Guidelines for municipal solid waste management planning in small island developing states in the Pacific region.

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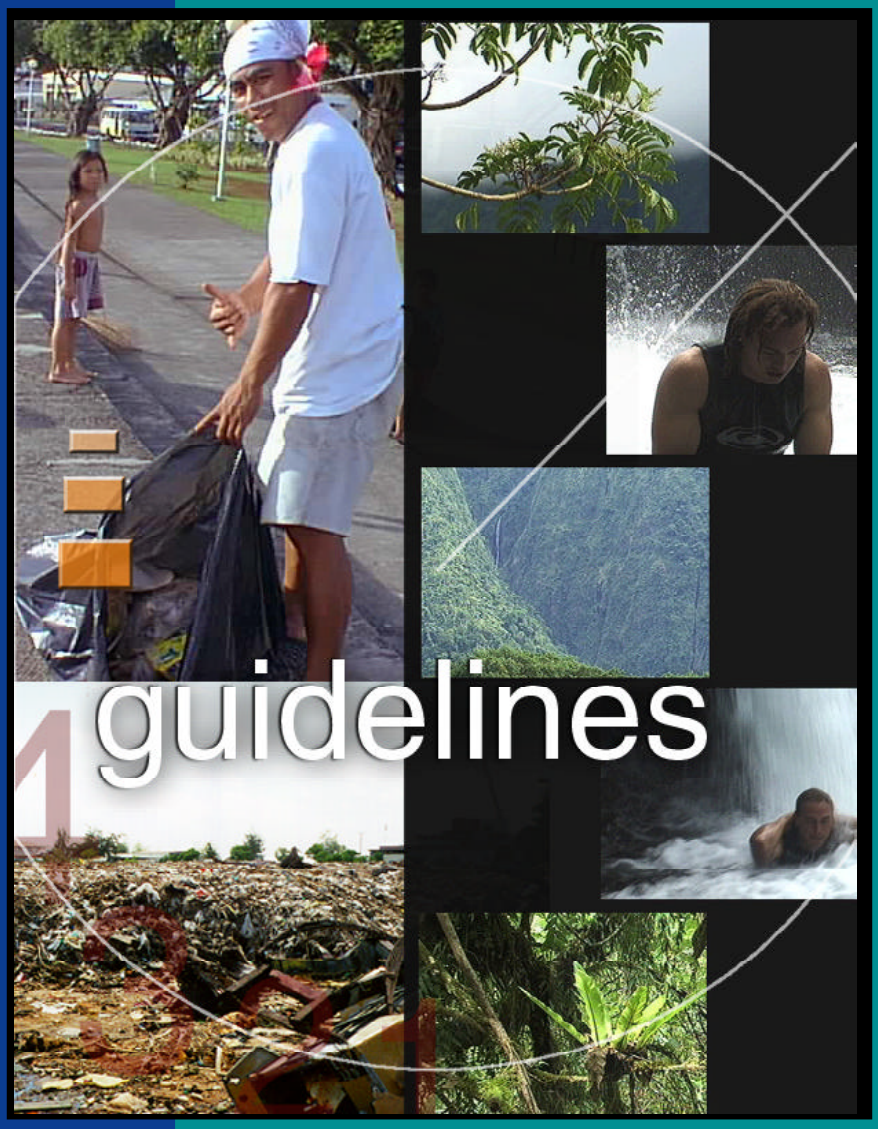
Guidelines for Municipal Solid Waste Management Planning in Small Island Developing States in the Pacific Region



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Guidelines for Municipal Solid Waste Management Planning in Small Island Developing States in the Pacific Region

Published by the
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assistance from the United Nations Environment Programme

Preface

All countries of the Pacific share the problem—how to dispose of solid wastes. Pollution from industrial wastes; landfills that are poorly managed and inappropriately sited; and disposal of toxic chemicals are significant contributors to marine pollution and coastal degradation. As a result the United Nations Environment Programme and the South Pacific Regional Environment Programme are assisting Pacific island countries to overcome these problems. SPREP's waste management programme area is expanding and this document is the first of what is hoped to be a series to address solid and chemicals waste management issues in Small Island Developing States in the Pacific islands region.

The majority of solid waste produced in the region is due to rapid urbanisation; this is compounded by an equally rapid rise in 'standard of living' expectations which relate to an increased demand for imported canned, plastic-wrapped and bottled goods. With limited land areas around many urban centres and with local reefs, lagoons or inshore fisheries particularly vulnerable to pollution, most of the Small Island Developing States of the Pacific have serious disposal problems. Only a very small number of disposal sites are acceptable socially, economically, or from the viewpoint of health. These problems are exacerbated in atoll countries with very limited land areas and highly vulnerable freshwater lens.

In larger towns the search for environmentally safe and socially acceptable sites for garbage dumps has become a perennial problem, and for several towns, seemingly insoluble. In some smaller settlements and coastal peri-urban situations, mangrove areas or beaches have become casual dumping grounds for all waste, ranging from derelict cars to household refuse. Various incidents involving toxins from industrial waste, effluent from abattoirs or food processing plants, biocides, and polluted effluent from sawmills and timber processing areas have been reported. Urbanisation and industrialisation expected in the future will make these problems even worse.

This document highlights the needs to both adopt a 'life-cycle' management approach, and to regard waste management as the responsibility of everyone and of all Government departments. We believe that it will be of use to Small Island Developing States and welcome feedback from those engaged in solid waste management in the region.

We particularly wish to thank the people of Yap State in the Federated States of Micronesia for allowing their island to be used as the Case Study thereby making this document specific to many of the unique features in Small Island Developing States of the Pacific.

Tamari'i Tutangata
Director
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The Guidelines for Municipal Solid Waste Management Planning in Small Island Developing States in the Pacific Islands Region is produced by SPREP's Waste Management, Pollution Prevention and Emergencies Programme with assistance from UNEP.

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Acronyms

AusAID	Australian Agency for International Development
BOD	Biochemical Oxygen Demand
CAE	Centre for Advanced Engineering
C&D	Construction and Demolition
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EU	European Union
GM	General Manager
GNP	Gross National Product
HDPE	High Density Polyethylene
MSW	Municipal Solid Waste
NZ	New Zealand
NZMfE	New Zealand Ministry for the Environment
NZODA	New Zealand Official Development Assistance
PCB	Polychlorinated Biphenyl
PET	Polyethylene Terephthalate
PICs	Pacific Island Countries
POPs	Persistent Organic Pollutants
PWD	Public Works Department
R&D	Resources and Development
SIDS	Small Island Developing States
SPREP	South Pacific Regional Environment Programme
UN	United Nations
UNDS	United Nations Department for Development Support and Management Services
UNEP	United Nations Environment Programme
USA	United States of America
VSO	Volunteer Services Overseas (UK)
YSPSC	Yap State Public Service Corporation
POPs in PICs	Management of Persistent Organic Pollutants in Pacific Island Countries Project

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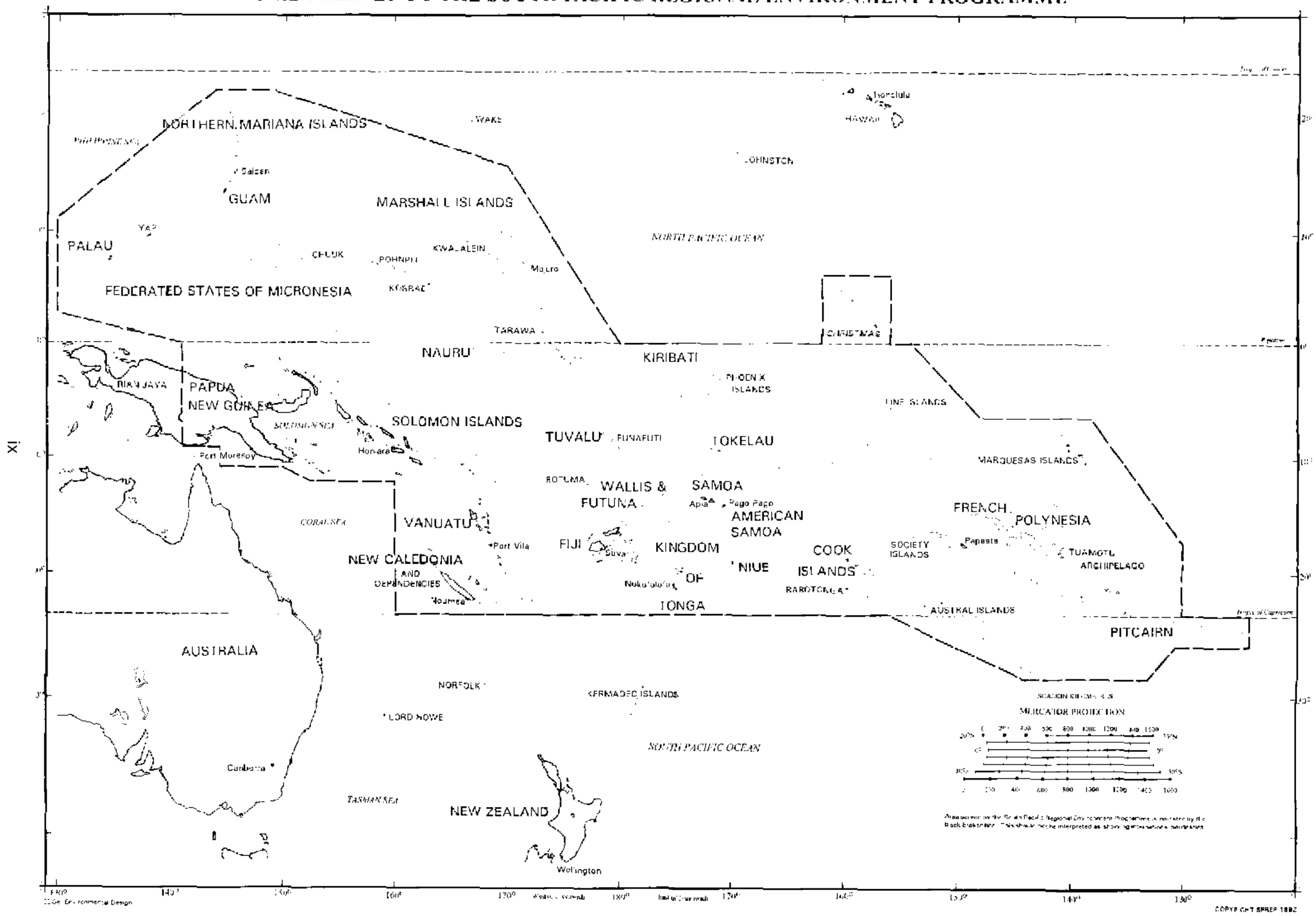

XI

1. Introduction

Disposal of solid waste is a world-wide problem. The Small Island Developing States (SIDS) of the Pacific increasingly share in this problem. As the economies of the island States develop and move toward a cash based, consumer goods society, the volumes and complexity of waste products increase. However, unlike the mainly organic waste of the past, much of the modern waste stream may take many years to break down. Some components of the waste may be harmful.

Inadequately managed waste disposal has the potential to affect the health of the people, damage the environment of the islands and be a barrier to economic development. Further discussion on the extent of the problem in the region may be found in SPREP (1998): "Solid Waste Issues in Pacific ACP Countries" by Dr Suresh Raj.

An integrated approach to all aspects of solid waste management is needed.

These Guidelines on Municipal Solid Waste Management Planning have been prepared by the South Pacific Regional Environment Programme (SPREP) and United Nations Environment Programme (UNEP) to assist Small Island Developing States to develop and implement their own solid waste management plans. The Guidelines bring together a number of aspects of solid waste management common to all of the small island States; and provide a process to follow and resource material that individual States can use to develop their own Action Plans for Solid Waste Management.

These Guidelines have been prepared following visits and discussions with people involved in solid waste management in several island States. As a result, the Guidelines have identified key problems facing solid waste managers in the island States and outline possible solutions. It is for the local managers and communities to develop and adapt these ideas to their own situation. While many of the island States share common problems, particularly isolation, limited land area and budget constraints, each island State will also have its own unique features. The Guidelines provide a methodology to identify and prioritise these for action.

The structure of the Guidelines links to the key phases of the waste cycle and provides a workable and logical planning process to follow. This is illustrated in Figure 1.

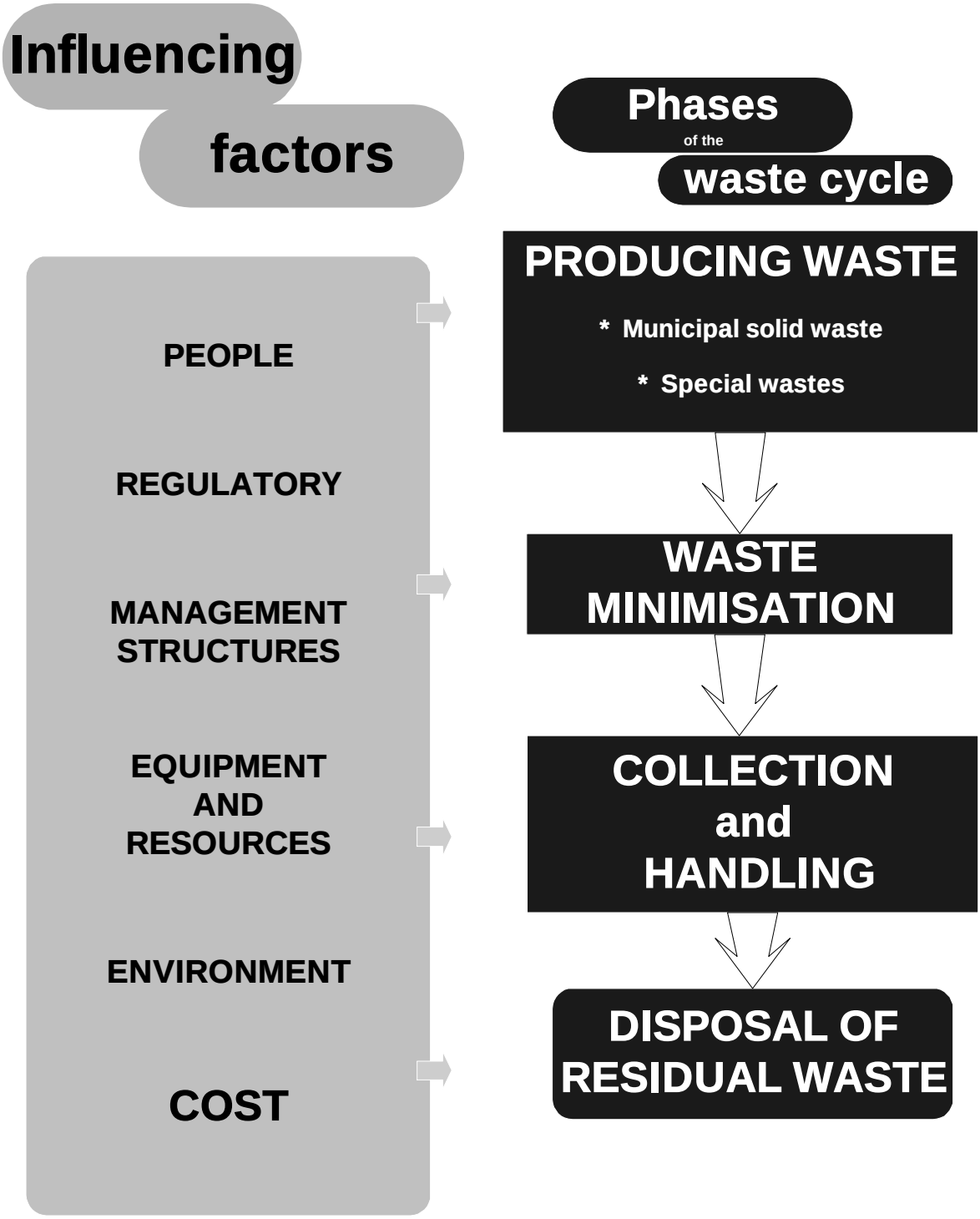

Figure 1
Integrated Waste Management

2 Key Phases of Solid Waste Management

This section provides detailed information on each phase of the waste management cycle as set out in Figure 2. Subsequent sections consider the factors which are common to all phases of the waste cycle. The steps to an integrated waste management plan are described in Sections 3 and 4 and graphically presented in Figure 2.

The adoption of waste minimisation principles is seen as critical to a successful solid waste management plan. Elaboration of the concepts of 'waste minimisation auditing' and a 'waste reduction plan' are included in Annexes I and II.

2.1 Features of the Waste Stream

Municipal solid waste is made up of a mixture of a wide variety of materials. Paper, plastics, metals, garden waste, food scraps mixed together with an inevitable small proportion of items which could be considered hazardous, such as batteries, household chemicals, waste oil, pesticides and so on.

Municipal solid waste in the island states has several features which make it unique from municipal solid waste found in the larger industrialised nations of the USA, Australia or New Zealand. It is important that these differences be recognised and defined (Section 4.1) as part of the waste plan process. If not there may be a danger of incorrectly scoping the problem of solid waste, perhaps leading to solutions which are excessively costly for the problems intended to be solved. The island states have many pressing demands upon resources of foreign exchange and it is important to prioritise correctly.

From field observations in Yap, Tuvalu and elsewhere the following general observations are made on the waste stream as relevant to waste planning:

- The traditional island economy based on shifting agriculture, agroforestry and fishing produced only biodegradable wastes. Wastes causing litter problems and occupying landfill space are largely comprised of imported materials.
- Island waste streams can be low in organic "kitchen waste" (vegetable peelings, food scraps). The pig (and the dog) is an ideal wastemaster. Where large numbers of households have pigs, very little food scrap material finds its way to landfill, from either households or restaurants.

This is a significant observation, for it means that small Pacific island landfills may have less nuisance potential (smell, vermin, birds) than may be expected given the climate.

- Green waste is present in variable amounts, dependent on the system of land tenure and strength of the traditional agricultural systems based on taro, shifting gardens and agroforestry. For example on Yap where households are largely self sufficient in home grown produce, little greenwaste is dumped. However, this is not the case in other locations. The proportion of greenwaste needs to be established by the waste survey to determine whether there is potential to reduce the waste stream through diversion of this material to mulch or compost projects. Greenwaste is a valuable resource for soil improvement, particularly on

the atolls.

- The content of paper is generally low.
- Municipal solid waste is likely to contain a similar range of domestic and light commercial "special" wastes to larger urban areas. Wastes such as auto batteries, nicad or lithium batteries, waste oil, cleaning chemicals will all be present and contributing to heavy metal burdens in leachate.
- Cardboard and plastic packaging are often present in substantial quantities. Often these may be sourced from a relatively small number of businesses involved in importing and distribution of retail goods.
- A very common item of litter and a significant component of the landfilled waste in some island states is the beer/soft drink can. However aluminium cans are a potentially recyclable commodity, and with a well designed and supported programme it can be returned from the island states.
- Waste generation is closely linked to economic status of the household. The higher income households spending more money on consumer goods produce more waste than traditional lifestyles.
- Bulky steel items such as car bodies and old machinery are often difficult to deal with in the island environment.

Table 2.1 provides examples of regional waste stream analyses.

Table 2.1: Waste Stream Analysis (%) (Extracted from Ref. 8)

Component	Port Vila, Vanuatu	Suva, Fiji
Metals	3	15
Glass/Ceramics	4	7
Vinyl/Plastics	6	9
Organic (vegetable)	40	25
Wood/Coconut	30	7
Paper	10	31
Fibre/Textiles	5	4
Other	2	2

2.2 Waste Minimisation

Waste minimisation strategies include all actions to reduce the quantity of waste requiring disposal. Waste minimisation includes:

- **Reducing waste at source**
- **Reusing materials**
- **Recycling waste materials**
- **Reducing use of toxic or harmful**

Why minimise waste?

Waste minimisation has the following advantages:

- Reduced volume of waste for disposal
- Reduced costs of collection and disposal
- Longer life of disposal sites
- Reduced environmental and health impacts
- Reduced costs through more efficient use of resources

Barriers to waste minimisation

Substantial waste reduction is technically possible for the island states. Options exist for the segregation and local reuse of materials and for more efficient purchasing. Other options exist for offshore recycling of waste materials.

However, the success of any waste reduction programme is dependent largely on people factors—the extent to which people are willing, motivated and able to reduce waste. Success is dependent on overcoming the following potential barriers:

- Uncaring attitude to waste. Without the cooperation of the community, waste reduction will not be achieved. It is essential that people are educated, stimulated, motivated (Section 5.1) and supported in order to implement projects and maintain momentum. This will require on going contact and support from an enthusiastic local “champion” of the waste reduction project.
- Limited incentive to reduce waste with free waste disposal. If people are to be encouraged to minimise waste there needs to be an incentive provided for doing so, such as reduced waste collection and disposal charges. Placing a charge on waste disposal will remind the community that there are costs to their health and environment from waste disposal (Section 5.6).
- Unreliable and poorly promoted waste recycling and collection services. People will only separate out wastes if they know someone wants the materials and that the collection will be reliable and regular. Effective promotion and collection systems are therefore crucial.

Steps to implement waste minimisation

The following steps would typically be involved in planning and implementing a waste minimisation strategy:

- Carry out waste analysis survey to characterise waste stream (Section 4.1)
- Carry out "waste audits" of key waste generators such as government offices, businesses, hotels. A methodology and worksheets for conducting a waste audit are included as Annex I.
- For targeted waste generators or streams, identify and assess the practicality and economics of possible waste minimisation measures. Each situation needs specific assessment as set out above. A number of possible measures are set out in Annex II and could form the starting point for a waste reduction plan.

2.3 Waste Collection and Handling

Careful consideration needs to be given to refuse collection services. Specialist collection and compactor trucks are often unavailable, or where requirements in the tropical climate. There is a temptation to overcommit the resources of plant and machinery, with the result that regular collection schedules cannot be maintained. For business premises in particular the dependability of a service is of importance. People will be unwilling to pay for an unreliable service.

Attention needs to be given to the collection of rubbish from bins (including provision of bins) in public places. This is an important part of any tourist promotion campaign.

Health and safety considerations of the staff on the refuse collection (including prison labour) should be attended to, with at least strong footwear and gloves provided.

Consideration could be given to the feasibility of separate collection days on a less frequent basis (say once per month, once per year) for particular wastes such as aluminium can or greenwaste.

2.4 Waste Disposal

Despite the best efforts to reduce, reuse and recycle, there will always be residual waste requiring disposal. There are only four alternatives:

- **Landfill**
- **Disposal to sea**
- **Incineration**
- **Export to someplace else**

2.4.1 Refuse disposal to landfill

Operation of an environmentally sound refuse landfill requires attention to a number of matters. The following will need to be addressed in preparing a waste management plan.

A. Limit dumping to designated sites

Landfills (dumps) are the normal disposal method. However, often there has been no consistent approach to where refuse is deposited. As a result a number of informal dumps may exist in addition to a designated site. Rubbish may also be dumped on roadsides and private property.

Specific and enforceable regulations need to be in place to prohibit disposal of solid waste at places other than the current designated dumping sites, which include control for litter on both private and public land.

To a certain extent the small scale dumping of refuse is controlled at the village level. If nuisance conditions develop due to the actions of a landowner this can often be more effectively dealt with by the community system.

B. Prepare a Landfill Management Plan

This would set out how the designated disposal site(s) is to be managed. It would cover:

- Compaction and cover of waste
- Leachate and stormwater control
- Separation of recyclables
- Sequence of site filling
- Control of vermin, scavenging dogs, pigs and insect pests
- Special waste acceptance procedures
- Control of site access
- Monitoring and record keeping
- Health and safety issues, training of site staff
- Site rehabilitation upon completion of landfilling
- Landfill gas management.

C. Covering of refuse

Effective landfill operation requires the use of soil or sand to cover the refuse and maintain sanitary conditions. This will stop smell and breeding of mosquitoes. When cover soil is included with the refuse the filled land will be more stable and of more use in future. Fill with a large proportion of sand will be akin to natural ground. If sufficient cover sand is placed over the completed fill the ground may in time be suitable for other uses such as agriculture or possibly building.

In atoll environments, soil for landfill cover is an extremely scarce resource. In many such instances it may be necessary to use 'synthetic' covering materials such as pulp mixed with crushed cardborad and water, or compost for daily covering. It may then be necessary to use sand for mid-term and final covering and the landfill operation will have to be integrated with

operations to obtain aggregate from the lagoon floor. This will raise other issues of environmental protection.

D. Heavy machinery for use at refuse disposal sites

Heavy machinery is needed to spread refuse, place cover soil and compact the fill. A suitable machine would be a tracked loader with a "4 in 1" bucket. This could spread refuse and cover, provide some compaction and also dig and lift spoil or refuse. It could also be used at a green waste site to crush and turn vegetation wind-rows. A larger bulldozer, perhaps supported on occasion with a hydraulic excavator would also be appropriate. All machinery supplied requires a selection of spare parts plus adequate maintenance facilities.

E. Carry out evaluation of the effects of landfilling on the environment

Polluted water seeping from landfills (leachate) can pollute groundwater and lagoons. Depending on the quantity and types of waste disposed in the landfill these effects could be minor, or could in some circumstances be serious and need to be prevented. The risk posed by leachate needs to be evaluated before a future, long term engineered landfill can be designed and built.

The evaluation would address the following issues:

- Levels of pollutants in groundwater
- Quantity and nature of leachate being produced
- Depth and direction of flow of groundwater and hence time to reach an area of concern
- Mobility of contaminants in groundwater
- Possible impact of landfill leachates on surface waters
- Significance of landfill sourced pollution in relation to other sources of pollution such as septic tanks
- Risk posed by landfill gas

F. Siting of future landfills

Often an existing landfill (dump) will have evolved rather than be a result of an engineered selection process. Dumps are often too close to water, housing has encroached or the site is simply running out of space.

In this case a major task for the waste planning exercise will be to site and design a properly engineered landfill with sufficient space for say 20 years filling. In the Pacific islands a further complication to the usually difficult task of siting refuse landfills is added by multiple owned land tenure. It is not uncommon for all land to be in multiple private ownership (traditional title) with a minimal stock of "public" or "government" land available for infrastructure.

Approaches which could aid in the siting of landfills include:

- Where possible target landfills for land already affected by quarrying or earthworks. The landfill proposal can then involve an eventual restoration of the land to a better state for the owners.

- Propose long term lease for the period of filling and aftercare rather than seeking purchase outright.
- Landfill plans to be specific and detailed on the eventual site capping and restoration.
- Include the need for a disposal site in the education material for solid waste.
- Commence by seeking agreement of the village leaders. Possibly agreement could be reached in principle that each main area in turn will be host to the landfill site.

To optimise the design of new landfills the results of the environmental assessment of existing operations will be useful. The results of the waste characterisation are also useful. With this information it will be possible to answer questions such as:

- The need for a base lining.
- The need for groundwater control.
- The area of land required.
- The final use of the land.

Ideally any new landfill would be constructed as a modern, lined and fully contained facility. However, if groundwater is not currently used for drinking water (as is often the case due to salinity in the atoll environment) it may be that a relatively simple design of landfill would suffice, depending on where the site is to be located. For example the landfill could be unlined, maximising use of the soils for leachate purification.

G. Rehabilitate existing landfill areas

Once landfilling of refuse is operating on a sound basis attention could be turned to rehabilitating past sites no longer required for refuse disposal. This could best be done by capping with cover soil. Compost from greenwaste shredding could be used to rehabilitate the soils on the reclaimed land. Specific assessment would need to be carried out to determine the suitability of reclaimed land for building. It would likely be more suitable for commercial buildings than houses. There may be a risk from landfill gas.

2.4.2 Refuse disposal to ocean

General

For island states a possible alternative to landfilling for some wastes may in the short term involve controlled dumping in the open ocean. The ocean surrounding the island states is often very deep and providing a sensible approach is taken to the types of waste disposed, adverse environmental effects would be avoided. Disposal to the ocean should be a last resort where alternatives are too costly or logistically difficult to implement. Any ocean dumping must be in accordance with the requirements of the London Convention (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter).

Materials dumped to ocean should be inert and non toxic. They may need to be treated to ensure that they sink. The following materials are suggested for ocean disposal:

- Steel scrap and vehicle bodies (for example old machinery). This could be used to form artificial reefs within the lagoon as habitat for fish. All fuels and oils would need to be removed first.
- Glass waste such as bottles (broken).

2.4.3 Incineration

It is unlikely that specialised high temperature incineration or waste to energy plant would be economic for the small refuse volumes involved in the island states. More basic methods of incineration such as pit incinerators may be appropriate for burning selected waste materials in order to reduce volumes to landfill. While air pollution problems due to incinerators are unlikely on small islands, there are several drawbacks to burning of refuse which need consideration. These drawbacks are:

- Fumes from low temperature incineration of mixed municipal refuse. These fumes will contain a number of toxic compounds, e.g. from burning of chlorinated plastics, solvents etc. These could be a hazard to people living and working in close proximity and are generally undesirable in the environment. Care and strict management of the waste to be burned in order to minimise contamination with undesirable waste types will be required.
- Most wastes which can safely be burned (i.e. vegetation, cardboard, paper) may be more useful if recovered for mulching and soil improvement.
- Residual ash and metal waste requiring disposal.

2.4.4 Export of waste

As the waste causing problems in the island states is almost universally imported, export would seem an appropriate disposal option. However, apart from the cost of shipping a worthless material, there are likely to be major regulatory obstacles also. Certainly in USA jurisdictions it would be a requirement to demonstrate that the waste was in fact just municipal solid waste and did not contain any hazardous wastes in excess of acceptance criteria for the final destined landfill. Such testing would be expensive. Export of waste must be in accordance with the requirements of the Basel Convention (Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal) and the Waigani Convention

(Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Waste and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region).

Export of waste is probably only practical as recyclable separated streams such as aluminium can or cardboard.

2.5 Special Wastes

What is Special Waste?

Special wastes are dangerous to people or have harmful effects on the environment. For example they could be toxic, flammable or explosive. Consequently special wastes require particular care in handling and disposal. Special wastes are not suitable for ordinary landfilling.

What special wastes may be present?

It is unlikely that there would be large quantities of special wastes on the island states as there are few industries to produce them. However, there will be a range of common special wastes which need to be dealt with. These would include:

- Batteries from automobiles (lead acid)
- Small batteries (nickel cadmium, lithium)
- Waste oil including filters (from vehicles, generating engines)
- Pesticides
- Medical waste
- Paint and solvent residues
- Septic tank cleanings
- Offal
- Asbestos
- Transformers

Even normal domestic refuse will contain items which can release substances damaging to the environment. For example nickel - cadmium batteries and waste oil. It would be expected that the proportion of wastes which would be classified as special wastes would be relatively small at say < 1 per cent.

Measures to deal with Special Wastes

Ideally special wastes should be collected and stored pending removal from the island states for safe disposal or recycling offshore. However, it is recognised that there are substantial cost and logistical difficulties with this which in many locations will prevent this approach in the immediate future. Therefore, suitable arrangements will need to be made for disposal in the meantime. This is likely to mean providing secure, weatherproof, bundled storage for an indeterminate time.

Measures which could be adopted to minimise problems with commonly encountered special wastes are included as Annex IV. This annex could form the basis for a Special Waste Management Plan.

SPREP has commenced, in 1998/99, two projects which will assist with the management of special wastes. The AusAID funded 'Management of Persistent Organic Pollutants in Pacific Island Countries' (POPs in PICs) project is assessing stockpiles of waste and obsolete chemicals. It is also undertaking a preliminary assessment of chemicals contaminated sites in thirteen countries throughout the region. The long-term goal of POPs in PICs is to remove the waste chemicals and remediate the contaminated sites. A summary of the total quantities of wastes located in the inspections phase of this project is shown below in Table 2.2.

The NZODA funded 'Development of a Hazardous Waste Management Strategy in Pacific Island Countries' project will develop and implement long-term hazardous waste management plans to allow countries to effectively deal with potentially toxic materials entering the region.

Table 2.2 Special Wastes - A Special Problem. Wastes identified under POPs in PICs. (Extracted from Reference 6 of these Guidelines)

Waste Type	Quantity
Waste Oil	180 tonnes
Potentially PCB Contaminated Transformer Oil	135 tonnes
Waste Bitumen	330 tonnes
Waste Timber Treatment Chemicals	160 tonnes
Waste Fertilisers	87 tonnes
Waste DDT	10 tonnes
Waste Pesticides (not including DDT)	47 tonnes
Buried Waste Pesticides	11 tonnes
Waste Medical Drugs	21 tonnes
Miscellaneous Special Wastes	38 tonnes
Oil Contaminated Sites	26 sites
Bitumen Contaminated Sites	9 sites
Hydrocarbon Contaminated Groundwater Lens	11 sites
Pesticides Contaminated Sites	21 sites
Buried Waste Pesticides Sites	7 sites
Timber Treatment Chemicals Contaminated Sites	7 sites
Miscellaneous Contaminated Sites	7 sites

3 Why have a Solid Waste Management Plan?

Management of solid waste is required at all stages from waste generation to the final disposal. Solid waste touches on the responsibilities of government authorities, businesses and community groups. Promoting coordination among these agencies is a key aim of waste planning. Decisions made about one aspect may influence other aspects. For example the amount of waste reduction carried out will affect the rate at which landfill space is used.

A solid waste plan is a means of:

- understanding the effects of current waste management practices
- identifying waste management needs
- setting priorities for actions required
- identifying budget needs
- coordinating the different parties with the responsibility for waste management
- measuring progress in achieving targets
- modifying priorities as the plan develops; and importantly
- Communicating to external agencies that the state is seriously attempting to address solid waste issues. A comprehensive waste management plan will support project proposals seeking grant or aid funding for solid waste projects.

4 How to go about the Planning Process

Developing an integrated waste management plan involves a number of steps which should be followed regardless of your location. Figure 2 summarises these steps. The sections below expand upon each of these steps.

4.1 Know what you are dealing with

Understanding the source of waste, how it enters the country, the quantity and nature of the material generated is essential to sound waste planning.

The solid waste produced by a society reflects many factors; for example climate, economic development, cultural attitudes, industries present, growth of GNP, vehicles registered and growth of industries which bring more generation of wastes, such as vehicle manufacturing, electronic appliances manufacturing, textile manufacturing, and so on. Waste produced in one area may be quite different to those produced in another area, significantly affecting how it would best be managed. Therefore, the essential first step in preparing a waste management plan is to understand your waste stream. This needs to consider not only the present but also the future changes likely to occur over a planning period of say 20 years.

Collecting information on the waste stream

Data on solid waste can be obtained from a number of sources. Some of these are outlined below:

- Statistics on imports and retail sales.
- The quantities of canned goods (beer, soft drinks) imported by individual island states can be established from importers. This gives a good estimate of the quantity of many wastes such as drink cans and car batteries.
- Review goods for sale in grocery, hardware stores.
- This will indicate the types of special wastes in circulation. It will also indicate the relative proportions of packaging types (plastic bottle types, tetrapak containers, cans etc).
- Review the waste being disposed.
- A Waste Analysis Survey is a method for measuring the actual quantity and composition of waste generated and disposed. Annex III gives an example of a survey methodology. A Waste Analysis Survey should be carried out on a regular (say every 3 to 5 years) basis on refuse being delivered to landfill. It is important to understand the source of waste so appropriate action can be taken with specific waste generators. For example specific analysis could be carried out on domestic sourced waste, or waste from tourist hotels. The Waste Analysis Survey needs to capture data on special wastes (Section 2.5). The amount and nature of special waste will be of particular importance in determining the environmental impact of waste disposal. The Waste Analysis Survey does not need to be exact, but should be done to sufficient detail to broadly categorise the components of the waste.
- **Landfill contour surveys**
  Landfill sites should be contour surveyed every 1-2 years and the volume of fill

placed is calculated. This gives a measure of the rate at which landfill space is being consumed and therefore the remaining life of landfill sites.

- **Recycling data**
  Contractors will give information on material being collected.

The above gives a measure of the current situation. Future influences such as growth of Gross National Product (GNP), vehicles registered, growth rate of industries, population growth, and development of new hotels may increase the rate of solid waste generation. This data can be obtained from Government planning authorities and used to estimate future waste generation.

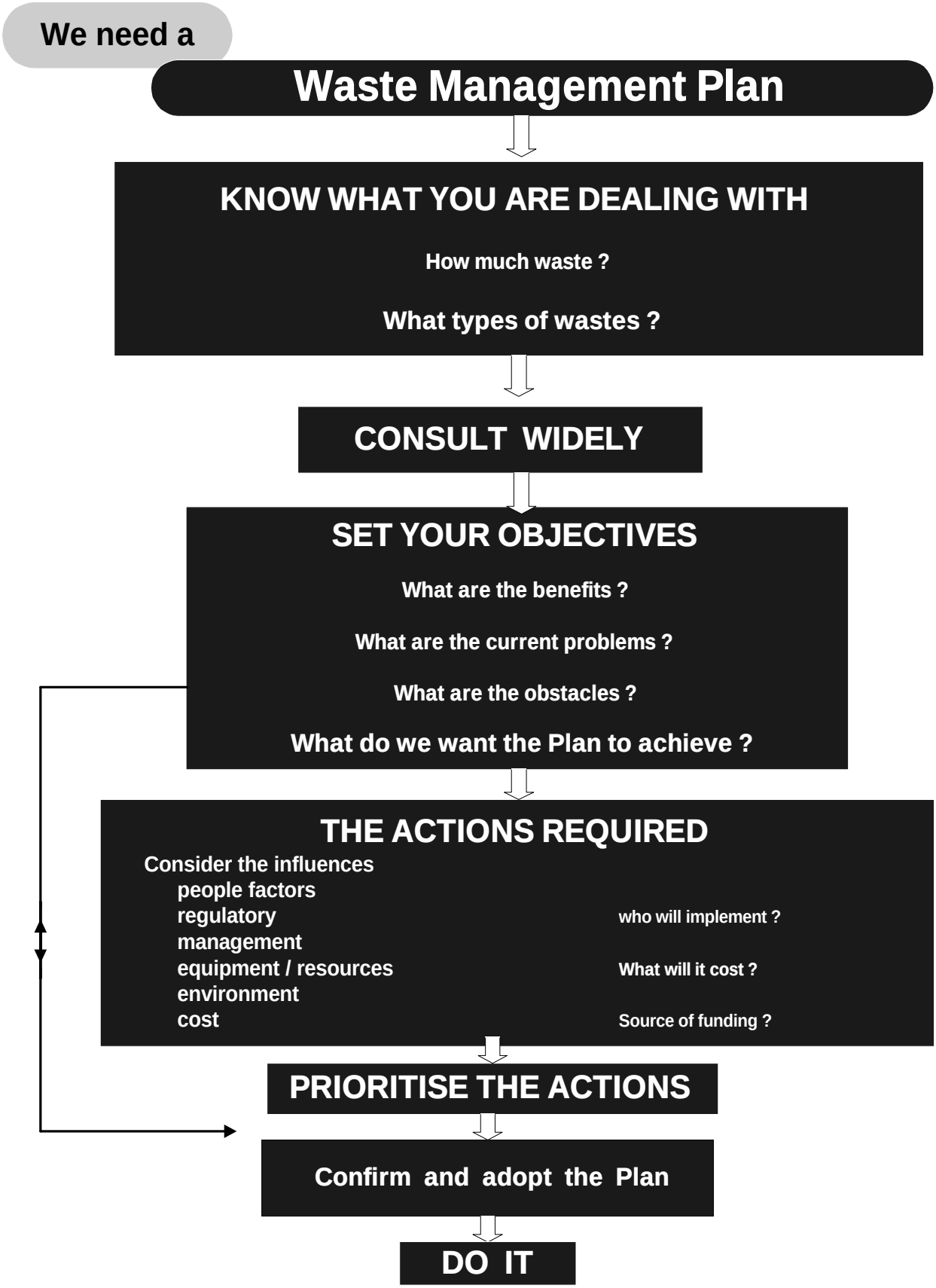

Figure 2
Pathway to a Waste Management Plan

4.2 Consult Widely

Early in the development of the waste management plan it is important to seek the views of people and organisations currently involved in waste management. Input from these groups will help in identifying concerns and establishing objectives which everyone supports. Gaining the support of people early on will help in achieving a successful outcome.

A good way to kick off the Plan process would be to hold a "Solid Waste Workshop". This workshop would bring together all those with an interest in and responsibility for aspects of solid waste management including, as a minimum, representatives from:

- Public Works Department
- Public Utilities Authority
- Environment Department
- Health Department
- Agriculture Department
- Village or Town Councils
- Electricity Corporation
- Cooperative Society or other importers
- Women's Council
- Government Representative(s)
- Community Representatives from the villages
- Education Department/schools
- Recycling Businesses
- Industries (such as tourism and fishing)
- Tourism or Visitors Bureau

The workshop would be intended as an introduction to the plan process and as a forum to discuss current problems. Useful information to assist with preparation of the workshop can be found in—*Waste Management in Small Island Developing States in the South Pacific*—Report of a Regional Workshop organised by UNEP and SPREP in collaboration with Environment Australia. Data from the waste characterisation will also be helpful.

The outputs from such a workshop should include:

- Increased awareness of the issues and constraints on solid waste management
- Recommendations for actions arising from the community
- Identification of key priorities requiring further investigation
- Monitoring and assessment of adverse effects in current waste management practices

4.3 Set the Objectives for your

Waste Management Plan

The Waste Management Plan needs a clear and widely agreed set of objectives. The objectives make clear what the plan is trying to achieve, provide targets against which its success can be measured and will assist in setting priorities for action. Developing the objectives is a process which requires input from the wider community.

In developing objectives and deciding what priority should be assigned to them consider the following questions.

What are the benefits which will arise from better solid waste management?

Identify the benefits to the community which will arise from better management of solid waste. These could be economic benefits, improved public health or more intangible ones such as a cleaner environment. Some of the benefits may be agreed to be more important than others. This will help to rank the objectives in an order of priority.

Monitoring and assessment of adverse effects from current waste management practices?

Reviewing current waste management practices will show up areas where improvement is needed. The workshop would be a good forum in which to discuss and agree on what are the most pressing problems from solid waste.

What are the obstacles to achieving the objectives?

Identify the obstacles to achieving improvement in each area of waste management. Consider the obstacles in terms of the factors which influence waste management as set out in Section 5. Identifying the obstacles will assist in setting priorities for the objectives and lead on to the next stage of developing action plans.

Example Objectives

Each objective should relate to a problem identified or improvement sought. The following are a set of possible objectives which relate to the key phases of waste management. Use these as a starting point for defining your own objectives relevant to your needs.

Objective 1: Through waste minimisation to reduce the effects of waste and cost of waste management.

***Comment*:**

By following the waste hierarchy of:

- **R**educe waste at source
- **R**euse waste materials
- **R**ecover from the waste stream (e.g. recycling, composting and waste to energy)
- **R**emaining waste to be disposed of safely.

Maximum use is made of waste materials and the amount to be finally disposed of is minimised.

Objective 2: To provide a convenient and cost effective service to the community.

Comment
Refuse is a low priority for people. Households and businesses want a convenient and low cost service to help them remove solid waste from their properties.

Objective 3: To protect and enhance the public health of the community.

Comment
Uncontrolled handling and disposal of wastes is unsanitary. Wastes such as plastics and cans do not break down quickly and trap stagnant water. Breeding of mosquitoes, flies and rats is encouraged by open dumping of waste. Disease can spread as a result. Sharp litter is a common cause of injury, particularly to children. Open burning and uncontrolled burning of wastes can result in air pollution and respiratory ailments. Leachate from dumps can contaminate surface and ground waters used for drinking or food gathering and affect people's health. A direct link between poor solid waste management and public health problems can be difficult to demonstrate but is real nonetheless. Protection and enhancement of public health must be a key objective for any solid waste management plan.

Objective 4: To protect the environment.

Comment
Uncontrolled dumping of rubbish can harm freshwater, marine and bird life, and affect food resources. Leachate from dumps may be a source of pollution to streams and shallow lagoon waters. Litter can kill marine life such as turtles and seabirds. Soil and groundwater may be contaminated with leachate making them unsuitable for other uses such as agriculture.

Objective 5: To assist economic development through tourism.

Comment
Tourism is a major component of the economy of many island states. Tourism which is largely based on the enjoyment of an unspoilt and clean environment. Poor solid waste disposal practices and general littering will detract from the appeal of a destination to tourists and can lead to negative publicity and reduction in visitor numbers.

Objective 6: To assist economic development through industry/business.

Comment
Waste management planning may be of assistance in developing the economic base of a region. Recycling or processing of otherwise "waste" materials can create new businesses and more employment.

Objective 7: To assist agricultural development.

Comment
Some waste materials currently being dumped, for example cardboard, greenwaste, fish waste and sewage sludges could provide low cost and

effective soil conditioners and fertiliser. Specialist advice should be sought on proposals such as this however to ensure the suitability of certain waste materials. Sewage sludges for example may contain heavy metals and cardboard may have been treated with acids in the manufacturing process.

Objective 8: To educate and motivate the community on solid waste.

Comment
Success in managing solid waste on the island states will only come from the whole community, government, village and private individuals, recognising that solid waste is a problem and agreeing on the need for change. An objective of the Waste Management Plan is to promote this community approach and increase awareness of the need to better manage solid waste.

Once a set of objectives has been developed which seems to cover all the issues it would be useful at this stage to take them back to the workshop participants for confirmation before proceeding to develop action plans.

4.4 What Actions are required to achieve the Objectives?

Identify actions needed to overcome the obstacles and achieve each objective. To completely achieve one objective may take actions in a number of areas. For the actions consider the social, regulatory, infrastructural, environmental and cost implications – i.e. the factors as set out in Section 5.

For each action, develop an "action plan". This will need to identify:

- Steps necessary to complete the action
- Responsibility for implementing the action - who is going to carry it out?
- Cost of carrying out the action - what are the capital and on going operational costs of what is proposed? What sources of funding are available (Section 4.6).
- Dates. When is the action to be completed by? Set a programme for completing the steps along the way.
- How will progress be monitored. It is very important to have targets against which progress can be measured. For example improvement in water quality downstream of a landfill, or reduction in a particular waste type.

Table 4.1 provides a checklist which could be used to develop the action plans.

4.5 Prioritise the Actions

Ideally all the actions would be implemented at once – but this is unlikely to be the case. Inevitably constraints of money and labour will require the implementation of the Plan over a number of years. It will be necessary to set priorities. Consider the benefits arising from an objective, the obstacles to achieving it and the resources available. Then sort the actions into the immediately achievable, the medium term and the long term.

The decision-making process must be sound with the precautionary principle uppermost. It is important to ensure that health and environment considerations are given the priority they deserve.

Some actions may need to be addressed before others. For example information on the environmental impact of an existing landfill may be very useful to the design of a new facility. Identify any linkages and dependencies between objectives and actions.

The case study in Section 6 provides an example of a summary plan prioritising actions.

4.6 Get agreement on the Plan

The plan will now be taking shape. The solutions proposed will be not only technical, for example requiring new equipment. There will be social and cultural issues also to be addressed. Unless all involved agree on their roles and budget provision is made, the Plan will remain as words on paper, changing nothing.

The draft plan should be confirmed by a follow up "Waste Management Workshop", bringing together all those previously consulted and any other parties identified in the plan. The outputs which this workshop would be aimed to produce would be:

- Agreement on the roles of the various parties
- A confirmed programme for actions
- Budget provision for the various action plans

It may be appropriate for the Plan to be formally adopted by Government.

4.7 Do It - Implement the Waste Management Plan

The Plan is now ready for implementation. The detailed action plans set out the process and steps to follow.

One person or organisation needs to be given overall responsibility for implementing the plan and reporting to Government on progress in achieving the objectives. Procedures for coordinating the activities of different agencies need to be set out. Budgets for the various actions need to be established and approval sought.

A steering "*Waste Management Committee*" could be established from the workshop participants to oversee and report annually to Government on the progress with the Plan actions.

A "*Waste Management Officer*" could be appointed to implement the plan

actions and assist the Committee. This could possibly be a role for a Volunteer Services Overseas (VSO) worker with skills in either a health or environmental sciences discipline.

4.8 Review Progress

The plan should be a working document, subject to periodic review and updating.

As the plan is implemented it will be appropriate to periodically (say every 2-3 years) review the objectives set and the priorities assigned. Were targets realistic? Have new needs become apparent?

Modify and update your plan to keep it relevant.

Table 4.1: Checklist for an Action Plan

Action	Steps to Implement	Who is to Implement	Costs		Target Dates	Progress Measure
			Capital	Operating		

5 Factors which influence Solid Waste Management Planning

In developing and implementing a solid waste plan, several factors will have an influence and need to be considered. These factors will be common to most or all of the various phases of the waste management cycle (Figure 1). These influencing factors are discussed in more detail below.

5.1 The People Factors

The success of any waste management programme is dependent largely on people factors – the extent to which people are willing, motivated and able to reduce waste.

In the island States where solid waste disposal has traditionally not been a problem there is a need to carefully explain why change to waste management practices is now required. People need to be aware of the actions they can take to support the plan.

Changing attitudes is a long term task. It can best be approached through a combination of the following areas.

Education

Education needs to spread the message across a broad section of the community. The following media could be used.

- Signs in public places
- Advertising spots on radio and community newspaper
- Information in the school curriculum, environment and public health sections
- Public health extension workers
- Rural/agricultural extension workers
- Traditional village authority
- Signs in shops and on reusable shopping bags

Education material, be it posters or curriculum material, needs to be developed with input from the local community. Different cultures use different images to convey messages.

Example: The owl is a sign of wisdom in European cultures and would be a good symbol to promote a healthy lifestyle. However in New Zealand Maori culture the owl is associated with spirits and could be a bad choice.

It is not enough just to promote a message that says, littering is illegal. People need to be given reasons to explain why it is necessary to change. Make sure your messages explain what is required of the target audience and why they should respond. For these messages look to the Objectives which have been set for waste management.

The following are powerful messages which will cross cultural barriers and are

universally appropriate.

- Protecting public health
- Protecting the land and water (the environment) from contamination
- Promoting jobs

A good means to implement an education campaign could be to form a subgroup of the waste management workshop with representatives of Health, Education, Agriculture and Visitors Bureau to coordinate activities.

Example

Lead by example. Government departments, local councils and businesses (such as those in tourism) need to demonstrate their commitment to solid waste management. For example, by providing bins in public places and keeping the streets tidy.

An excellent example from Yap State is the annual clean up day where government staff get out and clear litter from around their areas.

Enforcement

Use sanctions and fines for inappropriate waste disposal such as littering in public places and dumping refuse in other than authorised areas. Encourage village leaders to exercise their traditional authority over activity on private land.

Through a combination of Education, Example and Enforcement a culture will be developed which is receptive to sound solid waste management. This will aid in all aspects of the Plan, be it recycling, litter control or siting new refuse transfer or disposal facilities. Most of all, without a recognition that solid waste needs action, there will be no willingness to pay for its management.

5.2 Regulatory––The Legislative Framework available to Control Solid Waste Activities

The small island states do not need a thick lawbook to throw at solid waste. A basic regulatory framework is however required.

As a minimum this should cover.

Project Appraisal and Environmental Impact Assessment (EIA) procedures

The impact of a project on solid and hazardous waste management needs to be considered at the start of a project, along with other infrastructure such as roads, sewer or telecom. Too late once the new factory has started to think where to put the waste.

EIA procedures should specifically identify solid waste as a matter to be addressed in a project approval.

Public domain lands

There needs to be some mechanism whereby land can be used for public infrastructure such as waste disposal. This is a particular problem in the island states, where almost all land is often in multiple owned traditional title. Use for a landfill for example need not require transfer of ownership, but could be handled by a long term lease for the period of filling and aftercare. It must be recognised that this period of aftercare can be extensive, typically 20 years. During that time use of the land may be restricted for safety reasons.

Deposition of litter and unofficial dumps

A simple anti litter by law applying to public places is required. The dumping of waste on a larger scale in unauthorised dumps should be illegal. Action against dumping on public land such as road reserves is straightforward. The regulation should also apply to dumping on private land, although in this instance it is likely that the first action would be taken through traditional village authority.

Landfill siting and construction standards

Specific regulations concerning landfill siting and construction standards are probably not required in the island states. Siting and design of new landfills is likely to be a one off and infrequent exercise, which can be handled through project EIA procedures. The EIA process must ensure that appropriate standards are met. Discharge standards for leachate, and standards for daily and final covering of waste materials, for example, must be specified. Calling in of expert advice on geohydrology and landfill design to review proposals is also likely to be necessary.

Health and safety

A basic code covering the health and safety of workers involved in refuse collection and disposal is required. This would need to cover matters such as protective footwear and gloves, injections and training.

Funding of waste management

It would be helpful if laws covering taxation and imports allowed for the application of taxes or duties which could be directed towards waste management (Section 5.6).

Control over imported packaging

Regulations which could be applied to discourage the import of excessive or undesirable types of packaging may be of assistance.

5.3 Management Structures

The Plan needs to consider the organisational and management structures for solid waste. The nature of solid waste management is such that it falls into the domain of a number of authorities.

For example decisions by the commerce department will affect the type and quantity of waste entering the country, but it will be the public works department or equivalent department that is responsible for final disposal. Ideally one organisation should have an overview role. Effective communication between the various responsible agencies is essential to achieving integrated waste management.

How responsibility for solid waste is organised will vary from island state to island state. In reviewing existing arrangements consider the following aspects:

- Does the organisation charged with a particular function have access to the required resources of labour and plant? For example it will usually be the Public Works Department which has the earthmoving machinery.
- Which organisation can best manage collection of fees, say for refuse collection?
- What capability do private contractors have and where can they be used?
- Are collection and disposal functions best combined or with different organisations?

5.4 Resources and Equipment

The equipment and resources available for solid waste management will determine what options are feasible for the collection and disposal of waste.

Resources and equipment include people, machinery and services.

People

Staff involved in the management of solid waste need an appropriate qualification. Training of personnel in aspects of solid waste management such as proper landfill procedures, special waste identification and handling etc; is an important consideration. There will likely be a need to send staff on courses. Good short courses (one week duration) on waste management are available in New Zealand and elsewhere.

Machinery

Running a sanitary landfill and covering waste requires heavy earthmoving plant to be regularly available. Obtaining suitable plant may be the first priority in any plan to upgrade landfill activities. The operation and maintenance requirements of machinery are also vital considerations.

What could be achieved with collection services will depend largely on the vehicles available. Ideally a refuse compactor truck should be used.

Services

Analytical laboratory facilities are usually limited in the small island states, with capability to undertake basic tests such as pH, conductivity, faecal coliform, available chlorine and possibly a few metals only. This poses a problem for assessing the impact of waste disposal sites on the environment. Samples are

usually which has sent offshore, with cost and logistical difficulty.

A recommended minimum laboratory capacity for monitoring of leachate would be:

pH, Electrical conductivity, Chloride ion, Ammoniacal nitrogen, Nitrate nitrogen, Total Phosphorus, Zinc (acid soluble), BOD_5 (Biochemical oxygen demand) and heavy metals including Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Lead (Pb), Iron (Fe), Magnesium (Mg), Manganese (Mn) and Nickel (Ni).

5.5 The Environment

Inappropriate waste disposal practices can adversely affect the environment. The need to protect water resources from pollution will affect the choice of method for final disposal of waste. Conversely, the nature of the island environment and in particular its soils and geology, will influence the design and cost of disposal sites.

If land is composed of intact sedimentary bedrock, it implies that the ground will provide good natural containment to landfilled waste. Clay soils will contain and absorb harmful constituents in landfill leachates. In these situations there may not be much engineered site improvement required to provide adequate standard of landfill. Volcanic rocks on the other hand may be more permeable to water movement, allowing faster travel of landfill runoff and contamination of groundwater supplies. Artificial lining systems could be necessary.

The most difficult environment in which to achieve sound waste disposal by landfilling is the coral atoll. The typical atoll has a shallow soil of coral sand and a high water table. Often it also contains a valuable fresh water layer. This environment severely restricts waste disposal. Particular attention is needed to the siting of refuse storage and disposal facilities. Some form of artificial lining is likely to be required. The other major difficulty on the atoll is the scarcity of soil for covering refuse. Usually this would have to be dredged from the lagoon, with risk of damage to coral reefs and the general marine environment. Consequently, waste minimisation is of great importance to the atoll states, as their options for landfilling are very limited, and the cost of landfilling in an environmentally sound manner is greatest.

5.6 The Costs of Waste Disposal

Inevitably proposals to improve the standard of waste management come hard up against the realities of limited budgets and competing demands upon government funds. Cost, and the need to obtain maximum value from every dollar spent, will be the bottom line affecting all aspects of the Waste Management Plan.

Recognising the cost barriers

The waste management plan, and equally those external agencies involved in funding waste management projects, need to recognise the major barrier

regarding cost. It is important that a pragmatic approach be taken with staged improvements over an agreed time frame. A modern standard of service as would be ideal for an island state, comprises.

- transfer stations for outlying villages
- kerbside collections for urban centres
- greenwaste recycling
- recyclable collections
- special waste collection points
- a secure landfill with leachate containment and treatment

The above may be a long way off. Immediate objectives may need to be more basic, such as restricting refuse disposal to a limited number of locations and operating facilities so as to facilitate future upgrading.

Identifying the true costs of current operations

The actual costs of running present operations for recycling, collection and disposal need to be accurately captured. This may require consolidation of data from several operating accounts. When related back to the data collected on waste generation (Section 4.1) this gives information on actual cost per tonne or cubic metres of refuse handled. With this data, a valid assessment can be made of the economics of schemes for diverting waste, e.g. by recycling. Subsidies to the waste management account, e.g. through the use of prison labour, should be identified.

Costs not currently addressed but which will arise in the new plan, for example, budget for health and safety of operators.

Identifying the hidden costs of waste management

Current waste management practices, while appearing very low in cost to operate, are likely to have "hidden" costs associated with them that may have to be faced in the future. Examples would be:

- use of space in an existing fill with a short life. A replacement facility may be hard to find and more costly to develop. When this is allowed for, waste minimisation to conserve landfill space may seem more attractive
- pollution of a groundwater resource. Uncontrolled waste disposal may pollute a groundwater resource rendering it unsuitable for drinking or agriculture
- contamination of stream and lagoon sediments with leachate

These costs also need to be considered if a full understanding of the economics of alternatives is to be attained.

Minimising the costs of waste management

Each situation needs to be considered in light of local circumstances, such as freight rates, facilities available in neighbouring countries and so on. First steps to minimising the expenditure on waste management would be:

- Know the waste composition and quantity (Section 4.1)
- Know the costs of current practices
- Pursue waste minimisation schemes where they can show an economic or

strategic benefit (e.g. saving landfill space)

- Apply appropriate standards and technology to disposal operations (Section 2.4)

Means of financing the waste management budget

There are a variety of options for financing waste management operations. Table 5.1 below offers some suggestions for consideration.

The answer in any situation is most likely going to be a combination of several or all of the above. As a general statement, the current level of development of waste management services in the small island development states is such that indirect charging such as general revenue or service taxes will be the most feasible. As the sophistication of services increases, and society accepts the need to change (Section 5.1), a shift to more direct charging would be desirable.

Capital works, especially for the big ticket items of plant and equipment, landfill developments, transfer stations, special waste collections and disposal can probably only realistically be funded by external aid in many situations.

A comprehensive Waste Management Plan, which demonstrates a commitment to staged improvement of solid waste, will be a valuable tool in supporting project proposals.

Table 5.1: Financing Waste Management

Means of Financing	Advantages	Disadvantages
Property taxes (rates)	ë Simple to apply where already exist	ë Difficult where land is in traditional multi owned title ë Potentially unfair if service not used equally ë No efforts / economic incentives to reduce amount of waste
Development aid (i.e. external funding)	ë Obvious	ë Probably only available for capital rather than operating expenditure ë May be a danger of "Talking up" standards to meet donor country expectations
Import levies	ë Can target specific products causing problems	ë Tax structure may not allow ë Conflicts of national vs. regional income
Service tax	ë Simple to apply if already in existence	ë May not be specific to a particular waste
Hotel "bed" tax	ë Can target tourist sector ë Specifically identify as for waste reduction studies on hotel accounts	ë Administration costs

Means of Financing	Advantages	Disadvantages
User charges for collection and disposal	ë Direct and up front charging ë Economic incentive to minimise waste ë Can be volume based	ë Disincentive to use service, especially where long history of "free" disposal
General state/government revenue	ë Easy to apply	ë Cost of service is hidden to user ë Solid waste a low priority area which will usually suffer in the budget round
Deposit schemes	ë Targeted and specific, encourage recycling ë Provide economic incentives to minimise waste for both producers and consumers	ë May be administratively complex ë Careful tracking of scheme economics essential
Consumer products taxes	ë Impose taxes on products generating excessive wastes	ë May be administratively complex
Departure tax	ë Targets visitors	ë Where applied, usually committed to airport development

Grants in aid would be the preference for refuse management activities. Development loans, which require repayment through revenue raised by user charges, would be less desirable. For the reasons outlined above, user charges may be hard to recover in the early years of a waste management plan.

It must also be remembered that the attainment of the goal of waste minimisation will directly reduce the level of financing required for other aspects of the waste management strategy especially landfill management. Economic incentives to minimise waste then become a vital component of the waste minimisation process.

Waste management policy based on Cost-Benefit analysis

Procedures for developing solid waste management plans based on cost-benefit analyses must also be taken into consideration. Such analyses may emphasise the importance of both waste minimisation and landfilling as integral components of the plan.

The consideration of costs must be comprehensive including obvious financial costs (capital and operational, costs of land etc.), costs of impacts on environment, costs of human and social damages from pollution, potential benefits from waste management activities such as waste to energy by incineration, and benefits from the use of compost produced for use as a fertiliser or soil conditioner.

6 Case Study

6.1 Introduction

As a case study to illustrate application of these Guidelines, an outline Waste Management Plan has been prepared for Yap State, Federated States of Micronesia. The case study plan was prepared following preliminary discussions with a number of people in Yap and inspection of solid waste management in February 1998. The case study Plan as presented below is a preliminary draft which would be subject to further development by the Yap community. The case study Plan does not represent official policy of the Yap State Government.

About Yap

Yap State consists of 134 islands and atolls of which 22 are populated stretching across 100,000 square miles of ocean. The main island of Yap is made up of four hilly islands accounting for 38.7 of the State's 49.7 square miles of land area. Colonia the State capital is located here. 8000 people live on the main Yap islands, with some 2000 residents in Colonia.

Almost all of the land on Yap is held in traditional family-based multi-owned title. There is only a small area of state-owned land.

The geology of the main islands is schist bedrock with a generally shallow topsoil. Fresh water aquifers are present in some zones of fractured rock and are a vital source of drinking water.

The main sources of foreign exchange are tourism (in particular diving to see the manta rays) and deep sea fishing. A substantial portion of the Yap State operating account is directly funded by the USA government. This situation is due to change in the year 2000 when direct funding will reduce. However, the State will still have access to funding for specific programmes through the USA Department of Interior. A solid waste management plan will be a useful document to support project applications relating to environmental matters.

6.2 Solid Waste Generation

Features of the present solid waste stream on Yap include:

- There is a low proportion of green waste in the landfilled refuse. The traditional agriculture systems on the island are still maintained. Urbanisation in the Colonia area is not of a density which makes disposal of greenwaste on private land difficult
- There is a low proportion of "kitchen waste" or food scraps in the waste stream. Almost all such waste from houses and restaurants is used for pig food
- Landfilled refuse contains a high proportion of cardboard, and to a lesser extent, plastic packaging
- Aluminium can is a significant item in the landfilled waste and of general litter. There is an active can recycling scheme on Yap
- The island has a relatively high number of motor vehicles and automotive

wastes such as batteries, oil and tyres would form a significant component of the waste

- Apart from the normal household hazardous wastes, Yap has few special wastes requiring disposal. Those currently (or potentially) causing problems include waste oil (and filters etc.), lead acid batteries and power transformers
- Old machinery (e.g. truck chassis, buses etc.) is difficult to dispose

There is little specific data available on the quantities or proportions of waste types. A visual classification of waste at the Colonia landfill site is shown in Table 6.1.

ACTION: Conduct a waste characterisation survey on solid waste collected by the Colonia collection and on that delivered to the Colonia dump site.

Future trends which may affect solid waste generation include:

- Population growth in the Colonia area leading to smaller lot sizes and an increased need to dispose green waste off site
- Continued shift from traditional agriculture to imported foodstuffs - packaging waste is increasing faster than predicted
- Increase in tourism leading to greater generation of refuse from hotels and restaurants
- Development of fishing boat servicing industry means more special wastes such as paints , oils and solvents

ACTION: Ensure provisions of the Yap EIA regulations requiring consideration of solid waste impacts of development are applied.

Table 6.1: Waste Survey Record Sheet

Location: Colonia Waste Disposal Site, Yap
Date of waste survey: 18 February 1998
Names of people participating in waste survey: P Askey
Period during which waste was collected: 3 Day Previous
Source of waste: Delivered to site from Colonia businesses and households.

Primary Waste Classification	Secondary Classification	Examples of Waste	Visual Estimation Relative Amount	Estimated %
Paper	Corrugated cardboard	Boxes	High	35
	Magazines	All magazines	Small	}
	Newspaper	All newspapers	Small	} 7
	Office	Computer, printer, copier	Small	}
	Tetrapak (beverage containers)	Waxed carton	Small	}
	Other packaging	Cereal box, shoe box	Moderate	3
	Sanitary	Nappies	Some	1
Plastics	PET (1)	Soft drink bottles	Few	1
	Rigid HDPE (2)	Milk bottles	None	
	Flexible HDPE (2)	Carrier bags	Lots	} 10
	Other plastics	Not covered above	Few	}
Glass	Returnable bottles	Beer bottles	Few	} 3
	Bottles and jars	Wine bottles and jam jars	Few	}
	Other glass	Window glass	Nil	
Metals	Steel cans	Baked bean can	Moderate	2
	Aluminium cans	Soft drink can, beer can	Lots	5
	Appliances	Fridge	No	}
	Other ferrous	Car body, roofing iron	Low	} 3
	Other non-ferrous	Copper pipe	Few	}
Organics	Kitchen waste	Vegetable peelings, food scraps	Little	2
	Garden waste	Grass clippings, branches	Some	}

Primary Waste Classification	Secondary Classification	Examples of Waste	Visual Estimation Relative Amount	Estimated %
	Coconut husk		Some	} 7
	Soil	Topsoil	-	}
Textiles	Clothes	Clothing (offcuts)	Moderate	5
	Fittings	Carpet, curtains	-	
Potentially hazardous	Garden sprays and poisons	Pesticides, herbicides	-	<1
	Medicines	Human and animal prescriptions	-	}
	Small batteries	Dry cell, alkaline and button batteries	Present	}
	Vehicle batteries	Car, truck and motorcycle	Present	} <1
	Mineral oil	Engine oil, lubricating oil	Present	}
	Paint	Paint, varnish, stains, inks	-	}
	Aerosols	Pressurised aerosols	Present	}
	Other potentially hazardous	Florescent tubes, cosmetics, bleaches, disinfectants, pool chemicals	-	}
Construction and demolition	Wood	Sawn timber	Little	} 5
(C&D)	Wood fibre products	Softboard, hardboard, particle board	Some	}
	Rubble	Bricks, concrete, gib board, fired clay	No	}
	Clean fill	Clay, sand, rock	No	} 5
	Other C & D	Not covered above	Some	}
Other	Rubber	Tyres	Some	5
	Other	Not classified above		

6.3 Consultation

People consulted in course of preparing this case study are listed below in Table 6.2.

Table 6.2: Persons Consulted in Yap

Name	Title	Organisation
Robert Westerfield	General Manager (GM)	Yap State Public Service Corporation (YSPSC)
Faustino Yangmog	Assistant GM	YSPSC
Francis Faney	Director	Department of Public Works and Transportation
Michael Gaan		Department of Resources and Development (R&D)
Howard Zeder	General Manager	Yap Visitors Bureau
Henry Falan	Director	Department of Education
Kathleen Burch	Assistant Attorney General (AG)	Office of the AG
Bill Acker	General Manager	Manta Ray Hotel
	Board Director	YSPSC
J Raglmar-Subolmar	Director	Office of Planning and Budget
J Tamel Gajdusek	Deputy Director	Department of Resources and Development (R& D)
John Gilmatam	Director	Department of Health Services
George Wol Ken	Executive Director	Environmental Protection Agency

To advance the plan from a draft status it will be necessary to seek input of the above to the draft.

ACTION: Convene a workshop of interested parties to consider this preliminary plan.

6.4 Objectives

The following objectives are suggested for solid waste management in Yap.

Table 6.3: Yap Solid Waste Management Objectives

Objective	Comment
1. Through waste minimisation to reduce the effects of waste and cost of waste management	Pressure of population on land resources is not as severe on Yap as on atoll states. Nonetheless landfill space will be increasingly hard to find.
2. To Provide a Service to the Community	Households and businesses increasingly want a convenient and low cost service to help them remove solid waste from their properties.
3. To Protect and enhance the Public Health of the Community	The potential for diseases such as dengue fever to establish through mosquitoes is significant. Sharp object injuries are relatively common. Groundwater resources need to be protected form contamination.
4. To Protect the Environment	Uncontrolled dumping of rubbish can harm freshwater and marine life and affect food resources. The Yapese people rely heavily on the seafood resources of the inshore waters.
5. To assist economic development through tourism	Tourism is a major component of the economy of Yap.
6. To maximise use of waste materials in agriculture	Some waste materials currently being dumped, for example fish waste, may be able to be utilised as soil conditioners/fertiliser.
7. To educate and motivate the community on Solid Waste	Success in managing the solid waste will only come from the whole community, government, village and private individuals, recognising that solid waste is a problem and that there is a need for change.
8. To secure landfill space sufficient for a 20 year period	The present site has limited capacity before either substantial expansion or relocation is needed.

6.5 The Influencing Factors

People factors

There is an awareness of solid waste issues apparent in the pride which the Yapese take in the appearance of the village streets. Community clean up days are held regularly. Education efforts could be coordinated between several State departments

ACTION: Form a liaison group from Department of Education, Yap Visitors Bureau, Department of Health Services and EPA to prepare and coordinate public awareness campaign.

Regulatory

Yap State has regulations covering required aspects of solid waste management. The EIA regulations in particular specifically mention solid (and hazardous) waste.

Management

At present solid waste appears to be in a state of transition between the Public Works Department (PWD) and the Yap State Public Service Corporation (YSPSC). There is logic to either option. The PWD has the resources of heavy machinery needed for running the landfill (bulldozers, excavators). The YSPSC has the management structure and charging regime in place to operate the "user pays" refuse collection for Colonia. A suitable solution could be for the landfill operation to reside with the PWD as a State activity. This may help resolve concerns over liability issues surrounding the taking over of the dump site. The collection service on the other hand is more in the line of a utility and may be best operated on a commercial basis by the YSPSC.

ACTION: Resolve responsibility for collection and disposal.

Equipment and Resources

Compared to some island states Yap appears to have an adequate stock of operating plant sufficient to run a sound landfill operation.

Existing laboratory resources at the Environmental Protection Agency (EPA) should be supplemented to cover a range of basic testing appropriate to landfill leachates.

ACTION: Add following to laboratory capability : Ammoniacal Nitrogen, chloride, zinc.

Environment

The geology of Yap's main islands of massive schist bedrock should provide favourable hydrogeological conditions for landfilling refuse. Ripping and recompacting of *insitu* material would be likely to provide a low permeability soil barrier to leachate movement. Care is obviously required in siting to avoid aquifer recharge zones. This suggests that landfilling can be relied upon for refuse disposal for the foreseeable future.

Cost

Yap faces significant expenditure to upgrade the landfill or find a replacement site. This is unlikely to be within the resources of the existing businesses and households which use the site. It is suggested that the necessary environmental and engineering investigations and the following construction will have to be funded from an external source such as a USA Department of Interior programme.

ACTION: Scope environmental and engineering investigations relating to landfill upgrade and seek project approval.

The fundamental principle for waste management funding must be the 'polluter pays' principle. Operational expenditure on the refuse collection could therefore continue to be funded through user charges as at present. The landfill operation must also be funded through user or gate charges. It will then be necessary to increase intensive supervision over illegal dumping through the enactment of appropriate regulations.

Programmes for waste minimisation must be funded through economic incentives such as increasing charges for increasing generation of wastes. The adoption of measures such as import duties (targeting packaging) departure tax or a hotel bed tax (tourism waste) and deposit schemes (aluminium can) should also be considered on volume or amount.

ACTION: Investigate options for raising finance for waste minimisation programmes.

6.6 Phases of the Waste Management Cycle

Waste Minimisation

From the available data on the waste stream (to be confirmed by the waste survey) priorities for waste minimisation appear to be cardboard, aluminium cans and the tourist sector (because of its growth potential rather than current contribution).

ACTION: Investigate options for the separation and recycling or separate disposal of cardboard waste.

Cardboard could constitute up to 30-40 per cent of landfilled waste at Colonia. Further, most comes from a few main sources (cooperative store, clothing factory) and would be easy to separate out at source. Options for investigation include:

- Collect as a separate waste stream and use as a daily cover material for landfill after shredding and mixing with water
- Ship to Guam for recycling - economics dubious, would need levy on import of packaging to fund
- Purchase shredder and use as mulch in gardens or eroded areas of island. However cost of a shredder at approximately US$40,000 may be prohibitive (or seek as external funded project)

- Burn as separate waste stream, with care to avoid inclusion of other wastes such as plastics which would generate toxic fumes

ACTION: Adopt a deposit scheme to assist return of aluminium cans.

At present the can return scheme operates through the state paying through the recycling agent 1c/can for cans returned. This money was voted from the general State account. It would be more sustainable to operate a deposit scheme whereby the 1c (or more if felt appropriate) was included in the price of the drink, collected by the State and the refund administered by the recycling agent.

ACTION: Conduct a waste reduction programme in the tourist industry sector.

Waste minimisation audits could be used as a means of identifying the types of waste and options for its reduction from the tourism sector. Reference may also be made to the report 'Sustainable Tourism Development' by UNEP/Industry and Environment in this regard.

A number of other waste minimisation measures could also be of use. Many of these, such as encouraging composting of greenwaste, can be promoted through education activities.

Refuse Collection

Colonia has a regular refuse collection with a compactor truck. This services some 20 households and a number of businesses. The village areas have no refuse collection service, which for people without a vehicle makes removal of refuse from house areas very difficult. A long term aim could be to provide a simple transfer station service for these areas. This could consist of an open bin or skip into which people would place refuse. Containers for recyclable items such as aluminium can could also be provided.

Disposal of Residual Waste

There are several concerns with the existing Colonia landfill site which require investigation before it can be considered as providing a suitable long term disposal site. It may be that the available area for landfilling is such that a new site will be required in say, the next 3-5 years. A number of actions are suggested in regards to refuse disposal.

ACTION: Characterise the leachate from the existing dump

Runoff from the dump flows into a small gully eventually feeding to a creek which flows past houses to a bay around from Colonia. The leachate from the dump needs to be fully characterised covering general chemical parameters (pH, conductivity etc.), major ions, heavy metals and priority organic compounds. This full analysis will have to be done offshore and is relatively costly (approximately NZ$800). Ideally the exercise should be repeated at least twice. In addition there should be a regular (say six monthly) analysis of leachate for the basic parameters. The full analysis will give much useful information on the toxicity of the leachate and the extent to which any future

landfill should be contained (i.e. lined). A regular basic analysis will monitor any change in leachate strength.

ACTION: Prepare and implement a landfill management plan.

Several aspects of the landfill operation need attention. In particular the method of pushing refuse downhill into the gully is inappropriate. Vegetation should be cleared from the site and the landfill base prepared in advance of placing fill. Other aspects such as litter control, rat control, stormwater management and operator health and safety should be addressed.

ACTION: Determine volume remaining on current site.

The actual site boundaries require definition to determine the area available for placing refuse. Remaining volume of fill to achieve a suitable design surface is then calculated. This will establish whether to continue with the existing site.

ACTION: Upgrade landfill construction to provide adequate containment to leachate.

Once the results are known from the actions above, decisions can be made on the extent of containment (i.e. base liners) which are required for the waste. This could involve upgrade work on the existing location or perhaps development of a new site.

Special Wastes

Further information on the type of special wastes present would be useful. This would be obtained as part of the waste analysis survey. The following specific waste types require action.

ACTION: Provide collection point for lead acid batteries.

ACTION: Investigate options for the incineration or export of waste oil and associated products.

Waste oil is principally sourced from the power utility (quantity reduced from past years due to equipment modification) and from vehicle servicing. Options are limited, either burn in open air (environmentally a bad practice), purchase purpose built incinerator (ideally capable of taking filter cartridges as well as liquid), or return to Guam.

However, economic shipping to Guam requires the purchase of a large volume container vessel. If shipped in 200 litre drums, each drum needs a laboratory test certificate.

Building on the work done in the "Pacific Waste Oil Study Final Report RAS/94/03C" (Reference 4), determination of the most cost effective

solution is required.

ACTION: Identify a location and construct a storage area for special wastes.

A secure storage area consisting of a bundled compound and a weatherproof store is required for wastes to be held until such time as they can be removed offshore. Such items would include old transformers, batteries and possibly some pesticides. At least with a dedicated storage area, potentially hazardous materials will not be lost.

ACTION: Identify a location where bulky steel items (stripped of any oils etc.) can be dumped at sea.

Bulk steel scrap may best be disposed to an ocean site clear of any dive sites, shipping channels, fishing grounds and so on.

6.7 Set Priorities

A suggested priority for the actions listed above is set out in Table 6.4. In the waste planning process this Draft Action Plan could form the basis for a workshop to confirm priorities, assign responsibility and consider budget requests.

Table 6.4 Yap Solid Waste Management Priorities

Item	Actions			
	Priority One	**Priority Two**	**Priority Three**	**Priority Four and Five**
Plan Implementation	Hold Solid Waste Management Workshop. To confirm plan actions, timetable and budget	Establish steering committee to oversee Plan.	Appoint Solid Waste Officer.	
Waste Minimisation				
Waste Composition and Quality	Assess funding options			
Imported Goods	Undertake waste characterisation survey. Set waste reduction targets.			
Aluminium Cans & Tin Cans	Cardboard recycling.	Consider setting regulations and tariffs to discourage excess packaging		
Green Waste	Put in place a deposit scheme.		Investigate tin can recycling feasibility.	
		Prepare and distribute educational material on home composting.	Trial composting of green waste with pig manure.	
Refuse Collection				
	Agree on roles of IWD & YSPSC		Transfer stations for village areas.	
Landfill Disposal				
	Environmental effects analysis of existing site. Confirm life of existing site. Fence and secure landfill site.	Prepare landfill management plan.	New long term disposal site. Introduce landfill charges.	Record all past dump sites. Rehabilitate existing dump areas.
Ocean Disposal				
	Identify disposal site. Prepare rules governing disposal.			
Special Wastes				
	Storage area for special wastes. Waste oil investigation.	Battery recycling.		
Community Participation				
	Liaison group.	Publicity/Education through Health Department, Schools etc. Cleanest street competition.		

Definitions

Environmental Impact Assessment (EIA)

The process by which all environmental, health, social, cultural and economic impacts, including alternatives, of a project proposal are identified and analysed before a project is approved to proceed. The EIA is intended to assist in planning to prevent or reduce adverse effects to acceptable levels before investment is committed.

Greenwaste

Plant debris such as coconut husk, palm fronds, tree branches, leaves, lawn clippings, plant roots with soil and so on.

Kitchen Waste

Food scraps, either from food preparation or leftovers, from households and restaurants and so on.

Landfill Gas

As waste rots it produces a mixture of methane, carbon dioxide and trace compounds known as landfill gas. Landfill gas is a hazard if it collects in confined spaces (explosion, asphyxiation).

Leachate

The liquid which drains from a landfill. Leachates may contain environmentally harmful substances derived from landfilled material. In the absence of collection/treatment, leachate follows general stormwater paths to streams, groundwater and so on.

Municipal Solid Waste (MSW)

The large bulk of waste from houses, shops and businesses requiring disposal, consisting of mixtures of paper, plastic, glass, metal, wood, organic material. Generally disposed to landfill sites.

Recycling

The processes of transforming waste materials into a form which is potentially reusable, avoiding the need for disposal. Recycled products may be reused in their original form e.g. re-refined lubricating oil, or in a different form e.g. scrap metal.

Sanitary Landfill

A land disposal site for general domestic/commercial/industrial refuse, involving compaction of waste and covering with soil. The land is eventually reclaimed as pasture. The term "sanitary landfill" implies a good standard of management to control pollution and nuisances like litter, vermin and odour, as opposed to "tip" or "dump".

Special Waste

Wastes which require special measures in handling and disposal due to some hazardous property. Special wastes are generally not suitable for ordinary landfilling.

Special wastes are dangerous to people or have harmful environmental effects. Hazardous properties include toxicity, carcinogenicity, flammability, chemical reactivity etc.

Stormwater Runoff

Water flowing to surface drains after heavy rain. Quantity depends on type and water absorbing capacity of soil. May contain large amounts of silt or be polluted with leachate and oil.

Transfer Station

Refuse from outlying villages is collected at one location in large bins for haulage to the main disposal site. A transfer station could be simply constructed using large steel bins, or if larger volumes of waste are involved, could use a compactor to reduce the volume of waste and save on haulage costs.

Waste Analysis Survey

A method for surveying and measuring the quantity and type of waste materials making up the solid waste delivered to a landfill.

Waste Minimisation

Waste minimisation strategies include all actions to reduce the quantity of waste requiring disposal. This could include reducing waste at source, re-using materials, recycling wastes, reducing use of harmful or toxic materials.

References

1. CAE (1992): *Our Waste, Our Responsibility – Towards Sustainable Waste Management in New Zealand.* Centre for Advanced Engineering, University of Canterbury 1992. (Covers many aspects of the generation, minimisation and disposal of solid wastes. While specific to NZ, many aspects of rural waste management in NZ have similarity to the island states).

2. NZMfE (1992): *The New Zealand Waste Analysis Protocol*. New Zealand Ministry for the Environment. (covers detail of methodology for waste characterisation surveys).

3. USEPA (1988): *The EPA Manual for Waste Minimisation Opportunity Assessments.* (Covers detail of waste minimisation audit procedures).

4. UNDS (1996): *Pacific Waste Oil Study Final Report RAS/94/03C* – United Nations Department for Development Support and Management Services.

5. SPREP (1997): *Management of Persistent Organic Pollutants (POPS) in Pacific Island Countries* – Draft Project Design Document.

6. SPREP (1999): *Management of Persistent Organic Pollutants in Pacific Island Countries (POPs in PICs) – Waste and Obsolete Chemicals. Chemicals Contaminated Sites.* Report of Inspections.

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9. SPREP (1998): *Solid Waste Issues in Pacific ACP Countries* – Dr. Suresh Raj - Report for EU funded Pacific Regional Waste Education and Awareness Programme.

10. SPREP (1998): *Procedures for Solid Waste Characterisation Surveys in Pacific Island Countries* – Dr. Suresh Raj - Report for EU funded Pacific Regional Waste Education and Awareness Programme.

Annexes

Annex I An Introduction to Waste Minimisation Auditing

1.1 The Waste Audit

The "waste minimisation audit" is simply a tool or process for evaluating how much and what type of solid waste is being produced by a business or organisation, and then going on to identify practical measures to reduce waste. The audit addresses all aspects of waste minimisation i.e.:

- Reducing waste at source
- Reusing materials
- Recycling waste materials
- Reducing use of toxic or harmful materials

1.2 Steps in the Audit Process

Conducting an audit is a straightforward process of critically reviewing the waste being produced and considering what options are available to reduce it. The procedure for an audit is summarised in Figure A1.1. Considering these steps in more detail:

Planning and Organisation

It is essential that management be committed to the audit, willing to follow up on recommendations where feasible and that sufficient resources are made available to the audit team.

Goals are set for the audit with a list of desired outcomes.

A team for the audit is chosen. This would draw upon members from various interested departments, e.g. purchasing, cleaning services. For a large organisation with a complex waste stream, specialist outside advice may be needed.

Assessment Phase

All useful data is collected to define:

- where waste is produced and how much
- what is the costing of waste disposal
- areas of main waste production
- any regulatory requirements which need to be met

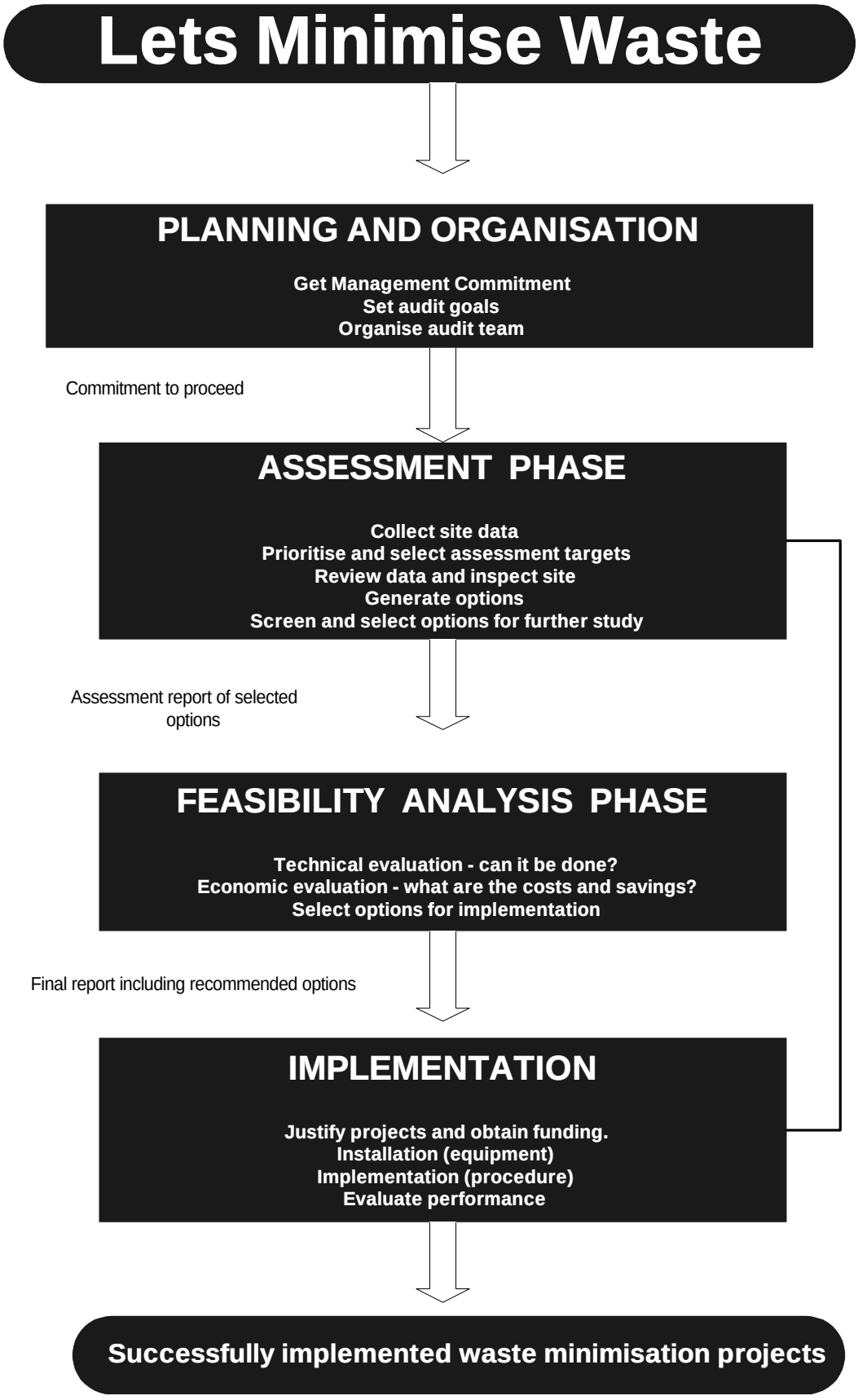

Figure A1.1
The Waste Minimisation Audit Procedure

Priorities are then set for the areas where attention is needed.

Options are generated for waste minimisation. Seek input from staff. Options would typically include:

- **Raw materials:** Could a change in raw materials result in a less hazardous waste, or a more easily recycled product?
- **General housekeeping:** Avoid contamination of general waste with special waste will assist handling. Separation of wastes at source may increase options for minimisation.
- **Production methods:** Changes to production methods may reduce quantities of waste produced.

Options generated are then screened and ranked for further study.

Feasibility Analysis Phase

Some options may be obvious and could be implemented immediately at little cost. For example a collection point for cardboard rather than dumping in a mixed refuse bin.

Options involving changes to production or work practice will involve capital cost. A technical and economic evaluation may be required to obtain funding

Implementation

Recommended projects are then implemented. Monitor the success of the project in terms of cost (hopefully saved) and waste reduced.

Review

An audit should be an ongoing exercise. Targets for waste reduction should be periodically reviewed. Importantly, proposed changes to the business or operation should be assessed for their effect on waste generation.

1.3 Audit Worksheets

The worksheets which follow provide a means of recording the audit information. They could form the starting point for an audit of any small - medium business or government organisation.

Annex II Measures for a Waste Reduction Plan

The following measures could form the basis of a waste reduction plan.

2.1 Manage Imported Goods with a view to minimising waste

Most of the waste materials which are causing problems with disposal are imported to the islands. Examples are packaged goods, consumer packaging and discarded or broken goods.

Part of the cost of imported goods and foodstuffs is the cost of managing the packaging waste which comes with them. Generally at present the cost of disposing this waste is not built into the cost of the imported product. Often the imports are being subsidised by standard waste disposal practises, to the detriment of local produce.

The importation of goods could be reviewed to minimise the amount of waste problems being created. Actions which could assist in this goal are:

- Buying in bulk and specifying the use of recyclable or reusable packaging. Where practicable customers would bring their own containers or plastic bags to collect groceries. In some cases this may be limited by health and food hygiene requirements.
- Use regulations, import duties or sales taxes to discourage the import of goods with excess or undesirable packaging (for example steel drink cans as discussed below).

2.2 Recycling of Aluminium Cans

Aluminium drink cans are the most common litter problem in the island states. Cans (are not biodegradable). However, aluminium is a useful resource and the cans are able to be recycled. The remoteness of island states does not necessarily prevent this. Cans from the outer islands could be brought to port centres for processing.

Cans need to be compacted into “bricks” as densely as possible to get best value from container shipping. This requires hydraulic machinery.

Quality Control for Can Crushing

Once crushed, the aluminium can “bricks” must contain only aluminium - no steel cans. Contamination with steel will heavily downgrade the price received.

A system needs to be in place to ensure the following happens (Strict quality control is needed):

- Check each brand of can with a magnet
- Prepare a list of cans which contain only aluminium - note that some brands may have a steel top or bottom
- Only crush aluminium

Check on Price Received for scrap aluminium from USA, Asia or Australia depending on shipping routes.

The current (March 1998) spot market for aluminium scrap is approximately

AU$870/tonne (90c/kg or approximately 2c/can). Provided the consignment can be guaranteed free of steel contamination, at least this amount should be received. The market is cyclical, but currently strong.

Deposit Scheme

To improve the return rate of cans, a deposit scheme could be introduced. For example this could work as follows:

- Government specify only all aluminium cans to be used for beer and soft drink imports
- Enact regulation that sale price of all canned beer and soft drink to include a deposit of say 2c/can
- Introduce collection points with suitable containers such as wire frame cages for cans around the islands. Schools would be a good location, with proceeds to go to the school funds
- Make refund available at collection point

The details of such a scheme would need to be worked out in cooperation with the retailers and importers of beer and soft drinks. A particular difficulty would be dealing with the accumulation of cans around the islands as the deposit would provide an incentive for the community to collect old cans.

2.3 Green Waste

Definition

Plant debris such as coconut husks, coconut leaves, tree clippings, leaves, grass clippings and so on.

Reason for Separation

Green waste does not need to be landfilled. Being vegetation, it rots down and doesn't provide useful fill. More importantly, green waste is a resource which can be used to produce compost and soil conditioner.

Methods for dealing with Green Waste

Green waste can be composted where it is produced by the householders for use in their own garden plots. Education on good compost methods will assist. Alternatively, the green waste can be taken to a central location for a bulk shredding and composting operation. The shreddings or compost produced could then be used for horticulture. With a centralised composting operation there may be an opportunity to also include pig manure in the compost and improve the fertiliser value of the compost.

If quantities of green waste being landfilled are large it may be worthwhile to have a separate day for collection of green waste only. This could be done in the following ways:

- Households to place green waste on roadside in a different pile to general waste
- Designate a special area for storage of green waste
- Place green waste in wind-row

If funds, allow a shredder could be used to mulch the green waste.

If shredding operations prove successful then the feasibility of composting green waste with addition of pig manure or fish waste to produce a compost rich in fertiliser value could be assessed as a project.

As an alternative means of reducing volume of green waste it can be dried and burnt. Care would be needed to ensure no undesirable materials are included. Burning is less desirable as it may contribute to local air pollution problems and loses most (except the ash) of the agricultural value of the waste.

2.4 Construction Debris

All solid concrete or masonry debris from any building demolition should be stockpiled for use as potential erosion protection. This material should not be landfilled.

2.5 Timber and Wood products

Timber is generally used for firewood. If this is being landfilled, an area should be set aside at the disposal site where it is stored for people to collect. Smaller woody debris may be able to be shredded for mulch or compost.

2.6 Used Appliances

Increasingly there will be a need to dispose of old appliances such as refrigerators and washing machines. Being bulky these would cause difficulty in a landfill without heavy machinery available to crush them. Maximum use should be made of any spare parts. Recycling of the steel is unlikely to be economic due to the cost of shipping it out.

Ideally refrigerant should be removed from refrigerators and air conditioning units before disposal. However equipment for collecting and recycling may not be available. This task could be well handled by the island power utility.

2.7 Cardboard

Small quantities of waste cardboard and paper can be used for mulch in taro and vegetable plots. On a small scale, burning may be appropriate. For the larger port distribution centres the quantities of kraft can be quite large, constituting perhaps up to 40 per cent by volume of the waste landfilled. In these cases baling and backloading to port of origin may be appropriate.

Cardboard recycling could possibly form the basis of a small business venture.

2.8 Businesses and Government

Businesses and Government offices can separate waste materials which could be usable by others. For example, paper offcuts, cardboard tubes, magazines

and fabric offcuts might be usable in the school or hospital.

2.9 Miscellaneous Items

Investigate providing financial incentives for the development of new businesses and industries which could use waste materials for example. Incentives could include grant assistance for researching the business viability, assistance with loan proposals, development finance or rebates for the amount of waste diverted from landfill. Such assistance may already be available through the Department of Commerce and Industry or its equivalent.

Annex III Waste Analysis Procedures

3.1 Introduction

A lack of consistent information on waste quantity and composition makes it difficult to plan for sound waste management. Without reliable data it is difficult to set realistic targets for say waste reduction, and to know when these have been achieved. By analysing the actual waste stream on a systematic and repeatable manner useful information can be collected. Better data on waste does not in itself imply better management, but it is a lot harder to manage waste effectively without it.

Municipal solid waste consists of a wide variety of materials. Some, such as cardboard and vegetation will be present in relatively large proportions and be easy to measure from a small sampling of the waste stream. Other components which could be of interest, such as certain recyclable plastics, or special wastes, will be present in relatively small proportions. To gain a reliable estimate of these types of waste it would involve a much more intensive sampling and analysis effort. Therefore, it is important that any waste analysis exercise has clear objectives and that the sampling effort be designed to provide the level of data needed.

For most situations in island states it is likely that an overview of waste composition is sufficient and that identification of a large number of waste types to a high degree of precision is unnecessary. The procedures given below should suffice to give this overview. If a more detailed analysis is required, as would be needed for a study into incineration, then a more intensive survey should be undertaken and reference made to the sources quoted.

Waste may need to be classified at two locations. Where a substantial proportion, say >20 per cent of refuse, is delivered from a bag/bin collection from domestic and commercial premises, then it would be appropriate to conduct a waste analysis on the refuse as collected. This allows conclusions to be drawn on a per household basis, and comparisons to be made between different income groups. However, most landfilled refuse is delivered direct to the disposal sites, and an analysis will need to be carried out on waste delivered to the disposal site.

The advice on carrying out a waste analysis as set out later in the Guidelines is largely sourced from a New Zealand Ministry for the Environment publication: *The New Zealand Waste Analysis Protocol*, November 1992 (Refrence 2).

Another useful reference is SPREP (1998) - *Procedures for Solid Waste Characterisation Surveys in Pacific Island Countries* (Reference 10) by Dr. Suresh Raj.

3.2 Waste Classifications

The number of categories is determined by the survey purpose and the size of sample needed to obtain a statistically meaningful result. Clearly the more categories, and the smaller the proportion of waste in each, then the greater effort needed to obtain a precise estimate for the less common components of the waste. Table A3.1 gives a recommended classification, into eight primary categories, each divided into several subcategories. These eight main categories are sufficient to cover both bag collections and waste delivered direct to landfill. Other subcategories could be added if appropriate.

3.3 Sample Size

Bag collections

Sample size will be directed by the accuracy needed for the least common waste type of interest. Reliable estimates for the main three constituents of the eight (paper, plastic and organic) can be obtained from approximately 50 samples. A maximum practical sample size is probably 300 households (and in many island situations there will not be that many households with regular collections). Sampling at this level would give accuracy of say within 10 per cent for organic, paper and plastic, 15 per cent for metals and 20-30 per cent for other categories. Quantities of potentially hazardous materials, which are typically less than one per cent in MSW would be indicative only.

A sampling strategy would be to collect every “nth” bag for sampling, where “n” is chosen to give the required number. Sampling at the disposal site is not a preferred strategy.

Table A3.1 Waste Survey Record Sheet

Location
Date of waste survey: .....
Names of people participating in waste survey.....
.....
Period during which waste was collected:.....
Source of waste: .....

Primary Waste Classification	Secondary Classification	Examples of Waste	Weight of Waste Recorded
Paper	Corrugated cardboard	Boxes	
	Magazines	All magazines	
	Newspaper	All newspapers	
	Office	Computer, printer, copier	
	Tetrapak (beverage containers)	Waxed carton	
	Other packaging	Cereal box, shoe box	
	Sanitary	Nappies	
Plastics	PET (1)	Soft drink bottles	
	Rigid HDPE (2)	Milk bottles	
	Flexible HDPE (2)	Carrier bags	
	Other plastics	Not covered above	
Glass	Returnable bottles	Beer bottles	
	Bottles and jars	Wine bottles and jam jars	
	Other glass	Window glass	
Metals	Steel cans	Baked bean can	
	Aluminium cans	Soft drink can, beer can	
	Appliances	Fridge	
	Other ferrous	Car body, roofing iron	
	Other non-ferrous	Copper pipe	
Organics	Kitchen waste	Vegetable peelings, food scraps	
	Garden waste	Grass clippings, branches	
	Coconut husk		
	Soil	Topsoil	
Textiles	Clothes	Clothing	

Primary Waste Classification	Secondary Classification	Examples of Waste	Weight of Waste Recorded
	Fittings	Carpet, curtains	
Potentially hazardous	Garden sprays and poisons	Pesticides, herbicides	
	Medicines	Human and animal prescriptions	
	Small batteries	Dry cell, alkaline and button batteries	
	Vehicle batteries	Car, truck and motorcycle	
	Mineral oil	Engine oil, lubricating oil	
	Paint	Paint, varnish, stains, inks	
	Aerosols	Pressurised aerosols	
	Other potentially hazardous	Florescent tubes, cosmetics, bleaches, disinfectants, pool chemicals	
Construction and demolition	Wood	Sawn timber	
	Wood fibre products	Softboard, hardboard, particle board	
	Rubble	Bricks, concrete, gib board, fired clay	
	Clean fill	Clay, sand, rock	
	Other C & D	Not covered above	
Other	Rubber	Tyres	
	Other	Not classified above	

Refuse delivered to landfill

A typical landfill will receive loads each day from a large number of cars and pickups carrying relatively small loads; and a small number of trucks carrying proportionally much larger loads. To design a survey for a particular facility it is necessary to have knowledge of the vehicle counts in each category, and how these vary through the week. However, for a smaller, rural landfill, typical of the situations likely to be encountered in the island states, the following survey methodology would yield useful data.

- Set up electronic wheel scales
- Weigh all incoming trucks and trailers (in and out) during operating hours over a week. The week to be typical of the period. Record all vehicle movements for the period.
- Sample and classify refuse from all trucks (excepting the municipal collection where this has been sampled separately)

- Sample and classify refuse from a large proportion of trailers (all if possible)
- Sample and classify refuse from a proportion (say 25 per cent) of cars/pickups. Cars are not weighed, load sizes for cars are obtained from those that are sorted.

3.4 Classification at Source from Bag/Bin Collection

In summary the approach is to:

- collect refuse put out for collection by the regular municipal collection (include shops and small business).
- identify refuse from each household, so data can be reported on a per household basis
- take to a sorting station
- sort to a minimum of eight categories
- weigh and record data
- statistical analysis

3.4.1 Sorting

The sorting area should be about 7 m x 4 m and ideally it is paved and under cover. A table is set up say 2-3 m long by 1 m wide. Bins behind the table are used to receive sorted waste. Typically one worker can classify around five bags per hour.

3.4.2 Weighing

Sorted material is weighed. The best scale is an electronic industrial scale weighing up to 70 kg by 10 gm increments. As a check weigh the total sample prior to sorting and check against the sum of the fractions.

3.4.3 Analysis and reporting

The main points in analysis are:

- the statistical unit is the household, not the bag
- analysis and reporting is by weight, not volume. Volume is greatly affected by the compaction of the refuse and a volume measure is more difficult to relate meaningfully to a landfill space requirement
- statistical analysis should be used to give confidence intervals

The mean percentage composition for a waste type is determined from the total weight of the constituent divided by the total weight of refuse sampled. This is not the same as the average of the compositions of the individual samples.

Data from the number of households sampled is extrapolated to provide an estimate of refuse generation for the full number of houses in the collection area.

For potentially hazardous substances it is appropriate to only list the substances found.

3.5 Classification at Landfill from Car and Truck Delivery

In summary the approach is to:

- weigh all or most large vehicle loads arriving at the site and a proportion of smaller loads
- sample a proportion of incoming loads in each category and to sort and weigh a sample of refuse from these
- visually classify the remaining loads, or a large proportion of them

Weighing vehicle loads

Unfortunately a weigh bridge is unlikely to be available in most island sites. In the absence of a weighbridge, either wheel scales (mechanical or electronic) or platform scales will be needed. Assistance from a local motor garage and probably the shipping company will need to be sought as to what equipment is available. Vehicles are weighed in and out of the site to give the refuse load.

Where no suitable vehicle scales are available then it will be necessary to work on a volume basis. In this case the volume of each load is estimated (in litres or cubic metres). When a sample is taken for the sort and weigh analysis, the proportion of the load taken is estimated (e.g. sample is 10 per cent of the load). From the known weight of the sample estimate the overall load weight. This approach will be less accurate than direct weighing.

Refuse sub sampling

Classifying a full truck load is a daunting thought. Fortunately a 140 kg sample is sufficient to give a good indication. The sample should be representative of the load, e.g. taken by dumping off the load, spreading it out with a loader bucket and taking a bucket load of about 140 kg. A more scientific method of using a marked grid could be used but is probably not necessary.

Ideally for trailers the full load should be sampled.

Sorting and weighing

Sorting and weighing of the sampled refuse is as per the bag collection. A larger area may be needed for processing the refuse.

Analysis and reporting

The basic statistical unit is the load (either truck, car, trailer or utility/pickup). Reporting is by weight.

Visual classification

Where there are a large number of loads coming into a site, visual classification of loads can be used to extend the survey coverage. A visual classification is obviously a lot less accurate than sort and weigh and will depend upon the classifier. A proportion of visual classifications should be checked by sorting and weighing.

3.6 Personnel

Having the right staff on the job is essential to getting useful data. The task is not pleasant and it may be offensive for cultural reasons. Staff involved in the sorting and weighing should be given training covering the reasons for the project, why good data is important, the methodology, the classifications and the need for confidentiality. Ideally personnel should be those with an interest in the environment and public health i.e. to whom the survey results will have some interest.

3.7 Health and Safety

The handling and classifying of refuse is potentially hazardous. Staff need to be aware of the possible hazards. The refuse will likely contain sharp objects, toxic substances, even syringes. Workers should have current tetanus vaccination. Hepatitis A is not essential. A public health officer should be included on the team to oversee health and safety aspects.

Equipment should include:

- overalls
- heavy duty rubber or Polyvinylchloride (PVC) gloves
- foot protection
- eye protection
- dust masks
- ear muffs (if machinery close by)
- first aid kit
- water and disinfectant for wash up

3.8 Other Considerations

Seasonal variability

The refuse stream may vary through the year. Vegetation waste in particular

will depend on season. Where shipping service is infrequent, waste delivery to landfill from businesses will vary depending on when the ship was last in port.

Sampling programmes should be matched to account for these factors, and if necessary the survey repeated on several occasions.

Confidentiality

Where refuse is being sorted by hand the potential to find confidential documents etc., arises. Collected refuse should not be identified by a street address, just give each sample a consecutive number. The need to maintain confidentiality should be stressed to staff. After sorting, all refuse should be returned to the landfill.

Annex IV Recommended Measures for dealing with Special Wastes

The following are suggested approaches for dealing with some of the more commonly encountered special wastes.

Car and Truck batteries

Drain acid and neutralise before disposing to ground. Recover lead for recycling. Batteries may be backloaded for recycling. Batteries are likely to be a significant contaminant of island states landfills.

Waste oil

Options for dealing with waste oil are limited and will vary depending on location. In some parts of the South Pacific waste oil is being collected for incineration in Fiji. However export to USA jurisdictions may be more difficult due to the quality assurance requirements. A dedicated incineration plant capable of burning oil and filter cartridges would be ideal except that it has ongoing maintenance requirements. The oil is likely to contain heavy metal contaminants from engine wear and leaded fuel, and the possibility of PCB contamination exists.

Use for timber preservation is a possibility. Use as dust suppressant on roads is an undesirable practice as it spreads contaminants through the environment.

Any shop or garage selling oil should be required (if necessary by a by-law) to provide a drum for collecting waste oil.

(Waste oil in the Pacific was the subject of a detailed report by the United Nations in 1996).

Pesticides

A collection point may be required for small quantities of unwanted pesticides. Any collected materials could be stored until disposal off the island can be arranged, for example through the SPREP/AusAID POPs in PICs project.

Medical waste

Medical waste should be incinerated in a dedicated unit. This is important from a public health consideration. Landfilling practices are not usually sufficiently well controlled for disposal of medical waste without sterilisation first.

Residue from the incinerator will still contain sharps (scalpels and needles). While sterile, these would still be unsuitable for general landfill disposal, especially with basic landfilling practices. Secure landfilling is required.

Septic tank cleanings

At present cleanings from septic tanks (septage) are often disposed of by excavating a pit beside the tank and dumping the material. This is not a desirable situation. In the longer term a specific septage disposal facility (lagoon or drying beds) needs to be established. Waste could be carted to the pits by a vacuum tanker. This piece of equipment may need to be sought through an aid project.

Sewage sludges

Sludges from sewage treatment processes should be allowed to air dry and mature (ideally for 12 months to destroy pathogens). These can then be used for fertiliser or soil conditioner. Where local culture precludes the use of human sourced manure directly on food crops the material could be used for rehabilitating eroded land or incorporated into landfill caps.

Offal

Disposal of small quantities of offal, e.g. from slaughter of individual animals, to the ocean as is a common practice is a practical option. Larger quantities as from commercial slaughterhouses would require specific treatment.

Pig manure

Pig manure should be reused for agriculture. Ideally it could be used with vegetation shreddings to make compost for horticultural use.

Paints

Small quantities of paints and solvents can be dealt with by brushing out on waste timber or iron.

Asbestos waste

Asbestos is used in some building materials. Inhalation of the dust causes serious lung disease. Asbestos could be encountered in building work on older buildings. Asbestos should be sealed in large plastic bags and buried sufficiently deep in the landfill so that it can not be subsequently dug up. Extreme care is needed in the handling of asbestos products.

Waste Minimisation Audit: Worksheet 1

Business questions	Comments
Name of business	
Business contact details (address and phone number)	
Manager's name	
Activities offered by business (brief description)	
Quantity of waste generated per year	
Name of waste contractor and annual disposal cost (include bin hire, collection and disposal)	
Does the business practice waste minimisation currently (yes/no, brief description)?	
Specify the materials that are currently recycled?	
Name of recycling contractors and annual recycling costs or income (specify for each material if possible)	

Auditor Team: …….. Date: ……

……..

……..

……..

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Worksheet 2: Activity Register

Activity	Present (Y/N)	Size	Comment	Priority
1. Office				
2. Retailing				
3. Warehousing				
4. Printing/Copying				
5. Vehicle Servicing				
6. Cafeteria/Restaurant				
7. Medical/First Aid				
8. Landscape/Grounds				
9. Manufacturing/Process				
10. Laboratory				
11. Accommodation				
12. Other				

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Worksheet 2A: Activity Details

Activity	Waste Types
Office	Paper ë computer ë quality other ë newsprint Cardboard Plastics Others Used stationery Printer ribbon Toner cartridges Old equipment
Retailing/Warehousing	Packaging ë cardboard ë plastic (polythene) ë plastic (other) Expired stock
Vehicle Servicing, Maintenance Areas	Metal ë ferrous ë non ferrous Lube oil Parts wash (solvent) Tyres/tubes Packaging ë cardboard ë plastic Other Paint Tins Batteries
Landscape/Garden	Combustible ë lawn clippings ë prunings Branches/wood Soil Old equipment Pesticides ë rinsate ë expired stock Packaging ë cardboard ë plastic

Cafeteria/Restaurant	Packaging **ë** aluminium cans, tin cans **ë** plastics **ë** paper Food waste Disposal utensils Broken crockery Bottles Table items Cleaners
Accommodation	Paper, magazine, stationery Old linen Laundry supplies Bathroom items

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Worksheet 3: Waste Minimisation Option Worksheet

Type of Waste (Material and Use)	Estimated Quantity of Waste	Current Disposal Method (Who and How)	Current Disposal Cost/ Income $	Can Waste be Prevented or Minimised by the Business?			Waste Minimisation Option (Brief Description of Option State whether Substitute, Reduce, Repair, Reuse, Recycle, Compost, Compact)	Cost to Implement (no-cost, low-cost or investment)	Feasibility Analysis Required?	
				Yes	No	Unsure			Yes	No

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Worksheet 3A: Prompt Questions for Considering the Potential for Waste Minimisation

Are materials purchased in maximum volume?

Are suppliers asked to minimise packaging?

Are suppliers asked to take back packaging (e.g. pallets, reusable containers)?

Are reusable, durable items purchased?

Are single-serve items purchased?

Are items repaired or recovered when worn or dated?

Can items be reused in existing or similar form?

Are items purchased for recyclable content?

Are items purchased to minimise hazardous substances or non-renewable resources?

Are faulty or damaged goods received from the supplier? Are they returned to the supplier?

Do goods become damaged or unusable (through expiry or contamination) before use?

Is information circulated to staff through noticeboards or circulation slips?

Is waste segregated?

Is hazardous and non hazardous waste and materials kept separate?

Are staff encouraged to minimise waste?

Firm _____ **Site** _____ **Date** _____	**Waste Minimisation Audit Worksheets**	**Prepared by:** _____ **Checked by:** _____ **Page** _____ **of** _____

Worksheet 4: Profitability

Capital Costs

Purchased equipment _____

Materials _____

Installation _____

Utility Connections _____

Engineering _____

Start-up and Training _____

Other Capital Costs _____

Total Capital Cost _____

Incremental Annual Operating Costs

Change in Disposal Costs _____

Change in Raw Material Costs _____

Change in Other Costs _____

Annual Net Operating Cost Savings _____

$$\text{Payback period (in years)} = \frac{\text{Total Capital Costs}}{\text{Annual Net Operating Cost Savings}} = \_\_\_\_\_$$

Firm _____ **Site** _____ **Date** _____	**Waste Minimisation Audit Worksheets**	**Prepared by:** _____ **Checked by:** _____ **Page** _____ **of** _____

Worksheet 5 : Implementation

Option	Waste Stream	Source Reduction Actioned	Recycle/Reuse		
			Storage Arranged	Agent Notified	Collection Underway