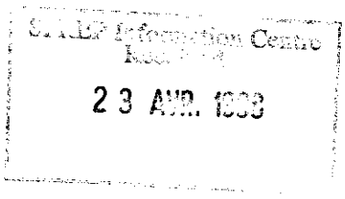
Land-based Pollution Sources of the Marine Environment in Western Samoa:

A Case Study



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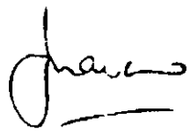
Foreword

This report presents the findings of a case study on land-based pollution sources in Kiribati. The study was commissioned by the South Pacific Regional Environment Programme as part of a regional pollution assessment and monitoring programme for the South Pacific. Kiribati was chosen as an example of a country where there is relatively little development.

Land-based pollution sources are discussed under the categories of solid waste, domestic wastewater, industrial waste, wastes from agricultural activities and household hazardous substances. For each particular waste category an assessment of the legislative framework for waste management is carried out. This is followed by a presentation of the current system of waste management and the potential within the system for creating an impact on the environment. The testing of water quality at a number of sites in South Tarawa was carried out to establish the degree of contamination of resources. Some recommendations have been made for improvements in waste management strategies.

The study has shown that systems of waste disposal currently in place are having a noticeable impact on the quality of the environment. Remedial measures are necessary if the environment is not to deteriorate further.



Vili A. Fuavao

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Acknowledgements

The authors of this report would like to thank the staff of the Environment and Conservation for their assistance during this study. Mr Roger Conforth and Mr Pati Liu provided an initial overview of the waste management situation in Western Samoa and supplied copies of all relevant documentation. Special thanks are due to Mr Laavasa Malua who devoted an enormous amount of time and energy through out the visit in organising details of the solid waste survey, arranging introductions with various individuals and organisations and generally fulfilling the role of the local counterpart.

Thanks are also due to Mr Laisiasa Tulega, the Environment Contaminants Officer at SPREP for making all the necessary prior arrangements for the study and to Talanoa, the Messenger/Driver at SPREP who drove uncomplainingly during many of our missions.

Gratitude is also expressed to our respective employers for providing the necessary support to enable us to undertake the consultancy.

Contents

MOLLUSCICIDE

Trade Names	Common Names	Places	Quantities*
Blitzem	mealdehyde	Ag. Store & MH	900/g

RODENTICIDE

Talon b	brodifacoum	Ag. Store & MH	277kg/313kg
Storm	flocoumaffen	Ag. Store	68.7kg/166kg

MITICIDE

Kelthane dicofol	Ag. Store

Notes:

Ag. Store: Agricultural Store

MH: Morris Hedstrom

* The quantities are for the Ag. Store imports for 1990/1991 only and are in litres escept where indicated.

Pesticides used in Western Samoa which are banned, severely restricted or classified as restricted-use pesticides elsewhere in the world and those classified as highly hazardous by the World Health Organization (WHO) (Mowbray, 1988).

Annex 6: List of Pesticides Sold in Western Samoa (as of May 1991)

From Taylor (1991).

HERBICIDES

Trade Names	Common Names	Places	Quantities*
Actril	2,4, -D + loxynil	Ag. Store	
Agriquat	paraquat	Ag. Store	19,760/1,950
Basagran	bentaxon	Ag. Store	/100
Butoxone	2,4, -D + dicamba	Ag. Store	
Diuron 80	diuron	MH	
Escort	metsulfuron-methyl	Ag. Store	20g/
Fusllade	fluazitop-butyl	Ag. Store	/60
Gramoxone	paraquat	Ag. Store	49,980/38,140
Round-up	glyphosate	Ag. Store & MH	120/148
Sting	glyphosate	Ag. Store	3,608/3,164

INSECTICIDES

Actellic Dust	pirimiphos-methyl	Ag. Store	/625 kg
Attack	p-m + permethrin	Ag. Store	/390
Baygon	Propoxur	Ag. store	
Decis	deltamethin	MH	
Dipel	*Bascillus thruengiensis*	Ag. Store	48 kg
Flcam	bendlocarb	Ag. Store	1425 kg
Furadan	carbofuran	MH	200/
Lepidex	tri-chlorion	Ag. Store	
Malathion 50	malathion	Ag. Store	150/
Maldison	malathion	Ag. Store	
Naled	dibromec	MH	
Tridex	tri-chlorion	Ag. Store & MH	

FUNGICIDES

Bavistin	carbendazin	Ag. Store & MH	
Benlate	benomyl	Ag. Store	156kg/67kg
Calixin	tridemorph	Ag. Store & MH	
Mancozeb 80	mancozeb	MH	
Manzate 200	mancozeb	Ag. Store	20kg/20kg
Milcurb	dimethirimol	Ag. Store	/40
Perenex	cyprous oxide	Ag. Store	
Punch	flusilazol	Ag. Store	82/65
Sumisclex	procythldone	Ag. Store	
Tilt	propiosonazole	Ag. Store	160/60

NEMATICIDES

Furadan	carbofuran	Ag. Store	
Vydate	oxyamyl	Ag. Store	400/600

1. Introduction

The marine environment is an important resource base for the people of the South Pacific island countries. The livelihood of many people in this region is closely connected with the sea. The potential for enhanced development and utilisation of marine resources is considerable, particularly as the demand for resources increases and the land becomes limited in its capacity to fulfil this demand. It is therefore imperative that appropriate measures are taken to safeguard the quality of the marine environment.

There are two general ways in which the quality of the marine environment can deteriorate. The first, over which we have relatively little control, is through the forces of nature such as floods, hurricanes and landslides. The second is the deliberate introduction into the marine environment of substances that cause pollution. This can be regulated. It is generally believed that pollutants generated on land are amongst the most significant threats to the quality of the marine environment, as indicated by the following statement made at the UNCED, 1992:

> *"Degradation of the marine environment can result from a wide range of sources. Land based sources contribute seventy percent of marine pollution. Many of the polluting substances originating from land-based sources are of particular concern to the marine environment since they exhibit at the same time toxicity, persistence and bio-accumulation in the foodchain."*

In the island countries of the South Pacific the above statement is especially applicable because of the concentration of development activities along coastal areas. Increasing populations, changing landuse patterns and increasing development has meant that the amounts and types of substances being generated that could become marine pollutants are increasing in magnitude and complexity. It is important to devise proper management strategies for these substances.

However, before this can be done, an assessment of the amounts and types of pollutants is necessary. The type of activities that would be expected to generate pollutants are recognised but the extent of pollution from each such activity is not generally known for South Pacific island countries.

This study was commissioned by the South Pacific Regional Environment Programme (SPREP) as part of a more comprehensive investigation into the land-based pollution sources in South Pacific island countries with different degrees of development. This report presents the findings of a case study on Western Samoa, a country perceived to have a moderate degree of industrial development.

1.1 Objectives

Specific objectives of the study were to:

a. identify the land based pollution sources

b. determine the extent of pollution of the marine environment from these sources

c. assess the capability of the existing frameworks to manage the pollution.

d. recommend ways in which the system can be improved.

The full terms of reference are given in Annex 1. The authors of this report visited Western Samoa from the 2nd to the 12th of September 1993 and worked closely with officers from the Division of Environment and Conservation within the Department of Lands, Survey and Environment. The work programme during the visit is given in Annex 2.

The approach adopted in this report is similar to that by Convard (1992) in her regional report on land based pollution sources which is the consideration of the waste management situation under the broad categories of solid waste, industrial wastes, domestic wastewater, and wastes from agricultural practices.

As stated in the terms of reference, the report is intended to be of use to other countries with comparable characteristics. It is also likely to be used as resource material for training of personnel involved in waste management in the South Pacific.

Annex 5: Working table for the calculation of waste loads from domestic wastewater.

From Convard (1992).

Area WESTERN SAMOA Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Apia		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Residential		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	16,430	Septic tanks	pers.	6.9	90,694	16	184,016	3.3	51,508	0.4	6,243
	15,444	Latrines	pers.	6.9	85,251	16	172,973	3.3	48,417	0.4	5,869
	986	over water latrine	pers.	6.9	6,803	16	15,776	3.3	3,254	0.4	394
Apia		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Commercial	500	Sewered: primary	pers.	12.7	4,255	20	4,000	3.3	1,526	0.4	180
(incl. tourists		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	276	Septic tanks	pers.	6.9	1,524	16	3,091	3.3	865	0.4	105
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Sawaii		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	4,900	Septic tanks	pers.	6.9	27,048	16	54,880	3.3	15,361	0.4	1,862
	44,100	Latrines	pers.	6.9	243,432	16	493,920	3.3	138,254	0.4	16,758
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	63,486	0	41,206	4,995
	59,676	0	38,734	4,695
	6,803	15,776	3,254	394
TOTAL	123,161	0	79,940	9,690
	0	0	0	0
	4,255	4,000	1,526	180
	0	0	0	0
	1,066	0	69	84
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	18,934	0	12,289	1,490
	243,432	493,920	138,254	16,758
	18,934	0	12,289	1,490
TOTAL	262,366	493,920	150,543	18,248
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	385,527	493,920	230,483	27,937

2. Country Background

The assessment of the waste management situation in any country must take into consideration all those particular features of the country that are likely to have a bearing on the prevailing or proposed systems. Such features for Western Samoa are described briefly in the following subsections.

2.1 Physical Environment

Western Samoa lies in the South Pacific between 13° and 14°S,and 168° and 173°W. Fig. 1 shows the location of the country in the South Pacific region. The country consists of a number of islands (see Fig. 2), the largest of which, Upolu and Savai'i, make up 2920 square kilometres of the total land area of 2930 square kilometres. The capital and principal port of Western Samoa is Apia, located on the northern coast of Upolu.

The islands are of volcanic origin and many parts of the land are steep with narrow coastal flat areas. In the past many parts of Upolu and Savai'i had swampy areas which have been greatly reduced through drainage and reclamation (Warren and Sisarich, 1992).

The soils are generally porous and rocky. The climate is tropical and mild. The mean annual temperature is 26°C and the rainfall is high (2500 - 7000 mm), with about seventy percent of it occurring in the wet season, which lasts from November to April. Less than fifty percent of the rainfall is believed to be held as surface water (Warren and Sisarich, 1992), most of it contributing to the groundwater or evapotranspiration loss.

2.2 Land

A major proportion of the land (81%) is in customary title, which is controlled by traditional village administrative systems. Legislation prevents land alienation, except through short- and medium-term leases or where land is taken for public purposes. The proportion under government control is 11 percent. The remainder is either freehold or belongs to the Western Samoa Trust Estates Corporation.

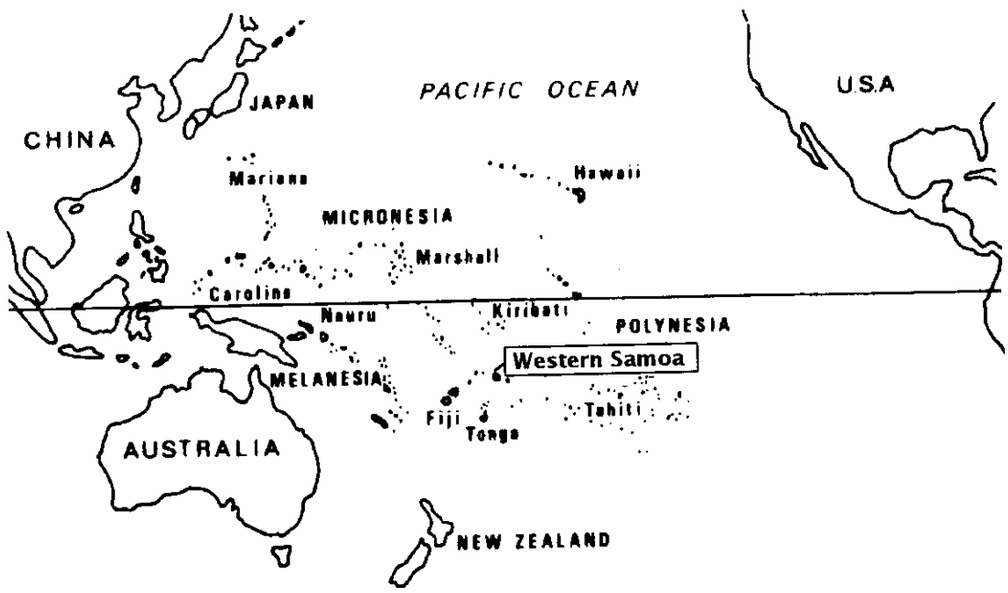

Fig. 1: Location of Western Samoa in the Pacific Islands region.

Annex 4: Recommended Operation Plan for the Tafaigata Dump

1. The site or mound should be prepared first by excavation to 1 metre depth and the soil laid at the side to provide the cover material. The excavated site should then be compacted.
2. A layer of 100 tonne sand bed should be laid to provide cushion for the impermeable membrane. Clean soil should then be laid over the membrane (see Fig. 2 on the next sheet). Perforated polythene pipe should be laid along sides to take away leachates.
3. Refuse should be dumped and compacted into "cells" measuring 16 m x 10 m x 1 m high. This should be the maximum size of each cell and refuse compacted with a rubber -tyred machine preferably a loader and compactor.
4. At the end of the day refuse should be covered with soil to a depth of 300 mm and compacted.
5. The next day the rubbish should be dumped into the adjacent cell.
6. The maximum length of line of cells to be 48 m and width to 50 m or 5 lines of cells (see Fig. 3 on the next page). The maximum height of each mound is to be m from the excavated base.
7. After mounds have filled the area, new mounds can be constructed over them.

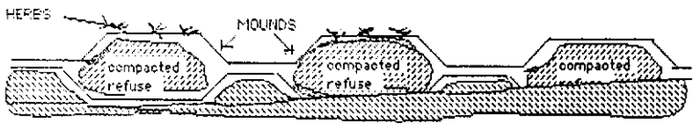

Fig. 1: *Cross-section of a series of mounds.*

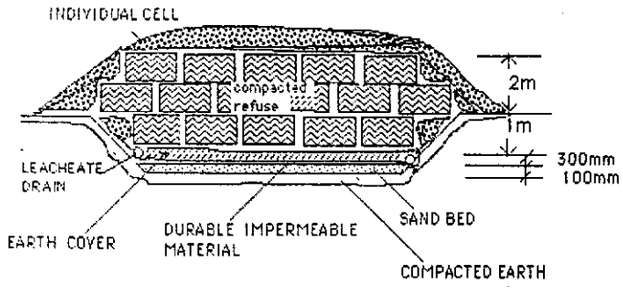

Fig. 2: *Typical cross-section of one mound (48m x 50m 3m high).*

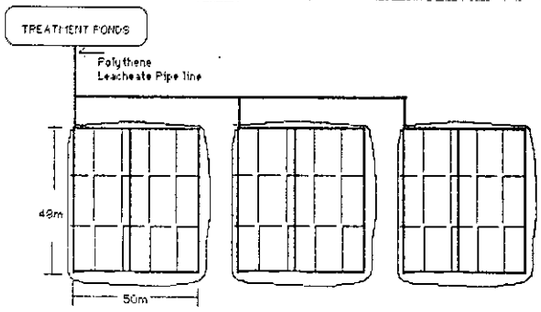

Fig. 3: *Plan of proposed leachate drainage system from each mound.*

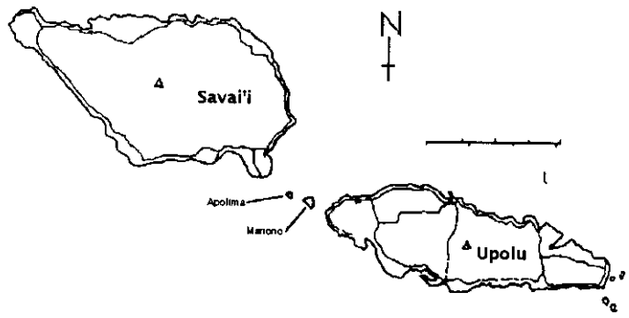

Fig. 2: The islands of Western Samoa.

The population is concentrated in densely populated villages around the coastal fringe of the islands. Villages usually control a section of land extending from the sea to the mountain tops where they practise a form of shifting agriculture, where land is abandoned to fallow as fertility falls. This pattern of agriculture is being replaced by more continuous cropping, using pesticides and fertilisers. Clearing forest for agriculture is estimated at 4000 ha/annum (Warren and Sisarich, 1992). About 55% of the land area is still covered by indigenous forests.

2.3 Population

The population of Western Samoa is about 165,000, with 70% living on Upolu, and the capital, Apia, with twenty percent. The natural population growth is 2.1%, but emigration reduces this to 0.7%.

2.4 Economy and Resource Use

Warren and Sisarich (1992) reported that remittances from emigrants contribute nearly $90 million to the Western Samoan economy, which depends mostly on subsistence agriculture and cash crops. About $40 million is received from overseas aid. Fishing is an important economic activity, engaging approximately 59% of households in 1989. The inshore fishery is, however, reported to be declining due to the declining quality of the nearshore marine environment.

There is no mineral production in Western Samoa. The industrial development is considered to be modest compared to other Pacific island neighbours. The Government is actively pursuing a programme for increased industrial development, particularly those which are export-oriented and labour intensive.

An industrial area has been established west of Apia at Vaitele, and industrialisation has increased with the involvement of overseas and joint ventures.

Tourism development is also being encouraged. Over the last five years, hotel and motel accommodation has increased to meet rising demands.

Annex 3: Survey on Solid Waste Generation in Apia

A survey to determine waste generation rate, composition and density was carried out in Apia during the course of the study with help from the staff of the Environment Division.

The survey was carried out largely in the manner suggested in a WHO Workshop on Solid Waste Management held in Suva, Fiji in November, 1992. A total of 25 dwelling types consisting of households, offices, shops and hotels and motels over various socioeconomic status were selected.

The wastes generated by each dwelling were collected for six days, and measure-ments were made to determine the amounts and types of wastes generated. Ideally, the survey should cover 8 days but because of time limitations this could not be done.

Objectives

1. To determine the volume of waste that would require on -site storage, transportation and disposal.
2. To determine appropriate methods of collection and disposal of solid wastes.
3. To identify recycling or resource recovery potential of solid waste.
4. To generate data that would enable the estimation of the expected lifespan of the disposal site.

Expected Outputs

1. Daily generation rates in kg / person / day.
2. Density of solid waste in kg / litre
3. Composition of solid waste generated in percentage by weight.

Preparation for Survey

1. All necessary resources for the survey were organised as follows:

   Transport: An open truck belonging to the Environment Division was used for the collection and transport of garbage.

   Manpower: A driver and two casual workers were assigned for the survey by the Environment Division.

   Equipment: Plastic garbage bags.
   Weighing scale.
   buckets (volume - 8 litres),
   Plastic sheet for sorting garbage, and
   Gloves.

2. A preliminary visit to the selected areas around Apia was made and dwellings (houses, motels, offices and shops) were selected on a random basis. Each dwelling included in the survey was assigned a number and six garbage bags with the sample number clearly written on them were given to each.
3. The following information was obtained for each dwelling:
   - number of people on -site
   - container used for on -site storage
   - means of garbage disposal
   - frequency of public garbage collection in area

Procedure during Survey

The authors of this report supervised the survey.

1. Each day garbage bags containing the rubbish were collected from each dwelling and taken to the sorting site.
2. Each bag was weighed and its weight was recorded against the number on the bag.
3. The contents of the bag were then emptied out into buckets and the number of buckets filled was also recorded.
4. The contents of the bag were then separated into its constituents (vegetable and food, paper, textiles, plastics, garden, metals, glass and ceramic and others) and the weight of each constituent was then determined and recorded.
4. The results for each day were analysed to determine:

   a. bulk density from the total weight and volume;

   b. waste generation rate from total weight and number of persons contributing; and,

   c. the proportion of each constituent in the waste.

5. Results for the six days were used to obtain average results.

3. Solid Waste

3.1 Introduction

The term solid waste has been used in this report to refer to all refuse material generated in homes, businesses, hospitals and other such enterprises that would normally be accepted for disposal at a municipal landfill site. Hazardous or special solid wastes are also included in this category.

Depending on the nature of the wastes disposed off in a landfill site and the proximity of the site to the ocean, any site has the potential to pollute the marine environment, either through contamination of surface runoff or through contamination of groundwater by percolating leachates.

A land-based pollution study on Western Samoa carried out by Convard (1992) presented very little information on the solid waste situation. There was some brief indication that the old solid waste disposal site (the Vaitoloa site) was a significant source of pollution and that contamination from the new site would depend on local soil conditions and hydrogeological conditions.

The terms of reference for this study required an in-depth investigation into all aspects of the solid waste management system in Western Samoa. During this study an attempt was made to determine the amounts and nature of solid wastes generated through the conduction of a comprehensive survey, details of which are given in Annex 3.

3.2 Current System of Solid Waste Management in Western Samoa

3.2.1 Legislative Framework

The Division of Environment and Conservation is charged with the responsibility for solid waste management in Western Samoa. Provisions for the control of solid waste are contained in Division 8 of Part VIII of the Lands, Survey and Environment Act, 1989 under the title "Control of Litter".

The term **litter** is deemed to include any refuse, rubbish, animal remains, glass, rubble, ballast, stones, earth or waste matter, or any other thing of a like nature. The provisions can be summarised as follows:

a. For the designation of disposal sites, the Minister of Lands, Survey and Environment has the authority to designate Government or State land as the disposal site by notification in the Gazette.

b. The Act makes it an offence to litter a public place or to litter private land without the owner's consent. There is provision for:

- requiring offenders to clean up litter;
- instant fines for littering of $10.00;
- court fines (upon prosecution for littering) of up to $500 (individuals) and $5,000 (companies); and,
- court fines (upon prosecution) for refusing to comply with clean-up requirements.

c. Administrators or owners of public places are required to provide rubbish bins and arrange for their regular and efficient emptying.

d. The enforcement of the law is to be carried out by Conservation Officers who have the following powers:

- prevent littering of public places or private land;
- require removal of litter by offender;
- levy instant fines of $10.00;
- require names and addresses of offenders; and,
- lay charges for not complying with the above.

e. The Department of Lands, Survey and Environment can enter into contracts to fulfil its requirement for solid waste management.

Annex 2: **Work Programme During Visit**

September	*Activities*
1	Arrival in Apia
2	Met SPREP Director
	Briefing With SPREP Environment Contaminants Officer, Briefing at the Division of Environment and Conservation with Mr Conforth and Mr Pati Liu.
	Visits to the Vaitoloa and Tafaigata dump sites and the waste oil recycling plant.
3 - 4	Arrangements for the conduction of the solid waste generation survey. Survey of areas to be included in study. Interview with householders.
	Visits to the south and west of Upolu to assess extent of solid waste management problem in rural village areas.
6	Conduction of the solid waste survey.
	Research of documentation relevant to study in SPREP library.
7	Training of staff from the Division of Environment and Conservation in conduction of solid waste generation surveys. Visit to the Health Department.
8	Investigation of Division of Environment files for information on regulation of industrial discharge. Meeting with solid waste collection contractor.
	Collection and on -site testing of water samples from coastal areas of Apia.
	Additional testing of water samples for nutrients and microbiological testing.
9	Sampling visit to clean site at Fagaloa Bay. Analysis of samples. Visits to the Public Works Department and the Agriculture Store.
10	Visits to laboratories with capability for monitoring of water samples -the Observatory and the Hospital Lab. Visits to industries.
11	Return to Suva.

3.2.2 Waste Storage, Collection and Disposal in Apia

Waste Generation Rate and Nature of Waste

The information obtained from the solid waste survey conducted during the course of the study is presented in Table 1, together with corresponding data for Vanuatu, a nation that would compare with Western Samoa in its degree of development, and Hawaii which is considerably more developed.

The data for Western Samoa must be treated with some caution as it may not be a reflection of the normal situation. In spite of repeated requests for participants to collect rubbish generated only through the normal activities of a daily cycle, it appeared that some participants who were not being serviced frequently by the regular rubbish collection system used the survey to get rid of rubbish collected over some time. The percentage of food and vegetable in the waste determined to be 45% may also be somewhat of an underestimate of the real amount of such wastes generated. A lot of such material is used as pigfood.

Table 1: Amount and Nature of Waste Generation

Parameter	Apia	Port Vila[a]	Hawaii[b]
Bulk density (kg/m^3)	350		
Generation rate (kg/person/day)	0.52		1.6
Composition (%)			
Vegetable and food	45	65*	17
Paper	13	15	31
Textiles	3		1
Plastics	8	5	7
Garden	14		19
Metals	14		10
Glass	2		10
Others	<1	15	5

* includes garden wastes as well

a data from a report on a new rubbish disposal site for Port Vila, author and publication details not available

b Hawaii. Department of Planning and Economic Development (1983)

However, despite these shortcomings, the data reinforces what is generally known about the waste generation of developing countries. Although the rate of generation is considerably smaller, the bulk density seems to be greater, consistent with the higher proportion of dense material such as putrescibles in the waste. Lower density values associated with more developed countries are related to the higher percentage of non-putrescibles such as paper, plastic, glass and metals which often result from the packaging of consumer items.

On-site Storage

Most dwellings in the Apia region use an open half 44-gallon drum to store their rubbish. This drum is left at the roadside, frequently on a platform erected to a height of approximately 1 metre to protect the rubbish from stray dogs which the participants of the survey identified as a serious problem. As the frequency of garbage collection is at best twice a week in most areas, it means that garbage can be left uncovered at the roadside for a period of days. Other containers observed to be commonly in use are garbage bags, plastic bags, baskets, plastic containers and tea chests.

For 20% of the dwellings surveyed, the question of storage did not arise as the rubbish was being disposed off on-site. Burning was found to be quite a common occurrence as was composting and the use of wastes to reclaim swampy land or to extend the coast line. Direct disposal into the sea was also being practised.

Collection

Two companies contracted the Department of Lands, Survey and Environment collect solid waste. They service households at no extra cost, covering an area from the west of Apia to Vaitele, east to Letogo and south to Tiapapata. The contractors have undertaken to provide a garbage collection service at least once a week.

However, the survey revealed that a significant proportion (60%) of the households using the service were dissatisfied with the frequency of the service, claiming that the service was not as regular as it should be.

An article registering such a complaint appeared in the *Samoa Observer* during the study. A later article presented the views of the contracting company. These articles showed that there are still problems with solid waste management in Apia.

4. Identify all the waste source types and category of wastes in Western Samoa.

5. Assess present and future waste loads and if possible cross check against total import data.

6. Estimate and predict existing refuse dump life and make provisions if need be to make it life prolonging as it possibly can through reduction of waste.

7. Assess the viability of the existing dump; public health, social and economic wise.

8. Assess the possibility of leachates from the dump getting through to water course and underground water supply and coastal waters by carrying water quality tests near and off sites. In addition carry out water quality tests on six (6) sites around Upolu, deemed to be polluted as compared to a reference site which is totally healthy and unaffected preferably at a site in Lefaga or Falealili coastal waters.

9. Introduce a report which could be integrated into a regional study on land based pollution sources detailing findings and commendation. This report will make some recommendations with regards to assessment, strategies on waste management, waste disposal site management, pollution monitoring and pollution control and disposal site restoration.

10. Work closely during the study with local counterparts and show them or teach them wherever and whenever possible how to identify the types and categories of waste, assess the load of pollutants and apply the result in the calculation of the life span of the dump. In addition how water quality monitoring is planned and carried out.

11. Will spend at least one hour of your last day in Western Samoa with the Environment Director of the Lands, Survey and to discuss your findings and would be recommendations.

12. Generally give advice and assistance to the government of Western Samoa whenever possible and if required.

Disposal

The Vaitoloa dump site which is in a mangrove area and was in use for approximately thirty years has been officially closed:

A new 100 acre dump site has been designated at Tafaigata, south-west of Apia. Specific areas of the site have been set aside for different categories of waste such as sewage sludge, recyclables (glass and metal), material suitable for landfilling and hazardous wastes (see Fig. 3) and signposts have been erected pointing to these areas. It is expected that wastes would be separated into different categories before being brought to the dump site but in practice this does not appear to be taking place. There are obvious signs of mixed dumping in all areas. The wastes are also left uncovered.

3.2.3 Management of Tafaigata Dump Site

The Division of Environment and Conservation is responsible for the management of the Tafaigata dump site. A new all weather road has been constructed to the entrance of the site. Sectional roads which are dirt tracks lead to different areas designated for different categories of waste.

The site preparation has been carried out by clearing the vegetation in various sections of the land for disposal of specific categories of wastes. A trench has been dug up in one section for dumping material suitable for landfilling (essentially those that are non-recyclable) and another trench in another area for the disposal of sewage sludge emptied from septic tanks. No provisions have been made to divert the surface runoff from the site nor any provisions instated for leachate control.

The entrance has a gate which is supposed to be manned by the Site Manager at all times and he is also required to oversee the disposal of wastes in the correct manner. However, the Site Manager was nowhere in sight on all occasions that the authors of this report visited the dump site.

The waste at the site is meant to be levelled and compacted with machinery from the Public Works Department but this also appeared not to be taking place. Instead burning appeared to be carried out quite often. As wastes are left uncovered, there is a serious fly problem. Scavenging by humans and animals was also apparent.

3.2.4 Hazardous Waste

The hazardous wastes in Western Samoa have been identified by Ogawa (1992) to be:

a. **Pesticides** - It is believed that unspent pesticides and contaminated containers are discarded in many locations throughout the country.

b. **Waste oil** - No special precautions are taken for the disposal of waste oil by some operators. However with the commissioning of a waste oil recycling plant, this problem can be tackled.

c. **Timber treatment chemicals** - Unspent copper - chrome - arsenic chemicals are known to be left unchecked in places.

d. **Hospital wastes** - Infectious waste is incinerated, liquid waste discharged to an Imhoff tank and solid waste is disposed of at the dump site. However waste separation is reported to be not effective and some infectious waste could end up with general solid waste or wastewater streams.

e. **Photoprocessing chemicals** - Some such wastes are being disposed of at the dump site with no special precautions.

f. **Polychlorinated biphenyls** (PCB) waste - Old transformers are reported to be discarded in someone's backyard.

g. **Asbestos waste** - Asbestos waste has been packed into shipping containers and buried at the Tafaigata dump in the area designated for hazardous waste.

3.2.5 Solid Waste Management in Rural Areas

In the rural areas of Western Samoa, wastes which are not suitable to be fed to pigs are generally disposed of through burning in the open. Smoke from such fires is a common feature in villages. The responsibility for solid waste management in rural areas is not clearly identified in existing legislation.

Draft solid waste regulations have been prepared which attempt to redress this situation by placing the responsibility on village councils to ensure that suitable disposal facilities are available.

Annexes

Annex 1:

Background on Consultancy

This is a joint consultancy between Inia Wele of Fiji School of Medicine, Suva, Fiji and Dr Philomena Gangaiya of the School of Pure and Applied Science of the University of the South Pacific on a case study on land based pollution sources in Western Samoa on 2 12 September 1993.

The study is part of a two country study project (Western Samoa and Kiribati) which represents two countries with different development strategies.

Western Samoa represent a case study alongside domestic discharges also concentrate on commercial and industrial discharges to the coastal areas, whereas Kiribati represents an atoll with major land based pollutant from domestic sources.

Whilst the final report, is intended to be of use to countries of similar geographical structures and facing the same situation, it is also meant to be of us as resource materials for training of personnel involved in waste management in the South Pacific.

Hence the study if it were to be used for such purposes must include the following:

Study on Waste Management Storage Collecting, Transport.

(i) study of the current waste management, practice and legislation

(ii) assessment of existing and future sources, types and category of wastes and waste loads

(iii) conclusions on the existing practice

(iv) recommendations for improving the current waste management practice which will also include final disposal options, and a waste management plan which will also look at waste reduction efforts, etc.

Waste Disposal Site Management

(i) the assessment of the viability of a new site if needed be in terms of public health, engineering, social and economical aspects or improvement to existing sites.

(ii) a waste disposal site management plan

(iii) the putting into place of a pollution control monitoring programme

(iv) waste disposal site restoration progr-amme

The two case studies and the report of the consultant currently undertaking the survey of land based pollutants are to be discussed in a meeting / workshop in 1993 on land based pollutants in the islands environment assuming that resources will be available. The regional application of the two studies will be assessed and identified at the meeting. Use of recommendations by governments to control marine pollution and the methodology for the quantitative survey of land based pollutants may be adopted and applied to other countries in the region.

Terms of Reference

Dr Philomena Gangaiya and Mr Inia Wele, during the period 2-12 September 1993, shall:

1. Work closely with designated govern-ment staff (the officers of the Ministry of Land and Environment) of the Western Samoa Government, and
2. Visit sources and quantify information on land based pollutants, including the 1992 report by Pavel Klinckhammers on "Land Based Pollution Sources and their effects on the Marine Environment of Western Samoa" and that section of the report on LBPS on Western Samoa by Miss Nancy Conard could be used as a basis for the field study.
3. Conduct a survey on the existing waste management practices and waste management legislation in Western Samoa in both urban and rural areas.

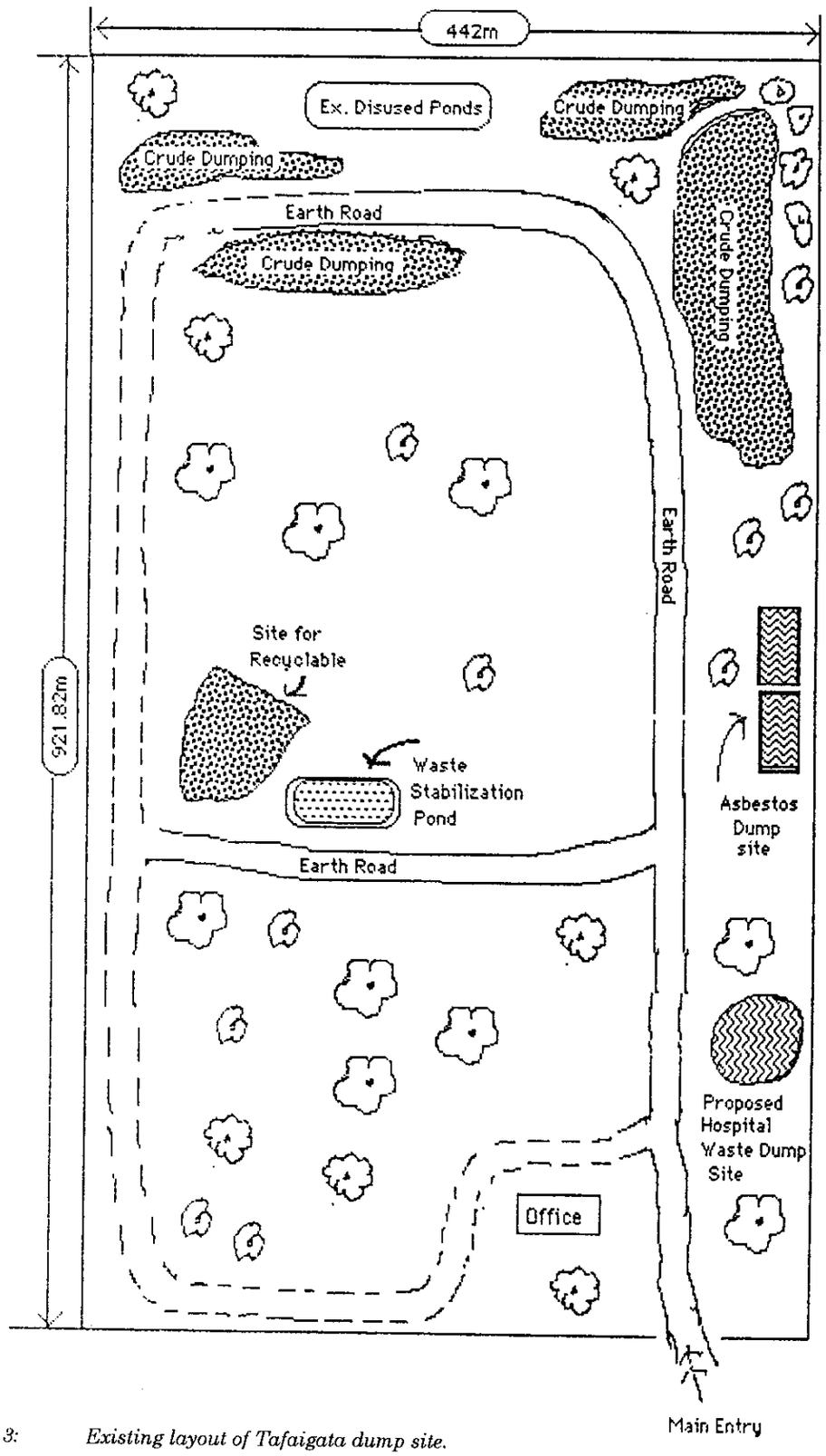

Fig. 3: *Existing layout of Tafaigata dump site.*

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3.3 Assessment of the Waste Management System

3.3.1 Legislation

The problems with solid waste management in Western Samoa appear not to stem principally from the inadequacy of legislation, although there are certain areas in which the legislation can be improved. For example, legislation must be made more explicit in respect of the type of receptacle to be used for waste storage on-site in both domestic households, commer-cial enterprises and public places. Specific-ations must state that containers are to have lids that will keep the rubbish covered at all times.

The legislation is also not specific on the removal of rubbish, stating that this must be done at regular intervals. The exact frequency must be specified. Special provisions for the handling of hazardous solid waste must also be made. This is missing from the legislation at the moment.

As was obvious during the solid waste survey, the legislation is not being enforced. However, in traditional culturally-based societies such as that of Western Samoa, control through implementation of legislation alone is perhaps not advisable. Community participation and awareness through public education must be fully exploited. Ways in which this may be done are outlined later.

> ***Recommendation***
>
> *That a public education campaign on solid waste management be mounted to increase community awareness of the issues involved.*

3.3.2 Waste Storage, Collection and Disposal

Storage

The use of 44-gallon drums positioned on platforms raised to a height of a metre or more is clearly not appropriate. Heavy loads would be difficult for garbage collectors to manage. One of the contractors also expressed concern that his workers were injuring themselves with the sharp edges of the half-cut drums. Besides, the use of open containers runs the risk for scavenging by dogs and breeding of insects.

To overcome such problems, it is recommended that all dwellings be required to use a container with a well-fitting lid, preferably a standardised type.

> ***Recommendation***
>
> *That containers for solid waste storage be required to have lids to keep the wastes covered at all times.*

Collection

The problem with collection of solid waste appears to be partly the result of a lack of communication between the authorities responsible (the Division of Environment and Conservation through the contractors in this case) and the households. People are not aware of the days on which they will be serviced. This information must be made clear to everyone in the best possible way. An option would be to use radio programmes to publicise such information.

> ***Recommendation***
>
> *That people in the areas which have a collection service be advised of days of collection in their respective areas.*

The performance of the contractors can be improved through increased monitoring of their activities by the Division of Environment and Conservation and by making provisions in the contract for accountability in the event of unsatisfactory performance.

> ***Recommendation***
>
> *That the Division of Environment and Conservation take steps to improve the performance of the solid waste collection contractors.*

8. Conclusions

This study showed that contributions to the pollution of the marine environment in Western Samoa were made by solid wastes, industrial wastes, domestic wastewater and agriculturally related wastes.

The most obvious threat to the marine environment from solid wastes is when such wastes are disposed of directly into the sea. Fortunately, for Western Samoa, this did not appear to be widespread. Provisions are in place in Apia for a communal waste collection and disposal system, although it appeared not to be functioning very effectively. There is considerable room for improvement of the system through increased co-operation and commitment from all parties concerned - householders, contractors, and administrators.

When wastes are collected and concentrated in a particular disposal area, all necessary precautions must be taken to prevent leachates from contaminating ground water and the marine environment. In Western Samoa, although a step in the right direction has been taken with the closure of the Vaitoloa dump site which was in an ecologically sensitive area of the marine environment, considerable improvements are necessary both at Vaitoloa and Tafaigata before the threat from contaminated leachates is completely abated.

Within the industrial sector, direct evidence of marine pollution has been found for the effluent from the Vailima brewery. In addition, the potential for significant marine pollution has been identified for the oil storage depots, the power plants, the concrete industry and the slaughter house. As with pollution from other wastes, the effects of long term discharge of small amounts of industrial wastes may not be discernible in the short term. For this reason, some complacency may prevail, which appears so case in Western Samoa. The complete absence of monitoring of the wastestreams of industries means that industries are not compelled to carry out adequate and efficient treatment of wastes. The situation can be redressed through appropriate regulations and monitoring.

Evidence for contamination of the marine environment by domestic wastewater was obtained through microbiological testing of coastal waters of Western Samoa. As expected, contamination was most significant around Apia. The factors controlling the extent of contamination are many, significant amongst which is the poor design of septic tanks and the permeability of the substrata in many areas.

In recognition of the problem, there are plans afoot for the provision of a public sewage collection, treatment and disposal system in Apia, but it is important that the discharge from this facility be located so that important marine resources are not endangered.

The potential impact from agriculturally based activities on the marine environment in Western Samoa has been established with information obtained from previously published reports. A significant problem seems to be the release of sediments into sensitive marine environments. The solution to this problem is appropriate watershed management. This is already being proposed in affected areas.

Although, as already made clear in preceding paragraphs, contributions from solid wastes, industrial wastes, domestic wastewater and agricultural wastes are contributing to the pollution of the marine environment in Western Samoa, it is difficult and perhaps irrelevant to attempt to distinguish which particular category makes the largest contribution. As far as the protection of the quality of the marine environment is concerned, contributions from all sources must be regulated.

The regulation by existing legal frameworks can regulate marine pollution in Western Samoa. Although improvements can be made in some areas, existing and draft legislation are generally appropriate. However, enforcement of legislation alone as a means of waste management will be disastrous. Public environmental awareness must be enhanced alongside other control measures. Suggestions for improvements in control mechanisms in various areas have been made.

Overall the study has shown that development activities in Western Samoa are having a noticeable impact on the marine environment. However, with effective management strategies, the benefits of development can be attained without compromising the quality of the marine environment.

Disposal

People must be discouraged from disposing of wastes through burning, reclaiming land or dumping in the sea as these will contribute to the deterioration of the quality of both the land and sea in coastal areas.

Disposal at the Tafaigata dump site must be carried out in a more systematic manner. The intention for waste separation before dumping is clearly not working for household waste. The reason for this appears to be the lack of a clear framework for waste separation to be effective. For example, it is not obvious whether the general public should separate waste at source or whether the contractor is required to separate wastes upon collection. The latter is obviously unpractical and the former unachievable without some commitment from the public.

One way to solicit public cooperation would be to provide incentives for waste separation. Repositories for bottles, cans, etc can be set up at various places where such material can be exchanged for some small sum of money. An arrangement can be worked out between the Government, the recyclers and the people operating the repository for the management of the recycling system.

Recommendation

That the Division of Environment and Conservation work with the commercial sector in identifying and instating strategies through which recycling can become effective.

3.3.3 Dump Site Management

Vaitoloa Site

Although the Vaitoloa dump site had been officially closed for some months prior to this study, evidence of some recent dumping of wastes, particularly in areas alongside the approach road to the site, was apparent. This must be stopped immediately. Most sections of the site appear to have been covered with soil except the area where the most recent dumping had taken place. The rubbish in this area has been compacted but there is no cover material.

No restoration work had been carried out at the time of the study. Ogawa (1992) has suggested a restoration programme for the site and the authors of this report fully agree with those suggestions.

The basic components of the restoration programme are:

- the construction of a dyke between the dumping ground and the bay water. Specifications for the dyke are given by Ogawa(1992).
- The raising of the level of the dump site to a height that takes into account the intended final landuse of the site. As the organic waste in the dump will take about five to ten years to fully decompose, it was suggested that the area be used as a playground during this stabilisation period.
- when the area has reached the post-closure ground level, a final cap of compacted clay with a thickness of 50 to 60 cm must be laid to minimise infiltration of water.

Recommendation

That a restoration programme as suggested by Ogawa (1992) for the Vaitoloa dump site be undertaken.

Tafaigata Site

There is no question that the management of the Tafaigata dump site is unsatisfactory and should be improved considerably. As the site has been in operation for two months only, it is not too late to instate improvements. The first thing that needs to be addressed is an improvement in the overall layout of the dump site. A suggested layout is given in Fig. 4. The next thing is proper site preparation to minimise contamination of groundwater with leachates from the waste.

There are no detailed studies into the hydrogeology of the site. However, some general information on the geology and hydrology of Western Samoa (Kear and Wood, 1959) suggests that the site is underlain by either the Malifanua rocks or the Salani volcanics both of which have the characteristic of being highly permeable. Therefore it is possible that groundwater will be contaminated with leachates from the waste.

To prevent groundwater contamination, the site has to be protected from surface runoff from reaching it. This can be done by constructing drains around the perimeter of the site leading the runoff away from the site. Some mechanism for leachate control in the landfill areas must be installed. Dumping of wastes must be carried out in a controlled manner. Details of one particular approach are given in Annex 4.

7.4.3 Faecal Coliform

Data in Table 9 showed at all sites in Western Samoa except 1 and 8, showed contamination from sewage discharges. The negative result at Site 1 was due to the presence of noticeable amounts of alcohol in the water, making microbiological growth impossible. Site 8, at Uafatu was remote from human influence and therefore the negative value was expected.

The highest value was obtained at the Vaitoloa dump (Site 2) which is explained by the presence of a village in the surrounding mangrove swamps. Sewage wastes are probably finding their way into the sea. A value of 300 colonies / 100 ml of water was obtained for the water in front of Aggie Grey's hotel where recreational vessels were moored. United States Environmental Protection Agency regulations advocate a maximum value of 200 colonies / 100 ml of water as guideline value for recreational purposes.

The lowest value was obtained for Site 5 at the marine reserve park, which is favourable for the purpose it is being used for.

7.5 Overall Patterns

Taking all possible factors into account, this data indicated that water pollution is occurring at Site 1 (from the brewery effluent), Site 2 (possibly from leachates from the old dump and the nearby village) and Site 4 (possibly through the Vaisigano River and any direct sewage discharges). Little significant pollution at the WSTEC Slaughterhouse site is surprising, but this may be due to an absence of effluents at the time of testing. More moni-toring should be carried out to investigate water quality at other sites and also to ascertain trends in pollution.

Recommendation

That monitoring of water quality in coastal waters be carried out to determine the extent of pollution from land-based activities.

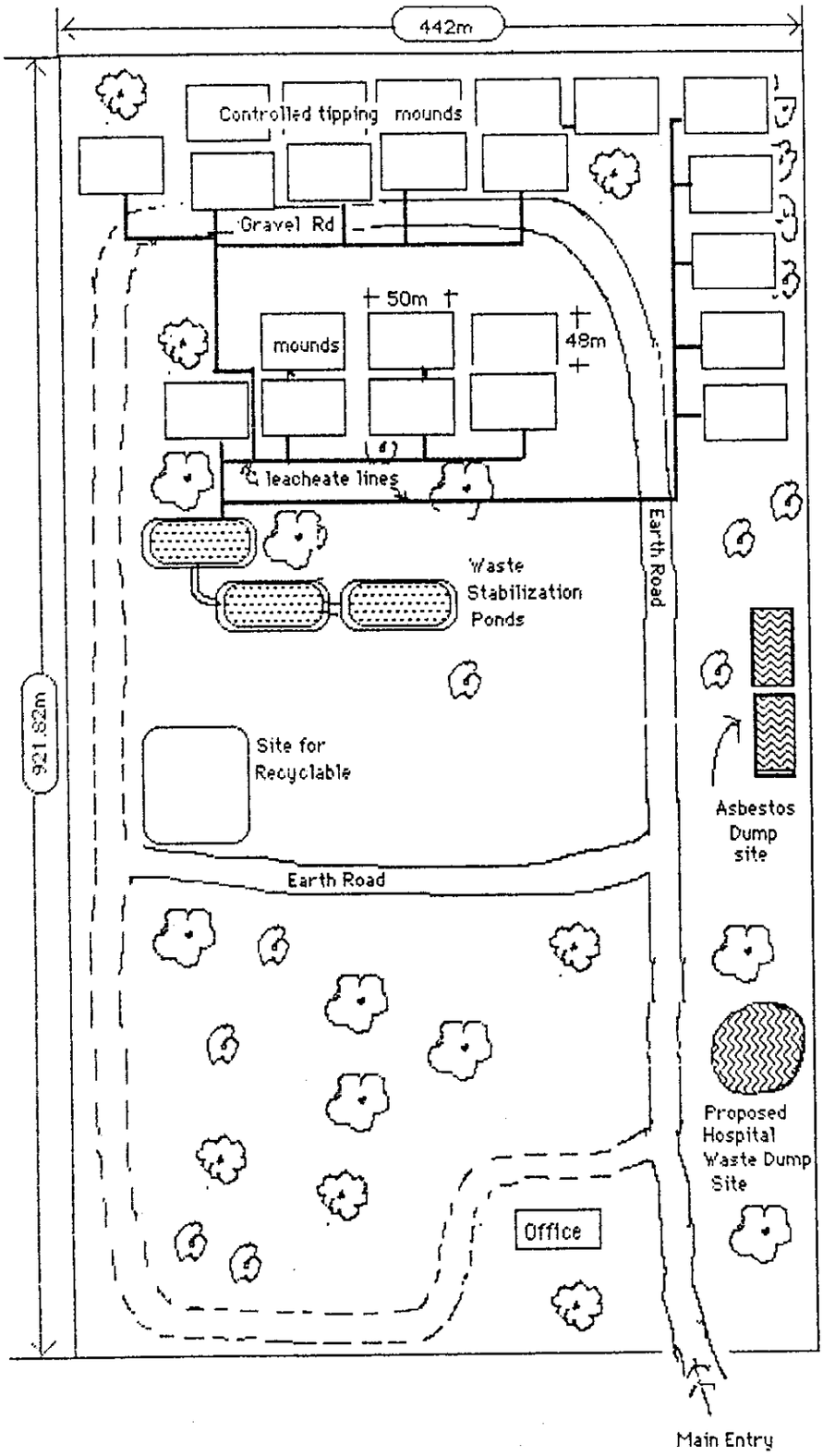

Fig. 4: *Proposed layout of Tafaigata dump site.*

Table 3: Water Quality Data for Western Samoa

	Site number								Data from Naidu et al(1991), for Fijian coastal waters	
Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Polluted site[a]**	**Clean site[b]**
Temperature (^{0}C)	38	31	30	29	30	31	29			
pH	7.6	8.4	8.6	8.6	8.6	8.6	8.6	8.8		
Diss oxygen (mg/L)	5.8	6.0	7.1	7.7	*	*	*	*		
Salinity (g/kg)	1.7	16	40	40	39	38	28	40		
Phosphate (mg/L)	4.8	2.4	0.08	2.3	1.6	0.21	0.09	1.8	0.62	0.13
Nitrate (mg/L)	9.1	0.4	0.9	0.9	1.1	1.1	0.9	1.0	1.1	0.04
Faecal Coliforms (colonies/100 ml)	<1	1000	30	300	6	16	50	<1	12000	37

a: average value for Site 13 at the mouth of Nuboukalou creek considered to be very polluted

b: average value for Site 10 at Nukulau island away from the coast considered the cleanest of all sites

*: no data available because of instrument malfunction

If an overall comparison is carried out of the values obtained at the sites in Apia with those obtained for Fagaloa Bay, an unexpected result comes to light which is that the concentration of phosphate in the water at the clean site near Uafatu (Site 8) turned out to be quite considerable. The reason for this does not appear to be sewage discharge as the site was suitably far from village influences and the faecal coliform count which was practically zero also does not suggest this. There may have been some undetected source of phosphorus in the water.

If a value of 0.09 mg/L, as obtained for Site 7 at Lona village in Fagaloa Bay, is considered the typical phosphate concentration of unpolluted waters in Western Samoa, then all sites in Apia (except Site 3 for reasons already discussed above) showed enrichment, the most significant being at Sites 1, 2 and 4 (in front of Aggie Grey's Hotel). The sources of nutrients at Sites 1 and 2 have already been described.

An additional source of nutrients at Site 2 appears to be wastes from a village in the nearby mangrove swamps. The source of the enrichment at Aggie Grey's appears to be from sewage discharges (supported by the faecal coliform data) and the Vaisigano River.

It is also interesting to note that the phosphorus enrichment of Apia coastal waters is greater than that at one of the more polluted sites in Suva, Fiji (see relevant data in Table 9), although such an outright comparison must be made with some reservations as different methods were used for the determinations.

Nitrate

Except for Sites 1 and 2, the nitrate content of Western Samoan waters appears to be consistent at a value of approximately 1 mg/L, regardless of the location of the site. In fact, comparison with data for Fiji shows that the Samoan waters have about the same level of nitrates as one of the most polluted sites in Fiji. This conclusion seems somewhat questionable in view of the considerable pollution of the water known to be occurring at the site in Fiji.

Either of two reasons may responsible for the high nitrate results obtained for Western Samoa - that the instrument used gave erroneous results or that the Western Samoan waters contain a naturally high level of nitrates. Further testing would be required to find the exact reason.

Site 1 showed a nitrate enrichment of about nine times the background value, again implicating the brewery effluent as being responsible. The value at Site 2 is the lowest of all sites - no immediate reason for this can be seen.

Access to other areas on the site not intended to be used immediately must be restricted by movable fencing. The fencing can then be moved as new areas come into use. Wastes must be compacted and periodically covered with soil excavated from the landfill site. The site where hazardous wastes are buried should be fenced off. The performance of the Site Manager must be improved.

> ***Recommendation***
>
> *That steps be taken to design and manage the Tafaigata dump site in an environmentally acceptable manner.*

3.3.4 Life Span of Dump

For the calculation of the life span of a dump, information about the total land area, the height to which dumping will take place, the rate of generation of wastes, the bulk density and the rate of decomposition of the wastes is required.

The Tafaigata dump site with an area of 40.7 ha will have a total volume of 1,221,000 cubic metres if dumping of wastes is carried out in the manner suggested in Annex 6, that is to a height of 3 metres. At a daily generation rate of 0.52 kg/person the half-yearly amount of waste generated for a population of 33,000 (for Apia) will be 3 million kg. Using a bulk density of 350 kg/m^3, this is equal to a volume of about 8,500 cubic metres. It is generally known that wastes reduce to approximately 55% of the original volume in six months. Therefore 8,500 cubic metres generated in six months will reduce to 4700 cubic metres. To fill up the entire area available for landfilling 259 half-years or 129 years will be taken.

However, it is important to remember that the rate of growth of the population and also the increases in generation rate have not been taken into account. Cosideration of these two factors will reduce the life span of the site.

3.4 Waste Management Plan for Western Samoa

Management of solid waste in Apia is fragmented at the moment. Refuse bins are provided by the Department of Tourism to some people. Others improvise their own containers. House-to-house collection is by private contractors. Residents are also allowed to cart their own rubbish directly to the dump site.

Maintenance of the dump site is carried out by the Division of Environment and Conservation. This Division is dependent on PWD for machinery to compact and cover the waste material. The Division of Environment and Conservation is currently responsible hiring contractors and monitoring their services and handle complaints from the public.

It would be ideal to have one institutional body handling all aspects of solid waste manage-ment but clearly such changes can not be brought about immediately. Further financial resources may need to be injected into the system for the idea to become operational. However, considerable improvement in the present system is possible with better coordination between the different agencies involved in waste management. The Division of Environment and Conservation should take overall responsibility and prepare a plan for solid waste management, with a section giving explicit descriptions of the role of each party. Regular meetings of the parties concerned should be held to ensure that the system is working effectively.

The broad aim of the plan would obviously be to deal with all solid wastes in a safe, effective and environmentally acceptable fashion. More specific objectives should be outlined, the methods with which these objectives would be fulfilled identified, and the responsible organisations for implementation designated.

Some objectives to be considered are:

a. *To minimise waste generation at source by the best practicable means and to reuse as much as practicable waste articles which cannot be eliminated at source.*

   This objective can only be fulfilled through community cooperation and therefore it is essential that the message about the advantages of good solid waste management practices is driven home, so to speak. This can be done through public education through the popular media, small workshops in schools and villages, demonstrating the alternative uses of some waste materials such as bottles, cans, plastic containers, etc. Organisations that may be involved are the Division of Environment and Conservation, the Health Department, schools, women's groups, etc.

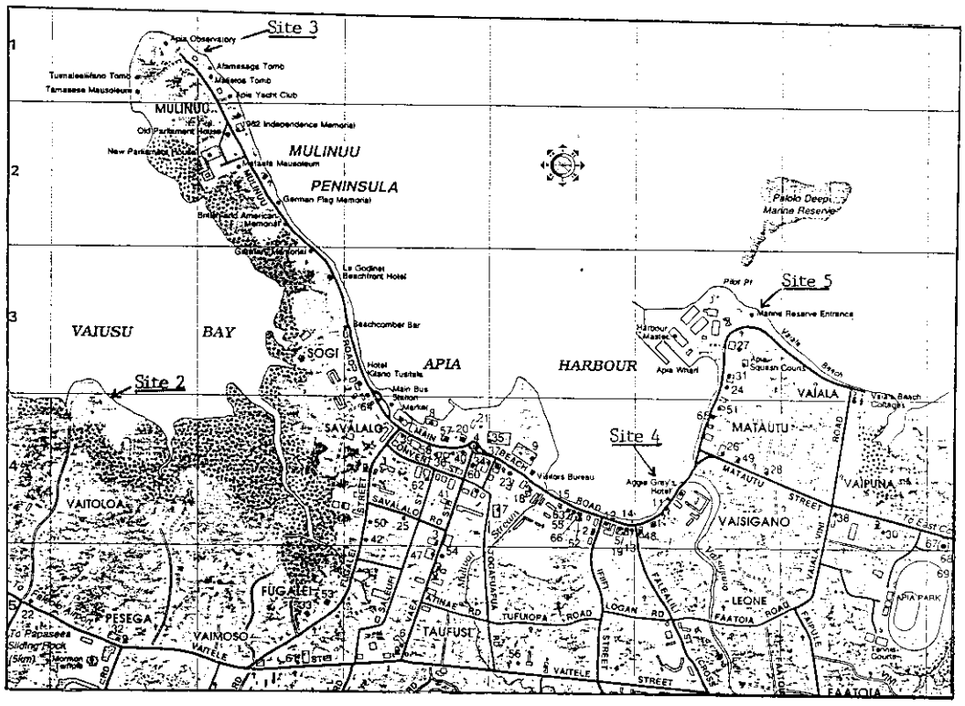

Fig. 7: *Location of sampling sites 2, 3, 4 and 5.*

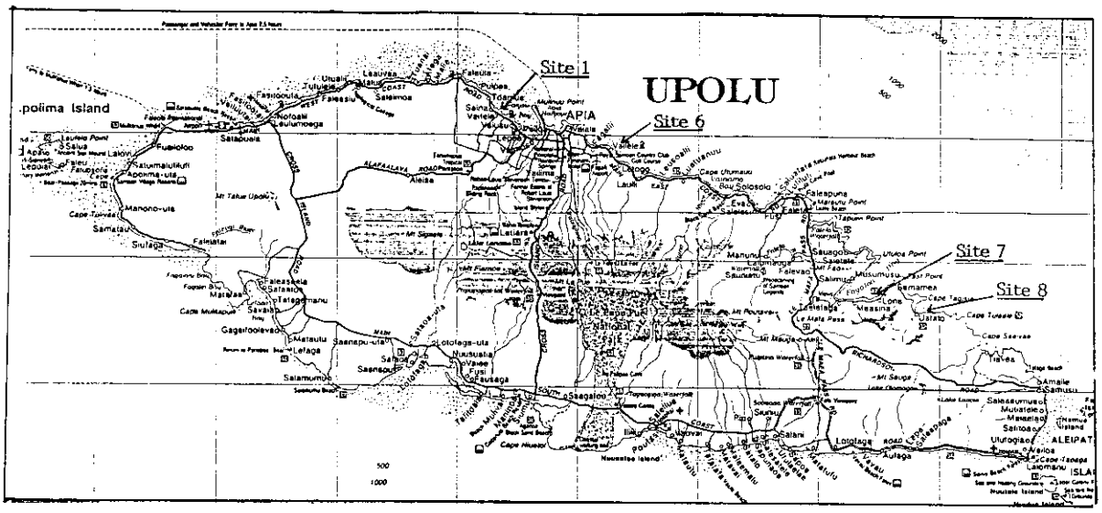

Fig. 8: *Location of sampling sites 1, 6, 7, and 8.*

b. *To recycle as much as practicable waste materials for which demand exists.*

This can be done by instituting effective mechanisms for recycling to occur. The Division of Environment and Conservation and the commercial sector should explore ways in which this may be done. The recommendations made in Section 3.3.2 should be given consideration.

c. *To use environmentally-acceptable receptacles for waste storage.*

Appropriate rubbish bins should be provided by the Government in all government administered public places. The commercial and domestic sectors should initially be encouraged and later be required to use proper receptacles. Again, recommendations already made in the previous section should to be considered.

d. *To provide efficient collection, handling, transport and disposal of solid wastes.*

As part of the waste management system is carried out by contractors, the Division of Environment and Conservation must ensure that it is being done effectively by closer monitoring of their activities (see earlier recommendations). Regular meetings with contractors must be held.

e. *To provide environmentally safe disposal of wastes.*

This objective can be fulfilled through appropriate management of the dump site. Better coordination between the Division of Environment and Conservation and the PWD is required. The Vaitoloa site must be restored and the Tafaigata managed as suggested in Section 3.3.2.

f. *To manage hazardous wastes in ways that will protect human health and environment quality.*

In addition to consideration of recommendations made for hazardous waste management, the Division of Environment and Conservation should explore with regional organisations, such as SPREP the possibility of SPREP formulating a regional framework for handling hazardous waste management.

g. *To provide responsive customer service, timely public information and effective community consultation.*

It is essential that maximum community participation is solicited. Community representatives at meetings may be useful.

Financial Implications

Obviously, an effective solid waste management system requires adequate financial resources to cover all aspects of operation, maintenance and administration while taking expansion requirements into account. This can only happen through a well administered system of budgeting control.

The solid waste management system in Apia is maintained with a grant from the national government. This is not satisfactory for the long term as solid waste management will continue to compete with and liable to come out as of lowest priority against education, health and other areas that generate economic growth.

Charging people for waste management may not be acceptable to the public but the Government should explore this possibility to boost the financial resources for solid waste management.

7. Water Quality of Coastal Waters

As part of this consultancy, the water quality of a number of sites around the coastal areas of Upolu were determined. Basic water quality indicators such as pH, temperature, dissolved oxygen and salinity, phosphate and nitrate concentrations and faecal coliform counts were measured to determine the extent of pollution in each of these areas.

7.1 Location of Sampling Sites

The sites were chosen on the basis of known sources of pollution. Six sites from Apia mostly in areas known to be exposed to pollution sources and two sites from Fagaloa bay, a relatively clean area, were selected. The location of these sites are shown in Figs. 7 and 8. Site descriptions are given in Table 8.

Table 8: Decriptions of water sampling sites on Upolu, Western Samoa.

Site	Description
Apia	
1	10 m from shore at outfall of Vailima brewery
2	off the now closed Vaitoloa dump site
3	at the tip of Mulinu'u peninsula
4	off the seawall in front of Aggie Grey's hotel
5	at the marine reserve park in Apia
6	in effluent discharge area of WSTEC slaughter house
Fagaloa Bay	
7	off Lona village
8	300 m from Uafatu village

7.2 Methods of Determination

Parameters such as temperature, pH, dissolved oxygen and salinity were determined with a Horuba U-10 Water Checker meter on site. Phosphate and nitrate concentrations were determined within 24 hours on samples collected in polyethylene bottles, using HACH reagents and a DREL 2000 spectrophotometer. Faecal coliform counts were determined with a field microbiological kit using the membrane filtration technique on samples collected in sterilised bottles.

7.3 Results

The results are given in Table 9. Also included for comparison purposes are results for two sites from Suva, Fiji - one considered to be highly polluted and another which is relatively clean.

7.4 Interpretation of Results

7.4.1 Temperature, pH, Dissolved Oxygen and Salinity

Considering characteristics such as temperature, pH, dissolved oxygen and salinity alone is sufficient to show that the brewery effluent is affecting the quality of the water at Site 1. The temperature of the water at Site 1 was significantly higher than at other sites, presumably because of the higher temperature of the effluent being discharged. The pH, dissolved oxygen and salinity values were lower than at other sites. Salinity had decreased to a value of 1.7 g/kg indicating the considerable volume of effluent that was being discharged in comparison to the volume of the receiving sea water. The lower dissolved oxygen content at Site 1 is indicative of the demand for oxygen for decomposition of the organic material in the effluent.

Site 2 at the Vaitoloa dump site also had a relatively low dissolved oxygen content, probably also due to the release of organic material into the water.

7.4.2 Nutrients

Phosphate

The lowest phosphate value occurred at Site 3 at the tip of the Mulinu'u peninsula. This value is even lower than the lowest value for the sites at Fagaloa Bay, which is considered to be a relatively clean area of Upolu. The reason for this may be that the large amounts of suspended sediments in the water at Site 3 may be able to bind the phosphate, effectively removing it from the dissolved state.

4. Industrial Wastes

4.1 Introduction

As part of the industrial process of transforming raw materials into products, various wastes are generated. The amount and nature of the waste will depend on the industry responsible for generating it. For example, a food processing factory may generate wastes containing mostly organic residues which when treated appropriately can degenerate into relatively harmless substances. On the other hand, an ore smelter will generate wastes containing heavy metals which regardless of treatment cannot be broken down into simpler substances and will persist in the environment.

Wastes which are usually also considered under the category of industrial wastes may be generated through activities which are not strictly industrial processes as such. Oil storage depots, for instance, are the source of petroleum-based wastes in a number of South Pacific island countries. However, whatever the origin and nature of the waste, some means of disposal are required so that human health and environmental quality are protected.

In the island countries of the South Pacific, it is generally found that industries, which are almost exclusively situated in areas very close to the sea, discharge their wastes directly into the sea, often with very little prior treatment. The water bodies into which these wastes are discharged are often enclosed by the land on one side and fringing coral reefs on the other so that water exchange with the open ocean water is limited. Under these circumstances, there is bound to be some impact on the quality of the marine environment.

In this section, the wastes produced by the industries in Western Samoa are described and an attempt is made to identify those that are likely to have the most significant effect on the marine environment. But first, the legislative framework governing industrial waste discharge into marine environments is presented.

4.2 Legislative Framework.

The provisions for the protection of the quality of the marine environment from industrial wastes are made within some general legislation for the control of pollution of seas and inland waters in Division 6 of Part VIII of the Lands, Survey and Environment Act, 1989.

Under this legislation, it is an offence for a person, manufacturing establishment or mill of any kind to discharge into Western Samoan waters refuse matter of any kind or description or to deposit such materials in places from where they can be washed into Western Samoan waters causing pollution.

No discharge of any oil, noxious liquid or solid substances are allowed except in case of emergency endangering life or property or unavoidable accident or as otherwise permitted by regulations made under this Act. No regulations have yet been formulated to control industrial waste discharge into coastal waters.

4.3 Sources of Industrial Waste in Western Samoa

The number of industries in Western Samoa has been reported by Convard (1992) to be 75. Klinckhamers (1992) on the other hand has reported the number to be 118 although only about 50 were discussed. An enquiry with the Department of Trade, Commerce and Industry during this study was informed that the number was 32. The reasons for the differences appear to result from the tendency to include small-scale commercial enterprises as industries in some cases and in other cases to leave them out.

In this report, only those industries are considered that appear to contribute to the industrial waste production in Western Samoa. The total number is 46, classified into different groups shown in Table 2.

6.5 Pesticides

Pesticides are widely used in Western Samoa, with paraquat the most common. The intensive use of pesticides means that mobilisation into waterways and the marine environment is a possibility where they can kill through direct exposure or bioaccumulation. It has also been reported that unwanted pesticides are poured into drains and streams. Warren and Sisarich (1992) indicated that the risk from pesticides may be larger in occupational health than in environmental damage.

Efforts to obtain the most recent figures on the sale of pesticides in Western Samoa from the Agricultural Store were unsuccessful as the manager of the store refused to co-operate, maintaining that such information is often distorted to portray a very negative image of pesticides. While this may be true in some cases, the attitude of the manager shows a general lack of an appreciation of the pesticides issue in its proper perspective - that it has its advantages and disadvantages, and if it must be used then it should be done in a way that minimises the disadvantages. Obviously there is a need for public education on the issue. In the absence of the most recent figures on pesticide use, those reported by Taylor (1991) are presented in Annex 8.

Recommendation

That a community awareness programme be launched on the uses and misuses of pesticides.

6.6 Initiatives to Control Agricultural Wastes

Sediment, nutrient and pesticide run-off can be controlled through modifying landuse and management practices to be in harmony with the area being cultivated. In recognition of this, *Watershed Protection and Management Regulations* have been formulated as part of the Vaisigano Pilot Watershed Management Project.

The major emphasis of this Project is to stop the non-sustainable forms of land use such as the cultivation of sloping lands without soil conservation measures and extensive pesticide use. The regulations on watershed manage-ment must be enforced.

Recommendation

That the Watershed Protection and Management Regulations be finalised and enforced in intensively cultivated areas.

Table 2: Industries in Western Samoa.

Industry Name	Location
Food and Beverage	
Talofa Wines	Vaiala
Vailima Breweries	Vaitele
Manuia Breweries	Vaimea
CCK Trading	Vaigaga
R V Meredith	Levili
Natural Foods	Savalolo
Selprize	Vaitele
Ice Cream Factory	Taufusi
Samoa Coconut Products	Vaitele
Samoa Tropical Products	Taufusi
Hellaby	Vaitele
Alexander Coolstore	Vaitele
WSTEC Slaughter House	Vaitele
Piggery of G Ross	Tiavi Road
	Total number : 15
Oil Storage	
Mobil	Sogi
British Petroleum	Sogi
	Total number : 2
Mechanical Shops	
H J Keil and Company	Taufusi
Air Cool and General	Leififi
Refrigeration:	
Mr Leiu	Savalolo
MacDonalds Motors	Savalolo
Burns Philp	Savalolo
Palm Island Motors	Matautu
Rees Refrigeration Service	Lotopa
Public Works Mechanical Shop	Vaitele
	Total number : 8
Photoprocessing and Printing	
Apia Studio	Beach Road
Photomart	Vaisigano
Pacific Printers and Publishers	Saleufi
	Total number : 3
Saw Mills	
Samoa Forest Corporation	Asau
New Samoa Industries	Vaitele
	Total number : 2
Manufacturing:	
Secondary Products	
Samoa Iron and Steel - Aluminium Division	Puipa'a
Samoa Iron and Steel - Fabrication	Fugalei
Samoa Upholstery	Saleufi
Pacific Aluminium	Vaitele
Yazaki	Vaitele
Apia Concrete Products	Vaitele
	Total number : 6
Industrial Chemical Manufacturing	
Samoa Paints	Savalolo
South Pacific Industries	Vaitele
Island Styles	Vaiala
Samoa Industrial Gases	Vaitele
	Total number : 4
Power Plants	
EPC Upolu	Tanugamanono
EPC Savai'i	Salelologa
	Total number : 2
Other Industries	
Pepa Industries	Savalolo
Rothmans	Vaitele
Aegis Oil Ltd	Vaitele
Bitumen Batching Plant	Vaitele
	Total number : 4

As it was not possible to visit many industries during this study, the information presented in this report has mainly been extracted from Klinckhamers(1992). The nature of wastes generated from the industries within each category and the methods of disposal are described in the following sections.

4.3.1 Food and Beverage

The food and beverage industry forms the largest sector of industrial development in Western Samoa. Information about the products manufactured, the raw materials used, the wastes generated and the disposal methods is presented in Table 3.

6. Pollution from Agricultural Activities

6.1 Introduction

Agriculture and environment are paradoxically related. On one hand, agriculture demands good environmental quality. However, agriculture contributes to habitat loss through release of sediments, excess nutrients from fertilisers, and pesticides to the marine environment.

Sediments, as already discussed, damage reefs and marine organisms, excess nutrients cause eutrophication and all its associated problems, and pesticides have a high level of toxicity and persistence in the environment.

6.2 Legislation

If sediments, nutrients or pesticides are deteriorating marine resources, then managing these materials can be regulated within the framework of the general legislation already described for the protection of these resources.

The *Watershed Protection and Management Regulations* are also relevant in this regard. These are discussed in Section 6.6

6.3 Sedimentation

Sedimentation is a natural process and some sediments will reach the marine environment without any interference from man. However, what is important is that man's activities play a major role in exacerbating the sedimentation problem. One of these activities is deforest-ation for agricultural or other purposes. It has been estimated that on Savai'i, 20,000 ha of land were cleared or grossly disturbed over three years prior to 1991 (Fythe, 1991 as reported by Taylor, 1991). With land clearing the natural ability of the vegetation to trap sediments is lost and sediments are washed into marine environments.

The Vaisigano River on Upolu, which flows into Apia harbour, is reported to carry large amounts of sediments into the harbour during heavy rains. The suspended solids content of the Vaisigano river at Leone was measured during this consultancy to be 6 mg/L. This value is considered very low. However, it is worth noting that the consultancy took place during what is considered the "dry" period and there was no significant rainfall in the period prior to testing. The result will nevertheless be useful for comparison purposes for any future testing.

The extent of sedimentation in Apia harbour is evident from a comparison of the seabed depth contours from bathymetric surveys done in 1975 and 1981, which indicated that the seabed in the central and eastern parts of the harbour had shallowed by up to five feet in the short period of six years (Bell, 1985 as reported by Taylor, 1991). Samoans from various districts have attributed the destruction of reef communities and deterioration of fishing to an accelerated soil erosion due to land clearing (Johannes, 1982 as reported by Taylor, 1991). The situation is expected to deteriorate with increasing population, when the demand for more agricultural land will force farmers on to steep slopes and river banks which are more vulnerable to erosion.

6.4 Fertilisers

Fertiliser use is reported to be not widespread in Western Samoa because of the inherent high fertility of the soils. Warren and Sisarich (1992) have reported that 22% of farm holdings used fertilisers in 1989, as compared to 59% of holdings which used pesticides. Pollution from fertilisers is not considered a major problem and is therefore not considered in this report.

Table 2: Some information on food and beverage industries in Western Samoa

Industry Name	Location	Products	Raw material	Wastes	Disposal
Talofa Wines	Vaiala	wine	fruit pulp	Organic wastewater	Carden
			fruit jiuce ginger	Cleaning water	on-site seepage
Vailima Breweries	Vaitele	beer	barley, yeast	Organic wastewater	outfall into sea
				9500 cubic metres/mon	
Manuia Breweries	Vaimea	beer	as above	organic wastewater	into Vaiusu Bay
Apia Bottling	Taufusi	fruit juice	fruit juice	fruit residue	animal food or at dump site sump hole on-site
				cleaning water	
CCK Trading	Vaigaga	cocoa, coffee, kava	cocoa, coffee, kava	Plastic bags	burned
RV Meredith	Levili	cream, biscuits, bread	coconuts, flour	nutshells,	reused in process
				coconut residues	into drain
				cleaning water	
Natural Foods	Savalalo	Snack foods	wheat	plastic wrappers	dump site, into swampc leading to ocean
				cleaning water with oil	
Selprize	Vaitele	taro chips, plastic bags	taro, plastic	food residues,	not known but pollution possible as close to ocean
				plastic and ink residues	
Ice Cream factory	Taufusi	ice cream	milk, sugar	wastewater with milk and sugar	into soakhole on site, treated with acidic material
Samoa Coconut Products	Vaitele		coconuts	coconut solid wastes	dump site
				cleaning water	storm water drain
Samoa Tropical Products	Taufusi	coconut cream	coconuts chemicals	effluents with residues	uncertain
				solid wastes	
Hellaby	Vaitele	canned meat	meat	effluents with fats and meat residues	some treatment on site in ponds
Alexander Coolstore	Vaitele	meat	meat	meat wastes	made into dripping or dog food
				liquid effluent	
				solid wastes	sump pit in tidal influence
					burnt
WSTEC Meat Slaughter	Vailele	meat	carcasses	meat effluents	into ocean with no treatment
Piggery of G.Ross	Tiavi Rd	pigs meat	pigfood	effluents with nutrients	into river but nutrients probably taken up soils before river

It must be remembered that the figures in Table 5 were calculated only from estimates of the number of people using each type of toilet facility, and assumptions on the nature of the wastes from each type of facility. Therefore, these figures may not have the degree of accuracy that is displayed. The full table of calculations is shown in Annex 5.

All these features make it likely that sewage is causing nutrient enrichment and bacterial or viral pollution of marine areas and water supplies. While this consultancy was in progress, an outbreak of typhoid fever was reported on both Savai'i and Upolu Islands.

5.5 Initiatives to Improve the Situation

In recognition of the significant problem with sewage disposal, several initiatives are being taken to improve the situation:

- the development of a drainage and sewage disposal system for Apia;
- work by the Department of Health to improve rural sewage treatment and disposal; and,
- the drafting of the **Sewerage Bill, 1979.**

> ***Recommendation***
>
> *That initiatives on the provision of a public drainage and sewage disposal system for Apia, the improvement of rural sewage treatment and disposal and the adoption of the Sewerage Bill, 1979 be brought to fruition.*

The limited range of food and beverage commodities produced (beer, wine, snack foods and some meat) highlights the need for Western Samoa to be dependent upon imported food items.

As is characteristic of industries of this nature, the bulk of the wastes generated are solid or liquid organic residues or effluents. Solid residues are generally either used as animal food or disposed off at the Tafaigata dump. Liquid effluents are either directed to a sump pit on site or discharged into nearby coastal environments. These latter types would be expected to have the most significant impact on the marine environment and those which can be identified include the breweries and the slaughter house. The wastes from these premises are known to be released directly into the nearby ocean.

4.3.2 Oil Storage

There are two oil storage facilities in Western Samoa, Mobil and British Petroleum, both located close to each other in Apia on the Mulinu'u peninsula at Sogi. When a shipment of oil products arrives, the oil products are pumped into tanks on land through a submarine pipeline with seawater being pumped in between different products. Before filling a land tank with any particular product, the pipeline is cleared off sea water (normally contaminated with oil). The seawater is fed into a separator which separates the oil from the seawater. The oil from the separator can be a mixture of different products and is considered to be waste oil. The seawater which could still retain some oil is discharged into Vaiusu Bay. Some information for each depot is given in Table 4:

Table 4: Oil facilities in Western Samoa

	Mobil	British Petroleum
Oil Products	LPG, lubrication oil gasoline, diesel	aviation fuel lubrication oil
Quantity (tonnes/5 weeks)	2880	800
Use of waste oil	Wood Preservation	Burnt
Quantity of waste seawater released (tonnes/5 weeks)	50	20

4.3.3 Mechanical Shops

The mechanical shops in Western Samoa generally sell or repair vehicles, refrigeration equipment or other household machinery. The wastes generated are mostly solid wastes consisting of unusable metallic parts and some waste oil. With the opening of an oil recycling facility in Apia, a suitable method for managing waste oil is now available.

4.3.4 Photo Processing and Printing

There are three photoprocessing and printing shops in Western Samoa (see Table 5 below). The solid wastes generated are mostly bottles, films and paper which are dumped at the dump site. The liquid wastes consist of wastewater contaminated with photo-chemicals. These are either also disposed of at the dump site or buried or fed into drains on site.

Table 5: Photo processing facilities in Western Samoa

Company	Processing Rate (films/day)	Methods of Disposal Solid	Liquid
Apia Studio	6	burned	buried at back of store
Photomart	1 - 15	all wastes taken to dump site	
Pacific Printers	1000 (Prints newspapers, books, magazines)	dump site	into drains on site

4.3.5 Saw Mills

There are two saw mills in Western Samoa: Samoa Forest Corporation Mill and New Samoa Industries. The wastes produced are all solid wastes consisting of saw dust and off-cuts of wood which are used as fuel.

4.3.6 Manufacturing of Secondary Products

Included under this section are enterprises which manufacture iron and steel products (building materials such as window and door frames and glass, roofing iron, nail, wires, etc) and furniture. These are Samoa Iron and Steel - Aluminium Division, Samoa Iron and Steel Fabrication, Samoa Upholstery, Pacific Aluminium and Yazaki.

The commonly used disposal methods are:

- **Septic tanks**

This is a common means of disposal in residential areas with piped water. Information recorded by Convard (1992) and Warren and Sisarich (1992) as well as enquiries during this study indicate that septic tanks and associated soakage facilities are rarely properly designed, usually consisting of single compartment tanks, the sizes of which are not adjusted for the number of persons using the facility.

Soakage pits, if used, are also not designed for the population using the facility and the inlet and outlet piping are often not in the correct positions. It is also likely that most septic tanks are not cleaned regularly and that the cleaning carried out does not remove most of the sludge.

The sludge extracted from septic tanks is disposed of in a stabilisation pond at the Tafaigata dump site. However the pond is not suitably constructed. It is too deep and therefore decomposition tends to be anaerobic, creating a smell problem. The pond is also not lined. This will permit leachates to infiltrate the groundwater.

Properly constructed and maintained, the septic tank would be the best means of disposal for rural areas.

- **Treatment Systems**

These are used in the hospital, the Tusitala hotel and at the Vailima Brewery. Apia Hospital has a sewage treatment plant consisting of an imhofff tank and a trickling filter. Discharge from the plant enters the Mulivai stream. The Tusitala hotel has a Pasveer Ditch system and the Vailima brewery uses a sedimentation tank. Mechanical difficulties have been reported in all of these.

- **Improved ventilation pit latrines and water seal latrines**

These are promoted by the health inspectors in areas where water supplies do not allow septic tanks to be constructed.

- **Pit latrines**

These are still used in many areas.

- **Primitive latrines without pits**

These are usually located at drains or streams. In some cases (e.g. on Manono Island) the latrines empty directly into the sea or on to beaches.

Details regarding the present number of each type of facility and the percentage of the population using it were not available from the Health department. Some information for Apia was provided which showed that 45% of households have septic tanks and 53% use the earth pit system (both water seal and open pit). The remaining 2% are not known to have latrines of their own.

5.4 Marine Pollution from Sewage

Three main factors make marine pollution from sewage a distinct possibility:

a. Methods of sewage disposal - methods currently in use appear not to have the capability of reducing the risk of contamination significantly.

b. The porous soils in most areas resulting in high percolation rates. Thus, groundwater can be contaminated by sewage wastes. Results from the bacterio-logical test carried out during this study confirmed this. A borehole in Fuipa, Apia which is suitably fenced off to prevent surface contamination, contained a faecal coliform count of 70 colonies per 100 ml water. The obvious source for this contamination is the groundwater feeding the well. The monitoring carried out by the Public Works Department also shows significant contamination of drinking water supplies (Health Department, pers. comm.).

c. The proximity of houses to waterways and the sea. Sewage wastes can reach the marine environment through surface and groundwater sources. The seawater off Aggie Grey Hotel had a faecal coliform count of 300 colonies per 100 ml water.

Calculations by Convard (1992) showing the total waste loads from domestic wastewater to the marine environment are in Table 6.

Table 6: Calculations of the total waste loads from domestic wastewater to the marine environment

Item	Amount (kg)
Biochemical oxygen demand	385,527
Suspended solids	493,920
Nitrogen	230,483
Phosphorus	27,937

(from Convard 1992)

The wastes generated are mostly solid wastes which are either sent for recycling or disposed of at the dump site. The impact of these on the environment is likely to be low.

Also included in this section is Apia Concrete Products which is located at Vaitele and produces about 2500 concrete blocks per day, 50,000 cubic meters of crushed metal per year, sand and 10,000 cubic meters of ready mixed concrete per year. The raw materials used are lava rock and black sand obtained locally and imported cement. Waste sand and rock are stored near the shore. Both the extraction of black sand from coastal areas and the deposition of waste sand on the shore must cause some siltation and destabilisation of coastal sediments.

4.3.7 Industrial Chemical Manufacture

Included in this category are Samoa Paints, which only mixes paints, South Pacific Industries which moulds bars of soap from a mix of dry soap ingredients and produces bottles, Island Styles which manufactures garments, soaps and printed textiles and Samoa Industrial Gases for which very little information was recorded by Klinckhamers (1992) because management from this industry was not co-operative.

However, it is understood that a by-product of the industrial gas facility is calcium hydroxide which has been put to some good use in the oil recycling plant (to neutralise acidic clay). The former three industries produce only minimal solid wastes which are disposed of at the dump site. Very little impact on the marine environ-ment is expected from them.

4.3.8 Power Plants

There are two power plants (EPC) in Western Samoa, in Upolu and Savai'i. The EPC plant in Upolu is now sending its waste oil for recycling at the Aegis Oil Ltd although problems with waste oil spills into the nearby Vaisigano river have been reported in the past (Klinckhamers, 1992 and Division of Environment and Conservation, personal communications). Some mobilisation of oil into water courses and thence into the marine environment on both Upolu and Savai'i probably still occur. Copper wire wastes are exported for recycling.

4.3.9 Other Industries

The wastes from other industries include:

Pepa Industries

Manufactures rolls of toilet tissue from bulk tissue (6,500 rolls/day), solid wastes consist of waste tissue (3 kg/day) and wastewater from cleaning; dumped in swamp behind factory

Rothmans

Assembles cigarettes and packaging material, solid wastes consisting of packaging material and the like taken to dump site

Aegis Oil Ltd

Oil recycling facility, one of the waste products is acidic clay with high levels of heavy metals extracted from the oil. The clay is being neutralised with calcium hydroxide from the industrial gas facility. Methods of disposal of the treated clay are still being explored

Bitumen Batching

Solid bituminous coal is liquified and mixed with gravel to produce asphalt. The smoke from the plant was noted during the study to contain high levels of soot - a source of air pollution in Apia.

4.4 Assessment of Marine Pollution from Industrial Waste

There are a number of features of the industrial development in Western Samoa that are significant in assessing the potential for marine pollution. **First**, almost all industries are located in and around Apia so if there is going to be any impact from industrial wastes then it will mostly be concentrated around the coastal areas of Apia.

Secondly, the nature of the wastes produced by most industries does not make them significant marine pollutants. For the most part, industries are involved in the production of secondary or smaller items from bulk materials which are imported. For example, Pepa Industries produces small rolls of toilet tissue from big bales of imported tissue. In such cases, the pollution associated with the production of the primary materials remains in the country of origin.

5. Domestic Wastewater

5.1 Introduction

Domestic wastewater includes all household wastes that would normally be discharged into the sewer, the most significant being wastes arising from the disposal of sewage. Sewage effluents contain high levels of organic material the decomposition of which could drain the oxygen content of the receiving water, nutrients which could lead to eutrophication and microorganisms which may be pathogenic.

Thus the discharge of untreated or relatively untreated sewage wastes into the sea is a potential health risk to humans through direct infection of swimmers or contamination of fisheries. In addition, oxygen depletion and eutrophication will have adverse effects on reef health and inshore fisheries.

5.2 Relevant Legislation

There are provisions in a number of different Acts relating to the protection of marine resources from pollution in general. For example, the *Agriculture, Forests and Fisheries Ordinance, 1959,* requires the conservation of natural resources such as soil, water and forest; the *Fisheries Act, 1988,* promotes the protection and preservation of the marine environment permitting regulations to be made for the prevention of marine pollution; and the *Lands, Survey and Environment Act, 1989,* also has similar provisions (as described in Section 4). The nature and origin of pollution are not specifically identified in any of these Acts, and therefore pollution from sewage discharges could be regulated within these frameworks.

Legislation specific to contamination from sewage are contained in the Nuisance section of the *Health Ordinance, 1959* and in the *Samoa Village Regulations, 1938.*

In the *Health Ordinance, 1959* a nuisance is deemed to be created where:

- a pool, ditch, gutter, or watercourse, privy or other sanitary convenience, cesspool, drain, or ventpipe is in such a state or is so situated as to be dangerous to health or offensive.
- any accumulation or deposit is in such a state or is so situated as to be dangerous to health or offensive.
- any premises are so situated, or are of such construction or are in a such a state, as to be dangerous to health or offensive.

The penalty for creating a nuisance is a fine not exceeding $40, and if convicted a fine not exceeding $10 for every day during which such nuisances remain unabated.

Under the *Samoa Village Regulation, 1938* various specifications are given for the construction and maintenance of privies. Some of those relevant to pollution are:

- no privy to be constructed within 50 yards of any well, stream, or spring or water used or likely to be used by man for drinking or domestic purposes, or otherwise in such position as to render any such well, stream or spring liable to pollution.
- penalty for contravening regulations is a fine not exceeding $4.

More comprehensive legislation covering all aspects of sewage disposal is in the pipeline with the drafting of the *Sewerage Bill, 1979.*

5.3 Methods of Sewage Disposal in Western Samoa

There are no public sewerage systems in Western Samoa and the majority of the population are served by on-site facilities.

The types of wastes that Western Samoa has to contend with are solid wastes and cleaning water and the like which are not particularly hazardous to the marine environment. However, the commonly encountered practice of disposing of such wastes in the immediate vicinity of the premises must be curtailed.

The industries of major significance for marine pollution are the breweries, the oil depots, the power plants and possibly the WSTEC slaughter house. The potential for marine pollution from each of these sources are:

4.4.1 Breweries

The effluents generated from breweries are likely to have a high concentration of organic residue. The Vailima Brewery residue is reported to contain 0.2% caustic soda, acidic materials, 0.5% sugar and 2500 kg of yeast daily. The effluent is discharged into the nearby sea via an outfall which extends approximately 50 metres from the shore. The effluent passes through a small treatment chamber which is supposed to make the quality of the effluent suitable for discharge into the sea.

The site was visited during this study and both visual and experimental observations showed that the effluent is having a deleterious effect on the environment. As the outfall is very close to the shore and in fairly shallow water, the bulk of the effluent is carried straight back to the shore. The decomposition of the organic residues has increased the nutrient levels in the water and brought about a profusion of algal growth. There is also a strong smell of beer in the surrounding environment. This industry is an obvious source of marine pollution in Apia.

4.4.2 Oil Depots

At the two oil storage facilities in Apia, there are separators to separate the bulk of the oil from the seawater that is released back into the ocean. There is no monitoring of the performance of the separators to establish that the oil remaining in the water has been reduced to an acceptable level. There is therefore the possibility that some oil is being discharged into the marine environment.

The presence of small amounts of oil in the water will not bring about any immediate visual changes in the quality of the environment but the ecological risk of chronic sources of petroleum contamination is probably much larger than has yet been established (UNEP, 1992).

4.4.3 Power Plants

The Environment Division has received complaints in the past about oil leakages from the EPC premises into the Vaisigano river which flows into Apia harbour. Although the waste oil is now being collected for recycling, continued vigilance is required to prevent accidental spillages finding their way into water bodies. Pollution from this source would be similar to that described in Section 4.4.2.

4.4.4 Concrete Industry

The activities of the concrete industry is contributing to the sediment load in coastal waters of Apia, particularly in Vaiusu Bay. The dredging operation is causing the resuspension of bottom sediments, reducing the clarity of the water to as low as a quarter of a metre in some places. The presence of high sediment loads is detrimental to marine life because they restrict the penetration of light into the water column and causes the smothering of bottom organisms.

4.4.5 Slaughter House

The effluent from the WSTEC Slaughter house would be expected to contain organic residues that require decomposition. The effect in the water would be similar to that of the brewery. A site visit, however, did not reveal any visual symptoms of eutrophication.

4.5 Regulation of Industrial Discharge

The activities of the Division of Environment and Conservation in controlling waste discharge from industries are limited to investigation of specific complaints received from the general public about offending wastes. In such cases, officers of the Division carry out on-site investigations to establish the cause of the problem and advise management of ways to resolve them. Follow-up visits are made to assess progress.

This mode of operation has two drawbacks:

a. Only problems that draw sufficient attention from the public for them to register a complaint will be addressed.

b. Pollution that is not of highly visual or noticeable nature will tend to remain undetected.

A more vigilant regulation of industrial waste discharge will require regular monitoring of the wastes to ensure that they meet acceptable criteria. However, in the absence of regulations specifying acceptable levels and laboratory capability for testing, this type of monitoring remains a difficulty at the present time.

Recommendations

That regulations are made for wastes to satisfy a minimum requirement for disposal into water bodies.

That the capability of a laboratory in Apia be enhanced so that testing for minimum requirements can be carried out.

That a regular monitoring programme of wastes from major industries be instated.