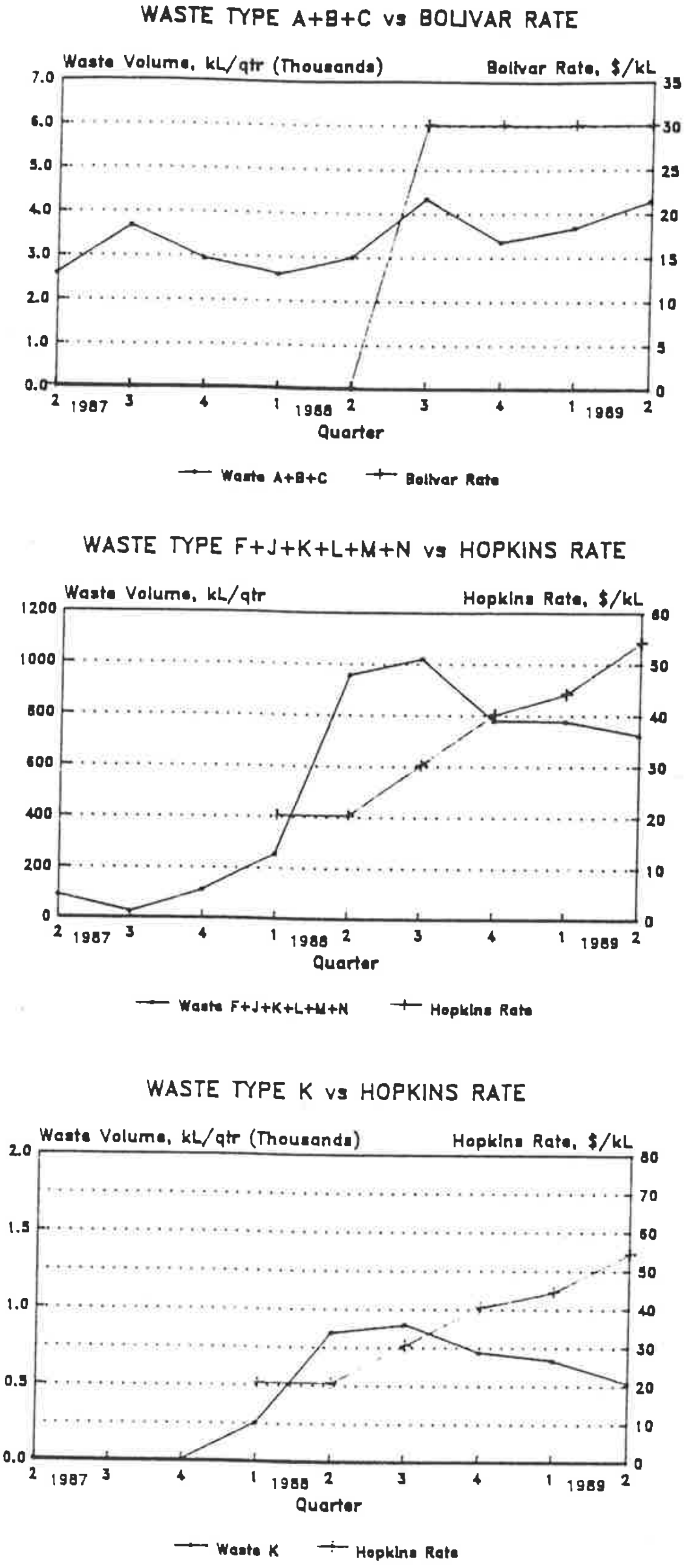


Figure 2.7
Impact of price increases on waste generation

- increased volumes of on-site treatment residues requiring off-site treatment and disposal, arising from the introduction of on-site treatment to minimise disposal of contaminants to sewer (with associated charges).

2.5.3. Conclusions

Waste minimisation is now recognised as an important component in regional hazardous waste management systems. It is likely to play an increasingly important role in the future, particularly as detailed and practicable procedures are developed to implement the currently available more generalised guidelines.

An important component of any waste minimisation system is the ability to define the `base case' and then to meaningfully monitor progress towards targets that may be set for guidance, or which may be mandated in some cases. This applies equally to individual generators as to a State wide authority such as the Commission.

Chapter 3 describes in some detail the activities that could be undertaken to encourage waste minimisation in a structured and cost effective manner.

2.6. Hazardous Waste Treatment Facilities

2.6.1. Introduction

This section provides an overview of on-site and off-site hazardous waste treatment facilities existing and proposed for South Australia. Existing lagoon disposal facilities, such as the EWS Liquid Waste Depot, which are being phased out, will not be included. These sites should, however, be regarded as potential contaminated land sites and should be managed as such (refer Section 2.3).

2.6.2. Off-site Treatment Plants in S.A.

There is one major hazardous waste off-site treatment plant in South Australia; the National Waste Company (NWC) liquid waste treatment plant at Wingfield. Approval is being sought by Waste Management Services for a plant at Dry Creek.

The NWC plant consists of the following unit processes:

- neutralisation and heavy metal precipitation as a metal hydroxide sludge,
- batch tank chemical detoxification of wastes such as cyanides and chromates,
- oily water separation into oil and water phases,
- grease trap waste separation into grease and water phases,
- sludge dewatering, with sludge disposal to an off-site landfill,
- Sludge and solids stabilisation using cement based reagents in a transit mixer,
- effluent storage in a batch tank, to enable analysis prior to discharge to sewer,
- proposed (future) fluid bed incineration.

Simplified flowcharts of this process are illustrated in Figure 2.8.

The proposed Waste Management Services plant consists of the unit processes of (Figure 2.9):

- Gravity separation to remove oil and solids from aqueous wastes.

- Chemical emulsion breaking and dissolved air flotation to remove fine oil and emulsions from aqueous wastes.

- Acid/alkali neutralisation and heavy metal precipitation as a metal hydroxide sludge.

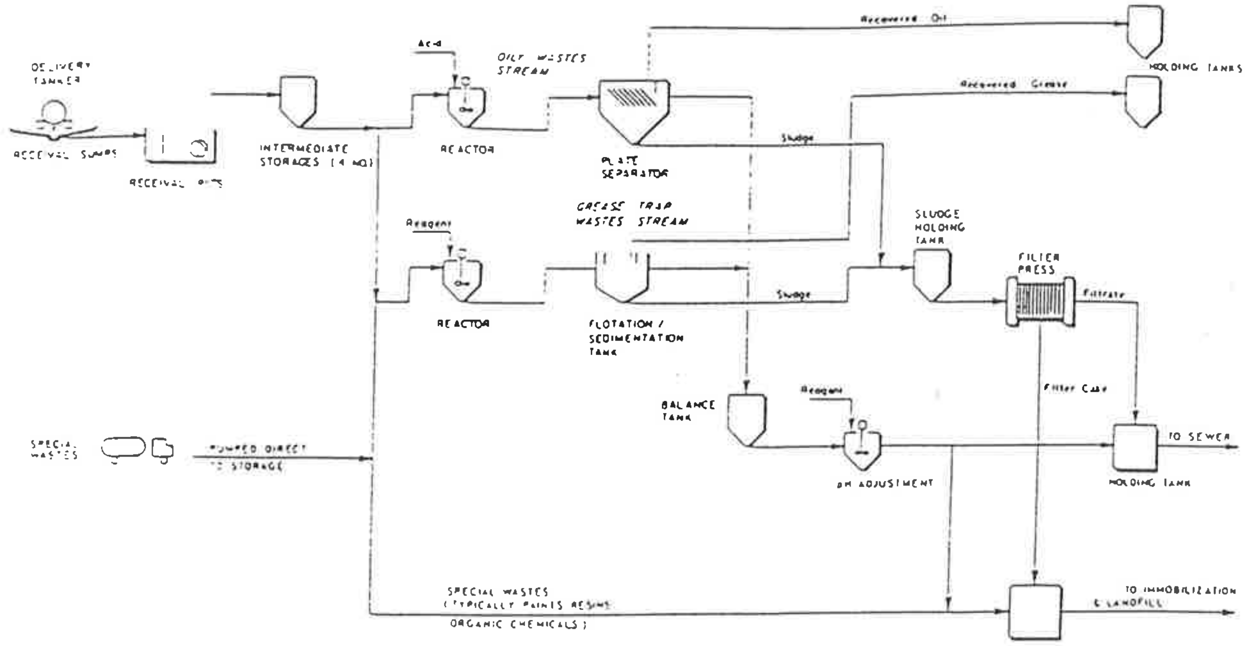
- Sludge dewatering, with effluent disposal to sewer and dewatered sludge disposal to landfill off-site.

The combined capacity (8 hour shift) of the above treatment plants to treat the range and quantities of wastes produced in Adelaide is summarised in Table 2.8, and illustrated in Figure 2.10. Salient features of this analysis and comparison are:

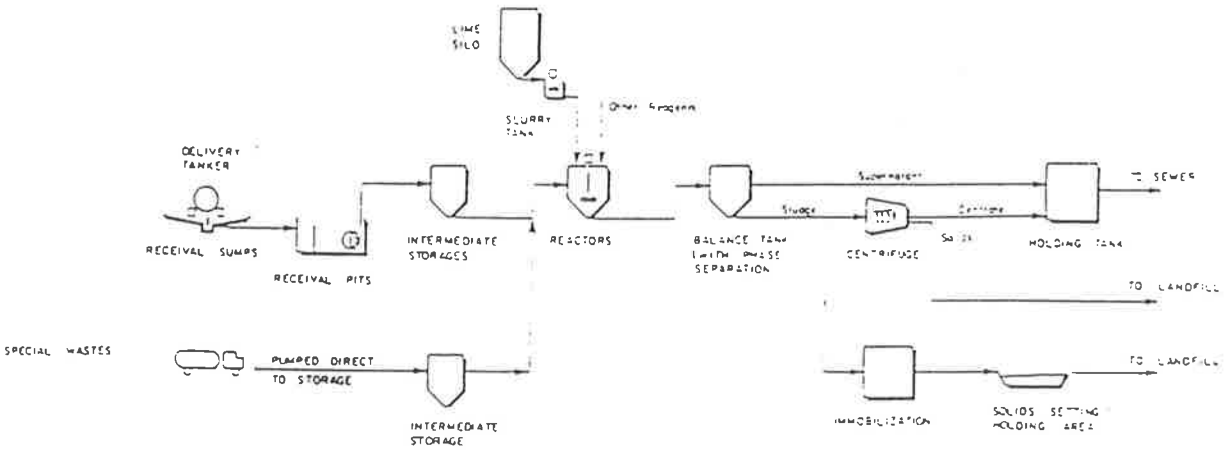
- The capacity to treat waste types A and B may be constrained by immobilisation treatment capacity, depending on the proportions of these waste streams that are contaminated with heavy metals.

- Treatment capacity for waste type F is provided by stabilisation with cement. Depending on the outcome of investigations in SA and interstate on the `non-BAT' wastes, this may be unacceptable in the short to medium term. Commissioning of the proposed NWC incinerator may overcome this potential problem; depending on the ability of the fluid bed incinerator to accept all forms of organic wastes and/or the capacity of the NSW's intractable waste incinerator to accept non-BAT wastes from interstate.

- There is no treatment (incineration) capacity for waste type G, waste organic solvents, in Adelaide, but recycling is available and back-up recycling and incineration facilities are available interstate. These are able to cope with the current relatively small demand from Adelaide. The proposed NWC incinerator would provide capacity for those solvents that could not be recycled locally, thereby avoiding the need to transport these solvents to Melbourne for



Oil arrester & grease trap waste



Acid & Alkali waste

Figure 2.8
Simplified flowchart
National Waste Company liquid waste processing facility

(Source : Waste Disposal and Water Management in Australia , Nov. 1989)

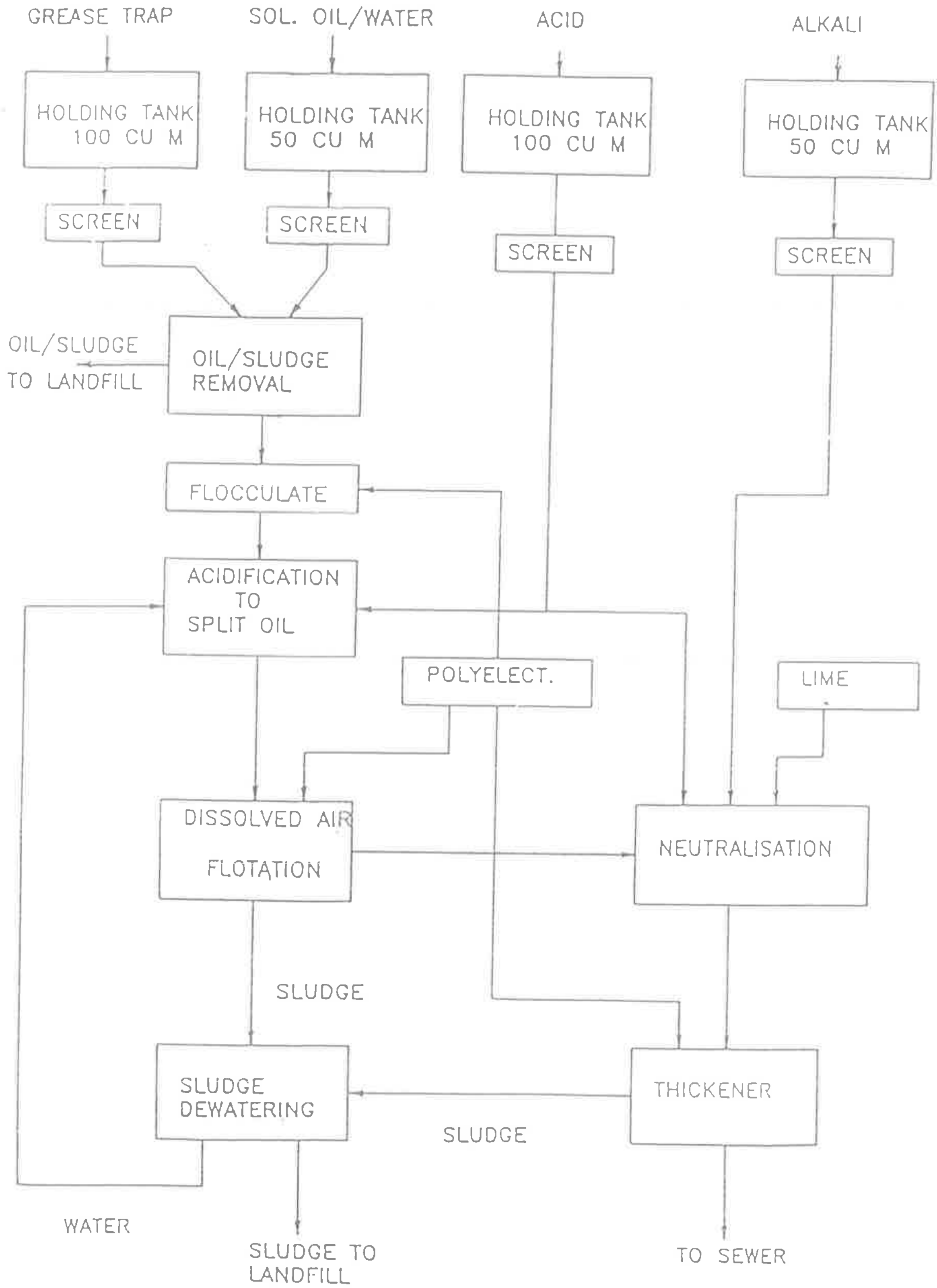


Figure 2.9
Simplified flowchart
Waste Management Services aqueous waste plant

(Source : SAWMC , development approach) incineration.

- For waste Type J a proportion of waste oils will contain only small quantities of contaminating water and grit and will not require treatment at the NWC and WMS facilities. Therefore, the apparent under capacity may not be significant. This should be investigated in more detail because of the problems with the lack of recycling markets for waste oil. There is currently no treatment capacity for recovered oil waste (i.e. incinerator), and this is causing problems because of the limited number of recycling opportunities (e.g. low grade fuel, dust suppressant).

- For textile, tannery, wool scour wastes (Type K) treatment capacity listed is by cement based stabilisation. Similarly to waste type F, this may become unacceptable in the short to medium term; again this possible problem should be overcome following installation of waste incineration capacity at the NWC plant.

- For grease traps wastes (Type L) there appears to be a deficiency in the capacity of the off-site treatment plants to handle the total demand from Adelaide. As there is limited opportunity to minimise these wastes at source, investigations should confirm the generation quantities and then installation of additional treatment capacity should be encouraged.

- The treatment capacity of waste types M & N is determined by mechanised dewatering capacity. Provided effluent batch tank capacity matches (or exceeds) dewatering capacity, then ample treatment capacity should be available.

As indicated in Figures 2.8 and 2.9 two residues arise from the treatment processes and are disposed of off-site:

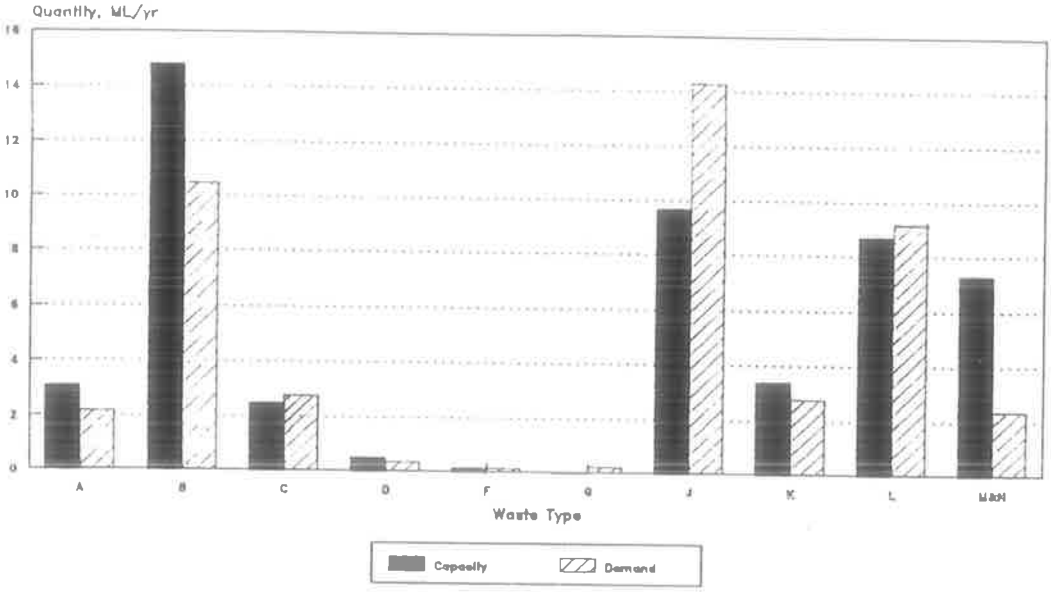
- Liquid effluents are disposed of to sewer from an effluent batch tank, which holds the effluent until tests prove that sewer acceptance criteria (Appendix 4.2) have been met. Effluent discharge quantities will approximate aqueous waste quantities, i.e. about 45 ML/yr. These liquid effluents are pumped to the trunk sewer draining to Bolivar Sewage Treatment Works, which has adequate capacity to treat these effluent flows. The quality of the effluent from these treatment plants is such that it may be possible to re-use these effluents for industrial wash-down, irrigation or dust suppression at locations in the vicinity of the plants.

- Dewatered sludge cake and cement stabilised solids will need to be disposed of to an off-site landfill. The quantity of solids requiring off-site disposal is difficult to determine because of the lack of detailed information on the untreated waste characteristics (solid content, pH, metal concentrations etc.). An indicative estimate would be approximately 2000 t/yr, or 1500m^3/yr. This is relatively small compared to municipal solid waste (refuse) generation in Adelaide, which is in excess of 2000 t/d. However, these solid residues need to be disposed of with more control than refuse. Contaminated sites will contribute much greater volumes (Section 2.3.7). There is currently no dedicated off-site landfill licensed to accept these solid residues only, for ultimate disposal. This important deficiency in the existing system is discussed in more detail in Section 3. Currently these solid residues are allowed to be disposed of to a specially licensed refuse landfill provided they pass an Extraction Procedure Test (Appendix 8).

Table 2.8
Hazardous Waste Treatment Capacity v's Demand

Waste Type		Capacity (2) ML/yr	Demand (1) ML/yr
A.	Plating	3.1	2.2
B.	Acids	14.8	10.5
C.	Alkalis	2.5	1.8
D.	Inorganic Chemicals	0.5	0.37
F.	Paints, Resins, organic sludges	0.14	0.15
G.	Organic Solvents	0	0.23
J.	Waste oils, oily water	9.7	14.3
K.	Textile, tannery, wool scour	3.4	2.8
L.	Grease Trap	8.7	9
M&N	Washwater and Inert	7.3	2.4
Total		**43.5**	**47.95**

NOTES:
1. From Table 2.4
2. Calculated from Development Applications; multi-purpose unit process capacity apportioned according to demand.



WASTE TYPES

A – Plating
B – Acids
C – Alkalis
D – Inorganic Chemicals
F – Paints, Resins, Organic sludges
G – Organic Solvents
J – Waste oils, Oily Water
K – Textile, Tannery, Wool scour
L – Grease Trap
M&N – Washwater & Inerts

Figure 2.10 : Hazardous waste treatment capacity versus demand

2.6.3. Off-site Treatment Plants Interstate and Overseas

South Australian industry uses the services of interstate and overseas facilities to complement the treatment capacity described above. In all cases these interstate and overseas facilities are only used where local facilities do not exist. The major interstate and overseas facilities forming part of the South Australian system of hazardous waste management are:

- The solvent recycling residue (still bottoms) and waste solvent incineration facilities in Melbourne.

- Back-up solvent recovery facilities in Albury and Melbourne when the capacity of Adelaide's solvent recovery plant (Solvent Distillers of S.A.) is exceeded.

- The UK high temperature incinerators for the destruction of intractable organic wastes generated in S.A. (PCBs, organochlorine pesticides). The medium to long term availability of this facility is not assured because of the possibility of stricter UK government or union controls on importation of hazardous waste, greater demand from the UK and European market for incineration capacity, and the influence of the possible introduction of uniform EEC environmental controls. The proposed WMA of NSW intractable waste incinerator will replace the UK incinerator and intractable wastes will need to be stored (or remain in service) should there be a gap between the closing of the UK service to Australia and the commissioning of the WMA of NSW's incinerator.

The establishment of the proposed National Waste Company incinerator would overcome the need to send solvent wastes and recovery residues interstate, so that, at this time, S.A. would be self-sufficient in off-site waste treatment facilities for all hazardous waste except for the intractable wastes (a sub-set of hazardous wastes).

The Joint Taskforce on Intractable Waste has included CFCs and halons in the intractable waste category, thereby requiring high temperature incineration of these materials when they become wastes. CFCs and halons are not specifically included in the Prescribed Waste List, but could be included under the general categories of "Fluoride compounds" and/or "organic halogen compounds". The S.A. government has yet to include CFCs and halons in the intractable waste category requiring high temperature incineration disposal, although its policy of "The production, use, sale and disposal of CFCs will be shortly banned in South Australia, except where the Minister for Environment and Planning has granted exemptions", could enable this requirement. (DEP information sheet, CFCs and the Ozone Layer, Sept. 1989).

2.6.4. Significant On-site Treatment Facilities

Most generators of Prescribed Waste with on-site treatment and disposal facilities are licensed and provide annual returns describing the fate of wastes produced on their site (Section 2.3.1). Some generators are exempt because of special conditions in Indenture Agreements, and are subject to the reporting requirements and controls set down in those Agreements.

Regional centres place a high reliance on on-site treatment facilities, generally because of the dominance of a single industry in each region. In these circumstances it is generally more efficient for the industry to treat and dispose of its waste in-house. In many OECD countries on-site treatment accounts for the majority of treatment and disposal capacity; for example, at least 80% of hazardous wastes are treated on-site in the USA.

The introduction of new off-site treatment facilities in Adelaide has been accompanied by the setting of stringent standards and monitoring, on the quality that must be achieved by:

- Effluent before it is disposed to sewer, including the provision of effluent discharge batch tanks.

- Solid residues before they can be disposed of to landfill, including the passing of the USEPA Extraction Procedure toxicity test.

On-site treatment and disposal facilities are not required to meet the same conditions as the newly commissioned off-site plants. Treatment of more homogeneous waste streams would facilitate better control, and the need for uniform standards would not be as great for on-site treatment and disposal facilities. However, the situation needs to be reviewed and deliberate decisions made based on comprehensive data.

2.7. Hazardous Waste Treatment Residue Disposal Facilities

Current hazardous waste treatment residue arisings requiring ultimate disposal have generally been identified in the preceding sections and, in summary, are:

- sludge from off-site treatment facilities in Adelaide, estimated at 2000 t/yr.

- sludges from on-site treatment facilities in Adelaide. Currently these are generally treated at the off-site treatment facility; but increasingly, on-site plants will produce residues of a quality that can be disposed of without further processing.

- sludges produced at on-site treatment facilities in Regional centres which are disposed of on-site.

- liquids arising the above treatment processes.

- gaseous emissions arising from:

- burning of recycled oil as fuel in brick kilns and boilers,
- evaporation of hydrocarbons from waste oily water separation processes and ponds, and from spraying oily wastes for dust suppression,
- incineration of clinical wastes and small quantities of waste solvents in hospital incinerators and two central incinerators in Adelaide (not covered in this Review as they are dealt with in a parallel review, and they do not incinerate other hazardous organic wastes).

Ultimate disposal facilities for these residues currently consist of:

Solids

♦ Selected Municipal Solid Waste Landfills licensed to accept asbestos and sludges provided these waste residues pass certain acceptance criteria related to controlling migration of contaminants to the environment (Appendix 7).

♦ On-site disposal of sludges in evaporation lagoons or landfills at on-site treatment facilities at industrial sites.

♦ Disposal of organic sludges arising from agricultural produce processing (wineries, abattoirs etc) to agricultural land; this waste disposal is controlled by the E&WS through the Water Resources Act to ensure that application rates do not lead to water quality deterioration.

♦ Storage of some residues and wastes pending ultimate disposal in the above facilities, or at treatment and disposal facilities interstate and overseas, namely:

  - Waste Management Services: drums of stored liquid waste and storage of ongoing generation of clinical waste incinerator ash.

- Timber Preservation Residues being stored at the site of generation or at off-site storage facilities.

- United Transporters: Minor quantities of stored liquid waste awaiting treatment and disposal at interstate and/or overseas facilities.

- Asbestos storage/transfer stations, where smaller quantities of asbestos are bulked prior to disposal in licensed MSW landfills.

♦ There is no dedicated off-site storage facility (lagoon or tanks) for hazardous wastes generated by emergency response actions such as chemical store fire fighting, clean-up from chemical tanker spills etc.

Liquids

♦ In Adelaide, treated liquid effluents are disposed to sewer following demonstration that they comply with the E&WS sewer acceptance criteria (Appendix 4.2). Liquid effluents from off-site treatment plants are charged according to volume and contaminant concentration, but liquid effluents from on-site treatment plants currently do not attract any special trade waste charges. This situation is currently under review by the E&WS.

♦ Some liquid wastes are currently disposed of by evaporation (and possibly infiltration), but these facilities will be closed and decommissioned following introduction of new Regulations under the Waste Management Act, which will prohibit this method of waste disposal.

♦ Regional on-site treatment facilities dispose of liquid effluent to sea (coastal facilities) or by evaporation (inland facilities). Control of these discharges is currently by:

- Conditions in Indenture Agreements (generally by the Department of Environment and

Planning);

- the Water Resources Act for inland facilities (E&WS Department);

- the Mines Act and the Petroleum Act for mining and petroleum related wastes (Department of Mines and Energy).

Gases

♦ Gaseous emissions from hazardous waste treatment and disposal facilities are controlled by the Department of Environment and Planning under the provisions of the Clean Air Act. Monitoring and control generally concentrates on concentrated stack emissions rather than diffuse fugitive emissions and emissions from evaporation lagoons.

2.8. Conclusions

The adequacy of the existing hazardous waste management system as described in this Section in relation to an ideal system is assessed in Section 3. In relation to the adequacy of the data available, used to prepare this Section, the following conclusions can be drawn:

♦ **Hazardous Waste Generation**

- the database for hazardous wastes treated at off-site facilities, as derived from the manifest system, is organised around the preferred AEC classification system, has as long a record in accordance with this classification as any in Australia, and is readily accessible via the dBASE III information sorting and retrieval capabilities. It is equal to the best currently available in Australia.

- the data on quantities and characteristics of wastes treated and disposed of on-site is poor in comparison to data for hazardous wastes treated at off-site facilities. Waste descriptions do not follow the AEC classification; the basis of waste quantity estimates is not clear and would be expected to be less rigorous than for wastes directed to off-site facilities; and some major facilities are not included in the data because of exemption conditions in Indenture Agreements.

- Information on the location of contaminated sites is improving and there is a methodical and rigorous approach being implemented to complete the identification of potentially contaminated sites over the next year. Information on contaminant characteristics and the extent of contamination is currently poor and will remain so until the identification phase is complete. Thereafter, a priority will need to be allocated to enable this information to be obtained for critical sites. In relation to data on contaminated sites, only Victoria would have a better database. In comparison to other OECD countries, most would have commenced the process now being undertaken in South Australia in the early to mid 1980's.

- Information on the nature and quantity of household hazardous waste (other than those used for agricultural purposes) in South Australia is poor. This is not of great concern because of data available from interstate collection days, which would be expected to be similar to the South Australian situation. Data collection should be an integral part of all household hazardous waste collection programmes.

♦ **Policy, Legislation and Guidelines:**

- Current policy, legislation, regulations and guidelines have been developed over the past decade and, individually, are well documented. However, it is difficult for those involved in the management of hazardous waste to gain an overview of the system and to quickly locate guidelines etc. that may be relevant to their field of activity. To date, this has not been a major problem, as the SAWMC will provide verbal or written advice at short notice on any matter relating to the management of hazardous wastes. However, as the complexity of the system inevitably increases, these demands on the Commission will grow and a Manual, similar to the Procedures Manual - South Australian Planning System, will become increasingly necessary. The overview provided in this Section, the detailed content of the relevant Technical Bulletins (Appendix 7) and a series of decision trees and logic diagrams would form the basis of such a Manual.

- **Waste Minimisation**

  - Because of the informal nature of the SAWMC's role in promoting waste minimisation, the developing nature of this field, and the uncertainty on the scale of reductions that will arise from recent increases in off-site treatment costs, little quantitative data is currently available.

    The SAWMC does have a number of case studies that it has been involved in South Australia, particularly in the area of Solvent Waste Reduction, but these case studies have not been documented in a form that could be widely distributed.

- **Treatment and Disposal Facilities**

  - the capacity of off-site treatment plants is currently based on information provided with planning approval documents. After commissioning and operation of these relatively new plants, more reliable data will become available on the capacity of these plants in practice (which may be above or below design figures).

  - the nature, capacity and performance of off-site treatment plants is not well documented.

- the capacity and details on the conditions of waste acceptance to disposal facilities (MSW Landfill and the sewerage system) for off-site treatment plant residues is well defined; but the availability and detail available for on-site facilities is variable and poor in some cases.

- the capacity, and conditions of acceptance and operation for interim storage facilities are generally well documented in licence conditions for those facilities.

3 AN OUTLINE OF AN IDEAL HAZARDOUS WASTE MANAGEMENT SYSTEMS FOR SOUTH AUSTRALIA

3.1. Introduction

A comprehensive system for the management of hazardous waste will provide details on procedures and facilities for:

- Guiding Principles
- Waste Classification
- Waste Manifest Controls
- Minimisation
- Treatment
- Residue management

This section provides an outline for an ideal system comprised of the above elements and compares the existing system to it; highlighting achievements to date and issues remaining to be resolved. Options for improvements to the first four elements are provided in this section; alternatives for upgrading treatment and residue management are provided in Section 4.

3.2. Guiding Principles

The guiding principles for the management of hazardous waste in South Australia should include:

- Adoption of the preferred hierarchy of waste management;
- Adoption of a multi-media approach in setting emission standards for various contaminants to

the environment;

- o Adoption of policies in relation to the effects of hazardous waste management on ozone depletion and the greenhouse effect;
- o Adoption of the polluter pays principle.

3.2.1. Preferred Hierarchy of Waste Management

Adoption of the preferred hierarchy of waste management requires that incentives and penalties are in place to force the use of the following practices in order of decreasing priority:

- o waste avoidance
- o waste minimisation
- o waste recycling
- o waste treatment
- o landfill disposal of residues

The first three are often collectively referred to as waste minimisation. The Commission has supported these principles by way of their objectives and informal advice for some time. They should be formally adopted as policy and possibly included in the Commission's objectives when the Act is next amended. The SA Government should support the adoption of the hierarchy by the ANZEC and to modify its Guidelines for the Management of Hazardous Wastes to include the hierarchy as a guiding principle.

Details of how the SAWMC could encourage waste minimisation are provided in Section 3.5.

3.2.2. Multi-media Approach to Setting Emission Standards

To date, in South Australia and in most countries, emission standards have been set for one environmental media, such as the atmosphere, without full examination of the implications for the impact on other environmental media, such as waters and soils. There is a need to co-ordinate the setting of standards for all environmental media so that the best overall environmental protection is achieved. Similarly, the introduction of technology to control emission of contaminants to one medium (baghouses for heavy metal contaminated dusts) needs to consider the impact on other media and to provide a comprehensive system for management of these contaminants so that the mere transfer from one medium to another (e.g. soil, waterbodies) is avoided.

There are two approaches which can be employed in this regard:

- Consider the impact on other environmental media when setting emission standards, and modify standards for other media as appropriate, through a more integrated approach to licensing and control.

- Establish regulations for the control of individual chemicals, having regard for their fate when released to the environment and their impacts when contained in various media. This is a rational, but complex and expensive exercise and to date has only been undertaken for a small number of chemicals in some countries (e.g. dioxin, PCBs in Ontario, Canada). The SPCC of NSW has adopted this approach for certain chemicals through `Chemical Control Orders' under the Environmentally Hazardous Chemicals Act, 1985. This Act takes precedence over the control of these chemicals by other legislation. To date aluminium smelter wastes, dioxin contaminated waste, asbestos wastes, organochlorine pesticide wastes, organotin wastes and PCBs have Chemical Control Orders regulating their management.

In setting standards the SAWMC should liaise with Departments responsible for other relevant legislation and have regard for the impact on other facilities in the overall system for managing hazardous wastes. In particular:

- Sludge disposal regulations controlling inorganic contaminant concentrations and leaching characteristics should have regard for the impact on the E&WS trade waste discharge controls.

o Regulation of on-site treatment facilities in regional centres should be co-ordinated with forthcoming marine pollution control regulations.

o Clean-up criteria for contaminated sites should have regard for the capacity of the existing off-site and future treatment and disposal system to manage large volumes of contaminated soils, particularly in regard to the total environmental impact of various management techniques.

o The impact of exemptions to normal control procedures.

3.2.3. Ozone Depletion and Greenhouse Effect

The control of CFCs and halons needs to include guidelines for the disposal of CFCs currently in use. The Joint Taskforce on Intractable Waste has included CFCs and halons in their designation of intractable wastes and it is therefore likely that these materials in NSW and Victoria will be disposed of by high temperature incineration.

The development of detailed policy for the control of the greenhouse gases methane and carbon dioxide, should include controls on these gases arising from hazardous (and solid) waste treatment and disposal. For instance, the following measures should be considered:

o Methane arising from anaerobic decomposition of organic wastes should be:

- collected and be utilised for energy production where the generation exceeds a certain level;
- collected and flared to produce CO_2 where the generation rate is at a lower level;
- allowed to disperse to the atmosphere where the generation rate is small.

- Incineration of waste organics should have energy recovery and utilisation where the rate of CO_2 production exceeds a certain level.

3.2.4. Polluter Pays Principle

The SAWMC is currently fully funded by various fees on the generators and managers of hazardous (and other) waste, with the cost of controlling the management of hazardous wastes ultimately being born by the waste generator. With the commissioning of improved treatment facilities, the establishment of additional controls and facilities arising from issues identified in this report (e.g. treatment residue management facilities), and the introduction of trade waste charging for discharges to sewer, the full cost of environmentally responsible hazardous waste management will be borne by the waste generators.

The cost of treatment and disposal of hazardous wastes is related to the difficulty and cost of treatment and disposal. SAWMC charges currently do not distinguish between different types of hazardous waste. The potential to relate SAWMC charges to the potential environmental impact of different types of wastes, thereby further encouraging minimisation of the more toxic types, is discussed in Section 3.5.

3.3. Classification System

Ideally, a classification system should serve two needs:

- An ability to unambiguously designate a waste as being a hazardous waste requiring management in accordance with the SAWMC's controls.

- An ability to classify wastes into types to facilitate their monitoring by manifest systems and to monitor the impact of policies on waste generation and management; and to be able to compare S.A. data with interstate and overseas data.

The inclusionary list approach (Appendix 3.3), using chemical constituents and generic waste types, is the most flexible and administratively easy method to use for designating hazardous wastes. It is entirely appropriate for South Australia and is the basis of the Prescribed Waste List used by the SAWMC.

The AEC waste classification system is used by the SAWMC for the manifest forms and the storage of data in their dBASEIII database. This makes S.A.'s system compatible with the manifest procedures in NSW and Victoria and enables the management of hazardous wastes in these three states to be easily compared.

3.4. Manifest System and Control of Hazardous Waste

An ideal manifest procedure and system to control the generation of hazardous wastes will include the following elements:

- o A multi-copy manifest system in accordance with AEC recommendations in order to facilitate interstate tracking of hazardous wastes.

- o Comprehensive control of all sources of hazardous waste generation.

- o Integration and compatibility with waste management practices and controls prior to acceptance into the SAWMC manifest procedure (e.g. with E&WS trade waste discharge controls) and after leaving the manifest controls (e.g. MSW landfill for some residues) i.e. a system of control that is truly "cradle to grave" in its scope.

- o Unambiguous responsibilities for the various parties involved in hazardous waste management, with prime responsibility in the hands of the waste generator.

- o Training facilities for users of the system.

3.5. Waste Minimisation

The aim of state promoted waste minimisation programmes is to develop a system, by encouragement and/or penalties, which ensures real commitment to implementation of waste minimisation in preference to treatment and disposal. No model system has yet been developed for widespread application. Each region should develop a programme suited to the needs of local industry and waste types, and be responsive to local cost conditions and legislative requirements.

A variety of measures have been introduced in waste minimisation programmes in Victoria and overseas, and many of these measures are not exclusive i.e. a programme can be developed by selecting a number of measures suited to the needs of particular regions. A description of these measures is provided in Section 3.5.2 and in the draft ANZEC Guidelines in Appendix 6.1.

3.6. Hazardous Waste Treatment

An ideal hazardous waste treatment system will:

- o Provide Best Practical Means (BPM) goals to be achieved for treatment of various waste types by a realistic date (1995); and provide Best Available Technology (BAT) goals to be achieved by a later date (2000). Current BAT for the various waste streams is illustrated in Figure 3.1. Alternative BAT needs to be continually reviewed and designated; and a similar definition of approved BPM needs to be developed to enable new and existing waste treatment facilities to be approved within a framework that is clear to all parties at the outset.

- o Provide redundancy in the hazardous waste treatment system so that if a component is unavailable (through failure or repair) then back-up facilities are available. The level of redundancy or security will vary among waste types and will depend on:

  - the consequences of not having treatment facilities available, including the risks associated with storage of the waste.
  - the ability to introduce short term alternative treatment methods.
  - the ability to store wastes at the generator's site.

- o Provide capacity for short term storage of wastes produced by emergency events such as tanker spills and chemical warehouse fires.

- o Provide guidelines for the treatment of contaminated land that are consistent with the treatment goals (BPM and BAT) set for ongoing waste generation in relation to environmental protection.

3.7. Hazardous Waste Treatment Residue Disposal Facilities

This component of the hazardous waste management system should ideally be characterised by and comprised of:

- o An hierarchy of waste management above it which minimises the demand on residue disposal facilities.

- o Provision of a well controlled appropriately sited secure landfill for ultimate disposal of residues and/or the secure interim storage of solids awaiting recovery or further treatment.

o A system with at least 20 years capacity and advanced planning for a 50 year horizon to ensure the long term viability of the total hazardous waste management system.

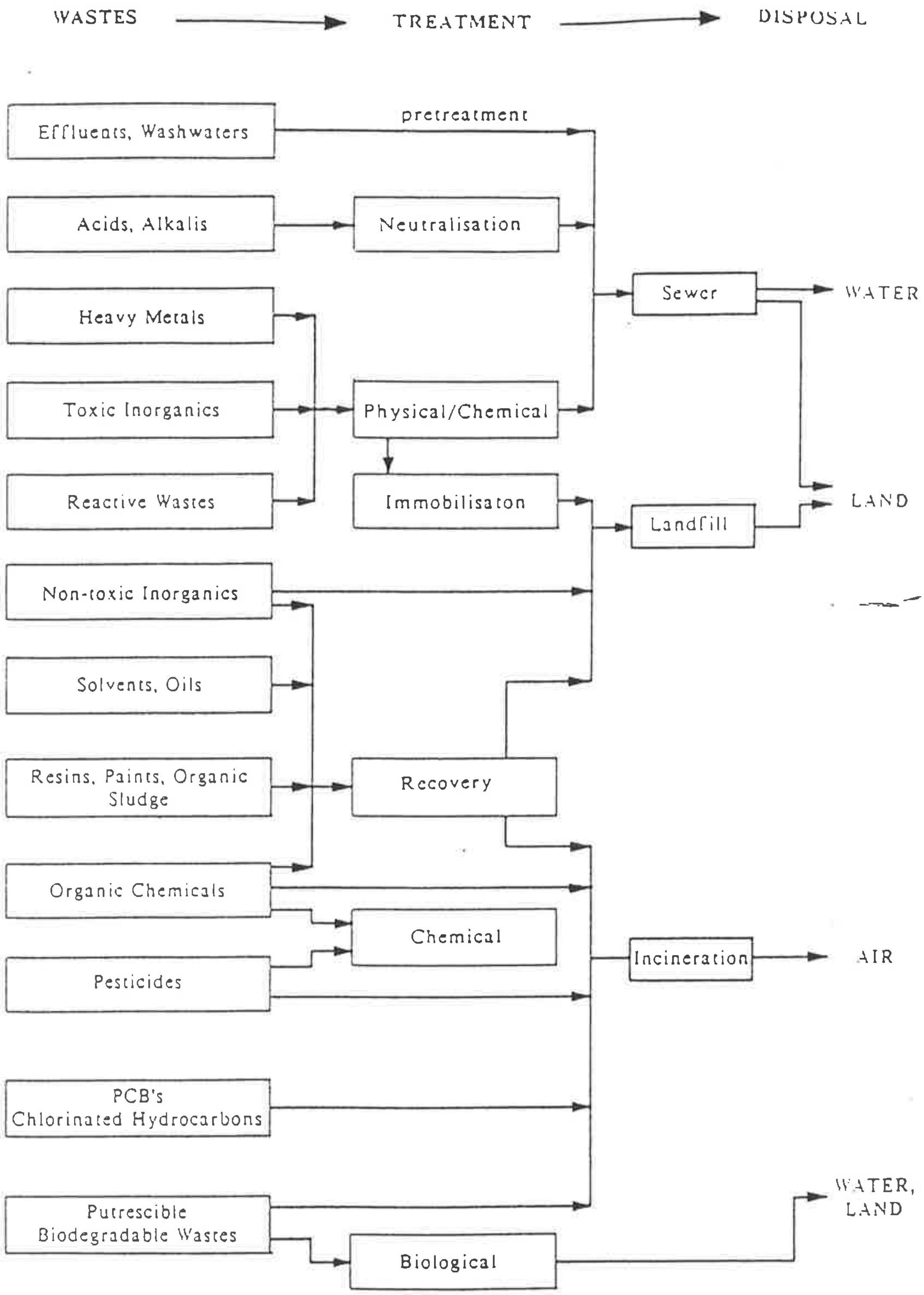


Figure 3.1 : Treatment and Disposal of Industrial Wastes

4. ALTERNATIVE OPTIONS FOR IMPROVEMENTS

4.1. Introduction

Section 3 provided a comprehensive review of the existing hazardous waste management system and, in identifying issues requiring investigation, suggested a series of options for some of the system components (such as minimisation). In upgrading the existing system, a number of these options can be employed as they are generally not mutually exclusive. This will be undertaken following government and community comment on this Review.

This section concentrates on the hazardous waste treatment and residue management components of the total system. The upgrading of these components will require choices among a number of alternative options i.e. the options are generally mutually exclusive. Selection criteria that could be used to choose the most appropriate option are suggested. Final selection among alternatives will be undertaken following government and community comment on this Review, in accordance with the decision procedure adopted as outlined in Section 5.

4.2. Hazardous Waste Treatment

Alternatives for upgrading the following areas are presented in this section:

- Treatment technology standards,
- Emergency storage capacity,
- On-site treatment and Regional treatment facilities,
- Off-site treatment.

4.2.1. Treatment Technology Standards

Setting of standards to ensure an appropriate level of treatment can be achieved by:

- Requiring "Best Practical Means" (BPM) for treatment of a particular waste type. This has regard for the availability of technology, its cost and the economic implications on the process producing the waste. It can be determined by negotiation and/or arbitration on a case by case basis, but should include examples of technology considered adequate for each waste type. Waste generators must then provide evidence that alternative technologies are at least as good as nominated technologies before they can be included in an approved list.

- Requiring the adoption of "Best Available Technology" (BAT) for treatment of particular waste types. This requires the use of best commercially available technology as defined by its reliability, and performance in minimising emissions of contaminants to the environment. BAT should be nominated for each waste stream in order to make the administration of the system manageable. Proponents of new technology will need to prove that their technology is superior or equivalent to BAT before it can supersede existing BAT or be listed as an alternative (respectively).

- Setting of Performance Standards, which can take a variety of forms, for instance:

  - setting the conditions required for treatment e.g. residence time at a specified minimum temperature in the presence of minimum excess oxygen for incineration;

  - setting the destruction and removal efficiency (DRE) for a particular waste constituent e.g. 99.0% removal of HCl emissions by air pollution control devices;

  - setting limitations on the contaminant loading on the environment e.g. limitation on concentration of heavy metals in liquid effluents to a specified mg/L and limitation on total loads in terms of kg/annum.

A time scale needs to be included in the system adopted to clarify the status of technology commissioned today in 5 to 20 years time, when it may not still be BPM, BAT or in compliance with then current performance standards. For instance, technology approved today should have a sunset clause included in its approval which requires a new application towards the end of the economic life of the equipment, which could vary from 10 to 30 years.

4.2.2. Emergency Storage Capacity

Emergency storage capacity is required to temporarily securely store abnormal waste arisings; for instance, those arising from warehouse fires and tanker spills. These wastes can then be treated and disposed in a managed programme using existing off-site treatment facilities. Storage facilities could consist of one or a combination of the following:

- Provision of a dedicated emergency storage tank at each licensed off-site treatment facility.
- Provision of other dedicated storage tanks and drum warehouse facilities for interim storage of liquids, and secure areas for storage of contaminated absorbent solids. This could be at the site of the treatment residues management facility.
- Utilisation of existing unused lagoons at Bolivar sewage treatment works, with appropriate lining to cater for the range of waste types anticipated.

This could be owned and maintained by a number of parties involved in the clean-up of emergency events:

- The SAWMC
- The Metropolitan Fire Service (MFS)

- The owner of the off-site treatment facility.

There are administrative advantages for the "generator" of the wastes, the MFS, to own and manage the storage facility. The costs of maintaining the storage facility could then be recovered from the owners of the warehouse etc. as part of the recovery of costs by the MFS for controlling the fire or other emergency events.

4.2.3. On-Site Treatment and Regional Treatment

The adequacy and licensing of on-site treatment facilities is currently poorly defined and should be reviewed (Section 3.4.2). Where appropriate, this review should be co-ordinated with the introduction of new regulations under the proposed marine pollution legislation.

However, there are a number of matters that need to be considered in the development of policy in this area:

- Should on-site treatment of wastes be encouraged or discouraged? The best outcome may well be a combination, for instance:

    - a requirement that certain waste types be treated on-site because of the nature of those wastes e.g. because of the hazards associated with transporting them to an off-site treatment plant, or because the experience required to handle the wastes only resides with the waste generator;

    - a preference for some waste types above a certain generation rate to be treated on-site to encourage waste minimisation at the sites of major generators;

    - a preference for some waste types to be treated off-site in special processes operated by experienced personnel because the generator does not have the expertise or the volume to justify economic and reliable on-site treatment.

- Regions are often dominated by one or a small number of large waste generators. Hazardous waste treatment in the regional centres in South Australia is therefore best managed by:

  - on-site treatment by the major generators and possibly the acceptance by them of wastes generated by small generators in the region, or

  - establishment of regional treatment facilities to treat the major waste streams in the region, with transfer of smaller streams and residues in bulk to facilities in Adelaide for further treatment and disposal.

4.2.4. Off-site Treatment

Alternatives for components of the off-site treatment system which require review and further investigation are:

- Treatment of highly odorous wastes can be achieved without offence to neighbours by:

  - rigorous sealing of waste discharge connections in the receival area and venting of all emission sources to an odour control process, such as incineration or activated carbon filtration. This is sometimes difficult to achieve, especially for wastes containing mercaptans arising from oil refining.

  - requiring highly odorous wastes to be treated on the site of the generator, where experience in handling these materials and buffer distances to neighbours are less likely to cause off-site offence.

- Treatment of hazardous organic wastes and residues is best undertaken by incineration, representing Best Available Technology. Some of these residues are currently being treated by cement and lime stabilisation prior to disposal to MSW landfill. This technology represents Best Practical Means at present and a sunset clause should be included in its approval so that planning and implementation of BAT can occur within a reasonable time.

Intractable organic wastes (PCBs, pesticides) should continue to be managed by exporting to high temperature incineration facilities overseas or to be securely stored pending commissioning of the Waste Management Authority of N.S.W.'s high temperature incinerator. Incineration of other hazardous organic wastes in South Australia could be by:

- a dedicated waste incinerator as proposed by National Waste Company and/or,

- utilisation of organic wastes, such as waste oil and solvents, for industrial fuel in boilers, and lime and cement kilns. Extensive testing in north America has demonstrated the effectiveness of these processes in treating hazardous organic wastes and controlling emissions by the nature of the process itself and the air pollution control devices normally provided.

♦ Asbestos is currently being disposed of in containers in mapped locations in above ground and `gully-fill' MSW landfills. This technique is satisfactory provided there is little chance of the landfill being excavated at a future date because of changed landuse needs. Experience interstate has shown that above ground landfills and landfills in the vicinity of transport corridors are more likely to be reformed in the future than gully-fill or quarry fill MSW landfills. The presence of asbestos in these landfills makes excavation and reshaping to accommodate changed uses more difficult and expensive. Consideration should be given to restricting disposal of containerised asbestos to those landfills with least potential for future reshaping and excavation.

In the medium term the Commission should consider promoting, through the ANZEC, research and development in the area of asbestos treatment and disposal. Current practice around Australia and worldwide. does not treat the asbestos fibres to render them non-hazardous - they are only stored securely in an environment which minimises, but does not eliminate their potential to adversely affect human health. To be consistent with the approach taken for treatment of other hazardous wastes (namely, to change the nature of the waste to minimise its hazardous characteristics prior to ultimate disposal) a goal of changing the nature of the fibres to a non-hazardous form by a treatment process should be set. Preliminary studies in this regard have commenced at Harwell Laboratories, U.K.

Because of the established health concerns with asbestos, it is unlikely that it will become a valuable resource in the future. Therefore secure storage with the facility to recover the material for re-use in the future is not recommended. However, secure storage with the facility to recover in the future for treatment prior to ultimate disposal may be a possibility. Decisions in this regard need to have regard to the quantity of asbestos still in use which will eventually become waste, and the time frame within which alternative treatment methods may become viable.

- **Copper Chrome Arsenate (CCA) wastes** arising from timber preservation are currently being treated by cement based immobilisation with storage of the product on the generator's site or, subject to meeting leaching test criteria, disposal to MSW landfill. This currently represents Best Practical Means technology. Upgrading this to Best Available Technology would require implementation or investigation of the following:

    - disposal of immobilised residues to a secure landfill;

    - investigation of the feasibility of recovering CCA solution from waste sludges for recycling back to the timber preservation process.

- **Liquid Wastes high in ammonia** are not known to be currently generated in significant quantities in South Australia. Should these wastes arise in the future, then a decision on BPM and BAT needs to be made from among the following:

- recovery for use as nitrogen fertilizer;
- incineration;
- air stripping to disperse to the atmosphere.

4.3. Hazardous Waste Treatment Residue Management

4.3.1. Residue Arisings

The arisings of residues from hazardous waste treatment plants are described in Section 2 and, as discussed in Section 3, disposal of liquid residues to sewer and gaseous emissions to atmosphere are generally well managed. Issues still requiring investigation in relation to liquid and gaseous emissions are described in Section 3.

As noted in Section 3.7.2, a major issue requiring resolution is the need for a secure repository for solid residues arising from hazardous waste treatment processes. These residues include:

- ♦ metal hydroxide sludges arising from neutralisation and precipitation of heavy metal bearing acid wastes;
- ♦ inorganic, particularly heavy metal contaminated, dusts arising from air pollution control devices. These dusts may be in untreated form or could be fixed in a cement based product;
- ♦ organic and stabilised organic sludges arising from BPM technology of organic waste dewatering and stabilisation of the sludge with cement formulations. Establishment of an appropriate waste incinerator or adoption of alternative incineration techniques (e.g. lime and

cement kilns) would eliminate the need to dispose of this residue. Intractable organics, such as PCBs and organochlorine pesticides, are not included in this arising.

- Inorganic pesticides (arsenic) arising from agricultural chemical recalls and not suitable for treatment and disposal by incineration overseas or interstate.

- Contaminated soils and absorbents arising from tanker spills, chemical warehouse fires, and past poor management of chemicals and wastes at existing and disused factories, processing plants and storage facilities.

As noted in Section 2, the arisings from off-site hazardous waste treatment facilities in Adelaide are approximately 2000t/yr (1500m^3/yr). Additional residues currently being defined by separate investigations will arise from residues currently being stored on the site of on-site treatment facilities and, most significantly, contaminated soils. This could give rise to significantly larger quantities of residues requiring disposal.

With the continuing implementation of waste minimisation and the gradual conversion from Best Practical Means to Best Available Technology, the quantity of residues arising from the ongoing generation of hazardous waste can be expected to decline in relative terms (i.e. it could be offset by increased value-added production in South Australia). However, until comparisons can be made between waste generation in regions which have implemented waste minimisation to the maximum extent currently possible, the extent of these reductions cannot be predicted. While large reductions in total waste quantities in regions have often been demonstrated, a significant proportion of this has been through removal of excess water prior to being released by the generator to an off-site facility. In these cases the quantity of solid residues arising would decline only marginally.

Any improvements to the quantity of solid residues arising from on-site and off-site treatment are likely to be countered many times over by the need to manage contaminated soils. This waste is likely to remain a significant (i.e. at least as large as off-site treatment plant residues) portion of solid waste arisings for the next two decades, based on overseas and interstate experience. It is therefore essential that a residue repository facility be established so that these residues can be provided with greater care and control than is generally required and available at MSW landfills.

The following sections discuss alternative technologies for residue repositories and describe criteria that have been developed to technically assess the suitability of particular sites. There is a more pressing need to decide on interim management of these residues, which could consist of:

- Continuing with disposal to a selected MSW landfill provided acceptance criteria based on leaching tests are met.

- Temporary storage (approximately 3 years) in reinforced PVC lined and covered stockpiles in bundled areas. Compatible dual landuse on government owned land would be suitable; for instance a sewage treatment plant or MSW landfill with adequate land buffers, and generally complying with the technical criteria listed in Section 4.3.3.

4.3.2. Alternative Residue Management Options

There are a range of options that are being developed worldwide for the management of solid residues arising from hazardous waste treatment processes. Other than the need to minimise the demand on these facilities through waste minimisation, there is no clear consensus on the best approach. Solutions being developed result from a complex interaction of legal, political, social and historical reasons as much as the physical environment predominating in any one country. The approaches being developed can be described in relation to two factors:

- The nature of the repository, namely:
    - Municipal Solid Waste (MSW) landfill
    - Double lined secure landfill

- Above ground vault/storage
- Geologically stable mined space
- Burial below pavements, above groundwater influences
- A clean fill area

♦ The treatment or management of the residues themselves:

- treatment to immobilise contaminants
- segregation of residues, treatment to a form that will facilitate future recovery, and storage in a manner that will facilitate future recovery
- no segregation of residues, and no special treatment to immobilise hazardous constituents in the residue

Selected combinations of these two factors produce the range of approaches that are currently being developed worldwide. These are illustrated in Table 4.1. Brief descriptions of each of the factors follows, with the description of the possible approaches following obviously from their combination as illustrated in Table 4.1

Residue Repository Options:

Municipal Solid Waste (MSW) landfill is currently being used in South Australia, Victoria and in some overseas countries (the UK) for the disposal of treatment residues. The practice of disposing of "environmentally available" residues in MSW landfills ("co-disposal"), while being practised overseas, is generally not accepted and is not recommended for further consideration. Only residues which, by themselves or following immobilisation treatment, pass leaching tests designed to simulate the leaching conditions in MSW landfills, should be disposed by this route. There is, as yet, no clear consensus on the acceptability of this option (option 1A), with debate centring on the design of a leaching test that will accurately simulate landfill conditions over the required time scale of decades (at least).

TABLE 4.1
TREATMENT RESIDUE REPOSITORY OPTIONS

RESIDUE TREATMENT / ULTIMATE REPOSITORY	IMMOBILISATION OF CONTAMINANTS A	NOT FIXED: SEGREGATED & RETRIEVABLE B	NOT FIXED: MIXED C
1. MSW LANDFILL	X		
2. DOUBLE LINED SECURE LANDFILL	X	X	X
3. ABOVE GROUND VAULT/STORAGE		X	
4. GEOLOGICALLY STABLE MINED SPACE	X	X	X
5. BURIAL BELOW PAVEMENTS, ABOVE GROUNDWATER	X		
6. CLEAN FILL	X		

"Double lined secure landfills" is a term which has been used to generally describe a range of secure landfill configurations including:

- Use of deep clay deposits alone to contain residues.

- Use of imported compacted clay in combination with at least one synthetic liner. A typical configuration consists of the following layers:

  - residue
  - protection bedding material (sand)
  - synthetic liner (e.g. high density polyethylene)
  - a drainage layer with leak detection instrumentation
  - a back-up synthetic liner
  - back up compacted clay layer
  - natural soils/rock, preferably remote from groundwater.

Because of the secure nature of the liner/envelope, all forms of solid residue have been stored/disposed of in these repositories. Problems associated with this type of repository include:

- Poor past installation and joining of synthetic liners has led to the failure of a number of them. Investigation of the reasons for failure have led to improved installation techniques, particularly in relation to bedding, joint testing and installation of protective layers prior to placement of residues.

- Difficulty in repairing the liner if a leak is detected during filling or after completion of the repository. Recently developed proprietary repair methods, such as those developed by BASF for their secure landfills located on islands in the River Rhine, have overcome these difficulties.

- Uncertainty over the long term integrity of the synthetic liner. Liner material guarantees are generally 30-50 years, while repositories designated as ultimate disposal sites must retain their integrity for much longer. Experience to date is limited to about 20 years.

Above ground storage `vaults', essentially secure warehouses, have been used for the interim storage of hazardous residues pending the development of contaminant recovery or treatment techniques. They may take the form of horizontal bulk grain storage terminals, with appropriate liner and cover materials depending on the nature of the stored material and the intended life of the facility. Alternatively, conventional steel clad, reinforced concrete floored warehouses have been utilised.

Geologically stable mined space has been used and proposed as an ultimate repository for residues from hazardous waste treatment, as well as for nuclear waste repositories. Dry formations in salt, tuff and granite have been proposed, with the disused German salt mines being the waste repository most frequently cited. This option is more economically attractive if the mined space exists and does not have to be specially formed. No such existing mined space is known to exist in South Australia. The major argument in favour of this repository is that formations that have been free of groundwater and tectonic activity for millennia are more likely to continue to be so in the future than alternative formations.

Burial below pavements, has been used generally as a pragmatic approach for containment of contaminated soils, enabling a low value use of the site that may otherwise be quarantined. More recently, Dutch trials have commenced on the behaviour of stabilised and immobilised residues placed within road sub-grade material, above potential groundwater levels. The road pavement provides an impermeable surface to prevent the formation of leachates that could interact with the residues. Careful mapping and identification, and use in road sections unlikely to be affected by the need to install subsurface services, would ensure accidental excavation of the residue did not occur (i.e. in the same way that high voltage buried cables are protected from accidental excavation damage). The option has the advantage that the repository, the road formation, has intrinsic value and there is therefore an economic incentive to maintain it in good condition. The Dutch tests should be replicated under South Australian conditions before this option is considered in more detail.

Clean Fill repositories require that the waste residues be immobilised to a form equivalent, in terms of leaching characteristics and gas evolution potential, to the natural soils and rock in the vicinity of the clean fill location. The Swiss have adopted this as a goal for all waste residues (arising from both MSW and hazardous waste). However, the goal has not yet been achieved because treatment technologies to immobilise the hazardous constituents in the waste, and testing protocols to ensure that the "final storage quality" condition has been reached, have not been fully developed and proven. Research in this area is currently being undertaken overseas and in Australia by BHP's research laboratories.

Residue Treatment and Management Options. The horizontal axis of Table 4.1 lists the options for treating and managing the waste residues themselves. These are described below.

Immobilisation of contaminants in waste residues requires additional treatment beyond that generally provided by the hazardous waste treatment method. A comprehensive review of immobilisation techniques is provided in a recent AEC publication (McFarland, 1989), and concludes that cement (or similar pozzolanic materials) based fixation of inorganic contaminants is likely to be the most commonly adopted process in the short to medium term. Organic hazardous constituents should ideally be mineralised to carbon dioxide and water by incineration rather than being stabilised with cement based formulations. If this cement based technology is used for organics, (i.e. as BPM), the mechanism of control is generally one of micro encapsulation rather than true fixation (i.e. incorporation into the hydrated silicate crystal structure).

Immobilisation retards the leaching of hazardous constituents from the waste residue, with the appropriate degree of immobilisation being defined by a standard leaching test. A number of these tests have been developed to attempt to simulate long term leaching conditions in an accelerated manner. Comparisons among these tests are currently underway in North America (Environment

Canada, 1987) and there is no widely accepted international standard yet available. The USEPA Toxicity Characteristic Leaching Procedure (TCLP) is the test most commonly used in Australia.

The technology of immobilisation, and the testing procedures used to indicate confidence in the long term integrity of the solidified product, are still developing. For this reason, most countries have adopted a cautious approach and prefer that these stabilised products be disposed of in landfills that can be regarded as secure, rather than any conventional MSW landfill. There is insufficient confidence in the various technologies currently available to allow the solidified products to be used as clean fill.

Because immobilised waste residues are intended to remain inert indefinitely to enable them to be placed in an ultimate disposal landfill, little care is generally taken in segregating the waste residues by hazardous constituents for the purpose of future recovery of the constituent. However, residues are often segregated at least into organics and inorganics streams to enable the formulations to be better tailored to the individual needs of particular waste residues.

Un-fixed Residues

Unfixed waste residues may be managed by two methods:

- Segregation by hazardous constituent to facilitate the future recovery or further treatment of the constituent. For instance heavy metal contaminated solid residues should be segregated according to metal type, with greater effort being placed on the high value metals such as cadmium, nickel and silver. Solid residues containing hazardous organics should be segregated for future treatment if BAT is not currently available.

- Mixed waste residues, with all wastes being disposed to ultimate repositories, with no intention of future recovery for re-use or further treatment. If this is the management procedure adopted, residues should be at least segregated into organics and inorganics to enable the efficient control of possible gaseous emissions from the biological breakdown of the former.

4.3.3. Assessment of Treatment Residue Repository Options

Table 4.2 provides an assessment of the feasible options from Table 4.1 against the criteria of:

- Type of barrier normally provided by the option, and an indication of whether each barrier should be required (R), preferred (P) or not required (NR).

- Number of barriers normally provided by the option, as a measure of the security of the option.

- Ability of the option to facilitate the future recovery of waste constituents for re-use or further treatment, as a measure of the flexibility of the option in not foreclosing future options. Options are rated as low flexibility (L), such as in immobilised residue disposal to MSW landfill (Option 1A); medium flexibility (M) or high degree of flexibility (H), such as option 2B - secure storage of segregated un-fixed waste streams.

- Simplicity of operation, as a measure of the likely relative cost and reliability of the operation.

Evaluation of the alternative options has not been attempted at this stage because of the fundamentally different criteria which could be selected to undertake the evaluation, i.e. should the preferred criteria be:

- simplicity and flexibility, facilitating future recovery of hazardous constituents, or

- simplicity and security, emphasising the greatest number of barriers.

TABLE 4.2
ASSESSMENT OF TREATMENT RESIDUE REPOSITORY OPTIONS

OPTION (SEE TABLE 4.1)	BARRIERS					CRITERIA		
	MANAGERIAL ACCEPTANCE (PROTOCOL)	FINAL STORAGE QUALITY (WASTE AS A BARRIER)	ARTIFICAL ENVELOPES		NATURAL GEOLOGICAL BARRIERS	NUMBER OF BARRIERS (SECURITY)	ABILITY TO RECOVER/TREAT IN FUTURE (FLEXIBILITY)	SIMPLICITY OF OPERATION (RELIABILITY)
			LIQUIDS	GASES				
1A	R	R	P	P	P	2-5	Low	Simple
2A	R	R	R	NR	P	3-4	M	M
2B	R	NR	R	R	P	3-4	H	C
2C	R	NR	R	R	P	3-4	M	M
3B	R	NR	R	R	P	3-4	H	M
4A	R	R	NR	NR	R	3	M	M
4B	R	NR	NR	NR	R	2	H	C
4C	R	NR	NR	NR	R	2	M	M
5A	R	R	R	NR	P	3-4	M	S
6A	R	R	NR	NR	NR	2	L	S

R:	REGIONAL	L:	LOW	S:	SIMPLE
WR:	NOT REQUIRED	M:	MODERATE	M:	MEDIUM
P:	PREFERRED	H:	HIGH	C:	COMPLEX

A decision will need to be made on the appropriate criteria following receipt of government and community responses to this Review, in accordance with the general decision process recommended in Section 5.

4.3.4. Residue Repository Siting

No specific sites have yet been identified as possible locations for a waste residue repository. The selection of an appropriate site, from a technical viewpoint, will need to be an interactive one between the characteristics of potential sites and the alternative repository option chosen (Section 4.3.3), and vice versa. Site selection will not only be governed by technical considerations, however, and alternative site selection procedures are discussed in Section 5. As in the selection of residue repository technology, the site selection decision process itself will be subject to the comments made by government and the community and will only be defined after the Steering Committee has taken these comments into account (Section 5).

Regardless of the site selection process adopted, a site, or a series of sites will need to be evaluated against a set of technical criteria (in addition to any social or other criteria the Steering Committee may select). A number of sets of criteria have been developed by various authorities worldwide with each new set often drawing on the experience of previously formulated sets. Examples of technical selection criteria from Australia, Canada and the USA are provided in Appendix 6.5. As in the case of residue repository technology criteria, site selection criteria are not all consistent or complementary. For instance, transport economics may be in conflict with nearly all other criteria.

The AEC National Guidelines on Hazardous Waste (AEC,1987) propose, in summary, the following criteria for selection of a site for a hazardous waste secure landfill.

- Preference for flat land, not flood prone.

- Preference for a special use zone, with reuse on completion of the landfill for landscape/habitat or as a buffer zone for other hazardous installations.

- Non-residential, low density, non intensive agricultural landuse.

- Provision of buffer within the site.

Supplementary criteria chosen from more recent siting criteria lists (Appendix 6.5) which could also be employed include:

Adaptation from Joint Taskforce criteria (Joint Taskforce, 1989):

- Requirement for good road access for materials movement and site workers, and preference for proximity to the source of waste generation.

- Telephone and electricity services would be preferred, but mains water and sewerage are unlikely to be required.

- Depending on the nature of the facility, proximity to a population centre for access to a range of skilled workers is not likely to be required. The volumes to be disposed of are low and the site could operate on the basis of acceptance of waste residues on one day per week or fortnight. Skilled chemists would need to be on-site for those days, but on most days staff would only be required for security and maintenance tasks.

- Depending on the nature of the facility, a seismically stable area may be preferred. Site geology and hydrogeology should enhance the safety of the facility rather than create additional technical problems.

- Site area requirements are likely to be determined by buffer preferences rather than the area required by the actual facility. Residues from ongoing waste generation in Adelaide, at a depth of 3m, will only require an area 20m square per annum, or 100m square over a 20 year life. Additional depth and/or area will be required for contaminated soils. Site buffers do not need to be quarantined land - they can be compatible industrial or other materials storage landuses.

- The site should not be located within, nor in proximity to the following landuses which would be regarded as incompatible:

    - environmentally sensitive areas (national parks, conservation and recreation parks)
    - areas with a high water table
    - areas of heritage or visual significance
    - water supply catchments

Socio-economic criteria will need to be developed as part of the implementation procedure (Section 5). Costs and benefits will need to be clearly stated, and a decision process and site which meets the needs of the general community and is fair to local communities needs to be developed.

5 PROCESS FOR IMPLEMENTATION

5.1. Introduction

Sections 2, 3 and 4 describe the facilities and control procedures that are required to provide South Australia with a comprehensive system for the management of hazardous wastes. The process by which these facilities and controls are introduced is critically important to their successful implementation.

The process adopted must firstly establish the need for facilities followed by selection of preferred technologies and sites by application of screening and evaluation criteria. Flexibility must, however, exist within the process to solicit or receive registrations of interest from individual Councils and companies, as appropriate, to provide possible sites for evaluation. Conceptual designs and site specific surveys must be undertaken prior to formal draft EIS preparation followed by community submission on the Draft EIS.

Throughout the process the community must be kept informed of progress.

5.2. Detailed Process for Implementation

The steps required to implement the agreed recommendations in this report to provide South Australia with a comprehensive system of hazardous waste management are:

1. Release of this report by the Commission and preparation of a summary document to facilitate broad community input.

2. Public review of the Summary Report, and Full Report and Appendices on request for a period of eight weeks, both by open invitation and solicitation.

3. Assessment of public comments.

4. Formulation of a representative Steering Committee to advise the government on implementation process and to monitor and advise the government on progress.

5. Public release of public comments, including those made during preparation of this Review, assessment, and an outline of the decision process to be followed in implementing the agreed recommendations from this report.

6. Investigations and design of procedures, facilities and sites. Investigations to proceed for the various recommendations in accord with the priorities set following assessment of public comments by the Steering Committee.

7. Preparation of formal EIS's and approvals following definition of facilities.

8. Preparation of detailed designs with appropriate input and consultation with relevant parties. This is to be undertaken in parallel and with close interaction with (6).

9. Formal approval by the Planning Authority(s) for facilities on sites.

10. Construction and commissioning of facilities.

11. Operation and ongoing monitoring and management of facilities in accordance with the approval conditions and undertakings provided in the EIS and/or development applications. For some sensitive facilities, it is reasonable to anticipate that local communities and Local Government will play a role in reviewing monitoring data and have some powers to control

operations on the site. The recommendations in Section 4 on options for improvements to the existing hazardous waste management system deal with:

- alternatives for improving treatment of hazardous waste
- alternatives for improving the disposal of hazardous waste treatment residues

The options presented in Section 3 for upgrading the system are non-exclusive and a selection of these options can be implemented in a priority to be decided by the Steering Committee following assessment of public comments. A programme for their implementation can be determined at this time.

A preliminary programme for implementation of options in Section 3 and resolution of the alternatives presented in Section 4 (or others that may arise during public review) and their implementation is presented in Figure 5.1. The timing will be dependent on the decision process to be employed and therefore the programme will need to be reviewed following Steering Committee formation (i.e. for activity (j): site selection).

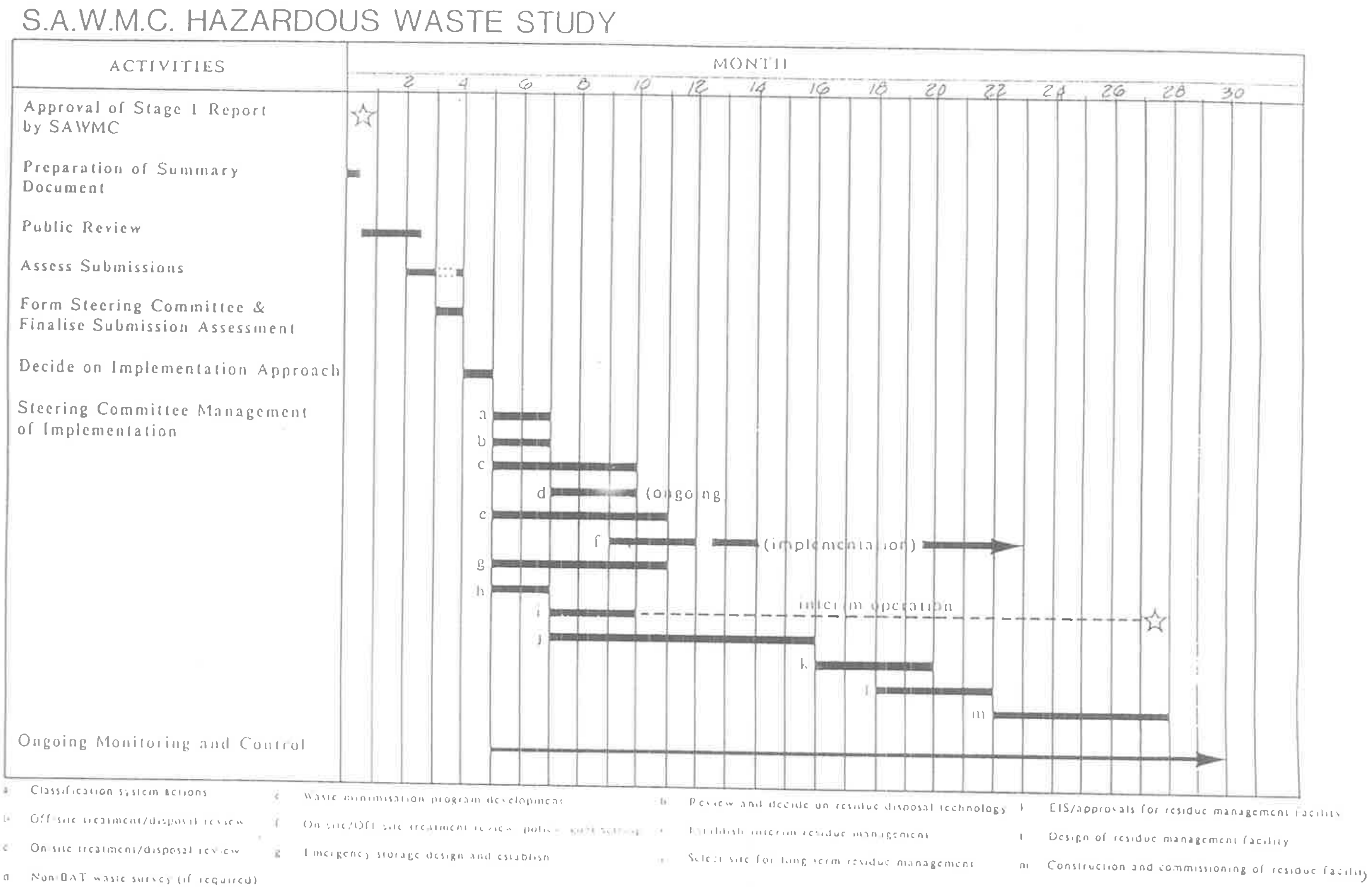


Figure 5.1 : Preliminary Implementation Programme

MAUNSELL

References

REFERENCES

AEC 1986; *National Guidelines for the Management of Hazardous Waste*, AGPS, Canberra.

AGSM (Australian Graduate School of Management) 1989, *Total Quality Management*, course notes for the Graduate Management Qualification, AGSM at UNSW, Sydney .

ANZECC 1989; *Draft National Guidelines for Waste Minimisation*, AGPS, Canberra.

ANZECC; Standing Committee on Environment Protection 1993, *Background paper for Agenda item 5*, fifth meeting, internal document, not published.

ANZEC 1990, *Towards a National Greenhouse Strategy for Australia,* AGPS, Canberra.

ANZECC 1992; *National Strategy for the Management of Scheduled Waste*, AGPS, Canberra

Baas, L., Hofman, H., Huisingh, J., Koppert, P., Neumann, F., 1990, *Protection of the North Sea : Time for Clean Production*, Erasmus Centre for Environmental Studies, Erasmus University, Rotterdam.

Baccini, P & Brunner, P H 1991; *The Metabolism of the Anthroposphere*, Springer Verlag, Berlin

Bartels J, Bruin W de, Walle F de 1989a; 'An Information System for the Control of Transfrontier Shipments of Hazardous Wastes in Europe', *Waste Management & Research* , Vol 7, p 1 - 11.

Bartels J, Briun W de, Meer K van der, Koppelaar H, Sol H, Walle F de 1989b; 'An Analysis of a European Hazardous Waste Transport Registration System (EARS)', *Waste Management & Research,* Vol 7, No 3, Sept 1989, pp 229 - 240

Beck, U (translated by Mark Ritter) 1992; *Risk Society, Towards a New Modernity,* Sage Publ., London,

Brunner, Paul; Professor of Waste Management at the Technical University of Vienna, a series of conversations on waste management during a two week lecture tour of Australia sponsored by the Waste Management Association of Australia, July 1993. (Brunner is co-author with Peter Baccini of The Metabolism of the Anthroposphere, Springer Verlag, 1992)

Brunner, P & Zimmerli, R ; The implications of the "final storage" concept for the management of hazardous wastes, *EAWAG News*, 24/25, Sept 1988 edition.

Brunner, P H ; Baccini, P 1992; Regional Material Management and Environmental Protection; *Waste Management & Research*, Vol 10, p 203 - 212

BUS (1986), *Leitbild fur die Schweizerische Abfallwirtschaft*, ed by Bundesamt fur Umweltschutz, Schriftenreihe Umweltschultz Nr 51, Berne

Caldwell Connell Engineers Pty Ltd. 1985, *Desk Study of Industrial Waste Generation in Victoria*, for Victorian EPA,

CRCWMPC; Project 7.1 : Context of Waste Solids Disposal; in progress (1993).

CRCWMPC; Project 2.1 : National Waste Database 1992, *Review of Current Waste Data Collection Systems in Australia*, unpubl.

Dept of Prime Minister and Cabinet 1990, *Ecologically Sustainable Development - A Commonwealth Discussion Paper*, AGPS, Canberra.

Doig, A.J. 1991; High Temperature Flue Gas Scrubbing, *CASANZ*, Vol 25, No. 1

ESD Working Groups 1991a, *Draft Report - Executive Summaries*, AGPS, Canberra

ESD Working Groups 1991b, *Final Report - Manufacturing*, AGPS, Canberra

ESD Working Groups Chairs 1992, *Intersectoral Issues Report*, AGPS, Canberra

Fluet, J. E.; Badu-Tweneboah, K ; Khatami, A 1992; A Review of Geosynthetic Liner System Technology, *Waste Management & Research*, vol 10, no 1, p 47 - 65.

Francis C W, Maskarinec M P, Lee D W 1989; 'Physical and Chemical Methods for the Characterisation of Hazardous Wastes', in *The Landfill : Reactor and Final Storage*, ed P Baccini, Springer Verlag, Berlin

Freeman, H M. 1990; *Hazardous Waste Minimisation*, McGraw Hill, NY.

Freeman, H. (ed) 1989; *Standard Handbook of Hazardous Waste Treatment and Disposal*, McGraw Hill, NY

Harding, R & Fisher, L 1993 ; The Precautionary Principle in Australia : a background paper, in *Proc of the Precautionary Principle Conf.*, Institute of Environmental Studies, UNSW, Sydney

Hirschhorn, J S.; Oldenburg, K.U. 1991; *Prosperity Without Pollution*, Van Nostrand Reinhold, NY.

Huisingh, D 1989.; *Cleaner Technologies Through Process Modifications, Material Substitution, and Ecologically Based Ethical Values*, UNEP Industry and Environment, Paris

Independent Panel on Intractable Waste Aug 1992; *Independent Briefing*, newsletter of the Independent Panel on Intractable Waste, No 10

Inform 1985; *Cutting Chemical Wastes*, Inform Inc., 381 Park Ave South, New York, NY 10016,

Intergovernmental Agreement on the Environment, May 1992 (obtained from CouncilNet, from info.anu.edu.au under the document '/legislation/igae.txt')

Institute of Environmental Studies, University of NSW; *The Precautionary Principle, Proc. Conference, 20 -21 September 1993*. Inst. Env. St. at UNSW

Jackson, T (ed), 1993, *Clean Production Strategies : Developing Preventive Environmental Management in the Industrial Economy*, Stockholm Environment Institute, Lewis Publ. Boca Raton.

Joint Taskforce on Intractable Waste 1990; *Phase 3 Report*, SPCC of NSW, Sydney

Lee, G F ; Jones-Lee, A 1993; Geosynthetic Liner Systems for Municipal Solid Waste Landfills : An Inadequate Technology for the Protection of Groundwater Quality ? report in *Waste Management & Research*, Vol 11, No 4, p 354 - 360.

Maunsell Pty Ltd 1990, *Hazardous Waste Management Review*, for South Australian Waste Management Commission, Adelaide

Maunsell 1991; *EIS for Proposed Hunter Regional Liquid Waste Treatment Facility*, Maunsell, Sydney

Monahan, D J ; Estimation of Hazardous Wastes from Employment Statistics; Victoria, Australia, in *Waste Management & Research*, Sept 1989.

Moore, S J ; Harvey, M ; Smith, R ; Worrall, M 1991 ; "Regional Hazardous Waste Management Strategies", *Proc. National Waste Management Conf., March 1991,* Adelaide (Adelaide, EPC Pty Ltd.).

Moore, S. J.; Worrall, M J 1991.; Waste Management Plans for Major Industries, in *Waste Technology and Management*, DITAC, Canberra

Moore, S J & Chelliah, N 1992; 'Designation of Non-BAT wastes and estimation of quantities in NSW', *Proc. 1st National Hazardous Waste and Solid Waste Convention*, April 1992, Sydney (AWWA/WMAA) Vol 1, pp 34.1 - 34.8

Moore, S J & Tu, S-Y 1993; 'Designation and Classification of Hazardous Wastes', in *Soil Technology : Applied Soil Science*, P A Hazelton, A S Kopp (ed), Aust. Soc. of Soil Science Inc., Sydney

Moore, S J ; Tu, S-Y 1993; 'Unit Production Indices of Hazardous Waste Generation for Measuring Environmental Performance', *Proc. Seminar on Tools for Environmental Managers,* Munro Centre for Civil & Environmental Engineering, UNSW, 14 July 1993.

Moore, S J; Kung, B ; Tu, S-Y; Toong, P; van den Broek, B 1994; 'Towards the Establishment of a National Waste Database', in *Proc. AWWA/WMAA 2nd National Solid and Hazardous Waste Conference,* AWWA, Melbourne.

OECD; Environment Monograph No 34 : *Monitoring and Control of Transfrontier Movements of Hazardous Wastes*, May 1990, OECD.

Ontario Ministry of Environment 1983, *Interim Guidelines for the Interpretation of the Hazardous Waste Definition (Regulation 309),* ME, Ontario,

Ontario Ministry of the Environment, 1985, *Scientific Criteria Document for Standard Development, No 4-84, PCDDs and PCDFs,* Ontario Min of the Environment.

Overcash, M.R. 1986; *Techniques for Industrial Pollution Prevention, A Compendium for Hazardous and non-Hazardous Waste Minimisation*, Lewis Publ. Inc, Michigan, Prime Minister of Australia, P J Keating, *Statement on the Release of National ESD and Greenhouse Strategies, 8 Dec 1992*, No 138/92.

Reid Crowther & Partners Ltd 1980., *Hazardous Wastes in Northern and Western Canada*, prepared for Environment Canada

Scaife, P.H. 1991; Environmental Management and the Role of Auditing - An Australian Perspective, *Proc AMIC Environment Conference, Perth*

Singer, P 1993; *How are we to live? Ethics in an age of self interest*, The Text Publishing Company , Melbourne.

Standards Australia; *Draft Methods for the Examination of Wastes, Sediments and Contaminated Soils; Method Y.1 : Preparation of Leachates - Volatile Organic Compounds.*

Tasmanian Department of Environment and Planning 1991, *draft Industrial Waste Management Strategy*, Tas DEP, Hobart

UNEP March 1989; *Basel Convention on the Control of Transboundary Movements of hazardous Wastes and their Disposal, Final Act*, UNEP, Paris

UNEP/UNIDO 1991, *Audit and Reduction Manual for Industrial Emissions and Wastes, Technical Report Series No. 7*, UNEP, Paris

US EPA; 40 CFR Part 148 et al; *Land Disposal Restrictions for Third Third Scheduled Wastes*, June 1990.

USEPA, Office of Environmental Engineering and Technology Demonstration; Pollution Prevention Office 1989- *The Electronic Information Exchange System*,

Victorian EPA 1985; *Hazard Assessment of Industrial Waste Disposal Facilities*, EPA Publ. No. 214, Melbourne

Victorian EPA 1985; *Draft Industrial Waste Strategy*, Melbourne

Vignesevaran, S.; Moore, S. J.; 'Waste Minimisation in Hazardous Waste Management', *Proc. 1st National Hazardous and Solid Waste Convention, Sydney, April 1992.*

Vigneswaran, S.; Muttamara, S.; Srianandakumar, K.; 'Low Waste Technologies in Selected Industries', in *A.I.T. Environmental Sanitation Reviews, No. 27,* June 1989.

Waugh, G; *Lecture notes for CIVL9888 Environmental Management & Economics*, UNSW, Session 2 1993.

WHO; *Draft Technical Manual for the Safe Disposal of Hazardous Wastes with Special Emphasis on the problems and needs of Developing Countries*, WHO, Geneva, 1987

WMA of NSW; *Sydney Solid Waste Management Strategy,* May 1990.

WMA of NSW 1990; *Waste Planning for Industry, A Guide*, WMA of NSW, Sydney

World Commission on Environment and Development (WCED) 1990, *Our Common Future,* Australian Edition , with an introduction by the Commission for the Future on "a Sustainable Future for Australia", Oxford University Press, Melbourne.

Wynne B (ed) 1987; *Risk Management and Hazardous Waste - Implementation and the Dialectics of Credibility,* Springer - Verlag, Berlin.

PART D

APPENDICES

Part D : Appendices

Contents

Appendix I

AUSTRALIAN AND NEW ZEALAND
ENVIRONMENT AND CONSERVATION COUNCIL

STANDING COMMITTEE ON ENVIRONMENT PROTECTION

FIFTH MEETING

AGENDA ITEM 5 : NATIONAL HAZARDOUS WASTE MANAGEMENT GUIDELINES

BACKGROUND

The background paper (part A and part B) on this item is attached.

ACTION

Standing Committee is requested to consider recommendations 1 to 3 on page 1 of the background paper.

ANZECC STANDING COMMITTEE ON ENVIRONMENT PROTECTION

MEETING NO 5

TITLE: **Waste Management - National Hazardous Waste Management Guidelines (Victoria - EPA)**

BACKGROUND:

The Standing Committee at its 4th meeting accepted the proposed National Manifest System.

However, two issues required clarification before the Manifest System was implemented. The issues are:

(1) Interrelationship between the proposed classification and the systems used by the Basel Convention and the OECD Classification; (Part A contains the recommended classification system.)

(2) Members sought a mechanism for prior notification of interstate waste movement to be included in a national scheme. (Part B contains a prior notification/approval system and recommends a procedure.)

RECOMMENDATION:

1. That members endorse the attached classification system and agree to the attached mechanism for prior notification.

2. An implementation date of 1 August 1993 be agreed to.

3. A working group convened by Victoria coordinate the implementation program and monitor its operation.

G:\ANZECC\AGENDA\AGENDA2.Doc

ANZECC STANDING COMMITTEE ON ENVIRONMENT PROTECTION

MEETING NO 5

TITLE: **Waste Management - National Hazardous Waste Management Guidelines**

Part A - Classification of Hazardous Wastes

BACKGROUND:

The classification system (List 1 attached) has been revised to take account of categories and codes in the Basel Convention and OECD Guidelines. In addition, suggested improvements made by NSW have been incorporated.

In the proposed classification, waste categories are arranged to suit Australian industries, and consequently the structural arrangement of the system differs from that of the OECD or Basel Convention. However, all categories listed in these codes are included so that all OECD/Basel categories have an appropriate code under the proposed system and similarly all proposed National codes have a Basel code where appropriate.

Lists 2 to 6 (attached) set out codes for other types of information to be included in the manifest (eg. source industries, disposal/treatment options etc.).

The recommended classification system can be readily adopted by States with current manifest systems as well as those proposing to implement one.

RECOMMENDATION:

That members endorse the attached classification system.

G:\ANZECC\AGENDA\AGENDA2.Doc

Appendix A

LIST 1

Hazardous Waste Type

One of the following prefixes should be assigned to the appropriate number:

L for liquids

S for Solids

P for Sludges

M for mixed loads

WASTE CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Cyanides, Surface Treatment and Heat Treatment Wastes		
Waste resulting from treatment of metals and plastics	A100	Y17
Waste from heat treatment and tempering operations containing cyanides	A110	Y7
Complexed cyanides	A120	Y33
Other cyanides	A130	Y33
Acids		
Sulphuric acid	B100	Y34
Hydrochloric acid	B110	Y34
Nitric acid	B120	Y34
Phosphoric acid	B130	Y34
Chromic acid	B140	Y34
Hydrofluoric acid	B150	Y34
Sulphuric/hydrochloric acid mixtures	B160	Y34
Other mixed acids	B170	Y34
Organic acids	B180	Y34

BC Corresponds to the Basel classification included in the Basel Convention (BC) on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. When moving wastes to overseas countries, these codes must be used.

N/A Less hazardous wastes - No applicable code under Basel Convention
+ Hazardous wastes - No specific code under Basel Convention
FP Flashpoint
n.o.s. not otherwise specified

WAS... CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Alkalis		
Caustic Soda, Potash, Alkaline Cleaners	C100	Y35
Ammonium Hydroxide	C110	Y35
Waste lime and cement	C120	Y35
Lime neutralised wastes containing metallic constituents	C130	Y35
Other	C140	Y35
Inorganic Chemicals		
(The following items are listed in order of importance. If more than one constituent is identified, select the constituent related to the lowest category code number.)		
Metal carbonyls	D100	Y19
Inorganic fluorine compounds	D110	Y32
Mercury; mercury compounds	D120	Y29
Equipment and articles containing mercury	D121	Y29
Arsenic; arsenic compounds	D130	Y24
Chromium; chromium compounds	D140	Y21
Tannery wastes containing chromium	D141	Y21
Cadmium; cadmium compounds	D150	Y26
Beryllium; beryllium compounds	D160	Y20
Antimony; antimony compounds	D170	Y27
Thallium; thallium compounds	D180	Y30
Copper compounds	D190	Y22
Cobalt; cobalt compounds	D200	+
Nickel; nickel compounds	D210	+
Lead; lead compounds	D220	Y31
Zinc compounds	D230	Y23
Selenium; selenium compounds	D240	Y25
Tellurium; tellurium compounds	D250	Y28

WASTE CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Silver compounds	D260	N/A
Photographic waste containing silver	D261	N/A
Vanadium; vanadium compounds	D270	+
Alkali metals and alkali metals containing compounds n.o.s..	D280	+
Barium; barium compounds	D290	+
Non toxic salts (eg sodium chloride, calcium chloride)	D300	N/A
Boron, boron compounds	D310	+
Inorganic non metallic phosphorous compounds	D320	+
Sulphur; inorganic sulphur containing compounds n.o.s.	D330	+
Other inorganic compounds and complexes	D340	+
Reactive Chemicals		
Oxidising agents	E100	+
Reducing agents	E110	+
Explosives	E120	Y15
Highly reactive chemicals	E130	+
Paints, Lacquers, Varnish, Resins, Inks, Dyes, Pigments, Adhesives		
Aqueous based wastes (non combustible/non-flammable vapours) from the production, formulation and use of paints, lacquiers, varnish, inks, dyes, pigments	F100	Y12
Aqueous based wastes (non combustible/non-flammable vapours) from the production, formulation and use of adhesives, glues, resins, latex, plasticizers	F110	Y13
Solvent based wastes (FP > 61°C - combustible) from the production, formulation and use of paints, lacquers, varnish, inks, dyes, pigments	F120	Y12
Solvent based wastes (FP > 61°C - combustible) from the production, formulation and use of adhesives glues, resins, latex, plasticizers	F130	Y13

WASTE CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Paints, Lacquers, Varnish, Resins, Inks, Dyes, Pigments, Adhesives (cont'd)		
Aqueous based wastes (flammable vapours) from the production, formulation and use of paints, lacquers, varnish, inks, dyes, pigments	F140	Y12
Aqueous based wastes (flammable vapours) from the production, formulation and use of adhesives, glues, resins, latex, plasticizers	F150	Y13
Solvent based wastes FP < 61°C (combustible) from the production, formulation and use of paints, lacquers, varnish, inks, dyes, pigments	F160	Y12
Solvent based wastes FP < 61°C (combustible) from the production, formulation and use of adhesives, glues, resins, latex, plasticizers	F170	Y13
Paint residues	F180	Y12
Cured adhesives or resins	F190	Y13
Organic Solvents, Solvent Residues		
Ethers	G100	Y40
Non-halogenated, n.o.s. FP > 61°C (combustible)	G110	Y42
Non-halogenated FP < 61°C, n.o.s. (flammable)	G120	Y42
Halogenated FP > 61°C, n.o.s. (combustible)	G130	Y41
Halogenated FP < 61°C, n.o.s. (flammable)	G140	Y41
Halogenated, n.o.s. (non combustible/non flammable vapours)	G150	Y41
Wastes from production and formulation of organic solvents	G160	Y6
Solvent recovery residues	G170	Y41/Y42
Others	G180	Y6
Pesticides		
Inorganic, organo-metallic pesticides	H100	+
Organo phosphorous pesticides	H110	Y37
Nitrogen containing pesticides	H120	+
Halogen containing pesticides	H130	Y45
Sulphur containing pesticides	H140	+

WASTE CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Pesticides (cont'd)		
Biological pesticides	H150	+
Mixed pesticide residue	H160	+
Copper-Chrome-Arsenic (CCA)	H170	Y5/Y24
Other inorganic wood preserving compounds	H180	Y5
Organic wood preserving compounds	H190	Y5
Oils, Hydrocarbons, Emulsions		
Waste mineral oils unfit for their original intended use (lubricating, hydraulic)	J100	Y8
Waste hydrocarbons	J110	Y9
Waste oils/water, hydrocarbons/water mixtures, emulsions (mainly oil and/or hydrocarbon, ie, >50%)	J120	Y9
Waste oils/water, hydrocarbons/water mixtures, emulsions (mainly water, ie, >50%)	J130	Y9
Transformer fluids (excluding PCBs)	J140	Y9
Other (cutting oils, soluble oils)	J150	Y9
Tarry residues arising from refining and any pyrolytic treatment	J160	Y11
Putrescible/Organic Wastes		
Animal effluent and residues (Abattoir,poultry and fish processing wastes)	K100	N/A
Grease interceptor trap waste - domestic	K110	Y46
Grease interceptor trap waste - industrial	K120	N/A
Bacterial sludge (septic tank)	K130	Y46
Tannery wastes not containing chromium	K140	N/A
Vegetable oils and derivatives	K150	N/A
Vegetable wastes	K160	N/A
Animal oils and derivatives (e.g. tallow)	K170	N/A
Abattoir effluent	K180	N/A
Wool scouring wastes	K190	N/A

WASTE CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Industrial Washwaters, Effluents		
Truck, machinery washwaters with or without detergents	L100	Y9
Boiler blowdown sludges	L110	Y34
Cooling tower washwaters	L120	Y4
Fire washwaters	L130	N/A
Textile effluent and residues	L140	N/A
Other industrial plant washdown waters	L150	Y9
Organic Chemicals		
Polychlorinated biphenyls (PCBs) and/or Polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)	M100	Y10
Equipment containing PCBs and/or PBBs and/or PCTs	M110	Y10
Solvents and materials contaminated with PCBs and/or PBBs and/or PCTs	M120	Y10
Non-halogenated (non solvent) n.o.s.	M130	+
Heterocyclic organic compounds	M140	N/A
Phenols; phenol compounds including chlorophenols	M150	Y39
Halogenated compounds n.o.s.	M160	+
Any congener of polychlorinated dibenzo-furan	M170	Y43
Any congener of polychlorinated dibenzo-p-dioxin	M180	Y44
Organic phosphorous compounds	M190	Y37
Organic sulphur compounds	M200	N/A
Organic cyanides	M210	Y38
Organic isocyanates	M220	+
Amines and other nitrogen compounds (Aliphatic)	M230	+
Amines and other nitrogen compounds (Aromatic)	M240	+
Surfactants and detergents	M250	N/A
Highly odorous eg. mercaptans, acrylate	M260	N/A
Methacrylate compounds (excluding solid inert polymeric materials)	M270	+
Other	M280	N/A

WASTE CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Solid/Sludge Wastes Requiring Special Handling		
Drums which have contained hazardous substances (hazardous substance to be specified)	N100	N/A
Containers and bags which have contained hazardous substances (hazardous substance to be specified) n.o.s.	N110	N/A
Contaminated soils (must specify contaminant eg. cyanide, PCBs, etc)	N120	N/A
Spent catalysts (must specify contaminants)	N130	N/A
Fire debris	N140	N/A
Fly ash	N150	Y18
Encapsulated wastes	N160	Y18
Chemically fixed wastes	N170	Y18
Solidified or polymerised wastes	N180	Y18
Residue from filter press (Filter cake)	N190	Y18
Ion-exchange column residues	N200	Y18
Residues from pollution control operations n.o.s.	N210	N/A
Asbestos	N220	Y36
Mineral fibres	N230	N/A
Clinical and Pharmaceutical Wastes		
Infectious substances	R100	Y1
Pathogenic substances	R110	Y1
Pharmaceuticals and residues	R120	Y3
Cytotoxic substances	R130	Y3
Wastes from the production and preparation of pharmaceutical products	R140	Y2

WASTE CATEGORY AND DESCRIPTION	WASTE TYPE	B.C. CODE*
Miscellaneous		
Waste chemical substances arising from research and development or teaching activities which are not identified	T100	Y14
Scrubber sludge	T110	N/A
Photographic chemicals which do not contain silver	T120	Y16
Inert sludges/slurries eg. clay, ceramic suspensions	T130	N/A
Other (hazardous substance to be specified)	T140	N/A

LIST 2

Waste Constituents/Contaminants

Constituent/Contaminant Description	Code
Polychlorinated biphenyl and related compounds	1
Halogenated hydrocarbons	2
Mercury and mercuric compounds	3
Chromium and chromium compounds	4
Arsenic and arsenic compounds	5
Cadmium and cadmium compounds	6
Boron compounds	7
Cyanide, thiocyanate and isocyanate compounds	8
Mercaptans, methacrylates and sulphides	9
Lead compounds	10
Copper and copper compounds	11
Zinc and zinc compounds	12
Nickel and nickel compounds	13
Silver compounds	14
Vanadium compounds	15
Cobalt compounds	16
Fluorine compounds	17
Acidic solutions	18
Basic solutions	19
Asbestos	20
Peroxides	21
Perchlorates	22
Isocyanates	23
Phenols	24
Organic solvents	25
Aromatic compounds	26
Other	27

LIST 3

Industry from which waste originates

Agriculture	0100
Poultry	0120
Services to Agriculture	0200
Forestry and Logging	0300
Fishing	0400
Mining	1100
Manufacturing	
Food, Beverages and Tobacco	2100
Poultry Products	2116
Milk Products	2120
Fruit and Vegetable Products	2130
Margarine and Oils	2140
Beverage and Malt	2180
Textiles	2300
Textile Fibres, Yarns	2340
Wool Scouring and Top making	2341
Other Textile Products	2350
Wood, Wood Products and Furniture	2500
Paper, Paper Products, Printing, Publishing	2600
Chemical, Petroleum, Coal Products, Paint	2700
Basic Chemicals	2750
Paints	2762
Pharmaceutical Products	2763
Pesticides	2764
Inks	2767
Chemical Products	2768
Petroleum Refining	2770
Non-Metallic Mineral Products (Glass and Chemical Products)	2800
Clay products and Refractories	2860
Basic Metal Products	2900
Fabricated Metal Products	3100
Transport Equipment	3200
Motor Vehicles and Parts	3230
Leather Taning and Fur Dressing	3451
Other Manufacturing	3487
Electricity, gas and water	3600

Construction	4100
Wholesale and retail trade	4700
Transport and Storage	5100
Rail Transport	5200
Water Transport	5300
Air Transport	5400
Communication	5900
Finance property and business service	6100
Public administration and defence	7100
Community services	
Health	8100
Hospitals and nursing homes	8140
Dental laboratories	8153
Community health services n.o.s.	8158
School education	8230
Post-school and other education	8240
Research and scientific institutions	8461
Recreation, personal and other services	
Entertainment, and recreational services	9100
Restaurants, hotels and clubs	9200
Personal services	9300
Photography services, n.o.s.	9361
Funeral directors	9362
Misellaneous	9900

Why change terminology from Basel Annex IV on Disposal options

LIST 4

ISPOSAL/TREATMENT OPTIONS

peration which do not lead to the possibility of resource recovery, recycling, reclamation, direct reuse or alternative uses

Description	Treatment Type
Landfill	1
Land farming	2
Deep well injection	3
Surface impoundment	4
Specifically engineered landfill	5
Release into a water body except seas/oceans	6
Release into seas/oceans	7
Biological treatment n.o.s.	8
Immobilisation/Solidification	9A
Other Physico/Chemical treatment	9B
Incineration on land	10
Incineration at sea	11
Permanent storage	12
Blending or mixing prior to submission to any of the above operations	13
Repackaging prior to submission to any of the above operations	14
Storage pending any of the above operations	15

peration which may lead to resource recovery, recycling, reclamation, direct reuse or alternative uses

Description	Treatment Type
Use as a fuel (other than direct incineration)	R1
Solvent reclamation/regeneration	R2
Recycling/reclamation of organic substances which are not used as solvents	R3
Recyling/reclamation of metals and metal compounds	R4
Recycling/reclamation of other inorganic materials	R5

Regeneration of acids or base	R6
Recovery of components used for pollution abatement	R7
Recovery of components from catalysts	R8
Used oil refining or other re-uses of previously used oil	R9
Land treatment resulting in benefit to agriculture or ecological improvements	R10
Use of residual materials obtained from any of the operations numbered R1-R10	R11
Exchange of wastes for submission to any of the operations numbered R1-R11	R12
Accumulation of material intended for any operation numbered R1-R12	R13

LIST 5

nited nations number and description of Waste Dangerous Good.

Note: The listed waste dangerous goods below are the "not otherwise specified" (n.o.s.) classes in Section 9 of the Australian Dangerous Goods Code. Where appropriate the specific waste dangerous good description in Section 9 of the Code should be used.

Code Number	Hazardous Waste
1760	Corrosive liquid, n.o.s.
2920	Corrosive liquid, flammable, n.o.s.
2922	Corrosive liquid, poisonous, n.o.s.
1759	Corrosive solid, n.o.s.
921	Corrosive solid, flammable, n.o.s.
23	Corrosive solid, poisonous, n.o.s.
1993	Flammable liquid, n.o.s.
1992	Flammable liquid, poisonous, n.o.s.
2924	Flammable liquid, corrosive, n.o.s.
3178	Flammable solid, inorganic, n.o.s.
3179	Flammable solid, inorganic, poisonous, n.o.s.
3180	Flammable solid, inorganic, corrosive, n.o.s.
25	Flammable solid, organic, n.o.s.
2926	Flammable solid, organic, poisonous, n.o.s.
2925	Flammable solid, organic, corrosive, n.o.s.
1479	Oxidizing solid, n.o.s.
39	Oxidising liquid, n.o.s.
2810	Poisonous liquid, n.o.s.
29	Poisonous liquid, flammable, n.o.s.
2927	Poisonous liquid, corrosive, n.o.s.
2811	Poisonous solid, n.o.s.
2930	Poisonous solid, flammable, n.o.s.
2928	Poisonous solid, corrosive, n.o.s.
2813	Water - reactive solid, n.o.s.
3021	Pesticides, liquid, flammable, toxic, n.o.s.
2903	Pesticides, liquid, flammable, toxic, n.o.s.
2588	Pesticides, solid, toxic, n.o.s.
2902	Pesticides, liquid, toxic, n.o.s.
3082	Environmentally hazardous substances, liquid, n.o.s.
7	Environmentally hazardous substances, solid , n.o.s.

LIST 6

LIST OF HAZARDOUS CHARACTERISTICS

Characteristics	UN Class	
Explosive		
An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.	1	H1*
Flammable Liquids		
The word "flammable" has the same meaning as "inflammable". Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers etc., but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5°C, closed-cup test, or not more than 65.6°C, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)	3	H3*
Flammable Solids		
Solids, or waste solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.	4.1	H4.1*
Substances or Waste Liable to Spontaneous Combustion		
Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.	4.2	H4.2*
Substances or Wastes which, in Contact With Water emit Flammable Gases		
Substances or wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.	4.3	H4.3*

* Corresponds to the hazard classification system included in the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

xidizing		
ıbstances or wastes which, while in themselves not necessarily ɔmbustible, may, generally by yielding oxygen cause, or contribute to e combustion of other materials.	5.1	H5.1*
rganic Peroxides		
rganic substances or wastes which contain the bivalent -o-o- structure e thermally unstable substances which may undergo exothermic lf-accelerating decomposition.	5.2	H5.2*
oisonous (Acute)		
ıbstances or wastes liable either to cause death or serious injury to harm human health if swallowed or inhaled or by skin contact.	6.1	H6.1*
fectious substances		
ıbstances or wastes containing viable micro organisms or their ıxins which are known or suspected to cause sease in animals or humans.	6.2	H6.2*
orrosives		
ıbstances or wastes which, by chemical action, will cause ver damage when in contact with living tissue, or, in the case leakage, will materially damage, or even destroy, other goods r the means of transport; they may also cause other hazards.	8	H8*
iberation of Toxic Gases in Contact with Air or Water		
ıbstances or wastes which, by interaction with air or water, are e to give off toxic gases in dangerous quantities.	9	H10*
oxic (Delayed or Chronic)		
ıbstances or wastes which, if they are inhaled or ingested or they penetrate the skin, may involve delayed or chronic fects, including carcinogenicity.	9	H11*
cotoxic		
ıbstances or wastes which if released present or may resent immediate or delayed adverse impacts to the ıvironment by means of bioaccumulation and/or toxic fects upon biotic systems.	9	H12*
pable, by any means, after disposal, of yielding another material, g leachate, which possesses any of the characteristics listed above.	9	H13*

\ANZECC\AGENDA\LIST1.DOC

ANZECC STANDING COMMITTEE ON ENVIRONMENT PROTECTION

MEETING NO 5

TITLE: **Waste Management - National Hazardous Waste Management Guidelines**

Part B - Prior Notification of Inter-state Movements of Waste

BACKGROUND:

In 1987 the Australian Environment Council agreed that hazardous wastes should not be moved interstate for treatment or disposal where adequate facilities were available in the state of origin. Where such facilities were not available, waste should only be transported interstate for treatment or disposal in an environmentally safe manner.

At present, there is only limited movement of hazardous waste across state and territory borders, but this may increase because of emerging processes and technologies for dealing with such wastes.

Recently, the issue of prior notification/approval for interstate movement of hazardous wastes was raised. The proposed national manifest (refer Appendix A) is a waste tracking system which enables regulatory bodies to minimise opportunities for illegal and or inappropriate disposal of hazardous wastes within their jurisdictions and facilitates post event remedial actions where illegal practices are detected. However, in the case of interstate movements, a prior approval or prior notification system is needed to supplement the manifest system. In conjunction with the manifest system it provides a comprehensive mechanism for the control of waste movements. (See paper attached)

ISSUES:

Prior approval of interstate waste movements is needed to ensure that wastes shipped interstate actually reach an appropriate treatment or disposal facility. However it is important that approval mechanisms do not impose an undue administrative burden on industry or agencies and are implemented in a manner which does not breach constitutional guarantees in relation to freedom of interstate trade.

RECOMMENDATION:

That members agree to the attached mechanism for prior notification.

CONTROL OF THE INTERSTATE MOVEMENT OF HAZARDOUS WASTES

1. Introduction:

In developing a national manifest for tracking interstate movement of hazardous wastes, the issue of prior notification/approval was raised. This important issue warrants consideration independently from the national manifest system.

Prior approval and prior notification systems are cradle to grave control procedures which can be employed to control the movement of hazardous wastes between States. Information obtained through prior notification/approval would allow regulatory agencies to act rapidly to minimise the possibility of inappropriate treatment, disposal and handling of hazardous wastes. This information would also enable regulatory authorities to be aware of current waste flows and the whereabouts of hazardous wastes.

2. Options for Controlling Interstate Movement of Hazardous Wastes

2.1 Prior Notification:

Prior notification simply involves notification of the receiving State of the intention to transport waste, indicating details of its origin, destination and nature.

This procedure has already been tested for waste moving between Victoria and New South Wales using the Victorian waste transport certificate format. Initially this was done via fax, but direct telephone advice was found to be more efficient.

While prior notification makes the receiving State's regulatory authority aware of a proposed waste shipment, it does not provide a direct mechanism for the authority to block such a shipment.

2.2 Prior Approval:

Prior approval systems provide additional control over waste shipments by comparison with prior notification. Such systems would allow regulatory authorities to determine the fate of any given consignment, and to encourage reuse of waste material where appropriate.

2.3 Need for a Flexible System:

The development of an efficient control procedure for cross border movements requires a clear delineation of the waste streams to be controlled.

Where wastes are moved interstate on a regular and frequent basis, prior notification/approval for each load of most types of hazardous waste may not be necessary. In such circumstances a single notification/approval to cover waste movements for a defined period is likely to be acceptable to regulatory authorities. However, in the case of cross border movements of intractable wastes, approval/notification should be applied to all shipments.

3. **Preferred Option:**

The broad aims of prior notification and prior approval systems are similar, but the requirements under a prior approval system are more comprehensive with regard to the obligation of both waste generators and regulatory agencies.

However, section 92 of the Constitution requires that there be freedom of trade between the States/Territories. Therefore, the application of a prior approval system for interstate waste movements may raise significant constitutional issues if approval ever needs to be withheld. Given this potential constitutional impediment to the application of a prior approval system to interstate transport, a prior notification system is seen as the most practicable approach for the management and monitoring of cross border movements of hazardous wastes. Such a system should provide regulatory agencies with adequate information on shipments, to minimise the risk of illegal or inappropriate disposal practices.

4. **Implementation:**

To give practical effect to a prior notification system, each jurisdiction needs treatment/disposal/storage facilities to only accept interstate consignments of waste where an identification number has been given by the regulatory authority in the receiving State. Such identification number can be incorporated into the manifest, since the manifest has made provision for a generating premises number. Agreement will be required among the States as to the format of the identification number.

5. **Outline of Proposed Procedure:**

(a) The waste generator wishing to transport waste interstate must contact the local authority in the receiving State and provide the following details at least seven days prior to the intended transport of the waste.

i) the quantity of hazardous waste to be transported;
ii) the time at which, or period during which, the hazardous waste is to be transported;
iii) the facility to which the hazardous waste is to be transported;
iv) the way in which the hazardous waste is to be disposed of safely;
v) hazard class of the hazardous wastes.

(b) The regulatory authority of the receiving State should record the above information in a register.

(c) The generator will then receive an identification number from the receiver state and this number will be entered onto the manifest as a record of notification.

(d) Where wastes are moved interstate on a regular and frequent basis, notification for each load is not necessary. However, in these circumstances, the regulatory agencies in both jurisdictions should agree on a period of time during which an initial notification of intent will apply. Such initial notification will indicate the types of waste (including hazard class), the total amount expected to be shipped, the size range of each shipment, the frequency of shipments, the destination and type of treatment/disposal. A single identification number applied to all shipments during the agreed period, would be sufficient.

(c) Where any particular notification raises concerns in an agency in the proposed receiving State, primary follow up should occur through the agency in the State of origin. Additionally, the receiving State should follow up with the proposed treater/disposer/storer.

ommendation:

t the proposed notification system be implemented for interstate movements azardous wastes.

EPORTS\PRIORAPP.DOC

Appendix 2

Explanatory Notes on the Proposed Manifest

1. Format of the Certificate

General:

Details on the regulatory authority for the area in which the waste is initially originated including an address for postage and return of certificates should be included, preferably at the top right-hand corner of the form.

Part A:

Part A is to be completed by the waste generator or storer, and identifies the source of waste, the characteristics of waste, its quantity, and the consignment pick up date. Generally, fields which should or could be computerised have been shaded.

The first section of the certificate provides information regarding the generator of the waste, and the location where the waste is produced. Data elements of this section include (i) generator's name, (ii) postcode of the premises where waste is produced, (iii) emergency contact number (iv) and the Premises Number/Approval Number.

Premises Number is the most important field for data entry and processing, particularly where interactive data entry is used. It also enables regulatory authorities to establish a computer file for each hazardous waste generator. This numbering system can be configured to provide a useful key field when it is necessary to interrogate computerised data according to a given waste generator.

Experience shows that the generator's name has limited value as a key field since it will need to be spelled exactly the same way each time for searches to be successful. However, the generator's name must also be included to cater for circumstances where a registration number is not available and also to act as a check digit precursor against the premises number.

The emergency contact name and number provide a useful contact for obtaining further details regarding the waste consignment, particularly during emergencies.

The post code enables computerised data to be accessed by area or region thus enabling the retrieval of data on the distribution of hazardous waste quantities. In some states this information may be incorporated into the generator registration number, thus reducing the number of key strokes to be keyed in for data processing.

The onus is placed on the waste generator to nominate a suitable treatment facility. This is an essential element of the cradle to grave approach, and is regarded as a key element of the manifest.

Provision is also included to allow the generator to indicate the type of treatment appropriate to the waste. The format is modelled on the South Australia manifest and is more user friendly than the waste treatment codes and more suitable for generators to complete.

The generator must be required by waste treaters to provide a written description of the waste. This supplements the waste code which itself is essential but a more descriptive verbal version is important to allow verification of the accuracy of the waste code.

Coded information depicting the physical form of the waste, waste type, constituents, and industry of origin must be included. It is important that these be in accordance with the proposed revised National Classification system if a functional national system is to operate. It is also an essential field, if any useful statistical information is to be compiled.

The National Classification system identifies the type of wastes uniformly, and provides the following advantages:

(i) Identification of waste material anywhere in Australia.
(ii) Assistance in the assessment of disposal options and recording purposes.
(iii) Assistance in the exchange of data between regulatory authorities.

Details of the proposed national code are provided in Section 3 of this Discussion Paper.

In addition the manifest requires United Nations (UN) Number, UN Hazard Class and Packaging Group. These details provide sufficient information to personnel involved with handling of waste for safety during transport, and to emergency services in the event of an accident. These numbers are listed in the Australian Code for the Transport of Dangerous Goods by Road and Rail (ACTDG). The manifest therefore acts to comply with requirements of the ACTDG code. Where appropriate, the code numbers in List 5 and List 6 of the National Classification System should be used. ACTDG is likely to be updated to include environmentally hazardous wastes.

Provisions have been made to express quantities in commonly used units. Experience has shown that this section is difficult to complete accurately and for this reason it has been made more user friendly by providing three separate fields with frequently used units.

Provision for signing and dating by the generator is an essential component of the cradle to grave approach.

Part B:

Part B of the certificate requires transporter to sign a declaration acknowledging the receipt of the waste described in Part A of the certificate. Once again this is an essential component of cradle to gave tracking. Details of the name and address of the transporter are required together with a vehicle registration number and vehicle permit number.

The proposed certificate differs from certificates currently used in Australia by making provision for an extra vehicle which may be involved with the same consignment. This reflects Victorian experience of increasing use of truck/trailer combinations which require different permit numbers. This also allows the possibility of intermediate vehicles being used to transport the same consignment, particularly between states. Road and rail combinations are also possible.

Part C:

This part of the certificate is to be completed by the waste treater/disposer providing the name of the premises, licence number, treatment type and acceptance date. These fields are useful to ascertain the through-put of a given treatment facility, the treatment capacity of the waste treatment industry and the feasibility of waste utilisation/recycling.

The disposer's licence number is the key field for data processing. The name and address act as a check, and with interactive data entry these fields would not normally need to be keyed in.

A code for the treatment types is also considered important. A classification system is introduced to enable waste treaters to indicate appropriate treatment procedures for a given waste consignment. The proposed treatment type classification system (see list 4) takes account of Disposal Options in Annex IV of the Basel Convention.

Tear Off:

Additional copies are required to establish a coordinated approach between States and Territories. It is proposed that there be tear off sections attached to 3 leaves of the certificate, 2 serving to notify interstate regulatory authorities and the third acting as a notice from the disposal facility to the generator. The latter is considered important in closing the loop to the cradle to grave responsibilities. Each person handling the waste would complete the relevant sections of the tear off.

In the tear off section, provisions are made for the disposer to bring discrepancies to the attention of the relevant regulatory authority. A similar section might also be included in the Part C of the main manifest.

The attached diagram outlines the procedure for the distribution of manifest copies to respective parties.

2. Number of Copies

The manifest should comprise an original and four carbonless copies. The copies should be spot glued and perforated. (Recommended minimum size is 215 X 260 mm.)

(Original) - White - This copy is the original and contains the signature of generator, transporter and disposer/treater. It accompanies the waste consignment and is finally forwarded to the regulatory authority in the State of treatment/disposal (Step xii below).

The tear off section may be removed by the disposer who can send it to the generator to verify that the waste was received.

Pink (2nd leaf) (1st copy) - This copy is forwarded by the generator to the regulatory authority in the State of origin. It will have a copy of the signature of generator and transporter and will have Parts A and B completed (Step v below).

Green (3rd leaf) (2nd copy) - This copy is retained by the generator.

When there is interstate movement the generator must complete the relevant area of the tear off section. This must be removed and sent to the interstate (Step vii below).

Yellow (4th leaf) (3rd copy) - This copy is retained by the disposer/treater and will have Parts A, B and C completed.

When there is interstate movement the disposer must complete the relevant area of the tear off section. This must be removed and sent to the State of origin by the disposer/treater (Step xiv below).

Blue (5th leaf) (4th copy) - This copy is retained by the transporter and will have Parts A, B and C completed.

When the transporter moves through any State or Territory without collecting or depositing waste then the transporter should remove the tear off section and forward it to the State of transit (Step ix below).

3. <u>Movement of Hazardous Wastes - Outline of Procedures</u>

(i) The generator must arrange for transport and disposal or storage.

(ii) The generator must complete Part A of the manifest.

(iii) The transporter must complete Part B of the manifest on collection of the waste.

(iv) The generator must provide the white (original), yellow and blue leaves to the transporter of the waste to accompany the waste consignment.

(v) The generator must notify the local regulatory authority by lodging the pink copy with the authority within seven (7) days. Tear off section must be left attached to the main copy.

(vi) The generator retains the green copy.

(vii) Where interstate movements are involved, the generator would be required to provide the tear-off part attached to the green copy to the regulatory authority in the receiving State.

(viii) The transporter must keep the white (original), yellow and blue copies intact with the consignment, and submit them to the disposal/treatment facility operator.

(ix) Where there is interstate movements involving transit through a state with no collection or deposit, the transporter would be required to provide the tear-off part attached to the blue copy to any transit State(s) within 3 days.

(x) The treater/disposer must complete Part C on receipt of the waste, and return the blue copy to the transporter who must retain it.

(xi) The disposer/treater may choose to remove and post the tear off attached to the white (original) leaf to the generator.

(xii) The treater/disposer must mail the original (white) manifest to the local regulatory authority within seven days.

(xiii) The disposer then retains the yellow copy.

(xiv) Where interstate movements are involved, the treater/disposer will be required to send the tear off part attached to the yellow leaf to the regulatory authority in State of origin of the waste.

In summary:

1. Original copy (white) - to local regulatory authority by disposer. White tear off - from disposer to generator.

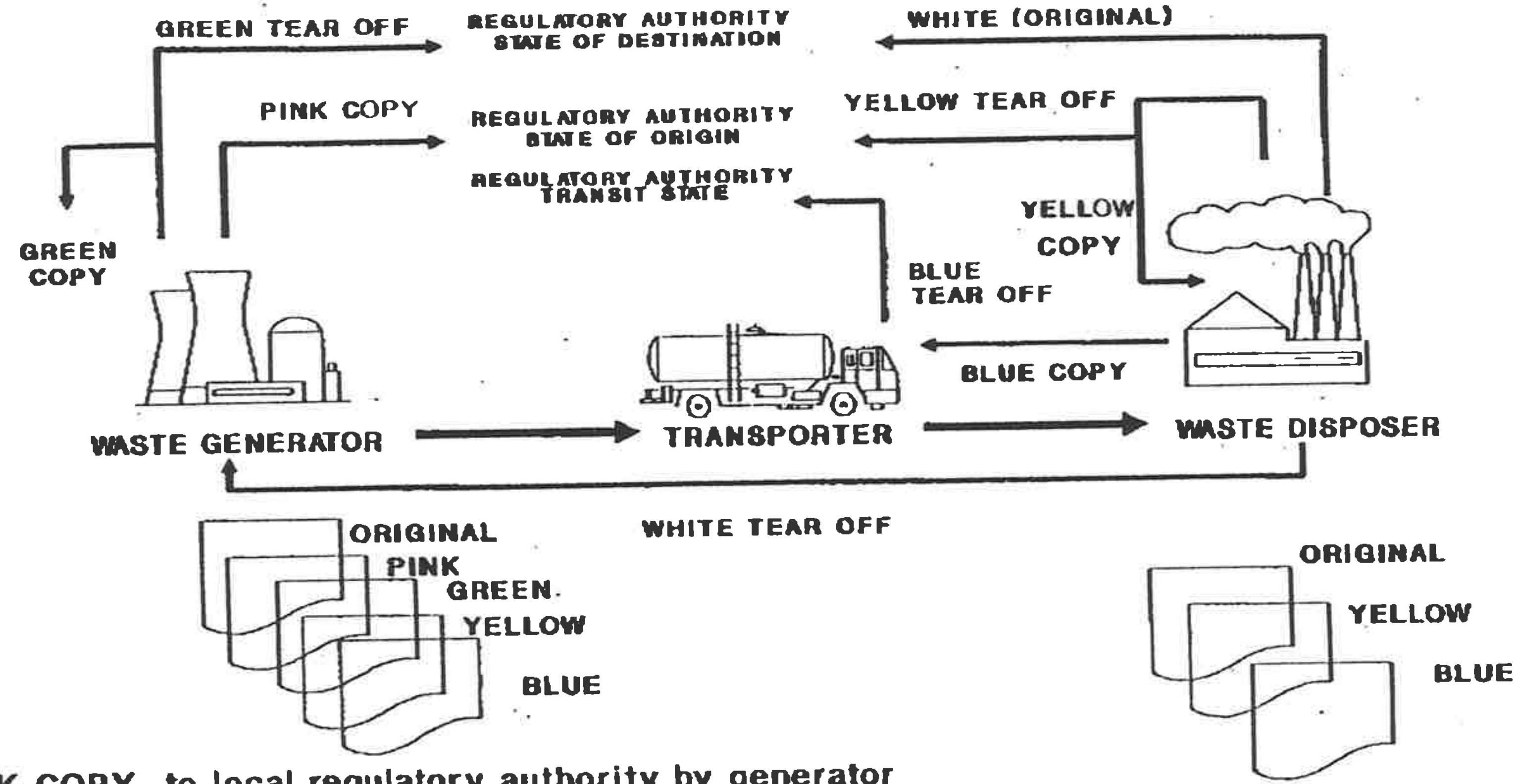
2. Pink copy - to local regulatory authority by generator.

3. Green copy - kept by generator;
Green tear off - to regulatory authority in State of destination.

4. Yellow copy - kept by disposer;
Yellow tear off - sent to regulatory agency in State of origin.

5. Blue copy - kept by transporter.
Blue tear off sent by transporter to regulatory agency in any transit State/Territory.

INTERSTATE MOVEMENT OF HAZARDOUS WASTE



PINK COPY to local regulatory authority by generator
GREEN TEAR OFF to receiving State by generator
GREEN COPY kept by generator

YELLOW TEAR OFF to State of origin by disposer
YELLOW COPY kept by disposer

BLUE TEAR OFF to transit State by transporter
BLUE COPY kept by transporter

WHITE TEAR OFF to producer by disposer
ORIGINAL to local regulatory authority by disposer

WASTE TRANSPORT CERTIFICATE

Certificate No. 000000

NAME, ADDRESS AND LOGO OF REGULATORY AUTHORITY

PART A — This section to be completed by the Producer or Storer of Waste.

1. Name of Waste Producer [redacted]
Address of Site of Waste Source ....
Post Code [redacted]
Name of Emergency Contact .... Phone [redacted]
Premises No. [redacted]

2. Proposed Disposal/Treatment/Storage Site [redacted] State [redacted]

3. Intended Disposal Route - Recycling ☐ Landfill ☐ Chem/Phys Treatment ☐ Storage ☐ Incineration ☐ Immobilisation ☐ Biodegradation ☐ Other ☐

4. Description of Waste [redacted]

5. Waste Code No. (List 1) [redacted] Contaminant (List 2) [redacted] Waste Origin (List 3) [redacted]
U.N. Number ☐ Class ☐ Packaging Group ☐ Bulk/No of Packages ☐
Amount of Waste [redacted] kg or [redacted] m^3 or [redacted] L

I declare that to the best of my knowledge and belief the above information is true and correct.
Name and Position ....
Signature .... Date [redacted]

PART B — To be completed by the Waste Transporter.

6. Name of Transporter ....
Address ....
Vehicle No.1 Registration [redacted] Licence or Permit No. ☐ Vehicle No.2 Registration [redacted] Licence or Permit No. ☐
I acknowledge receipt of the waste described in part A. *mode of transport* ☐
Name (in block letters) ....
Signature .... Date [redacted]

PART C — To be completed by the Depot Receiving Waste.

7. Name of Treatment Facility .... Licence No. [redacted]
Address .... Type of Treatment [redacted]
I hereby acknowledge acceptance of the waste described in part A.
Name ....
Signature .... Date [redacted]

ORIGINAL TO BE FORWARDED TO REGULATORY AUTHORITY BY DISPOSER/STORER.

Certificate No. 000000

8. Name and Address of Producer .... Premises No. [redacted]
Description of Waste ....
Interstate Movement? Y/N Transit States .... Quantity [redacted]
Signature ....
Name of Transporter .... Licence No. [redacted]
Name and Address of Treatment Plant Operator .... Licence No. [redacted]
Any Discrepancy? Y/N Signature ....
Briefly note any discrepancy ....

TO BE RETURNED TO THE WASTE GENERATOR BY THE PERSON/COMPANY WHO COMPLETE PART C

WASTE TRANSPORT CERTIFICATE

Certificate No. 000000

NAME, ADDRESS AND LOGO OF REGULATORY AUTHORITY

PART A

This section to be completed by the Producer of Store of Waste.

1. Name of Waste Producer [redacted]

Address of Site of Waste Source

Post Code [redacted]

Name of Emergency Contact

Phone [redacted]

Premises No. [redacted]

2. Proposed Disposal/Treatment/Storage Site [redacted]

State [redacted]

3. Intended Disposal Route - Recycling ☐ Landfill ☐ Chem/Phys Treatment ☐

Storage ☐ Incineration ☐ Immobilisation ☐ Biodegradation ☐ Other ☐

4. Description of Waste [redacted]

5. Waste Code No. (List 1) [redacted] Contaminant (List 2) [redacted] Waste Origin (List 3) [redacted]

U.N. Number

Class

Packaging Group

Bulk/No of Packages

Amount of Waste [redacted] kg or [redacted] m^3 or [redacted] L

I declare that to the best of my knowledge and belief the above information is true and correct.

Name and Position

Signature

Date [redacted]

PART B

To be completed by the Waste Transporter.

6. Name of Transporter

Address

Vehicle No.1 Registration [redacted]

Licence or Permit No.

Vehicle No.2 Registration [redacted]

Licence or Permit No.

I acknowledge receipt of the waste described in part A.

Name (in block letters)

Signature

Date [redacted]

PART C

To be completed by the Depot Receiving Waste.

7. Name of Treatment Facility

Licence No. [redacted]

Address

Type of Treatment [redacted]

I hereby acknowledge acceptance of the waste described in part A.

Name

Signature

Date [redacted]

Certificate No. 000000

8. Name and Address of Producer

Premises No. [redacted]

Description of Waste

Interstate Movement? Y/N Transit States

Quantity [redacted]

Signature

Name of Transporter

Licence No. [redacted]

Name and Address of Treatment Plant Operator

Licence No. [redacted]

Any Discrepancy? Y/N Signature

Briefly note any discrepancy

COPY 1 - TO BE FORWARDED TO THE LOCAL REGULATORY AUTHORITY, WITH PARTS A & B COMPLETED, BY THE PERSON/COMPANY WHO COMPLETED PART A

WASTE TRANSPORT CERTIFICATE

Certificate No. 000000

NAME, ADDRESS AND LOGO OF REGULATORY AUTHORITY

PART A — This section to be completed by the Producer or Storer of Waste.

1. Name of Waste Producer [redacted]

Address of Site of Waste Source

Post Code [redacted]

Name of Emergency Contact

Phone [redacted]

Premises No. [redacted]

2. Proposed Disposal/Treatment/Storage Site [redacted] State [redacted]

3. Intended Disposal Route - Recycling ☐ Landfill ☐ Chem/Phys Treatment ☐ Storage ☐ Incineration ☐ Immobilisation ☐ Biodegradation ☐ Other ☐

4. Description of Waste [redacted]

5. Waste Code No. (List 1) [redacted] Contaminant (List 2) [redacted] Waste Origin (List 3) [redacted]

U.N. Number Class Packaging Group Bulk/No of Packages

Amount of Waste [redacted] kg or [redacted] m^3 or [redacted] L

I declare that to the best of my knowledge and belief the above information is true and correct.

Name and Position

Signature Date [redacted]

PART B — To be completed by the Waste Transporter.

6. Name of Transporter

Address

Vehicle No.1 Registration [redacted] Licence or Permit No. Vehicle No.2 Registration [redacted] Licence or Permit No.

I acknowledge receipt of the waste described in part A.

Name (in block letters)

Signature Date [redacted]

PART C — To be completed by the Depot Receiving Waste.

7. Name of Treatment Facility Licence No. [redacted]

Address Type of Treatment [redacted]

I hereby acknowledge acceptance of the waste described in part A.

Name

Signature Date [redacted]

COPY 2 - TO BE RETAINED BY THE PERSON/COMPANY WHO COMPLETED PART A

---

8. Name and Address of Producer

Certificate No. 000000

Premises No. [redacted]

Description of Waste

Interstate Movement? Y/N Transit States Quantity [redacted]

Signature

Name of Transporter Licence No. [redacted]

Name and Address of Treatment Plant Operator Licence No. [redacted]

Any Discrepancy? Y/N Signature

Briefly note any discrepancy

TO BE FORWARDED TO REGULATORY AUTHORITY OF THE STATE OF DESTINATION BY THE PERSON/COMPANY WHO COMPLETE PART A

WASTE TRANSPORT CERTIFICATE

Certificate No. 000000

NAME, ADDRESS AND LOGO OF REGULATORY AUTHORITY

PART A — This section to be completed by the Producer or Storer of Waste.

1. Name of Waste Producer [redacted]
   Address of Site of Waste Source ____
   Post Code [redacted]
   Name of Emergency Contact ____ Phone [redacted]
   Premises No. [redacted]

2. Proposed Disposal/Treatment/Storage Site [redacted] State [redacted]

3. Intended Disposal Route - Recycling ☐ Landfill ☐ Chem/Phys Treatment ☐ Storage ☐ Incineration ☐ Immobilisation ☐ Biodegradation ☐ Other ☐

4. Description of Waste [redacted]

5. Waste Code No. (List 1) [redacted] Contaminant (List 2) [redacted] Waste Origin (List 3) [redacted]
   U.N. Number ☐ Class ☐ Packaging Group ☐ Bulk/No of Packages ☐
   Amount of Waste [redacted] kg or [redacted] m^3 or [redacted] L

   I declare that to the best of my knowledge and belief the above information is true and correct.
   Name and Position ____
   Signature ____ Date [redacted]

PART B — To be completed by the Waste Transporter.

6. Name of Transporter ____
   Address ____
   Vehicle No.1 Registration [redacted] Licence or Permit No. ☐ Vehicle No.2 Registration [redacted] Licence or Permit No. ☐

   I acknowledge receipt of the waste described in part A.
   Name (in block letters) ____
   Signature ____ Date [redacted]

PART C — To be completed by the Depot Receiving Waste.

7. Name of Treatment Facility ____ Licence No. [redacted]
   Address ____ Type of Treatment [redacted]

   I hereby acknowledge acceptance of the waste described in part A.
   Name ____
   Signature ____ Date [redacted]

COPY 3 - TO BE RETAINED BY THE PERSON/COMPANY WHO COMPLETED PART C

- -

Certificate No. 000000

8. Name and Address of Producer ____ Premises No. [redacted]
   Description of Waste ____
   Interstate Movement? Y/N Transit States ____ Quantity [redacted]
   Signature ____
   Name of Transporter ____ Licence No. [redacted]
   Name and Address of Treatment Plant Operator ____ Licence No. [redacted]
   Any Discrepancy? Y/N Signature ____
   Briefly note any discrepancy ____

TO BE FORWARDED TO THE REGULATORY AUTHORITY OF THE STATE OF ORIGIN OF THE WASTE BY THE PERSON/COMPANY WHO COMPLETE PART C

WASTE TRANSPORT CERTIFICATE

Certificate No. 000000

NAME, ADDRESS AND LOGO OF REGULATORY AUTHORITY

PART A — This section to be completed by the Producer or Storer of Waste.

1. Name of Waste Producer [redacted]
Address of Site of Waste Source ____
Post Code [redacted]
Name of Emergency Contact ____
Phone [redacted]
Premises No. [redacted]

2. Proposed Disposal/Treatment/Storage Site [redacted] State [redacted]

3. Intended Disposal Route - Recycling ☐ Landfill ☐ Chem/Phys Treatment ☐
Storage ☐ Incineration ☐ Immobilisation ☐ Biodegradation ☐ Other ☐

4. Description of Waste [redacted]

5. Waste Code No. (List 1) [redacted] Contaminant (List 2) [redacted] Waste Origin (List 3) [redacted]
U.N. Number ☐ Class ☐ Packaging Group ☐ Bulk/No of Packages ☐
Amount of Waste [redacted] kg or [redacted] m^3 or [redacted] L

I declare that to the best of my knowledge and belief the above information is true and correct.
Name and Position ____
Signature ____ Date [redacted]

PART B — To be completed by the Waste Transporter.

6. Name of Transporter ____
Address ____
Vehicle No.1 Registration [redacted] Licence or Permit No. ☐ Vehicle No.2 Registration [redacted] Licence or Permit No. ☐
I acknowledge receipt of the waste described in part A.
Name (in block letters) ____
Signature ____ Date [redacted]

PART C — To be completed by the Depot Receiving Waste.

7. Name of Treatment Facility ____ Licence No. [redacted]
Address ____ Type of Treatment [redacted]
I hereby acknowledge acceptance of the waste described in part A.
Name ____
Signature ____ Date [redacted]

COPY 4 - TO BE RETAINED BY THE WASTE TRANSPORTER

Certificate No. 000000

8. Name and Address of Producer ____ Premises No. [redacted]
Description of Waste ____
Interstate Movement? Y/N Transit States ____ Quantity [redacted]
Signature ____
Name of Transporter ____ Licence No. [redacted]
Name and Address of Treatment Plant Operator ____ Licence No. [redacted]
Any Discrepancy? Y/N Signature ____
Briefly note any discrepancy ____

TO BE FORWARDED TO THE STATE OF TRANSIT BY THE PERSON/COMPANY WHO COMPLETE PART B

Appendix II

Extracts from the Basel Convention

Article 1

Scope of the Convention

1. The following wastes that are subject to transboundary movement shall be "hazardous wastes" for the purposes of this Convention:

(a) Wastes that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III; and

(b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import or transit.

2. Wastes that belong to any category contained in Annex II that are subject to transboundary movement shall be "other wastes" for the purposes of this Convention.

3. Wastes which, as a result of being radioactive, are subject to other international control systems, including international instruments, applying specifically to radioactive materials, are excluded from the scope of this Convention.

4. Wastes which derive from the normal operations of a ship, the discharge of which is covered by another international instrument, are excluded from the scope of this Convention.

Article 2

Definitions

For the purposes of this Convention:

1. "Wastes" are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law;

2. "Management" means the collection, transport and disposal of hazardous wastes or other wastes, including after-care of disposal sites;

3. "Transboundary movement" means any movement of hazardous wastes or other wastes from an area under the national jurisdiction of one State to or through an area under the national jurisdiction of another State or to or through an area not under the national jurisdiction of any State, provided at least two States are involved in the movement;

4. "Disposal" means any operation specified in Annex IV to this Convention;

5. "Approved site or facility" means a site or facility for the disposal of hazardous wastes or other wastes which is authorized or permitted to operate for this purpose by a relevant authority of the State where the site or facility is located;

6. "Competent authority" means one governmental authority designated by a Party to be responsible, within such geographical areas as the Party may think fit, for receiving the notification of a transboundary movement of hazardous wastes or other wastes, and any information related to it, and for responding to such a notification, as provided in Article 6;

7. "Focal point" means the entity of a Party referred to in Article 5 responsible for receiving and submitting information as provided for in Articles 13 and 16;

8. "Environmentally sound management of hazardous wastes or other wastes" means taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes;

9. "Area under the national jurisdiction of a State" means any land, marine area or airspace within which a State exercises administrative and regulatory responsibility in accordance with international law in regard to the protection of human health or the environment;

10. "State of export" means a Party from which a transboundary movement of hazardous wastes or other wastes is planned to be initiated or is initiated;

11. "State of import" means a Party to which a transboundary movement of hazardous wastes or other wastes is planned or takes place for the purpose of disposal therein or for the purpose of loading prior to disposal in an area not under the national jurisdiction of any State;

12. "State of transit" means any State, other than the State of export or import, through which a movement of hazardous wastes or other wastes is planned or takes place;

13. "States concerned" means Parties which are States of export or import, or transit States, whether or not Parties;

14. "Person" means any natural or legal person;

15. "Exporter" means any person under the jurisdiction of the State of export who arranges for hazardous wastes or other wastes to be exported;

16. "Importer" means any person under the jurisdiction of the State of import who arranges for hazardous wastes or other wastes to be imported;

17. "Carrier" means any person who carries out the transport of hazardous wastes or other wastes;

18. "Generator" means any person whose activity produces hazardous wastes or other wastes or, if that person is not known, the person who is in possession and/or control of those wastes;

19. "Disposer" means any person to whom hazardous wastes or other wastes are shipped and who carries out the disposal of such wastes;

20. "Political and/or economic integration organization" means an organization constituted by sovereign States to which its member States have transferred competence in respect of matters governed by this Convention and which has been duly authorized, in accordance with its internal procedures, to sign, ratify, accept, approve, formally confirm or accede to it;

21. "Illegal traffic" means any transboundary movement of hazardous wastes or other wastes as specified in Article 9.

Article 3

National Definitions of Hazardous Wastes

1. Each Party shall, within six months of becoming a Party to this Convention, inform the Secretariat of the Convention of the wastes, other than those listed in Annexes I and II, considered or defined as hazardous under its national legislation and of any requirements concerning transboundary movement procedures applicable to such wastes.

2. Each Party shall subsequently inform the Secretariat of any significant changes to the information it has provided pursuant to paragraph 1.

3. The Secretariat shall forthwith inform all Parties of the information it has received pursuant to paragraphs 1 and 2.

4. Parties shall be responsible for making the information transmitted to them by the Secretariat under paragraph 3 available to their exporters.

Annex I

CATEGORIES OF WASTES TO BE CONTROLLED

Waste Streams

Y1 Clinical wastes from medical care in hospitals, medical centers and clinics

Y2 Wastes from the production and preparation of pharmaceutical products

Y3 Waste pharmaceuticals, drugs and medicines

Y4 Wastes from the production, formulation and use of biocides and phytopharmaceuticals

Y5 Wastes from the manufacture, formulation and use of wood preserving chemicals

Y6 Wastes from the production, formulation and use of organic solvents

Y7 Wastes from heat treatment and tempering operations containing cyanides

Y8 Waste mineral oils unfit for their originally intended use

Y9 Waste oils/water, hydrocarbons/water mixtures, emulsions

Y10 Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)

Y11 Waste tarry residues arising from refining, distillation and any pyrolytic treatment

Y12 Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish

Y13 Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives

Y14 Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
Y15 Wastes of an explosive nature not subject to other legislation
Y16 Wastes from production, formulation and use of photographic chemicals and processing materials
Y17 Wastes resulting from surface treatment of metals and plastics
Y18 Residues arising from industrial waste disposal operations

Wastes having as constituents:

Y19 Metal carbonyls
Y20 Beryllium; beryllium compounds
Y21 Hexavalent chromium compounds
Y22 Copper compounds
Y23 Zinc compounds
Y24 Arsenic; arsenic compounds
Y25 Selenium; selenium compounds
Y26 Cadmium; cadmium compounds
Y27 Antimony; antimony compounds
Y28 Tellurium; tellurium compounds
Y29 Mercury; mercury compounds
Y30 Thallium; thallium compounds
Y31 Lead; lead compounds
Y32 Inorganic fluorine compounds excluding calcium fluoride
Y33 Inorganic cyanides
Y34 Acidic solutions or acids in solid form
Y35 Basic solutions or bases in solid form
Y36 Asbestos (dust and fibres)
Y37 Organic phosphorous compounds
Y38 Organic cyanides
Y39 Phenols; phenol compounds including chlorophenols
Y40 Ethers
Y41 Halogenated organic solvents
Y42 Organic solvents excluding halogenated solvents
Y43 Any congenor of polychlorinated dibenzo-furan
Y44 Any congenor of polychlorinated dibenzo-p-dioxin
Y45 Organohalogen compounds other than substances referred to in this Annex (eg. Y39, Y41, Y42, Y43, Y44).

Annex II

CATEGORIES OF WASTES REQUIRING SPECIAL CONSIDERATION

Y46 Wastes collected from households
Y47 Residues arising from the incineration of household wastes

Annex III

LIST OF HAZARDOUS CHARACTERISTICS

UN Class*	Code	Characteristics
1	H1	Explosive An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.
3	H3	Flammable liquids The word "flammable" has the same meaning as "inflammable". Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5°C, closed-cup test, or not more than 65.6°C, open-cup test. (Since the results of open-cup tests and of closed cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)
4.1	H4.1	Flammable solids Solids, or waste solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.
4.2	H4.2	Substances or wastes liable to spontaneous combustion Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.
4.3	H4.3	Substances or wastes which, in contact with water emit flammable gases Substances or wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

---

* Corresponds to the hazard classification system included in the United Nations Recommendations on the Transport of Dangerous Goods (ST/SG/AC.10/1/Rev.5, United Nations, New York, 1988).

5.1	H5.1	**Oxidizing** Substances or wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.
5.2	H5.2	**Organic Peroxides** Organic substances or wastes which contain the bivalent-O-O-structure are thermally unstable substances which may undergo exothermic self-accelerating decomposition.
6.1	H6.1	**Poisonous (Acute)** Substances or wastes liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact.
6.2	H6.2	**Infectious substances** Substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause disease in animals or humans.
8	H8	**Corrosives** Substances or wastes which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.
9	H10	**Liberation of toxic gases in contact with air or water** Substances or wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.
9	H11	**Toxic (Delayed or chronic)** Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity.
9	H12	**Ecotoxic** Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.
9	H13	Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

Tests

The potential hazards posed by certain types of wastes are not yet fully documented; tests to define quantitatively these hazards do not exist. Further research is necessary in order to develop means to characterise potential hazards posed to man and/or the environment by these wastes. Standardized tests have been derived with respect to pure substances and materials. Many countries have developed national tests which can be applied to materials listed in Annex I, in order to decide if these materials exhibit any of the characteristics listed in this Annex.

Annex IV

DISPOSAL OPERATIONS

A. OPERATIONS WHICH DO NOT LEAD TO THE POSSIBILITY OF RESOURCE RECOVERY, RECYCLING, RECLAMATION, DIRECT RE-USE OR ALTERNATIVE USES

Section A encompasses all such disposal operations which occur in practice.

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 in' ' 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 elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations in Section A

D9 Physico chemical treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations in Section A, (e.g., evaporation, drying, calcination, neutralisation, precipitation, etc.)

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 operations in Section A

D14 Repackaging prior to submission to any of the operations in Section A

D15 Storage pending any of the operations in Section A

B. OPERATIONS WHICH MAY LEAD TO RESOURCE RECOVERY, RECYCLING, RECLAMATION, DIRECT RE-USE OR ALTERNATIVE USES

Section B encompasses all such operations with respect to materials legally defined as or considered to be hazardous wastes and which otherwise would have been destined for operations included in Section A

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 reuses 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 in Section B

Annex V A

INFORMATION TO BE PROVIDED ON NOTIFICATION

1. Reason for waste export
2. Exporter of the waste 1/
3. Generator(s) of the waste and site of generation 1/
4. Disposer of the waste and actual site of disposal 1/
5. Intended carrier(s) of the waste or their agents, if known 1/
6. Country of export of the waste
   Competent authority 2/
7. Expected countries of transit
   Competent authority 2/
8. Country of import of the waste
   Competent authority 2/
9. General or single notification
10. Projected date(s) of shipment(s) and period of time over which waste is to be exported and proposed itinerary (including point of entry and exit) 3/
11. Means of transport envisaged (road, rail, sea, air, inland waters)
12. Information relating to insurance 4/
13. Designation and physical description of the waste including Y number and UN number and its composition 5/ and information on any special handling requirements including emergency provisions in case of accidents
14. Type of packaging envisaged (eg. bulk, drummed, tanker)
15. Estimated quantity in weight/volume 6/
16. Process by which the waste is generated 7/
17. For wastes listed in Annex I, classifications from Annex III: hazardous characteristic, H number, and UN class.
18. Method of disposal as per Annex IV
19. Declaration by the generator and exporter that the information is correct
20. Information transmitted (including technical description of the plant) to the exporter or generator from the disposer of the waste upon which the latter has based his assessment that there was no reason to believe that the wastes will not be managed in an environmentally sound manner in accordance with the laws and regulations of the country of import.
21. Information concerning the contract between the exporter and disposer.

20. Information transmitted (including technical description of the plant) to the exporter or generator from the disposer of the waste upon which the latter has based his assessment that there was no reason to believe that the wastes will not be managed in an environmentally sound manner in accordance with the laws and regulations of the country of import.

21. Information concerning the contract between the exporter and disposer.

Notes

1/ Full name and address, telephone, telex or telefax number and the name, address, telephone, telex or telefax number of the person to be contacted.

2/ Full name and address, telephone, telex or telefax number.

3/ In the case of a general notification covering several shipments, either the expected dates of each shipment or, if this is not known, the expected frequency of the shipments will be required.

4/ Information to be provided on relevant insurance requirements and how they are met by exporter, carrier and disposer.

5/ The nature and the concentration of the most hazardous components, in terms of toxicity and other dangers presented by the waste both in handling and in relation to the proposed disposal method.

6/ In the case of a general notification covering several shipments, both the estimated total quantity and the estimated quantities for each individual shipment will be required.

7/ Insofar as this is necessary to assess the hazard and determine the appropriateness of the proposed disposal operation.

Annex V B

INFORMATION TO BE PROVIDED ON THE MOVEMENT DOCUMENT

1. Exporter of the waste 1/

2. Generator(s) of the waste and site of generation 1/

3. Disposer of the waste and actual site of disposal 1/

4. Carrier(s) of the waste 1/ or his agent(s)

5. Subject of general or single notification

6. The date the transboundary movement started and date(s) and signature on receipt by each person who takes charge of the waste

7. Means of transport (road, rail, inland waterway, sea, air) including countries of export, transit and import, also point of entry and exit where these have been designated

8. General description of the waste (physical state, proper UN shipping name and class, UN number, Y number and H number as applicable)

9. Information on special handling requirements including emergency provision in case of accidents

10. Type and number of packages

11. Quantity in weight/volume

12. Declaration by the generator or exporter that the information is correct

13. Declaration by the generator or exporter indicating no objection from the competent authorities of all States concerned which are Parties.

14. Certification by disposer of receipt at designated disposal facility and indication of method of disposal and of the approximate date of disposal.

Appendix III

Extracts from the OECD Decision on Transfrontier Movements of Hazardous Waste

DECISION

ON TRANSFRONTIER MOVEMENTS OF HAZARDOUS WASTE

C(88)90(Final)

(adopted by the Council on 27th May 1988)*

THE COUNCIL,

Having regard to Article 5 a) of the Convention on the Organisation for Economic Co-operation and Development of 14th December 1960;

Having regard to the Decision and Recommendation of the Council of 1st February 1984 on Transfrontier Movements of Hazardous Waste [C(83)180(Final)];

Having regard to the Decision-Recommendation of the Council of 5th June 1986 on Exports of Hazardous Wastes from the OECD Area [C(86)64(Final)];

Having regard to the Resolution of the Council of 20th June 1985 on International Cooperation Concerning Transfrontier Movements of Hazardous Wastes, by which it has been decided to develop an international system for effective control of transfrontier movements of hazardous wastes [C(85)100];

Convinced that the development of such a system requires a clear delineation of the wastes to be included in the system;

On the proposal of the Environment Committee;

I. DECIDES that for the purpose of implementing the above mentioned Council Acts on the control of transfrontier movements of hazardous wastes involving any Member country:

a) the terms "wastes" and "disposal" shall be defined as specified in the Annex, which is an integral part of this Decision;

b) those wastes which are referred to in the above-mentioned Council Acts as Hazardous Wastes shall consist of:

---

* Australia and Spain abstained.

(i) a core list of wastes as specified in the Annex; and

(ii) all other wastes which are considered to be or are legally defined as hazardous wastes in the Member country from which these wastes are exported or in the Member country into which these wastes are imported*;

c) Member countries shall ensure that the wastes subject to control are classified in the manner specified in the Annex unless these wastes are subject to a transfrontier movement which takes place entirely among the parties to a bilateral or multilateral agreement or arrangement specifying a different method of classification.

II. DECIDES that the definitions of Waste and Hazardous Waste contained in the above-mentioned Council Acts are hereby repealed.

III. INSTRUCTS the Environment Committee:

a) to take account of this Decision in developing the draft international agreement referred to in the Resolution on International Cooperation Concerning Transfrontier Movements of Hazardous Wastes [C(85)100];

b) to report to the Council after an appropriate period not exceeding three years on the implementation of this Decision and to make any proposals it deems necessary for revisions of the Annex in the light of experience gained in its implementation.

---

* The Council agreed that, "when implementing paragraph Ib) ii) of this Decision Member countries shall not be obliged to enforce laws other than their own".

ANNEX

A series of seven tables serves to define and classify the wastes to be controlled when subject to transfrontier movements. The tables cover the following:

Table Y - Core list of wastes to be controlled

Table 1 - Reasons why materials are intended for disposal

Table 2 - Disposal operations

Table 3 - Generic types of potentially hazardous wastes

Table 4 - Constituents of potentially hazardous wastes

Table 5 - List of hazardous characteristics

Table 6 - Activities which may generate potentially hazardous wastes

DEFINITIONS

For the purposes of this Decision:

1. WASTES are materials other than radioactive materials intended for DISPOSAL, for reasons specified in Table 1.

2. DISPOSAL means any of the operations specified in Table 2.

CORE LIST

For the purposes of this Decision those wastes which belong to any of the categories described in Table Y shall be controlled unless such wastes do not possess any of the hazardous characteristics listed in Table 5.

CLASSIFICATION - INTERNATIONAL WASTE IDENTIFICATION CODE

Tables 1 to 6 contain code numbers which, taken together, provide a means of complete characterisation of wastes, through an International Waste Identification Code, in order to facilitate their control from generation to disposal.

The International Waste Identification Code (IWIC) is obtained as follows:

1. Choose the one or at most two major reason(s) why the wastes are intended for disposal from the list in Table 1. Mark down the reason(s) as Q... plus the code number(s).

2. Indicate the method which has been selected for disposal of the wastes by choosing the one operation from Table 2 which most closely describes the fate intended for the wastes. Mark down as D... or R... plus the code number from Table 2.A or Table 2.B as appropriate.

3. Decide whether the wastes are liquid (L), sludge (P) or solid (S). Powders are considered to be solids.

4. Select from Table 3, the one descriptor which most closely describes the generic form of the wastes. Mark down this descriptor as L..., P... or S... plus the code number.

5. Examine Table 4 ; either the wastes do or do not contain one or more of the constituents listed. If none, mark down as code "CO". If one, mark down the appropriate code number. If more than one, then the best estimate for the group of no more than three entries in terms of descending hazard should be made. This estimate is meant to be qualitative and based upon the best judgment of the generator of the wastes; physical testing is not implied.

6. Select from Table 5 the one or at most two major potential hazard(s) presented by the wastes. Mark down as H... plus the code number(s).

7. Select from Table 6 the most appropriate single activity generating the wastes. Mark down as A... plus the code number.

8. The order of the International Waste Identification Code is the same as Tables 1 through 6. Main heads of the coding system are set off by double oblique lines. Where more than one entry from a specific Table is applicable, the plus sign (+) is used to separate the codes for each such entry:

Q___ + ___//D,R___//L,P,S___//C___ + ___ + ___//H___ + ___//A___

(N.B. See Appendix 2 for additional notes regarding the International Waste Identification Code.)

TABLE Y

CORE LIST OF WASTES TO BE CONTROLLED

Y1	Clinical wastes from medical care in hospitals, medical centers and clinics
Y2	Wastes from the production and preparation of pharmaceutical products
Y3	Waste pharmaceuticals, drugs and medicines
Y4	Wastes from the production, formulation and use of biocides and phytopharmaceuticals
Y5	Wastes from the manufacture, formulation and use of wood preserving chemicals
Y6	Wastes from the production, formulation and use of organic solvents
Y7	Wastes from heat treatment and tempering operations containing cyanides
Y8	Waste mineral oils unfit for their originally intended use
Y9	Waste oil/water, hydrocarbon/water mixtures, emulsions
Y10	Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCB's) and/or polychlorinated terphenyls (PCT's) and/or polybrominated biphenyls (PBB's)
Y11	Waste tarry residues arising from refining, distillation and any pyrolytic treatment
Y12	Wastes from production, formulation and use of inks, dyes, pigments, paints, laquers, varnish
Y13	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives
Y14	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
Y15	Wastes of an explosive nature not subject to other legislation
Y16	Wastes from production, formulation and use of photographic chemicals and processing materials
Y17	Wastes resulting from surface treatment of metals and plastics

<u>Wastes having as constituents</u>:

Y18 Metal carbonyls

Y19 Beryllium; beryllium compounds

Y20 Hexavalent chromium compounds

Y21 Copper compounds

Y22 Zinc compounds

Y23 Arsenic; arsenic compounds

Y24 Selenium; selenium compounds

Y25 Cadmium; cadmium compounds

Y26 Antimony; antimony compounds

Y27 Tellurium; tellurium compounds

Y28 Mercury; mercury compounds

Y29 Thallium; thallium compounds

Y30 Lead; lead compounds

Y31 Inorganic fluorine compounds excluding calcium fluoride

Y32 Inorganic cyanides

Y33 Acidic solutions or acids in solid form

Y34 Basic solutions or bases in solid form

Y35 Asbestos (dust and fibres)

Y36 Organic phosphorous compounds

Y37 Organic cyanides

Y38 Phenols; phenol compounds including chlorophenols

Y39 Ethers

Y40 Halogenated organic solvents

Y41 Organic solvents excluding halogenated solvents

Y42 Organohalogen compounds excluding inert polymerized materials and other substances referred to in this Table.

Y43 Any material contaminated with any congenor of polychlorinated dibenzo-furan

Y44 Any material contaminated with any congenor of polychlorinated

TABLE 1

REASONS WHY MATERIALS ARE INTENDED FOR DISPOSAL

Q1	Production residues not otherwise specified below
Q2	Off-specification products
Q3	Products whose date for appropriate use has expired
Q4	Materials spilled, lost or having undergone other mishap including any materials, equipment etc. contaminated as a result of the mishap
Q5	Materials contaminated or soiled as a result of planned actions, [e.g., residues from cleaning operations, packing materials, containers, etc.]
Q6	Unusable parts, [e.g., reject batteries, exhausted catalyst, etc.]
Q7	Substances which no longer perform satisfactorily, [e.g., contaminated acids, contaminated solvents, exhausted tempering salts, etc.]
Q8	Residues of industrial processes, [e.g., slags, still bottoms, etc.]
Q9	Residues from pollution abatement processes, [e.g., scrubber sludges, baghouse dusts, spent filters, etc.]
Q10	Machining/finishing residues, [e.g. lathe turnings, mill scales, etc.]
Q11	Residues from raw materials processing, [e.g., mining residues, oil field slops, etc.]
Q12	Adulterated materials, [e.g. oils contaminated with PCB, etc.]
Q13	Any materials, substances or products whose use has been banned by law in the country of exportation
Q14	Products for which there is no further use, [e.g., agriculture, household, office, commercial and shop discards, etc.]
Q15	Materials, substances or products resulting from remedial actions with respect to contaminated land
Q16	Any materials, substances or products which the generator or exporter declares to be wastes and which are not contained in the above categories

TABLE 2

DISPOSAL OPERATIONS

(Table 2 is divided into two sections)

2.A OPERATIONS WHICH DO NOT LEAD TO THE POSSIBILITY OF RESOURCE RECOVERY, RECYCLING, RECLAMATION, DIRECT RE-USE OR ALTERNATIVE USES

Table 2.A is meant to encompass all such disposal operations which occur in practice, whether or not they are adequate from the point of view of environmental protection.

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 elsewhere in this Table which results in final compounds or mixtures which are discarded by means of any of the operations in Table 2.A

D9 Physico chemical treatment not specified elsewhere in this Table which results in final compounds or mixtures which are discarded by means of any of the operations in Table 2.A, [e.g., evaporation, drying, calcination, etc.]

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 operations in Table 2.A

D14 Repackaging prior to submission to any of the operations in Table 2.A

D15 Storage pending any of the operations in Table 2.A

2.B OPERATIONS WHICH MAY LEAD TO RESOURCE RECOVERY, RECYCLING, RECLAMATION, DIRECT RE-USE OR ALTERNATIVE USES

Table 2.B is meant to encompass all such operations with respect to materials considered to be or legally defined as hazardous wastes and which otherwise would have been destined for operations included in Table 2.A.

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 reuses 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 in Table 2B

TABLE 3

GENERIC TYPES OF POTENTIALLY HAZARDOUS WASTES* (THESE MAY BE LIQUID, SLUDGE OR SOLID IN FORM)

Code Number**	
1	Clinical wastes from medical care in hospitals, medical centers and clinics
2	Wastes from the production and preparation of pharmaceutical products
3	Waste pharmaceuticals, drugs and medicines
4	Wastes from the production, formulation and use of biocides and phytopharmaceuticals
5	Wastes from the manufacture, formulation and use of wood preserving chemicals
6	Wastes from the production, formulation and use of organic solvents
7	Wastes from heat treatment and tempering operations containing cyanides
8	Waste mineral oils unfit for their originally intended use
9	Waste oil/water, hydrocarbon/water mixtures, emulsions
10	Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCB's) and/or polychlorinated terphenyls (PCT's) and/or polybrominated biphenyls (PBB's)
11	Waste tarry residues arising from refining, distillation and any pyrolytic treatment
12	Wastes from production, formulation and use of inks, dyes, pigments, paints, laquers, varnish
13	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives
14	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
15	Wastes of an explosive nature not subject to other legislation
16	Wastes from production, formulation and use of photographic chemicals and processing materials
17	Wastes resulting from surface treatment of metals and plastics

* If liquid, preface "L" is used
If sludge, preface "P" is used
If solid, preface "S" is used

** Items 1 to 17 in Table 3 correspond to items Y1 to Y17 in Table Y.

Code Number**	Materials which contain any of the constituents listed in Table 4 and consisting of:
18	Animal or vegetable soaps, fats, waxes
19	Non-halogenated organic substances not employed as solvents
20	Inorganic substances without metals
21	Ashes and/or cinders
22	Soil, sand, clay including dredging spoils
23	Non-cyanidic tempering salts
24	Metallic dust, powder
25	Spent catalyst materials
26	Liquids or sludges containing metals
27	Residue from pollution control operations, except (28) and (29)
28	Scrubber sludges
29	Sludges from water purification plants and waste water treatment plants
30	Decarbonization residue
31	Ion-exchange column residue
32	Sewage sludges
33	Wastewaters not otherwise taken into account within Table 3
34	Residue from cleaning of tanks and/or equipment
35	Contaminated equipment
36	Contaminated containers, whose contents included one or more of the constituents listed in Table 4
37	Batteries and other electrical cells
38	Vegetable oils
39	Materials which have been segregated from households and which also exhibit any of the characteristics listed in Table 5
40	Any other wastes which contain any of the constituents listed in Table 4

* If liquid, preface "L" is used
If sludge, preface "P" is used
If solid, preface "S" is used

TABLE 4

CONSTITUENTS OF POTENTIALLY HAZARDOUS WASTES

Code Number	Constituents*:
C1	Beryllium; beryllium compounds [Y19]
C2	Vanadium compounds
C3	Hexavalent chromium compounds [Y20]
C4	Cobalt compounds
C5	Nickel compounds
C6	Copper compounds [Y21]
C7	Zinc compounds [Y22]
C8	Arsenic; arsenic compounds [Y23]
C9	Selenium; selenium compounds [Y24]
C10	Silver compounds
C11	Cadmium; cadmium compounds [Y25]
C12	Tin compounds
C13	Antimony; antimony compounds [Y26]
C14	Tellurium; tellurium compounds [Y27]
C15	Barium; Barium compounds; excluding barium sulfate
C16	Mercury; mercury compounds [Y28]
C17	Thallium; thallium compounds [Y29]
C18	Lead; lead compounds [Y30]
C19	Inorganic sulphides
C20	Inorganic fluorine compounds excluding calcium fluoride [Y31]
C21	Inorganic cyanides [Y32]
C22	The following alkaline or alkaline earth metals:lithium, sodium, potassium, calcium, magnesium in uncombined form
C23	Acidic solutions or acids in solid form [Y33]
C24	Basic solutions or bases in solid form [Y34]
C25	Asbestos (dust and fibres) [Y35]
C26	Organic phosphorus compounds [Y36]
C27	Metal carbonyls [Y18]
C28	Peroxides
C29	Chlorates
C30	Perchlorates
C31	Azides
C32	Polychlorinated biphenyls (PCB's) and/or polychlorinated terphenyls (PCT's) and/or polybrominated biphenyls (PBB's) [Y10]
C33	Pharmaceutical or veterinary compounds
C34	Biocides and phyto-pharmaceutical substances
C35	Infectious substances
C36	Creosotes
C37	Isocyanates, thiocyanates
C38	Organic cyanides [Y37]
C39	Phenols; phenol compounds including chlorophenols [Y38]
C40	Ethers [Y39]
C41	Halogenated organic solvents [Y40]
C42	Organic solvents, excluding halogenated solvents [Y41]
C43	Organohalogen compounds, excluding inert polymerized materials and other substances referred to in this Table [Y42]

* The correspondance with Table Y is indicated in brackets.

C44	Aromatic compounds; polycyclic and heterocyclic organic compounds
C45	Organic nitrogen compounds; especially aliphatic amines
C46	Organic nitrogen compounds; especially aromatic amines
C47	Substances of an explosive character [Y15]
C48	Sulphur organic compounds
C49	Any material contaminated with any congenor of polychlorinated dibenzo-furan [Y43]
C50	Any material contaminated with any congenor of polychlorinated dibenzo-p-dioxin [Y44]
C51	Hydrocarbons and their oxygen, nitrogen and/or sulphur compounds not otherwise taken into account in Table 4

TABLE 5

LIST OF HAZARDOUS CHARACTERISTICS

Code Number*	Characteristics
H1	Explosive An explosive substance is a solid or liquid substance (or mixture of substances) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.
H3	Inflammable liquids The word "flammable" has the same meaning as "inflammable". Inflammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc. but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off an inflammable vapour at temperatures of not more than 60.5°C, closed-cup test, or not more than 65.6°C, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)
H4.1	Inflammable Solids Solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.
H4.2	Substances or Wastes Liable to Spontaneous Combustion Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up in contact with air, and being then liable to catch fire.
H4.3	Substances or Wastes which, in Contact with Water Emit Inflammable Gases Substances or wastes which, by interaction with water, are liable to become spontaneously inflammable or to give off inflammable gases in dangerous quantities.

* Corresponds to hazard class numbering system included in the United Nations Recommendations on the Transport of Dangerous Goods (Orange Book) for H1 through H9; omissions of H2, H7 and H9 are deliberate.

H5 Oxidizing

Substances which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials. (Organic substances which contain the bivalent-0-0-structure are thermally unstable substances which may undergo exothermic self-accelerating decomposition.)

H6 Toxic (Poisonous)

Substances or wastes that have been found to be fatal to humans in low doses or which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic hazards, including carcinogenicity.

H8 Corrosives

Substances or wastes which, by chemical action, will cause reversible or irreversible damage when in contact with living tissue, or, in case of leakage, will materially damage, or even destroy, other items or the means of transport, or can liberate corrosive fumes when in contact with air or water.

H10 Liberation of toxic gases in contact with air or water

Substances or wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.

H11 Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

H12 Ecotoxic

Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.

The potential hazards posed by certain types of wastes are not yet fully documented; objective tests to define quantitatively these hazards do not exist. Further research is necessary in order to develop means to characterise potential hazards posed to man and/or the environment by these wastes. Standardized tests have been derived with respect to pure substances and materials. Many Member countries have developed tests which can be applied to materials destined for disposal by means of operations listed in Table 2 in order to decide if these materials exhibit any of the characteristics listed in Table 5.

TABLE 6

**ACTIVITIES WHICH MAY GENERATE
POTENTIALLY HAZARDOUS WASTES**

Agriculture - Farming Industry

A100	Agriculture, forest management
A101	Cultivation
A102	Animal husbandry
A103	Forest management and forest exploitation (lumbering)
A110	Animal and vegetable products from the food sector
A111	Meat industry, slaughterhouses, butchery
A112	Dairy industry
A113	Animal and vegetable oil and grease industry
A114	Sugar industry
A115	Others
A120	Drink industry
A121	Distillation of alcohol and spirits
A122	Brewing of beer
A123	Manufacture of other drinks
A130	Manufacture of animal feed

Energy

A150	Coal industry
A151	Production and preparation of coal and coal products
A152	Coking operations
A160	Petroleum industry
A161	Extraction of petroleum and natural gas
A162	Petroleum refining
A163	Storage of petroleum and products derived from refining of natural gas
A170	Production of electricity
A171	Central thermal facilities
A172	Central hydraulic facilities
A173	Central nuclear facilities
A174	Other central electricity facilities
A180	Production of water

Metallurgy - Mechanical and Electrical Engineering

A200	Extraction of metallic ores
A210	Ferrous metallurgy
A211	Cast iron production (coke oven)
A212	Raw steel production (pig iron)
A213	Primary steel transformation (rolling mills)
A220	Non-ferrous metallurgy
A221	Production of alumina
A222	Aluminium metallurgy
A223	Metallurgy of lead and zinc
A224	Metallurgy of precious metals
A225	Metallurgy of other non-ferrous metals
A226	Ferro-alloy industry
A227	Manufacture of electrodes
A230	Foundry and metalworking operations
A231	Ferrous metal foundries
A232	Non-ferrous metal foundries
A233	Metalworking (not including machining)
A240	Mechanical, electrical and electronic construction
A241	Machining
A242	Thermal treatment
A243	Surface treatment
A244	Application of paint
A245	Assembly, wiring
A246	Production of batteries and dry cells
A247	Production of electrical wires and cables (cladding, plating, insulation)
A248	Production of electronic components

Non-Metallic Minerals - Construction Materials - Ceramics - Glass

A260	Mining and quarrying of non-metallic minerals
A270	Construction materials, ceramics, glass
A271	Production of lime, cement and plaster
A272	Fabrication of ceramic products
A273	Fabrication of products containing asbestos-cement
A274	Production of other construction materials
A275	Glass industry
A280	Building, building sites, landscaping

Primary Chemical Industry

A300	Production of primary chemicals and chemical feedstocks
A301	Chlorine industry
A351	Fertilizer fabrication
A401	Other manufacturing generators of primary inorganic industrial chemicals
A451	Petroleum and coal industry
A501	Manufacture of basic plastic materials
A551	Other primary organic chemical manufacture
A601	Chemical treatment of fats; fabrication of basic substances for detergents
A651	Fabrication of pharmaceuticals, pesticides, biocides, weed killers
A669	Other manufacture of finished chemicals

Industries producing products based upon primary chemicals

A700	Production of inks, varnish, paints, glues
A701	Production of ink
A702	Production of paint
A703	Production of varnish
A704	Production of glue
A710	Fabrication of photographic products
A711	Production of photosensitive plates
A712	Fabrication of products for photographic treatments
A720	Perfume industry and fabrication of soap and detergent products
A721	Fabrication of soap products
A722	Fabrication of detergent products
A723	Fabrication of perfume products
A730	Finished rubber and plastic materials
A731	Rubber industry
A732	Finished plastic materials
A740	Fabrication of products based upon asbestos
A750	Production of powders and explosives

Textiles and Leathers - Various Wood Based and Furniture Industries

A760	Textile and clothing industry
A761	Combing and carding of textile fibres
A762	Threading, spinning, weaving
A763	Bleaching, dyeing, printing
A764	Clothing manufacture
A770	Leather and hide industry
A771	Tanneries, tanning
A772	Fur trade
A773	Manufacture of shoes and other leacher products
A780	Wood and furniture industry
A781	Sawmills, production of wood panels
A782	Manufacture of wood and furniture products
A790	Various related industries

Paper - Cardboard - Printing

A800	Paper and cardboard industry
A801	Fabrication of paper pulp
A802	Manufacture of paper and cardboard
A803	Finished goods of paper and cardboard
A810	Printing, publishing, photographic laboratories
A811	Printing, publishing
A812	Photographic laboratories

Commercial Services

A820	Laundries, bleaching services, dyers
A830	Business enterprise
A840	Transport, automobile dealers and repair facilities
A841	Automobile dealers and automobile repair facilities
A842	Transportation
A850	Hotels, cafés, restaurants

General Services

A860	Health
A861	Health (Hospitals, medical centres, nursing homes, laboratories)
A870	Research
A871	Research (including research laboratories)
A880	Administrative activities, offices

Households

A890	Households

Pollution Control - Waste Disposal

A900	Cleaning and maintenance of public areas
A910	Urban water treatment facilities
A920	Urban waste treatment
A930	Treatment of industrial effluents and wastes
A931	Incineration
A932	Physico-chemical treatment
A933	Biological treatment
A934	Solidification of wastes
A935	Collection and/or pretreatment of wastes
A936	Landbased disposal above, on or below the surface

Regeneration - Recovery

A940	Regeneration activities
A941	Regeneration of oils
A942	Regeneration of solvents
A943	Regeneration of ion exchange resins
A950	Recovery activities

RESOLUTION

ON CONTROL OF TRANSFRONTIER MOVEMENTS OF HAZARDOUS WASTES

C(89)1(Final)

(adopted by the Council on 30th January 1989)

THE COUNCIL,

Having regard to the Decision and Recommendation of the Council of 1st February 1984 on Transfrontier Movements of Hazardous Waste [C(83)180(Final)];

Having regard to the Decision-Recommendation of the Council of 5th June 1986 on Exports of Hazardous Wastes from the OECD Area [C(86)64(Final)];

Having regard to the Decision of the Council of 27th May 1988 on Transfrontier Movements of Hazardous Wastes [C(88)90(Final)];

Having regard to the Resolution of the Council of 20th June 1985 on International Cooperation Concerning Transfrontier Movements of Hazardous Wastes, by which it has been decided to develop an international system for effective control of transfrontier movements of hazardous wastes [C(85)100];

Considering that substantial progress has been made in the development of a draft International Agreement in response to Council Resolution C(85)100;

Considering that a Global Convention concerning the control of Transboundary Movements of Hazardous Wastes is being negotiated within the framework of the United Nations Environment Programme;

Recognising that there is an essential interrelationship between global and regional systems to control transfrontier movements of hazardous wastes and that there is a need for continuing complementary activity;

Acknowledging the measures already taken by several Member countries to adopt and implement bilateral and regional systems of control;

Welcoming the fact that the work carried out by the OECD in order to promote common approaches by Member countries has contributed to the ongoing negotiations of the Global Convention, and affirming its intention to continue these efforts in the coming weeks with a view to arriving at the early conclusion of this Convention;

Considering that a Diplomatic Conference has been scheduled for 20 March 1989 for the purposes of adoption of the above-mentioned Global Convention;

Affirming strong support for the early conclusion and implementation of the Global Convention;

I. AGREES that an international systems for the control of transfrontier movements of hazardous wastes should be adopted and implemented as soon as practicable;

II. NOTES with satisfaction the substantial progress made in the Environment Committee in the development of a draft International Agreement which would provide for an international system for effective control of transfrontier movements of hazardous wastes;

III. NOTES that pending full implementation of a Global Convention concerning transfrontier movements of hazardous wastes, or, failing that, full implementation of an OECD International Agreement, Member countries will make special efforts to ensure that existing legal and administrative instruments for controlling transfrontier movements of hazardous wastes are applied, consistent with the spirit and intent of the draft OECD International Agreement and the draft Global Convention. In so doing, particular attention will be given to measures intended to protect public health and the environment in developing countries;

IV. AGREES to reconsider in Spring 1989, in light of the outcome of the above-mentioned Diplomatic Conference, the draft International Agreement, in particular its comprehensive notification system, for the purposes of establishing and implementing an international system for control of transfrontier movements of hazardous wastes;

V. INSTRUCTS the Environment Committee to review at its 48th Session in Spring 1989 the results achieved at the Diplomatic Conference and to report to the Council with appropriate recommendations;

VI. INSTRUCTS the Environment Committee to consider at its 48th Session the implications and modalities of further restricting hazardous waste exports to developing countries pending entry into force of a Global Convention.

RESOLUTION

ON THE CONTROL OF TRANSFRONTIER MOVEMENTS OF HAZARDOUS WASTES

C(89)112(Final)

(adopted by the Council on 18th-20th July 1989)

THE COUNCIL,

Having regard to the Decision and Recommendation of the Council of 1st February 1984 on Transfrontier Movements of Hazardous Waste [C(83)180(Final)];

Having regard to the Decision-Recommendation of the Council of 5th June 1986 on Exports of Hazardous Wastes from the OECD Area [C(86)64(Final)];

Having regard to the Decision of the Council of 27th May 1988 on Transfrontier Movements of Hazardous Wastes [C(88)90(Final)];

Having regard to the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted in Basel on 22nd March 1989;

Considering that steps should be taken as soon as possible to implement a number of principles that are contained in these Instruments;

I. WELCOMES efforts at the global level to establish a system to control the transfrontier movements of hazardous wastes;

II. INSTRUCTS the Environment Committee to keep under review progress made towards implementation of the Basel Convention, to consider the need for further action by OECD Member countries, and to report periodically to the Council thereon;

III. INSTRUCTS the Environment Committee to continue working towards the goal of harmonizing waste management programmes, in particular in the area of waste minimisation, pollution prevention and recycling;

IV. REQUESTS the Secretary-General to promote closer co-operation between experts in the fields of transport and waste management;

V. INSTRUCTS the Environment Committee to collect and collate statistics on transfrontier movements of hazardous wastes involving Member countries;

VI. INSTRUCTS the Environment Committee to monitor progress in harmonizing the notification systems and procedures for the control of transfrontier movements of hazardous wastes and, where appropriate, to contribute towards such progress;

VII. AUTHORISES the Secretary-General to make available to the Executive Director of UNEP, upon his request, the results achieved within the OECD in various technical fields related to hazardous waste management for the purposes of effective implementation of the Basel Convention.

Appendix 2

NOTES CONCERNING THE INTERNATIONAL WASTE IDENTIFICATION CODE

General Comments

Council Decision C(88)90(Final) of 27 May, 1988 requires Member countries to ensure that wastes subject to control in cases of transfrontier movement be classified by means of an International Waste Identification Code (IWIC) unless these wastes are subject to a transfrontier movement which takes place entirely among the parties to a bilateral or multilateral agreement or arrangement specifying a different method of classification. The IWIC is based upon the six Tables included in Council Decision C(88)90(Final); the full text of which is reproduced in Appendix 1 of this document.

Classification of wastes by means of the International Waste Identification Code (IWIC)

Tables 1 to 6 of the Annex to Council Decision C(88)90(Final) contain code numbers which, taken together, provide a means of complete characterisation of wastes, through an International Waste Identification Code, in order to facilitate their control from generation to disposal.

The International Waste Identification Code (IWIC) is obtained as follows:

1. Choose the one or at most two major reason(s) why the wastes are intended for disposal from the list in Table 1. Mark down the reason(s) as Q... plus the code number(s).

2. Indicate the method which has been selected for disposal of the wastes by choosing the <u>one</u> operation from Table 2 which most closely describes the fate intended for the wastes. Mark down as D... or R... plus the code number from Table 2.A or Table 2.B as appropriate.

3. Decide whether the wastes are liquid (L), sludge (P) or solid (S). Powders are considered to be solids.

4. Select from Table 3, the <u>one</u> descriptor which most closely describes the generic form of the wastes. Mark down this descriptor as L..., P... or S... plus the code number.

5. Examine Table 4 ; either the wastes do or do not contain one or more of the constituents listed. If none, mark down as code "CO". If one, mark down the appropriate code number. If more than one, then the best estimate for the group of no more than three entries in terms of descending hazard should be made. This estimate is meant to be qualitative and based upon the best judgment of the generator of the wastes; physical testing is not implied.

6. Select from Table 5 the one or at most two major potential hazard(s) presented by the wastes. Mark down as H... plus the code number(s).

7. Select from Table 6 the most appropriate single activity generating the wastes. Mark down as A... plus the code number.

8. The order of the International Waste Identification Code is the same as Tables 1 through 6. Main heads of the coding system are set off by double oblique lines. Where more than one entry from a specific Table is applicable, the plus sign (+) is used to separate the codes for each such entry:

Q___ + ___//D,R___//L,P,S___//C___ + ___ + ___//H___ + ___//A___

Examples:

A drum of spent acids used for pickling of metal components from a ferrous metal foundry destined for regeneration could be coded:

Q7//R6/L26//C23//H8//A231

Similarly, contaminated soil from an old gasworks site to be landfilled might be coded:

Q4//D1//S22//C39 + 7 + 6//H6//A935

Anyone who receives one or a set of waste specifications using the IWIC is thus in a position to know the potential hazardous characteristic (H), the activity giving rise (A), the reason for disposal (Q), the generic type (L, P, S) and main constituents (C) of the wastes as well as the disposal method selected (D, R). In effect, a single line of information provides a dossier concerning the batch of wastes without recourse to descriptive language. Use of the IWIC should reduce ambiguity in describing wastes while still allowing for environmental sound decisions to be taken with respect to monitoring and controlling wastes.

Detailed Comments concerning Tables 1 - 6 of Council Decision C(88)90(Final)

Table 1 - Reasons for disposal

1. Table 1 provides a list of sixteen choices for reasons why a discrete batch of materials might be intended for disposal. Several of the entries to Table 1 include a few examples; the remainder are self-explanatory. Certain overlaps and ambiguities inevitably occur between various entries. Despite these overlaps, the exporter should be able to select one or at most two choices which most closely resemble the reason(s) why a discrete batch of materials was intended for disposal. More than two choices is not allowed by the IWIC.

2. If the entry at Q13 is applicable, it <u>must</u> be included as a reason. With respect to other entries, the exporter is in the best position to most accurately match his reason(s) to the entries in the list. The entire selection process is meant to take <u>seconds</u>, not minutes or hours.

<u>Table 2</u> - <u>Disposal operations</u>

3. Table 2 is divided into two sections; Section 2A is meant to encompass <u>all</u> disposal operations which do <u>not</u> lead to the possibility of resource recovery, recycling, reclamation, direct re-use or alternative uses of wastes. Certain of the operations listed may or may not be acceptable from the point of view of environmental protection. Of the fifteen choices, several include a few examples; the others are self-explanatory.

4. For wastes destined for any of the operations listed in Table 2A, the exporter must be aware of the disposal technique foreseen for each discrete batch of wastes being sent across frontiers. In almost every case, the importer and the exporter will have agreed a disposal technique (and the price of disposal) by means of contract clauses. Thus, the exporter should be easily able to select <u>one</u> disposal operation from Table 2A which closely matches the fate foreseen for his wastes.

5. Selection of any of the entries D8, D9, D13, D14 or D15 by the exporter as the intended disposal operation is satisfactory in terms of the control system because any subsequent activity involving the treated or blended or stored, etc. wastes presumably occurs within the importing country. Hence, these subsequent activities are subject to the existing laws and regulations in the importing country and are not normally a matter for international scrutiny. The one operation most closely approximating the fate foreseen for the wastes upon transfer to the importer is to be selected from the fifteen options in Table 2A.

6. The operations listed in Table 2B are meant to encompass all those which might lead to resource recovery, recycling, reclamation, direct re-use or alternative uses of wastes. Entries R1 through R9 are concerned with fairly specific <u>outcomes</u> of these operations, e.g., energy generation, solvent recovery, extraction or winning of metallic units, obtaining useful acids or bases, etc. Thus, the exporter, by nature of his contacts with the importer combined with his knowledge of his wastes, is in a position to know which, if any, of these nine entries is most applicable. If the wastes are to be subjected to a processing regime which might result in more than one useful outcome, the exporter should select the one descriptor from Table 2B which, <u>in his view</u>, reduces any hazard associated with the wastes by the greatest amount. For example, in stainless steel pickling operations a residuum of nitric acid plus alloys of ferrous metal can occur. A reclamation process could yield some usable ferrous units plus a quantity of regenerated nitric acid. In this case, selection of R6 is indicated since the quantity and corrosive propensities of the acid probably represent a larger hazard than the ferrous components.

7. Choice of R10 means that the process selected must be of proven benefit and be legally acceptable in the importing country. If there is any doubt on this point, then D2 should be selected instead.

8. Entry R11 enables an exporter who is also acting as a reclaimer, recycler, etc. to export residua from any of the operations delineated as R1-R10 provided such residua can be used further in any of these ten operations by the importer.

9. The entry R12 is to be utilised when direct exchange of wastes occurs and the importer intends to utilise the wastes as a feedstock for one or more of the operations R1-R10.

10. The entry R13 is to be used when a commercial recycling, reclamation, etc. operation acting as importer has the legal right in the importing country to receive and accumulate material in order to better utilise such material later, e.g., when sufficient quantity makes it economically worthwhile to extract certain units or when the secondary materials market is more favourable for sale of the recoverables, etc.

Table 3 - Generic types of wastes

11. The exporter must indicate whether the wastes to be included in the movement are liquid, coded as L, sludge, coded as P, or solid, coded as S (powders are taken as solids). The physical state under the conditions of loading on to the conveyance is to be selected. If the physical state under transport conditions is expected to be different than this, select the physical state for transport.

12. Table 3 describes generic types of hazardous wastes and is divided into two portions. Entries 1-17 represent wastes which would be subject to control if these wastes exhibit one of the hazard characteristics included in Table 5. These seventeen entries correspond exactly to items 1-17 in the Core List of wastes to be controlled according to Decision C(88)90(Final). Moreover, if involved in transfrontier movement, these wastes would be required to be accompanied by a Transport Document (Consignment Note) under terms of one or more international protocols governing transport of dangerous materials.

13. Entries 18-40 of Table 3 are generic descriptors which represent wastes which may contain any of the constituents listed in Table 4. In other words, what makes the item represented by these entries a potentially hazardous waste is the fact that it is a waste in terms of the OECD definition and contains one or more constituents listed in Table 4: of course, the waste would also need to exhibit one of the hazard characteristics included in Table 5.

14. The entries listed in Table 3 are meant to represent a basic general descriptor for a discrete batch of wastes. In other words, if one were to describe in response to a question "what is that batch of material?", the answer could be "wastes in the form of ..." (any single entry in Table 3 depending upon the situation). The single entry in Table 3 most closely describing the wastes in this way is what is to be selected for inclusion in the IWIC. If more than one entry seems possible, the descriptor which most closely describes the main mass of the batch of wastes being sent for disposal should be selected. For example, suppose a mass of soil has been contaminated by a spill of wood preserving chemicals. What is being sent for disposal would be classified as 22 (soil containing constituents listed in Table 4) and not as entry 5 (wood preservatives).

15. The reason for this approach in this case is that the disposal operation must deal with contaminated soil whose constituents and hazards are known (from the remainder of the IWIC) and not waste wood preservatives as such. In general, the selection of the Table 3 entry based upon main mass of the wastes being sent for disposal alerts both the authorities and the disposal operation as to what techniques and capacity requirements will be needed for environmentally sound disposal.

Table 4 - Constituents

16. Table 4 contains a list of 51 entries. Many of these constituents have been proscribed in national lists such that wastes containing one or more of the entries in Table 4 are viewed as requiring special precautions, e.g., are referred to as hazardous, special, etc. Moreover, virtually all of them have been so proscribed under legislation of the European Community. For those who are concerned to know more of the reasoning underlying the selection of a given constituent of wastes which renders them hazardous, the Commission of the European Communities is compiling an extensive Guidance Document which summarises for each such constituent its:

-- Description;

-- Uses;

-- Correspondence with dangerous substances;

-- Main compounds appearing as wastes (waste arisings);

-- Dangerous properties;

-- General references concerning the information given.

17. Use of Table 4 does not imply that the batch of wastes must be subjected to qualitative and/or quantitative analytical chemistry techniques. Generators (and exporters) will normally be aware of the main constituents of a discrete batch of wastes. In selecting entries from Table 4, common sense criteria are to be applied. Some wastes may contain many of the listed constituents. If so, the best estimate for the group of no more than three entries in terms of descending hazard posed by the presence of a given constituent in the batch of wastes should be utilised. This estimate is meant to be qualitative and based upon the best judgment of the generator (or exporter) of the wastes; physical testing is not implied.

18. This approach for choosing entries from Table 4 is consistent with protocols governing the international transport of dangerous materials, e.g., ADR or RID. In the case of ADR and RID, the shipper must describe the materials as "wastes containing .... (the most hazardous one, two or at most three constituents in descending hazard order)". Thus, since the wastes subject to the OECD control system will almost always be also subject to such international transport of dangerous materials protocols, descriptors of the wastes under both the OECD system (Table 4) and the transport protocols should be identical.

19. In practice, a Transport Document (Consignment Note) must accompany international shipments of dangerous materials including wastes. In completing this Consignment Note in the case of wastes, the constituents in descending hazard order (up to three) must be listed by the shipper. Hence, for the IWIC, these same constituents would be located in Table 4 and selected. In effect, the person completing the Consignment Note would only need to consult Table 4 to select the IWIC code as an "extra" step. (Perhaps the descriptors in Table 4 would be used in fact as an initial step to choose identifiers for the constituents to be listed on the transport of dangerous materials protocol Consignment Note.)

20. Certain redundancies between Table 3 and Table 4 occur. These are intentional and should cause no concern to those who must complete the IWIC.

Table 5 - Hazardous characteristics

21. Table 5 includes a series of characteristic hazards which certain wastes may exhibit. The hazards listed as H1, H3, H4.1, 4.2, 4.3, H5, H6 and H8 correspond closely with recommendations prepared by the United Nations Committee of Experts on the Transport of Dangerous Goods for certain classes of dangerous goods. The specific relationships are as follows:

H1	corresponds with Class 1 -- Explosives
H3	corresponds with Class 3 -- Inflammable liquids
H4.1	corresponds with Class 4.1 -- Inflammable solids
H4.2	corresponds with Class 4.2 -- Substances liable to spontaneous combustion
H4.3	corresponds with Class 4.3 -- substances which in contact with water emit inflammable gases
H5	corresponds with Class 5 -- Oxidizing substances
H6	corresponds with Class 6.1 -- Poisonous (toxic) substances
H8	corresponds with Class 8 -- Corrosives

Some Member countries have developed tests which can be used to determine whether a waste exhibits the characteristics listed in Table 5.

22. The hazards listed as H10, H11 and H12 would each fall under Class 9 -- "Miscellaneous dangerous substances" in the UN classification system.

23. Omissions of the designations H2, H7 and H9 are deliberate.

24. All wastes subject to the OECD control system fall, for purposes of carriage, into the UN classification scheme for transport of dangerous goods. Under many international agreements, dangerous goods or materials which are transported across frontiers must be accompanied by a Transport Document with information containing a description of the materials and their transport class; this information is often compiled onto a form called a Consignment Note.

25. Table 5 contains definitions of the characteristics for entries H1 through H10 which indicate specific properties of a discrete batch of wastes enabling selection of the appropriate descriptor.

26. The H12 entry, ecotoxicity, is to be selected if the wastes could create apparent harm to the environment and/or to one or more ecosystems in case they (the wastes) are managed improperly. Again, physical testing or consultation of reference texts is not implied but rather a common sense estimation based upon some knowledge of the properties of the specific wastes in question.

27. Entry H11 is to some extent dependent upon the disposal operation chosen for the wastes (see Table 2). There have been many recorded instances of leachate release from waste deposits which caused contamination of resources such as groundwater. With respect to entry H11, the key point is that the wastes are "capable" of yielding a hazardous effluent or discharge after disposal. Thus, the engineering design and performance of the disposal operation is not to be taken into account when considering whether or not to select H11. Rather, if the disposal operation is one where the wastes do not tend to undergo rapid physical and/or chemical alterations (incineration for example), then there is a finite probability for these wastes to possess the characteristics described by H11. This probability is higher for disposal operations D1, D2, D6 and D8 than for options D3, D5 and D12, for example. The exporter should consider such points and invoke common sense in deciding whether or not to select H11 as being applicable. An important point is that the information should enable the competent authorities to reach a conclusion concerning whether or not the disposal facility selected is appropriate. The selection of a specific disposal operation is left to the exporter and disposer to decide.

28. A heterogeneous batch of wastes may well possess more than one of the characteristics listed in Table 5. The exporter should select the major one hazard or, at most, two hazards from among the entries. What is desired is an indication of the one or two hazards most likely to create the greatest harm if the batch of wastes were improperly managed.

29. The Note following the list of entries in Table 5 mentions tests which might be applied to determine if a specific batch of wastes does or does not possess a given characteristic. For purposes of the OECD control system, physical testing of waste batches <u>is not intended</u> unless a dispute arises between an exporter and the competent authorities. The System leaves it to the exporter to assert whether or not the wastes possess a given characteristic. If appropriate competent authorities challenge this assertion and the dispute cannot be resolved otherwise, test procedures exist for subjecting the disputed batch (or batches) of wastes to scrutiny on an impartial common basis.

<u>Table 6</u> - <u>Activities generating wastes</u>

30. Table 6 consists of a number of activities which might generate wastes subject to control. In choosing the most appropriate <u>single</u> activity what must be specified is the actual process which gives rise to the waste, i.e., the source; the branch of industry or commerce is <u>not</u> to be taken as the basis. For example, wastes arising from the machine shop facility of a factory producing cardboard boxes would be classified with the code A241 and not A802. The machine shop operation gave rise to the wastes, not the box producing operation.

Appendix IV

Extracts from the AEC National Guidelines for the Management of Hazardous Waste

. **Conclusion**

Australian and overseas research and development on hazardous waste management relevant to Australia should be monitored by AEC's Advisory Committee on Chemicals in the Environment.

4. Appendices

Appendix A

Proposed Hazardous Waste Classification System

The proposed common classification system for hazardous wastes identifies each waste according to several characteristics rather than under a single name. Hazardous wastes are identified according to the following features:

1) UN hazard class, (as used in the transport of dangerous goods);

2) UN number, (as used internationally to describe a dangerous good);

3) Generic waste description, (based upon classes which have been proposed by consultants to OECD).

   The letter L, S or P before the number indicates liquid, solid or sludge;

4) Waste source by industry, (in accordance with standard Australian statistical industry classes); and

5) Main toxic constituents, (using a comprehensive OECD listing drawn up for the purposes of describing hazardous wastes).

The categories of hazardous wastes under each of these five descriptors are specified in Annex 1. Each category is referred to by a list number. It would be possible for a hazardous waste to have a zero listing for lists 1, 2 or 5. When selecting under List 2 the most appropriate UN number for the particular hazardous waste should be identified in Section 9 of the current version of the Australian Dangerous Goods Code. The set of hazardous wastes presented under list 2 in Annex 1 are those UN numbers and waste classifications used most commonly in practice in Australia for hazardous wastes.

For example, using this classification system a petrol tank sludge would be identified as follows:

3.1/1993/P37/27/10,7

The descriptors under each list refer to the following -

- 3.1 is the UN hazard class, a flammable liquid (list 1)

- 1993 represents the UN number for a waste flammable liquid (list 2)

that the liquid is a non-halogenated organic
d has a flash point less than 61° C. The prefix
tes the physical state of the waste (list 3)

a waste arising from the petroleum industry (list

that lead compounds and to a lesser hazard extent
ounds, are present in the waste (list 5).

ANNEX 1

LIST 1

United Nations Hazard Classes

	Class
1.0	Explosives
2.1	Flammable gas
2.2	Nonflammable - compressed gas
2.3	Poison gas
3.1	Highly flammable liquid
3.2	Flammable liquid
4.1	Flammable solids
4.2	Substances liable to spontaneous combustion
4.3	Substances emitting flammable gases when wet
5.1	Oxidizing agents
5.2	Organic peroxides
6.1	Poisonous (toxic) substances
6.2	Infectious substances
7.0	Radioactive substances
8.0	Corrosives
9.1	Miscellaneous dangerous substances

LIST 2

United nations number and description of Waste Dangerous Good.

Note: The listed waste dangerous goods below are the "not otherwise specified" (n.o.s.) classes in section 9 of the Australian Dangerous Goods Code. Where appropriate the specific waste dangerous good description in Section 9 of the Code should be used.

Code Number	Hazardous Waste
1760	Corrosive liquids, n.o.s.
2920	Corrosive liquids, flammable, n.o.s.
2922	Corrosive liquids, toxic, n.o.s.
1759	Corrosive solids, n.o.s.
2921	Corrosive solids, flammable, n.o.s.
2923	Corrosive solids, toxic, n.o.s.
1993	Flammable liquids, n.o.s.
1992	Flammable liquids, toxic, n.o.s.
2924	Flammable liquids, corrosive, n.o.s.
1325	Flammable solids, n.o.s.
2926	Flammable solids poisonous, n.o.s.
2925	Flammable solids corrosive, n.o.s.
1479	Oxidizing substances, n.o.s.
2810	Poisonous liquids, n.o.s.
2929	Poisonous liquids, flammable, n.o.s.
2927	Poisonous liquids, corrosive, n.o.s.
2811	Poisonous solids, n.o.s.
2930	Poisonous solids, flammable, n.o.s.
2928	Poisonous solids corrosive, n.o.s.
2813	Substances which in water emit flammable gases, n.o.s.

3021	Pesticides, liquid, flammable, toxic, flash point less than 23°C, n.o.s.
2903	Pesticides, liquid, toxic, flammable, flash point 23°C to 61°C, n.o.s.
2588	Pesticides, solid, toxic, n.o.s.
2902	Pesticides, liquid, toxic, n.o.s.

LIST 3

Hazardous Waste Type

One of the following prefixes sould be assigned to the appropriate number:

L for liquids

S for Solids

P for Sludges

Plating and Heat Treatment

1. Discarded plating solutions
2. Discarded heat treatment solutions
3. Complexed cyanides
4. Other cyanide solutions

Acids

5. Sulphuric acid
6. Hydrochloric acid
7. Nitric acid
8. Phosphoric acid
9. Chromic acid
10. Hydrofluoric acid
11. Sulphuric/hydrochloric acid mixtures
12. Other mixed acids
13. Organic acids

Alkalis

14. Caustic Soda, Potash, Alkaline Cleaners, Ammonium Hydroxide
15. Lime Slurries, Cement Slurries (not containing metal sludges)

16. Lime neutralised metal sludges
17. Other sludges

Inorganic Chemicals

18. Non toxic salts (eg sodium, calcium chlorides)
19. Arsenic and arsenic compounds
20. Boron compounds
21. Cadmium and cadmium compounds
22. Chromium and chromium compounds
23. Lead compounds
24. Mercury and mercuric compounds, mercury containing equipment
25. Other inorganic salts and complexes

Reactive Chemicals

26. Oxidising agents
27. Reducing agents
28. Explosives and unstable chemicals
29. Highly reactive chemicals

Paints, Resins, Inks, Dyes, Adhesives, Organic sludges

30. Aqueous based (non combustible/non-flammable vapours)
31. Solvent based FP>61^{o}C (combustible)
32. Aqueous based (flammable vapours)
33. Solvent based FP<61^{o}C (flammable)
34. Paint residues
35. Cured adhesives or resins

Organic solvents

36. Non-halogenated FP>61^{o}C (combustible)
37. Non-halogenated FP<61^{o}C (flammable)

38. Halogenated FP>61°C (combusible)

39. Halogenated FP<61°C (flammable)

40. Halogenated (non combustible/non flammable vapours)

41. Others

Pesticides

42. Inorganic, organo-metallic pesticides

43. Organo phosphorous

44. Nitrogen containing pesticides

45. Halogen containing pesticides

46. Sulphur containing pesticides

47. Biological pesticides

Waste oil

48. Contaminanted oils (lubricating, hydraulic)

49. Oil/water mixtures (mainly oil) (cutting oils, soluble oils)

50. Water/oil sludge, (mainly water)

Textile

51. Tannery wastes

52. Wool scouring wastes

53. Textile washwaters

Putrescible/Organic wastes

54. Animal effluent and residues (abbatoir wastes)

55. Grease trap waste - domestic

56. Grease trap waste - industrial

57. Bacterial sludge (septic tank)

58. Vegetable oils and tallow derivatives

59. Vegetable waste - sludges

60. Animal oils

Washwaters

61. Truck, machinery washwaters with or without detergents

62. Other industrial washwaters

Inert Wastes

63. Inert sludges/slurries eg. clay, ceramic suspensions

Organic Chemicals

64. Non-halogenated aliphatics (non solvent)

65. Non-halogenated aromatics and phenolics (non solvent)

66. Highly odourous

67. Pharmaceuticals and residues

68. Surfactants and detergents

69. Polychlorinated, halogenated organics (non solvent)

70. Other

Bags, Containers

71. Containers and bags which have contained hazardous substances (hazardous substance to be specified)

Immobilised Wastes, Inert Wastes

72. Encapsulated wastes

73. Chemically fixed wastes

74. Solidified or polymerised wastes

75. Inert solids

Miscellaneous

76. Contaminated soils (must specify contaminant, eg, cyanide, PCB etc)

77. Pathogenic wastes

78. Other

LIST 4 Asic

Industry from which waste originates

1. Agriculture, foresting, fishing, etc.
2. Mining
3. Manufacturing
   - 3.1. Food, Beverages and Tobacco
   - 3.2 Textiles
   - 3.3. Clothing and Footwear
   - 3.4. Wood, Wood Products and Furniture
   - 3.5. Paper, Paper Products, Printing, Publishing
   - 3.6. Chemical, Petroleum, Coal Products, Paint
   - 3.7. Glass, Clay, Cement
   - 3.8. Basic Metal Products
   - 3.9. Fabricated Metal Products
   - 3.10. Transport Equipment
   - 3.11. Miscellaneous
4. Electricity, gas and water
5. Construction
6. Wholesale and retail trade
7. Transport and Storage
8. Communication
9. Finance property and business service
10. Public administration and defence
11. Community services
12. Recreation and other services

LIST 5

Waste Constituents

0. None of the below
1. Polychlorinated biphenyl and related compounds
2. Halogenated hydrocarbons
3. Mercury and mercuric compounds
4. Chromium and chromium compounds
5. Arsenic and arsenic compounds
6. Cadmium and cadmium compounds
7. Boron compounds
8. Cyanide, thiocyanate and isocyanate compounds
9. Mercaptans, methacrylates and sulphides
10. Lead compounds
11. Copper and copper compounds
12. Zinc and zinc compounds
13. Nickel and nickel compounds
14. Silver compounds
15. Vanadium compounds
16. Cobalt compounds
17. Fluorine compounds
18. Acidic solutions
19. Basic solutions
20. Asbestos
21. Peroxides
22. Perchlorates
23. Isocyanates

24. Phenols

25. Organic solvents

26. Aromatic compounds

27. Other

Appendix 3

National Manifest System for Movement of Hazardous Wastes

- Outline of Procedures

The manifest comprises a multiple-copy form (four copies) parts of which would be completed by each custodian of the waste consignment from the point of generation through each stage of transport, storage, treatment and disposal.

Generators, storers, transporters and disposers should complete the following actions where applicable:

(a) the generator/storer should arrange for transport and disposal or storage;

(b) the generator/storer initiating movement of the waste consignment should notify the relevant authority by completing the top sheet of the manifest from Sections 1 to 15, and by providing it in good time to the relevant authority. In the case of interstate movements, a photocopy of the top sheet of the manifest should be provided to the waste authorities in the receiving State or any transit State(s).

(c) the generator/storer retains the first copy and provides the remaining copies (2 to 4) to the transporter of the waste consignment.

(d) the transporter completes copy 2 (item 16) and retains it. The remaining copies are given to the disposer/storer; and

(e) the disposer/storer completes copy 3 and mails it to the authority whose address appears on the manifest. The disposer/storer retains copy 4.

AUSTRALIAN MANIFEST FOR MOVEMENT OF HAZARDOUS WASTES

NAME AND ADDRESS OF WASTE AUTHORITY IN STATE/TERRITORY WHERE WASTE IS GENERATED/STORED

GENERATOR/STORER

1. Name of Generator/Storer
Business Address ....
....
Phone No: Business Hours .... After Hours ....

2. Generator's/Storer's Licence No (if applicable)

3. Location where waste generated

4. Storage site prior to transport

5. Date of proposed transport

6. Transporter (Name) ....
(Address) ....
....

7. Name of Disposer/Storer to receive consignment ....
Disposal/Storage site address ....

8. Description of Waste

9. Additional description of waste

10 Coded Waste Description	LIST 1	LIST 2	LIST 3	LIST 4	LIST 5

11. Quantity m^3 (KG)

12. UN Packaging No ....

13. Generator's/Storer's Safety and Handling instructions for Waste

14. Packaging method

15. I declare that the above waste is accurately described and is in a proper condition for transport in accordance with the Australian Dangerous Goods Code.
Name .... Signature ....
Date ....

TRANSPORTER

16. I acknowledge the receipt of the waste consignment described above.
Name .... Signature ....
Date ....

DISPOSER/STORER

17. I declare that the waste consignment described above has been received.
Name .... Signature .... Date ....
Date of disposal .... Method of disposal (see List 5) .... Disposer's Licence No ....

18. Specify any discrepancy between waste described and waste received.
Name Storer Disposer .... Signature .... Date ....

COPY ROUTING

GENERATOR
Pink to Authority
White - retain

TRANSPORTER
Yellow - retain

DISPOSER/STORER
Blue to Authority
Green - retain

Explanatory Notes on the Manifest

Details on the waste management authority for the area in which the waste is initially located should be included in the relevant box at the top right-hand corner of the form.

Section 1 — The custodian (generator or storer) of the waste is responsible for commencing action to complete the manifest.

Section 3, 4 — Only one section should be filled out.

Section 8 — The waste should be described as precisely as possible, but preferably by the UN Substance name. These are detailed in column 2, Section 9 of the ACTDG*.

Section 9 — A full description of the waste should be provided including details of the industry of origin, waste colour, physical form and chemical composition.

Section 10 — The waste description section uses the national hazardous waste classification system available from the waste authority.

List 1 is the UN hazard class

List 2 is the UN number for the waste

List 3 is the waste type

List 4 is the industry of origin of the waste

List 5 is of particular hazardous waste constituents which need to be noted.

Section 14 — The appropriate packaging method for the waste may be determined by reference to Column 8, section 9 of the ACTDG*. If the waste is not listed as a dangerous good in the transport code then the packaging method considered appropriate by the generator/storer should be indicated.

Section 18 — This part need only be completed if the wastes received by the storer or disposer are not exactly as described in parts 11, 12 and 13.

* ACTDG: Australian Code for the Transport of Dangerous Goods by Road and Rail. (Available from the Australian Government Publishing Service.)

Appendix V

Proposal for a National Waste Database

CRC FOR WASTE MANAGEMENT AND POLLUTION CONTROL

Project Title: NATIONAL WASTE GENERATION DATABASE

CRC Program area: **Waste minimisation (Program 1)**

Duration:

A staged three year development program and then ongoing maintenance of the database. July 1992 to June 1995.

PROJECT OUTLINE

Participating organisations

The Project Leader, CEPA Research Associate and the Research Assistant will be based in the University of New South Wales. Existing links with government and private sector environmental and waste management groups throughout Australia will facilitate the rapid acquisition of data. CRC Partner links with national umbrella organisations (mining industry, chemicals industry, etc.) will be an important part of the information network being established. A technical advisory committee of experts in the field will meet quarterly to ensure quality control.

Project Aims & Objectives

The **aim** of the project is to establish a database on waste generation in Australia which will provide the information foundation for CRC waste minimisation projects. The project will also provide a national database which can be used by State and Commonwealth environmental and waste management agencies, to set and monitor the achievement of rational waste minimisation targets.

To achieve this aim, the following **objectives** will need to be met:

(a) Review and establish nationally agreed classification systems for various waste groups (eg: urban solid waste, hazardous industrial waste).

(b) Establish a protocol for sampling and characterising urban solid wastes in terms of its physical composition.

(c) Establish a national waste generation database to provide fundamental information on the generation of different types of waste by region and in relation to relevant parameters (e.g. population, industrial goods output, etc. as appropriate).

(d) Review Australian and overseas waste generation trends and establish waste minimisation benchmarks for each waste type by region. Waste minimisation benchmarks represent realistic targets achievable by best practice and they can be used by regulators and industry groups to drive waste minimisation research and development and implementation.

(e) By supplementing work undertaken in other CRC projects (eg. Context of waste disposal as solids, the project will suggest priorities among waste types (eg. Which types of waste minimisation will lead to the greatest environmental benefit and/or yield the greatest commercial benefits through the development of techniques and technology?)

Brief description of project

The tasks that will need to be completed to achieve the objectives are outlined in this section. They will need to be further refined after discussions with potential users of the database.

1. **National classification systems**

i.1 **Hazardous waste classification system**

A hazardous waste classification system has been established for some time (AEC, 1986 National Guidelines) and has been adopted by the NSW, Vic EPA and the SAWMC for their waste manifest systems. The AEC (now ANZECC) system used by the WMA of NSW should be retained. Some supplementary work to that undertaken by the Joint Task force on Intractable Waste, Phase 1 Report (by S. Moore, a project staff member) may be required to translate coarser systems in use in Queensland and WA to the AEC system.

i.2 **Urban solid waste classification system**

The ANZECC is currently developing a uniform national system. Some assistance from this project may be required to finalise this work to achieve a nationally agreed system. In general terms, this waste group encompasses:

- domestic waste
- non hazardous, solid commercial and industrial waste
- demolition and construction waste.

The current absence of a uniform national system makes national aggregation of statistics and interstate and overseas comparisons very difficult.

ANZECC is currently evaluating protocols to monitor changes to the packaging component of the major urban solid waste streams. This work has only recently commenced and there is an opportunity for the CRC to link in with this work.

While ANZECC has received a consultant's report on developing a uniform national solid waste classification system, this report only summarises the systems being used throughout Australia. The report makes recommendations, but these are unlikely to be adopted without further work.

Following establishment of the classification system, a standard protocol needs to be developed covering sampling and analysis of urban solid waste.

i.3 **Other waste groups**

Consideration needs to be given on the merits of including other waste groups in the database, namely:

- mining wastes
- clinical and related wastes
- radioactive wastes.

If these were to be included, it is likely that active data collection would occur after establishment of the urban solid waste and the hazardous waste databases.

i.4 **Information and liaison network establishment**

Early in the project, and in conjunction with developing agreement on national classification systems and determining Database user requirements, a network of information sources and liaison officers will be established. This will include CRC partners, State and Commonwealth environment and waste agencies, and relevant industry umbrella groups. Counterpart overseas organisations will also be contacted.

The contacts and links of individuals in CRC partner organisations should be sufficient to establish this network efficiently. The benefits of the database to users will need to be `sold' to them if they are to provide reliable data on an ongoing basis.

2. **Establish sampling and analysis protocol for urban solid waste.** Review overseas methods, particularly EAWAG (Swiss) and Warren Springs (UK) approaches to develop an appropriate standard for Australia.

..../3

3. Establish waste generation database

3.1 Review current published information

The Industry Commission report on Recycling has a good summary of urban solid waste generation data currently available. The raw data should be obtained and used as a starting point, having regard for the inherent problems with it, namely the lack of uniformity around Australia in:

- classifying waste
- sampling waste for composition
- analysing waste for composition and quantity
- purpose for which data was collected
- reliability of the data.

Annual Reports and strategy studies provide a background for hazardous waste generation data, including:

- Joint Task force on Intractable Waste Phase 3 report.
- Cleanaway EIS for proposed Newcastle Liquid Waste Treatment Facility.
- SAWMC Hazardous Waste Review for South Australia.

3.2 Review current Australian waste data collection

Environment and Waste agencies (and some major local government bodies) routinely collect waste generation data and store it in various databases. The most comprehensive are derived from the manifest procedure used to track the generation and fate of hazardous waste. The WMA of NSW has the longest record and has an impressive ability to provide extracts and summaries, according to a range of criteria. The SAWMC and the Vic EPA use (different) commercial software (dBase III + for the SAWMC).

An investigation of alternative database software will The study will cover the ability to interface with existing waste database software, where practical and beneficial.

3.3 Purchase appropriate computer software and hardware

The software and database capacity needs will be determined before purchasing hardware. A PC based system would be preferred to facilitate use of the database by CRC partners and others. To the extent possible, the database will be designed to be readily useable by both IBM and Macintosh PCs.

3.4 Design data collection

In addition to collecting waste generation data, according to the agreed national classification systems, information will be collected on the parameters that influence or `cause' waste to be generated, (eg. population for domestic urban waste, value of industrial output (?) or production employees for hazardous waste).

ABS collected information will be used where possible, but additional data will also need to be collected (e.g. ASIC industry group generating the waste type, as is now done for hazardous waste in the WMA of NSW's manifest database).

3.5 Confirm information/liaison network and commence data collection.

3.6 Trial Database Output on Customers

Various outputs from the database will be provided to customers at an early stage so that, if necessary, modifications to data collection can be made before the data collection procedure becomes too rigid.

..../4

4. **Establish waste minimisation benchmarks**

A review of overseas waste generation databases will be undertaken as part of the investigations for 3.4 *Design data collection*. Output from the Australian database should then be able to be compared with overseas figures. Economic, social and environmental differences need then to be accounted for if overseas and interstate figures are to be used to establish regional waste minimisation benchmarks (targets).

A useful adjunct to these regional and national waste minimisation comparisons, would be comparisons between Australian and best overseas practice at the level of the individual company. Hilmer's study of productivity by using paired comparisons yielded insights not obtainable from aggregated national comparisons (Fred Hilmer, Dean AGSM, for BCA).

5. **Prioritise waste types**

One of the outcomes of the Database would be the ability, in conjunction with other investigations, to identify those waste types whose minimisation would yield the greatest environmental and commercial gains. This could be achieved through the ability to answer such questions as:

- which waste types, industry groups, could most easily benefit from waste minimisation (by comparison with overseas counterparts)?
- which waste types appear to be the most difficult to minimise (by analysing trends among different waste types over a period).
- which particularly environmentally hazardous waste types are also large in quantity, and also have the potential to grow if the economy grows in certain directions.

Significance of project

The project is of national and international significance, as it will provide the basic data for interstate comparisons and monitoring, and for contributions to international studies by the OECD, UNEP, etc.

The project, possibly more than any other CRCWMPC project, will establish the CRC as the reference centre for waste management in Australia - both nationally and internationally.

Research plan, timetable, milestones

The research program will generally follow the objectives, and tasks set for each objective, as described above.

Important milestones and deliverables will be as follows:

Jul 1992:
- Appoint project staff.

Jan 1993:
- Agree on national classification systems.
- Complete interim review of existing Australian and overseas databases.

Feb 1993:
- **Provide progress report to CEPA.**

July 1993:
- Complete design of data collection system.
- Purchase software and hardware.
- Complete trial of data collection system and establish information network.

Jan 1994:
- Provide trial output of database available to customers and obtain their reactions.

Feb 1994:
- **Provide progress report to CEPA.**

..../5

June 1994: • Complete paired Australian/overseas studies of waste minimisation.

Jan 1995: • Compile suggestions on waste minimisation benchmarks for various waste types, regions, industries.

• Complete identification of priority waste areas for waste minimisation.

Feb 1995: • Provide progress report to CEPA.

June 1995 • Final report to CEPA on establishment of database with recommendations on routine maintenance of the database in ongoing manner.

Staffing

Project Leader: Stephen Moore (University of NSW)

Principal Consultant: Bert van den Brock (EPA of NSW)

CEPA Research Associate: to be recruited.

Research Assistant: to be recruited.

Review: A Technical Advisory Panel of experts will be established to ensure quality control.

The Project Leaders and Principal Consultant have extensive experience in urban solid waste and hazardous waste strategy studies which require waste classification and generation as their foundation. They have a working knowledge of the existing problems in Australia and the needs that a comprehensive database would satisfy.

Business basis

The project will provide the fundamental data needed to drive other CRCWMPC waste minimisation projects. It will:

- enable the need for other projects to be determined

- enable the Australia market for techniques and technologies to be quantified.

Information summaries from the database may be able to be sold to customers, offsetting the ongoing running costs, but probably not the establishment cost.

Successful implementation of the database could lead to assistance from the CRC to establish similar systems in overseas countries, particularly Asia. The flow on benefits to other waste management research and development projects could be substantial.

Budget

The overall budget for the three year project is $620,000 (on a 1991-92 cost basis) of which it is proposed CEPA provide $546,200, with the Centre providing $74,400 from its own resources. The proposal has been prepared on the assumption that funding for 1992-93 and subsequent years will be subject to inflation adjustment. A project funds estimate statement follows.