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Acronyms and Abbreviations

SPREP	South Pacific Regional Environment Programme
TEMPP Project	Tonga Environmental Management and Planning
WHO	World Health Organisation
EPACS	Environment Planning and Conservation Section
MoH	Ministry of Health
PWD	Public Works Department

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Executive Summary

Action Plan

Waste Management Sector	Action			Responsibility	Timeframe
	Priority 1	Priority 2	Priority 3		
Implementing the Plan	<ul style="list-style-type: none"> Workshop with government ministers, NGOs, business and community leaders, DoH and EPACS Prioritisation of actions and responsibilities 	<ul style="list-style-type: none"> Review of responsibilities and regulations for waste management in Nuku'alofa Review of potential for privatisation 	<ul style="list-style-type: none"> Appoint and train a Solid Waste Officer Set targets for waste reduction 		
Waste Minimisation Initiatives					
Metal wastes	<ul style="list-style-type: none"> Increase quantity of aluminium recycled through increased publicity for existing scheme Set up trial scheme for other non-ferrous metal collection and shipping for recycling 				
Biodegradable Waste	<ul style="list-style-type: none"> Designate area for green waste at landfill Notify public of segregated collection and dumping of green waste 	<ul style="list-style-type: none"> Arrange for separate municipal collection days for green waste 	<ul style="list-style-type: none"> Obtain shredder Mulch and compost any green waste and organic waste at landfill 		
Plastic waste		<ul style="list-style-type: none"> Negotiate/subsidise costs of shipping waste to Aust, NZ or Fiji 	<ul style="list-style-type: none"> Implementation of packaging legislation 		
Paper waste		<ul style="list-style-type: none"> Negotiate/subsidise costs of shipping waste to Aust, NZ or Fiji 	<ul style="list-style-type: none"> Implement separate paper collection Buy shredder & baler for paper. Ship overseas for recycling. 		

Waste Management Sector	Action			Responsibility	Timeframe
	Priority 1	Priority 2	Priority 3		
Refuse Collection System	<ul style="list-style-type: none"> Obtain new compactor truck Obtain new open collection truck Fix hydraulics on two existing compactor trucks 	<ul style="list-style-type: none"> Implement two household collections per week Increase charges for waste collection 	<ul style="list-style-type: none"> Buy rubbish bins for households and distribute when fees are paid 		
Landfill	<ul style="list-style-type: none"> Prepare an interim plan for regular use of PWD bulldozer at landfill Purchase new bulldozer for landfill Identify new landfill site and funding 	<ul style="list-style-type: none"> Introduce landfill charges 	<ul style="list-style-type: none"> Control access to landfill Appoint landfill gatehouse keeper 		
Special Wastes	<ul style="list-style-type: none"> Improve clinical and medical waste handling procedures, segregation and disposal Review efficiency of the use of the quarantine incinerator Investigate options for dedicated hospital incinerator 	<ul style="list-style-type: none"> Implement waste oil collection system for burning in boiler Implement waste pesticide container collection 	<ul style="list-style-type: none"> Implement waste batteries collection for proper disposal 		
Community Involvement	<ul style="list-style-type: none"> Public education campaign – DoH, schools curriculum, businesses, women's and church groups Publicity on new recycling schemes School collection schemes for recyclables 	<ul style="list-style-type: none"> Local business involvement in street/beach cleanups Local business sponsorship of competitions 			

1. Introduction

This report was financed by the European Communities from a grant of the European Development Fund and is presented by the consultant Sinclair Knight Merz Ltd for consideration of the Tongan Government. It does not necessarily reflect either the opinion of the latter or the European Commission.

Sinclair Knight Merz was commissioned by the South Pacific Regional Environment Programme (SPREP) to carry out the Solid Waste Characterisation and Management Plans Project in 8 Pacific Countries including Tonga, Fiji, Vanuatu, Papua New Guinea, Kiribati, Tuvalu, Solomon Islands and Western Samoa.

This is the final report for Nuku'alofa, based on the findings of the field work carried out by the author in Nuku'alofa from 24th August – 7th September 1999. The aim of the report is to present the results of the waste characterisation work carried out while in Tonga and to describe the current waste management practices in Nuku'alofa. The report also aims to formulate options and priorities for an integrated solid waste management plan for Nuku'alofa.

The terms of reference for the work in Tonga have been adjusted to compliment the work in solid waste management that is currently being carried out under the TEMPP (Tonga Environmental Management and Planning Project) project. In this respect, the waste characterisation components of this project have been concentrated on, while the formulation of the final integrated solid waste management plan will be the responsibility of the TEMPP project. The options and priorities identified in this report will contribute to the preparation of a final solid waste management plan in conjunction with the TEMPP Project.

2. Overview of Existing Solid Waste Management Practices, Methods and Regulations

2.1 Introduction

In Nuku'alofa the responsibility for solid waste management rests with the Ministry of Health (MoH). The Ministry has only 22 health inspectors covering a wide range of responsibilities throughout Tonga and it appears that solid waste management has a low priority. The management and operations for solid waste management are under resourced both in staff and funds and there is little enforcement of waste related regulations. Management of the waste collection and disposal service in Nuku'alofa is ineffective as the collection is erratic and at best only achieved once per week, there is only one compactor truck in operation and it is not operating to maximum capacity, the dump site has no regular bulldozer or front end loader operating and so frequently the access road becomes blocked and waste is dumped alongside the main road. At the time of the fieldwork the dump site posed significant problems to the residents of Nuku'alofa due to :

- Health risks to anyone in the vicinity if the dumpsite including inhabitants of the settlement nearby, as waste was accumulating to within 200metres of the nearest house
- Health risks to scavengers working freely at the dumping site
- Fire risk due to uncontrolled open dumping without any cover of the waste
- Significant loss of visual amenity as the waste was accumulating on the road side adjacent to the waterfront
- Potential for contamination of the lagoon

The Public Health Division of the Ministry of Health has responsibility for other aspects of environmental health including disease control services, food water and sanitation inspection services, sanitation approval, rural water supplies, village health workers, health education, maternal and child health and family planning services, immunisation, school health programme and nutrition services.

2.2 Legislation

There is no waste management legislation or waste management policy in Tonga. Environmental legal provisions are scattered throughout a range of legislation and administered by a number of Ministries and Departments. The Environmental Planning and Conservation Section located within the Ministry of Land, Survey

and Natural Resources is regarded as the leading institution in environmental matters. The Ministry requires the Section to administer its environmental programme jointly with other Departments, which have legal sectoral environmental responsibilities as part of their function. The shared environmental responsibilities depends upon a co-operative relationship, there being no legal obligations for these various Departments to consult with the Environmental Planning Section, or with one another, on environmental matters.

As stated earlier the Ministry of Health is in charge of municipal solid waste management, that includes waste collection, dumping and maintenance of the dumpsite. There are no regulations to regulate what should or should not be deposited at the dumpsite.

The Garbage Act 1949 as amended defines garbage to include household refuse, empty cans, rubbish, trade refuse and waste, but not night soil. Section 8 of the Act requires every owner or occupier of a premise to keep garbage cans covered, clean, in good repair and easily accessible to the garbage collector. Garbage from premises must be deposited in garbage cans and not deposited on roadways, vacant land, foreshore, streams or creeks (s 11).

The Public Health Act 1913 and Regulations, define “refuse”, allow the Minister of Health to declare certain places to be dumping grounds, and also provides remedies for environmental problems under the law of public nuisance. Abatement notices and fines can be imposed for creation of public nuisance caused by accumulation of waste on properties.

The Mosquito Control Regulations 1938 also have provisions for control of waste disposal .

There is no legislation for the management and disposal of hazardous waste in Tonga. The disposal of veterinary and hospital drugs, chemicals, fabric dyes, old paint, asbestos, photochemicals and other hazardous waste need to have regulations put in place. Pesticide containers are a major risk to the public as some of them are used for the storage of rain water. The Environmental Management Plan for the Kingdom of Tonga (ESCAP, 1990) recommends the establishment of a Hazardous Materials Act.

The disposal of septic tank sludge to the dump is at present uncontrolled and while it is being deposited in small dyke enclosures near the mangrove area with the dump the dykes are poorly secured. The design, operation, maintenance and security of sludge drying beds for septic tank waste disposal should be regulated.

The recommendations for solid waste management given in Chapter 10 of the Review of Environmental Law, by Mere Pulea 1992, that are relevant to this study can be summarised as follows:

1. Develop categories of waste to be specifically defined with stringent controls placed over disposal facilities such as sludge drying beds and hazardous waste disposal areas
2. Amend the Public Health (Dumping Grounds) Regulations to include the requirement for an environmental impact assessment to be carried out before designating a dumping site, and set restoration measures for the closure of an old dumping site.
3. Enact a Hazardous Materials Act.
4. Amend Regulations of the Public Health Act to allow for the control and security of a waste disposal site from animals and humans.
5. Consider and Act to specifically deal with littering.

A Land Use, Natural Resource and Environment Planning Bill is under consideration and will be passed in the near future.

2.3 Littering

It is illegal to litter in gazetted area such as Nuku'alofa due to the Town Regulations Act but there is very little if no enforcement of these regulations. While there are public rubbish bins along the waterfront in the centre of town there is little evidence that these are used – in fact the majority of them are vandalised. There are few rubbish bins available around the rest of the town. The MoH is responsible for cleaning the streets and other public places (they have one street sweeper for the main road), although EPACS is responsible for Parks and Beaches. Where there is no collection there is often indiscriminate dumping

2.4 Income and Expenditure

The MoH spends about T\$60,000 per annum on waste management (mainly for waste collection and maintenance of the rubbish dump) in Nuku'alofa. Most of this is assumed to come from government allocation because the fees charged for collection of waste are so low:

Table 2.1 Income from Collection Fees 1998 – 99

Type	Total Number	Rate per	Total Income
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		month (T\$)	per Year (T\$)
Private Home and Office	951	0.5	5,706
Schools and Stores	79	1.00	948
Restaurants, Motels, Hotels, Guest Houses	41	1.50	738
Whole Store Industries	31	2.00	744
Total (T\$)			8,133

The fees for waste collection are dictated by legislation (The Garbage Act, Amendment Ordinance 1977), and have been the same since 1977. It is also felt that at present when there is only one collection per week, the residents cannot be expected to pay any more than the current fees. If there was an improved collection system then it is anticipated that more fees could be charged but there would have to be an amendment to legislation to achieve this.

2.5 Collection System

Normally waste is collected twice per week in Nuku'alofa but this has been reduced to once per week for some time, due to lack of funds and lack of equipment (only one collection truck in operation). Collection days are not reliable. Collection covers 20% of households in Nuku'alofa, approximately 950 houses per week, plus 9 schools and 28 commercial properties. Domestic rubbish is put out loose in piles, in plastic bags, on stands but rarely in bins.

Commercial premises are provided with daily rubbish collection six day per week. Many commercial and industrial operations take their own waste to the dump. The hospital waste is collected twice per day.

Septic Tank waste is dumped in dykes at the landfill. A private contractor dumps about 7 tanker loads per day.

The single operating waste collection truck (Garwood, 160T Perkins) is about 15 years old and was given by Australia. The second truck has been out of use for some time due to a broken hydraulic system and the lack of funds to buy parts for repair of the vehicle.

At present there are no private waste collection contractors in Nuku'alofa. The MoH has been considering privatisation of the waste collection service in Nuku'alofa for some time. An action plan drafted by the MoH showed a survey of private homes in January 1999, an international expert to draft legislation in February 1999, Submission of draft legislation in March 1999 and the start of a private collection system in January 2000. It is believed that this process has not yet been undertaken.

2.6 Tukutonga Dump

The Tukutonga Dump is located about 4 kilometers from the centre of Nuku'alofa in an area that was previously a tidal mangrove swamp. An engineered foreshore and the Vuna Road separate the site from the sea. There are settlements adjacent to the dump to the west and north of the site. An alternative site for a landfill was identified at Sopu in 1995 but this was then designated for a golf course by the government and as a result the MoH have been forced to identify another site, which has not yet happened.

The current dump was upgraded, after an investigation and advice by WHO, in order to extend the life of the dump, through better management of the existing site. During January 1996 – December 1996 WHO spent \$50,000 on the site and it was prepared and operated as a controlled landfill, using a local engineering contractor. The following activities were undertaken:

- Site survey
- Initial site preparation
- Upgrading of access road
- Construction of gate house
- Connecting of water supply
- Excavation of the first trench and stockpiling of cover material
- Filling trench with solid waste
- Keeping face of trench clean
- Levelling waste
- Placing final cover

This project was a success at the time of implementation but it appears that at present the operations have degenerated to the prior uncontrolled operation. The reason for this is that there are no funds to allocate to the operation of the dump. There is no bulldozer operating at the dump and it costs the MoH approximately \$3,000 to hire one for 2 days. Consequently waste is being dumped anywhere, and at times the access road is blocked with waste and trucks then dump their loads outside the dump area. At times there is no bulldozer on site for periods of up to one month.

2.7 New Landfill

While it is recognised that the Tukutonga dump is nearing the end of its life, the process of identifying a new site has not been undertaken. The key agency involved in the identification and allocation of a new site is the Department of Lands and Survey The

TEMPP Project believes that this is the highest priority for Nuku'alofa and is working to get this process underway, and is aiming to work with the relevant departments to identify a suitable site. They want to run a workshop with the MoH and agencies on site selection for the landfill. Site selection is a difficult process as Tonga is 1-3m volcanic ash (permeable) on 250m deep coral limestone, the quarry sites are badly located eg. over water, clay is gone, quarry is into the water table, and the 2 best sites identified to date are right next to the water supply.

2.8 Recycling Initiatives

There are very few recycling initiatives in Nuku'alofa at present. There is no scrap metal recycler operating. There is no paper recycling, Coca-Cola has placed a few recycling bins for collection of used PET bottles. The collected bottles are returned to Coca-Cola Amatil in Sydney for recycling, but it is not clear how successful this initiative is. There was not a lot of evidence of the recycling bins being used.

At present all aluminium cans are being collected at the dump site by scavengers who sell the cans to a small recycling business (Sione Faupula in Sopu) which pays approximately T\$5/1000 cans or T\$6/1.5m³ bags of cans. About 12 x 1.5 m³ bags of cans are collected per month. Other metal items appeared to be collected in small quantities for recycling. For example copper is collected and recycled at Atenisi University - they pay 20cents/kilo for scrap copper.

The brewery Royal Beer recycles beer bottles and pays 10cents per bottle that is returned to the factory or any of its agent's outlets. As a result there are very few beer bottles seen lying around and they are perceived to be a valuable commodity

2.9 Education

There is little education or awareness about the management of solid waste within the general public, although there is a general consensus that they would like a more regular, more reliable collection service, and they would be willing to pay a small amount more for a better service. Dogs in the urban area create a problem by scattering rubbish that is waiting to be collected – there are no secure bins provided to the public for the collection of waste. Consequently a large number of resident dispose of their own waste using a number of different methods including burning or burying waste in backyard, and private use of the Tukumotonga Dump. Based

on the vehicle survey results the majority of people using the Tukumotonga Dump would be willing to pay a fee to use the dump.

The MoH do a monthly radio programme on health issues that often covers traditional waste disposal issues.

The Tonga Trust has an Environment Education Officer who is primarily involved in the following areas:

- Pesticides awareness
- Tree project
- Environmental education in general including solid waste issues

The Trust does not have the capacity to take on waste awareness and education activities at present. It suggested that the staff of the Public Health Unit of the MoH could be used to educate the public on solid waste issues such as waste minimisation and waste management.

3. Audit and Characterisation of the Solid Waste Stream

3.1 Introduction

In Tonga one of the factors that contributes to the poor management of solid waste is the lack of consistent data on the composition and quantity of solid waste being produced. The data will be necessary for the design of a new landfill site in the event that this proceeds, and it is also necessary for the setting of targets for waste reduction, reuse, recycling and will allow the measurement of success of any waste minimisation initiatives.

A solid waste management study was undertaken by the MoH in Tonga in 1994. The study was undertaken over a 5-day period. The results of the study showed that the waste had a composition as follows:

Table 3.1 Composition of Waste Produced in Tonga 1994

Waste Type	Volume (%)
Wood/Grass/Yard waste	65
Paper	10
Plastics	10
Miscellaneous Inert Materials	7
Food/Kitchen Waste	3
Metals	3
Glass	1
Rubber/Leather	1

Based on the results of the study it was estimated that the average daily waste generated was about 0.5 litres/person/day or 0.7 kg/person/day. However WHO experts stated that they believe these figures to be on the high side as the study was only conducted over 5 days, and it should have been conducted over 8 days, discarding the first days results. It is not known how these results were arrived at but it is likely the composition data was based only on visual assessment of waste.

The methodology used for this report uses analysis by weight as well as visual analysis of volume, so is more reliable and more up to date that the figures given above.

3.2 Methodology of Study

The following activities were programmed during the 2 weeks of fieldwork in Tonga:

-
- Survey of all vehicles using the Tukumonga Landfill over a 7 day period to determine waste types and quantities
 - Household survey to determine domestic waste types, waste quantities, types of waste disposal and attitudes to waste management in Nuku'alofa
 - Waste classification at the Tukumonga Landfill
 - Waste Audits on selected businesses

The fieldwork was followed up with a workshop for stakeholders, to present the results of the investigations and to determine options and priorities for a solid waste management plant for Nuku'alofa.

3.3 Vehicle Survey

In order to calculate total volumes of refuse reaching the landfill, a record of all types of vehicles and their volume of refuse was recorded over a week's period. The survey of vehicles entering the Tukumonga Landfill was carried out each day (except Sunday) over a 7-day period from the 28th August - 3rd September. The hours covered were 7am – 6pm. The survey noted the following data:

1. Time of arrival
2. Vehicle type based on the categories – waste compactor truck, large truck, medium truck, small truck, van/station wagon or car.
3. Waste type – domestic, industrial or commercial
4. How full was the vehicle – 25%, 50%, 75% or 100%
5. Visual Analysis of waste based on the following categories – mixed domestic, paper, plastic, glass, metal, organic, textile, hazardous, construction and other
6. Frequency of visits to the landfill
7. Willingness to pay a fee for use of the landfill

3.4 Household Survey

52 houses were randomly selected within 4 quadrants of the inner Nuku'alofa town area using a planning map. The number of houses was selected to be at least 5% of the area covered. The 4 areas were within the following streets and aimed to cover high, medium and low-income households:

1. Fatahi Road, Malealova Road, Albert Road
2. Hihifo Road, Albert Road, Vuna Road, Iselei Village
3. Tupoulahi Road, Alaivahamamao Street, Hihifo Road
4. Tupoulahi Road, Vuna Road, Bypass and Fasi Street

Introductory letters were delivered to each of the houses several days beforehand then the houses were surveyed over 2 days (30 – 31st August) with a team of two surveyors attending each house. Where there was no adult home, the house next door was used.

The survey questions were translated into Tongan and the responses to the questions were translated back into English. The survey questions covered the following:

1. How many people live in your house?
2. What is your household income per year?
3. What are your current methods of waste disposal?
4. If you do not use the government waste collection system why not?
5. How much waste do you produce in a week?
6. How could the existing waste collection system be improved?
7. Would you be willing to pay more for a better waste collection system? If so how much?
8. Do you know how to compost waste?
9. Would you be willing to compost your kitchen and garden waste if somebody showed you how?
10. Would you be willing to separate your kitchen and garden waste into separate piles/containers for collection?
11. Would you be willing to separate other materials for collection? Eg paper, plastic, glass, metal
12. Do you reuse or recycle any of your waste?
13. Does littering or dumping occur in your neighbourhood? If yes, why?
14. How could littering and dumping be stopped?
15. What do you think are the most serious problems caused by wastes in you city?
16. If you use the Tukutonga Landfill would you be willing to pay a fee at the gate? If so how much?

The responses to the survey were collated and analysed using a spreadsheet and the results are summarised in Section 3.7 below.

3.5 Classification at the Landfill

Waste classification was carried out on a mixed sample of waste from the waste compactor truck on three consecutive days (31/8/99 – 2/9/99). Weather was a limiting factor as it was raining for most of the week and it was not possible to sort and weigh wet waste as this would affect the results. A sample size of approximately 2 – 5 m³ was unloaded from the compactor truck at a clear area for sorting, and the remaining waste was dumped into the landfill area. Sorting into the 9 primary categories, and some

selected secondary categories of waste was carried out on a large plastic sheet and each category was weighed using a mechanical hanging weigh scale. The scales read up to 100 kg in 0.5kg intervals. Weighing was carried out using a 60 litre plastic rubbish bin and the scales were zeroed for the weight of the empty bin. Once weighed the waste was returned to the main landfill area. A total of 720kg of waste was sorted and weighed.

The density of the mixed waste was also checked by weighing the full 60 litre bin 7 times and averaging the results. It must be noted that this waste had already been compacted by the truck, so the density is likely to be higher than uncompacted waste.

3.6 Vehicles to Weighbridge

The weighbridge at the port was identified as a possibility for weighing selected vehicles in and out of the Tukutonga Landfill. It was intended to weigh several vehicles in each category in order to check waste factors for each vehicle and waste type. It was decided to try to check the full and empty weights of the waste compactor truck, and of the small and medium truck categories. However due to constraints on the use of the weighbridge, the cost of using the weighbridge (T\$5.50 per weighing), inaccuracies in the weighbridge readings and bad weather limiting the number of vehicles to the landfill, only limited results were achieved. The vehicles were also weighed when empty and the total weight of waste carried in each load was calculated. A count of the number of residential and commercial properties collected from by the Council trucks for each of the loads that was weighed. This allowed an average weight factor for the vehicles weighed to be calculated and an average weight of waste generated per household and per person to be calculated.

Typical waste factors for vehicle and waste type have been taken from work previously carried out by Egis Consulting (Australia).

The total weight of waste going to the landfill was calculated using the vehicle numbers and types and multiplying by the weight factors for each vehicle type.

3.7 Results

3.7.1 Vehicle Survey

The results of the Vehicle Survey are given in Appendix F. A summary of the results is given in the section below.

Table 3.2 Results of Vehicle Survey - Vehicle Numbers and Type

Type of Vehicle	Total Number in Week	Percentage %
Compactor	11	4
Large Truck	8	3
Medium Truck	39	15
Small Truck	122	47
Van/Station wagon	50	19
Car	32	12
Total	262	100
General Waste Type		
Domestic	149	57
Industrial	0	0
Commercial	111	43
How Full is Vehicle		
25%	29	14
50%	17	9
75%	27	13
100%	129	64

Table 3.3 shows the results of a vehicle survey carried out at the Tukutonga Landfill in 1996 by the Ministry of Health. These figures can be used as a comparison with the data gathered during the vehicle survey in this fieldwork. The numbers of vehicles going to the landfill appear to be significantly less now than in 1996 (Ref Table 3.4).

Table 3.3 Data from Vehicle Survey 27 March - 20 April 1996

	Com- pactor	Large Tracto r	Small tracto r	Pickup truck	Van	Car	Total/ week
Daily average of vehicles	2.3	6.7	16.7	7.7	16.8	7.1	
Weekly average of vehicles	13.8	40.2	100.2	46.2	100.8	42.6	343.8
Estimated volume (m3)	14	6	4	3	1	0.5	
Total Volume uncompacted (m3)	193.2	241.2	400.8	138.6	100.8	21.3	1,095.9

3.7.2 Total Quantity of Waste Delivered to Landfill

The total quantity of waste delivered to the landfill during the week of the survey has been estimated using the total number and type of vehicles and the waste factors obtained from Egis Consulting data. The waste factor for the compactor was checked using the data gathered at the weighbridge and an average waste factor of 2.28 tonnes was obtained. A factor for the average percentage fullness of the vehicle has been used and this was calculated using a weighted average based on the records taken during the vehicle survey (82% full). The compactor was assumed to be 84% full on average, based on the average waste factor of 2.28 tonnes.

Table 3.4 Total Waste Quantities (Domestic and Commercial) September 1999

Type of Vehicle	Total Number in Week	Waste factor - domestic (tonnes)	Average % full	Total weight of waste (tonnes/week)	Wt %
Compactor	11	2.72	84	25.1	25
Large Truck	8	1.16	82	7.6	8
Medium Truck	39	0.62	82	19.8	21
Small Truck	122	0.30	82	30.0	31
Van/Station wagon	50	0.30	82	12.3	13
Car	32	0.06	82	1.6	2
Total Weight/week (tonnes)				96.4	100

Using the figure calculated for the average weight of waste generated per person per day (See Section 3.3.6 below) of 0.82 kg/person/day, we can check the figure above of 96.4 tonnes/week total waste delivered to the landfill.

Total waste per week ÷ per capita generation x 7 = Total Population using Landfill

$$96,400 \text{ kg/week} \div (0.82 \text{ kg/person/day} \times 7 \text{ days}) = 16,794 \text{ people}$$

This figure correlates to the statistical population of the Kolofu'ou District of 16, 953 (from the 1996 census), who could be expected to be using the Tukutonga Landfill for waste disposal

The total weight of waste per week of 96.4 tonnes equates to a volume of approximately 600 m³ using a density of 159 kg/m³ (as measured during the waste classification at the landfill). This

volume is significantly lower than the figure given in the data in Table 3.3 above estimated for 1996 of 1,096m³. This may be due to a number of factors such as: weather during this current survey reducing the number of vehicles, seasonal variation, inaccuracies in weight or volume factors used for the vehicles or less people using the landfill now than in 1996.

3.7.3 Summary Points

Based on the results of the household survey, in response to the question regarding how much waste do they produce in the week, and the responses to methods of disposal, it is likely that in the Kolofou District there may be up 4 times more waste being produced than is ending up at the landfill. The factors affecting this are:

- Over half of the households are not using the government collection system
- A large part of the waste produced is kitchen waste which is generally fed to the pigs and dogs
- A large portion of waste generated is either burnt or buried by the waste generator in their backyard

3.7.4 Visual Analysis of Waste during Vehicle Survey

Table 3.5 gives the summarised results of the visual analysis of the waste that was delivered to the landfill over the period of 28/9/99 – 3/9/99.

Each vehicle that entered the landfill during the vehicle survey was observed while unloading and an assessment of the proportion (by volume) of each of the major waste streams was carried out. The data was then entered into a spreadsheet and the average composition of all waste, domestic waste only and commercial and industrial waste was calculated. The results are given in Table 3.5 below. The results of waste classification (Table 3.6 below) from the sorting and weighing carried out at the landfill (described in Section 3.5 above) are more accurate and the visual analysis results below should be used as a comparison only.

**Table 3.5 Results of Visual Analysis of Waste over Period
28/9/99 – 3/9/99**

Waste Type	Domestic and Commercial (Average %v/v)	Domestic Only (Average %v/v)	Commercial Only (Average %v/v)
Mixed Domestic	22.6	34.2	10.1
Paper	29.7	12.2	47.3
Plastics	6.0	3.1	9.6
Glass	1.4	0.9	1.9
Metals	8.3	9.3	7.7
Organics	29.2	37.4	20.0
Textiles	0.7	1.0	0.5
Hazardous	0.3	0.4	0.2
Construction	1.2	0.7	2.0
Other	0.8	0.8	0.6

The notable points from the data above are:

- Combined waste is at least one third paper and one third organics
- Commercial waste is nearly half paper
- Organics are between 37-50% in domestic waste and between 20-15% in commercial waste
- There is a significant amount of metals going to the landfill – nearly 10%

3.7.5 Results of Household Survey

The analysis of the responses to the household survey is given below and then conclusions are drawn in relation to the analysis.

1. The total number of houses surveyed was 42 and the average number of people per house was 7.
2. The division of household incomes was:
 - 24% Low income
 - 64% Middle income
 - 12% High income
3. 45% of those surveyed use the government waste collection system.
4. Other methods of waste disposal included:
 - 88% Burning in yard
 - 40% Bury in yard
 - 81% Feed to pigs/dogs

33% Take to dump

-
- 7% Dump in lagoon
 - 57% Reuse
 - 33% Return for refund
5. Of the 55% that do not use the government collection system the reasons given were
 - 17% No money
 - 13% Too far away/Don't stop here
 - 17% Take good care of it themselves
 - 13% No time
 - 17% Too difficult/Don't know about it
 - 4% Use neighbours
 - 17% Don't produce much waste
 6. The average amount of waste estimated to be produced by each household per week is:
 - 3 bins (small 25litres)
 - 2 big bags
 - 5 shopping bags (or Tongan baskets)
 7. Respondents reply to "how could the collection system be improved?":
 - 26% of those surveyed would like collection to be more often, and
 - 21% of those surveyed would like to be in the collection system, (or 39% of those not already in collection system).
 8. 93% are willing to pay more for a better collection system. 5% are not willing to pay more.
 - 56% 50 cents more per month
 - 18% \$1 more per month
 - 21% \$2 more per month
 - 3% \$5 more per month
 9. 38% say that they know how to compost waste. 62% do not know how to compost waste.
 10. 88% respondents would be willing to compost waste if shown how. 10% would not.
 11. 93% would be willing to separate their waste for collection. 7% would not be willing to separate.
 12. 31% do not recycle or reuse any of their waste.
 - 76% recycle plastic bags
 - 33% recycle plastic bottles
 - 14% recycle rags
 - 5% recycle cardboard boxes

-
- 7% recycle jars
13. 55% think that littering and dumping occurs in their neighbourhood. 43% do not think that this occurs.
14. Reasons given for why littering and dumping occurs were:
- 14% Uneducated
 - 10% Don't care
 - 14% Not enough bins
 - 7% Dogs scatter diapers
 - 10% Habit
 - 7% Luxury goods/packaging
 - 7% Laziness
 - 2% Collection not often enough
 - 2% Land reclamation
15. When asked how could littering and dumping be stopped, respondents replied:
- 50% Education/Workshops/School education
 - 31% Laws
 - 29% Fines/Enforcement
 - 24% More bins
 - 12% Awareness
 - 12% Housekeeping/Housewife
 - 10% Household bins
16. When asked what were the most serious problems associated with wastes:
- 69% Disease/unhealthy
 - 31% Flies/mosquitoes
 - 26% Ugly/appearance
 - 19% Air pollution
 - 17% General pollution
 - 17% Lack of tourism
 - 12% Water pollution
17. 76% would be willing to pay a fee for each load at the landfill. 19% would not be willing to pay a fee at the landfill.

3.7.6 Summary of Results of the Survey

- The rate of use of the government collection system is low due to the fact that people are not educated about the system, the system is not reliable or they cannot afford it.
- The majority of people use alternative waste disposal methods as well as the collection system such as burning, burying waste and feeding waste to the pigs. These methods of waste disposal are traditional and have been in existence for a lot longer than the collection system.
- Many people would like the collection to be more often – this is understandable as the collection has been reduced to once per week.
- The majority of people are willing to pay more for the collection system if it is improved.
- The majority of people would be willing to separate their waste
- The majority of people would be willing to compost waste if shown how
- There is a low awareness of littering - people think that it occurs because of lack of education, not enough bins and people not caring or habit
- Education, laws and enforcement are seen as the key to improving littering
- The most important issues associated with waste are perceived to be disease risk or unhealthiness and ugly appearance. Flies and mosquitoes are closely associated with disease risks from wastes.
- The majority of people would be willing to pay a fee at the landfill.

3.7.7 Results of Waste Classification at Landfill

The following table gives the typical average composition of the waste collected in the government collection system based on the results of the waste carried out at the landfill on 31/8/99 – 2/9/99. The results of the weighing and sorting on each day were entered into a spreadsheet and the average results were calculated. The spreadsheet with complete data is given in Appendix G. A total of 720 kg of waste was sorted and weighed over the three days.

Table 3.6 Waste Classification Results

Primary Waste Classification	Secondary Waste Classification	Average Percentage (wt%)	Primary Classification Average Percentage (wt%)
Paper	Cardboard boxes	3.7	31.3
	Other – magazines, newspaper, office, tetrapak, packaging	5.3	
	Sanitary	22.3	
Plastic	Polyethylene terephthalate (PET)	1.0	5.2
	Rigid High Density Polyethylene (HDPE)	0.5	
	Flexible HDPE and other plastics	3.7	
Glass	All glass	3.3	3.3
Metals	Aluminium cans	1.9	8.0
	Other metals	6.1	
Biodegradable	All organic	47.2	47.2
Textiles	All textiles including clothing, carpets and curtains	3.7	3.7
Potentially Hazardous	All	<1	<1
Construction and Demolition	All	1.0	1.0
Other	Including rubber and other	0.3	0.3
Total		100%	100%

3.7.8 Summary Points

- Paper wastes very high, mainly due to high proportion of nappies/diapers
- Plastics high at 5%
- Very few returnable bottles reaching landfill – this recycling scheme is working
- Aluminium cans are 2% - a high proportion of these are being removed by scavengers

-
- Biodegradable material is 47% - a significant amount of kitchen waste is not reaching the landfill because it is used as pig food. Most of the biodegradable waste is green waste.
 - There is very little construction waste reaching the landfill as it is used by villagers for village purposes
 - There was little hazardous waste identified at the landfill other than hospital waste.

3.7.9 Results of Vehicles at Weighbridge

The compactor truck was weighed with a full load 4 times in total and a small truck was weighed 3 times, twice with domestic waste and once with school waste. The results are given in Table 3.7. The number of households or commercial premises collected in each truck load is recorded and a generation rate per person is calculated.

Table 3.7 Results from Vehicles to Weighbridge

Number of houses collected	Average number people/house	Total number people	Commercial Premise	Weight of vehicle before unloading	Weight of vehicle after unloading	Weight of Waste	Estimated Volume	Density	Generation rate/capita
				kg	Kg	kg	m3	kg/m3	kg/person/day
Municipal truck									
84 (including 3 boarding houses of 25 people each) = 96	6.3	604.8	Boarding houses	12000	8400	3600	24	150	0.85
11	6.3	69.3	Army houses	2250	1500	750	4	188	1.55
64+ hospital (200beds)	6.3	603.2		9150	8400	750	6	125	0.18
3	6.3	18.9		2400	2250	150	3	50	1.13
Small trucks									
72	6.3	453.6		10650	8400	2250	20	113	0.71
0	-	?	Liahana High School	1900	1500	400	3	133	
82 + hospital (200beds)	6.3	716.6		10900	8400	2500	22	114	0.50
							Average	145	0.82

The calculations in the table above have assumed: 6.3 people per house based on statistics information; collection once per week for all loads; full occupancy at the hospital; each boarding house has 25 guests.

These results show that the waste has an average density of 145 kg/m³, which indicates relatively loose, uncompacted waste.

The average generation per capita of 0.82 kg/person/day equates to 300 kg/person/year is consistent with developing countries in the Pacific. It is low compared to international standards (New Zealand = 750 kg/person/day, USA = 1,000kg/person/day). The factors causing this low generation rate are described above in Section 4.2 ie lifestyle with limited dependence on packaged goods, other methods of waste disposal used in the home such as feeding kitchen waste to pigs, and burning or burying of waste in backyard.

3.7.10 Consultation

3.7.10.1 People Consulted

Consultation was carried out with a limited number of organisations due to the change in terms of reference at the initial meeting with EPACS, TEMPP and the Department of Health. Notes from the initial meeting are given in Appendix F.

Meeting/Waste Audits were held with the following organisations and notes of each meeting are given in Appendix H:

1. Vaiola Hospital, 26/8/99: Lelea Tuitupou – Chief Health Inspector, and William Tautuaa
2. International Dateline Hotel, 3/9/99: Simote Po’uliva’ati - General Manager
3. Morris Hedstrom Tonga Ltd, 26/8/99: Steve Aldrich – General Manager
4. Quarantine Waste Incinerator, 26/8/99: Tuifua

Workshop Issues and Concerns

A workshop was held on 7th September 1999 at the EPACS office to present the finding of the field work and to identify through discussion any options and priorities for a Solid Waste Management Plant for Nuku’alofa. The workshop was attended by the EPACS staff, and a representative from the Department of Health, Mr. Uepi Lea.

A summary of the issues/options and priorities raised are:

1. The data presented on waste characterisation is a snapshot only and should be repeated at regular intervals to build up a database.
2. One of the highest priorities is to get more equipment ie. waste collection trucks, a bulldozer and later more bins.
3. The question of when rural waste will be looked at was raised – this is outside the scope of this project.
4. EPACS would like to see an emphasis on how to minimise waste components. Administration/legislation and governance issues will be dealt with in the TEMPP project. Should concentrate on operations and organisation in this project
5. If an education programme is proposed then the rural sector will benefit as well.
6. Equipment and the operators is priority.

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7. DoH believe a new landfill site is the priority then concentrate on waste minimisation.
 8. EPACS would like to see a workshop later in the year to combine findings of TEMPP and SREP project as well as the chemical project POPs and PICs.
 9. DoH believe a new incinerator t the hospital is needed – the current one is too small.
 10. Landfill needs to controlled to prevent access from people and animals.
 11. Could use the DoH education system for waste minimisation education.
 12. Want a modern controlled landfill with a liner and leachate collection. His will allow more data be collected.
 13. Need more resources for enforcement of illegal dumping eg. staff and vehicles.
 14. Waste oil is a big problem and needs to be looked at.

Further issues that were raised when talking with the Health Inspector are:

1. Suggested a public workshop in each District. Use women's groups in each village. Also Church groups.
2. The practice of burying of cans is due to education to bury any water containing wastes during an outbreak of dengue fever in 1998.
3. Demonstration projects could be carried out during Heilala Week (July). Funds for prizes could come from businesses, tourism and government departments.
4. The link between solid waste and tourism is not understood by government departments – this is critical.
5. Believes people will pay more is the service is regular. There are at least 15 complaints per day regarding the waste collection system.
6. The waste truck can hold 7-8 tonnes but it is only running with up to 3.6 tonnes because the hydraulics are broken and is would cost \$1000 – 2000 to fix – DoH does not have these funds. Often the labourers are not paid for up to a month because there are no funds.
7. The Public Health Act needs to be changed - to increase penalties, increase charges. Act would have to change to support a privatised collection system.
8. Government should install a composting scheme – or a privatised scheme. Soil conditioner costs \$15-20 per bag.

4. Evaluation of Waste Management Systems and Markets for Recyclable Materials

This section of the report reviews existing integrated waste management programmes and resource recovery systems and evaluates them for their applicability to conditions in the Tonga. Access to markets for recyclables is assessed and the cost of utilising these markets is discussed.

The feasibility of establishing recycling markets within the country is examined with respect to scrap metals, glass, paper, plastics and compost.

Factors to be considered in strategic waste management planning is summarised in Table 4.1, taken from the World Health Organisation Publication titled “Healthy Cities – Healthy Islands”.

This table is prepared to help decision-makers at national and local government level make strategic decisions for the improvement of their solid waste management services. The table shows issues that should be considered when prioritising waste management strategy actions.

Table 4.1 Strategic Issues for Solid Waste Management in Nuku’alofa

Requiring Special Attention	Special Characteristic of Solid Waste Management	Strategic Measures to Improve Solid Waste Management
Small country size	Excessive amounts of packaging - recycling is difficult due to lack of economies of scale and remoteness from recycling markets	Firm commitment of the relevant Authorities for better solid waste management - credibility of waste management authorities is vital
Economy of country - small economy - dependence on foreign aid	Difficulty in equipment maintenance - problems getting spare parts - lack of skilled mechanics	Strategic planning - waste management planning is essential to achieve cost-effective use of limited resources
Improvement of environmental health - through better solid waste management	Difficulty in site acquisition for landfill - lack of land - land ownership issues	Waste minimisation first - source reduction is the most important rule for solid waste management in the future
Protection of fragile environment - groundwater - coral and mangrove ecosystems are	Insufficient or not duly trained human resources for waste management	Improvement of collection service and cost saving - collection is the most expensive process in solid waste management;

resource base for fisheries and tourism		improvement and cost savings can generate financial resources for sanitary landfilling
Promotion of tourism - clean town and beaches will attract more tourists	Lack of cleanliness awareness among the public - urban dwellers not familiar with disciplines of urban living such as refraining from littering	Use of saved cost for final disposal improvement - careful siting and management are key to successful landfill

It is recommended that the people involved in solid waste management in the Ministry of Health use the World Health Organisation document “Healthy Cities – Healthy Islands” as a reference for strategic planning of waste management in Nuku’alofa. This document contains specific recommendations and criteria for the collection service, vehicles, waste receptacles, composting, recycling, transfer stations, management of contractors, landfill site selection, controlled landfill requirements, operation of landfill, as well as management and organisation of solid waste.

4.1 Evaluation of Waste Management Programmes

4.1.1 Waste Reduction

Waste reduction activities are important to halt or slow down the increasing rate of waste generation per capita. Waste reduction has several aspects, all of which should be addressed. These include toxicity reduction and volume reduction as well as encouraging products that can be recycled more easily. There are many successful cases of reduction of wastes by individuals, commercial enterprises and agencies using their purchasing power, as well as governments and industries.

In Pacific Islands countries, almost all goods are imported to sustain people’s daily needs. This generates an excessive amount of packaging waste which, because of the limited market, has very little possibility of recycling except for aluminium cans and beverage bottles. Waste minimisation measures such as recycling of package waste practicable in other parts of the world are not easily applicable in Pacific Island countries.

Waste reduction is therefore one of the most critical elements of a solid waste management strategy for Nuku’alofa and is a practical option for a Pacific Island country. There **must** be a major focus on waste reduction in Nuku’alofa in the future.

Recommendation

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1. Prepare an action plan identifying how to reduce the amount of waste produced in Nuku'alofa, including education, media campaigns, legislation, home composting.
 2. Set targets for waste reduction for various waste streams and monitor them at regular intervals.

4.1.2 Collection and Transfer of Wastes

The waste collection system in Nuku'alofa is generally unsuccessful in terms of providing for the efficient, effective and economic removal of waste from source to point of disposal. This is the case in many of the Pacific Islands. The domestic collection system has not been privatised in Nuku'alofa and therefore the benefits of privatisation are not possible.

The collection system is an integral part of the waste management strategy for Nuku'alofa and in order to improve the current collection system and overcome the inefficiencies the following factors must be considered in a detailed analysis of how to improve the current situation:

1. Distance to disposal site
2. Suitability of individual household collection or communal bins
3. Size and type of waste receptacles
4. Conditions of roads and proximity to residences
5. Transfer station requirement
6. Size and type of collection vehicles
7. Frequency of service
8. Willingness to pay
9. Methods of charging and collection
10. Privatised operation or local government operation
11. Separation of policy setting, implementation and operations for collection and disposal of waste.

Recommendations

It is recommended that a complete review of the collection system arrangements in Nuku'alofa is carried out and the following issues are considered:

- Possibility of privatising the collection system
- Identify a funding source and plan for the next 5 years
- Plan for maintenance and operations of collection vehicles
- Clarify the definition of services to be provided
- Clarify responsibilities and key performance issues
- Ensure the contractors/waste workers are competent and trained
- Choose a fair fee structure – payment by either lump sum per month or payment by weight or volume of waste collected
- Effective monitoring and control – implementation and enforcement services to be provided

-
- Foreign aid and privatisation – public sector assets donated by foreign aid may be leased by contractors

4.1.3 Legislation/Regulation

One mechanism for waste reduction is to examine the imports to a country and identify which materials will lead to significant quantities of wastes. Action by the Government to reduce the imports that create wastes, through legislation or tariffs could be part of the waste management strategy. This type of intervention may not be appropriate due to the following reasons:

1. Reluctance to interfere with consumer choice
2. Contravention of World Trade Organisation agreements
3. Restricted sources of imported goods.

In the Tonga the use of legislation or tariffs to influence the purchasing and distribution policies for imported goods is a waste management option that should be considered in detail.

Government can also have influence on the success of waste minimisation schemes through tax structures. The exemption of taxes for the export of recyclable materials from the Tonga or other tax incentives should be considered as part of the waste management strategy.

An important part of the waste management strategy will be the implementation of waste management legislation as well as improving the enforcement of the Garbage Act. Factors that need to be considered to achieve this are:

1. What type of waste management legislation is required
2. Which authority will have responsibility for implementing any new or existing legislation relating to waste management
3. Multisectoral nature of waste management legislation
4. Number of officers for enforcement of Garbage Act
5. Training for enforcement
6. Level of fines
7. Regular review and updating of legislation
8. Financial resources for enforcement of legislation

Recommendations

1. Set up a working group to specifically examine, recommend and implement waste management legislation.

4.1.4 Recycling

There are two basic approaches to recycling. The first involves separating recyclable materials at source (by the waste generator) and separately collecting and transporting these materials to recycling markets. The second involves collecting mixed wastes and

separating these at a central processing facility. The key factors in the success of pre-separation efforts are the cooperation and willingness of the waste generator to participate in the programme over the long term, and the additional collection and transport costs that may be required. The success of centralised recycling plants depends on the processing costs and the quality of the recyclable material produced.

The highest recycling rates reported in 15 countries in 1990, were in the range of 10-18%. There are many good examples of successful recycling programmes throughout the world.

A major recycling impediment is the question of continued viability and availability of secondary materials market. The key points are:

- Recycling only occurs when the separated material is incorporated into a product that can be sold.
- Separation of materials does not constitute recycling – markets must be found first.
- Recycled products must be of a quality and price that compete in the marketplace.
- The difference in cost of disposal and recycling must be examined – ie. the price received for the recycled material, the waste collection and disposal costs avoided, the cost of separation, the costs of collection and processing the separated materials.

“The remoteness, relatively small size of the country and high degree of dispersion pose severe difficulty in transportation and market fragmentation. As a result, procurement of solid waste management tools, equipment, machinery, spare parts and even fuel is not only expensive but in many cases, very difficult to obtain. Very often the procurement encounters excessive delay. This situation also creates many constraints in waste recycling and often renders many alternatives not feasible.” (Ref; World Health Organisation Publication titled “Healthy Cities – Healthy Islands)

The transportation of recyclable goods is one of the highest costs and can be higher than the return on the commodity carried. The opportunity to backload recyclable goods should be investigated in detail. The significant imbalance of imports to exports in the Tonga means that there are significant opportunities to utilise empty ships leaving Nuku’alofa. Negotiation of appropriate shipping rates will also be critical to the viability of recycling in Nuku’alofa. It is recommended that a working group is formed to examine the feasibility of shipping recyclable materials to Australia, New Zealand and Asia, including importers, shipping companies, container leasing companies, local businesses, government and EPACS representatives.

Recycling has considerable potential, but is likely to be marginally viable in economical terms and may need to be subsidised by the community, government or another body wishing to dramatically reduce the amounts of material entering the landfill. Recycling of some materials might be feasible in Nuku'alofa or within the Pacific Region. Government, community and business support will be critical to the success of recycling.

Recommendations

1. Form a working group on feasibility of shipping recyclable materials from Nuku'alofa to overseas destinations.
2. Gain government and business support for implementing recycling in Nuku'alofa.
3. Negotiate a deal with overseas recycling companies for the recycling of materials that have been identified as feasible.

4.1.5 Incineration

Incineration/combustion processes use the controlled combustion of solid waste for the purposes of reducing its volume. The advantages are destruction of hazardous waste, reduction of volume by up to 90%, and the possibility of energy recovery. In Denmark, Switzerland and Luxembourg over 75% of the municipal waste stream is treated by combustion with energy recovery. In Sweden it is over 60%, in France 43% and in USA 17%. Japan uses waste combustion to treat over 75% of the waste remaining after recycling.

The disadvantages of incineration are high capital expense, complex technology, complex operations, air emissions and management of ash residues. There is an incinerator in use for quarantine waste from ships, airlines and a small amount of hospital waste at the wharves. An incinerator at the airport is not operational. It is operated as needed, typically once per week. Incineration is viable on a small scale for the disposal of hazardous wastes, if appropriate management systems are put in place.

Recommendations

1. Conduct a review of the hospital waste management systems and the segregation and the collection of waste for incineration.
2. Implement a new waste management system for the Hospital.

4.1.6 Sanitary Landfills

The disposal of waste to landfills continues to be the predominant method used worldwide. The 1990 International Solid Waste Association report indicated that the percentage of waste disposed of by landfills ranged from 20% to over 90% for 15 countries that

were examined (Ref. Skinner, J.H. 1998. International Progress in Solid Waste Management in “Solid Waste in the Pacific”. Proceedings 6th Annual Conference, Christchurch 1994).

Open dumping of waste on land without adequate controls as occurs in Nuku’alofa can result in serious public health and safety problems and severe adverse environmental impacts. Modern sanitary landfills are equipped with leachate collection systems, liner systems, systems for control of landfill gas, groundwater monitoring, closure and post-closure care plans. The objective is to ensure that the landfilling activities are performed in a manner that greatly reduces the chance of release of contaminants to the environment and that any release is quickly detected and corrected.

The issues that need to be considered in improved landfill management for Nuku’alofa are:

- Sources of funding and financial constraints
- Short term and long term planning
- Access to suitable land
- Lack of technical training
- Inappropriate selection of equipment

The provision of sanitary landfill services is a critical component of the integrated waste management strategy for Nuku’alofa.

Recommendations

1. A full review of landfill management in Nuku’alofa should be conducted by a working group and a programme and timeframe developed for the implementation of a new landfill and closure of the existing site.
2. A landfill management plan for the existing landfill should be prepared and implemented.
3. Identify funding for new landfill.

4.1.7 Composting

Due to the quantity of biodegradable waste being produced in Nuku’alofa it is recommended that composting be implemented as a major part of the waste management strategy. Composting produces a valuable product that can minimise the need to import expensive fertilisers. Composting is a well known technique and there are numerous proven operations around the world.

The issues that need to be carefully considered before implementing a composting scheme in Nuku’alofa are:

- Composting at community level or household level?
- Initial funding

-
- What is the economic value of the product - can it be sold?
 - Private scheme or government operated scheme?

Assuming a community or municipal scheme, there is at least 2400 tonnes per annum of organic matter available in Nuku'alofa based on the current waste generation figures. Assuming an 80% capture rate for this material and an average compression ration of 20 to 1 from loose green matter to finished product then there is approximately 600 cubic metres per annum of compost as product available. (This figure is conservative). Assuming compost could sell at Panga\$31/cubic metre (Aus\$30/cubic metre), there is a potential return of Panga\$9000 per annum (Aus\$9000 per annum). Note: the value of the compost product in Nuku'alofa will have to be determined.

Home composting is already carried out on a casual basis in Nuku'alofa by many homes. Much of the organic waste is fed to pigs as well. Three key factors in the support of home composting are:

- Improvement in nutritional balance
- Waste reduction at source
- Reduction in importation of food items

Keys to successful home composting are – organise community group; use grass-root communications; and make the operation simple with use of local resources.

Recommendations

1. Build on the existing use of home composting and biodegradable waste for pig food through education, media campaigns and subsidies for people that compost.
2. Implement a municipal demonstration composting scheme at a public garden, golf course or other appropriate place. Use market waste and green waste initially.

4.2 Opportunities and Obstacles

A summary of specific opportunities and obstacles to the successful implementation of waste minimisation initiatives in Nuku'alofa is highlighted in Table 4.2.

Table 4.2. Opportunities and Obstacles for Waste Minimisation in Nuku'alofa

Opportunities	Obstacles
TEMPP Project has highlighted wide range of needs in solid waste management	Lack of funds for waste management initiatives
When new landfill is designed a recycling centre and green waste collection depot could be incorporated	Lack of public awareness on waste management issues
	Poor management of existing waste collection scheme
	Lack of public ability to pay
Likely to be a market for compost	Lack of public "perception of waste"
	No financial incentive to segregate waste at source
	Small volume of recyclable material available
	Cost of shipping material to Australia or Asia for recycling
	Brewery not willing to undertake recycling unless economically viable

Further key opportunities that must be considered in justifying strategies and expenditure on solid waste management are related to the following significant environmental health impacts:

- **Fisheries** is an important economic resource which can easily be affected by improper solid waste management
- Protection of the "enchanted environment" as a valuable resource for the **development of tourism** is an important objective in the development of solid waste management. Tourism development has become an important economic strategy for the Tonga. Tidy towns, clean beaches and healthy people will definitely attract more tourists.
- **Health impacts** from contamination of the groundwater lens can be significant – protection of this vital resource is a priority in solid waste management
- Preventative measures to control the outbreak of infectious diseases through the improvement of solid waste management will improve the **cost-effectiveness of health care**.

4.3 Existing Markets

The only recycling that is being carried out at present in Nuku'alofa is aluminium canscrap metal recycling and glass bottle recycling at the Brewery.

- Scrap metals: Aluminium cans- Panga\$5/1000cans; about 12x1.5m³ bags of can collected per month
Copper – Panga\$0.20/kg
- Glass bottles Panga \$0.10 per bottle

4.4 Potential Markets

Table 4.3 gives a rough indication of the prices at present in New Zealand and Australia paid for recyclable materials and the estimate of amounts available in Nuku'alofa.

Table 4.3 Potential Markets for Recyclable Materials

Material	Type	NZ\$/tonne (bailed and shipped to NZ)	Aus\$/tonne (bailed & sorted to Asia)	Amount available in Nuku'alofa (tonnes/year)
Glass	Colour sorted	80 - 85		165
Paper	Cardboard	100 - 140	160	185
	Newspaper Mixed	100 40	112	265
Plastic	PET	Low density = 50 - 100		50
	HDPE LDPE	High density = 350 - 440		210
Metal	Al cans	1,500		95
	Steel cans	25		
	Other metal			305

Note:

Low density = loose to less than 500 kg/m³

High density = 500 kg/m³

4.4.1 Glass Recycling

There is the potential for further glass recycling to be implemented at two levels - increase the volume of recycled bottles returned to the Brewery, and shipping of crushed glass to Australia, New Zealand or Asia for recycling. Assuming an 80% capture rate for waste glass here could be up to 5 x 20 tonne containers of glass recycled per year if there was complete capture of the waste glass

4.4.2 Paper Recycling

Paper recycling is available in New Zealand, Australia and Asia. The waste paper is sorted and bailed in NZ and shipped to Indonesia, Malaysia and Australia for processing. It is recommended that only two grades of paper be used for recycling in the Islands – mixed grade and cardboard grade. The key aspects to making a paper recycling operation successful are:

- big equipment to bail a large volume of material,
- sufficient capital behind the operation to invest in equipment,
- the ability to withstand the fluctuations in the market price,
- the ability to put a large weight of material in a container to economise on shipping costs,
- the negotiation of cheap shipping costs,
- the volume, form and quality of the material.

A small paper bailer would cost approximately NZ\$10,000 – 15,000 and could process about 5-6 tonnes paper per eight hour day. Assuming a capture rate for waste paper of 80% there would be 360 tonnes of waste paper for bailing and 18 containers per year for shipping. Operational costs and shipping costs must be kept to a minimum in order for paper recycling to be feasible.

4.4.3 Plastic Recycling

Plastics including PET, HDPE and LDPE are sent to Indonesia, Phillipines, Thailand and Australia for recycling. New Zealand can recycle HDPE. The process generally involves collection, sorting, grinding and packing before shipping to Australia or Asia for re-processing.

The sorting of plastics is more critical to the successful recycling of plastics. LDPE can only be processed if well sorted, HDPE is better if it is uncontaminated with other materials eg. Milk bottles are good, household chemical bottles require separation of parts. Clean plastic bags can be recycled also.

The easiest plastics to recycle initially will be plastic containers. There are 50 tonnes per year of PET containers and it is estimated that half of the measured quantity of other plastics is recyclable plastic containers including rigid HDPE, and LDPE ie approximately 100 tonnes per year. Therefore, assuming an 80% capture rate for plastic containers there could be 120 tonnes per year (6 containers) for grinding, bailing and shipping for recycling. Cococola Amatil should be encouraged to improve the success of any plastic recycling that they have initiated in the past.

4.4.4 Metal Recycling

The only metal recycling that is being carried out in volume is aluminium can recycling by a private operation. Atenisi University is also carrying out a small amount of metal recycling, mainly aluminium cans and copper. Non-ferrous metal recycling is likely to be viable in Tonga and a working group should be formed to plan how to increase the volume and types of metals recycled. Assuming an 80% capture rate for waste metal there is approximately another 320 tonnes per year (16 containers) that could be recycled. An organisation that is appropriate to run a scrap metal recycling business must be identified or formed. The existing aluminium can recycler should be worked with to build on existing systems and skills.

4.4.5 Composting

Composting is identified as a highly favourable option as the process can be carried out locally thereby removing the requirement for transportation of goods out of Tonga. The process makes a valuable product that is useful in Nuku'alofa. Composting will need to be carried out on a small scale initially to ascertain the best operating parameters. A demonstration composting project using market waste at the University, the golf course or municipal gardens would be an ideal way to initiate composting in Nuku'alofa.

4.4.6 Prices for Recyclables

Table 4.3 gives prices for recyclable materials in 1992 in New Zealand as a rough indication of the value of various materials:

Table 4.3 1992 Prices for Recyclable Materials

Material	1992 Price (NZ\$/tonne)
Glass (broken and sorted by colour)	58
Glass bottles for reuse	3-30 cents
Window glass	45-75
Cardboard	80-100
Newspaper	10-40
Mixed waste paper	35-40
Computer paper	100-120
Cardboard (kraft)	60-80
Plastics	50-350
Plastic film	10-350
Textiles (clean cotton)	300
Textiles (clean woollen)	100
Non-ferrous metals	180-3000
Scrap iron and steel	30-150
Car bodies	\$15 per car stripped
Household batteries	No market
Compost	\$5-7 per 40 litre bag
Compost (bulk)	\$50 per cubic metre

4.4.7 Issues for Recycling from Pacific Islands to Overseas Destinations

1. Government needs to look at shipping costs
2. Container Leasing Companies need to be part of the negotiations
 - Is there a build up of containers in Nuku'alofa that need to be transported back to another centre?
3. Shipping to a hub will be required eg. New Zealand, Australia or Asia
4. The frequency of shipping is a key factor
5. Mixed containers can be utilised eg. half plastic, half paper – this will be important in Nuku'alofa where quantities are low
6. 44 gallon drums can be used for compression of recycled materials such as paper, metal, cans, and crushed glass.

5. Alternative Integrated Solid Waste Management Activities

5.1 Introduction

Alternative integrated solid waste management systems have been developed emphasizing source segregation, collection, composting, reuse, recycling and resource recovery as well as collection, transfer and disposal to landfill. The alternative systems have been evaluated and ranked for feasibility and compatibility with the needs of the Tonga. Ranking characteristics include:

- Capital costs
- Technical requirements
- Administrative requirements
- Operational requirements
- Ease of implementation
- Operation and maintenance costs
- By-products
- Political acceptability
- Social acceptability
- Environmental impacts

5.2 Implementation

The strength of an integrated waste management system lies in its working towards sustainability using an integrated approach and emphasizing prevention rather than cure. The waste management hierarchy is an important tool for prioritising actions. The definitions of levels of the hierarchy are given below:

- Prevention: covers methods whereby wastes or emissions are prevented from being generated at their source.
- Reduction covers methods whereby the quantity or hazardous nature of wastes and emissions are reduced at source.
- Re-use covers methods whereby waste and emissions are re-introduced to the same production process or re-used for the same purpose. These wastes do not require processing prior to re-use.
- Recycling covers methods whereby wastes and emissions are re-introduced to the same process or made available for use in another process. Recycling can occur on-site or off-site and the wastes and emissions usually require some form of processing prior to re-use.
- Treatment covers methods whereby wastes and emissions are altered in some way to reduce their quantity, concentration or hazardous properties.

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- Disposal covers methods whereby wastes and emissions are eventually returned to the earth or the atmosphere.
- Good waste management also depends on a partnership between all levels of government and the community. The success of recycling collection schemes can be highly variable. Often the collection and sorting of recyclables has been emphasized rather than the development of recycling schemes which produce marketable products. The future of recycling schemes is dependent on establishing viable markets for targeted materials.

Options for implementation of these integrated waste management strategies include the following:

- Through national environmental or waste management legislation
- Through health legislation
- Through local legislation and regulations
- Research, education and promotion of environmentally sound waste management practices
- Technical and general advice to authorities, operators and industry
- Voluntary measures such as codes of practice
- Economic instruments
- Bans of particular materials or products
- Systems for recovery

The options can be implemented at all levels of the community including the following groups:

- Central Government
- EPACS
- Waste collection and disposal operators
- Commercial waste producers
- Manufacturers
- Importers
- Domestic waste generators
- Special interest groups
- The public

5.3 Ranking of Alternatives

Table 5.1 gives a ranking from 1 to 3 for various waste management options against criteria including cost, social, environmental and technical criteria. A ranking of 1 is generally indicates a more preferable options where 3 indicates a less preferable option. The cost criteria are added to give a costs total and cost ranking and then all criteria are added to give a total and overall ranking.

Table 5.1 Ranking of Waste Management Options against Criteria

Criteria	Costs				Technical Requirements	Effectiveness							Overall	
	Capital Costs	O&M costs	Cost Total	Cost Ranking		Operational Requirements	Ease of Implementation	By-products	Political & Social acceptability	Environmental Impact	Effectiveness Total	Effectiveness Ranking	Grand Total	Overall Ranking
Waste Management Option														
Disposal to landfill	2	3	5	4	2	2	1	3	1	3	12	7	17	9
Incineration	3	3	6	5	3	3	3	3	3	3	18	8	24	10
Municipal Composting	2	3	5	4	3	2	2	1	1	1	10	5	15	8
Home Composting	1	1	2	1	1	1	3	1	2	1	9	4	11	4
Recycling within country	2	2	4	3	2	3	2	1	1	1	10	5	14	7
Recycling overseas	1	1	2	1	1	2	1	2	1	2	9	4	11	4
Reuse	1	2	3	2	1	2	1	1	2	1	8	3	11	4
Legislation to ban products	1	1	2	1	1	2	3	1	3	1	11	6	13	6
Legislation to tax packaging	1	2	3	2	1	2	3	1	2	1	11	5	13	6
Segregation at landfill	2	2	4	3	1	2	1	1	1	2	8	3	12	5
Segregation at source	1	2	3	2	1	2	2	1	2	1	9	4	12	5
Education programme	1	1	2	1	1	1	1	1	1	1	6	1	8	1
Media Campaign	2	1	3	2	2	1	1	1	1	1	7	2	10	3
Glass recycling to supplier	1	1	2	1	1	1	2	1	1	1	7	2	9	2
PET recycling by Cococola	1	1	2	1	1	1	2	1	1	2	8	3	10	3
Paper recycling	2	2	4	3	2	2	2	1	1	2	10	5	14	7
Metal recycling	2	2	4	3	2	2	1	1	1	1	8	3	12	5

Note:

1. Cost total is equal to the sum of rankings for capital costs and O&M costs.
2. The effectiveness total is equal to the sum of rankings for technical and operational requirements, ease of implementation, by-products, political and social impact and environmental impact.
3. Overall total is equal to the sum of ranking for all criteria.

Based on the criteria described under effectiveness the prioritised options would be as follows:

Effectiveness Priorities

- 1 Education Programme
- 2 Media campaign / Glass recycling to supplier
- 3 Segregation at landfill / Metal recycling/ PET recycling by Cococola Amatil/ Reuse
- 4 Segregation at source / Recycling overseas / Home composting
- 5 Municipal composting / Paper recycling
- 6 Legislation to ban or tax products
- 7 Disposal to landfill
- 8 Incineration

This ranking process gives the following overall priorities for waste management options in Nuku'alofa:

Overall Priority

- 1 Education programme
- 2 Glass recycling to supplier
- 3 Media campaign / PET recycling by Cocacola Amatil
- 4 Home composting / Reuse / Recycling overseas
- 5 Metal recycling / Segregation of wastes at landfill / Segregation at source
- 6 Legislation to tax or ban products
- 7 Recycling within Nuku'alofa / Paper recycling
- 8 Municipal Composting
- 9 Disposal to landfill
- 10 Incineration

6. Rate Structure for Finance Waste Management Activities

This section of the report assesses the capital and operational costs of the waste management programmes and the benefits of income generating waste minimisation activities. Recommendations are made on fee collection systems/disposal costs.

6.1 Cost Priorities for Waste Management Options

Based on the ranking procedure carried out in Table 5.1 above based on cost criteria only the following priorities were determined for Nuku'alofa:

Cost Priority

- 1 Education programme / Glass recycling to supplier / Legislation to ban products / Home composting / PET recycling by Cocacola Amatil / Recycling overseas
- 2 Legislation to tax products / Reuse / Media campaign / Segregation at source
- 3 Segregation at landfill / Recycling within country / Paper recycling / Metal recycling
- 4 Municipal composting / Disposal to landfill
- 5 Incineration

6.2 Recommendations on Fee Collections

The current rate structures for waste collection and disposal are given in Table 6.1 below for the eight countries in the Pacific that have been studied are part of the SPREP Waste Characterisation and Management Plans Study.

Table 6.1 Comparative Costs of Waste Collection and Disposal

Country	Collection per week	Domestic Waste	Commercial Waste	Industrial	Tip Fees	Skip/Bin (per load)
Tonga - Panga	1 - 2	6 (Aus\$5.77)	12 - 18 (Aus\$11-17)	24 (Aus\$23)	Free	-
Solomon Islands - SBD	1 - 2	Free	2.50/ collection (Aus\$0.79)	5.00/ collection (Aus\$1.59)	Free	
Fiji - FJS	2 - 3	Free	Free	-	3.30 (\$2.5) - household 5.50 (\$4.30)- trade/ commer. 16.50 (\$12.85)- condemned 22.00 (\$17)- hazardous	30 (Aus\$23)
Vanuatu - Vatu	3	6,000 (Aus\$72)	9,000 (Aus\$108)	60,000 - 360,000 (restaurants - hotels) (Aus\$722-4,337)	100 - car (\$1.2) 200 - Hilux (\$2.4) 300 -Lorry (\$3.6) 1,500 - Disclutcher (\$18)	2,500 - 3,500 (Aus\$30 - 42)
Kiribati (Aus\$)	1	(Aus\$17 - 29)	(Aus\$50 - 600)	-	Free	-
Tuvalu (Aus\$)		(Aus\$30 10/load green waste)	(Aus\$100 - 400)	-	Free	15
W. Samoa	2 - 7	Free	Free	Free	Free	-
Papua New Guinea (Aus\$)	1-7	120 - 420 (Aus\$60 - 208) (small) 395 - 1380 Aus\$196 - 685) (2401)	240 - 1380 (Aus\$119 - 685)		2(2.5) - car/utility 7(3.5) -1.5Tonne 10(5) -K600 Truck 8(4) -industrial bin	
New Zealand (Aus\$)	1	185 (Aus\$145) 6.5(Aus\$ 5.10) - recyclables			50 (Aus\$39)	

Note:

Figures given in brackets are in Australian Dollars.
All other figures are in the local currency.

The table above shows that the charges for waste collection and disposal in Nuku'alofa are low compared with other Pacific Island countries. In Western societies the rate structure for waste management is moving towards full cost recovery. Full cost recovery for waste collection and disposal in Nuku'alofa is the ultimate aim. However the public "ability to pay" is a significant factor to be considered in Nuku'alofa. It is recommended that the costs of waste collection and disposal are accounted for on an annual basis and that charges are set for the public based on a

survey of “ability to pay”, with increases towards full cost recovery over the medium term.

It is also recommended that a gate fee for using the landfill be implemented as this is an area where there is not enough revenue to maintain the facilities adequately. Records of vehicles entering the landfill and the amount collected should be kept as part of the daily operations.

7. Integrated Solid Waste Management Plan

7.1 Objectives of the Plan

The objectives for the Integrated Solid Waste Management Plan for Nuku'alofa are:

1. To create a framework for solid waste management in Nuku'alofa that integrates all levels of solid waste management from legislation, government involvement, ministerial department involvement, operations, businesses, community bodies and the public.
2. To ensure that solid waste is managed in the most appropriate manner for Nuku'alofa and the people that live there, both economically and environmentally.
3. To incorporate sustainable environmental management principles and waste minimisation initiatives into the plan so as to minimise the environmental effects of solid waste management.

The Plan will provide a basis for prioritising actions required by waste managers in Nuku'alofa in the short to medium term.

The Plan will be based on the information as presented in this report as well as economic factors, regional waste management activities and international best practice in solid waste management. The Plan will take into account the current situation for solid waste management in Nuku'alofa, the current waste generation rates and waste classification data, and will also look at factors such as future solid waste generation, population changes, wealth, social change, education, markets for recyclable materials and regional influences.

This draft report will only go so far as to discuss some of the priorities and options that have been identified during the fieldwork in Tonga, that may be incorporated into the final solid waste management plan.

7.2 Waste Minimisation

- Increase the quantity of aluminium recycled through increased publicity in existing scheme

-
- Set up trial scheme for other non-ferrous metal collection and shipping for recycling
 - Designate an area for green waste dumping at the current landfill. Notify the public of the change to segregated collection and dumping of green waste. Arrange for separate municipal collection of green waste. Obtain a shredder and mulch or compost any green waste or organic waste at the landfill
 - Negotiate a subsidised or cheap option for shipping of waste materials to Australia, New Zealand, Fiji etc. Consider using legislation or regulation to achieve this.
 - Implement a packaging legislation to create an incentive for return of packaging for recycling eg American Samoa has recently implemented legislation
 - Implement a separate paper collection and buy a shredder and baler to ship waste overseas for recycling.

7.3 Refuse Collection

- The highest priority is to get the existing dump and collection system working in a manner that minimises health and environmental risks. A new collection truck is needed urgently to allow waste to be collected on a more frequent and reliable basis than at present. A new compactor truck is recommended as well as a simple covered truck for use if one of the compactors is out of action.
- The existing compactor trucks should be fixed if this can be carried out for a reasonable cost.
- Subsidise or free rubbish bins with lids for those on the collection scheme would help to prevent the spread of rubbish on to the streets by dogs

7.4 Disposal of Refuse to the Landfill

- A bulldozer or front-end loader is required at the dump on a more regular basis – say once per week (minimum) to ensure that the dump access road is kept clear and the waste is moved to areas away from the public. A plan for the use of one of the PWD bulldozers should be prepared.
- Purchase of a new bulldozer dedicated for use at the landfill is recommended.

-
- The site for a new landfill should be selected as soon as possible and a programme out in place for the development of the new site and the closure of the existing dump site.
 - Funds are required for the operation of the dump and the collection system – the Department of Health is severely under-funded at present for solid waste management
 - The introduction of landfill charges should be introduced, and a landfill gatehouse keeper employed to collect fees, make records, direct vehicles and manage access to the landfill.
 - A management plan for the operation of the current dumpsite should be prepared to ensure that the dump is operated in a safe manner that minimises adverse effects on the public and the environment.
 - It is recommended that the access to the landfill area be controlled to prevent scavengers accessing the dumping site and attempt to minimise animals and rodents at the site.

7.5 Special Wastes

- Improve clinical and medical waste handling procedures, segregation and disposal facilities at the hospital
- Review efficiency of the use of the quarantine incinerator for hospital waste disposal
- Investigate options for a dedicated hospital waste incinerator
- Implement waste oil collection system for burning in a boiler
- Implement waste pesticide container collection
- Implement waste batteries collection for proper disposal

7.6 Community Involvement

- Education programme to raise public awareness of solid waste management principles and waste minimisation concepts. Concentrate on primary and secondary schools, businesses, church groups and women's groups in the community.
- Publicity on new recycling schemes eg. Posters, pamphlets, radio interviews
- School collection scheme for recyclables

7.7 Organisation of Solid Waste Management

- Appoint a Solid Waste Management Officer to organise solid waste management and waste minimisation in Nuku'alofa and to liaise between the Department of Health, EPACS, local business and the public as well as international organisations that can assist in solid waste management.
- Review responsibilities for waste management in Nuku'alofa and review the potential for privatisation of collection system and/or landfill

7.8 Implementing the Plan

- Hold a workshop with government ministers, NGOs, business and community leaders, DoH and EPACs staff. Discuss, revise and agree on the components of the Plan. Prioritise actions, responsibilities and timeframe for the Plan. Set targets for waste minimisation.
- Obtain Government or overseas agency funding to implement a demonstration scheme for PET recycling, paper recycling and scrap metal collection and recycling (recycling to Australia). Monitor the costs and success of the project for future privatisation do the schemes. Obtain business and community support and involvement eg. school collections of PET bottles with Coca-Cola providing refunds, or prizes for best collections.

Appendix A - Terms of Reference

Appendix B - Study Methodology

Appendix C - Curricula Vitae

Appendix D - List of Contacts

Tonga : List of Contacts

Name	Organisation/Company	Position	Phone/Fax
Ms Netatua Prescott	Ministry of Lands, Survey and Natural Resources	Senior Ecologist & Environmentalist	(676) 25050 (ph) (676) 23216 / 25051 (fax)
Mr Paula Taufua	Ministry of Lands, Survey and Natural Resources	Conservation Officer	(676) 25050 (ph) (676) 23216 / 25051 (fax)
Mr John Hibberd	Tonga Environmental Planning & Management Strengthening Project (TEMPP)	Team Leader	(676) 25050 (ph) (676) 23216 / 25051 (fax)
Mr Stuart Dever	TEMPP Project Egis Consulting	Waste Management Consultant Senior Engineer	(02) 9412 9867 (ph) (02) 9412 9686 (fax)
Mr Te'e Foto Mausia	Department of Health - Public Health	Health Inspector	23200 Ext 38 (ph)
Mr Lelea Tuitupou	Department of Health - Public Health	Senior Health Inspector	23200 Ext 38 (ph)
Mr Leopino Fa'asola	Department of Health - Public Health	Public Health Inspector	23200 Ext 38 (ph)
Mr Simote Po'uliva'ait	International Dateline Hotel	General Manager	23411 (ph) 23410 (fax)
Mr Sateki Telefoni	Department of Health - Public Health	Health Inspector Graduate	23200 (ph)
Ms Kasanita	Department of Health	Accounts	
Mrs Mele Folua	Department of Health	Senior Accounting Officer	
Mr Uepi Lea	Department of Health - Public Health	Health Inspector	23200 ext 38 (ph) 23200 (fax)
Mr Steve Aldrich	Morris Hedstrom Ltd	General Manager	
Tuifua	Quarantine Waste Incinerator		

Appendix E - References

1. Pulea, Mere. "Kingdom of Tonga Review of Environmental Law". 1992. South Pacific Regional Environment Programme; Regional Environment Technical Assistance (RETA) 5403; Strengthening Environment Management Capabilities in Pacific Island Developing Countries.
2. Environmental Management Plan for the Kingdom of Tonga (ESCAP, 1990)
3. AusAid, Pacific Regional Team, AusAid Centre for Pacific Development and Training. "Pacific Regional and Multicountry Waste Management Development Project – Pre-Feasibility Report", Draft, April 1997.
4. Tonga Statistics Department, Kingdom of Tonga, "Population Census 1996: Administrative Report and General Tables." January 1999 SDT :47-32
5. Kingdom of Tonga, The Public Health Act – 29 of 1992.
6. Ogawa, Dr. H. World Health Organisation Assignment Report – Advisory services on improvement of solid waste management in Nuku'alofa, January 1990.
7. World Health Organisation. Preliminary Inception Report for a National Solid Waste Management Plan (Draft), March 1990
8. Sakurai, Dr. K, Hoo, Mr Tan. World Health Organisation - Assessment of municipal solid waste management. October 1995
9. Ogawa, Dr. H. World Health Organisation – Development and management of solid waste landfill sites and operation of collection systems. June 1992.

Appendix F - Notes of Initial Project Meeting

Meeting at: EPACS Office, Nuku'alofa
Date: 25/8/99
Attending: Juliet Woodward – Sinclair Knight Merz
Andrew Reeve – Sinclair Knight Merz
Dr Suresh Raj – Project Coordinator
Netatua Prescott – Senior Ecologist &
Environmentalist
Paula Taufu – Conservation Officer
John Hibberd – TEMPP Team Leader
Stuart Dever – TEMPP Consultant
Foto Mausia – Health Inspector

1. Neta welcomed everybody and the opportunity to discuss the scope of the Regional WASTE project in relation to the current TEMPP Project. The purpose of the meeting was to define the TEMPP Waste and the Regional WASTE project scopes. It was made clear that EPCAs hoped that the projects could work concurrently without duplication of tasks, so that the maximum benefit could be obtained for solid waste management in Tonga.
2. There is Environmental Impact Assessment Legislation proposed to go to Cabinet for approval this year.
3. The Environment Planning and Conservation Section of the ministry of Lands, Survey and Natural Resources, covers an environmental education programme, a monitoring programme (lagoon), Project management and solid waste management.
4. The Ministry of Health (MoH) has the main responsibility for solid waste management but coordination rests with the Environment and Planning Department
5. EPACS and TEMPP would like to see the SPREP project concentrate on the waste characterisation because the TEMPP project is already carrying out the preparation of a Solid Waste Management Plan for Tonga.
6. Other donors eg. NZODA, are being put on hold until these two projects are defined.
7. The Terms of Reference for the TEMPP project were handed out – the purpose is to develop a solid waste management plan. Also handed out a draft table of contents for the TEMPP project. Have already looked at the current situation with waste management. This is summarised:
 - No waste management policy exists
 - Limited info on waste generation, MoH did audit in 1994, composition and quantities done
 - Waste Minimisation – there is Al can recycling and beer bottle recycling
 - Collection covers 20% of households, many burn waste in backyard, collection truck 15 years old, does 1000 houses per

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- week, costs 50 cents/month/household, \$2-2.5/month commercial
- Budget is \$50,000/year, \$30,000 on collection and \$20,000 on dump
 - Have requested a list of all properties that are on collection
 - Commercial and industrial take own waste to dump
 - Demolition waste is reused in villages
 - Rubbish is put out loose in pile, in plastic bags, on stands but rarely in bins
 - Collection days are not reliable
 - Wants to do a community survey
 - Where there is no collection there is often indiscriminate dumping
 - MoH has one street sweeper for the main road
 - Litter enforcement is non-existent
 - There is an Environment Week
 - EPACS is responsible for Parks and beaches
8. The dump is in the mangrove area, near a new residential development, it is uncontrolled, 2 years ago WHO spent \$50,000 to clean it up, funding has now run out. There is no dozer and it costs \$3,000 to hire one for 2 days.
 9. MoH do a monthly radio programme on waste
 10. Are looking at alternative landfill sites, highest priority is to get a new site.
 11. TEMPP project is institutional strengthening only, are helping the government to plan. Will be spending \$250,000 on solid waste management project.
 12. Want to run a workshop with the MoH and agencies on site selection for the landfill. Tonga is 1-3m volcanic ash (permeable) on 250m deep coral limestone. Quarry sites are badly located eg. over water, clay is gone, quarry is into water table. Very little stormwater runoff here, infiltration is good. The 2 best sites are right next to the water supply.
 13. TEMPP would like to see waste characterisation carried out – refer handout of proposed scope. Would like to see a vehicle analysis done, then a waste stream analysis.
 14. PET recycling, paper recycling are not likely to be viable. Metal recycling are viable – Moana Recycling, ties with Sydney and Moons Recycling, also Atenisi College do it. Costs \$2,000 for a 45m³ container to Sydney
 15. Vehicle count was done for 1 month in 1996 – type and number only
 16. There are no private waste contractors here
 17. Andrew gave overview of what the SPREP project wants to achieve
 18. Do not want 2 waste management plans for Tonga. The TEMPP one will not be ready for several months, therefore will not tie in

-
- with the requirements of the SPREP project. The plan could be a 2 stage process, with a strategy first, then a plan.
19. Suresh will need to revise the Terms of Reference for the SPREP WASTE project and get Tonga to agree.
 20. Paula said that they would like to move the money to some other project to avoid duplication. Suresh said that this is not possible as the EU has already agreed to spend the money on this project.
 21. John Hibberd said they would like to see the inputs compartmentalised to make them complimentary.
 22. Andrew said that we want to make sure that the Waste Management Plan is available to the EU. John agreed.
 23. SKM is keen to do the waste characterisation as discussed. Nuku'alofa area only will be covered.
 24. Will have to pay \$15-25 per day for assistants
 25. Neta is to get a copy of the UNEP Waste Questionnaire that has been filled in and give to Juliet.

Appendix G - Excel Spreadsheet of Waste Classification Data and Survey Results

Appendix H - Notes of Meeting with Industry

Meeting at: International Dateline Hotel
Date: 3/9/99
Attending: Juliet Woodward – Sinclair Knight Merz
General Manager

1. 76 rooms, 136 guests, 50 – 70% occupancy. 111 staff in total
2. 2 restaurants, 2 times per week buffet for public + Reception and conferences and seminars
3. Food waste goes to pig farmer – comes 2 times per day.
4. Use 44 gallon drums and bins. Collection supposed to be every day, Monday - Friday, but not reliable. Use their own truck when required
5. Restaurant waste, Guest waste, Garden waste, Office waste, - all to dump
6. 8-12 x 1m³ bins per day for collection. Bars produce 1-2 bins per day. 1 small truck 2 times per week. Kitchen waste 4-6 bins per day to pig farmers.
7. Pays about \$20/month. Thinks commercial should pay more, maybe it should be pro-rated for volume.
8. Do order some things in bulk. Use a lot of cans (keep 1 month of stock). Cleaning chemicals ordered in bulk – containers disposed of to dump. Fluorescent tubes to dump. Paint tins to dump.
9. Hotel would be willing to participate in a demonstration scheme.
10. Thinks importers of packaging should pay higher costs.
11. No separation of PET bottles at present. Sometimes people collected Al cans from hotel.