SOUTHLAND REGIONAL COUNCIL

Ap. .cation for a Resource Consent

For Office Use Only	
Received for processing :-	5.4.95
Application no. :-	A1323
Job no. :-	5178
Officer in Charge :-	S.B.W.

The General Manager,
Southland Regional Council,
Private Bag,
INVERCARGILL.

Dear Sir,

Pursuant to Section 88 of the Resource Management Act 1991,

X New Zealand Aluminium Smelters Limited
NAME OF APPLICANT — OCCUPATION

of Private Bag 90110
ADDRESS OF APPLICANT
INVERCARGILL

ereby applies ~~apply~~ to the Southland Regional Council for the resource consent(s) described below :-

1. Details of owner/~~occupier~~ of the land (where different to applicant) to which this application relates :-

Comalco New Zealand Limited
NAME OF OWNER
P O Box 1665
ADDRESS OF OWNER
WELLINGTON

NAME OF OCCUPIER

ADDRESS OF OCCUPIER

2. Details of location (this should include a plan showing the site, any property boundaries and names of adjoining landowners, any significant stream, river, or other water body to which the application may relate, and proximity to any well known landmark) :-

Site locality The south western end of Tiwai Peninsula, near Tiwai Point, as shown on the attached diagram

Grid reference (*if known*) NZMS 260; E47, D47 Bluff: 552: 914
NZMS 260 SERIES

Legal description Part CT 2A/78

3. The type of resource consent(s) sought are (*please circle appropriate consent(s) - more than one may be required*):-

~~Coastal permit (for any activity in the coastal marine area that would contravene any of Sections 12, 14, and 15 of the Act)~~

~~Land use consent (for any activity that would contravene any of Sections 9 and 13 of the Act)~~

~~Water permit (for any activity that would contravene Section 14 of the Act)~~

Discharge permit (for any activity that would contravene Section 15 of the Act)

PTO

4. Attached is a description of the activity to which this/these application(s) relate. To discharge contaminants onto and into land (including in circumstances where contaminants may enter water) at the NZAS landfill.

5. The following resource consents or approvals are required from another consent authority in relation to this proposal and have/have not been applied for :-

NIL	
Type of Consent/Approval	Consent/Approval Authority
Type of Consent/Approval	Consent/Approval Authority

6. Attached is an assessment of any effects that this proposal may have on the environment.

Note 1 Applicants for a resource consent to extract gravel from a river bed, who are submitting an evaluation form from the Regional Council's Operations Directorate, or to construct a whitebait stand, do not need to complete this assessment.

Note 2 A Regional Council hand-out entitled "Information for Resource Consent Applicants" is available to assist applicants.

Note 3 Where the application is for a coastal consent for a reclamation, information in accordance with Section 88(7) of the Act to show the area proposed to be reclaimed, including its size and location, and the portion of that area (if any) to be set apart as an esplanade reserve, must be provided.

7. Also attached is all other information (if any) required to be included in the application by the regional plan or Act or regulations.

Signed D T Brewer

Date 31/3/95

Name of Signatory D T Brewer, General Manager - Operations

Address for service of documents (if different from above) K J Duke, Specialist Environmental Scientist
N/A

Telephone no. (03) 218 5999

Facsimile no. (03) 218 9747

Annexures:

(a) A description of the activity to which this/these application(s) relate.

(b) An assessment of effects on the environment in accordance with the Fourth Schedule to the Act ;

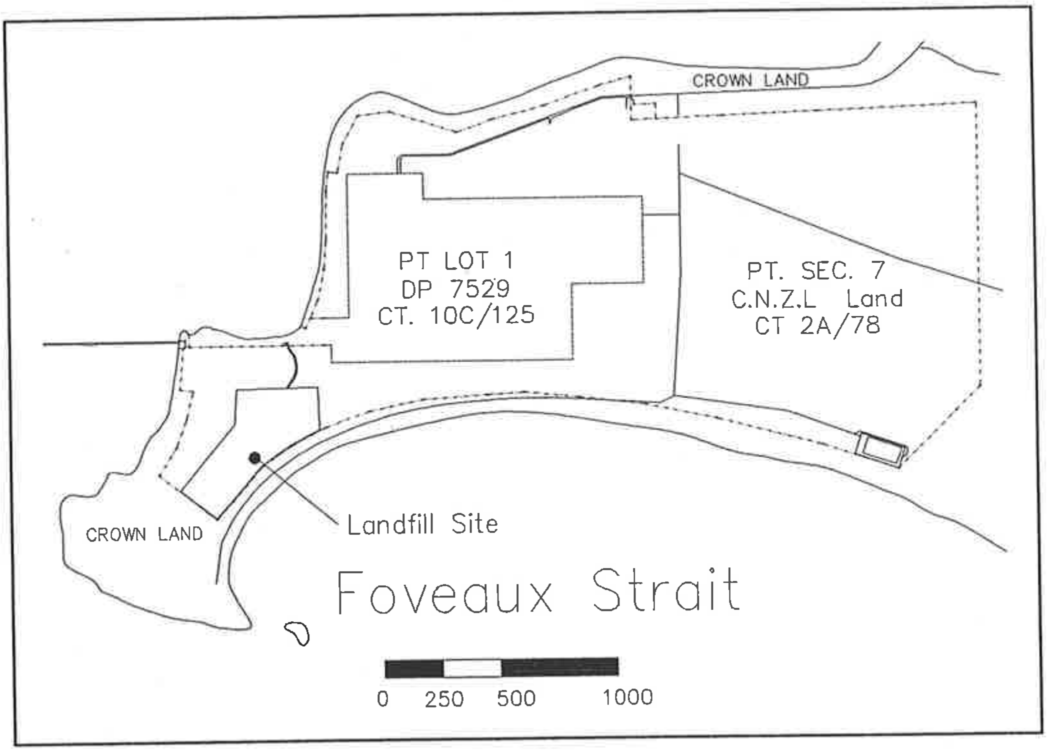
(c) Any other information required by the regional plan or Act or regulations to be included;

(d) *(For coastal permits for reclamations only)* Other information in accordance with Section 88(7) of the Act.

General Location of NZAS Landfill Site

Location of NZAS landfill

General Location of NZAS Landfill Site



SOUTHLAND REGIONAL COUNCIL

W. ten Approval to a Resource Consent

XI, New Zealand Aluminium Smelters Limited
(Name of Applicant)

of Private Bag 90110, INVERCARGILL
(Address of Applicant)

is
xam **applying for a resource consent to** (please provide a description of planned activity)

Discharge contaminants onto and into land (including in circumstances where contaminants may enter water) at the NZAS landfill.

The Southland Regional Council considers that the following persons could be adversely effected by the granting of the resource consent:

Comalco New Zealand Limited

If the written approval of those persons is received, the Council shall not take account of any actual or potential effect of the activity on these persons. [Section 94(4) of the Resource Management Act 1991]

If you as a potentially affected person, are satisfied after studying the attached proposal and plans that the proposed activity will not adversely affect your interests please sign the the following form and the attached plans:

XI, Comalco New Zealand Limited (full name)

of P O Box 1665, WELLINGTON (address)

has
have studied the prosposal by New Zealand Aluminium Smelters Limited (applicant)

its
and as owner /xoccupier (delete as appropriate) of the property gives my written approval to the proposal.

Signed: ....
T K McDonald, Managing Director, Comalco New Zealand Limited

Date: 30/3/95

SRC:10/91

ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

DISCHARGES ONTO AND INTO LAND

NZAS LANDFILL

30 March 1995

Table of Contents

Chapter 3 - Regulatory Requirements for Landfilling

Chapter 4 - Future Discharge of Contaminants

Chapter 5 - Effects of Discharges

Chapter 6 - Manawhenua Issues

Chapter 7 - Consultation

Chapter 8 - Monitoring

References

Appendices

Executive Summary

Discharges Into and Onto Land

Existing landfill

The application for a discharge permit is to allow NZAS to continue to use its landfill. This landfill has been in existence since the smelter commenced operation, over 23 years ago.

Resource Management Act section 418(1C)

This application has been submitted prior to 1 April 1995 in accordance with the Resource Management Act section 418(1C).

Permit term

The application requests a 20 year term for the permit.

Assessment of effects on the environment

This assessment of effects on the environment has been prepared to support the application to allow the discharges of:

- contaminants onto or into land in circumstances which may result in those contaminants (or any other contaminant emanating as a result of natural processes from those contaminants) entering water (section 15(1)(b) Resource Management Act, 1991), and
- contaminants from any industrial or trade premises onto or into land (section 15(1)(d) Resource Management Act, 1991).

The term "contaminant" refers to the Resource Management Act 1991, definition.

Continued on next page

Estimates of the proposed discharge

Estimates of the proposed discharges are:

- approximately 5000 tonnes per year of waste material from the smelter operations,

- approximately 8000 - 10000 tonnes of refractory material from Carbon Baking Furnace No 3 demolition in 1997 - 1998, although it is possible that a recycling option may be available,

- refractory and other construction or demolition materials if other Carbon Baking Furnaces or smelter facilities require rebuilding or substantial repairs, and

- appproximately 12000 - 16000 tonnes per year of COMTOR product if other uses are not established.

These estimates may require updating if there are changes to the characteristics of the waste materials or to the reuse, recycling and disposal options.

Likely over-prediction

The current situation has been used to predict the future discharges at the landfill. This approach is likely to result in an over-prediction due to the on-going efforts in:

- waste reduction,
- reuse and recycling opportunities, and
- improvements in waste management practices.

Regulatory requirements

The proposal will comply with the regulatory requirements specified in the:

- Resource Management Act, 1991,
- Proposed Regional Policy Statement for Southland,
- Proposed Regional Solid Waste Management Plan, and
- Transitional Southland Regional Plan.

Continued on next page

Suitable site for proposed landfill operation

Studies of the characteristics of the materials being landfilled and the geology and hydrology of the landfill site, indicate that the site is suitable for the proposed landfill operation.

Limited adverse effects on the environment

The studies of the existing landfill provide evidence that adverse effects on the environment from this operation are limited. The studies included:

- land,
- water quality,
- wildlife, and
- vegetation.

It is predicted that any adverse effects on the environment from the future landfill operation are likely to be limited.

Consultations

Iwi representatives, regulatory authorities and other organisations have been consulted on this proposal. A summary of this assessment of effects on the environment was presented during the consultations and issues with the proposed discharges were discussed.

Monitoring

Monitoring of the amount and the types of material landfilled, and the groundwater quality under and near the landfill is proposed.

Glossary

The acronyms used in this document are given below.

AEE	Assessment of Effects on the Environment
ANZECC	Australian and New Zealand Environment and Conservation Council.
CBF	Carbon Baking Furnace
CNZL	Comalco New Zealand Limited
ESP	Electrostatic Precipitator
m	metre
m^2	square metre
$m.day^{-1}$	metres per day
$m.s^{-1}$	metres per second
$m^3.year^{-1}$	cubic metres per year
MMMF	Man made mineral fibres
MRP	Metal Reclamation Plant which recovers aluminium from dross
NZAS	New Zealand Aluminium Smelters Limited
NZMS	New Zealand Map Series (topographical map)
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenols
RMA	Resource Management Act 1991
SCL	Spent Cathode Lining
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	United States Environmental Protection Agency

Chapter 1

Background

Overview

Introduction

This chapter provides background information in relation to this Assessment of Effects on the Environment (AEE) for the New Zealand Aluminium Smelters Limited (NZAS) discharges onto and into land.

The document content and structure are described.

A summary of the NZAS operation is given as the material to be landfilled in this proposal originates from the activities associated with the production of aluminium and related activities.

In this chapter

This chapter contains the following topics:

Reason for Assessment of Effects on the Environment

Existing landfill

The NZAS landfill on Tiwai Peninsula has been in existence since the smelter commenced operations, over 23 years ago. During this time the landfill and its operation have been discussed with regulatory agencies, takata whenua and other groups. Visits to the landfill have been associated with some of the discussions.

Resource Management Act section 418(1C)

The effect of the Resource Management Act (RMA) section 418(1C) is to require an application for a consent to be submitted prior to 1 April 1995 for the discharges onto or into land at the NZAS landfill.

This assessment of effects on the environment

This assessment of effects on the environment (AEE) has been prepared to support an application to allow discharges of:

- contaminants onto or into land in circumstances which may result in those contaminants (or any other contaminant emanating as a result of natural processes from those contaminants) entering water (section 15(1)(b) RMA), and

- contaminants from any industrial or trade premises onto or into land (section 15(1)(d) RMA).

Document Content and Structure

Data provided

This Assessment of Effects on the Environment has been prepared to provide the data outlined in the:

- Resource Management Act, Fourth Schedule,
- Proposed Regional Policy Statement, and
- Proposed Regional Solid Waste Management Plan.

NZAS has obtained and presented a considerable amount of data on the landfill. This is consistent with the NZAS continuous improvement philosophy where data is required to make informed decisions.

Data sources

Data from investigations and studies conducted by various environmental consultants have been used in the AEE. The source data are available from NZAS.

Consultations

Data obtained during the consultation process are included in this AEE. NZAS wishes to acknowledge the valuable contributions made by the people involved with this process. Further details are given in Chapter 7.

Headings and structure

Where possible this AEE uses similar chapter and section headings as in the Resource Management Act (RMA).

The order of data presentation is not the same as RMA Fourth Schedule or in the Proposed Regional Solid Waste Management Plan. Changes have been made:

- so that related data appears together in the document, and
- to improve the flow of information and readability.

The following table has been provided to assist in comparing this AEE with the RMA Fourth Schedule.

Continued on next page

Table 1 Comparison of this AEE and RMA Fourth Schedule.

RMA Fourth Schedule matters that should be included		Location in this AEE
(a)	A description of the proposal.	Chapter 4
(b)	Where it is likely that an activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods undertaking the activity.	It is predicted that significant adverse effects on the environment are unlikely to occur. However, possible alternative locations are discussed on pages 4.9 - 4.10 and other disposal options are discussed on page 4.11.
(c)	Repealed	
(d)	An assessment of the actual and potential effect on the environment of the proposed activity.	Chapter 5
(e)	Where the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment which are likely to arise from such use.	Not applicable

Continued on next page

Table 1, cont. Comparison of this AEE and RMA Fourth Schedule.

RMA Fourth Schedule matters that should be included	Location in this AEE
(f) Where the activity includes the discharge of any contaminant, a description of:	
(i) The nature of the discharge and the sensitivity of the proposed receiving environment to adverse effects; and	Chapter 2, pages 2.B.16 - 2.B.29 and Chapter 4, pages 4.3 - 4.4 give the nature of the discharge. Chapter 2, pages 2.B.4 - 2.B.13 and Chapter 5, give the sensitivity of the proposed receiving environment to adverse effects.
(ii) Any possible alternative methods of discharge into the any other receiving environment.	Chapter 4, pages 4.9 - 4.11.

Continued on next page

Table 1, cont. Comparison of this AEE and RMA Fourth Schedule.

RMA Fourth Schedule matters that should be included	Location in this AEE
(g) A description of the mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect.	Mitigation by waste reduction, reuse and recycling is discussed in Chapter 2, pages 2.A.4 - 2.A.10. Other methods being investigated for reducing the discharge are given in Chapter 4, pages 4.9 - 4.11.
(h) An identification of these persons interested in or affected by the proposal, the consultation undertaken, and any response to the views of those consulted.	Chapter 7
(i) Where the scale or significance of the activity's effect are such that monitoring is required, a description of how, once the proposal is approved, effects will be monitored and by whom.	Chapter 8

The Aluminium Smelting Process

Hall-Heroult process

Commercial production of aluminium is by the Hall-Heroult process. In this process alumina (Al_2O_3) is electrolytically reduced to aluminium.

The cells

The electrolytic process occurs in cells. Each cell consists of a carbon lined steel shell acting as the cathode. The cathode shell contains molten electrolyte (bath) consisting mainly of cryolite (Na_3AlF_6). Alumina is dissolved in this bath.

Carbon anodes are suspended from the superstructure above the cell. The anodes are immersed in the bath. The high electrical current flow between the anodes and the cathode maintains the cell and its contents at an operating temperature of approximately 970°C and provide the energy for the cell reaction.

Electrical circuit

Cells are connected in electrical series with the completed circuit being called a Potline.

Anode manufacture

The anodes are manufactured from petroleum coke, coal tar pitch and recycled anode material. The components are pressed into blocks which are then baked in furnaces at temperatures of typically 1100 to 1200°C. Anodes are consumed in the reduction process by the reaction with oxygen to form carbon dioxide. The anodes in the cells are replaced regularly.

Aluminium removal

The aluminium formed by the reduction process collects at the bottom of the cells. It is removed (usually by syphoning or suction) and transferred to casting facilities. This is usually a daily occurrence.

Casting

Aluminium is held in casting furnaces until it is at the correct casting temperature and condition. Often other metal alloys are added.

The aluminium is then cast into shapes and products to suit the customers. Water is used to cool the metal during casting.

The NZAS Smelter

Ownership

NZAS is a New Zealand registered company owned by Comalco New Zealand Limited (79.36%) and Sumitomo Chemical Company Limited (20.64%).

Location

The NZAS smelter is located on thc western end of Tiwai Peninsula, approximately 20 km south of Invercargill. It is 3.5 km north east of Bluff being separated by Bluff Harbour.

Employment

NZAS has 1150 permanent staff, employs approximately 140 - 160 contractors to support the operations and provides vacation employment to nearly 200 students. However, the employment effects of NZAS' presence in Southland are much wider than direct employment. The smelter operations require the supply of goods and services from a wide range of sectors, and many of these are locally supplied.

Current production

NZAS has three potlines each containing 204 cells. The current aluminium production rate is 269,000 tonnes per year. Approximately 90% of this is exported from New Zealand.

Smelter upgrade

Work commenced in October 1994 to upgrade the smelter. This project will increase the smelter aluminium production to over 313,000 tonnes per year over the next three years with the potential to increase the production over a 20 year time frame.

A significant proportion of the upgrade project is for health, safety, technical operating and environmental improvements.

Chapter 2

Waste Management at NZAS

Overview

Introduction

This chapter gives details of landfill related waste management at NZAS, including the development of the landfill site.

In this chapter

This chapter contains the following sections:

Section A

NZAS Wastes and Waste Minimisation

Overview

Introduction

The NZAS landfill related wastes and the on-going efforts to reduce these wastes are described in this section.

The terms reuse and recycling are used in this section. Reuse means the return of waste to the NZAS operation. Recycling means the use of NZAS waste as a raw material for other companies processes.

In this section

This section contains the following topics:

Waste Sources and Types

Sources

All the wastes described in this AEE originate from the activities associated with the production of aluminium at the NZAS Smelter on Tiwai Peninsula. The sources of these wastes include:

- losses from the smelting process,
- materials handling losses,
- maintenance work,
- administration and technical activities, and
- construction work.

Waste categories

The current wastes can be categorised as:

- disposed or recycled off-site (Table 2),
- stored on-site for future reuse or recycling (Table 3), and
- disposed at the NZAS landfill (Table 4).

The waste in each category may vary as options for dealing with the waste change, especially if recycling options become unavailable.

Table 2

Examples of Wastes Disposed or Recycled Off-Site

Cardboard	Plastics
Facsimile rolls	Non-process aluminium
Ferrous metals	Oils
Food waste	Packaging paper, cardboard, and office materials
Soda-glass ex Laboratories	Paper, ledger
Liquids containing oils	PCB's
Medical wastes	Printer cartridges
Non-ferrous metals	Refractory bricks
Wood	

Continued on next page

Table 3 Examples of Wastes Stored On-Site for Future Use or Recycling

Chemicals ESP tars (some stored at landfill) MRP Fines (stored at landfill) Spent cathode lining

Table 4 Examples of Typical Wastes Disposed at NZAS Landfill

Asbestos Ash/clinker residue for CBF3 Building waste Carbon dusts Dust collector bags Concrete Floor sweepings Glass MMMF	Miscellaneous materials (includes small amounts of some materials in Table 2, but does not include brick and waste) Refractory bricks Rubber Tree and garden materials Water based liquids, eg pit cleanings

Continuous Improvement and Waste Minimisation

Continuous improvement objectives

The NZAS continuous improvement programme has the five basic objectives given below:

- Improved safety and occupational health.
- Improved environmental performance.
- Staff development.
- Improved product quality.
- Improved processes which includes improved use of materials.

Environmental performance

Continuous improvement of environmental performance is a major objective of NZAS. Waste management is an important aspect of improved environmental performance.

Improved processes

Improved processes which improves the use of materials is applicable to a number of types of materials including:

- raw materials,
- equipment and equipment parts,
- packaging, and
- byproducts and wastes from parts of the process.

Waste minimisation

Waste minimisation is the use of practices which reduce, as much as possible, the amount of waste generated, or the amount that requires subsequent storage, treatment or disposal. It also includes activities which reduce the potential for waste to cause adverse effects on the environment. An example of waste minimisation is the work of process improvement teams who are examining the use of consumable items. Many consumable items are disposed at the landfill.

Continued on next page

Reduction, reuse and recycling

Three aspects of waste minimisation are:

- reduction at source,
- reuse at NZAS, either in its initial form or as a processed material, and
- recycling by others.

Recycling of NZAS wastes by others can result in these materials being supplied to NZAS as a raw material, eg waste bricks are processed to produce refractory mortar.

Current NZAS Waste Management Policy

Current policy

It is NZAS policy to recover the highest possible value from all materials used in the smelter operation and to deal with materials in an environmentally appropriate manner. This policy is pursued by dealing with process byproducts in the ways listed below:

- Reducing the amount of materials introduced and used in each process.
- Minimising the amount of byproducts from processes and reusing byproducts wherever possible.
- Ensuring that when byproducts are produced they are in a form which maximises the possibility of recycling.
- Recycling externally, byproducts which cannot be reused.
- Producing byproducts in such a way that, where appropriate, the return to NZAS is maximised.
- Recovering as much material and/or energy from the byproducts as possible.
- Providing environmentally acceptable and effective residual management once the amounts of byproducts have been reduced by the above stages.

Policy updates

The waste management policy will be updated when necessary, as are the other NZAS policies.

Continued on next page

Current policy direction and examples

The policy sets the direction for waste management and examples of the manner in which the policy is implemented includes:

- aluminium scrap from various processes is collected and recycled within the smelter,
- other non-ferrous and ferrous metals are segregated and sold for recycling,
- plastic milk bottles are not used at NZAS because they cannot be effectively recycled,
- soda-glass, wood, cardboard and ledger paper are recycled,
- oil based liquids are sold for refining,
- concrete and building materials are supplied to alternative users whenever possible, eg road and farm track bases,
- asbestos is disposed in a segregated cell in the landfill,
- process dusts which cannot be re-used at present are disposed in designated areas at the landfill while alternatives for recycling are investigated, and
- spent cathode lining is being stored under cover until a plant for treating the material is installed.

Waste Segregation

Segregation at source

A key feature of effective waste management is to segregate wastes at source. This increases the reuse, recycling and disposal options. Waste segregation is practised wherever possible at NZAS. Some examples of waste segregation are given below.

Food wastes

The method of segregating food wastes is by providing:

- designated receptacles in the canteens, and
- special small waste bags in kitchens and crib rooms and adjacent to offices.

Segregation and off-site disposal of food wastes provides better management of vermin during the waste handling operations and at the landfill.

Paper and cardboard

The method for segregating paper and cardboard is by providing:

- labelled Kleensaks for ledger paper
- labelled Kleensaks for general paper, and
- a separated collection system for cardboard packaging.

At this stage off-site recycling processes have been found for shredded ledger paper and cardboard. A large shredder has been installed at NZAS to assist with the recycling of ledger paper.

Plastics

Labelled Kleensaks are used to collect plastic material. Plastic milk bottles have been eliminated from site and the remaining plastics do not have recycling options available.

Timber

Wherever possible timber is kept separate to allow recycling.

Continued on next page

Metal

Provision is made for the segregation of waste metals to allow recycling. Examples are:

- scrap steel collected in designated bins and skips, and
- copper wire collected in designated bins.

Bricks

The largest source of brick waste is during flue wall repairs in the carbon baking furnaces. These bricks are usually loaded directly into trucks for transportation off-site for recycling.

Man made mineral fibres

Man made mineral fibre (MMMF) materials are used at NZAS as a thermal insulation to replace asbestos. Designated bins and skips are provided for the collection of MMMF materials.

Asbestos

Most of the asbestos in the NZAS facilities has been replaced. However, small amounts remain and this will be replaced when there is a need to dismantle the equipment.

Asbestos waste is segregated into sealed containers during the removal work.

Laboratory glassware

Designated containers are provided for the collection of broken or discarded laboratory glassware of the soda-glass type.

Education on waste segregation

An education package on waste segregation has been presented to NZAS staff. Continued attention to education on the benefits of waste segregation is an essential element of waste management.

Reuse and Recycling

Introduction

NZAS actively pursues reuse and recycling options for wastes. Segregation of waste streams is an important factor when considering material for reuse or recycling.

Examples of reuse

Reuse examples at NZAS are:

- process design which incorporates anode butt material in new anodes,
- remelting of scrap aluminium, including building cladding,
- return of particulate collected in the Potrooms air control system to the cell raw materials feed,
- waste oils refined in Christchurch,
- carbon samples sent to the laboratory being returned to the process, and
- mail envelopes re-used for internal smelter mail.

Examples of recycling

Recycling examples at NZAS are:

- shredded ledger paper and cardboard returned to the paper manufacturer,
- laboratory soda-glass waste taken to the Invercargill City Council recycling bin,
- steel, iron and copper sold to scrap metal dealers,
- refractory bricks sent to a brick manufacturer or sold as solid fill material,

Continued on next page

Examples of recycling, cont.

- wooden pallets returned to the suppliers, and
- miscellaneous wood waste, including broken pallets, used by Southland Enterprises Inc.

Section B

The Landfill Site

Overview

Introduction

The characteristics, history and development of the NZAS landfill site are described in this section. Data on the landfill contents and the characteristics of these contents are also given.

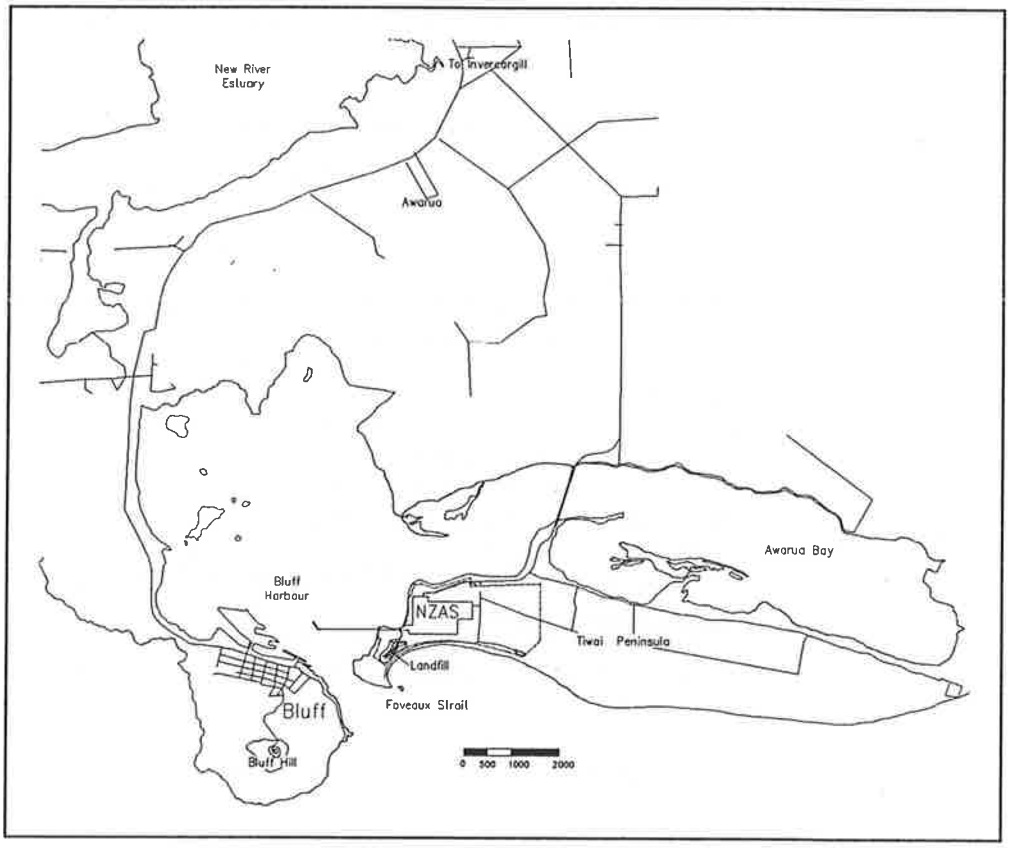
In this section

This section contains the following topics:

Location

Tiwai Peninsula The NZAS landfill is located at the western end of Tiwai Peninsula. Tiwai Peninsula is approximately 20 km south from the city of Invercargill. The location is shown in the figure below.

Figure 1 Location of Landfill



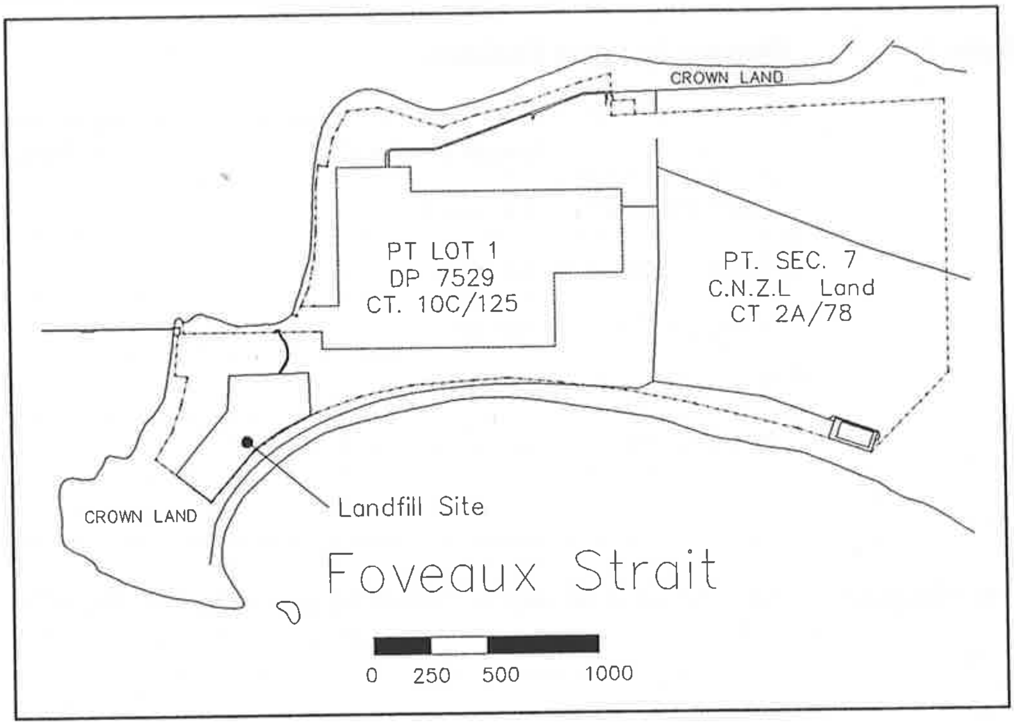
Continued on next page

CNZL land

The landfill is situated on land owned by Comalco New Zealand Limited (CNZL). It is at the south western corner of the land comprised in Certificate of Title 2A/78 (Southland Registry), as shown in the figure below.

Figure 2

Landfill on Comalco Owned Land



Continued on next page

Access from NZAS

The landfill is only accessible by road from the NZAS site. The landfill access road branches off the road between the NZAS site and the Tiwai wharf.

Distance from local features

The distances from the closest point of the landfill site to local features are given in the following table.

Table 5

Distance to Local Features.

Local Feature	Distance Metres
Bluff Harbour to the north	230
Bluff Harbour to the west	180
Foveaux Strait to the east	70
Tiwai Point to the south	600
Bluff residential area to the south west	1300

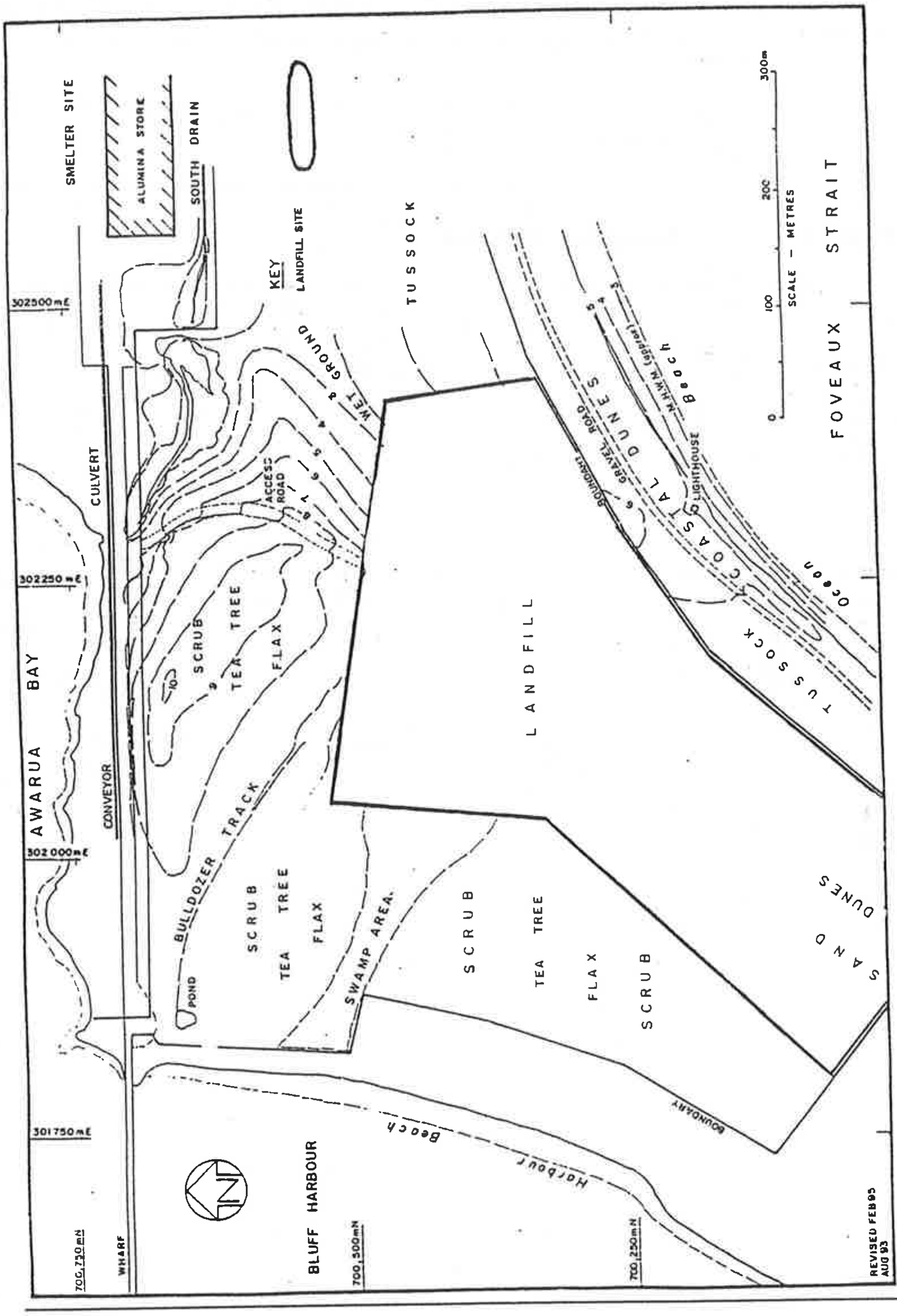
Site topography

The landfill is largely contained by low ridges to the north, east and south, as shown in Figure 3. West of the landfill natural swamp separates the landfill from the coast. East of the landfill, the ground gently rises before dropping to the coast.

Natural ground level beneath the landfill ranges from approximately 8 m above mean sea level at the northern end to 3 - 4 m above mean sea level at the southern end.

Continued on next page

Figure 3 NZAS Landfill Site Topography



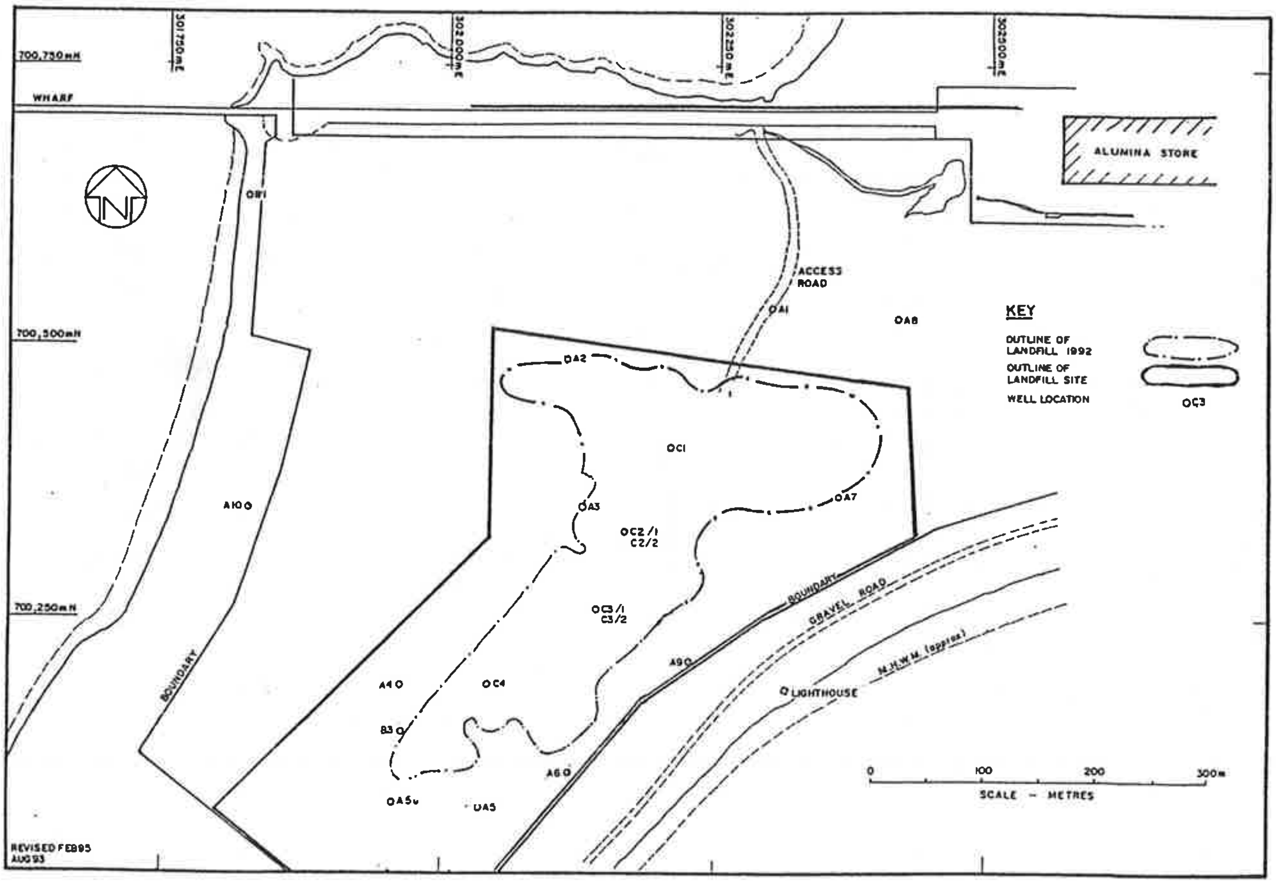
Continued on next page

Woodward-Clyde investigation

Woodward-Clyde (1994) established the geology and hydrology of the NZAS landfill site. Data was obtained for geological mapping by a walkover survey and logging of strata in the well holes.

The well locations are given in the figure below. Well B2 was not installed due to access difficulties.

Figure 4 Monitoring Well Sites



Continued on next page

Geology

The geology of the landfill area is presented as a map in Figure 5 and a south west to north east cross section shown in Figure 6. Two distinct geological materials occur below the landfill site (Figure 6). These are:

- unconsolidated materials comprising of gravels and sands with some silts and peats, and
- underlying bed rock which is hard, dense, tight, poorly (partially) fractured and fine grained.

Underlying bed rock

The underlying bed rock has been identified as being consistent with thermally metamorphosed recrystallised intermediate intrusive which probably belongs to the Greenhills Group (Watters, 1968).

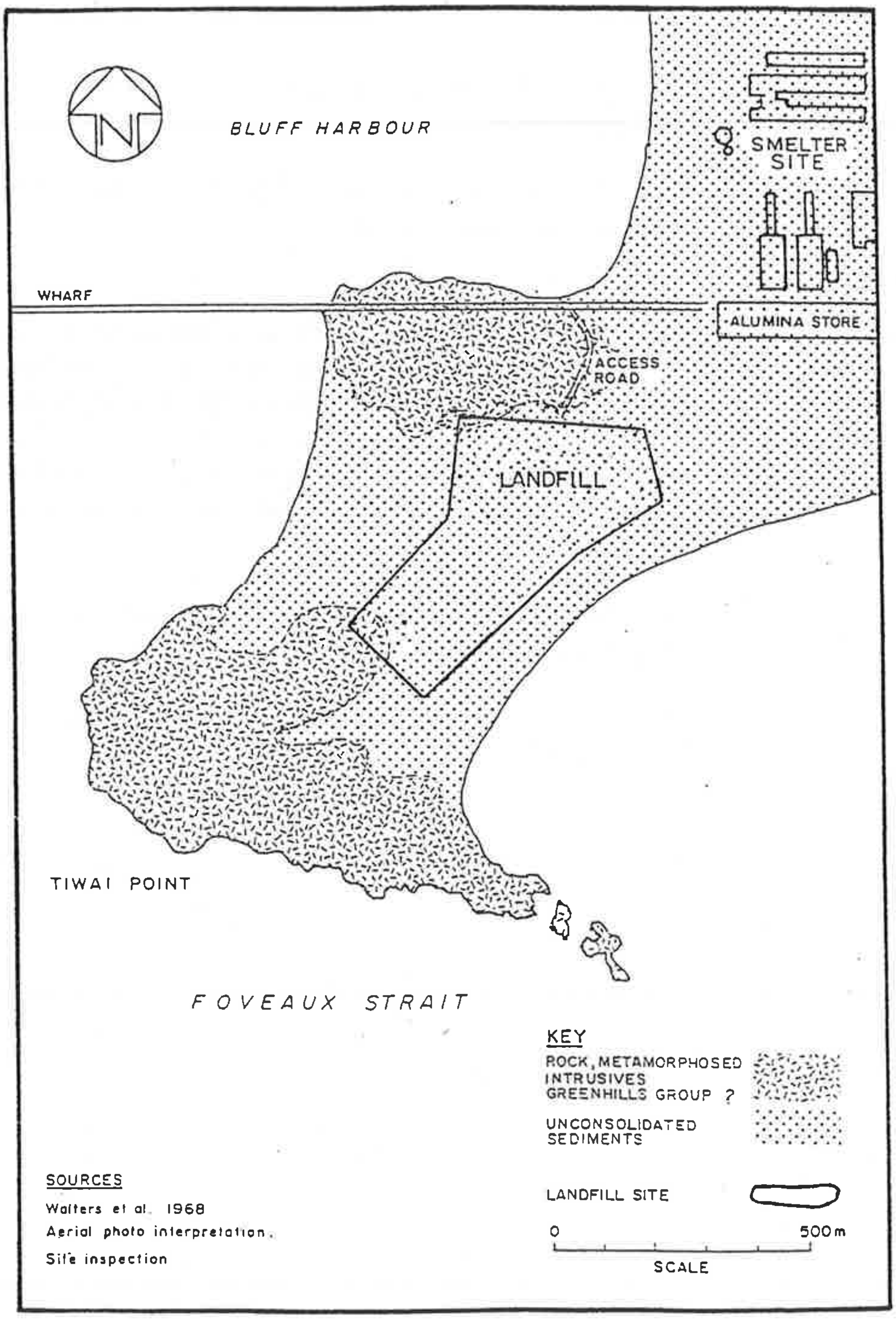
The surface of the bed rock varies in elevation as shown in Figure 6. To the north of the landfill the rock body outcrops and forms the land at higher elevation (see Figure 5).

Beneath the landfill and also to the east and west, the rock body remains at or below sea level.

South of the landfill the rock body outcrops to form the end of Tiwai Point (see Figure 5).

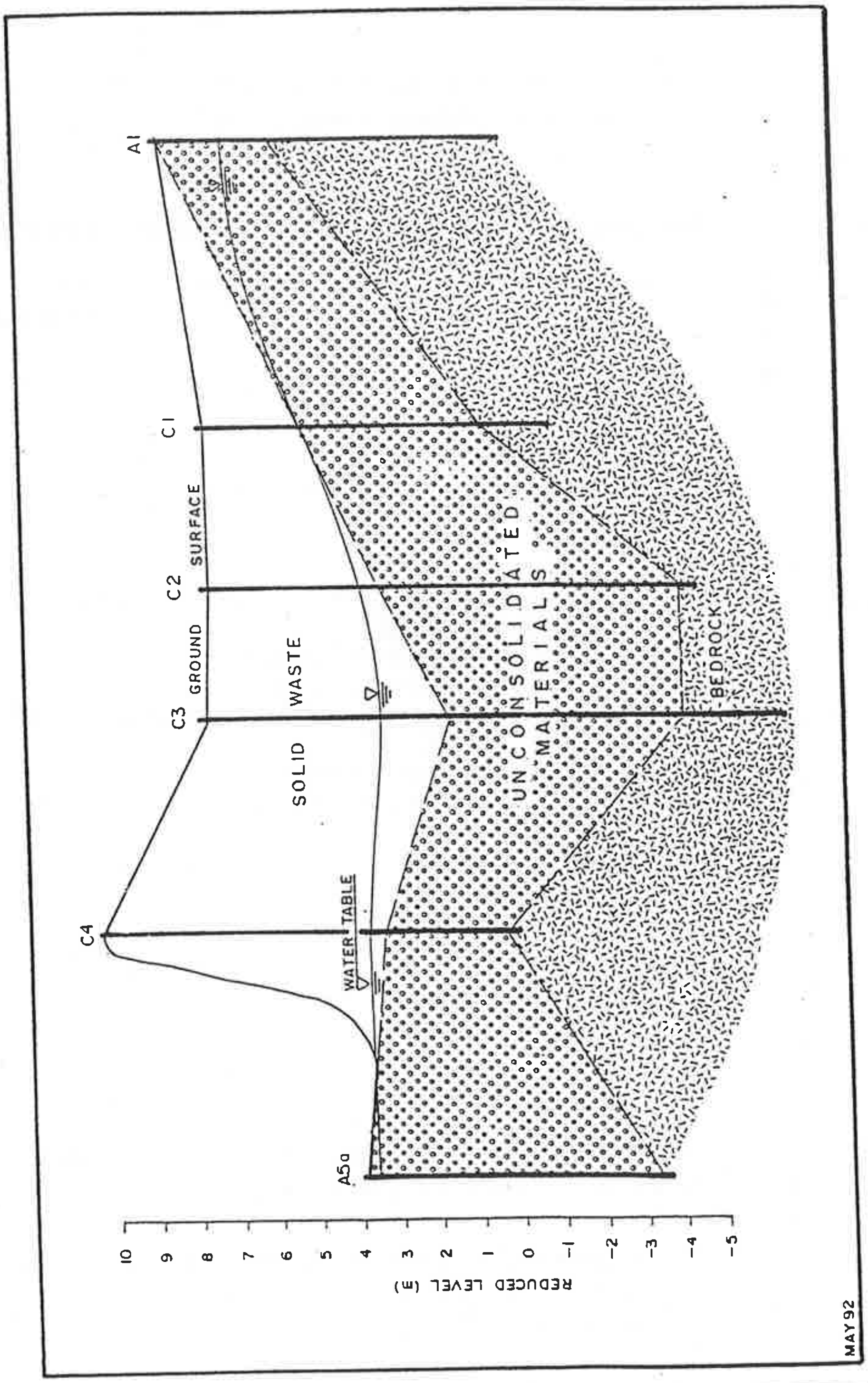
Continued on next page

Figure 5 Site Geology



Continued on next page

Figure 6 Schematic Hydrogeological Section



Continued on next page

Hydraulic conductivity

Hydraulic conductivity is a measure of permeability and is defined as the rate at which water will move through 1 square metre of aquifer, under a gradient of one horizontal to one vertical.

Some representative values of hydraulic conductivity are given in the table below to allow comparison with the NZAS landfill site data.

Table 5 Representative Hydraulic Conductivity Values (Bowen)

Material	Hydraulic Conductivity $m.day^{-1}$
Coarse, repacked gravel	150
Coarse, repacked sand	45
Silt	0.08
Clay	0.0002
Fine - grained sandstone	0.2
Limestone	0.94
Dune sand	20
Loess (wind blown glacial rock-flour)	0.08
Tuff (rock comprised of volcanic fragments)	0.2
Basalt	0.01
Weathered granite	1.4

Hydraulic conductivity measurements

Rising and falling head tests were performed in the wells at the landfill to determine the hydraulic conductivity.

The frequency distribution of the hydraulic conductivity data tended to be asymmetric. The geometric (logarithmic) mean was chosen to represent the central tendency of the data.

Continued on next page

Hydraulic conductivity results

The geometric mean of hydraulic conductivity of the unconsolidated materials at the site is 1.1 x 10^{-5} $m.s^{-1}$(0.95 $m.day^{-1}$). This value is consistent with those for fine sands and indicates that the sands, not the gravels, control permeability at this site.

The data indicates geometric mean hydraulic conductivities on the eastern side of the landfill at 2.5 x 10^{-5} $m.s^{-1}$(2.3 $m.day^{-1}$) (geometric mean) which are slightly greater than those on the western side of the landfill at 5.5 x 10^{-6} $m.s^{-1}$(0.48 $m.day^{-1}$). This variation in permeability would be consistent with greater reworking of sediments on the ocean beach side.

Cores from a drill hole north of the landfill and an inspection of the outcrop to the north of the landfill indicate that the permeability of the bed body is substantially less than that of the unconsolidated materials. The bedrock forms the local hydrogeological basement to the site. There is minimal groundwater movement through the bedrock in relation to the groundwater movement in the overlying unconsolidated materials.

Groundwater recharge

The cross section shown in Figure 6 shows that elevated portions of the water table underlie the landfill and the ground to the north. Some groundwater recharge from the elevated ground is indicated in Figure 7.

Most of the recharge to the groundwater system beneath the landfill results from the percolation of incident rainfall. It has been calculated that up to 60% of the rainfall onto the landfill site percolates to the underlying groundwater system.

Potentiometric surface determination

The potentiometric (piezometric) surface is the imaginary surface to which water will rise under its full head from a groundwater aquifer. Water flows from an area with a higher potentiometric surface to a lower potentiometric surface. The potentiometric surface is determined by drilling wells in the aquifer and measuring the water level in the wells. The nineteen wells drilled on and around the NZAS landfill are shown in Figure 4, page 2.B.6.

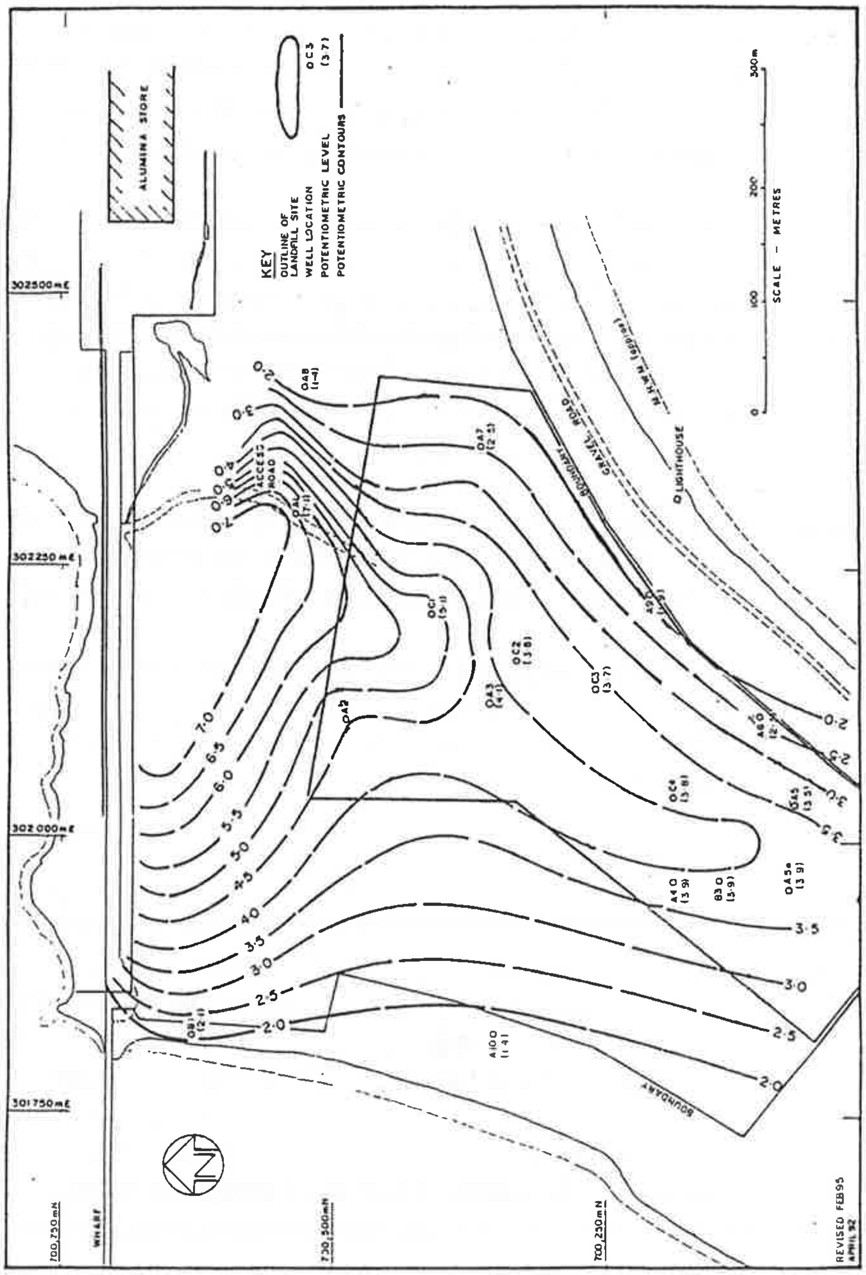
The locations and elevations of the wells were established by a registered surveyor. The water levels were measured weekly for a two month period.

Continued on next page

Potentiometric surface results

The potentiometric surface of the groundwater under and around the landfill site are given in the figure below.

Figure 7 Potentiometric Surface of Groundwater



Continued on next page

Groundwater flow rate and direction

The potentiometric contours in Figure 7 show that the groundwater from beneath the landfill flows down gradient to both the eastern and western coastlines. Groundwater discharges to both the ocean and harbour beaches.

The groundwater flow velocities have been estimated using the Hydrologic and Evaluation of Landfill Performance (HELP) model (Woodward-Clyde 1994). The estimated flow velocities were:

- about 140 $m^3.day^{-1}$ (94% of the recharge) flows to the ocean beach to the east, and
- about 9 $m^3.day^{-1}$ flows to the harbour beaches to the west.

The reason for this difference is the greater distance, lesser gradient and lower permeability to the west.

Groundwater flow times

Velocity calculations indicate that the average times for groundwater from beneath the existing landfill to reach the coasts are:

- 1.1 to 2.2 years to the east (ocean), and
- 20 to 40 years to the west (harbour).

History

Origins

The NZAS landfill has been in existence since the smelter commenced operations over 23 years ago. Although no formal records have been located it is believed the landfill was started during the initial construction of the smelter in 1970.

Construction materials

It is known that construction materials were deposited in the landfill early in the 1970's, in the mid 1970's and in the early 1980's. This coincided with the major construction and upgrades at NZAS.

NZAS materials

The materials deposited in the landfill in the past from the activities associated with the production of aluminium included a range of materials. Examples are:

- refractory bricks,
- aluminium dross and MRP fines,
- carbon dusts,
- petroleum coke and metallurgical coke which contains pitch and iron,
- an ash/clinker type residue from the No. 3 carbon baking furnace,
- alumina,
- cryolite (the main fluoride component of the landfill contents),
- aluminium,
- steel strapping in significant quantities,
- asbestos,
- paint tins,
- timber,
- mineral fibres,
- plastic materials,
- waste oil and grease (now recovered and removed), and
- copper wire.

Continued on next page

Operating history

Access to the NZAS landfill has always been restricted to NZAS and contractors working on the NZAS site. Prior to the mid 1980's the landfill management consisted of regular covering of completed areas. Since then there have been improvements to the management practices with the notable events being shown in the table below.

Table 7 Notable events in the landfill history

Year	Event
1984	Health Department approval as an asbestos disposal site.
1986-87	Reduction in the working face.
1990-92	Recovery of aluminium dross and MRP fines stored up to this time for off-site processing.
1991-92	Oil recovery from waste oil pond.
1992	Removal of bottom sediments and soil from waste oil pond and start of bioremediation.
1992	Start of landfill surface profiling.
1993	Start of revegetation programme
1994	Closure of burning pit, on 31 December. Small pit formed in case burning for border control purposes is required.

Current landfill practices

The current landfill management practice is detailed in the Landfill Management Plan which has been provided to the Southland Regional Council.

Materials recovery

The work to improve the landfill profile has exposed materials which are now considered to be recyclable. Wherever possible these materials are recovered.

Hydrocarbon Bioremediation

History

Oil contaminated soil was excavated from the waste oil disposal pit at the landfill in February 1992 and relocated to a treatment area in the western part of the landfill.

The bioremediation treatment area covers 9880 m^2, the depth of soil varying from 30 cm to one metre.

The treatment programme has been supervised by Bioremediation Services, Minenco Pty Ltd. of Australia.

Encouraging hydrocarbon degradation

The bioremediation programme is designed to encourage natural bacterial activity to degrade hydrocarbons in the treatment area soil. The activities required for this process include:

- adding nutrients when recommended by the Site Services MRU,
- monitoring and adjusting pH levels in the soil bed,
- carrying out regular tillage and deep ripping operations to enhance biological activity, and
- regularly sampling and analysing the soil to ascertain nutrient and pH levels, microbial populations and hydrocarbon content.

Treatment endpoint

A suitable endpoint for the treatment programme appears to be when all samples taken from the area show a hydrocarbon criterion equivalent to Dutch C level for mineral oils i.e. 5000 $mg.kg^{-1}$.

Upon the completion of the bioremediation treatment the area will be covered and revegetated.

Investigations

Three investigations have evaluated the characteristics of the landfill components. These are:

- An NZAS investigation in 1991 (Knight, 1991) which determined the leachable fluoride in landfilled materials and total cyanide and vanadium in selected materials, and
- A comprehensive investigation in 1992 by Woodward-Clyde (Woodward-Clyde 1994).
- Another investigation by NZAS in 1994 (Hitchcock 1994) which determined selected leachable components based on the Woodward-Clyde investigation.

As Woodward Clyde investigation uses the Knight data, the Knight data are not referred to in this topic.

Assessment methods

An assessment of the leachable components is commonly used to characterise landfilled materials. There are several methods specified by overseas regulatory authorities or used in scientific investigations. One widely accepted approach is the batch leachability test with variations of this method being used by:

- US Environmental Protection Agency (USEPA),
- American Society of Testing and Materials, and
- New South Wales Environmental Protection Authority.

Interpretation of results

The interpretation of leachability results usually considers the likely effects on underground potable water supplies. Leachability results are compared against standards or 100 - 150 times the drinking (potable) water standard. The 100 - 150 times criteria allows for dilution of the leachate by the groundwater before the water is available for its intended use.

New Zealand drinking water standards

The Drinking Water Standards for New Zealand, 1995 have recently been adopted in New Zealand. These standards are applicable to water intended for drinking.

Continued on next page

Victorian contamination criteria

The Australia and New Zealand Environment and Conservation Council (ANZECC) refers to the Environmental Protection Agency of Victoria's draft Ground Water Policy (1992) which is based on the Canadian criteria. The criteria are defined as follows:

- Level A — Typical "background" for tolerable level,
- Level B — Notification level for potable waters - further investigations likely, and
- Level C — Definite level of concern if potable use, else notification level for non potable use.

The notification levels are defined as "levels at which the Authority should be informed if any routine monitoring or investigative ground water analysis show levels exceeding the levels". A notification level is the level which may indicate a potential pollution problem.

Application to NZAS landfill

The NZ Drinking Water Standards and the Victorian levels A and B criteria are not applicable as the water near the NZAS landfill is not a potable water resource and it is extremely unlikely that the water would be used in the future. The Victorian level C criterion is considered appropriate to apply to the groundwater near the NZAS landfill.

A guideline of up to 100 times the Victorian level C criteria is suitable for assessing the leachable components of the NZAS wastes.

Assessment method used

Woodward-Clyde (1994) used a method based on the USEPA Toxicity Characteristics Leaching Procedure (TCLP). In this procedure a known weight of waste is mixed with a leach fluid and shaken for 18 hours. The leach fluid characteristics are adjusted to be similar to the conditions at the proposed waste disposal site.

After the shaking to extract the soluble components, the leach fluid is separated for laboratory analysis.

Sample collection method

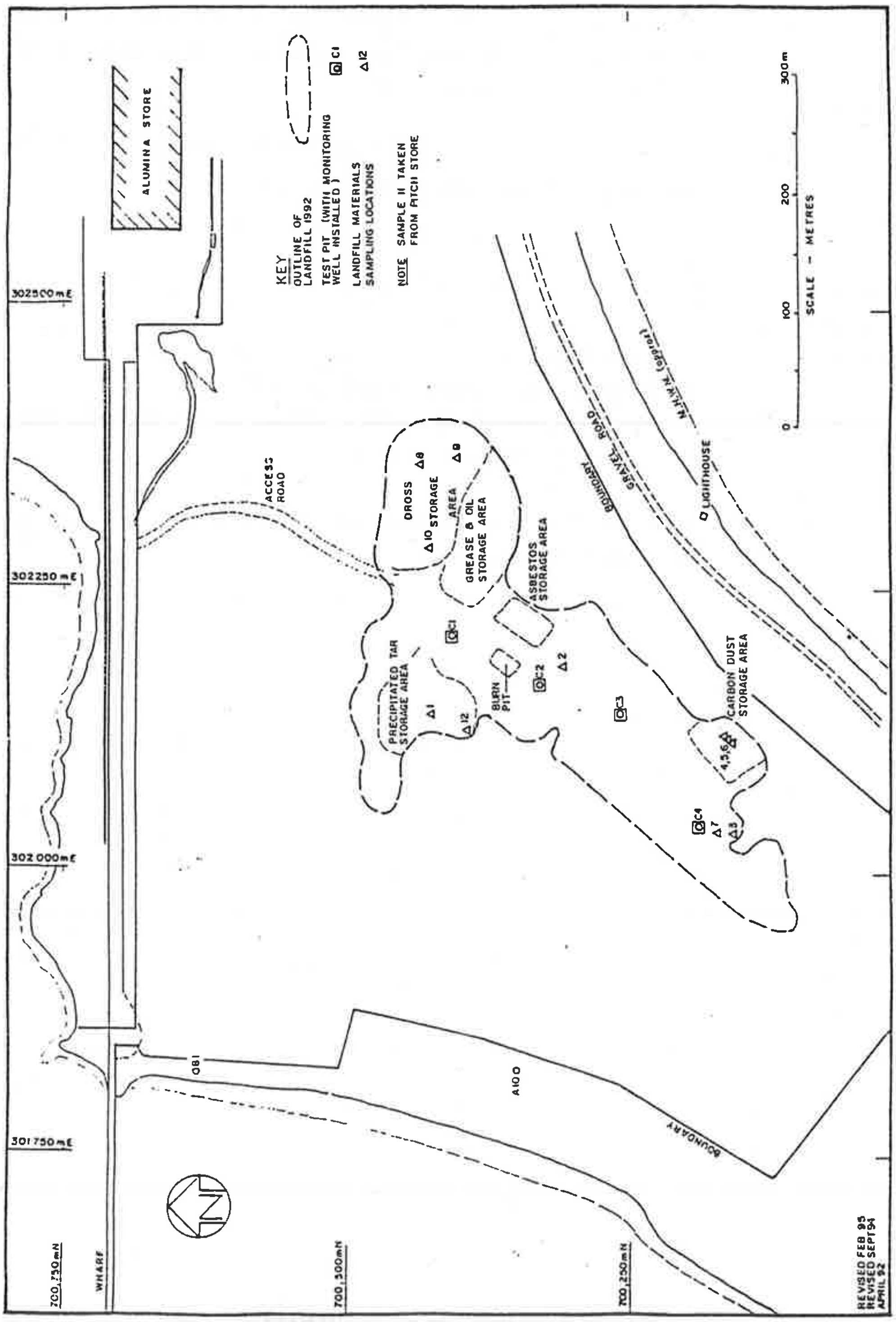
The samples were collected by:

- digging pits in the completed landfill areas,
- digging into recently deposited material,
- obtaining materials as they arrived at the landfill, and
- obtaining the pitch raw material.

The sampling location sites are shown in Figure 8 and the samples are described in Table 9.

Continued on next page

Figure 8 Sampling Sites for Leachability Testing



Continued on next page

Table 9 Woodward-Clyde Sample Description

Sample No.	Description
1	17 to 18 year old refractory bricks taken from near the ESP Tar storage area, 1 m below the surface.
2	10 year old refractory bricks taken from near the Asbestos storage area, 1 m below the surface.
3	New refractory bricks from the landfill face.
4	Two year old Carbon Rodding Room dust taken from 500 mm below the surface.
5	Carbon Rodding Room dust taken from a face exposed by the new enclosed placement area excavations, 1.5 metres below the surface, probable age 5 - 8 years.
6	Three week old Carbon Rodding Room dust from surface of new enclosed placement area.
7	Coke taken from just below the surface at one of two areas in which coke was placed in 1988/9 after it was accidentally mixed with pitch.
8	Dross comprising a composite of samples taken from eight locations around the dross pile, just below the surface. (Multiple sampling was undertaken to obtain a representative sample).
9	Large fragments of dross comprising a composite of samples taken from eight locations around the rejects pile, at or just below the surface, (Multiple sampling was undertaken to obtain a representative sample.)
10	Screened Dross comprising a composite of samples taken from eight locations around the pile at or just below the surface. (Multiple sampling was undertaken to obtain a representative sample).
11	Pitch from the Pitch Store (no pitch located in the landfill).

Continued on next page

Table 9, cont. Woodward-Clyde Sample Description

Sample No.	Description
12	ESP tar from storage boxes and the ground. (At original storage site now removed).
C1	Landfill test pit (north).
C2	Landfill test pit.
C3	Landfill test pit.
C4	Landfill test pit (south).

Selection of compounds to be examined

Woodward-Clyde reviewed the NZAS results of previous investigations at the landfill and the analysis results of the smelter raw materials. This data and discussions with NZAS staff provided the basis for selecting the potential constituents in the landfill leachate.

Organic leachable components

Organic compounds have chemical structures based on carbon atoms. A scan for organic components was conducted on the leachates from two composite samples. These were:

- a composite of samples No's 1-3, and
- a composite of samples No's 4-12.

The organic compounds investigated and the detection limits are given in Appendix 1.

Organic compound results

The results of organic compounds identified as above the detection limits are given in Appendix 2. The 100 x Victorian level C criterion is given as a guide.

Continued on next page

Inorganic leachable components	Inorganic compounds have chemical structures based on elements other than carbon. The inorganic leachable components were determined on selected samples and composite samples. The results for the metals and sulphur are given in Appendix 3. Further inorganic results are given in Appendix 4. The 100 x Victorian level C criterion is given as a guide.
Comment on results	All results were below 100 times the Victorian level C criterion (refer to pages 2.B.19 and 2.B.20 for discussion on the criterion).

Assessment method used

NZAS (Hitchcock 1994) used the same method as Woodward-Clyde (1994). The details are given on page 2.B.21.

Selection of leachable components to determine

The selection of the leachable components to be determined used the following criteria:

- update the data on fluoride,
- update the data on other components found to be elevated by Woodward-Clyde (1994), and
- provision of additional data on leachable components possibly present due to the characteristics of the material.

Sample collection method

The material streams which were the components of most of the waste going to the landfill were identified. Fifteen significant streams likely to contain leachable components were identified, all being transported to the landfill in skips.

Grab samples were collected from the skips. Each material stream was sampled once a week for three weeks between 13 to 27 October, 1994. The weekly samples from most of the material streams were combined to produce one sample to assess for each stream. Each week's sample was assessed for two of the material streams to indicate the variability of leachable components.

Continued on next page

Material streams sampled

The 15 material streams sampled and the abbreviations used in the results tables are given in the table below.

Table 10 Material Streams Sampled

Material Stream	Abbreviation
Green Carbon vacuum cleaner dust collector	GC Vacuum
Green Carbon mixer cleanings	GC Under Belt
Material from bottom of Green Carbon cooling trough	GC Cooling Trough
General dust waste from Carbon Baking Furnaces	CBF Rubbish
Baked anode cleaner dust collector	CBF3 Dust Collector
Carbon Rodding fines cleaner dust collector	RR 34-090
Carbon Rodding cathode bar cleaner, induction furnaces and tumbling mill dust collector	RR 34-101
Carbon Rodding butts crusher dust collector	RR 34-103
Carbon Rodding fines cleaner	RR Fines
Carbon Rodding flail cleaner	RR Flail
Metal Products metal reclamation plant dust collector	MP Dust
Metal Products metal reclamation plant drum	MP Fines
Metal Products metal reclamation plant ball mill screen	MP Flakes
Lumps of non-aluminium material from the Metal Products metal reclamation plant	MP Rocks
Cell Reconstruction waste bricks	Rec Lining Brick

Continued on next page

Leachable Component Results

The results from the assessment of leachable components are given in Tables 11 and 12. The 100 times the Victorian level C criterion is given as a guide.

Table 11 Chemical Analysis of Leachate Samples

	pH	Total CN	Al	Total PAH	Mn	Ni	Si	NH_3/N	F^-	SO_4
		$g.m^{-3}$	$g.m^{-3}$	$g.m^{-3}$	$g.m^{-3}$	$g.m^{-3}$	$g.m^{-3}$	$g.m^{-3}$	$g.m^{-3}$	$g.m^{-3}$
GC Vacuum	6.8			0.027					21	
GC Under Belt	7.0			0.0034					47	
GC Cooling Trough	7.2			0.0015					3.3	
CB Rubbish	7.0			0.0027					5.3	
CBF3 Dust Collector [1]	4.3									
CBF3 Dust Collector [2]									3.3	210
RR 34-090	6.9		27		2.8	0.7	<0.5	0.49	100	
RR 34-101 13/10			290		23	0.1	23	1.30	1290	
RR 34-101 20/10	7.4		147		11	<0.05	13	0.84	563	
RR 34-101 27/10			53		7.2	<0.05	9	0.89	319	
RR 34-103	7.0		26		0.03	<0.05	<0.5	0.38	91	
RR Fines	6.7		27		0.8	0.2	<0.5	0.30	115	
RR Flail	7.9		3		0.8	<0.05	<0.5	0.78	141	
MP Dust	9.3	<0.005	16				<0.5	25	137	
MP Fines	9.5	0.032	26				<0.5	35	91	
MP Flakes 13/10	9.2	<0.005	14				<0.5	11.2	53	
MP Flakes 20/10	9.2	<0.005	13				<0.5	6.6	47	
MP Flakes 27/10	9.2	<0.005	14				<0.5	8.6	55	
MP Rocks	9.6	<0.005	39				<0.5	51	68	
Rec Lining Brick	10.3	<0.005					31		0.2	
100 x Victorian level C		40		4.0		100		300	400	

[1] Extracted with deionised water only (pH = 4.3)
[2] Extracted in acetic acid/NaOH buffered water (pH = 4.93 ± 0.05)

Continued on next page

Table 12 Leachable Polycyclic Aromatic Hydrocarbon (PAH) Results

Compound	Concentration $g.m^{-3}$				
	GC Vacuum	GC Under Belt	GC Cooling Trough	CB Rubbish	100 x Victorian Level C
Naphthalene	<0.0005	<0.0005	<0.0005	<0.0005	3
Acenapthylene	0.00044	<0.0001	<0.0001	<0.0001	-
Acenaphthene	0.00468	0.00084	0.00022	0.00014	-
Fluorene	0.00469	0.00054	<0.0001	<0.0001	-
Phenanthrene	0.00858	0.00124	0.00012	<0.0001	1
Anthracene	0.00666	0.00081	<0.0001	<0.0001	1
Fluoranthene	0.00054	<0.0001	0.0001	0.00017	0.5
Pyrene	<0.0005	<0.0001	<0.0001	0.00017	0.5
Benz(a)anthracene	<0.0002	<0.0001	0.0001	0.00017	-
Chrysene	0.00017	<0.0001	0.00017	0.00024	-
Benzo(h)anthracene	0.000023	<0.0001	0.00026	0.00047	-
Benzo(k)fluoranthene	0.00014	<0.0001	0.00012	0.00025	-
Benzo(a)pyrene	<0.00015	<0.0001	0.00012	0.00035	0.1
Indo(1,2,3-cd)pyrene	0.00014	<0.0001	0.00014	0.00035	-
Dibenz(a,h)anthracene	<0.0001	<0.0001	<0.0001	<0.0001	-
Benzo(g,h,i)perylene	0.00014	<0.0001	0.00013	0.00035	-
Total (Also given in Table 11)	0.027	0.0034	0.0015	0.0027	4*

* not total of individual compounds

Continued on next page

Comment on results

This investigation provides data on the material streams going to the landfill. Twelve of the material streams contained significant quantities of leachable fluoride but only one material stream (RR 34-101) was in excess of 100 times the Victorian level C criterion.

There are no Victorian guidelines for aluminium.

The leachable polycyclic aromatic hydrocarbons (PAH) present in the four material streams from the areas where pitch is handled were below 100 x the Victorian level C criterion. Similar findings are evident for the individual PAH compound results given in Table 12.

Leachable ammonia nitrogen was present in the material streams, especially those associated with the Metal Products metal reclamation process. All the results were below 100 times the level C criterion.

Comparison with Woodward Clyde Assessment

The NZAS 1994 assessment supports the findings of the Woodward-Clyde assessment in 1992. Although fluoride is present in many of the materials being landfilled the levels do not produce a leachate containing fluoride in excess of 100 times the Victorian level C criterion.

The effects on the groundwater of the leachable components in the wastes are discussed in Chapter 5, pages 5.5 - 5.10.

Chapter 3

Regulatory Requirements for Landfilling

Overview

Introduction

This chapter summarises the regulatory requirements for a landfill. The requirements quoted are those considered to be most applicable as at 31 March 1995.

In this chapter

This chapter contains the following topics:

Resource Management Act 1991 (RMA)

Section 418(1C)

Section 418(1C) of the RMA requires NZAS to submit an application before 1 April 1995 for the discharges to the landfill.

Section 15(1)(b), (d) RMA

The application is for consent for a discharge permit to:

- discharge contaminants onto or into land in circumstances which may result in those contaminants (or any other contaminants emanating as a result of natural processes from those contaminants) entering water (s. 15(1)(b)), and
- discharge contaminants from an industrial or trade premises onto or into land (s. 15(1)(d)).

Other authorisations under RMA

NZAS has all other authorisations needed for the landfill. In particular, the landfill:

- being ancillary to the smelter operations, complies with section 9 of the RMA, and
- complies with section 15(1)(c) of the RMA as the discharges of contaminants to air from the landfill are covered by the Air Discharge Permit No. 93566.

Application is for a discretionary activity

Under Rule 5.5.2 of the Proposed Regional Solid Waste Management Plan, the discharge of solid waste onto or into a refuse disposal facility is a discretionary activity, provided the facility is not used for the uncontrolled disposal of hazardous substances. NZAS is therefore applying for a discharge permit for a discretionary activity.

Sections 104, 105

The application for a resource consent and the assessment of effects on the environment have been prepared in accordance with section 88 of the RMA to provide the information the Regional Council needs to:

- consider the application in accordance with section 104 of the RMA, and
- make its decision in accordance with section 105(1)(b) of the RMA.

A number of relevant policies	There are a number of relevant policies in the proposed regional policy statement for Southland. Those considered to be most relevant are set out in this section.
Policy 1.2	The "Te Whakatau Kaupapa O Murihiku" is not available, so compliance with this policy could not be assessed. However, the takata whenua issues were identified during previous discussions with iwi representatives. The takata whenua issues are addressed in Chapters 6 and 7 of this AEE.
Policy 12.14	The NZAS landfill operation is a land based disposal system in accordance with Policy 12.14. This policy promotes the adoption of land-based systems for the discharge or disposal of wastes and contaminants.
Policy 12.15 and 14.14	Policies 12.15 and 14.14 requires planning for a sea level rise of 35 cm by the year 2050, until such a time that there is evidence that the rate of rise is higher or lower. The natural topography (see Chapter 5, page 5.2), tidal range and absence of severe coastal wave action (see Chapter 5, page 5.11) indicates that a sea level rise of 35 cm is not likely to impact on the NZAS landfill.
Policy 15.1	The NZAS waste management policy has similar priorities as Policy 15.1, which adopts and implements the internationally accepted hierarchy of waste management.
Policy 15.3	This application complies with the rules in the proposed Regional Solid Waste Management Plan.
Policy 15.6	This policy promotes the upgrading of existing refuse disposal facilities which do not meet environmentally acceptable standards. NZAS considers its landfill does not meet environmentally acceptable standards and supporting data is provided in this AEE. However the NZAS landfill has been progressively improved in the past and improvements are planned for the future.

Continued on next page

Policies 16.2 and 16.5	Policies 16.2 and 16.5 relate to minimising risk and adverse effects on the environment from hazardous substances. The data in this AEE provides evidence that the NZAS landfill operation is consistent with these policies.
Monitoring Policy 1	The data in this AEE will assist the Regional Council with Monitoring Policy 1. It provides data which will improve the level of understanding necessary for effective resource management.

Landfill Rule 5.5.1	The NZAS landfill is not a discharge onto or into a water body so landfill rule 5.5.1 is complied with.
Landfill Rule 5.5.2	This application is made in accordance with Landfill Rule 5.5.2. The information required in the rule is provided in this Assessment of Effects on the Environment and the Landfill Management Plan.
Other Landfill Rules	None of the other Landfill Rules are applicable to the NZAS landfill operation.
Policies	The NZAS approach to waste management is consistent with the policies in the proposed plan.

Rule 4.3.1.S2 Rule 4.3.1.S2 of the Transitional Regional Plan allows the disposal of trade refuse onto land provided that the Regional Council is notified in writing of the proposed sites and methods of disposal. The application gives the required notice.

Survey methods for landfilled materials

NZAS has conducted four surveys of materials being landfilled. A summary of each survey is given below:

- The logs for the skip trucks were examined for the period January to March, 1991. The waste types were identified and the volume of material was estimated as 20040 to 29200 cubic metres per year.
- All the material being landfilled in a period during December 1991 to January 1992 was surveyed. The waste types, sources and disposal site in the landfill were identified.
- A survey in May 1993 established the average amount going to the landfill was 21170 tonnes per year, although there was an unusually high amount (equivalent to 14200 tonnes per year) of bricks at the time. The amount of each type of waste was also identified.
- Another survey was conducted in December 1994. This established the average amount going to the landfill was 4800 tonnes per year, estimated volume 18000 cubic metres per year. Further details are given in the following table.

Table 8 December 1994 Survey results.

Type of Material	Tonnes per Year
MRP fines	1651
ESP tar	0
Miscellaneous dust	1671
Office and Kitchen Waste	74 (since removed)
Asbestos	0
Bricks	736
MMMF	21
Tree/Garden Waste	0
General -- Burnables	258 (now non-burnable)
General -- Non-Burnables	388
Total	**4800**

Current landfill contents inventory

Woodward-Clyde (1994) presented the following broad assessment of the landfill contents in 1992 using the NZAS data up to that time.

- Approximate area of 88,000 m^2 (based on 1992 aerial photos).
- Assumed average depth of 5 m.
- Assessed volume of 440,000 m^3
- Possible range of materials present were identified as:

• Refractory materials	> 50 %
• Timber and construction materials	10-20 %
• Other	5-15 %
• Metals	3-7 %
• Carbon	< 5 %
• MRP fines	< 5 %
• Paper	< 1 %

Comment on method

NZAS considers that intensive surveys for short periods representing the typical situation is the most appropriate method of obtaining this type of information.

Asbestos Regulations

Approval

The NZAS landfill is approved by the Medical Officer of Health in accordance with the Asbestos Regulations for the disposal of asbestos.

Chapter 4

Future Discharge of Contaminants

Overview

Introduction

The current situation and predictions for future waste material generation have been used to predict the future discharges of:

- contaminants onto or into land in circumstances which may result in those contaminants (or any other contaminant emanating as a result of natural processes from those contaminants) entering water (section 15(1)(b) RMA), and
- contaminants from any industrial or trade premises onto or into land (section 15(1)(d) RMA).

It is important to note that this approach is likely to result in an over prediction due to on-going efforts on waste reduction, reuse and recycling opportunities.

In this chapter

This chapter contains the following topics:

Proposals for the Landfill

Landfill site

Use of the 15.49 hectare site on Tiwai Peninsula at approximately map reference NZMS 260;E47,D47, Bluff:552:914 is proposed. The location is shown in Figure 1, page 2.B.2 and Figure 2, page 2.B.3.

Landfill management plan

A Landfill Management Plan has been prepared that provides the level of detail to suit the NZAS requirements. The level of detail in this Plan is similar to the NZAS assessment of the intent of Appendix C of the proposed Regional Solid Waste Management Plan.

The details that must be included in accordance with Rule 5.5.2 of the proposed Regional Solid Waste Management Plan are included in the NZAS Landfill Management Plan.

Open burning

Open burning as a landfill management practice ceased on 31 December 1994 in accordance with Air Discharge Permit No 93566. This permit allows burning for border control purposes.

Planned life

The planned life of the NZAS landfill is over 20 years, based on the predicted maximum rate of waste disposal.

Types of discharge

The future operation of the NZAS landfill will result in the following types of discharges:

- contaminants onto or into land in circumstances which may result in those contaminants (or any other contaminant emanating as a result of natural processes from those contaminants) entering water (section 15(1)(b) RMA), and
- contaminants from any industrial or trade premises onto or into land (section 15(1)(d) RMA).

The term "contaminant" refers to the RMA definition.

Materials not deposited in water bodies

The location and management of the NZAS landfill will mean that the deposited wastes will not directly enter the water bodies in the area. However, rain falling on the landfill can leach components from the wastes and transport them to the water bodies by:

- rain passing through the landfilled materials to the groundwater below,
- rain water running across the surface of the landfill and entering the groundwater through the land beside the landfill, and
- rain water running across the surface of the landfill and nearby land until it reaches the seawater to the east and west of the landfill site.

Estimation of future discharges

The estimates of the future amounts, types and characteristics of materials to be discharged are based on:

- the current NZAS landfill operation,
- an assessment of wastes from future aluminium production and ancillary services, and
- the analysis of past and present components (Chapter 2, Section B).

Continued on next page

Material to be discharged

NZAS proposes to discharge:

- approximately 5000 tonnes per year of waste material from the smelter operations,
- approximately 8000 - 10000 tonnes of refractory material from Carbon Baking Furnace No 3 demolition in 1997 - 1998,
- refractory and other construction or demolition materials if the Carbon Baking Furnaces or smelting facilities require rebuilding or substantial repairs, and
- approximately 12000 - 16000 tonnes per year of COMTOR product if other uses are not established.

It is expected that the amount will reduce with continued improvement to NZAS waste management practices.

Waste material from smelter operations

Estimates of the composition of waste materials from smelter operations are given in the following table. These estimates may require updating if there are changes to the characteristics of the waste materials or to the reuse, recycling and disposal options.

Continued on next page

Table 14 Estimates of Materials Disposed from Smelter Operations

Material	Approximate Tonnes per year
Dust Collector Bags	<10
Dust wastes (carbon)	2000
Asbestos	<50
MRP Fines	2000
Refractory Bricks	1000
Mineral Fibres	<100
Tree and Garden Waste	<100
General Waste	800
Materials for Mitigation Work (fertilizer etc)	<10
Total Amount	4000 - 5000

Reduction in amount of materials disposed

The NZAS continuous improvement programme (Page 2.A.4) and the current NZAS waste management policy (Page 2.A.6) should result in a progressive reduction in the amount of waste requiring disposal. This includes identifying alternatives to landfilling of the carbon dust wastes.

Carbon Baking Furnace No 3 demolition

The Carbon Baking Furnace No 3 is scheduled for demolition in 1997 - 1998. This demolition will result in approximately 8000 - 10000 tonnes of refractory material requiring disposal. It is possible that a recycling use or an alternative disposal method will be found for this material.

Continued on next page

Refractory and other construction material

Rebuilding or substantial repairs to the Carbon Baking Furnaces or other smelter facilities are likely to produce significant amounts of refractory and other construction or demolition materials. Alternative uses and disposal options will be sought for these materials. However it may be necessary to dispose of these materials at the NZAS landfill.

COMTOR product

The COMTOR process is described on page 4.7 - 4.8. In the event of end uses not being established for the product from this process, landfilling may be required.

Consent term

A 20 year consent period is proposed based on:

- the amount of data available to fully assess the proposal,
- the maximum term of 35 years,
- the limited adverse effects on the environment from past and current discharges at the landfill,
- the predicted future limited adverse effect on the environment from discharges to the landfill,
- adequate provisions for reviewing the permit conditions being available to the Southland Regional Council.

COMTOR Process

Process description

The COMTOR process was developed by Comalco Aluminium Limited to treat spent cathode lining (SCL). The process consists of three stages:

- feed preparation,
- calcination, and
- ash treatment.

Feed preparation

The feed preparation stage consists of removing tramp iron and grinding the spent cathode lining to a size suitable for calcination.

Calcination

The calcination stage removes the cyanide in the SCL by thermal destruction. This stage is operated at the optimum temperatures for cyanide destruction. Only a small amount of carbonaceous material is burnt at these temperatures.

Ash treatment

The ash treatment stage can vary and may involve the addition of calcium salts, depending on the uses for the products. Sodium hydroxide and a solid spar material can be produced if suitable end uses an be found for these products.

This stage can also be designed to produce an ash with the fluoride content stabilised to minimise the amount of fluoride leached from the ash.

COMTOR at NZAS

A COMTOR process designed to treat 10000 tonnes per year of SCL is included in the current upgrade at NZAS. This process will have the capacity to treat the SCL generated in the future as well a treating 4000 - 5000 tonnes per year of the stored SCL.

COMTOR product

End uses for the COMTOR products are being evaluated. However considerable difficulty is being experienced in establishing uses for the products in New Zealand.

In the event of end uses not being established, the next option is likely to be landfilling. This option could result in approximately 12000 - 16000 tonnes per year of COMTOR product being disposed of at the NZAS landfill.

Continued on next page

Environmental benefits

The possible landfilling of the COMTOR product is considered to be minor in effects when compared with the environmental benefits of treatment to destroy the cyanide in the SCL.

Alternative Landfill Sites

Possible alternative sites

Possible alternative sites for the NZAS landfill operation include:

- sites on CNZL freehold land south of NZAS,
- sites on CNZL freehold land east of NZAS,
- sites on Crown land leased to CNZL, east of NZAS, and
- sites off Tiwai Peninsula.

Sites south of NZAS

The sites on CNZL freehold land south of NZAS do not have advantages over the existing landfill site. The disadvantages include:

- the bed rock hydrological basement not present,
- new access roads will be required, and
- considerable land surface disturbance will be required due to the land elevation.

Sites on CNZL land, east of NZAS

The sites on CNZL freehold land east of NZAS do not have advantages over the existing landfill site. The disadvantages include:

- the bedrock hydrological basement is not present,
- the sites will be close to the potable water bores,
- considerable land surface disturbance will be required due to the land elevation, and
- access roads and fencing will be required.

Continued on next page

Sites on Crown Land leased to CNZL

The sites on Crown land leased to CNZL, east of NZAS, do not have any advantages over the existing landfill sites. These sites have significant disadvantages including:

- the bedrock hydrological basement is not present,
- the sites will be in the vicinity of the potable water bores,
- use of this land conflicts with the conservation management ethic,
- considerable land surface disturbance will be required,
- across roading and fencing will be required,
- area security will be difficult to achieve and will require additional staff, and
- the additional distance to transport waste materials.

Sites off Tiwai Peninsula

Depending on the site, it may be possible to landfill in an area off Tiwai Peninsula which has better geological and hydrological characteristics. However, this possible advantage is not considered to outweigh the disadvantages which include:

- the need to purchase or acquire the use of the land,
- development of the site as a landfill,
- the additional distance, possibly considerable, required to transport waste material,
- possible adverse effects from the transport of waste, and
- the loss of security and managerial control.

Other Disposal Options

Landfilling

NZAS is disposing of office, kitchen and canteen wastes at the Invercargill landfill. This disposal method was chosen in late 1994 when burning ceased at the NZAS landfill. The office wastes are compressed and baled for transport. The kitchen and canteen wastes are transported in designated bins. This provides segregated materials for the Invercargill landfill operators.

There are several landfill sites in the Southland Region where the other NZAS waste material could be disposed. However, these sites do not appear better suited to landfilling than the existing NZAS landfill site. Waste material would need to be transported a considerable distance to these sites. The use of these sites would probably eliminate future recovery and recycling options made possible by the NZAS landfill management.

Incineration

NZAS does not have the option of open burning (Air Discharge Permit No 93566). The benefits of a purpose built incinerator are currently being investigated.

Regional waste disposal facility

This option is believed to be under discussion for the Southland Region. At this stage this appears to be a medium to long term solution. The NZAS use of a regional facility will be considered when data is available on this option. NZAS needs to landfill in the short term.

Composting and Bioremediation

Oily waste

NZAS has had considerable success with the bioremediation of the oily sediments from the now removed waste oil pond.

The application of bioremediation to future low volume oily wastes is being considered.

Other wastes

Minenco has been engaged to develop bioremediation and composting options for NZAS wastes suitable for these techniques.

Chapter 5

Effects of Discharges

Overview

Introduction

This chapter gives details of the effects on the environment of the discharges onto and into land at the NZAS landfill. The limited adverse effects from the past and current discharges has been used to predict that future adverse effects are also likely to be limited.

In this chapter

This chapter contains the following topics:

Land

Natural Topography

The natural ground level prior to the NZAS landfill ranged from approximately 8 metres above mean sea level at the northern end to 3 - 4 metres above mean sea level at the southern end. Projection of the contours from the topographic plans, plus data from drill holes through the landfill show that the average level of the original ground was likely to have been around 5 metres above mean sea level (Woodward-Clyde, 1994).

Current and future topography

The landfill has raised the ground level to 7.1 - 10.5 m above sea level and has evened out the land surface. The future landfilled area will result in similar effects.

Revegetation

The completed areas of the landfill have been revegetated using the Department of Conservation as consultants. Species typical of the Tiwai Peninsula are given reference in the revegetation programme.

The species and numbers of plants used in the landfill revegetation programme up until the Autumn of 1994 are given in Table 15 on page 5.3.

Future land use

It is extremely unlikely that there will be any industrial or urban development on the NZAS landfill area in the foreseeable future.

Mitigation

The current practice of profiling the completed landfilled areas will continue in the future. This profiling will remove the abrupt face of the landfilled areas and produce a more gradual slope down to the natural ground level.

Revegetation of the completed landfill areas and sloped sides will continue.

Continued on next page

Table 15 Landfill Revegetation Programme

Plant	**Number**
mixed native plants	13,835
Saphora Microphylla	50
Phormium Tenax	454
Hebes	1,094
Toe Toes	1,510
Ngaio	260
Coprosma	310
Pittosporum	555
Olearia	373
Carex	300
Cordyline Australis	1,700
Cassina	118
Aristotelia Serrata	100
Griselinia	213
Astelia Nervosa	50
tree ferns and mixed ferns	52
mixed flax	2,810
Manuka	1,850
Olearia Traversii	240
Total Planting	25,874

Hydrology

Hydrology at landfill site

The presence of the NZAS landfill has had little, if any effect on the hydrology of the western end of Tiwai Peninsula (see pages 2.B.6 - 2.B.13). The profile of the water table may have changed slightly due to the filling in of the natural hollows in the ground. A similar change in the local hydrology is possible in the future.

Hydrology of Tiwai Peninsula

The hydrology of Tiwai Peninsula has not been and is unlikely to be affected by the presence of the NZAS landfill.

Water quality assessment

The most recent and comprehensive assessment of the groundwater near the NZAS landfill was conducted by Woodward-Clyde (1994). Samples were collected during 1992 from 19 wells on and around the landfill.

The locations of the wells are shown in Figure 4, page 2.B.6.

Some wells were very close to the landfill so little attenuation or dilution of groundwater components had occurred.

Criterion for interpretation of results

The Victorian level C criterion is considered appropriate for a conservative comparison with the groundwater near the NZAS Landfill. It is not a potable water supply and there is a very low probability that the area would be considered for a future supply.

Woodward-Clyde results

The groundwater quality results for the Woodward-Clyde assessment are given in Table 16. The Victorian contamination criteria are also given in this table.

Fluoride

The groundwater on the eastern side of the landfill contained fluoride in excess of the Victorian level C criterion. The highest levels were to the north east where the MRP fines are stored. The fluoride in the south east area was probably sourced from the dusts from the Carbon Rodding operation.

Ammonia Nitrogen

The ammonia nitrogen concentrations in the groundwater on the eastern side of the landfill exceeded the Victorian level C criterion. MRP fines were probably the major landfill based source with Carbon Rodding dusts contributing some of the nitrogen.

Total phosphorus

The groundwater total phosphorus concentrations under the landfill, apart from the northern edge, exceeded the Victorian level C criterion. No source of phosphorus has been identified in the NZAS landfilled materials (see Appendix 3).

Continued on next page

Table 16 Results of Groundwater Analyses

Date Sampled	Site	pH	Conductivity	Alkalinity	Cl	F	NH_4-N	NO_3-N	C.O.D.	Ca	Mg	Na	K	SO_4	Total P	Fe	Mn	Al	Cu	Ni	Co	V	Total Cyanide	Oil & Grease
			(mS.m^{-1})	(g.m^{-3}CaCO3)	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})
Victorian Level C						4.0	3.0								0.70				1.0	1.0	0.20		0.40	0.60
26/03/92	A1	6.0	58	64	95	0.50	0.24	0.2	540	27	15.9	75	3.5	39	0.15	51	0.86	7.4	<0.02	<0.04	<0.04	0.3	<0.01	0.3
26/03/92	A2	6.4	71	82	142	1.18	0.37	0.2	145	15.9	17.1	88	4.8	30	0.13	1.80	0.38	2.2	<0.02	<0.04	<0.04	0.3	<0.01	0.3
26/03/92	A3	5.9	45	18	104	<0.05	0.13	0.3	266	5.9	7.2	64	1.61	24	0.11	5.5	0.08	2.2	<0.02	<0.04	<0.04	0.1	<0.01	0.1
30/03/92	A4	5.8	36	15	91	<0.05	0.18	<0.1	179	4.5	7.0	49	2.0	13	0.05	2.3	0.02	1.5	<0.02	<0.04	<0.04	0.1	<0.01	0.1
30/03/92	A5	6.8	128	330	147	0.29	7.7	0.1	1120	11.8	4.7	241	7.0	141	1.65	7.6	0.11	18.8	<0.02	<0.04	<0.04	0.4	0.08	0.4
30/03/92	A5a	6.8	129	235	127	3.7	0.16	2.0	620	8.3	4.5	235	12.9	177	0.43	1.71	<0.02	8.6	<0.02	<0.04	<0.04	0.4	0.11	0.4
30/03/92	A6	6.7	220	280	142	12.9	0.15	5.9	750	4.6	4.1	415	17.9	480	0.80	4.2	0.22	14.2	<0.02	<0.04	<0.04	0.4	0.04	0.4
25/03/92	A7	7.2	970	920	2400	30	196	15.4	1340	26	22	1730	120	360	4.0	25	5.2	52	0.04	<0.04	0.06	0.9	0.07	2.2
25/03/92	A8	6.9	120	102	200	48	0.15	17.2	330	4.0	3.2	225	22	54	0.33	2.6	0.19	21	0.04	<0.04	<0.04	2.2	0.01	0.9
25/03/92	A9	7.5	187	570	134	39	0.40	2.1	320	6.7	4.2	393	17.9	126	0.57	6.3	0.17	9.0	<0.02	<0.04	<0.04	0.1	0.10	0.1
24/03/92	A10	5.4	65	15	170	0.59	0.06	<0.1	199	8.0	10.9	93	4.6	24	0.08	1.87	0.05	2.8	<0.02	<0.04	<0.04	0.1	<0.01	0.1
23/03/92	B1	5.6	62	20	169	0.06	0.22	0.2	400	7.8	11.7	88	1.53	15	0.05	7.0	0.07	1.5	0.04	0.07	<0.04	0.1	<0.01	0.1
30/03/92	B3	5.5	53	27	136	0.18	0.07	0.1	970	6.3	10.2	77	2.1	16	0.25	9.2	0.11	3.1	<0.02	<0.04	<0.04	0.2	<0.01	0.2
24/03/92	C1	7.5	350	1240	340	19.5	65	2.2	240	13.4	19.5	630	53	171	0.38	6.2	0.98	5.5	<0.02	<0.04	<0.04	0.4	<0.01	0.4

Continued on next page

Table 16, cont. Results of Groundwater Analyses

Date Sampled	Site	pH	Conductivity	Alkalinity	Cl	F	NH_4-N	NO_3-N	C.O.D.	Ca	Mg	Na	K	SO_4	Total P	Fe	Mn	Al	Cu	Ni	Co	V	Total Cyanide	Oil & Grease
			(mS.m^{-1})	(g.m^{-3}CaCO3)	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})	(g.m^{-3})
24/03/92	C1 (dup)	7.5	351	1240	340	19.0	65	2.2	240	13.5	18.9	620	53	162	0.32	6.2	0.96	5.5	<0.02	<0.04	<0.04	0.4	<0.01	0.4
26/03/92	C2/1	7.3	330	1000	430	0.48	100	0.3	1780	20	11.4	480	16.9	171	4.9	5.5	0.06	35	0.08	<0.04	<0.04	0.9	0.03	0.9
26/03/92	C2/2	7.3	1060	2020	2100	0.16	340	0.1	3630	53	48	1910	59	930	15.0	14.3	0.11	98	<0.02	<0.04	<0.04	2.3	0.07	2.3
25/03/92	C3/1	7.6	400	1200	250	41	15.4	31.2	116	6.2	10.0	920	19.1	420	0.11	0.46	0.40	6.4	<0.02	0.05	<0.04	0.9	0.23	0.9
25/03/92	C3/2	7.4	290	800	260	12.0	8.9	5.8	151	8.9	12.7	550	15.7	285	0.45	1.44	0.05	4.4	<0.02	<0.04	<0.04	0.5	0.12	0.5
30/03/92	C4	7.2	300	760	220	19.2	0.26	16.4	430	13.5	7.6	626	25	370	3.0	3.1	0.09	9.1	0.03	<0.04	<0.04	0.4	0.22	0.4
25/03/92	Unfiltered Blank	6.8	0.1	1	<1	<0.05	<0.01	<0.1	<10	<0.05	<0.02	<0.02	<0.02	<3	<0.04	<0.04	<0.02	<0.5	<0.02	<0.04	<0.04	<0.1	<0.01	<0.1
25/03/92	Filtered Blank									<0.05	<0.02	<0.02	<0.02	<3	0.06	<0.04	<0.02	<0.5	<0.02	<0.04	<0.04	<0.1		<0.1
30/03/92	Blank	6.6	0.2	2	<1	<0.05	<0.01	<0.1	<6	<0.5	<0.2	1.8	<0.2	6	<0.04	<0.04	<0.02	0.7	<0.02	<0.04	<0.04	0.1	<0.01	0.1
30/07/92	A5	6.7	105		140	0.18	5.1		1070						1.02	10.5	0.101	15.9				0.2	0.047	
30/07/92	A5 (dup)	6.7	104		144	0.18	4.9		830						0.94	10.5	0.102	16.2				0.2	0.047	
22/07/92	A6	6.7	268		150	4.0	1.77		490						0.49	10.2	0.23	15.6				<0.1	0.053	
30/07/92	A7	7.0	960		2600	26	260		2400						2.0	27	12.9	93				0.9	0.057	
22/07/92	A8	6.8	112		190	25	0.06		230						0.15	3.3	0.21	18.0				<0.1	0.013	
22/07/92	A9	7.3	219		160	15	2.0		410						0.41	13.5	0.165	12.2				<0.1	0.144	
22/02/92	A10	5.6	60		165	0.53	0.04		158						0.039	5.6	0.05	2.1				<0.1	<0.001	
22/02/92	A10	5.6	61		160	0.55	0.04		149						0.037	5.6	0.049	1.44				<0.1	<0.001	
22/07/92	B1	5.6	54		130	0.13	0.21		480						0.017	9.6	0.045	0.44				<0.1	<0.001	

Continued on next page

Groundwater Quality, Continued

Table 16, cont. Results of Groundwater Analyses

Date Sampled	Site	pH	Conductivity	Alkalinity	Cl	F	NH_4-N	NO_3-N	C.O.D.	Ca	Mg	Na	K	SO_4	Total P	Fe	Mn	Al	Cu	Ni	Co	V	Total Cyanide	Oil & Grease
			($mS.m^{-1}$)	($g.m^{-3}CaCO3$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)	($g.m^{-3}$)
22/07/92	B3	4.5	49		120	2.7	0.033		350						0.88	4.5	0.025	2.9				<0.1	<0.001	
22/07/92	C2	7.0	435		880	0.14	121		1290						3.8	31	0.091	14.8				<0.1	0.022	
30/07/92	Blank	6.5	0.2		<1	<0.05	<0.01		<6						<0.004	<0.002	<0.0003	<0.005				<0.1	<0.002	
03/09/92	A3	4.9	47		120	2.5	0.01		1060						0.95	11.0	0.05	22				<0.1	<0.002	
03/09/92	A5	6.9	122		130	0.31	5.1		740						1.21	7.5	0.12	9.8				<0.1	0.070	
03/09/92	A6	6.5	158		160	3.0	1.25		470						0.72	9.9	0.26	16.6				-	0.054	
03/09/92	A7	8.3	1030		2300	104	310		2500						3.0	58	9.1	89				0.9	0.086	
03/09/92	A8	6.7	70		120	36	0.42		64						0.052	0.58	0.10	11.1				-	0.007	
02/09/92	A9	7.2	240		200	18.3	2.4		480						0.45	10.0	0.17	13.2				-	0.133	
02/09/92	A10	5.5	54		140	0.23	0.12		152						0.033	4.4	0.05	1.38				-	-	
02/09/92	B1						0.15		60														<0.001	
03/09/92	B1 (dup)	5.7	49		130	0.10									0.017	8.2	0.03	0.66				<1		
02/09/92	C2	6.9	370		720	0.16	88		1130						3.1	27	0.08	13.3				-	0.014	
04/09/92	Blank																							

Continued on next page

Oil and grease

The oil and grease content of the groundwater in the north eastern area of the landfill exceeded the Victorian level C criterion. This in the area where the waste oil pond was located until 1992. All this oil has been recovered, and reused.

The soils and sediments at the bottom of the pond have been treated using bioremediation.

Other Victorian level C criterion

Not all the parameters measured in the groundwater have Victorian level C criterion levels. However other Victorian level C criterion applying to copper, nickel, cobalt and total cyanide were not exceeded in the groundwater near the NZAS landfill.

Other comment on groundwater quality

The groundwater under the eastern side of the landfill contained higher aluminium and sulphate concentrations than the remainder of the landfill. The leachability results (Chapter 2) indicate that the Carbon Rodding dust was the major source of the aluminium and sulphur (sulphate) with other landfill components containing lower amounts of these components.

Conclusions

Woodward-Clyde (1994) reached the following conclusions:

- the groundwater resource itself is of relatively low value because of its low natural quality and is not used,
- the actual effects of the landfill, in terms of contamination of groundwater as a resource, are small.

Continued on next page

Future effects and mitigation

The effects of the NZAS landfill on groundwater discussed in this topic reflect over 23 years of operation. During this time there have been improvements in waste management and landfill operations which will have reduced the effects on the groundwater. The most significant of these are:

- a reduction in the amount of waste going to the landfill,
- recovery of some materials, eg dross,
- rehabilitation of areas, eg oily soils and sediments,
- keeping the landfill operating face as small as possible, and
- the covering and revegetation of completed landfill areas which will reduce the rain leaching of the waste materials.

The current mitigation activities will continue and this should reduce the rain leaching of the waste materials. In addition there appear to be opportunities to further reduce the amount of material going to the landfill and to recover some of the waste materials for use in other industries.

It is predicted that the quality of the groundwater should improve in the medium to long term.

Vegetation

Source of data

The vegetation at and around the NZAS landfill site was assessed during the study by Woodward-Clyde (1994). This part of the study involved:

- a walk-over survey to identify the species present and the primary influences on the vegetation, and
- a more detailed survey to quantify the effects of MRP fines storage.

General habitat description

The vegetation on the coarse sand and gravel dunes between the landfill and the southern coast of Tiwai Peninsula is dominated by grasses, flax, tussock, bracken and small shrubs.

Near the south western and at the landfill, the vegetation is varied with bare sandy - shingle patches, small areas of rough grass and extensive areas of flax and mixed shrubs dominated by manuka up to 3 metres high.

The land adjacent to the western side of the landfill is relatively flat and vegetated by very dense manuka, about 4 metres high and areas of flax.

Towards the north-west corner of the landfill, there is a low-lying area with ponded surface water which extends to the north-west towards the coast. The vegetation of the wetter area is dominated by flax and sedges. West of the access road is a rocky area with a low vegetation of grass and shrubs. North-east of the landfill is a low-lying dune area with grasses, flax, bracken and small shrubs dominant.

Continued on next page

Walk-over survey results

The walk-over survey in December 1991 indicated the status of the vegetation was as described below.

- Dust from the MRP fines storage area was affecting plants over an area extending about 200 m north east of the landfill.
- Dust from the Carbon Rodding dust was visible up to 30 m from the landfill but only appeared to be affecting vegetation within 2 - 3 metres of the landfill.
- An area approximately 20 x 30 metres indicated effects from wind blown oil. The waste oil has since been removed and the area revegetated.
- Surface water was ponding in several small areas at the toe of the landfill but this was having only very minor effects on the vegetation.
- There was no indication that the vegetation was being affected by the components in the groundwater.
- Wind blown plastic was distributed in habitats surrounding the landfill but was not causing significant adverse effects on the vegetation.

MRP fines storage area assessment

The more detailed examination or the MRP fines storage area indicated:

- low plant diversity and some species damaged due to covering by dust at the site 50 m north-east of the area,
- less effect at the site 150 m north-east of the area, but the overall species diversity was low, and
- no effects at the site 250 m north-east of the area.

Continued on next page

MRP fines handling and storage

Prior to the December 1991 assessment, the MRP fines had been recovered from the landfill for recycling by another industry. This involved screening and stockpiling of the fine material. The recycling process probably made a significant contribution to the effects on vegetation in this area.

Since this time the MRP fines have been stored in cells. The completed cells are covered with gravel and revegetated.

Woodward-Clyde conclusion

Woodward-Clyde (1994) concluded that the MRP fines effects warranted the mitigation work which has since been conducted. In the context of the overall locality the effects of the NZAS landfill on vegetation are relatively minor.

Fire

In late 1994 there was a small fire east of the landfill which damaged an area of vegetation. This situation should not reoccur with the ceasing of open burning as a waste management practice. The burnt area will be left to naturally revegetate.

Future effects and mitigation

The future effects of the NZAS landfill on revegetation are likely to be similar to the existing situation. The covering and vegetation work will mitigate adverse effects.

Wildlife

Assessment methods

An assessment of the wildlife in the area of the NZAS landfill was included in the study by Woodward-Clyde (1994). This assessment was conducted by Bioresearches by:

- recording the bird species from six stationary observation sites on or in the vicinity of the landfill,
- making observations while walking around the landfill or while gaining access to the adjacent areas, and
- making observations of the other wildlife while walking around the landfill or while gaining access to the adjacent areas.

Birds observed

The bird species observed on or in the vicinity of the landfill are given in the following table.

Table 17 Bird Species at the Landfill

Scientific Name	Common Name
Anthus novaeseelandiae	New Zealand Pipit
Carduelis carduelis	Goldfinch
Carduelis flammea	Redpoll
Circus approximans	Harrier
Emberiza citrinella	Yellowhammer
Fringella coelebs	Chaffinch
Gerygone igata	Grey Warbler
Haematopus finschi	South Island Pied Oystercatcher
Larus dominicanus	Southern Black-backed Gull
Larus scopulinus	Red-billed Gull
Porphyrio melanotus	Pukeko
Prunella modularis	Hedge Sparrow
Sturnus vulgaris	Starling
Tadorna variegata	Paradise Shelduck
Vanellus miles	Spur-winged Plover
Zosterops lateralis	Silvereye

Continued on next page

Summary of bird observations

No bird species were identified which were being adversely affected by the presence of the landfill or by the landfill operations. There were no birds attracted to the landfill by the wastes that are disposed of, or by the landfill operations.

Other animals

No adverse effects on other animals as a result of the landfill were observed.

Loss of habitat

The area occupied by the landfill represents a loss of wildlife habitat. However, Bioresearches considered that because the natural habitats of the landfill area are not of high value, this does not represent a significant loss.

The progressive revegetation of completed landfill areas will create new habitats for wildlife.

Future effects and mitigation

There are unlikely to be future effects on wildlife apart from loss of habitat. New habitat areas will continue to be created by the revegetation programme.

Coastal Water

Relationship with NZAS landfill

The NZAS landfill operation is not in the coastal marine area. However, the western end of Tiwai Peninsula, where the landfill is located, has Bluff Harbour to the north and west, and Foveaux Strait to the east and south.

The hydrology of the area (see Chapter 2, page 2.B.6) indicates that groundwater from the landfill site moves primarily to the east with some flow to the west. This is also the possibility of surface water flows from the landfill.

No coastal water contact with discharge

The materials discharged at the NZAS landfill will not come into contact with coastal water. The landfill base is 3 - 4 m above mean sea level at the lowest point (see Figure 6, page 2.B.9). The maximum spring tide is 1.4 m above mean sea level. The coast west of the landfill is not subjected to severe coastal wave action as it is harbour water and sheltered from strong westerly winds by Bluff Hill.

The coast east of the landfill protected by the dunes up to 5 m above mean sea level (see Figure 3, page 2.B.5). Extreme strength winds are not experienced from the easterly sectors.

Water quality assessment

The coastal water and groundwater seepage quality near the NZAS landfill has been assessed by:

- Woodward-Clyde (1994) who reported studies by Bioresearches, and
- Bioresearches (1995) who provided additional information to Woodward Clyde (1994).

Continued on next page

Woodward Clyde (1994) study methods

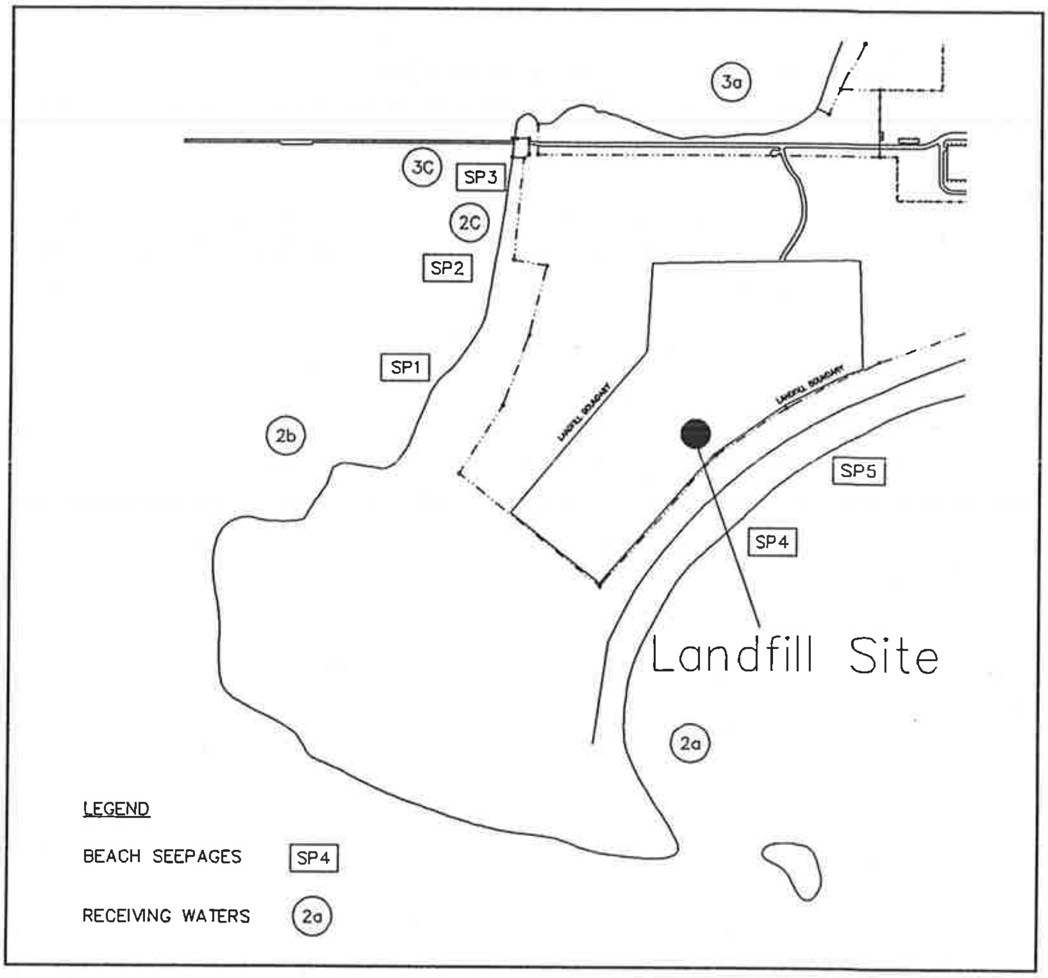
The methods used in Woodward-Clyde (1994) included:

- data review,
- walk over survey of beaches,
- sampling of groundwater seepages on the beaches, and
- sampling of coastal water.

These samples were collected in mid 1992 and the sampling sites are shown in Figure 9. Additional data on this beach seepage work is given in Bioresearches (1994).

Continued on next page

Figure 9 Woodward-Clyde (1994) study Sampling Sites



Woodward-Clyde (1994) results

The Woodward-Clyde (1994) results of the beach seepage analysis are given in Table 18 and the coastal water analysis results are given in Table 19.

Continued on next page

Table 18 Results of Beach Seepage Analysis

	Seepage Number	pH	Conductivity mSm^{-1}	Alkalinity g.m^{-3} $CaCO_3$	Cl g.m^{-3}	F g.m^{-3}	NH_4.N g.m^{-3}	NO_3.N g.m^{-3}	COD g.m^{-3}	Ca g.m^{-3}	Mg g.m^{-3}	Na g.m^{-3}	K g.m^{-3}	SO_4 g.m^{-3}	V g.m^{-3}	Total CN g.m^{-3}	Al g.m^{-3}	Fe g.m^{-3}	Mn g.m^{-3}	DRP g.m^{-3}
7-4-92	SP1	7.5	3830	188	15200	0.75	0.30	<0.1	760	330	970	8200	310	2060	3.4	0.81	-	-	-	-
	SP2	7.7	1373	200	4800	3.7	0.13	0.2	162	136	340	2560	86	640	1.4	0.004	-	-	-	-
	SP3	6.5	62	44	145	0.40	0.08	<0.1	38	23	10.8	76	1.94	36	0.1	0.112	-	-	-	-
22-7-92 or 29-7-92	SP1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SP2	7.6	435	-	880	8.8	0.05	-	152	-	-	-	-	-	<0.01	0.003	0.28	0.32	0.010	0.108
	SP3	7.4	60	-	135	0.45	0.08	-	250	-	-	-	-	-	<0.1	<0.001	0.16	0.93	0.021	0.011
	SP4	7.9	3670	-	15000	0.97	0.18	-	320	-	-	-	-	-	1.7	<0.002	0.053	0.033	0.010	0.043
	SP5	8.0	4320	-	18900	0.91	<0.1	-	450	-	-	-	-	-	1.9	<0.002	0.038	0.029	0.002	0.024
4-9-92	SP1	6.8	84	-	210	0.86	0.08	-	162	-	-	-	-	-	<0.1	<0.001	0.38	0.90	0.03	-
	SP2	7.9	390	-	1060	18.2	0.19	-	220	-	-	-	-	-	<0.1	0.004	0.43	0.42	<0.02	-
	SP3	7.8	114	-	200	0.69	0.30	-	132	-	-	-	-	-	<0.1	<0.001	0.43	0.24	<0.02	-
	SP4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SP5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Continued on next page

Table 19 Coastal Water Quality

Station	Time	Temp °C	D.O.	D.O. %Satn	Salinity ($g.kg^{-1}$)	pH	Secchi (m)	F $g.m^{-3}$	Total CN $g.m^{-3}$	SS $g.m^{-3}$	Cd $mg.m^{-3}$	Al $mg.m^{-3}$	V $mg.m^{-3}$	Hg $mg.m^{-3}$	PAH $mg.m^{-3}$	FC per 100 ml
2aL	9.10	13.0	8.2	96	34.2	7.9	2.0	1.34	<0.01	6	<0.1	9	<10	-	<1	NR
2bL	9.15	12.2	7.7	87	33.8	7.8	<u>0.6</u>	1.35	<0.01	1	<0.1	3	<10	-	<1	NR
3cL	9.25	12.3	8.0	93	34.0	7.9	<u>0.5</u>	1.34	-	2	<0.1	4	<10	<0.2	-	NR
2aH	5.00	13.0	9.0	105	34.0	8.2	2.0	1.28	<0.01	5	-	5	<10	-	<1	0
2bH	5.10	12.2	9.8	112	34.0	8.2	<u>1.0</u>	1.25	<0.01	2	<0.1	2	<10	-	<1	0
2cH	5.15	13.0	9.4	110	34.0	8.2	<u>1.0</u>	1.23	<0.01	2	<0.1	2	<10	-	<1	1.9
3aH	5.25	13.0	9.6	112	34.0	8.2	<u>1.0</u>	1.24	<0.01	1	<0.1	4	<10	<0.2	-	0

Notes: L = Low tide sample 6.3.92
H = High tide sample 8.4.92
For station locations refer Figure 25
Secchi number underlined is clear to bottom depth
FC Faecal Coliform
SS Suspended Solids
PAH Polycyclic Aromatic Hydrocarbons - 15 compounds analysed
< Below the lower limit of detection

Continued on next page

Bioresearches (1995) study methods

The Bioresearches (1995) study provided more data on the beach seepages. The samples were collected in September, 1994 and the sites were the same as used in mid 1992. The sites are shown in Figure 9, page 5.18 and the results are given in the following tables.

Table 20 Beach Seepage Water Quality, 29 September 1994

Station	Time	Conductivity ($ms.s^{-1}$)	Chloride ($g.m^{-3}$)	Tot.F ($g.m^{-3}$)	Total CN ($g.m^{-3}$)	Vanadium ($g.m^{-3}$)
SP 1	1645	791	3100	1.07	<0.002	<0.010
SP 2	1700	1760	6700	9.73	<0.002	<0.010
SP 3	1715	68	135	0.45	<0.002	
SP 4	1610	4140	19070	1.08	<0.002	<0.010
SP 5	1600	4110	18890	1.32	<0.002	<0.010

Table 21 Beach Seepage Water Quality, 10 October 1994

Station	Time	Salinity ($g.kg^{-1}$)	Conductivity ($ms.s^{-1}$)	Chloride ($g.m^{-3}$)	Tot.F ($g.m^{-3}$)	Total CN ($g.m^{-3}$)	Vanadium ($g.m^{-3}$)
SP 1	1330	20.9	2850	10880	0.78	<0.002	<0.010
SP 2	1345	24.5	3160	13000	2.44	<0.002	<0.010
SP 3	1355	7.3	910	3299	0.58	<0.002	
SP 4 (1)	1245	33.5	4420	19210	1.28	<0.002	<0.010
SP 5 (2)	1235	33.5	4110	19070	1.14	<0.002	<0.010

(1) 200 m west of Station 5
(2) Station 5 directly offshore from old concrete foundations

Continued on next page

Table 22 Beach Seepage Water Quality, 13 October 1994

Station	Time	Salinity ($g.kg^{-1}$)	Conductivity ($ms.s^{-1}$)	Chloride ($g.m^{-3}$)	Tot.F ($g.m^{-3}$)	Total CN ($g.m^{-3}$)	Vanadium ($g.m^{-3}$)
SP 1	1715	22.4	2880	12020	0.91	<0.002	<0.010
SP 2	1725	24.6	3120	13100	6.89	<0.002	<0.010
SPP 3	1740	4.9	651	2167	0.53	<0.002	
SP 4 (1)	1635	33.1	4300	18860	1.25	<0.002	<0.010
SP 5 (2)	1625	33.0	4280	18910	1.23	<0.002	<0.010

(1) 200 m west of Station SP 5
(2) SP 5 directly offshore from old concrete foundations

Interpretation of results

The beach seepage results indicate that landfill derived components can be transported by groundwater or possibly surface water to the beaches. However, the 1994 beach seepage results indicated less components which could be landfill derived than in the 1992 seepage results. Most of the seepages contained coastal water therefore having a natural fluoride content. Seepage SP 2 also contained additional fluoride which was probably sourced from the landfill.

The coastal water results indicate that the beach seepage and the presence of the NZAS landfill has no effect on the coastal water quality of Bluff Harbour and Foveaux Strait.

Future effects and mitigation

Based on the current situation and the planned landfill operation there is unlikely to be future effects on the coastal water quality. In addition, surface water flow paths to the coast have been blocked and will be avoided in the future.

Marine Sediments

Bioresearches studies

The marine sediments near the NZAS landfill site were sampled during:

- the environmental study by Bioresearches (1994), and
- another study by Bioresearches (1995) to provide additional data.

Bioresearches study methods

The samples collected in February, 1992 during the Bioresearches (1994) study were from:

- station 7, 20 m off shore near beach seepage SP3
- station 8, 26 m off shore near beach seepage SP1, and
- station 9, 190 m off shore, middle of beach south of Tiwai wharf.

The beach seepages are shown in Figure 9, page 5.18.

Bioresearches (1994) results

The marine sediment results from the Bioresearches (1994) study are given in Tables 23, 24, and 25. The National Oceanic and Atmospheric Administration (NOAA), United States, Environmental Response Limit (ERL) values for PAH are also given as a guide in Table 25.

Continued on next page

Table 23 Sediment Grain Size Analysis (February 1992)

Percentage Dry Weight				
Grain Size (mm)	**Description**	**Sample No.**		
		7	8	9
>3.35	Pebble	20.5	19.1	10.2
2.00 - 3.35	Granule	2.3	2.1	2.0
1.18 - 2.00	Very coarse sand	3.5	1.8	2.2
0.6 - 1.18	Coarse sand	7.7	2.8	3.6
0.3 - 0.6	Medium sand	37.1	18.6	21.4
0.15 - 0.3	Fine sand	28.1	53.2	56.7
0.063 - 0.15	Very fine sand	0.9	2.2	3.9
<0.063	Silt	0	0.2	0

Table 24 Intertidal Surficial Sediment Quality in the Vicinity of NZAS Discharges (February 1992)

Station	Distance from shore (m)	Fluoride ($mg.kg^{-1}$) mean (n)	Cadmium ($mg.kg^{-1}$)	Vanadium ($mg.kg^{-1}$)	PAH ($mg.kg^{-1}$)
7. Beach South of wharf	20	221(4)	<0.1	30	1.226
8. Beach South of wharf	26	66(1)	<0.1	13	0.376
9. Beach South of wharf	190	72(3)	<0.1	30	0.197

Continued on next page

Table 25 Polycyclic Aromatic Hydrocarbons in Sediment, February 1992; mg.kg^{-1} dry weight

Sample	7	8	9	NOAA ERL Values
Naphthalene	0.013	<0.01	<0.005	0.34
Acenaphthylene	<0.01	<0.01	<0.005	-
Acenaphthene	<0.01	<0.01	<0.005	-
Fluorene	0.004	<0.01	<0.005	0.035
Phenanthrene	0.032	0.01	0.007	0.225
Anthracene	<0.005	<0.005	<0.002	0.085
Fluoranthene	0.102	0.021	0.02	0.6
Pyrene	0.105	0.022	0.02	0.35
Benzo[a]anthracene	0.091	0.016	0.014	0.23
Chrysene	0.094	0.018	0.016	0.4
Benzo[b]fluoranthene and Benzo[k]fluoranthene	0.287	0.103	0.051	-
Benzo[a]pyrene	0.144	<0.005	<0.005	0.4
Indeno[1,2,3-cd]pyrene	0.196	0.103	0.035	-
Dibenzo[a,h]anthracene	0.016	<0.005	<0.005	0.06
Benzo[g,h,i]perylene	0.142	0.083	0.034	-
Total	**1.226**	**0.376**	**0.197**	**4.0***

* Not total of individual compounds

Continued on next page

Bioresearches (1995) study

Marine sediment samples were collected from 3 sites west of the landfill in September, 1994 during the study by Bioresearches, (1995). The sampling sites are shown in Figure 9 on page 5.18. The results are given in the following table with the NOAA ERL values also given as a guide.

Table 26

Polycyclic Aromatic Hydrocarbons in Sediment, September 1994; mg.kg^{-1} dry weight

Station	**1**	**2**	**3**	**NOAA ERL Values**
Naphthalene	<0.05	<0.05	<0.05	0.34
Acenaphthalene	<0.05	<0.05	<0.05	0.15
Acenaphthene	<0.05	<0.05	<0.05	-
Fluorene	<0.05	<0.05	<0.05	0.038
Anthracene	<0.05	<0.05	<0.05	0.085
Fluoranthene	<0.05	<0.05	<0.05	0.6
Pyrene	<0.05	<0.05	<0.05	0.35
Benzo(a)anthracene	0.17	0.58	<0.05	0.23
Chrysene	0.20	0.38	<0.05	0.4
Benzo(b)fluoranthene	0.26	0.76	<0.05	-
Benzo(k)fluoranthene	0.08	0.25	<0.05	-
Benzo(a)pyrene	0.10	0.32	<0.05	0.4
Indeno(1,2,3-cd)pyrene	<0.05	0.16	<0.05	-
Dibenzo(a,h)athracene	<0.05	0.06	<0.05	0.06
Benzo(g,h,i)perylene	<0.05	<0.05	<0.05	-
Total	**0.81**	**2.51**	**0.05**	**4.0***

* Not total of individual components

Continued on next page

Interpretation of fluoride results

Bioresearches (1994) study found a higher fluoride concentration in the marine sediments at one site (site 7). This fluoride may have been derived from a nearby beach seepage.

Interpretation of polycyclic aromatic hydrocarbon results

Both Bioresearches studies found low levels of polycyclic aromatic hydrocarbons in the marine sediments.

All samples were below the 4.0 $mg.kg^{-1}$ ERL limit for total polycyclic aromatic hydrocarbons. One of the samples (site 2) in September, 1994 contained benzo(a)anthracene over the ERL. The source of the polycyclic aromatic hydrocarbons has not been positively identified and does not appear to be the landfill. It could be from fugitive dust during pitch shipment unloading or the south and west stormwater drain discharges.

Bioresearches conclusions

Bioresearches (1994) study concluded that none of the possible waste constituents analysed in the intertidal marine sediment in the vicinity of landfill were present in concentrations that present any risk of adverse effects on the marine ecosystem. The Bioresearches (1995) study did not alter these conclusions.

Future effects and mitigation

Adverse effects on marine sediments are unlikely to occur in the future. In addition, process improvements at NZAS, including the liquid pitch system, will reduce the sources of polycyclic aromatic hydrocarbons.

Marine Species

Marine species studies

The marine species in the vicinity of the landfill have been included in the following studies:

- Street (1994) environmental study "Marine Life"
- a study of Bull Kelp by Street (1993), and
- a study by Zenith (1995).

Street (1994) visual assessment

Street observed no marine life in the intertidal zone and relatively sparse marine life below low tide on the beach to the east of the landfill. This is due to the natural characteristics of the beach which is steep with a substrate comprising of coarse sand and gravel.

The marine life on the reef bottom on the north side of Tiwai Point (east of the landfill) contained marine life typical of that to be found on an exposed rocky coastline. There was no visible evidence of any species being affected by the proximity to the NZAS landfill.

Analysis results

The analysis results for the marine species collected in March and April, 1992, from the area adjacent to the NZAS landfill are given in the following tables.

Continued on next page

Table 27 Landfill Area Samples: Cadmium, Vanadium, Fluoride

Site Information	Sample Type	Total Cadmium (mg.kg^{-1} dry wt)	Total Vanadium (mg.kg^{-1} dry wt)	Fluoride (mg.kg^{-1} wet wt)
Landfill site	Crabs	12.1	0.93	-
Landfill site	Sea Tulips	0.09	1.09	-
Landfill site	Small wheel shellfish	1.3	2.98	-
Landfill site	Mussels	1.3	6.2	4.7
Landfill site	Paua	2.4	0.4	4.8
Landfill site	Gastropods	0.4	6.9	5.8

Table 28 Landfill Area Samples: Polycyclic Aromatic Hydrocarbons in Mussels $\mu g.kg^{-1}$ (wet weight)

Compound	Mussels at Landfill Area
anthracene	n.d.
fluoroanthene	0.4
pyrene	0.6
chysene/benz[a]anthracene	0.4
benzo[b]fluoranthene	0.4
benzo[k]fluoranthene	0.2
benz[a]pyrene	0.3
dibenz[a,h]anthracene	n.d.
benzo[g,h,i]perylene	n.d.

n.d. = not detected

Continued on next page

Street (1994) conclusions from analysis results

Street (1994) conclusions on marine life indicated:

- the cadmium and vanadium concentrations were within the normal ranges
- there was no significant accumulation of polycyclic aromatic hydrocarbons, and
- the fluoride concentrations were similar to the pre smelter surveys.

Bull kelp study findings

During the study by Street (1993) the following findings relevant to the proximity of the landfill were made:

- the bull kelp (Durvillaea antarctica) stand at Tiwai Point appeared to be in good condition
- some bull kelp plants were infested with Herpodiscus, a naturally occurring parasite, and
- exposed rocks and rock pools on Tiwai Point were rich in both algae and animal life.

Bull kelp study conclusion

Bull kelp stands in other areas were inspected and the overall conclusion was that the study found no evidence that the smelter was having any adverse effects on bull kelp.

Zenith (1995) study

The study by Zenith (1995) included fluoride in cockle shell and total phenols and polycyclic aromatic hydrocarbons in cockle flesh in the area to the west of the landfill. Cockles were chosen as an appropriate species to sample following discussions between iwi representatives and NZAS.

The sampling sites are shown in Figure 10 and the results are given in the Tables 29 - 31. The sample sites "A" are in the intertidal zone and the sites "B" are at the low water mark.

Continued on next page

Figure 10 Zenith (1995) study Sampling Sites

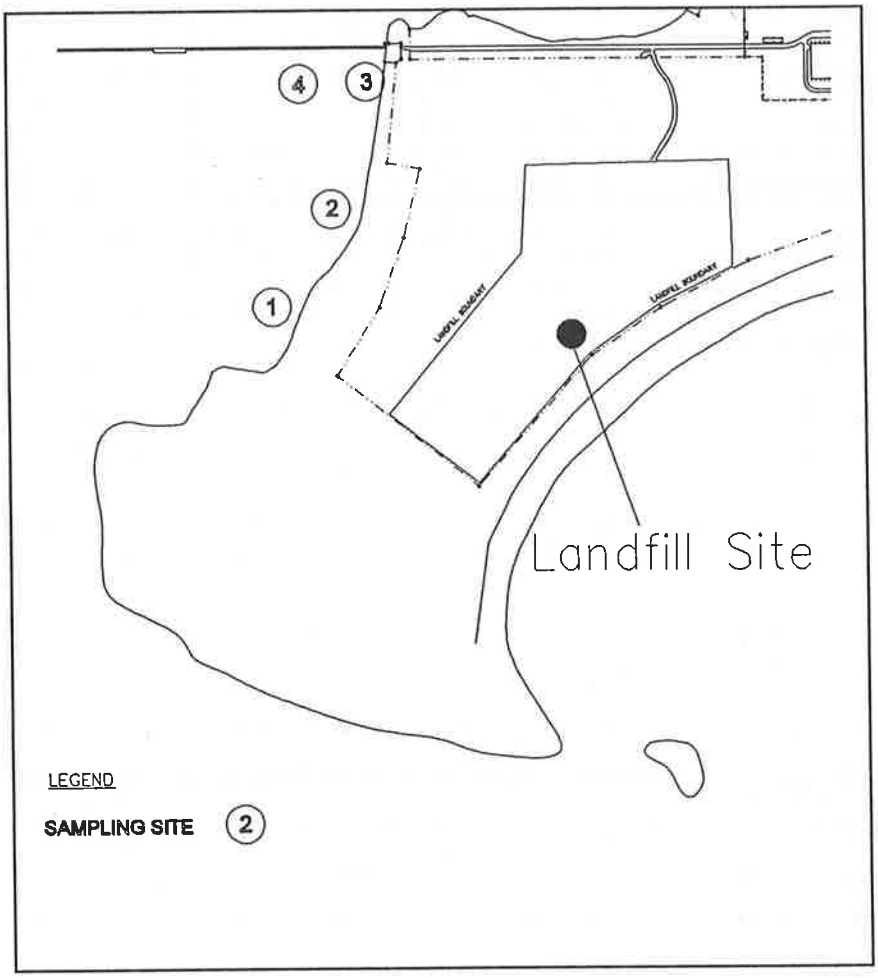


Table 29 Fluoride in Landfill Area Cockle Shells (ashed).

Site Number	Fluoride mg.kg^{-1}
1A	260
1B	320
2A	330
2B	280
3A	560
3B	610
4A	490
4B	730

Continued on next page

Table 30 Concentration of PAH's in cockle flesh; $\mu g.kg^{-1}$ (wet weight).

Site No	1A	1B	2A	2B	3A	3B	4A	4B
Fluoranthene	6.6	4.6	NQ	6.3	15.5	14.8	42.4	18.5
Pyrene	<4.0	<4.0	5.1	<4.0	5.1	4.6	13.8	8.4
Benzo(a)anthracene	2.5	1.7	2.7	2.5	3.5	2.6	1.9	2.7
Chrysene	7.4	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Benzo(b)fluoranthene	3.8	2.1	3.6	3.6	4.9	4.1	1.8	2.5
Benzo(k)fluoranthene	1.5	1.0	1.5	1.6	2.2	1.9	0.7	1.0
Benzo(a)pyrene	2.3	1.2	3.0	2.8	3.7	2.9	1.2	1.7
Dibenzo(a,h)anthracene	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Benzo(g,h,i)perylene	<2.0	<2.0	2.7	2.4	<2.0	1.9	<2.0	<2.0
Indeno(1,2,3-cd)pyrene	<40	<40	<40	<40	<40	<40	<40	<40
Total	**24.1**	**10.6**	**18.6**	**19.2**	**34.9**	**32.8**	**61.8**	**34.8**

NQ = Not Quantifiable

Table 31 Concentration of phenols in cockle flesh; $\mu g.kg^{-1}$ (wet weight)

Site No	1A	1B	2A	2B	3A	3B	4A	4B
Phenol	1994	1254	1386	1307	930	1151	622	728
Orthochlorophenol	<20	<20	<20	<20	<20	<20	<20	<20
Parachlorophenol	302	<50	<50	<50	1519	141	128	<50
Metachlorophenol	111	<20	194	<20	1402	<20	108	1139
2,4 - Dichlorophenol	<20	<20	<20	<20	<20	<20	<20	<20
2,5 - Dichlorophenol	<20	<20	<20	<20	<20	<20	<20	<20
Pentachlorophenol	<20	<20	<20	<20	<20	<20	<20	<20
Total	**2407**	**1254**	**1580**	**1307**	**3851**	**1292**	**858**	**1867**

Continued on next page

Interpretation of fluoride results

The fluoride concentrations in cockle shells measured by Zenith (1995) are compared with background data in the following table.

Table 32 Fluoride in Cockle Shells

Reference	Location	Fluoride, $mg.kg^{-1}$ shell ash
Zenith (1995)	West of landfill	260-730
Zenith (1995)	Waitati, Otago	440
Street (1994)	Waituna	690
Street (1994)	Waikawa	890
Stewart (1974)	Tiwai area	145

There is no evidence that the discharges at the NZAS landfill are increasing the fluoride concentration in cockle shells.

Interpretation of PAH results

The PAH concentrations in cockles are higher than the concentrations in mussels by Street (1994). The PAH data has been compared with overseas data in the following table.

Continued on next page

Table 33 Comparison of PAH concentrations in shellfish.

Reference	Species	Location	PAH, $\mu g.kg^{-1}$ wet wt
Zenith (1995)	Cockles	East of Landfill	10.6 - 61.8
Zenith (1995)	Cockles	Waitati, Otago	5.9
Street (1994)	Mussels	Near landfill	2.3
Mackie (1980)	Mussels (unpolluted)	Scottish Coast	50 - 140
Mackie (1980)	Mussels (heavily polluted)	Scottish Coast	1930 - 2850
Rainio (1986)	Mussels	SW Finland	<0.5 - 148
Pancirov (1977)	Mussels	Falmouth Mass. USA	2.5 - 6.5
Iosifidou (1982)	Mussels	Thermaikos Gulf, Greece	77 - 111
Amodio - Cocchieri (1990)	Mussels	Gulf of Naples	295
Amodio - Cocchieri (1990)	Cockles	Gulf of Naples	198
Amodio - Cocchieri (1993)	Mussels	Ionian Sea, Italy	256 - 920

Comment on the comparison of PAH data

The PAH concentrations in cockles and mussels near the landfill are generally lower than overseas areas where data is available. There is no evidence that the discharges at the landfill are causing elevated PAH concentrations in shellfish. In addition, NZAS process improvements, including the liquid pitch system, will reduce the amount of PAH discharged into the marine environment.

Continued on next page

Interpretation of phenol results

The phenol concentrations of 858 - 3851 $\mu g.kg^{-1}$ in cockles measured by Zenith (1995) was:

- higher than the <25 $\mu g.kg^{-1}$ measured at Waikawa by Street (1994),
- similar to other areas in Bluff Harbour and Awarua Bay measured by Zenith (1995), and
- similar to the 1559 $mg.kg^{-1}$ measured at Waitati (Otago) by Zenith (1995).

Improved analytical techniques may have contributed with more phenolic compounds being measured by Zenith (1995). There is no known source of phenols from the landfill but phenols are known to be in biocides occasionally discharged from the NZAS west and south drains. Other sources, possibly some natural, could also be present in the Bluff Harbour area.

The data does not indicate that the discharges as the landfill are increasing the phenol content of cockles.

Future effects and mitigation

The existing discharges at the NZAS landfill are not adversely affecting the marine life in Bluff Harbour and Awarua Bay. Based on the current situation, planned landfill operation and waste management improvements, adverse effects on marine life are unlikely to occur in the future. Improvements with other processes and practices should also avoid adverse effects in the marine area near the landfill.

Visual Aspects

Boffa Miskell study

The environmental study of the visual aspects of the smelter by Boffa Miskell (1993) included the landfill. This study involved visual assessments of the smelter from 30 locations. The landfill was only visible from the Bluff sites.

Boffa Miskell findings

At the time of this assessment (March 1992) the landfill was very visible from Bluff, particularly the elevated sites.

Improvements

Since the Boffa Miskell study the following actions have been taken:

- the exposed landfill face has been reduced,
- the sides of the landfill have been profiled,
- MRP fines are now stored in cells which are covered and revegetated when completed, and
- completed areas of the landfill have been revegetated.

The above actions have significantly reduced the visibility of the landfill from Bluff.

Future effects and mitigation

The landfill will become less visible from Bluff in the future as the revegetated areas become more established. This improvement has been acknowledged during discussions with community groups and during the consultation process.

The current vegetation of completed landfill areas will continue.

Other Effects

Noise

Possible noise sources at the landfill include:

- vehicles delivering waste,
- loaders working at the landfill face, and
- equipment preparing the completed landfill areas for revegetation.

Most of this activity is in the day time with only waste delivery occurring at night.

The environmental study by Hegley (1994) did not detect any noise in the residential areas of Bluff from the landfill operations.

Landfill gases

The putrescible content of the NZAS wastes is very low so landfill gas generation from waste decay is insignificant. A small amount of gas may be generated from the MRP fines when they are wet. However this gas is unlikely to cause adverse effects on the environment.

Odour

The type and quantity of wastes landfilled and the location of the NZAS landfill do not result in noxious odours in neighbouring areas.

Chapter 6

Manawhenua Issues

Overview

Introduction

The iwi representatives were consulted on this proposal. In addition, the NZAS landfill operation has been included in the topics discussed at several meetings with iwi representatives. The manawhenua affected by the likely discharges at the landfill are unlikely to be affected by the discharges at the landfill.

In this chapter

This chapter contains the following topics:

Manawhenua Issues with Landfilling

Consultation with iwi representatives

The selection of appropriate landfill sites and well managed landfill operations is consistent with the issues raised during consultation with iwi representatives. The consultation involved a visit to the landfill and discussions in July 1994 and discussions on this application in March 1995. The issues raised were:

- protection of water resources,
- preference for land-based disposal of waste, and
- protection of mahinga kai.

Southland takata whenua issues

The proposed Regional Solid Waste Management plan prepared by the Southland Regional Council gives the two main issues for the takata whenua with regard to solid waste. These are:

- the need to keep waste and leachate from waste out of water (surface, ground and coastal), and

- the need to ensure that solid waste disposal facilities are not sited on areas of cultural or historic significance.

The proposed plan states these issues were highlighted during consultation with the takata whenua.

Manawhenua issues

Consultation between the iwi representatives and the NZAS has indicated that issues being addressed are manawhenua issues.

Southland climate

The climate of Southland makes it extremely difficult to operate a landfill without rain water coming in contact with the waste material at some stage of the process. This will invariably result in some leachable components being carried to water. However the contact between waste and rain water has been minimised by:

- keeping the operating face of the landfill as small as possible,
- covering and profiling closed areas, and
- the revegetation programme.

The groundwater quality is discussed in Chapter 5, pages 5.5 to 5.10.

Protection of water bodies

The current and future operating practices at the NZAS landfill are designed to:

- minimise the environmental effects on the groundwater under the landfill, although this is a low value resource (Chapter 5 page 5.5)
- maintain the quality of the aquifer water resource on Tiwai Peninsula, and
- not adversely affect the sea water quality in Bluff Harbour and Foveaux Strait (Chapter 5, page 5.16)

Land based disposal

The current and proposed future NZAS landfill operations use only land based disposal.

Mahinga kai

The marine species are predicted to remain unaffected by the NZAS landfill operation (Chapter 5, page 5.28).

Areas of cultural and historic significance

Consultation with the iwi representatives has indicated that the NZAS landfill site is not in an area of cultural and historic significance.

Chapter 7

Consultation

Overview

Introduction

This chapter provides details of the consultation process, issues raised and the NZAS responses. The issues raised were:

- on-going monitoring,
- monitoring by an external agency,
- the permit term,
- the possibility of leachate collection and treatment, and
- regular meetings on NZAS operations.

In this chapter

This chapter contains the following topics:

Organisations and People Involved

Organisations

The following organisations were consulted:

- Southland Regional Council,
- Invercargill City Council,
- Bluff Community Board,
- Te Oraka Aparima Runaka,
- Hokonui Runaka Inc,
- Awarua Runaka
- Waihopai Runaka
- Rakiura Maori Land Incorporation,
- Historic Places Trust,
- Department of Conservation,
- Southland Conservation Board,
- Southern Health,
- Royal Forest and Bird Protection Society, and
- Comalco New Zealand Limited

In addition MAF, Fisheries South was contacted and technical data provided.

NZAS staff

The following NZAS staff were involved in the consultation process:

- K Duke - Specialist Environmental Scientist, and
- A Groves - Specialist Public Relations Officer.

Data Provided During Consultation

Discharges at the NZAS Landfill

The following data relating to the discharges at the NZAS landfill were provided during the consultations:

- the type of discharge permits being applied for,
- the proposed discharges, and
- a summary of the studies on the environment associated with the landfill.

Other data

NZAS will shortly be making applications for discharge and coastal permits for discharges at locations other than the landfill. Data on these proposals were also provided at the same time as the consultation on the discharges at the landfill. In addition any general questions relating to NZAS were answered.

Issues Raised and NZAS Response

Issues raised

The issues raised during the consultation which relate to the landfill were:

- on-going monitoring,
- monitoring by an external agency,
- the permit term,
- the possibility of leachate collection and treatment, and
- regular meetings on NZAS operations.

Explanation and clarification of the data were also addressed during these consultations.

On-going monitoring

The benefits of on-going monitoring are recognised. Monitoring programmes are proposed in Chapter 8 of this AEE for:

- waste amounts and types, and
- groundwater.

Monitoring by an external agency

The Southland Regional Council has an existing programme to audit the NZAS environmental monitoring results. NZAS considered that the monitoring proposed in Chapter 8 should be added to this programme.

Possible leachate collection and treatment

The possible benefits of leachate collection and treatment were discussed with some of the organisations. The NZAS response to leachate collection and treatment is given below.

- The characteristics of the landfill site and the nature of the materials being disposed indicates that leachate collection and treatment are not required to minimise adverse effects on the environment.

- The limited adverse effects on the environment from past and current landfill operations provide further support to leachate collection and treatment not being required.

- Collecting leachate and creating a point discharge is likely to have more adverse effects on the environment than the existing diffuse discharge due to the natural groundwater system.

Continued on next page

The permit term

The 20 year term for the discharge permit is considered appropriate because of:

- the amount of data available to fully assess the application,
- the maximum term available of 35 years,
- the limited adverse effects on the environment from past and current discharges to the landfill,
- the predicted future limited adverse effect on the environment from discharges to the landfill, and
- adequate provisions for reviewing the permit conditions being available to the Southland Regional Council.

Regular meetings

NZAS recognises the benefits of regular meetings to explain and discuss the smelter operations. Arrangements already exist for meetings with some organisations. Future arrangements will be made based on the discussion between NZAS and the organisations concerned.

Chapter 8

Monitoring

Overview

Introduction

A considerable amount of data is available on the NZAS landfill operations and the surrounding environment. The existence of this data has enabled suitable monitoring programmes to be designed.

In this chapter

This chapter contains the following topic:

Proposed Monitoring

Waste amounts and waste types

NZAS proposes to monitor the amount and types of materials being landfilled by detailed surveys during periods chosen to represent typical conditions. The frequency of these surveys will vary depending on NZAS operations but they will be at least 2 yearly.

This monitoring approach has been proposed because:

- it is practical, and
- it is capable of providing the required level of data.

Changes in material types

The types of waste material being deposited at the NZAS landfill are likely to be relatively constant as the only source is the smelter operations. However, changes in the smelter operations may result in small changes in the types of wastes. It is proposed to monitor the impact of such changes on the types of waste being landfilled by:

- data from the detailed surveys of amounts and types of materials being landfilled,
- data from the allocation of skip trucks to transport the waste, and
- knowledge of the smelter operation changes.

Groundwater

A good database exists on the groundwater at the landfill site. NZAS proposes to monitor the groundwater for changes over time by sampling 12 of the existing bores twice each year. One set of samples will be collected in the summer and the other set will be collected in the winter.

Auditing

It is appropriate that the monitoring associated with the landfill is added to the Southland Regional Council's programme to audit the NZAS environmental monitoring results.

Other effects

No other environmental effects are known to be occurring or are likely to occur in the future which require a monitoring programme. However, the landfill operation can be included in any future studies of the environmental aspects of the NZAS operations.

References

Amodio - Cocchieri, R, et al, 1990; Polycyclic Aromatic Hydrocarbons in Marine Organisms from Italian Central Mediterranean Coasts; Mar. Pulut. Bull; 21: 15-18

Amodio - Cocchieri, R, et al, 1993; Heavy Metals and Polycyclic Hydrocarbons in Marine Organisms from the Ionian Sea; Bull. Environ. Contam. Toxicol; 50: 618-625

Bioresearches, 1994; Discharges into the Coastal Marine Area; Environmental Study, NZAS, July 1994.

Boffa Miskell, 1993; Visual Aspects; Environmental Study, NZAS, November 1994.

Bowen Robert; Groundwater, Second Edition; Elsevier Applied Science Publishers.

Hitchcock, 1994; Leachate Analysis of Material Currently brought to the Landfill, NZAS Internal Report, 1 December 1994.

Hegley, 1994; Noise; Environmental Study, NZAS, August 1994.

Harkness, 1994; NZAS Landfill Survey, Internal Report

Iosifidou, H G, et al, 1982; Analysis for Polycyclic Aromatic Hydrocarbons in Mussels from the Thermaikos Gulf, Greece; Bull. Environ. Contam. Toxicol; 28: 535-541

Knight, 1991; Solid Material Fluoride Leachate Survey, NZAS Internal Report, 24 June 1991.

Mackie, P R, 1980; The Tissue Hydrocarbon Burden of Mussels from Various Sites Around the Scottish Coast. In Bjorseth, D (ed), Polynuclear Aromatic Hydrocarbons: Chemistry and Biological Effects; Battelle Press

Pancirov, R J, et al 1977; Polynuclear Aromatic Hydrocarbons in Marine Tissues; Environ Sci Technol; 11: 989-992

Rainio, K, et al, 1986; Bull Environ. Contam. Toxicol; 37: 337-343

Street R, 1993; Observations on Bull Kelp (Durvillaea Antarctica) in Northern Foveaux Strait and near Dunedin, September 1993.

Street R, 1994; Marine Life; Environmental Study, NZAS, June 1994.

Woodward-Clyde, 1994; Landfill Study, NZAS, May 1994.

Continued on next page

Zenith Technology Corporation Limited, 1995; Fluoride, Phenols and Polycyclic Aromatic Hydrocarbons in Cockles; NZAS Project

Appendices

Appendix 1	Organic Compounds Investigated in Leachates from Waste Samples
Appendix 2	Results of Organic Compounds Investigated in Leachates from Waste Samples
Appendix 3	Leachates from Waste Samples - Metal Scan
Appendix 4	Leachates from Waste Samples - Further Inorganic Analysis

Appendix 1 - Organic Compounds Investigated in Leachates from Waste Samples

ORGANIC COMPOUNDS INVESTIGATED IN LEACHATES FROM WASTE SAMPLES

PARAMETER	DETECTION LIMIT ($g.m^{-3}$)
VOLATILE ORGANICS	
Benzene	<0.001
Toluene	<0.001
Ethyl benzene	<0.001
Xylenes, total	<0.001
1,1-Dichloroethene	nd
Methylene chloride	nd
1,1-Dichloroethene	nd
Chloroform	nd
Carbon tetrachloride	nd
Trichloroethene	nd
1,2-Dichloropropane	nd
Chlorobenzene	nd
Acetone	nd
2-Butanone	nd
4-Methyl-2-pentanone	nd
2-Hexanone	nd
trans-1,2-Dichloroethene	nd
cis-1,2,-Dichloroethene	nd
1,1,1-Trichloroethane	nd
Bromodichloromethane	nd
cis-1,3-Dichloropropene	nd
trans-1,3-Dichloropropene	nd
Tetrachloroethene	nd
Dibromochloromethane	nd
Styrene	nd
Bromoform	nd
1,1,2,2-Tetrachloroethane	nd
Trimethylbenzene	*

Continued on next page

ORGANIC COMPOUNDS INVESTIGATED IN LEACHATES FROM WASTE SAMPLES

PARAMETER	DETECTION LIMIT ($g.m^{-3}$)
SEMI-VOLATILE ORGANICS	
Basic & Neutral Compounds	
bis(2-chloroethyl)ether	<0.006
1,3-Dichlorobenzene	<0.002
1,4-Dichlorobenzene	<0.002
Benzyl alcohol	<0.003
1,2-Dichlorobenzene	<0.002
n-Nitroso-di-n-propylamine	nd
Hexachloroethane	<0.002
Nitrobenzene	<0.005
Isophorone	<0.002
bis(2-Chloroethoxy)methane	<0.006
1,2,4-Trichlorobenzene	<0.002
Naphthalene	<0.001
Hexachlorobutadiene	<0.001
2-Methylnaphthalene	<0.001
Hexachlorocylopentadiene	nd
2-Chloronapthalene	<0.002
Dimethyl phthalate	<0.002
Acenaphthylene	<0.001
Acenaphthene	<0.001
Dibenzofuran	<0.001
Diethyl phthalate	<0.002
Fluorene	<0.001
4-Chlorophennyl phenyl ether	<0.002
N-Nitrosodiphenylamine	<0.005
4-Bromophenyl phenyl ether	<0.002
a-BHC	nd
b-BHC	<0.005
c-BHC (Lindane)	<0.005
Phenanthrene	<0.001
Anthracene	<0.001
d-BHC	nd

Continued on next page

Appendix 1 - Organic Compounds Investigated in Leachates from Waste Samples, Continued

ORGANIC COMPOUNDS INVESTIGATED IN LEACHATES FROM WASTE SAMPLES

PARAMETER	DETECTION LIMIT ($g.m^{-3}$)
Heptachlor	<0.002
Di-n-butyl phthalate	<0.002
Aldrin	<0.002
Heptachlor epoxide	<0.002
Fluoranthene	<0.001
Pyrene	<0.001
4,4'-DDE	<0.006
Dieldrin	<0.003
Endosulfan II	nd
4,4'-DDD	<0.003
Butyl benzyl phthalate	<0.003
Endosulfan sulphate	<0.006
Methoxychlor	<0.006
Endrin ketone	nd
Benzo(a)anthracene	<0.001
4,4'-DDT	<0.005
Chrysene	<0.001
Bis(2-Ethylhexyl) phthalate	<0.003
Dibenzo(a,h)anthracene	<0.001
Benzo(g,h,i)perylene	<0.001
Isoindole-1,3-dione	*
1,2-dihydroacenaphthalene	*
Fluoren-9-one	*
Xanthen-9-one	*
Benzo(c)cinnoline	*
Anthracenedione	*
Carbazole	*
<u>Acidic Compounds</u>	
Phenol	<0.001
2-Chlorophenol	<0.002

Continued on next page

Appendix 1 - Organic Compounds Investigated in Leachates from Waste Samples, Continued

ORGANIC COMPOUNDS INVESTIGATED IN LEACHATES FROM WASTE SAMPLES

PARAMETER	DETECTION LIMIT ($g.m^{-3}$)
2-Methylphenol	<0.002
4-Methylphenol	<0.002
2-Nitrophenol	<0.002
2,4-Dimethylphenol	<0.002
2,4-Dichlorophenol	<0.002
4-Chloro-3-methylphenol	<0.002
2,4,6-Trichlorophenol	<0.002
2,4,5-Trichlorophenol	<0.002
Pentachlorophenol	<0.005
Benzopyran-2-one	*
Benzoic acid	*
Phthallic acid derivatives	*
Napthalenol	*
Naphthalenecarboxylic acid	*
Fluoren-9-one	*

nd = not detected (detection limit has not been determined).
* = non-target compounds tentatively detected.

RESULTS OF ORGANIC COMPOUNDS INVESTIGATION IN LEACHATES FROM WASTE SAMPLES

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C ($g.m^{-3}$)
Volatiles			
Toluene	Composite of Samples 4-12	0.002	5
Xylenes - total	Composite of Samples 4-12	0.002	6
Semi Volatiles			
Naphthalene	Composite of Samples 4-12	0.002	3
Acenaphthylene	Composite of Samples 4-12	0.001	-
Acenaphthene	Composite of Samples 4-12	0.001	-
Dibenzofuran	Composite of Samples 4-12	0.004	-
Fluorene	Composite of Samples 4-12	0.002	-
Fluoranthene	Composite of Samples 4-12	0.009	0.5
Pyrene	Composite of Samples 4-12	0.006	0.5
Anthracene	Composite of Samples 4-12	0.022	1
Total PCA's	Composite of Samples 4-12	0.047	4
Acidic Compounds			
Phenol	Composite of Samples 4-12	0.002	5

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian - Level C Criterion ($g.m^{-3}$)
Aluminium	1 (Old bricks, tar area	0.2	-
	2 (Refractory material)	5.9	
	3 (New refractory bricks)	0.63	
	4 (Two year old C Rodding Room dust)	183	
	5 (Rodding Room dust : exposed)	153	
	6 (Three week old Rodding Room dust)	24.5	
	7 (Coke mixed with Pitch)	3.9	
	8 (Dross composite)	6.3	
	9 (Dross - large fragments)	3.1	
	10 (Dross - screened)	1.5	
	11 (Pitch from store)	0.88	
	12 (Precipitator tar)	0.59	
	13 (Duplicate of No. 6)	24.0	
	Blank	0.03	
	Test Pit C1	18.5	
	Test Pit C1, C2, C3 (composite)	5.1	
	Blank	<0.02	
Arsenic	1 (Old bricks, tar area	<0.03	10
	2 (Refractory material)	<0.04	
	3 (New refractory bricks)	<0.03	
	4 (Two year old C Rodding Room dust)	<0.04	
	5 (Rodding Room dust : exposed)	<0.03	
	6 (Three week old Rodding Room dust)	<0.03	
	7 (Coke mixed with Pitch)	<0.04	
	8 (Dross composite)	<0.03	
	9 (Dross - large fragments)	<0.03	
	10 (Dross - screened)	<0.03	
	11 (Pitch from store)	<0.04	
	12 (Precipitator tar)	<0.03	
	13 (Duplicate of No. 6)	<0.04	
	Blank	<0.03	
	Test Pit C1	<0.04	
	Test Pit C1, C2, C3 (composite)	<0.03	
	Blank	<0.04	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level Criteria ($g.m^{-3}$)
Boron	1 (Old bricks, tar area	0.009	-
	2 (Refractory material)	0.03	
	3 (New refractory bricks)	0.01	
	4 (Two year old C Rodding Room dust)	0.03	
	5 (Rodding Room dust : exposed)	0.03	
	6 (Three week old Rodding Room dust)	0.01	
	7 (Coke mixed with Pitch)	0.02	
	8 (Dross composite)	2.4	
	9 (Dross - large fragments)	2.4	
	10 (Dross - screened)	3.4	
	11 (Pitch from store)	0.04	
	12 (Precipitator tar)	0.03	
	13 (Duplicate of No. 6)	0.02	
	Blank	0.01	
	Test Pit C1	0.17	
	Test Pit C1, C2, C3 (composite)	0.15	
	Blank	0.006	
Cadmium	1 (Old bricks, tar area	<0.003	2
	2 (Refractory material)	<0.004	
	3 (New refractory bricks)	<0.003	
	4 (Two year old C Rodding Room dust)	<0.004	
	5 (Rodding Room dust : exposed)	<0.003	
	6 (Three week old Rodding Room dust)	<0.003	
	7 (Coke mixed with Pitch)	<0.004	
	8 (Dross composite)	<0.003	
	9 (Dross - large fragments)	<0.003	
	10 (Dross - screened)	<0.003	
	11 (Pitch from store)	0.01	
	12 (Precipitator tar)	<0.003	
	13 (Duplicate of No. 6)	<0.004	
	Blank	<0.003	
	Test Pit C1	<0.004	
	Test Pit C1, C2, C3 (composite)	<0.003	
	Blank	<0.004	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 X Victorian Level Criteria ($g.m^{-3}$)
Calcium	1 (Old bricks, tar area	2.2	-
	2 (Refractory material)	5.4	
	3 (New refractory bricks)	1.1	
	4 (Two year old C Rodding Room dust)	17.7	
	5 (Rodding Room dust : exposed)	40.0	
	6 (Three week old Rodding Room dust)	4.7	
	7 (Coke mixed with Pitch)	1.1	
	8 (Dross composite)	0.27	
	9 (Dross - large fragments)	0.45	
	10 (Dross - screened)	0.25	
	11 (Pitch from store)	1.0	
	12 (Precipitator tar)	1.3	
	13 (Duplicate of No. 6)	4.7	
	Blank	0.06	
	Test Pit C1	1.4	
	Test Pit C1, C2, C3 (composite)	2.7	
	Blank	0.04	
Chromium	1 (Old bricks, tar area	<0.003	50
	2 (Refractory material)	<0.004	
	3 (New refractory bricks)	<0.003	
	4 (Two year old C Rodding Room dust)	<0.004	
	5 (Rodding Room dust : exposed)	<0.003	
	6 (Three week old Rodding Room dust)	<0.003	
	7 (Coke mixed with Pitch)	<0.004	
	8 (Dross composite)	<0.003	
	9 (Dross - large fragments)	<0.003	
	10 (Dross - screened)	<0.003	
	11 (Pitch from store)	<0.004	
	12 (Precipitator tar)	<0.003	
	13 (Duplicate of No. 6)	<0.004	
	Blank	<0.003	
	Test Pit C1	<0.004	
	Test Pit C1, C2, C3 (composite)	<0.003	
	Blank	<0.004	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Cobalt	1 (Old bricks, tar area	0.005	20
	2 (Refractory material)	<0.004	
	3 (New refractory bricks)	0.03	
	4 (Two year old C Rodding Room dust)	0.04	
	5 (Rodding Room dust : exposed)	0.05	
	6 (Three week old Rodding Room dust)	<0.003	
	7 (Coke mixed with Pitch)	<0.004	
	8 (Dross composite)	<0.003	
	9 (Dross - large fragments)	<0.003	
	10 (Dross - screened)	<0.003	
	11 (Pitch from store)	<0.004	
	12 (Precipitator tar)	<0.003	
	13 (Duplicate of No. 6)	<0.004	
	Blank	<0.003	
	Test Pit C1	<0.004	
	Test Pit C1, C2, C3 (composite)	<0.003	
	Blank	<0.004	
Copper	1 (Old bricks, tar area	<0.003	100
	2 (Refractory material)	<0.004	
	3 (New refractory bricks)	<0.003	
	4 (Two year old C Rodding Room dust)	0.03	
	5 (Rodding Room dust : exposed)	0.008	
	6 (Three week old Rodding Room dust)	<0.003	
	7 (Coke mixed with Pitch)	<0.004	
	8 (Dross composite)	<0.003	
	9 (Dross - large fragments)	<0.003	
	10 (Dross - screened)	<0.003	
	11 (Pitch from store)	<0.004	
	12 (Precipitator tar)	<0.003	
	13 (Duplicate of No. 6)	<0.004	
	Blank	<0.003	
	Test Pit C1	0.04	
	Test Pit C1, C2, C3 (composite)	<0.003	
	Blank	<0.004	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Iron	1 (Old bricks, tar area	0.10	-
	2 (Refractory material)	0.02	
	3 (New refractory bricks)	0.02	
	4 (Two year old C Rodding Room dust)	0.02	
	5 (Rodding Room dust : exposed)	0.07	
	6 (Three week old Rodding Room dust)	0.09	
	7 (Coke mixed with Pitch)	0.05	
	8 (Dross composite)	0.19	
	9 (Dross - large fragments)	0.21	
	10 (Dross - screened)	0.06	
	11 (Pitch from store)	0.36	
	12 (Precipitator tar)	0.11	
	13 (Duplicate of No. 6)	0.05	
	Blank	0.01	
	Test Pit C1	0.66	
	Test Pit C1, C2, C3 (composite)	0.05	
	Blank	0.01	
Lead	1 (Old bricks, tar area	<0.02	10
	2 (Refractory material)	<0.02	
	3 (New refractory bricks)	<0.02	
	4 (Two year old C Rodding Room dust)	<0.02	
	5 (Rodding Room dust : exposed)	<0.02	
	6 (Three week old Rodding Room dust)	<0.02	
	7 (Coke mixed with Pitch)	<0.02	
	8 (Dross composite)	<0.02	
	9 (Dross - large fragments)	<0.02	
	10 (Dross - screened)	<0.02	
	11 (Pitch from store)	<0.02	
	12 (Precipitator tar)	<0.02	
	13 (Duplicate of No. 6)	<0.02	
	Blank	<0.02	
	Test Pit C1	<0.02	
	Test Pit C1, C2, C3 (composite)	<0.02	
	Blank	<0.02	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration (g.m^{-3})	100 x Victorian Level C Criteria (g.m^{-3})
Magnesium	1 (Old bricks, tar area	0.09	-
	2 (Refractory material)	0.55	
	3 (New refractory bricks)	0.07	
	4 (Two year old C Rodding Room dust)	0.26	
	5 (Rodding Room dust : exposed)	0.83	
	6 (Three week old Rodding Room dust)	0.53	
	7 (Coke mixed with Pitch)	0.13	
	8 (Dross composite)	0.93	
	9 (Dross - large fragments)	2.0	
	10 (Dross - screened)	3.3	
	11 (Pitch from store)	0.06	
	12 (Precipitator tar)	0.03	
	13 (Duplicate of No. 6)	0.47	
	Blank	<0.02	
	Test Pit C1	1.1	
	Test Pit C1, C2, C3 (composite)	3.3	
	Blank	<0.03	
Manganese	1 (Old bricks, tar area	0.006	-
	2 (Refractory material)	0.15	
	3 (New refractory bricks)	0.02	
	4 (Two year old C Rodding Room dust)	3.8	
	5 (Rodding Room dust : exposed)	13.0	
	6 (Three week old Rodding Room dust)	0.79	
	7 (Coke mixed with Pitch)	0.03	
	8 (Dross composite)	0.003	
	9 (Dross - large fragments)	0.02	
	10 (Dross - screened)	0.02	
	11 (Pitch from store)	0.01	
	12 (Precipitator tar)	0.004	
	13 (Duplicate of No. 6)	0.83	
	Blank	0.002	
	Test Pit C1	0.02	
	Test Pit C1, C2, C3 (composite)	0.07	
	Blank	<0.0005	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Molybdenum	1 (Old bricks, tar area	<0.003	10
	2 (Refractory material)	<0.004	
	3 (New refractory bricks)	<0.003	
	4 (Two year old C Rodding Room dust)	<0.004	
	5 (Rodding Room dust : exposed)	<0.003	
	6 (Three week old Rodding Room dust)	0.004	
	7 (Coke mixed with Pitch)	<0.004	
	8 (Dross composite)	0.01	
	9 (Dross - large fragments)	<0.003	
	10 (Dross - screened)	0.004	
	11 (Pitch from store)	<0.004	
	12 (Precipitator tar)	<0.003	
	13 (Duplicate of No. 6)	0.005	
	Blank	<0.003	
	Test Pit C1	<0.004	
	Test Pit C1, C2, C3 (composite)	<0.003	
	Blank	<0.004	
Nickel	1 (Old bricks, tar area	0.02	100
	2 (Refractory material)	0.005	
	3 (New refractory bricks)	0.03	
	4 (Two year old C Rodding Room dust)	0.88	
	5 (Rodding Room dust : exposed)	1.7	
	6 (Three week old Rodding Room dust)	0.14	
	7 (Coke mixed with Pitch)	0.02	
	8 (Dross composite)	<0.003	
	9 (Dross - large fragments)	<0.003	
	10 (Dross - screened)	<0.003	
	11 (Pitch from store)	0.01	
	12 (Precipitator tar)	<0.003	
	13 (Duplicate of No. 6)	0.15	
	Blank	<0.003	
	Test Pit C1	0.02	
	Test Pit C1, C2, C3 (composite)	<0.003	
	Blank	<0.004	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Phosphorous	1 (Old bricks, tar area	0.07	70
	2 (Refractory material)	<0.05	
	3 (New refractory bricks)	<0.05	
	4 (Two year old C Rodding Room dust)	<0.05	
	5 (Rodding Room dust : exposed)	<0.05	
	6 (Three week old Rodding Room dust)	<0.05	
	7 (Coke mixed with Pitch)	<0.05	
	8 (Dross composite)	<0.05	
	9 (Dross - large fragments)	<0.05	
	10 (Dross - screened)	<0.05	
	11 (Pitch from store)	<0.05	
	12 (Precipitator tar)	<0.05	
	13 (Duplicate of No. 6)	<0.05	
	Blank	<0.05	
	Test Pit C1	<0.05	
	Test Pit C1, C2, C3 (composite)	<0.05	
	Blank	<0.05	
Potassium	1 (Old bricks, tar area	0.15	-
	2 (Refractory material)	0.4	
	3 (New refractory bricks)	0.21	
	4 (Two year old C Rodding Room dust)	1.3	
	5 (Rodding Room dust : exposed)	2.8	
	6 (Three week old Rodding Room dust)	0.77	
	7 (Coke mixed with Pitch)	0.48	
	8 (Dross composite)	45.	
	9 (Dross - large fragments)	11.1	
	10 (Dross - screened)	10.	
	11 (Pitch from store)	0.11	
	12 (Precipitator tar)	<0.1	
	13 (Duplicate of No. 6)	0.55	
	Blank	<0.1	
	Test Pit C1	2.8	
	Test Pit C1, C2, C3 (composite)	1.6	
	Blank	<0.11	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Selenium	1 (Old bricks, tar area	<0.03	5
	2 (Refractory material)	<0.04	
	3 (New refractory bricks)	<0.03	
	4 (Two year old C Rodding Room dust)	<0.04	
	5 (Rodding Room dust : exposed)	<0.03	
	6 (Three week old Rodding Room dust)	<0.03	
	7 (Coke mixed with Pitch)	<0.04	
	8 (Dross composite)	<0.03	
	9 (Dross - large fragments)	<0.03	
	10 (Dross - screened)	<0.03	
	11 (Pitch from store)	<0.04	
	12 (Precipitator tar)	<0.03	
	13 (Duplicate of No. 6)	<0.04	
	Blank	<0.03	
	Test Pit C1	<0.04	
	Test Pit C1, C2, C3 (composite)	<0.03	
	Blank	<0.04	
Silica	1 (Old bricks, tar area	0.12	-
	2 (Refractory material)	0.35	
	3 (New refractory bricks)	0.14	
	4 (Two year old C Rodding Room dust)	0.37	
	5 (Rodding Room dust : exposed)	0.57	
	6 (Three week old Rodding Room dust)	0.71	
	7 (Coke mixed with Pitch)	0.27	
	8 (Dross composite)	0.13	
	9 (Dross - large fragments)	0.21	
	10 (Dross - screened)	1.3	
	11 (Pitch from store)	0.18	
	12 (Precipitator tar)	0.97	
	13 (Duplicate of No. 6)	0.26	
	Blank	0.16	
	Test Pit C1	0.71	
	Test Pit C1, C2, C3 (composite)	0.35	
	Blank	0.14	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Sodium	1 (Old bricks, tar area	1.9	-
	2 (Refractory material)	26.	
	3 (New refractory bricks)	4.6	
	4 (Two year old C Rodding Room dust)	442	
	5 (Rodding Room dust : exposed)	567	
	6 (Three week old Rodding Room dust)	188	
	7 (Coke mixed with Pitch)	12.3	
	8 (Dross composite)	592	
	9 (Dross - large fragments)	232	
	10 (Dross - screened)	229	
	11 (Pitch from store)	1.3	
	12 (Precipitator tar)	1.4	
	13 (Duplicate of No. 6)	180	
	Blank	0.65	
	Test Pit C1	86	
	Test Pit C1, C2, C3 (composite)	99	
	Blank	0.18	
Strontium	1 (Old bricks, tar area	0.01	-
	2 (Refractory material)	0.02	
	3 (New refractory bricks)	0.007	
	4 (Two year old C Rodding Room dust)	0.11	
	5 (Rodding Room dust : exposed)	0.23	
	6 (Three week old Rodding Room dust)	0.04	
	7 (Coke mixed with Pitch)	0.03	
	8 (Dross composite)	0.03	
	9 (Dross - large fragments)	0.02	
	10 (Dross - screened)	0.02	
	11 (Pitch from store)	0.007	
	12 (Precipitator tar)	0.009	
	13 (Duplicate of No. 6)	0.04	
	Blank	<0.0002	
	Test Pit C1	0.03	
	Test Pit C1, C2, C3 (composite)	0.03	
	Blank	<0.0003	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Sulphur	1 (Old bricks, tar area	0.95	-
	2 (Refractory material)	2.8	
	3 (New refractory bricks)	2.6	
	4 (Two year old C Rodding Room dust)	229	
	5 (Rodding Room dust : exposed)	323	
	6 (Three week old Rodding Room dust)	89	
	7 (Coke mixed with Pitch)	2.9	
	8 (Dross composite)	16.6	
	9 (Dross - large fragments)	5.0	
	10 (Dross - screened)	5.0	
	11 (Pitch from store)	2.2	
	12 (Precipitator tar)	0.33	
	13 (Duplicate of No. 6)	86	
	Blank	0.23	
	Test Pit C1	0.75	
	Test Pit C1, C2, C3 (composite)	6.8	
	Blank	0.03	
Tin	1 (Old bricks, tar area	<0.003	15
	2 (Refractory material)	<0.004	
	3 (New refractory bricks)	<0.003	
	4 (Two year old C Rodding Room dust)	<0.004	
	5 (Rodding Room dust : exposed)	<0.003	
	6 (Three week old Rodding Room dust)	<0.003	
	7 (Coke mixed with Pitch)	<0.004	
	8 (Dross composite)	<0.003	
	9 (Dross - large fragments)	<0.003	
	10 (Dross - screened)	<0.003	
	11 (Pitch from store)	<0.004	
	12 (Precipitator tar)	<0.003	
	13 (Duplicate of No. 6)	<0.004	
	Blank	<0.003	
	Test Pit C1	<0.004	
	Test Pit C1, C2, C3 (composite)	<0.003	
	Blank	<0.004	

Continued on next page

LEACHATES FROM WASTE SAMPLES - METAL SCAN

Parameter	Sample	Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{-3}$)
Zinc	1 (Old bricks, tar area	0.01	1000
	2 (Refractory material)	0.02	
	3 (New refractory bricks)	0.02	
	4 (Two year old C Rodding Room dust)	0.06	
	5 (Rodding Room dust : exposed)	0.07	
	6 (Three week old Rodding Room dust)	0.02	
	7 (Coke mixed with Pitch)	0.02	
	8 (Dross composite)	0.009	
	9 (Dross - large fragments)	0.005	
	10 (Dross - screened)	0.004	
	11 (Pitch from store)	0.07	
	12 (Precipitator tar)	0.19	
	13 (Duplicate of No. 6)	0.007	
	Blank	0.005	
	Test Pit C1	0.13	
	Test Pit C1, C2, C3 (composite)	0.02	
	Blank	0.007	

LEACHATES FROM WASTE SAMPLES - FURTHER INORGANIC ANALYSIS

Parameter		Sample	Concentration ($g.m^{-3}$) (except pH)	100 x Victorian Level C Criteria ($g.m^{3}$)
pH	i	Composite of Samples 7, 11 and 12	4.1	-
	ii	Screened Dross - Sample 10	7.9	
	iii	Composite of Refractories - Samples 1, 2 and 3	6.8	
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	5.9	
	v	Large Dross Fragments - Sample 9	8.0	
	vi	Dross Composite - Sample 8	8.9	
	vii	Duplicate of iv	7.2	
	viii	Test Pit C1	6.8	
	ix	Composite - Test Pits C2, C3 and C4	7.3	
	x	Blank	5.0	
Ammonium-N	i	Composite of Samples 7, 11 and 12	6.4	300
	ii	Screened Dross - Sample 10	3.9	
	iii	Composite of Refractories - Samples 1, 2 and 3	1.12	
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	6.0	
	v	Large Dross Fragments - Sample 9	13.6	
	vi	Dross Composite - Sample 8	31	
	vii	Duplicate of iv	5.5	
	viii	Test Pit C1	0.42	
	ix	Composite - Test Pits C2, C3 and C4	0.12	
	x	Blank	0.03	
Fluoride	i	Composite of Samples 7, 11 and 12	22	400
	ii	Screened Dross - Sample 10	120	
	iii	Composite of Refractories - Samples 1, 2 and 3	17	
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	310	
	v	Large Dross Fragments - Sample 9	136	
	vi	Dross Composite - Sample 8	190	
	vii	Duplicate of iv	240	
	viii	Test Pit C1	58	
	ix	Composite - Test Pits C2, C3 and C4	76	
	x	Blank	0.1	

Continued on next page

LEACHATES FROM WASTE SAMPLES - FURTHER INORGANIC ANALYSIS

Parameter	Sample		Concentration ($g.m^{-3}$)	100 x Victorian Level C Criteria ($g.m^{3}$)
Total Cyanide	i	Composite of Samples 7, 11 and 12	<0.002	40
	ii	Screened Dross - Sample 10	0.006	
	iii	Composite of Refractories - Samples 1, 2 and 3	<0.002	
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	<0.002	
	v	Large Dross Fragments - Sample 9	0.003	
	vi	Dross Composite - Sample 8	<0.002	
	vii	Duplicate of iv	0.002	
	viii	Test Pit C1	<0.002	
	ix	Composite - Test Pits C2, C3 and C4	0.002	
	x	Blank	<0.002	
Mercury	i	Composite of Samples 7, 11 and 12	<0.0001	2
	ii	Screened Dross - Sample 10	<0.0001	
	iii	Composite of Refractories - Samples 1, 2 and 3	<0.0001	
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	<0.0001	
	v	Large Dross Fragments - Sample 9	<0.0001	
	vi	Dross Composite - Sample 8	<0.0001	
	vii	Duplicate of iv	<0.0001	
	viii	Test Pit C1	<0.0001	
	ix	Composite - Test Pits C2, C3 and C4	0.0003	
	x	Blank	0.0003	
COD	i	Composite of Samples 7, 11 and 12	23	-
	ii	Screened Dross - Sample 10	6	
	iii	Composite of Refractories - Samples 1, 2 and 3	11	
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	<6	
	v	Large Dross Fragments - Sample 9	9	
	vi	Dross Composite - Sample 8	11	
	vii	Duplicate of iv	10	
	viii	Test Pit C1	<6	
	ix	Composite - Test Pits C2, C3 and C4	<6	
	x	Blank	<6	

NZAS

New Zealand Aluminium Smelters Limited

Landfill Management Plan

30 March 1995

Preface

Introduction

This document is the current New Zealand Aluminium Smelters Limited. (NZAS) Landfill Management Plan. This Landfill Management Plan is a dynamic document. It will be reviewed and updated as new landfill management practices are accepted and applied.

NZAS Landfill Management Plan - Table of Contents

Section 1

Introduction

Overview

Introduction

This section outlines the background to waste management at New Zealand Aluminium Smelters Limited (NZAS). It also provides a method of comparing the contents of the NZAS Landfill Management Plan with the requirements of the Proposed Regional Solid Waste management Plan.

The NZAS Landfill Management Plan is a dynamic document. It will be reviewed and updated as new management practices are accepted and applied.

In this section

This section contains the following topics:

Approvals

The Resource Management Act

The Resource Management Act 1991 (RMA), requires approvals to be obtained for the discharges including:

- any contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water, and
- contaminant from any industrial or trade premise onto or into land.

Definition of contaminant

The wastes that are landfilled are included in the definition of "contaminant" in the Resource Management Act.

Authorising activities

Accountability under (RMA) for authorising the discharge associated with landfilling in Southland lies with the Southland Regional Council.

Approval requirements

The effect of RMA section 418(1C) is to require NZAS to submit an application for a discharge permit prior to 1 April 1995 for the discharges onto or into land at the NZAS landfill.

Discharge Permit

The Discharge Permits relating to the NZAS landfill are in Appendix 1.

Asbestos disposal approval

The approval for disposal of asbestos at the NZAS landfill is given in Appendix 2.

Effect of Rule 5.5.2(i)

The effect of the proposed Regional Solid Waste Management Plan, Rule 5.5.2(i) is to require a refuse disposal facility management plan to be prepared. This rule specifies what must be included in the refuse disposal facility management plan.

Management Plan headings

Appendix C of the proposed Regional Solid Waste Management Plan provides headings which could be used in a management plan for a refuse disposal facility site. The headings cover more topics than those which must be included under Rule 5.5.2.

NZAS landfill management plan content

This NZAS landfill management plan has been prepared to provide a level of detail based on Appendix C of the proposed Regional Solid Waste Management Plan. However the following table gives the location in the NZAS Landfill Management Plan of the details which must be included in accordance with Rule 5.5.2(i).

Continued on next page

Data which must be included

The following table shows where the data which must be included is located in the NZAS Landfill Management Plan.

Data	Location
(i) Methodology for minimisation of disposal of reusable or recyclable material	• Continuous Improvement Programme, page 1-6. • NZAS Waste Management Policy, pages 1-6 and 1-7. • Waste Segregation and Current Disposal Methods, pages 1-8 - 1-13.
(ii) The type of fencing proposed for the refuse disposal site.	• Access, page 3-2. • Perimeter fencing, page 4-3. • Litter, page 4-10.
(iii) Methodology proposed for the management of stormwater within the refuse disposal site.	• Water control, page 4-4. • Landfill revegetation Programme, pages 4-8 and 4-9.
(iv) An operator's guide.	• Landfill Operation, pages 4-1 - 4-11. • Landfill Operation Current Best Practice, Appendix 3.
(v) Type of work to be carried out to prepare the site for use as a refuse disposal facility.	• Site preparation, page 4-3. • Stormwater control, page 4-4.

Continued on next page

Data which must be included, cont.

Data	Location
(vi) The methodology proposed by the consent holder to monitor the groundwater at the refuse disposal facility site.	• Monitoring, page 4-12.

Continuous Improvement and Waste Minimisation

NZAS objectives

NZAS has objectives of minimising the amount of waste generated from the smelting operations, and providing environmentally acceptable and effective management of residual wastes. The methodologies for achieving these objectives are currently provided in the:

- continuous improvement programme, and
- waste management policy.

Continuous improvement programme objectives

The NZAS continuous improvement programme has the five basic objectives given below:

- Improved safety and occupational health.
- Improved environmental performance.
- Staff development.
- Improved product quality.
- Improved processes which includes improved use of materials.

Current waste management policy

It is NZAS policy to recover the highest possible value from all materials used in the smelter operation and to deal with materials in an environmentally appropriate manner.

This policy is pursued by dealing with process byproducts in the following ways:

- reducing the amount of materials introduced and used in each process,
- minimising the amount of byproducts from processes and reusing byproducts wherever possible,
- ensuring that when byproducts are produced they are in a form which maximises the possibility of recycling,
- recycling externally, byproducts which cannot be reused,

Continued on next page

Current waste management policy, cont.	• producing byproducts in such a way that, where appropriate, the return to NZAS is maximised, • recovering as much material and/or energy from the byproducts as possible, and • providing environmentally acceptable and effective residual management once the amounts of byproducts have been reduced by the above stages.
Reuse and recycling	Reuse means the return of the waste to the NZAS operation. Recycling means the use of NZAS waste as a raw material for other peoples processes.
Policy updates	The waste management policy will be updated when necessary, as are the other NZAS policies.

Waste Segregation and Current Disposal Methods

Segregation at source

Wherever possible NZAS will segregate waste at source.

Waste segregation improves the potential for:

- reuse,
- recycling, and
- alternative disposal methods.

Waste categories

The current wastes from the NZAS operation can be categorised as:

- reused at NZAS,
- disposed or recycled off-site,
- stored for future processing, and
- can be disposed at the landfill.

Future changes in reuse, recycling and disposal options may change the type of waste in each category. Provision at the landfill may be required for COMTOR product, refractory and other construction or demolition materials if other uses are not established.

Reuse at NZAS

These wastes are usually managed by the generating MRU and are unlikely to be included in the landfill operation.

Continued on next page

Wastes currently disposed or recycled off-site

The table below shows the NZAS wastes that are currently disposed or recycled off-site.

Waste Type	Collected In	Disposed In	Future Plans
Cardboard	Recycling cages	Recycled	No change
Facsimile rolls	Plastic bag to receptionist	Armourgard disposal	No change
Ferrous metals	Skips and bins	Scrap dealer	No change
Food waste	Kleensaks and bins	Off-site disposal	No change
Soda glass ex laboratories	Bins	Off-site recycling	No change
Liquids containing oils	Oil storage tank at store	Refined off-site	On-site collection for blending with Carbon Baking Furnace (CBF) fuel
Medical wastes	Segregated at Medical Centre	Kew Hospital	No change
Non-ferrous metals	Skips and bins	Scrap dealer	No change
Wood	Skips and bins	Recycled	No Change

Continued on next page

Waste Segregation and Current Disposal Methods, Continued

Wastes currently disposed or recycled off-site, cont.

Waste Type	Collected In	Disposed In	Future Plans
Plastics	Kleensaks	Off-site disposal	No change
Non-process aluminium	Skips and bins	Scrap dealer	No change
Oils	Drums and special receivers	Refined off-site	No change
Packaging paper, cardboard and office materials	Kleensaks	Off-site disposal	No change
Ledger paper	Kleensaks	Shredded and recycled	No change
PCB's	Original equipment or designated containers	Off-site collection system	No change
Printer cartridges	Kleensaks with office waste	Off-site disposal	No change
Refractory bricks	Skips	Off-site recycling	No change

Continued on next page

Wastes currently stored for future processing

The table below shows the NZAS wastes that are currently stored for possible future processing.

Waste Type	Collected In	Disposed In	Future Plans
Chemicals	Vessels and containers	Designated storage facilities	Depends on disposal options available
Electrostatic Precipitator Tars	Plastic lined crates	Some at landfill, some at smelter site	Reuse in CBF as fuel
MRP fines (dross)	Skips	Designated area at landfill	Reuse options being evaluated
Spent cathode lining	Direct transport to storage	Covered stockpile and designated building	On-site processing plant (COMTOR)

Wastes that currently can be disposed at NZAS landfill

The table below shows the NZAS wastes that currently can be disposed at the NZAS landfill.

Waste Type	Collected In	Disposed In	Future Plans
Asbestos	Segregated in labelled bags	Buried in designated area	No change but amount reducing
Ash/clinker residue from CBF 3	Skips	Landfill face	CBF 3 to be decommission -ed

Continued on next page

Wastes that currently can be disposed at NZAS landfill, cont.

Waste Type	Collected In	Disposed In	Future Plans
Building waste	Bags and skips	Landfill face	Builder to remove from site
Carbon dusts	Skips	Defined area	Possible alternative
Dust collector bags	Skips	Landfill face	No change
Concrete	Skips	Landfill face	Off-site fill
Floor sweepings	Skips	Landfill face	No change
Glass	Skips and bins	Landfill face	No change
Man made mineral fibre (MMMF)	Segregated in marked bags	Buried in defined area	No change but amount reducing
Miscellaneous materials (includes small amounts of materials currently disposed or recycled off-site but does not include PCB's and medical wastes)	Skips	Landfill face	Improved segregation

Continued on next page

Waste Segregation and Current Disposal Methods, Continued

Wastes that currently can be disposed at NZAS landfill, cont.

Waste Type	Collected In	Disposed In	Future Plans
Refractory bricks	Skips	Landfill face	Off-site recycling
Rubber	Skips and bags	Landfill face	No change
Tree and garden material	Skips	Landfill face	Composting
Water based liquids, ie pit cleanings	Sump cleaner	Exposed landfill area	Some possibly blended with CBF fuels

Section 2

The NZAS Landfill Site

Overview

Introduction

This section gives details of the current status of the landfill site. It outlines its history, upgrading and staging, projected life and geotechnical features.

In this section

The section contains the following topics:

History

Origins

The NZAS landfill has been in existence since the smelter commenced operations over 23 years ago. Although no formal records have been located it is believed the landfill was started during the initial construction of the smelter in 1970.

Construction materials

It is known that construction materials were deposited in the landfill early in the 1970's, in the mid 1970's and in the early 1980's. This coincided with the major construction and upgrades at NZAS.

NZAS materials

The materials deposited in the landfill from the NZAS operations included:

- refractory bricks,
- aluminium dross and MRP fines,
- carbon dusts,
- petroleum coke and metallurgical coke which contains pitch and iron,
- an ash/clinker type residue from the No. 3 carbon baking furnace,
- alumina,
- cryolite (the main fluoride component of the landfill contents),
- aluminium,
- steel strapping in significant quantities,
- asbestos,
- paint tins,
- timber,
- mineral fibres,
- plastic materials,
- waste oil and grease (now recovered and removed), and
- copper wire.

Operating history

Access to the NZAS landfill has always been restricted to NZAS and Contractors working on the NZAS Site. Prior to the mid 1980's the landfill management consisted of regular covering of completed areas.

Continued on next page

Notable events

Notable events in the landfill history are:

Year	Event
1984	Health Department approval as an asbestos disposal site.
1986-87	Reduction in the working face.
1990-92	Recovery of aluminium dross and MRP fines stored up to this time for off-site processing.
1991-92	Oil recovery from waste oil pond.
1992	Removal of bottom sediments and soil from waste oil pond and start of bioremediation.
1992	Start of landfill surface profiling.
1993	Start of revegetation programme.
1994	Closure of burning pit, on 31 December. Small pit formed in case burning for boarder control is required.

Materials recovery

The work to improve the landfill profile has exposed materials which are now considered to be recyclable. Wherever possible these materials are recovered.

Landfill Development

Initial upgrading

Since 1991 upgrading work at the NZAS landfill has included:

- more effective management practices,
- cleaning up and re-contouring,
- upgrading signage, particularly around separate waste cells,
- removing and remediating the waste oils storage area,
- increasing the protection of the celled areas against the spreading of waste by wind,
- the clearer separation of wastes, and
- revegetating the majority of the site.

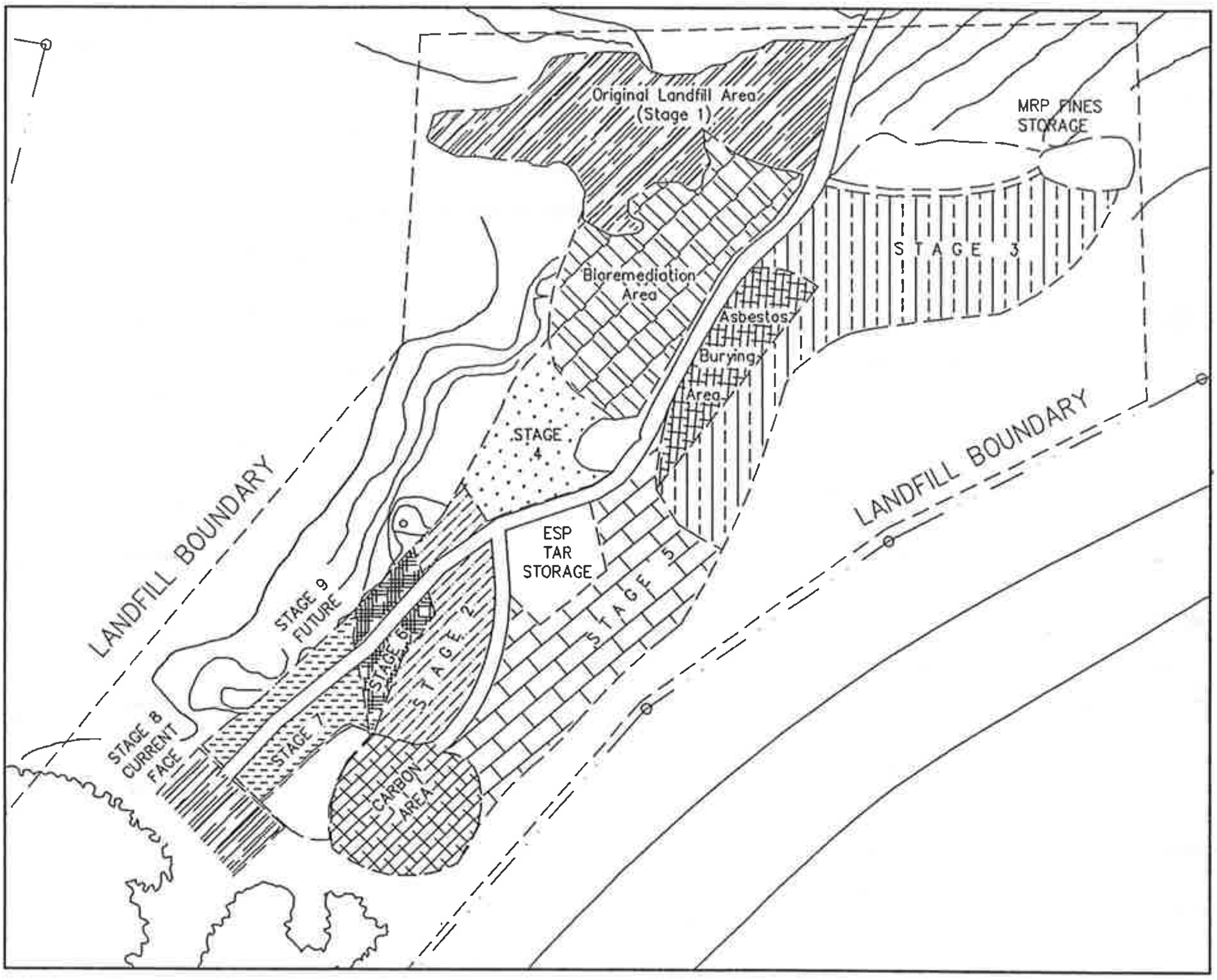
Staging

General wastes have been placed within the landfill in stages. Each stage represents an area of the landfill that is filled, levelled, contoured and revegetated. The following table outlines the staged use of the landfill and correspond to the landfill map shown in Figure 1.

Stage	Area	Area Status
one	original landfill	
two	far southern end	closed 11\91
three	east of burning pit	closed 4\92
four	northwest of burning pit	closed 10\92
five	southeast of main road	closed 3\93
six	southwest of main road	closed 7\93
seven	southern end	closed 9\93
eight	far southeast end	open
nine	far southern end	closed, future use

Continued on next page

Figure 1 Map of Landfill



Continued on next page

Upgrading during staging

During staging, the General Services Output Team have regularly improved the completed landfilled areas. These areas have been incorporated into the staged development by:

- removing large amounts of waste metal (in the form of industrial steel, machinery and ducting) from the landfill site for recycling,
- excavating and boxing pitch tar prior to relocating it in a defined storage area for future removal, and
- recovering waste oils for recycling and remediating the residual oil sludges,
- excavating general waste and removing it to the active landfill face.

Projected Life

Over 20 years life

There is sufficient capacity in the landfill site for over 20 years disposal, based on the predicted maximum rate of waste disposal.

Future improvements in waste stream and disposal efficiencies which lessen the volume of waste materials disposed of at the landfill would extend its projected life.

Geotechnical Investigation

Woodward Clyde investigation

The geotechnical aspects of the landfill site were investigated by Woodward-Clyde (NZ) Ltd.(1994). This investigation included the drilling of wells, logging the strata in the wells, and a walkover survey. Details of the methods used and the well locations are given in the Woodward Clyde report.

Geology

The landfilling geology is shown in Figures 2 and 3. Two distinct geological materials occur below the landfill site (Figure 4). These are:

- unconsolidated materials comprised of gravel and sands with some silts and peats, and
- underlying bedrock which is hard, dense, tight, poorly (partially) fractured and fine grained.

Hydraulic conductivity

Hydraulic conductivity is a measure of permeability and is defined as the rate at which water will move through one square meter of aquifer under a gradient of one horizontal to one vertical.

Rising and falling head tests were performed in the wells at the landfill to determine the hydraulic conductivity.

The data for the unconsolidated material indicates that hydraulic conductivities on the eastern side of the landfill at 2.5×10^{-5} $m.s^{-1}$ are slightly greater than those on the western side at 5.5×10^{-6} $m.s^{-1}$.

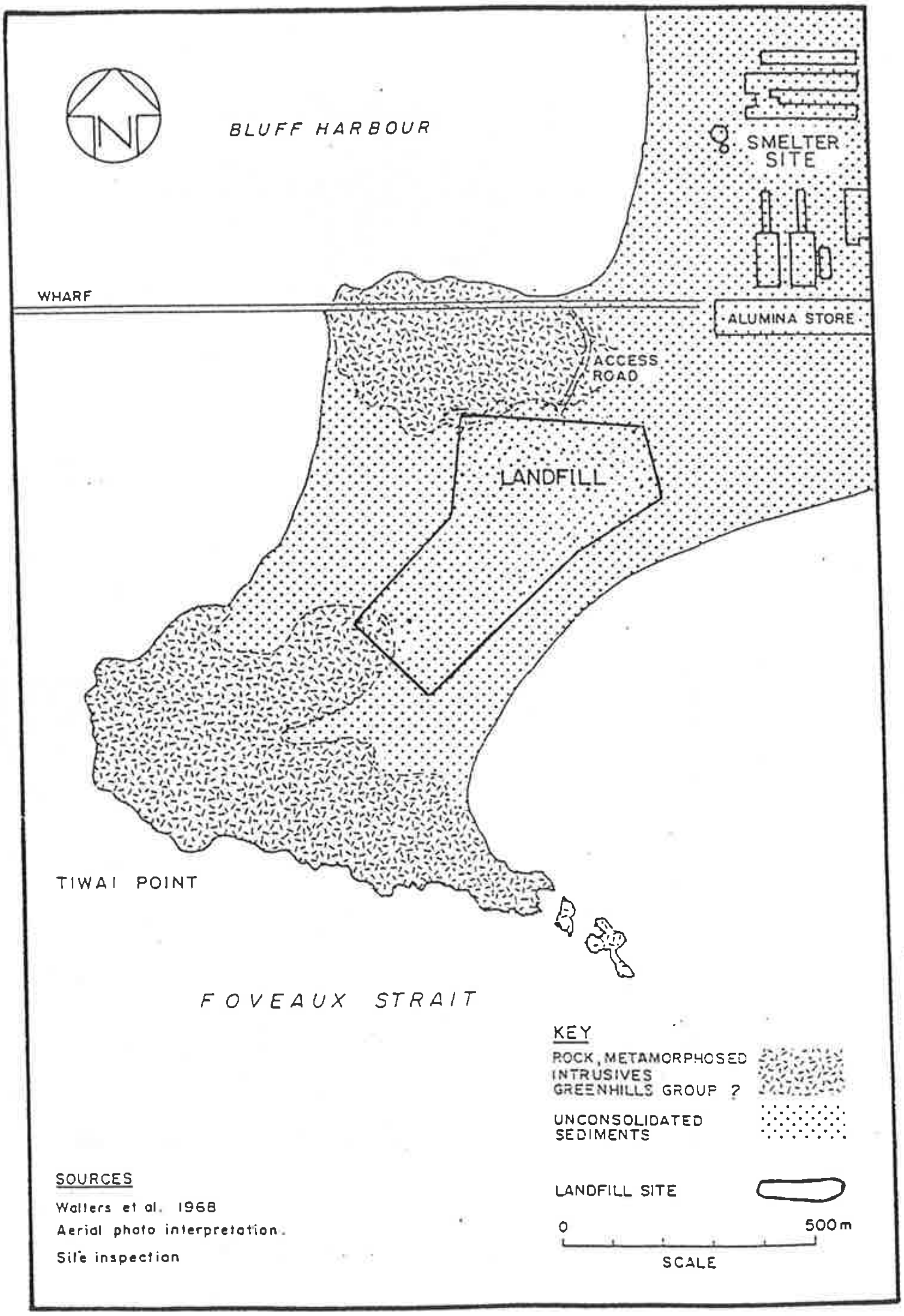
This variation in permeability would be consistent with greater reworking of sediments on the ocean beach side.

The underlying bedrock hydraulic conductivity is substantially less than that of the unconsolidated materials. This bedrock forms the local hydrological basement for the landfill site.

Continued on next page

Geotechnical Investigation, Continued

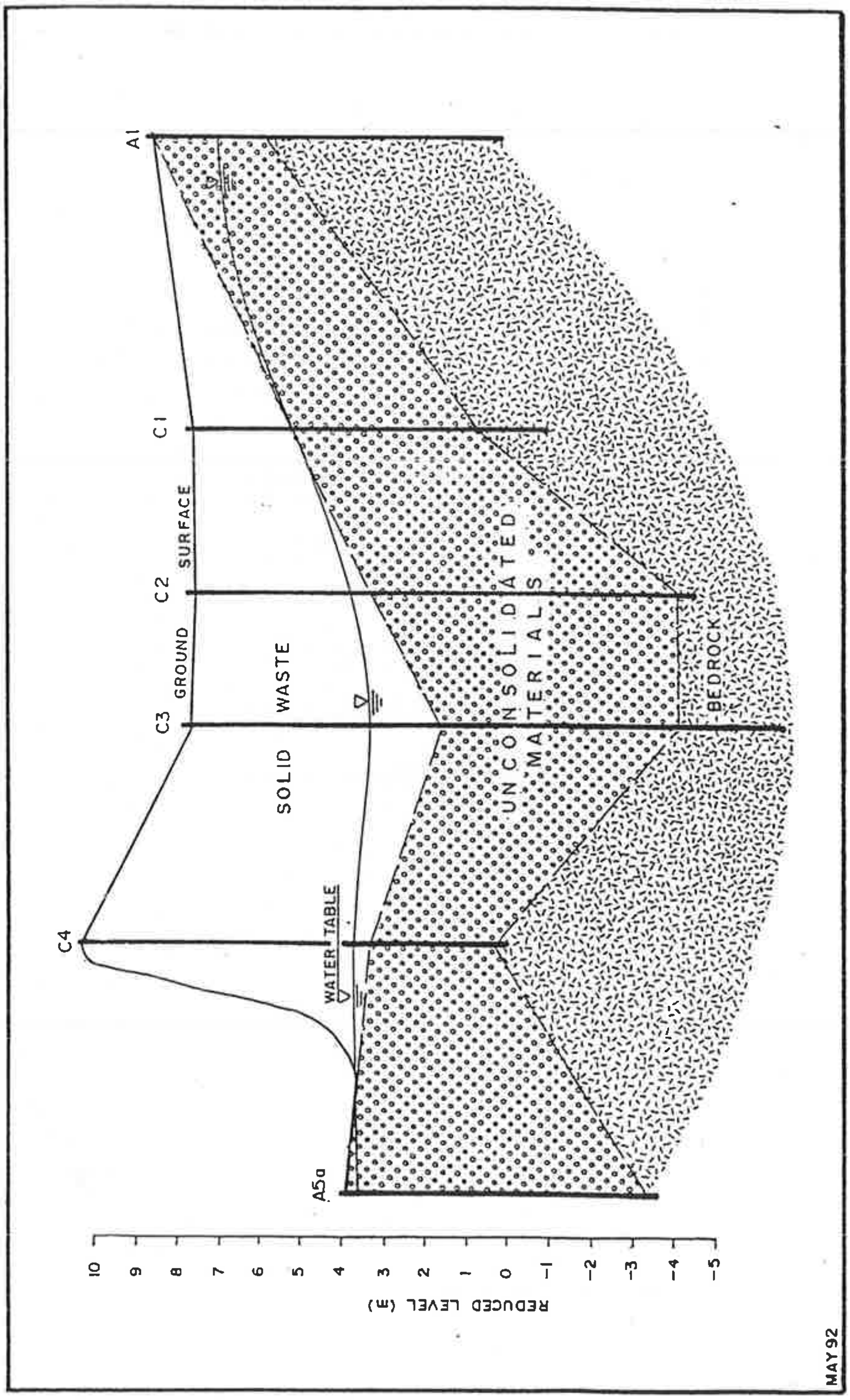
Figure 2 Site Geology



Continued on next page

Geotechnical Investigation, Continued

Figure 3 Schematic Hydrogeological Section



Continued on next page

Potentiometric surface

The potentiometric surface of groundwater is the imaginary surface to which water will rise under its full head from a groundwater aquifer. The potentiometric surface of the groundwater under and around the landfill site is given in Figure 4.

Groundwater recharge

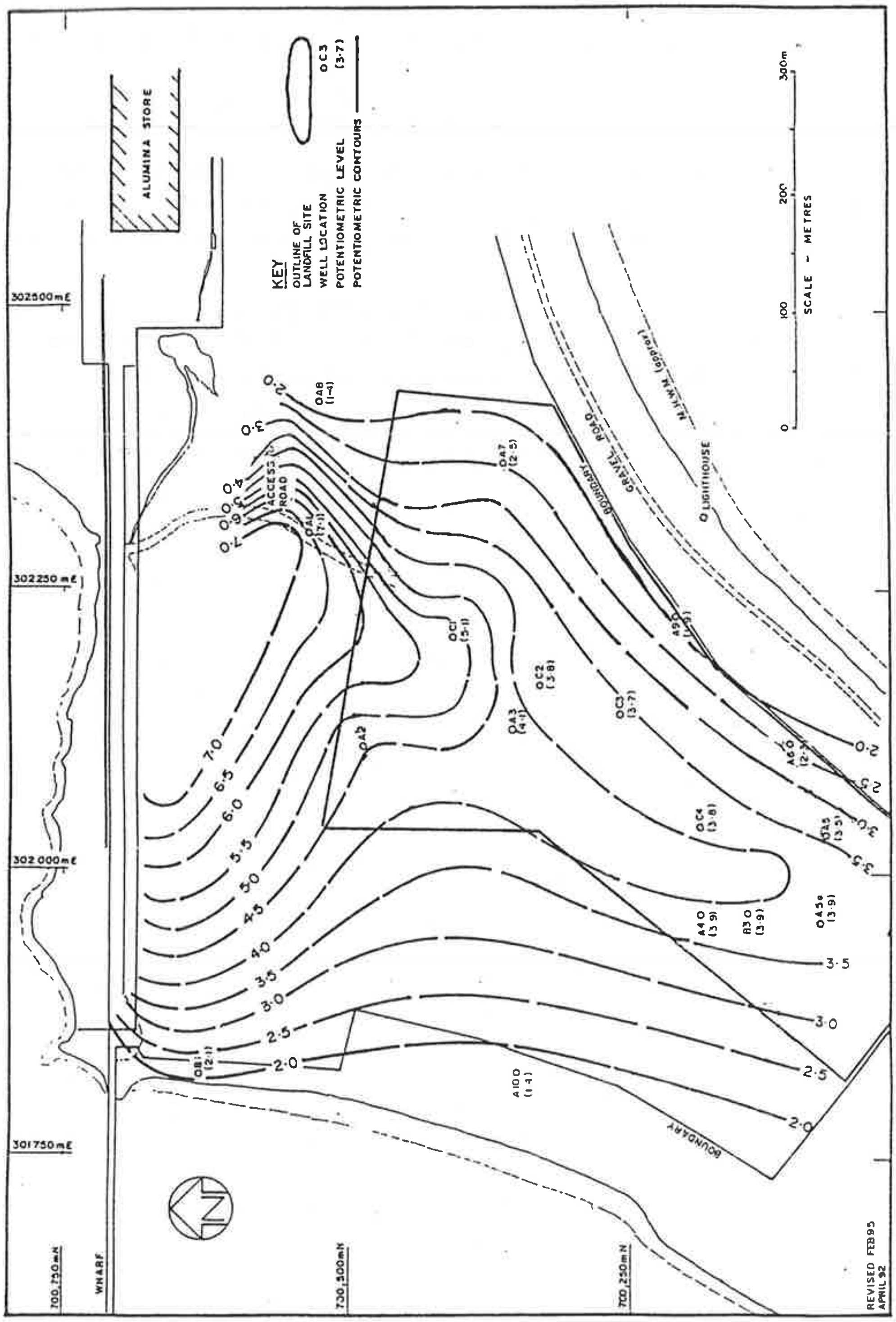
The cross section shown in Figure 3 shows that elevated portions of the water table underlie the landfill and the ground to the north. Some groundwater recharge from the elevated ground is indicated in Figure 4.

Most of the recharge to the groundwater system beneath the landfill results from the percolation of incident rainfall. It has been calculated that up to 60% of the rainfall onto the landfill site percolates to the underlying groundwater system.

Continued on next page

Geotechnical Investigation, Continued

Figure 4 Potentiometric Surface



Continued on next page

Groundwater flow rate

The potentiometric contours in Figure 4 show that the groundwater from beneath the landfill flows down gradient to both the eastern and western coastlines. Groundwater discharges to both the ocean and harbour beaches.

The groundwater flow has been estimated at:

- about 140 m^3 day^{-1} (94% of the recharge) flows to the ocean beach to the east, and
- about 9 m^3 day^{-1} flows to the harbour beaches to the west.

The reason for this difference is the greater distance, lesser gradient and lower permeability to the west.

Groundwater flow times

Velocity calculations indicate that the average times for groundwater from beneath the existing landfill to reach the coasts are:

- 1.1 to 2.2 years to the east (ocean), and
- 20 to 40 years to the west (harbour).

Section 3

Management

Overview

Introduction

This section outlines the management of the NZAS landfill, under the current organisational structure. It includes access, hours of operation, management structure, staff requirements and training.

In this section

This section contains the following topics:

Access

General access

The landfill is located at the western end of Tiwai Peninsula and can only be accessed by road from the NZAS site.

The NZAS site is bordered by a 2 metre high security fence. Access onto the NZAS site is controlled by security officers.

Vehicle access

Vehicle access to the NZAS landfill shall be provided off the wharf road at the western end of the site.

Vehicle access shall continue to be controlled by a gate at the road entrance. Currently the gate is activated by remote control in the General Services vehicles, restricting after hours access to vehicles authorised by the General Services Output Team.

Hours of operation

The current practice is to open the landfill when the Landfill Operator is in attendance. This is usually 4 hours per day on week days. General Services Output Team staff may open the landfill at other times during the day if waste requires disposal.

Smelter operating needs may require the hours of operation to be changed. Any changes to the hours of operation require the approval of the Superintendent, General Services.

Access during day shift hours

During the day shift hours access to the landfill shall be restricted to:

- General Services Output Team staff,
- contractors authorised to deposit waste by the General Services Output Team, and
- other NZAS staff depositing waste under General Services Output Team supervision.

Access outside day shift hours

Access outside day shift hours shall be restricted to vehicles authorised by the General Services Output Team.

Management Structure

Accountability

Under the current NZAS organisational structure, the Superintendent, General Services, is accountable for the landfill operations. The Site Services MRU staff are accountable for providing technical advice and specialist services.

Structure

The current management structure for landfill operations is:

Manager
Engineering Services

↓

Superintendent
General Services

↓

Supervisor
General Services

Landfill Operator
General Services

Staff

Landfill operator

The current routine landfill operations require one staff member for approximately 4 hours per day. These routine operations are included in the tasks assigned to the Landfill Operator who is a member of the General Services Output Team.

Additional staff

Improvement activities, eg profiling and revegetation, usually require additional staff. These staff may be from the General Services Output Team, contractors or other NZAS MRU's.

The task assignment for the additional staff is the accountability of the Superintendent, General Services.

Immunisation programme

Hepatitis A immunisation is mandatory for General Services staff working at the landfill and will be arranged through the NZAS Medical Centre.

Staff Training

Training accountability	The Superintendent, General Services, shall be accountable for ensuring that all staff involved in landfill operations are trained. The Occupational Health MRU shall assist with education and advise the Superintendent, General Services, of appropriate precautions.
Special wastes	All staff managing landfilled special wastes shall receive training in the characteristics of the material, the safe method of use, the necessary personal protective equipment and emergency procedures. This shall include all relevant Current Best Practices.
Training	The Superintendent, General Services, shall ensure that all staff involved in landfill operations are fully conversant with correct landfill procedures and current landfill issues. The training content shall be decided by the Superintendent, General Services, from the best available material and courses.

Improvements to Practices

Ongoing reviews

The operation of the landfill shall be reviewed on an ongoing basis by the Superintendent, General Services, as information on improved landfill and waste management practices becomes available. Improved practices will be implemented where practicable.

Section 4

Landfill Operation

Overview

Introduction

This section outlines the operation of the NZAS landfill. It summarises the preparation of the site, access, water control, landfilling and compaction, waste segregation, the control of nuisances, the landfill revegetation programme, inventory and monitoring.

In this chapter

This section contains the following topics:

General Requirements for Landfill Operation

Application of operator's guide

The practices outlined in this section apply to all NZAS staff at the landfill. They are adopted to:

- minimise the risk of harm to those handling waste materials,
- minimise any potential adverse effects on the environment resulting from the operation of the landfill, and
- ensure that all landfill activities are carried out within NZAS Waste Management Policy.

Current Best Practices

NZAS staff accountable for disposing of or managing waste at the landfill site must be conversant with all Landfill Current Best Practices. The Current Best Practices are regularly updated and the latest (16 August 1994) Current Best Practice for Landfill operation is attached as an Appendix 3.

Site Preparation

Signs

Signs at the beginning of the landfill road shall inform users of the hours of operation.

Within the landfill there shall be signs to:

- direct vehicles to the active landfill face,
- show where waste is to be deposited during the hours of darkness,
- show designated areas were specific wastes are to be deposited, and
- warn against excavation in the Asbestos Burial Area.

Screens

The relatively remote location of the NZAS landfill means that the screens are not required to isolate the landfill from other activities. Improvements to the visual aspects from the elevated parts of Bluff is provide by:

- restricting the working face,
- profiling, and
- revegetation.

Perimeter fencing

The location of the landfill, at the western end of Tiwai Peninsula, means that access can only be gained through the security controlled NZAS main gate. There is no need for separate perimeter fencing around the landfill.

Site preparation

Future areas for landfilling should be prepared by:

- removing the vegetation cover,
- removing any small mounds, and
- removing the uncompacted surface pea gravel up to a depth of approximately 1 metre.

Any soil, sand and pea gravel should be stockpiled for use to cover completed landfill areas.

Water Control

Stormwater catchment area

The catchment area for the stormwater is the landfill site. Stormwater from other catchment areas on Tiwai Peninsula do not flow through the landfill site.

Storm water control

All surfaces within the landfill shall be contoured to divert water away from the fill sites. Rainfall will either infiltrate into the landfill or flow overland and infiltrate the land surrounding the landfill.

No stormwater channels shall be formed without Site Services MRU approval.

Ponding prevention

There are no major areas of standing water within the landfill. Surface water collects in excavations within the site boundaries during extended rainfall periods but is quickly absorbed.

Excessive ponding shall be avoided by continuing to grade surfaces whenever landfill areas are closed, either at an intermediate or final stage.

Reducing leachate

Leachate production shall be reduced by covering waste at both intermediate and final stages of closure and by the landfill revegetation programme.

Periods of high rainfall

Extra control and remedial work may be required during periods of high intensity rainfall to minimise adverse effects. This work is likely to include:

- avoiding washouts, and
- maintaining the segregation of wastes by rebuilding bunds where necessary.

Landfilling and Compaction

Compaction

The materials landfilled at the NZAS landfill require minimal compaction. To date there is no evidence of subsidence in the areas covered. This includes both roads and revegetated areas.

The active landfill face is compacted by the vehicles that transport the waste material. Compaction at the active face shall be further aided by:

- the thinning of waste material over the face, and
- maintaining, wherever possible, a sloping active face.

Size of landfill face

The total landfill face shall be maintained at approximately 50 metres in width. This should allow for the segregation of landfill face waste, currently into general waste and Man Made Mineral Fibre (MMMF).

Size of active landfill face

The active landfill face shall be kept between 10 and 15 metres in width to minimise the area of exposed waste.

Waste at the landfill face

All depositing of waste at the landfill face should be concentrated in the active area.

Waste intended for the landfill face that is deposited by contractors should be first placed in a landfill face bunker. General Services Output Team staff shall then relocate the waste to the appropriate position on the landfill face.

Access to the face

General access to the landfill face shall be supervised by General Services Output Team staff. The active face is reached by a vehicle track, positioned to allow only one vehicle at a time to deposit waste.

Statutory body access shall be allowed, including the Ministry of Forestry and Ministry of Agriculture and Fisheries officers for border control purposes. Every effort shall be made to assist the officers during these visits.

Waste Segregation

Landfill categories

For landfilling purposes, wastes shall be categorised as:

- unacceptable waste,
- waste requiring segregated disposal or storage, and
- general waste.

Unacceptable waste

Unacceptable wastes are wastes which are considered unsuitable for landfilling at NZAS. Details of the current wastes in this category are given in the tables on pages 1-9 - 1-10.

Waste requiring segregated disposal or storage

The landfill shall be divided into defined areas for the segregation of wastes where required. This facilitates, where appropriate, the future recovery of the waste materials for disposal, recycling or reuse.

Currently the defined areas in the landfill area for the segregation of wastes are:

- packaged asbestos
- man made mineral fibres
- carbon dust, and
- Metals Reclamation Plant (MRP) fines.

General Waste

Waste materials entering the landfill site that do not require segregated disposal or storage, are currently classified for landfilling purposes as general waste. These general wastes are disposed at the landfill face.

·Hydrocarbon Bioremediation

Bioremediation area

Currently an area of 9880 m^3 at the north west part of the landfill is being used for the bioremediation of oil contaminated soil from mitigation work at the landfill.

The treatment programme is being supervised by Bioremediation Services, Minenco Pty Ltd. of Australia.

Encouraging hydrocarbon degradation

The bioremediation programme is designed to encourage bacterial activity to degrade hydrocarbons in the treatment area soil. The General Services Output Team activities required for this process are:

- adding nutrients and making pH adjustments when recommended by the Site Services, MRU, and
- carrying out regular tillage and deep ripping operations to enhance biological activity.

Future bioremediation

Future uses of the bioremediation process for hydrocarbon wastes require the design criteria to be specified by the Site Services MRU.

Landfill Revegetation Programme

Overview

NZAS has carried out an extensive revegetation programme at the landfill site since late 1991. This has involved, where necessary, surface covering followed by the planting of over 26,000 native trees and shrubs. By mid Autumn 1994 an area of approximately 4.7 Ha. had been revegetated.

Revegetation goals

NZAS aims to revegetate the completed landfill areas with native plants, with an emphasis on the selection and planting of trees and shrubs typical of Tiwai Peninsula. The benefits of the revegetation programme include:

- return the closed areas back to their original state as closely as is possible,
- stabilising the final cover, and
- reducing the visual impact of the landfill.

Covering

The General Service output team shall cover completed landfill areas with up to 500 mm of pea gravel, sourced from site excavation.

The gravel shall be placed on the closed area, then combined with the subsoil mix using a post auger.

Planting

Advice and assistance with the revegetation of the closed areas shall be obtained. Currently this advice and assistance is from the Department of Conservation, Invercargill.

The advice and assistance required includes:

- advice on the plants best suited to the Tiwai Peninsula environment,
- source the native plant material, and
- overseeing the planting programme.

Continued on next page

Future revegetation

The revegetation programme shall continue as areas of the landfill become closed and available for restoration.

All completed landfill areas shall be returned as closely as possible to their original state and the planting programme maintained.

Control of Nuisances

Litter

The spread of litter in the landfill shall be minimised by proper landfill face placement and waste containment. Fencing should be installed if required.

The Landfill Operator shall be accountable, on a daily basis, for picking up any loose litter in the landfill.

Dust

The spread of dust shall be minimised by the construction of bunds around designated areas containing dust waste. The carbon dust area, near the landfill face, should be compacted.

Open burning not permitted

Open burning is not permitted at the landfill (Air Discharge Permit No. 93566, Condition F6). There is an exemption for border control requirements and this will be carried out under the instruction of the officers from the statutory bodies.

Pests

NZAS shall continue to cooperate with the Southland Regional Council in the reduction of pests in the landfill. Currently the council officers visit the area quarterly and upon request in order to carry out shoots. The results of these shall be reported to the General Services Output Team.

Birds

The landfill area has not been host to significant numbers of scavenging birds in the past. Future management emphasis to minimise the scavenging birds in the future shall include:

- litter control,
- the size of the active landfill face, and
- minimising of exposed earthworks and shallow pools and puddles.

Unauthorised people

NZAS access controls prevent unauthorised people from entering the landfill area. Scavenging at the landfill is not considered an issue.

Emergencies

Required actions

The following actions are required in the event of an accident or an uncontrolled fire in the landfill area

- contact Security Services immediately by either using a radio telephone or dialling 888 on the nearest NZAS telephone,
- remain available to advise and assist emergency services, and
- report the incident as soon as possible to General Services supervision.

Monitoring

Waste amount and types

Data on amount and types of materials being landfilled will be obtained by detailed surveys during periods chosen to represent typical conditions. The frequency of these surveys will vary depending on NZAS operations but they will be at least 2 yearly.

This is the current method and has been chosen because:

- it is practical, and
- it is capable of providing the required level of data.

The design and timing of these surveys are the accountability of the Superintendent, General Services acting on the advice from Site Services, MRU.

Changes in material types

The types of waste material being deposited at the NZAS landfill are likely to be relatively constant as the only source is the smelter operations. However, changes in the smelter operations may result in small changes in the types of wastes. Data on the impact of such changes on the types of waste being landfilled can be obtained from:

- data from the detailed surveys of amounts and types of materials being landfilled,
- data from the allocation of skip trucks to transport the waste, and
- knowledge of the smelter operation changes.

Groundwater

A good database exists on the groundwater at the landfill site. The Site Services, MRU is accountable for the groundwater monitoring.

The monitoring proposal currently being developed involves sampling up to 12 of the existing bores twice each year. One set of samples will be collected in the summer and the other set will be collected in the winter.

Appendices

Appendix 1	Discharge Permits Relating to the Landfill
Appendix 2	Approval for Asbestos Disposal at the Landfill
Appendix 3	Landfill Operation Current Best Practice

Appendix 1 - Discharge Permits Relating to the Landfill

Appendix 2 - Approval for Asbestos Disposal at the Landfill

Address all communications to
The Medical Officer of Health.
Telegraphic Address:
Health, Invercargill.

Reply reference
....34/1/1.....

DEPARTMENT OF HEALTH
DISTRICT OFFICE

STATE INSURANCE BUILDING, INVERCARGILL,
NEW ZEALAND

P.O. BOX 828
TELEPHONE:
87 242

3 September 1984

The General Manager
NZ Aluminium Smelters Ltd
Private Bag
INVERCARGILL

ATTENTION: Mr K Drake

Dear Sir

This is to confirm my inspection of the smelter tip on the 29th August. I wish to advise that the tip site is approved for disposing of asbestos waste.

It is recommended that the disposal of asbestos waste be confined to one particular locality of the tip and that a record be kept of this.

If you have any queries about this do not hesitate to contact me.

Yours faithfully

(P.E. Perry)
for Medical Officer of Health

pep/ap

Appendix 3 - Landfill Operation Current Best Practice

NEW ZEALAND ALUMINIUM SMELTERS LIMITED
CURRENT BEST PRACTICE

GENERAL SERVICES

LANDFILL OPERATION - C.B.P. 31

CONTENTS:

NEW ZEALAND ALUMINIUM SMELTERS LIMITED CURRENT BEST PRACTICE GENERAL SERVICES CBP NO. : 31	Page: Page 1 of 5 Date: 16.08.94 Supersedes: Approved:
SUBJECT : LANDFILL OPERATION	
TOPIC : Introduction	

The purpose of this Current Best Practice is to ensure the safe and correct operation of the New Zealand Aluminium Smelters landfill.

Important Steps	Key Points
Safety Clothing	NZAS approved long-sleeved shirts, long trousers, woollen overalls, gloves, safety glasses or goggles, safety boots. When doing manual work in either MRP or Carbon areas wear correct dust mask for that area: . Carbon Area - 3M 1710 . MRP Area - Combined dust and gas cartridge No.RC75.
General Safety	Vehicle speeds are restricted to 30 km/hr. Access is restricted if wind speeds exceed 50 km/hr. During the hours of darkness the General Service operators must tip waste in the general tipping bunker. Activities at the Landfill tipping face are restricted to the hours of daylight. The tipping face and product bunkers are restricted to use by General Service operators.

Important Steps	Key Points
Access to Landfill	To stop unauthorised tipping at Landfill, Open barrier arm at the start of dayshift, Close barrier at end of dayshift. After 4 p.m. and nightshift use remote controls to operate barrier arm. Note: Key in G.S. Key Cabinet.
M.R.P. Storage Area	Check the cab pressurisation system is working and that the gas module is in place, level off M.R.P. in designated area (not above storage area wall). Note: When doing manual work in MRP storage area, wear a combined dust and gas cartridge No. RC75.
Carbon Area	Clean out tipping area to storage area. Level off carbon in designated landfill area.
Active Landfill Face	Level off waste to required ground contour. Surface cover waste with pea gravel. Report to General Service Supervision any incorrect tipping activity.
Man Made Mineral Fibres (MMMF)	Tip all MMMF in designated area.

Important Steps	Key Points
Asbestos Pit	General Services are notified when asbestos is to be landfilled. Asbestos is picked up by General Services operator, landfilled, and covered.
Washing Bay	Clean down area. Check sump solid level. Empty when required. Note: All areas are signposted to indicate where each material should be landfilled: e.g., Asbestos, MMMF, Landfill reclaiming area, etc.

NEW ZEALAND ALUMINIUM SMELTERS LIMITED CURRENT BEST PRACTICE GENERAL SERVICES CBP NO. : 31	Page: Page 5 of 5 Date: 16.08.94 Supersedes: Approved:
SUBJECT : LANDFILL OPERATION	
TOPIC : Nightshift Operations	

Important Steps	Key Points
Barrier Arm	Use remote control to operate barrier arm.
M.R.P.	Tip in lighted area. To be shifted on dayshift to storage areas.
Carbon Area	To be tipped in designated lighted area.
Active Landfill Face	No tipping during the hours of darkness.
Nightshift Waste Bunker	Tip all waste in bunker during hours of darkness.
Man Made Mineral Fibre (MMMF)	No tipping during the hours of darkness.
Asbestos Pit	No tipping during the hours of darkness.
Washing Bay	Clean down area after use.