FIJI NATIONAL LIQUID WASTE MANAGEMENT STRATEGY AND ACTION PLAN

August 2006

INTERNATIONAL WATERS of the Pacific Islands

List of Acronyms

AGO	Attorney General's Office
ADB	Asian Development Bank
AH&P	Animal Health and Productivity Division
ANZECC	Australia and New Zealand Conservation Council
BOD	Biological Oxygen Demand
CBH	Central Board of Health
EIA	Environment Impact Assessment
EMA	Environment Management Act
EU	European Union
FAB	Fijian Affairs Board
FBoS	Fiji Bureau of Statistics
FEA	Fiji Electricity Authority
FHA	Fiji Hotel Association
FIMSA	Fiji Islands Maritime Safety Authority
FSC	Fiji Sugar Corporation
FSM	Fiji School of Medicine
FTIB	Fiji Trade and Investment Board
GDP	Gross Domestic Product
GEF	Global Environment Facility
IAS	Institute of Applied Sciences
ICM	Integrated Coastal Management
INR	Institute of Natural Resources (now IAS)
JICA	Japan International Cooperation Agency
MASLR	Ministry of Agriculture, Sugar and Land Resettlement
MC	Municipal Councils
MFNP	Ministry of Finance and National Planning
MMEA	Ministry of Multi-Ethnic Affairs
MoCI	Ministry of Commerce and Industry
MoE	Ministry of Environment
MOEd	Ministry of Education
MoH	Ministry of Health
MoTT	Ministry of Tourism and Transport
MLIRP	Ministry of Labor, Industrial Relations and Productivity
MPUID	Ministry of Public Utilities and Infrastructure Development
MRD	Mineral Resources Department
NEC	National Environment Council
NFU	National Farmers Union
NGO	Non-Government Organizations
NIWA	National Institute of Water and Atmospheric Research
NOHS	National Occupational Heath and Safety
NSFC	National Small Flows Clearing House
NWQL	National Water Quality Laboratory
PAFCO	Pacific Fishing Company
PC	Provincial Council
PCDF	Partners in Community Development Fiji
RLA	Rural Local Authority
RFMF	Republic of Fiji Military Force
SKM	Sinclair Knight Merz
SOPAC	South Pacific Applied Geoscience Commission
SPC	Secretariat of the Pacific Community

SPREP	Secretariat of the Pacific Regional Environment Programme
STP	Sewage Treatment Plant
TBT	Tributyl tin
TCP	Town and Country Planning
TDS	Total Dissolved Solids
TPAF	Training and Productivity Authority of Fiji
TSS	Total Suspended Solids
UNEP	United Nation Environment Programme
USP	University of the South Pacific
WHO	World Health Organization
WSD	Water and Sewerage Department

Table of Contents

Acknowledgement

The Ministry is foremost grateful for the financial support provided by the International Waters Programme of the Global Environment Facility, the United Nations Development Program and the Secretariat of the Pacific Regional Environment Programme, who has made this and other work possible and acknowledges the staff of the International Waters Program Fiji, in particular the National Coordinator, Ms. Sandeep Kaur Singh and the Program Assistant, Ms. Lusiana Railogaivao for coordinating the formulation of the National Liquid Waste Management Strategy and Action Plan for Fiji. The Ministry is also thankful to the Consultants, Professor Bill Aalbersberg and his team of the Institute of Applied Sciences of the University of the South Pacific.

The National Liquid Waste Management Strategy and Action Plan is timely and a requirement under the Environment Management Act of 2005. The Strategy and Action Plan was formulated in close collaboration with line Ministries such as the Ministry of Public Works, Ministry of Health and the Ministry of Finance and National Planning; Non-Government Organizations and the private sector which included the resort operators.

The different types of liquid waste covered under the strategy include domestic wastewater such as sewage and greywater which is collected by sewerage systems or goes into septic tanks; Commercial and industrial wastewater including that from the tourism industry; Animal waste; Marine shipping; Urban stormwater; Leachate from landfills/dumps; and sludge (septic tanks, industries and sewerage treatment plants).

The Strategy and Action Plan is a living document and can be revised as and when required to cater for the new types of technologies or liquid waste that might be generated.

1.0 Executive Summary

Sanitary and environmental conditions in many areas in Fiji are becoming a threat to public health and the preservation of natural resources. Thus, there is an urgent need to develop better ways to manage waste, and in particular liquid waste in Fiji. There is a need for holistic and integrated planning especially in the context of the fragile ecology and limited natural resource base of Pacific Island Countries. Partnerships are required between government, community, the private sector and non-government organizations (NGO) to accomplish waste reduction and pollution control objectives.

The recently passed Environmental Management Act (EMA) calls for the development of a National Liquid Waste Management Strategy. The National Solid Waste Management Strategy and Action Plan was developed in 2005. The proposed strategy will set the direction for sustainable liquid waste management in Fiji and was developed through a process of wide consultation with all stakeholders involved in the production and the management of liquid waste. The strategy developed will be led by Government working in close partnership with local government and other key stakeholders.

Through two Liquid Waste Forums and the set up of 5 Working Groups, information and expertise from various sections of the community such as industry, NGO, academia, local government were obtained. The Working Groups were set up based on the types of waste that were agreed to by all stakeholders in the first forum convened under this strategy. The two public forums provided opportunity for discussion of critical issues and effective ways of managing liquid waste in Fiji and to solicit the viewpoints of all stakeholders. Based on the public forums and the Working Groups deliberations, the National Strategy and Action Plan for Fiji was developed. It was then sent out for review by forum participants and the Ministry of Environment.

The plan is divided into five sections, one for each working group topic. The strategy outlines the goal, which generally ***aims to minimize the negative human health and environmental effects from liquid waste***. Specific objectives and activities to achieve the goal were determined, also identifying lead agencies, key contributing agencies, output indicators, indicative costs and other resources needed. In general, the objectives and activities fall into categories coherent with regional waste strategies:

- Identifying existing liquid waste management activities and their effectiveness to determine best technologies and practice,
- Developing a regulatory framework that effectively encourages adoption of best practice and monitors change,
- Creating awareness and willingness of people ready to achieve goals,
- Implementing pilot projects and up-scaling successful ones,
- Developing the needed human and capital resources to carry out the needed activities.

2.0 Scope and Objectives

2.1 Scope

The proposed strategy covers liquid wastes and includes:

- Domestic waste such as sewage and greywater which is collected by sewerage systems or goes into septic tanks etc,
- Commercial and industrial wastewater including that from the tourism industry,
- Animal waste,
- Marine shipping,
- Urban stormwater,
- Leachate from landfills/dumps
- Sludge (septic tanks, industries, and sewerage treatment plants).

2.2 Objectives

The key objectives of the National Liquid Waste Management Strategy are to:

- Reduce the amount of wastewater produced in Fiji
- Improve and upgrade waste management and disposal systems to improve wastewater quality
- Improve coordination of departments/stakeholders involved in regulating and managing liquid waste
- Improve awareness and practices of public in relation to sanitation/wastewater management

3.0 Why manage liquid waste?

The discharge of untreated or inadequately treated wastewater from industry, agriculture, and sewage often causes pollution or harmful effects to the environment and to human health. These effects may be undesirable changes to ecosystems, reduction in economic value of resources, aesthetic damage, and human health risks (Fagan *et al.*, 1995). Wastewater may be defined as any discharge into the environment (effluent or sludge) with or without treatment (human excrement, effluent, flushing water, industrial water and stormwater) (SOPAC, 2002). Contaminants of concern that are present in wastewater include pathogens (microorganisms), nutrients, heavy metals, suspended solids, biological oxygen demand (BOD), and oil and grease.

3.1 Environment Impacts

Effects on the environment of poor wastewater management are already becoming evident in many parts of the country. Coastal environments near urban areas in Fiji, such as Suva Lagoon, are subject to contamination from wastewater from industry, domestic waste, urban stormwater and shipping related activities. High concentrations of nutrients and micororganisms related to sewage contamination appear to be the major problem. Metal contamination is generally isolated to “hot spots” near industry and there are no major issues with hydrocarbons or oil. Nutrient data for Suva Lagoon over the last 25 years indicate that nitrate concentrations in nearshore waters are usually present at significant levels. Data for metals in shellfish collected from Laucala Bay indicate no

significant levels of concern however at Lami dump mercury and lead levels in shellfish were particularly high (Morrison *et al.*, 2001). For metals in sediments, high concentrations or metals of concern for health (Pb, Hg, Cd, Sn) are found only at 'hot spots' such as Lami Dump, Wailada industrial area and Walu Bay industrial area (Morrison *et al.*, 2005).

Other water quality studies indicate sewage contamination around coastal villages, tourism hot spots, and sewage outfalls. The concern here is the presence of pathogens that could have health effects and high levels of nutrients that upset the productivity of water bodies leading to algal growth and the degradation of coral reef environments. High levels of algal growth have been observed on many reef areas in Fiji (Coral Cay, 2001) which is a symptom of increased nutrient levels and overfishing of herbivore grazer species (Goreau & Thacker, 1994; McCook, 1999; Szmant, 2002). Extensive growth of algae results in competition for space between the algae, coral and other organisms leading to the overgrowth and smothering of coral and prevents fish and other reef inhabitants from finding food and shelter. There may also be a shading effect caused by the algae, which would decrease the amount of light reaching the coral. Increased nutrients are also thought to cause blooms of undesirable toxic phytoplankton such as blue-green algae, which causes ciguatera fish poisoning (Kelly, 1994).

Elevated BOD in effluent reduces dissolved oxygen levels in receiving waters reducing survivorship of many organisms. Suspended solids affect sea grass and coral reefs by decreasing light penetration, smothering benthic organisms or clogging respiratory structures. Oil may smother benthic organisms, clog respiratory structures, taint commercial species, smother breathing roots of mangroves and inhibit growth of fish and invertebrates (Cripps, 1992). Heavy metals and other persistent pollutants may have direct lethal or sublethal effects killing or reducing survivorship of individuals. They also biomagnify in the food chain and have ill effects on living organisms causing neuronal damage and inhibiting embryonic development and normal metabolic processes in man (Cripps, 1992).

Extremely high levels of tributyl tin (TBT) concentrations have been detected in sediments in the immediate vicinity of slipways and boatyards in Suva Harbour and from mangrove oysters indicating that they are exceedingly contaminated (Maata, 1997). TBT is a widely recognized toxin that has been a component of marine antifouling paint causing shell deformation and reproduction anomalies in molluscs. This localized contamination is a result of the unregulated use of TBT in Fiji and uncontrolled activities at shipyards where wastewater from repainting and shiphull hydroblasting are discharged without restriction into the harbour (Stewart and Mora, 1992).

3.2 Health Impacts

The discharge of inadequately treated sewage effluent from both humans and animals into the marine environment may result in bacterial contamination of waters and exposed biota (IAS, 2004). Discharge may be via sewerage outfalls or via seepage from septic tanks and other toilet types. Human sewage contains enteric bacteria, pathogens, viruses, and eggs of intestinal parasites. Human pathogens that cause salmonellosis, typhoid fever, hepatitis, cholera, dysentry and various other gastrointestinal diseases may be released into the water and

transmitted to new hosts by contact (bathing, swimming) or by consuming contaminated biota (Feacham *et al.*, 1989). Both coastal waters and groundwater may be contaminated. Pathogens in wastewater may also be transmitted by direct contact with sewage such as playing in a yard with a failed septic system or coming into contact with animal waste, or via drinking contaminated water or through contact with insect carriers (NSFC, 2006).

The measurement of faecal coliform bacteria found exclusively in the gut of warm-blooded animals is used to indicate contamination from sewage and is a standard by which water and biota may be evaluated. Data for Suva Lagoon indicate high values of faecal coliforms especially around Kinoya, Nabukalou Creek and Lami with little improvement over the last 25 years (Morrison *et al.,* 2005). Levels of faecal coliforms in mangrove oysters found to be above the internal safety standard for consumption and potential health hazard particularly if eaten raw (Naidu and Morrison, 1988). High levels of faecal coliforms have also been found in “kaikoso” clams in inshore environment (Tawake, 2004).

Drinking water may also become contaminated as a result of contamination of aquifers through seepage from septic tanks and water seal toilets, pollution of catchment areas from animal waste, and poor sanitation practices in general. Assessing the incidences of dysentry in Fiji for the period 1998-2002 it was observed that rural areas with untreated water supplies such as Ovalau, Ba, Ra and Tavua had high numbers of cases. Assessment of drinking water quality from untreated sources such as boreholes, wells and creeks in rural areas of Fiji indicated a high degree of contamination from faecal matter particularly in areas of Ba, Lautoka, Levukaand Sigatoka. Communities drawing water from these sources are at risk of having diarrhoea and other gastro-intestinal diseases (Litidamu *et al.*, 2004).

3.3 Economic Impacts

The economic impact of poor liquid waste management is often not considered in planning decisions. For health issues, costs can be associated with days lost from work, the costs of medical treatment and even loss of life. Although this analysis has not been done for Fiji, it is likely to result in losses of millions of dollars a year. In addition, an outbreak of a serious disease like cholera could cost millions in lost tourism earnings.

On the environmental side, the costs can be less primary productivity on land or sea due to pollution, loss of value of property near pollution, loss of environmental services if important habitats are degraded, loss of tourism earnings and the cost of clean up. The reduction in quality of natural assets and aesthetic value because of pollution from liquid waste can lead to economic costs such as loss in tourism earnings in areas where coral reefs are degraded because of poor wastewater management. A study done on a 20-kilometer stretch of tourism coast in Hawaii estimated that the cost of algal overgrowth of the coral reef amounted to US $60 million per year.

4.0 Relevant Regional Agreements

4.1 Pacific Wastewater Policy Statement and Framework for Action

The development of a National Liquid Waste Management Strategy by the Fiji government is consistent with the policy and actions proposed in the Pacific Wastewater Policy Statement and Framework for Action which was developed in 2001 at a regional meeting in the Marshall Islands. In addition, a broader regional framework, the Pacific Regional Action Plan on Sustainable Water Management (2002), exists which includes wastewater management, and is endorsed by the Fiji government.

A summary of the vision, principles and policies of the Pacific Wastewater Policy is provided below (SOPAC, 2002).

Vision: Protect the health of the people and safeguard our fragile environment through improved, effective and efficient management of wastewater.

Guiding Principles	*Details of Policies*	*Proposed Actions*
1. National Wastewater Management Policies and regulations will be appropriate and acceptable to the people and cultures of the Pacific Islands.	Governments are required to place high priority on wastewater and sanitation issues. They should have appropriate integrated wastewater management polices and a consistent regulatory framework with effective enforcement.	▪ Prepare policy paper ▪ Education and awareness on policies and regulations ▪ Involvement of stakeholders ▪ Review of regulations and actions with all sectors
2. Appropriate national institutions, infrastructure and information will support sustainable wastewater management	Clearly defined responsibilities for all stakeholders and agencies, and if need be creation of specific responsible agency. Collection of appropriate information and data on wastewater technologies and dissemination. Development of water quality monitoring programmes.	▪ Identify lead agencies involved in management of wastewater and their responsibilities/activities ▪ Establish process for collection of information etc on wastewater ▪ Review existing wastewater technologies and infrastructure ▪ Develop a national monitoring capacity
3. Better access to funding will improve service delivery and develop the private sector	Encourage private sector to invest in wastewater management. Cooperation in obtaining funding to address needs in urban and rural areas.	▪ Determine funding sources/mechanisms for wastewater services ▪ Identify aspects of wastewater management where private sector may be involved
4. Community participation in wastewater management and sanitation will ensure equitable benefit with recognition of socio-cultural sensitivities.	Develop education and awareness of wastewater and sanitation issues incorporating social and cultural values. Partner with communities to develop and implement culturally appropriate strategies. Allow communities to participate in development and implementation of wastewater projects. Providers	▪ Develop and implement public awareness programmes ▪ Create a group that represents all stakeholders to facilitate development and implementation of cultural appropriate strategies for wastewater management (include women, disabled and disadvantaged). ▪ Consult with communities in

	will take into account traditional knowledge and practices.	development programmes ▪ Obtain information on traditional practices
5. Viable and sustainable levels of skilled and knowledgeable people in wastewater sector and communities	Development of human resource development programmes for wastewater management including training courses, community capacity building, securing of funding.	▪ Carry out training needs assessment. ▪ Develop training programmes and pilot projects

5.0 Country Background

5.1 Size

Fiji consists of more than 300 islands, about 100 of them inhabited, covering a total land area of 18,376 square kilometers. The two largest islands Viti Levu and Vanua Levu comprise more than 85% of total area. Islands are largely of volcanic origin and mountainous which limits the area of land for most development to coastal areas.

5.2 Population

According to the 1996 population, the population of Fiji was 772,625. The 2005 estimate was 846,085, with the natural growth rate between 1986 and 1996 of 0.8% per annum (Government of Fiji, 2005). Over 90% of the population is located along coastal areas. Around 40% live in the urban areas of Suva, Lautoka, Nadi, Lami and Nausori Towns and there is increasing urbanisation which has led to development of squatter settlements which lack basic services like water and sanitation. The lack of basic amenities such as piped water and sanitation is thought to be a major factor in a number of disease outbreaks. Approximately 20% live in poverty increasingly in the urban/periurban areas (Litidamu *et al*., 2004), although other estimates are as high as 35%.

5.3 Climate

Fiji has a mild tropical climate with plentiful rain. It is, however, subject to potentially catastrophic climate events such as cyclones, flooding particularly from months of November to April. During El Nino years, droughts can be severe especially on the western part of islands during the May to October dry season. On the larger volcanic islands, there is a relative abundance of annual rainfall, and perennial rivers and numerous springs ensure that there is a generally sufficient domestic water supply. On the low-lying, smaller and outer islands, there are no such perennial streams and fresh water is a much scarcer resource. In such situations, shortages are a common occurrence (Government of Fiji, 2005).

5.4 Natural Resources

Diverse ecosystems exist including significant areas of natural forest and a range of coastal and marine ecosystems including an extensive system of mangroves and coral reefs (Government of Fiji, 2005). These resources form the basis of Fijian culture, employment, and food supply and therefore need to be well maintained for future generations. The remaining area of natural forest is approximately 860,000ha (ESCAP, 1998) and the current rate of deforestation is moderate. Fiji's EEZ covers some 1.3 million square kilometers and contains rich marine resources. Reefs systems include barrier, fringing, and platform reefs, some of which are under pressure from pollution, coral mining and hurricane damage (ESCAP, 1998).

5.5 Economy

Fiji's economy is dependent mainly on tourism. Tourism has grown substantially and in 1999 contributed approximately 16% of GDP and 22% of foreign exchange. In 2005, tourism was estimated to provide 30% of GDP. Tourism provides employment directly and indirectly to around 40,000 people. It is highly focussed on the western region of Fiji in Nadi, the Mamanuca Islands, and the Coral Coast. Visitor arrivals in 2003 were at 430,800 and soared to 550000 in 2005 (Fiji Bureau of Statistics, 2005). Ecotourism/Backpacking is an important and growing form of tourism. Agriculture (especially sugar), forestry, and fishing employ a large percentage of Fiji's workforce. It is estimated that agriculture contributes 16% of Fiji's GDP. Sugar is Fiji's second largest industry and is mainly concentrated in dry northern and western portions of Viti Levu and the northern coast of Vanua Levu. Industry, including mining and manufacturing is also significant. The main components of the sector are textiles, beverage and tobacco production, food processing, and wood-based industries (Government of Fiji, 2002).

5.6 Environmental Problems

Increasing population, urbanization, industrial and economic development have placed increasing pressure on coastal resources leading to loss of habitat as a result of coastal development, pollution due to improper waste disposal, increase water demand from freshwater lenses and depleted fisheries (IMR, 2004).

Causes of degradation of coastal habitats include inappropriate agricultural activities, mining, sewage pollution, inappropriate solid waste disposal, fishing activities, use of destructive fishing practices, beach sand mining, building of jetties and groynes, commercial harvesting of coral, soil erosion and siltation, improper disposal of industrial waste, and natural hazards such as climate change and sea level rise and hurricanes. The absence of consistent monitoring of the coastal zone makes it difficult to assess the extent and pervasiveness of pollution and degradation in Fiji.

5.7 Environmental Legislation

Fiji's environmental laws are many and varied a relic of the colonial period when environmental problems were limited and clearly sectoral. At least 25 Acts have some important role in environmental management, administered by 14 different ministries or departments, statutory bodies or other agencies. Most of the laws are both old and ineffective in the modern context of environmental management, or suffer from the lack of regulatory enforcement through inadequate staffing, lack of technical resources and funding, and through administrative failures (Government of Fiji, 2005). The situation improved somewhat with the passage of the EMA. The regulations to enact it are still being formulated.

6.0 Existing Scenario of Liquid Waste Management in Fiji

This section describes the different types of liquid waste that exist in Fiji, their extent, current systems of management and regulation, limitations and barriers and opportunities for better management. The main categories include domestic waste such as sewage, which is collected by sewerage systems, domestic waste that treated by septic tanks or other on-site methods, industrial and commercial wastewater, wastewater from tourism industry, animal waste, and marine shipping. Minor categories are urban stormwater, leachate from dumps and sludge. A review of applicable legislation is provided first.

6.1 Current Legislation

Existing legislation that applies to liquid waste pollution from industry, tourism and other commercial facilities and from liquid waste being discharged from domestic sources into the environment include:

1. *Public Health Act 1955*
   Under this Act, inspectors have powers to abate nuisances and to inspect to ascertain a nuisance (the deposit of any material which is offensive to the public or injurious to health) (Section 56 (e)) (Watling and Chape, 1992). It is limited in terms of environmental protection and provides few remedies for compelling the abatement of nuisances that may affect human health such as pollution of waterways. It is not meant for regulating pollution although in limited situations may provide a means for intervening in the absence of other means (Evans, 2004). The strength of the Act lies in its institutional set up specifically the Central Board of Health (CBH), which has over 80 Environmental Health Inspectors around the country (Watling, 2005). Section 22 of the Bill provides wide-ranging powers for environmental health officers to enter premises in order to carry out their duties in relation to the Bill. These powers could assist with inspecting trade waste discharges into sewerage systems and with enforcing of environmental regulations related to discharge of waste into the environment. (Kirkwood and Hughes, 2005).

2. *Ports Authority of Fiji Regulations 1990*
   Regulations under the Ports Authority Act establish some control over pollution in port waters. The discharge of oil, waste, sewage, and contaminated ballast into the waters of a port is prohibited unless authorised by the Authority. Standards for effluent discharge to ports have also been produced in 1998 (Evans, 2004). It is an offence to pollute port areas with a maximum fine of $400.

3. *Water Supply Act 1955*
   This states it is an offence to pollute water if is used for water supply or in a declared catchment area (Evans, 2004).

4. *Town Planning Act*
   Permissions to develop are granted by local authorities with approval from Director Town & Country Planning. Conditions are often put on new development approvals in which appropriate wastewater treatment systems are specified.

5. *Mining Act*
   This provides powers for the Director, Mineral Resources Department to impose conditions before granting a mining permit which may include environmental management conditions such as discharge standards and monitoring requirements (Watling, 2005).

   Existing legislation that relates to the operation of a sewerage system and the discharge of trade waste or industrial waste and domestic waste into the sewerage system include:

   1. *Sewerage (Amendment) Act* 1974
      This Act governs the management and disposal of wastewater to a sewerage system. It contains all provisions in regards to declaration of sewerage schemes, sewerage connections, and penalties for non-compliance.

      The amendments and by-laws that relate to acceptance of trade wastewater to sewer are:
      - Section 14 – 'No sewer connection to be connected without approval'. Should Water & Sewer Department (WSD) become aware of a property discharging trade wastewater to sewer without its written permission a penalty of up to $250 per day until consent is given may be imposed.
      - Section 2 of the Nadi and Suva Sewerage By-laws defines trade waste as '*...all waste products and by-products of and liquids flowing from any engine or machinery, and shall include all waste products, by-products and liquids arising or accruing from the manufacture of any articles or thing of whatsoever description'.* Section 2 of the Nausori Sewerage By-laws defines trade waste as '*the liquid wastes from industrial manufacturing process, trade or business as distinct from sanitary sewage'.* Both these definitions define trade waste as a liquid product that is distinct from the domestic sewage component of the sewage discharged from a property.
      - The Suva (Section 4), Nadi (Section 5) and Nausori (Section 11) By-laws state the need for permission in writing before trade waste can be permitted to discharge to sewer. The Nausori By-laws further define this by requiring restaurants, hotels, and butcheries to install a grease trap. These provisions allow the Consent Authority to review a non-residential development and determine an appropriate level of on-site pre-treatment before accepting the wastewater to sewer (Kirkwood and Hughes, 2005).

6.2 Sewage Waste

The purpose of this section is to discuss the current management practices, problems, and opportunities of sewage wastewater disposal in Fiji. The discussion will be divided according to two sub-headings – public sewerage systems and non-sewerage systems.

Public sewerage systems consist of the collection of sewage wastewater from houses, institutions and hotels by an underground piping system flowing to a sewage treatment plant (STP). A pump station is usually part of this set up conveying sewage through the system. The wastewater is treated at the treatment plant prior to discharge into the environment (IAS, 2004).

Non-sewerage systems encompass all sewage waste disposal systems that are not connected to sewer lines. This includes septic tanks and the direct disposal of waste onto the ground, waterways, and the sea. Septic tanks are often built underground, usually consist of two compartments, and often connected to a flush toilet. Sludge (heavy particles) is formed at the bottom of the tank and the less dense materials form a scum layer. Bacteria digest the organic matter and the sludge requires regular removal, the interval depending on its size. Septic tanks are often connected to a seepage pit (IAS, 2004).

The direct disposal of sewage waste into the environment is the release of raw sewage into the environment untreated and unfiltered. It is the least desirable system of sewage waste disposal in terms of its environmental and human health impacts.

6.2.1 Sewerage Systems

6.2.1.1 The Current Situation

The public sewerage treatment plants in Fiji collectively serve an estimated population of 194,700 as shown in Table 1 below. This covers approximately 23 per cent of the country's total population[1]. There are 11 public sewerage systems currently operating and most of them service urban populations. There are eight major sewerage treatment plants (STP) including Suva (Kinoya), Nausori, Pacific Harbour, Lautoka, Nadi, Sigatoka, Ba and Labasa. Significant portions of the population in these centres are not connected although the carrying capacity of most of the STPs is underutilized. There are also three minor institutional schemes. These are at Adi Cakobau School, Wailada Industrial Sub-Division, and the Naboro Prison. These systems collectively cater for approximately 4000 people and will not be dealt with extensively in this section (WSD, 2005).

Plans are also underway to expand sewerage system services nationally. Three master plans are currently in their initial implementation stages and are expected to collectively service an additional population of 116,000. These projects include the Suva-Nausori Water Supply and Sewerage Project (90,000), the Labasa Sewerage Scheme (6,000), and the Nadi Regional Sewerage Scheme (20,000). Most other STPs have completed master plans for expansions but these are on hold awaiting financial resource allocations. Initial master plans have also been completed for three urban centres that previously did not have public sewerage systems. These include Navua, Savusavu and Tavua. However, the implementation of these projects depends on resource availability as well as land negotiations.

Sewerage collection and treatment via the sewerage system in Fiji is covered by the Sewerage Act. A key weakness of the Act is that it does not ensure residents connect to the sewers when they are installed. Many households continue to use poorly functioning septic tanks and some industries choose to discharge effluents into the environment instead of using the sewer.

The provision, operation, and maintenance of sewerage services in Fiji is the responsibility of the Ministry of Works and Energy. The Water and Sewerage

[1] 31 December 2005 Provisional Estimate, Fiji Bureau of Statistics.

Department (WSD) of the Public Works Department (PWD) manages the sewerage services for the Ministry. Sewerage service in urban areas is funded by the Fiji Government at a cost recovery of 30 per cent (ADB, 2005). WSD is also responsible for conducting wastewater quality monitoring and this is undertaken by its National Water Quality Laboratory (NWQL).

6.2.1.2 Problems

Environmental quality, public health, and the efficient service delivery of the public are central to the sustainability of the public sewerage system in Fiji. Hence, issues that negatively affect the quality of these three factors may be regarded as problems. Issues that pose threats to human health and the environment as well as to the efficient running of sewerage systems in Fiji are predominantly infrastructure related as discussed below.

Infiltration into the sewer network
The disruption of the sewerage treatment process because of infiltration creates problems for the effective operation of the plant and poses environmental and health threats when overflows occur. Infiltration from seawater during high tide and during heavy rain occurs as a result of the continued use of old and broken sewer pipes and is prevalent in sewerage systems that have been in operation for a long period of time. The Kinoya STP can sometimes have 90 per cent flow of seawater at midnight because of decreased flow of sewage at night and increased infiltration due to broken sewer pipes (Gutteridge *et al*., 2006). This is a major contributor to the high levels of total dissolved solids (TDS) evident in the wastewater received at Kinoya (Gutteridge *et al.,* 2006).

Further, the significant increase in wastewater flows because of infiltration has led to overflows of man holes and pump stations (Kirkwood and Hughes, 2005). Between Jan-Feb 1999, 178 of the 334 complaints made to WSD related to overflows. Overflows from pump stations results in the discharge of raw sewage to drains and creeks and pose potential health risks (Kirkwood and Hughes, 2005). The Ministry of Health and Suva City Council have received numerous public complaints about raw sewerage exposure in residential areas (Gutteridge *et al.*, 2006).

Sewerage system blockages
Overflows may also be caused by sewerage system blockages. Blockages or chokes are a common occurrence throughout the sewer network with about five being attended to each day by a choke crew (Kirkwood and Hughes, 2005). Between Jan-Feb 1999, 152 of the 334 complaints made to WSD related to sewerage blockages. Blockages are largely caused by lack of awareness and poor practices of sewerage system use such as:

- Disposal of non-sewage waste such as rags and sanitary pads into the sewer system, particularly in the low income housing areas, settlements and garment factories;
- Discharge of untreated trade waste into the sewer lines such as fat and grease from restaurants and solids from industry.

Blockages and overflows also occur because sewer pipes and manholes are not properly covered allowing rainwater and other debris to easily enter the sewer lines.

Quality of effluent discharge
The effluent discharged from STPs around Fiji is of poor standard and poses a significant threat to the natural environment and health of people living or consuming resources within the vicinity of the outfall areas. All STP effluents are directly discharged into the sea or rivers. A review by Kirkwood and Hughes (2005) showed that effluent quality from all the treatment plants exceeded some of the standards proposed for EMA. This was particularly so for treatment plants serving large urban populations and industrial areas, which have almost or exceeded maximum capacity such at the Kinoya and Nadi sewerage treatment plants. The Lautoka, Sigatoka and Nausori plants produce effluent of slightly better quality but still are above recommended guidelines and Ba and Labasa produce the best quality effluent.

Fecal coliforms levels are often high around outfall sites. A study conducted in 1994 by Ministry of Infrastructure, Public Works and Maritime showed high levels of turbidity caused by the presence of suspended solids and diatoms (microscopic plants) placing limitations on the primary ecological productivity of the Laucala Bay area.

The health implications of sewerage discharge practices in Fiji can only be inferred as there are few studies linking the two. Illnesses connected to the consumption of water containing fecal coliforms include diarrhea and other gastro-intestinal illnesses. Many of the marine areas close to sewage outfalls are unsuitable for contact activities such as swimming and fishing as they pose potential health risks (Government of Fiji, 2005). Available data show that between 1995-2000 over 10,000 incidences of diarrhea were recorded among infants and children in the Suva-Nausori area where piped water was either not available or compromised.

6.2.1.3 Limitations and Barriers

The problems with the public sewerage system outlined above may be adequately dealt with if a number of key barriers and limitations are addressed. These relate to regulatory frameworks, consumer awareness, resource provision and infrastructure development and maintenance. Addressing these limitations may reduce the negative impacts of the sewerage system on the environment, human health and efficient sewerage service delivery.

Regulatory Frameworks
There are currently no formal regulations pertaining to the sewerage effluent standards, which WSD must comply to. WSD has a set of well-founded in-house standards of effluent disposal whish is a useful interim measure but incentives to comply with these are minimal (ADB, 2000). Furthermore, the credibility of this system may be questionable because the data are not accessible to the public or shared with other concerned regulatory bodies such as the Ministry of Environment, Suva City Council, and Ports Authority of Fiji (ADB, 2000).

Community Awareness
The need for community education on proper sewerage system practices is evident in:

- the high incidence of sewerage system blockages as a result of disposal of non-sewerage waste such as rags, sanitary pads and untreated trade waste;
- the continued harvest of marine resources in outfall areas; and

- the continued use of marine areas close to sewerage outfalls for recreational purposes.

An improved understanding of sewerage infrastructure and how they affect people may improve sewerage use practices and, hence, reduce maintenance costs. Similarly, a better understanding of the environmental and health implications of sewerage overflows and effluent quality may encourage people to be more cautious about where they swim and harvest marine resources as well as to expect better environmental management standards by STPs.

Finance

The Fiji Government currently finances sewerage services nationally and the funding or tariff provision by government to cover sewerage operation and maintenance costs is insufficient (ADB, 2000). The cost recovery for sewerage services is approximately 30 per cent and this is a major concern. The low level of cost recovery is attributable to the low sewerage connections (ADB, 2000). For example, many residents in the Suva area prefer to use septic tanks and pit latrines although they have access to sewers. The current Sewerage Legislation does not require property owners in sewered areas to connect to sewer lines and, hence, the low cost recovery of sewerage services may continue (ADB, 2000). Further to this, water and sewerage tariffs have declined significantly in real terms over the past 15 years (ADB, 2000). This has resulted in tariffs covering only about half of capital, operating and maintenance costs and negatively affecting the ability of the WSD to provide reliable and efficient services to its customers.

Sewerage system development and maintenance

The current status and conditions of the existing sewerage treatment systems influence the quality of effluent discharge and is a key contributing factor to the problems of infiltration and overflows. Such is the case for most of Suva's 71 pump stations where the numerous overflows have been caused by infiltration, blockages, broken exposed mains and sewerage pump breakdowns (Gutteridge *et al.*, 2006). The poor maintenance capacity for STPs around Fiji is evident in the frequent overflows that occur throughout the sewerage system, the state of plants and equipment, and in the low number of hours, sewerage pumps can operate in. Pre-emptive maintenance is seldom undertaken even for essential machinery, and pumps can take months to repair (Gutteridge *et al*., 2006).

The existing technology used for treating sewerage waste is also a key factor in determining the quality of effluent discharged into the environment. All STPs in the country treat sewerage waste up to the secondary level only. Effluent quality may be further improved through tertiary treatment and the technology required to conduct this is available and used in developed countries.

6.2.1.4 Opportunities

There are a number of key developments in the environment and sewerage sectors that present several opportunities to deal with the problems and limitations outlined above. These include the passage of the EMA and the implementation of new STP upgrade projects.

Environment Management Act

The recently passed EMA requires that regulations be developed to address the storage, production, handling, and discharge of liquid waste. The EMA will provide

the opportunity for the Ministry of Environment to set up a regulatory framework to more effectively regulate sewerage overflows, effluent standards and access to wastewater quality information.

All sewage treatment plants will be required to obtain a permit in order that discharge to the environment can continue. This permit may be specific to each outfall, or may incorporate the whole sewerage scheme catchment including overflows (Kirkwood and Hughes, 2005).

ADB Suva-Nausori Water and Sewerage Project

The sewerage upgrade component of this project is expected to be implemented over a period of three and a half years at a cost of F$39.0 million. Some of the progressive developments from this project will include:

- increased sewerage service capacity to cater for a further 90,000 people;
- improvements in the sewerage treatment capacity;
- extension of sewer lines into previously non-sewered areas;
- specially designed community education campaign on water and sanitation practices;
- improvements in the nearby environment;
- reduction in public health risks; and
- establishment of more efficient and effective sewerage service.

This project will provide WSD the opportunity to learn how to operate and maintain the new sewerage systems to design standards.

Table 1: Summary of current Status and Plans of Urban Sewerage Schemes in Fiji

Sewerage plant	capacity	Pop. Connect-ed	Treatment type	Outfall	Problems	Future plans
Kinoya (Suva)	150,000	120,000	Conventional	Approximately 3 million litres of treated wastewater is discharged through the Kinoya outfall, which extends approximately 1190m from an overflow pit at the end of the plant. It comprises a 400m long buried concrete pipeline and 790m long offshore outfall.	Infiltration into the sewer network during any rainy weather and from seawater during high tide due to old piping and breaks in pipe.	ADB funded project to be implemented includes the following: ▪ rehabilitation of existing sewerage system ▪ extension of sewerage system to further cater for additional population of 90,000 ▪ expansion of treatment plant
Nausori	6,000	2,000	Oxidation	Outfall (with diffusers) extends 22 meters from the shore of the Rewa River.	Sewerage coverage limited to main town area.	
Pacific Harbour	10,000	2,000	Conventional	Outfalls into man-made canal	Sand infiltration due to broken pipes	
Sigatoka	4,000	1200	Oxidation	Outfall discharged underground (sandbank) then into the river	Hospital and villages in towns not connected	A master plan for further expansion completed awaiting resource allocation
Nadi	20,000	23,000	IDEA Lagoon	Outfall discharges downstream Nadi River	Exceeded carrying capacity	Master plan for expansion to cater for an additional population of 20,000 has been allocated funding from government and ready for implementation
Lautoka	45,000	35,000	Oxidation	Outfall discharges 2,400 meters from the plant into the sea with 60 meter diffusers		None currently
Ba	6,500	3,000	Oxidation	Outfall discharges into Ba River		
Labasa	6,000	4,500	Oxidation	Outfall discharged into mangrove then river		Master plan for expansion to cater for an additional population of 6,000 has been

						allocated funding from government and ready for implementation
Adi Cakobau Sschool		1,000				
Naboro Prison		2,000				
Wailada		1,000				

6.2.2 Non-Sewer Systems

6.2.2.1 The Current Situation

Sewerage wastewater from the non-sewered population either is treated through a septic tank or is directly disposed into the ground (inclusive of pit latrines), waterways or the sea. Fiji's 1996 census figure shows that 40 per cent of households in Fiji owned a septic tank. As such, the remaining 60 per cent of the population would either be connected to a sewer line or dispose sewerage waste directly into the environment. Using a similar distribution ratio for 2005, the estimated proportions of various sewage wastewater disposal methods as shown in Table 2 below may be justifiable.

Table 2: Estimated Population Distribution According to Sewerage Waste Disposal Systems

Sewage wastewater disposal system	Estimated Proportion of Population (2005)	Estimated population numbers (2005)
Treated sewer system	23%	194,700
Septic tank system	40%	338,434
Direct disposal (land and marine)	37%	313,051

The 1978 Public Health Act states, under Part III (Buildings), that sanitary conveniences of buildings are to be either connected to a sewerage system, where available, or a septic tank. However, other types of toilets such as pan or pit would be permitted upon approval by the relevant local authority. There is a standard septic tank design, construction, and maintenance plan approved by the CBH that dates back to 1964. These standards are enforced by Health Officers in local municipal councils through the 1985 Local Government Act (under the Local Council By-Laws) that states "any dwelling-house, business premises, lodging house of any place shall construct latrines or privies of such type as the Council may, by notice, require".

Sewage waste disposal system standards vary significantly between urban and rural populations. All local councils in urban areas require the use of septic tank systems based on the CBH standards. These requirements do not pertain to squatter settlements within the relevant municipal council jurisdiction. Residents in rural areas, on the other hand, are not necessarily required to build septic tanks and may choose a sewage waste disposal system that suits their needs. There may be practical issues linked to this, as septic tank bailing services are not readily available in rural areas. Further, the Public Health Act and Local Government Act do not apply to Fijian villages as they are governed by the Fijian Affairs Act. This Act also does not have requirements for village households to acquire septic tanks. As such, it may be assumed that most of the population that directly dispose sewage waste into the environment are predominantly rural.

6.2.2.2 Problems

While septic tanks are an ecologically preferable option of disposing unsewered waste, they also present problems. For instance, much of the area in Suva sits on 'marl' (type of soap or sand stone) which disallows the proper percolation of septic tank effluents. Further to this, the high rainfall and low evaporation in the Suva areas leads to slow and inefficient natural treatment

in the septic tanks. Hence, the geology of this area combined with climatic factors results in the extensive seepage of sewage waste into Suva's numerous waterways (Watling and Chape, 1992).

The current standard septic tank design approved by the CBH does not necessarily ensure that the quality of effluent discharged into the environment is of an acceptable standard. These designs do not explicitly require that a filter and soak pit be part of the septic tank construct (Tanner and Gold, 2004). A filter is important for preventing solids from leaving the tank. The soak pit is vital for ensuring a thorough filtering process. Including these items into the design of the septic tanks would improve the quality of effluent discharge into the environment. Further to this, it is not uncommon to find below-standard septic tanks in rural areas. Soakage pits, which comprise two 40-gallon metal drums surrounded by coral rock is also referred to as septic tanks in rural areas (Tanner and Gold, 2004). The septage removal for this system is poor and the sludge storage capacity low. Leaking septic tanks are also a problem.

The fact that a significant proportion (approximately 37 per cent) of Fiji's population does not use sewer or septic tanks is a problem in itself. In the absence of septic tanks, wastewater disposal systems are prone to clogging and untreated wastewater may surface. Such a situation poses health risks as people and domestic animals are exposed to pathogen-infected wastewater (Tanner and Gold, 2004). These risks are concerning for densely populated urban squatter communities, where space is limited and sanitation regulations do not apply. This is particularly so for Suva, where a survey by the Squatter Resettlement Unit in 2005 indicated that the number of squatters is expected to be 90,000 by 2006.

The discharge of untreated sewage waste into the environment is a threat to sustainable development in Fiji. This is because it has negatively impacted and has further potential to affect the economic, social and environmental resources of local communities as well as at the national level. The coastal areas of Fiji hold most of Fiji's population and tourist accommodation. As such, significant volumes of sewage wastewater are released into the nearby coast and reefs on a continuous basis (Mosley and Aalbersberg, 2003). This is dangerous because sewage inputs are high in nutrients and therefore "allow macro-algae to thrive which can smother coral and reduce settlement sites for coral larvae resettlement" (Mosley and Aalbersberg, 2003). For example, past studies by Coral Cay have shown that the death of most of the coral along the Coral Coast is mainly caused by the sewage waste flows from coastal villages and hotels. The deterioration of the reef ecosystems and biodiversity may jeopardize Fiji's tourism industry and food source of local communities.

6.2.2.3 Limitations and Barriers

The limitations and barriers to better managing sewerage waste from non-sewerage disposal system differ between rural and urban centers. Urban areas have regulatory requirements and standards for septic tank designs, which are currently administered by municipal authorities. The use and standards of septic tanks in rural areas, on the other hand, is not required by nor overseen by a particular institution.

Institutional and Regulatory Gaps

Treated sewerage systems are currently the best method of managing sewage wastewater in Fiji. As seen in Table 1, the current capacity of most STPs around Fiji has not been fully utilized. There are plans to develop and build new STPs around the country. This will increase the potential capacity for sewerage wastewater services in urban centers. The absence of a sewerage regulation requiring compulsory connection by residents in areas covered by sewer lines may mean the continued use of septic tanks in urban centers.

The absence of an improved septic tank design standard also allows the continuation of low quality sewage effluents being discharged into the environment. Improving the current septic tank standards in areas where this method of sewerage disposal is prevalent may significantly improve the environmental and health standards of those areas.

The absence of appropriate regulation and administering institutions to oversee wastewater management standards is an essential barrier to improving sanitation systems in rural areas.

Resource Allocation for Improved Rural Sanitation
The incentives for rural household and squatters to build septic tanks are currently very limited.

Technology
A key contributing factor to poor sewage wastewater management practices in the rural areas is due to limitations in available alternative technology.

6.2.2.4 Opportunities

Opportunities for improved wastewater management systems in non-sewered areas can be found in existing and upcoming projects. They are as follows:

Wastewater Sanitation Park - Fiji School of Medicine (FSM)/South Pacific Applied Geoscience Commission (SOPAC)/Ministry of Health
The FSM Environmental Health School in Suva is working towards increasing the use of septic tanks in villages and part of this initiative has been the construction of a demonstration septic tank as a part of their onsite wastewater education project. This provides an opportunity to ensure that the systems promoted through this project are designed, constructed and managed appropriately and suitable for Fiji conditions. The inclusion of effluent filters into this design would be a cost-effective way of significantly reducing suspended solids carry-over from septic tanks (Tanner and Gold, 2004). The use of effluent filters would also protect the infiltration capacity of soil absorption fields (Tanner and Gold, 2004).

Wastewater Education – SOPAC
SOPAC has worked previously with the United Nations Environment Programme (UNEP) in conducting a Pacific regional wastewater management capacity building workshop. Such training workshop could be conducted at the national level to further enhance the understanding and skills of personnel who deal with sanitation issues. In addition, they have produced a number of booklets on rural sanitation for the region.

Development of Sustainable Waste Treatment Systems for Coastal Fijian Villages – Institute of Applied Sciences (IAS) and National Institute of Water and Atmospheric Research (NIWA)

IAS and NIWA have commenced in USP for a new sustainable waste treatment system project. The New Zealand funded project will develop, pilot, and demonstrate sustainable community wastewater treatment solutions for coastal Fijian villages. Modern scientific and engineering approaches will be incorporated with local indigenous knowledge, resources, and infrastructure to develop a practical village-scale demonstration project. The project is expected to be completed by January 2008.

Wastewater Management Awareness Raising
Wastewater management awareness raising workshops have been conducted in local villages along the Coral Coast by the Institute of Applied Sciences and its Integrated Coastal Management (ICM) project, Vunisinu village (Rewa) by the Ministry of Environment through its IWP Project and on Bau Island. These activities have also involved the promotion and building of compost toilets and the use of wetlands to further treat wastewater from septic tanks.

6.3. Industrial and Commercial Wastewater

6.3.1 Introduction

Industrial wastewater is simply defined as "the liquid wastes from industrial processes or business as distinct from sanitary sewage, which is discharged, to sewer or environment". Increased industrialization in Fiji has led to the production of wastewater and subsequent need for disposal. Industrial activities in Fiji are varied and quite robust for a small country in an isolated location. The main types of industry which have potential to cause liquid waste pollution include tourism (discussed in a separate section), sugar, sawmilling, mining, fish processing, tanneries and abattoirs, slipways and manufacturing and processing in the urban areas (Watling and Chape, 1992). The main constituent present in industrial wastewater is organic waste, which has considerable oxygen demand for decomposition, although other toxic substances such as heavy metals are also present. Commercial establishments such as restaurants and garages or mechanical workshops also produce liquid waste such as oils and grease that require proper disposal.

Liquid waste from industry is either discharged into the municipal sewers if located within or close to urban areas or is discharged into the environment. Industry such as sugar mills, fish processing, sawmills, slipways, and mines discharge almost exclusively to the environment, whereas most manufacturing and processing industry in the urban areas would discharge to a sewerage system.

6.3.2 Extent & Quality

Industry Discharging to Environment
Under the recently endorsed EMA, any commercial facility that is discharging liquid waste to a drain, surface water or ground is classified as discharging liquid waste to the environment. Nationally, commercial and industrial facilities may be classified either as:

1. Significant dischargers: (i.e industry/resorts that discharge large volumes of liquid waste, discharge excessively contaminated water, or a mine) OR
2. Standard discharger: all other facilities with liquid waste discharge to drain, surface water or ground from processes including cleaning and/or contaminated stormwater (Watling, 2005).

The number of possible significant dischargers to the environment nationwide may be around 30 and would include the following:

- Water & Sewerage Department (sewage outfalls, overflows, etc.)
- Fiji Sugar Corporation (4 mills)
- Fiji Industries Ltd
- Goodman Fielder Poultry Farm (Colo-i-Suva)
- Sawmills
- Pacific Fishing Company (PAFCO)
- Abbatoirs (Vuda, Suva)
- Emperor Gold Mine
- Large resorts with sewage treatment plants (approx. 15).

Standard dischargers would include:

- Industry not within sewered areas that are discharging to the environment
- Industry within sewered areas but whose waste cannot be accepted to the sewerage system
- Smaller Resorts/Hotels
- Commercial facilities such as butchers, restaurants, cafeterias, laundries, service stations, mechanical workshops, vehicle maintenance and repair, photolabs, fuel storage facilities etc. that are discharging to the environment either because they are outside sewered areas or within a sewered area but currently not forced to connect to sewer.

This latter category is extensive and at this point difficult to determine numbers mainly because little information is available on which commercial facilities in urban areas are connected to sewer and which discharge to the environment.

Sugar

Sugar is the second largest industry in Fiji. Cane is crushed at the four mills of Lautoka, Rarawai at Ba, Labasa and Penang. Effluent from the mills is an organic rich mixture of cane wash water containing soil, waste sugar, and wastewater from washing of equipment and floors which may contain caustic soda. Effluent is discharged to environment and is high in BOD and temperature thus causing considerable reduction of dissolved oxygen levels in receiving water for the six months of the year that they operate (Watling and Chape, 1992), from around June to December. This causes damage to the aquatic environment including fish kills in some of the main rivers.

Rarawai mill is located on the banks of Ba River into which effluent is discharged. In 1994, both Rarawai mill and Labasa mill installed effluent treatment systems consisting of primary and secondary treatment ponds. Monitoring of effluent in 1994 from both Rarawai and Labasa mills showed high BOD levels indicating treatment systems were not performing as expected. This could be due to input loading frequently exceeding design value leading to anaerobic conditions in ponds (Anderson and Lloyd, 1995). Monitoring of water quality in the Ba River during the crushing season in 1994 and 1995 showed very low dissolved oxygen at sites close to the discharge point of Rarawai mill (Fagan *et al.*, 1995). Dissolved oxygen levels in the river downstream from the mill were also below that necessary to maintain healthy aquatic life (Tamata and Lloyd, 1994). Monitoring of water quality in Qawa River, Labasa during crushing season in 1995 showed water temperature and BOD levels higher and dissolved oxygen levels lower than background levels near FSC mill discharge outlet, possibly the cause of pollution reported in this river (Tamata *et al.*, 1996).

Sawmills

There are about 20 sawmills with timber treatment facilities in Fiji with Tropik Wood at Drasa near Lautoka being the largest (Litidamu *et al.*, 2004). The main environmental hazard at sawmill sites is the potential toxic effects of wood preservative (copper chromium arsenic solution) being used to treat pine timber. Monitoring of the environment at Tropik Wood for these trace metals was carried out in 1992. Wastewater leaving a drain from an area with treated sawdust was found extremely high in copper and chromium with levels exceeding guidelines for metal finishing plants. Soil samples from around the plant also showed elevated levels of all three metals compared to background levels. However, values of these metals in Teidamu River nearby were similar to background levels (Green, 1992).

Fish processing

The largest cannery nationwide is the PAFCO plant at Levuka. Fish wastes are collected and turned into fish meal with waste from the fish meal plant and from the processing of fish being discharged into the ocean via an outfall which extends out to the barrier reef. The effluent is high in organic matter and is very turbid (Watling and Chape, 1992). Although effluent leaving the plant is fairly polluted, the outfall constructed in 1991 which discharges at a distance out into the port is effective in retaining satisfactory water quality in the port waters (Tamata and Thaman, 2001). Monitoring of water quality around the PAFCO outfall and reef health nearby was undertaken between 1990 and 1996 as part of the construction of the new outfall with results indicating a proliferation of algae on the barrier reef. Another cannery, Voko Industries at Laucala Beach Estate produces effluent with fish wastes which is very high in BOD and is discharged into the sewerage system greatly taxing the Kinoya STP (Watling and Chape, 1992).

Mining

Currently only one mine, the Emperor Gold Mine at Vatukoula, is operating. Production is from both open cut pits and underground workings. The tailings ponds of the mine are poorly controlled and could have unacceptable high concentrations of suspended solids and hazardous levels of cyanide and arsenic. Seepage of the old now unused tailings dams could also be a source of water pollution. The Mineral Resources Department currently monitors the Nasivi River and leachate of the tailings dam (Watling and Chape, 1992).

The extraction of underwater sand deposits from Laucala Bay is carried out by Fiji Industries Ltd to be used in industrial manufacture of cement at their plant in Lami (Watling and Chape, 1992). The cement plant produces liquid waste, which is discharged into a creek that empties into Lami Bay. The effluent is whitish and high in suspended solids (Cripps, 1992).

Other Industry – Manufacturing and Processing and Commercial Customers

Most manufacturing and processing industry is concentrated around the two urban areas of Suva and Lautoka within industrial areas. In Suva, these areas are at Walu Bay, Vatuwaqa, Laucala Beach Estate, Kalabo, and Wailada. Some of the types of industries present and the likely constituents in wastewater are summarised below (Cripps, 1992).

Table 3. Types of Industry Present and Constituents of Wastewater

Type of industry	Constituents
Battery manufacturers	Heavy metals (lead, cadmium, zinc) oil & grease, solids, nitrogen, acids, sulphur
Paint manufacturers	Lead, oil & grease
Fuel storage facilities	Oil & grease, suspended solids
Photo processing	Acids, oil & grease, silver
Printing	Solvents, acids, oil & grease
Food processing	Organics, solids, oil & grease
Wire manufacturing	Lead, zinc, tin
Manufacture of cleaning products	Oil & grease, acids, alkali
Metal fabricating shops	Oil & grease, solvents
Electroplating shops	Lead, tin, zinc, chromium, cadmium
Vehicle mechanical workshops	Oil & grease, solvents, solids
Marinas/Slipways	Tributyl tin, solvents, solids
Brewery	Organics, solids, oil & grease
Edible oils	Organics, solids, oil & grease , emulsified oils

These industries discharge industrial wastewater or trade waste into the sewerage system or into creeks or coastal areas. The water pollution from industry discharging into the coastal environment significantly reduces water quality in the near-shore waters around Suva and Lautoka and the creeks and streams that drain these industrial areas are probably the most polluted in the country (Watling and Chape, 1992).

In 1992, a study to determine point sources of pollution being discharged into the port of Suva found that 29 of the 39 industries discharged effluent directly into the port waters or into stormwater drains. Effluent was analysed for nine of the larger industries and all significantly exceeded levels permissible for discharge into port waters under the Ports Authority Act (Cripps, 1992). Effluent from petroleum storage terminals were found to pose little threat as discharges are not voluminous and precautionary and treatment facilities are present on-site, however, two of the oil terminals had effluent exceeding ports standards for oil and grease (Cripps, 1992). In 1999/2000, IAS undertook monitoring of various major industries discharging effluent into port waters of Suva, Lautoka and Levuka. The main industries causing pollution of port waters were identified (Tamata and Thaman, 2001). Some of these industries in Suva and Lautoka, however, now discharge effluent into the municipal sewerage system.

Mechanical workshops and car washes are a large sector that often performs their work outside on either gravel or concrete or within a workshop where common practice is to hose floors directly into stormwater, contaminating them with oil and grease. Service stations report that waste oil is stored in drums and taken to Casco steel (now Fletcher Steel) which utilizes used oil for burning of their furnaces, however observations at some indicate that oil is often dumped into stormwater drains and observed on the ground in open areas.

There are some industries located within sewered areas that discharge tradewaste to the environment. In the Suva-Nausori area there are around 10 industries in this category. Reasons for non-connection are either because it is not currently regulated or in the case of Wailada-based industries, it is because the Kinoya STP cannot accept their trade waste as it is running over capacity (Kirkwood and Hughes 2005). Many industries however do have permission from WSD to discharge effluent into the sewerage system.

Industry Discharging to Sewerage System

Data from monitoring of influent at Kinoya STP indicate high BOD as compared to domestic quality. It is estimated that around 30% of this BOD is from non-residential customers, in particular the larger food manufacturing industries. Analysis of influent at Kinoya for hydrocarbons indicated high levels, most probably from mechanical workshops and printers or other industrial discharges into the sewer lines (Kirkwood and Hughes, 2005). Inspections of pump stations around Suva and Walu Bay and manholes outside industry and commercial outlets indicated the presence of trade waste such as grease and solids which affect the efficiency of the system and contributing to blockages of pumps and piping (Kirkwood and Hughes, 2005). The potential that hazardous substances that are entering the sewerage system may appear in coastal waters through plant outfalls is also a concern.

The number of significant industries in the Suva-Nausori corridor that are connected to sewer is around 50. Of these industries, 27 discharge trade wastewater into the sewer. In Lami only 1 of the 10 industries discharges trade wastewater into the sewer. In the Suva and Lami area the practice of industries connecting their domestic wastewater to sewer but still discharging trade wastewater to environment is a concern. Lautoka has another 10 or so large industries connected to sewer, with 6 of these discharging trade wastewater to the sewer; nationally around 50 significant industries are/should be connected to sewer (Kirkwood and Hughes, 2005).

Within the Suva-Nausori corridor the number of commercial customers connected or possibly connected to sewer is around 430, Lautoka has a further 200 or so, Nadi around 150 and the other small towns of Ba, Sigatoka, Tavua and Labasa probably another 150 or so. Nationally the total is between 800 to 900 (Kirkwood and Hughes, 2005) (see Table 5).

The main components of trade wastewater from industries entering the sewer system are from cleaning processes and cleaning chemicals such as caustic and acids, cleaning of factory floors and processing areas which include use of chlorine, rinsing of containers/vessels used to manufacture products such as paint, moisturizers and those used for commercial laundries, and dyes, paint, and oil.

Around 50% of significant industry currently have appropriate pretreatment. Within the Suva-Nausori corridor, only small portions of the commercial customers (particularly restaurants) have pretreatment, which in most cases consist of a grease trap. In Lautoka, all of their restaurants and takeaways supposedly have grease traps, as it is a requirement by the council. However, it was mentioned that some of these traps are small and could not cater for the volume of grease generated. Most of these grease traps are cleared manually and the sludge dumped in the Lautoka dump. For the larger grease traps, sludge is collected by waste collectors such as Waste Management Ltd and Waste Care and dumped at the STPs (Kirkwood and Hughes, 2005).

Few industries undertake in-house sampling of their wastewater to determine their effluent quality (Table 4). Staff of the National Water Quality Laboratory (NWQL) at Kinoya conduct sampling of industry in Suva and the west. NWQL and 7 commercial customers have sampled around 26 industries. If the results of past monitoring of effluent quality by NWQL are compared to the old trade waste standards set by PWD, only a few industries would violate them and only for BOD. However, if the results are compared to the proposed effluent standards in trade waste policy, many would have effluent above the recommended BOD, TSS, fats/oil and grease, temperature and pH. This

indicates that the major dischargers are introducing poor effluent quality into the sewer (Kirkwood and Hughes, 2005)

Table 4. Number of significant dischargers to sewer that monitor effluent in-house and number monitored by NWQL

	Lautoka	Nausori	Suva	Nasinu	Lami	Nadi	Ba
Number of industries that analyse effluent in-house	1	-	3	1	1	1	1
Number of industry monitored by NWQL	4	3	8	5	4	1	1

Table 5. Summary of non-residential trade waste customers in each area (assumed connected or should be connected to sewer) and number with pretreatment (all approximate numbers)

	LAUTOKA (Natabua STP)	NAUSORI (Nadali STP, 2 to kinoya)	SUVA (Kinoya STP)	NASINU (Kinoya STP)	LAMI (Wailada STP)	NADI (Navakai STP)	BA (Votua STP)	SIGATOKA	
Commercial Customers									**TOTALS**
Restaurants & Takeaways	167	27	231	20	Maybe 2 connected	~100	8	5	560
Butchers	12	3	23	7	None connected	2	-	-	47
Bakeries	14	3	15	25	None connected	3	3	4	67
Hotel Kitchens	7	-	15	-	-	20	1	2	45
Laundries	2	1	8	-	-	1	1	-	13
Printers/Screen Printers	11	2	29	4	-	1	1	-	48
Photo Labs	3	3	9	-	-	4	2		21
Hospitals/Labs	1 hospital	-	3 hospitals 2 labs	2 Health Centers	-	1 hospital 1 lab?	2 hospitals	1 hospital	13
Total commercial customers	217	39	335	58	2	133	18	12	814
Tertiary Institutions/ Large Government Facilities			3 tertiary 5 other (FEA, MPAF etc)						
Number having pretreatment	All grease traps	1/3 have grease traps			A few				
Significant Industry									
Number Significant Industries	11	7	35	~20	~15	~2	1		80
Number connected to sewer	10	6	~30	11	~10	1	1		67
Number discharge trade wastewater to	~6	5	15	5	1	1	1		34

sewer									
Number that have pretreatment	~3	~4	6	2	1	1	1		
Number connected to sewer but discharge tradewaste to environment	-	1	5 (4 with pretreatment)	2	3				11

6.3.3 Management and Enforcement

Three government departments currently have direct responsibility for management of waste and pollution into the environment, the Ministry of Environment, Ministry of Health and Department of Mineral Resources which under the Mining Act is responsible for the environmental management of mines (Watling, 2005).

Some management of pollution is currently carried out by the health officers attached to the Municipal and Rural Authorities under the direction of the Central Board of Health of the Ministry of Health through their regular inspections of industrial and tourism facilities. However, the effectiveness of this administration is doubted. Issues of pollution and waste management have also intensified in the past few decades. Some of the municipal councils require commercial facilities such as restaurants and butchers to install grease traps as pretreatment. Many municipal councils have also successfully required many large industry to divert their discharge to sewer from environment in the last 5 years.

The Ports Authority of Fiji undertakes monitoring of urban and industrial pollution in designated port areas, however, this has been largely ineffective. Although some monitoring of ports and industrial point sources polluting the port has been carried out, no prosecutions/fines have been instigated. In addition, a National Oil Pollution Committee (Marine Department) was formed in 1991 with the purpose to coordinate the preparations and implementation of a national oil pollution response plan.

The Ministry of Environment mainly acts in an advisory role to other government departments on environmental related issues in the absence of supporting legislation. They also comment on national environmental issues of importance.

The Water & Sewerage Department in Ministry of Works and Energy is now the primary body responsible for constructing, operating and maintaining sewerage systems throughout the country (Kirkwood and Hughes, 2005). Currently, although the Act specifies that permission is required prior to discharging trade waste into the sewer, no special arrangement or permit has been issued to industries discharging to sewer thus far except for Carlton Brewery which has a flow meter at which sewer rates are charged. The Kinoya NWQL, however, regularly monitors the effluent of the significant discharges. Notices are given to industry if they are below standard and some progress has been made with industry in improving effluent quality through requiring them to install pretreatment.

6.3.4 Issues/Limitations

Discharge to Sewerage Systems

Issues that exist with the management of commercial/industrial liquid waste discharges to sewer system include:

1. Uncertainty by WSD regarding which customers are actually connected to the sewerage system including cases where domestic sewage goes to sewer and trade waste to the environment. Many customers discharging to sewer were

not listed as connected or paying sewer rates on the list of non-residential connections kept by WSD (Kirkwood and Hughes, 2005).

2. Poor coordination with other government departments and councils in relation to new developments that require sewer connection and discharge of trade waste.

3. Limitations of the Sewerage Act in relation to trade waste management include:
   - Powers of Entry (Section 5) which do not provide for entering sites for purposes of inspecting trade waste discharges or ascertaining source of pollution or unapproved discharges to sewer.
   - The provisions relating to trade waste, except charging, are within specific by-laws of the Act. Thus, it could be argued that the requirements for trade waste only apply in the Nadi and Nausori sewerage scheme areas.
   - There is no provision within the Act to disconnect a customer not complying with provisions of the Act (Kirkwood and Hughes, 2005).

4. Difficulties with monitoring of industrial effluent such as:
   - Most sites have not been set up with trade waste sampling points.
   - WSD staffs do not carry any form of identification and are often challenged when requesting access to customers' sites.
   - There are no data available indicating the volumes discharged to sewer from premises.

5. Potential increase of trade waste dischargers due to EMA. As most industry currently discharging to the environment in sewered areas are likely to exceed acceptance criteria to be developed by the Ministry of Environment there is a strong possibility that the option of discharge to sewer, where available, will be viewed as a preferred alternative. It is also expected that Councils will ensure that all new developments in sewered areas will have the trade waste discharges directed to sewer rather than direct to the environment. The combination of these two factors will potentially increase the amount of trade wastewater received at sewage treatment plants (Kirkwood and Hughes, 2005).

Discharge to Environment

Issues that exist with the management of liquid waste being discharged to the environment include:

1. Capacity of Ministry of Environment. Although now endowed with a modern applicable environmental legislation, the MoE currently has minimal human, technical and financial resources to implement the Act. The Ministry currently has 9 professional and support staff with a request for additional 15 staff. A review of the institutional requirements indicates the need for 59 staff to effectively implement the EMA. In addition, apart from involvement at policy level, the Ministry of Environment has little expertise in regulatory waste administration and enforcement (Watling, 2005). The Ministry will need personnel and resources as well as training to become effective in implementing EMA at the local level and government does not seem to be prepared to put sufficient resources into the Ministry to develop its capacity.

2. National capacity to handle industrial waste sludges. The majority of liquid waste currently transported is septic waste although there is some industrial waste such as pumping out of grease traps and industrial waste treatment tanks, by a number of private contractors and some local councils. Waste is either dumped in sludge lagoons at STPs or bushes nearby. However, this is

only viable in areas where there is a STP. Disposal is largely unregulated. Where STPs are not located nearby landfills are sometimes used and in the absence of a landfill, disposal in mangroves is sometimes practiced. With the introduction of a trade waste management system and the enactment of Section 5 of the EMA there will be an increase in the generation of waste sludge from both the commercial and industrial sector and need for proper disposal (Kirkwood and Hughes, 2005). This is a concern as there is currently no industrial waste treatment plants or hazardous waste landfills in the country for disposal of hazardous waste such as hydrocarbons, heavy metals and acids that may be produced from industry (Watling and Chape, 1992).

3. Local capacity to design and manufacture wastewater systems and pretreatment for industry. Local industry is extremely reliant on New Zealand and Australia in relation to advice on appropriate wastewater treatment technology. Consultant expertise is often sought from overseas in relation to wastewater management. There are a few consultants in Fiji with wastewater experience but they mainly deal with government and resorts at present. There are two local manufacturers of pretreatment for industry such as grease traps or settling pits, Humes and Fletchers, and no manufacturers of oil water separators in the country (Kirkwood and Hughes, 2005).

4. Access to appropriate waste management technologies and information.

5. Lack of regulation. In the past, there was a lack of specific legislation to regulate the discharge of liquid waste to the environment by industry and commercial facilities.

6. Lack of information of extent of standard or commercial dischargers to environment nationwide.

6.3.5 Opportunities / Options

Discharge to Sewerage Systems

Regulation/Policies

A proposed system for the management of trade waste entering into the sewerage systems, the Fiji Liquid Trade Waste Policy, was put forward by an ADB Technical Assistance Project in 2005 and was endorsed by the WSD. It includes:

- Formal application and assessment of trade waste discharges
- Acceptance standards
- Standardized pre-treatment for commercial discharges
- Monitoring program
- Enforcement procedures, and
- Charging mechanisms

Awareness & Capacity

The post of trade waste manager has since been advertised and it is envisaged that implementation of the trade waste policy by WSD will commence sometime in 2006. In addition, WSD personnel in the West have

commenced negotiations with industry on the standard of effluent being discharged to sewer line. Some awareness with industry in urban areas on the proposed trade waste policy and implication of EMA was carried out as part of an ADB Technical Assistance program in 2005 (Kirkwood and Hughes, 2005).

The proposed upgrading of the STPs in Suva and Nadi will also ensure that they have the capacity to receive an increase in volume of trade waste from industry and commercial customers (Kirkwood and Hughes, 2005).

Industry Initiative

A number of industries realise the impact of their wastewater on sewer systems and environment and conduct their own in-house monitoring of effluent quality and one has its own pretreatment facility.

Discharge to Environment

Legislation/Regulation

The recently passed EMA will cover the regulation of waste being discharged into the environment by commercial facilities. Under Part 5 it is an offence to discharge any waste or pollutant into the environment without a permit, including liquid waste discharges. Section 14 of the Act provides for the implementation of a Waste and Pollution Control Unit within the Ministry which includes staffing for an inspectorate (including a Waste and Pollution Control Administrator) that will issue permits and notices to all facilities, including government institutions, that discharge waste to the environment (Kirkwood and Hughes, 2005). Section 20 of the Act provides a wide range of powers for the waste inspectors to enter permitted and non-permitted sites (Watling, 2005).

The Act will require all commercial facilities such as restaurants, industry, mines, animal farms, workshops, resorts and those run by government to apply for a permit in order to discharge liquid or solid waste to the environment. Regulations are currently being developed for Part 5 of the Act thus are not currently in force. After Regulations come into force there will be a two-year phase in period before they are operational (Watling, 2005).

A proposed permitting system for liquid waste classifies the facilities discharging to the environment into:

- Cleanwater dischargers – facilities not discharging liquid waste into the environment
- Standard discharger – facilities discharging liquid waste to drain, surface water or ground from processes including cleaning and/or contaminated stormwater
- Significant discharger – facilities with significant liquid waste discharges. i.e. industry/commercial facilities/resorts that discharge large volumes of liquid waste (>20,000 litres per day) or discharge excessively contaminated water or is a mine or is having a detrimental impact on receiving waters
- Livestock discharger – confined livestock facilities discharging liquid waste such as piggeries, dairy milking sheds, cattle feedlots, and poultry farms.

Classification will determine if a permit is required, type of permit, standards, and permit fees (Watling, 2005).

Part 4 of the Act codifies the requirements of the Government in relation to Environmental Impact Assessment (EIA). Liquid waste from new

developments may thus be controlled to a certain degree by ensuring proposals for managing industrial wastewater are specified and that comments be made by relevant departments such as WSD on trade waste and sewerage capacity issues (Kirkwood and Hughes, 2005).

Administration

Options for the new administrative structure to implement Part 5 of the EMA include:
1. Local authorities develop their own capacity for management under the standards/monitoring directions of unit within Ministry of Environment or
2. A waste management authority be set up in Ministry of Environment to oversee national waste disposal and pollution control which has officers stationed in the Local Authorities as Environment Officers.

The first option would require government assistance in terms of financial assistance and building of capacity. Under the second option, the Environmental Health Inspectors under the CBH already provide nation-wide coverage and experience in regulatory waste administration and enforcement Given this experience and their qualifications they should be able to administer the EMA if provided with resources and training, (Watling, 2005). The MoE would draw up standard procedures, process permit applications and set conditions, audit inspection reports, issue improvement and penalty notices whereas local authorities/municipal councils would receive permit applications and forward to MoE, undertake general and annual inspections, issue notices, monitor and report to MoE (Watling, 2005). Some discussion of structures for implementation was held at a training workshop on the EMA conducted by MoE in early 2006.

Awareness

The Training and Productivity Authority of Fiji (TPAF) currently holds courses for industry in relation to environmental management systems such as ISO 14000 at which awareness on the trade waste policy and EMA was provided and its implication to industry.

Monitoring

Some monitoring of effluent quality being discharged to the environment is being carried out by major industries to inform them of possible impact on the environment. In addition, regular monitoring of all ports/urban areas/tourism areas to determine water quality status should continue.

6.4 Wastewater from Tourism Industry

6.4.1 Problem

An assessment of nutrient (nitrate and phosphate) levels along the near shore water of the Coral Coast (Mosley & Aalbersberg, 2003) and the Mamanuca Island group (unpublished data) showed that average values are above water quality guidelines for coral reef areas (ANZECC, 2000). Nutrient levels tend to be especially high in front of resorts and settlement areas along the Coral Coast. Surveys by Greenpeace in the Mamanuca Islands in 1997 also indicated widespread growth of algae and although nutrient levels were low, fecal coliform levels were particularly high, in some cases exceeding

recreational exposure standards especially near point sources of sewage discharge such as near tourist resorts (Greenpeace, 1997). Extreme seaweed growth around some island resorts and coastal areas and findings of high nutrient levels in coastal waters indicate that resort wastewater effluent poses a serious problem to coastal environment in Fiji. This will undermine the resource that tourists are coming to Fiji to see as well as the subsistence livelihood of coastal villages nearby (IAS, 2004).

Sewage effluent is thought to be the main source of the pollution around resorts. Effluent normally contains high levels of nutrients, suspended matter, and occasionally pathogens. Proper sewage waste disposal is a difficult challenge for resorts in Fiji, particularly on small islands, but also on the larger main islands where the public reticulated sewage system does not extend to many areas (IAS, 2004).

6.4.2 Extent and Quality

Liquid waste from the tourism industry is largely sewage but also includes greywater (wastewater from laundry, kitchen, pool overflows, showers and sinks). Most of the large hotels have sewage treatment systems, which are primary or secondary treatment. Fiji wide there are approximately 15 large resorts (over 100 room) and 25 medium resorts (30-100 room). Smaller resorts and backpackers (1-30 rooms) usually have septic tank and Fiji wide there are an estimated 65 of these tourism facilities.

A survey by Greenpeace (1997) found that the majority (66%) of resorts were only carrying out primary treatment of their effluent (i.e. basic separation of solids from liquids such as settling ponds and septic tanks). Only 7% had secondary treatment. This is somewhat concerning as secondary treatment (i.e removal of dissolved organic matter and fine suspended solids) is the accepted minimum level of effluent treatment in many countries around the world.

A Japanese sponsored study by the Institute of Applied Sciences found the standard of wastewater treatment of resorts is poor (IAS, 2004). Key findings of the survey, which covered 30 resorts were:

- Around 30% of resorts reuse their greywater for irrigation and particularly for watering golf courses and gardens. The porous nature of sand and soil at most sites however, would not remove much of the nutrients. Around 40% of resorts surveyed use low or non-phosphate detergents, which lowers phosphate content of their wastewater.
- Around 40% of resorts had on-site sewage treatment plants, 40% had septic tanks, and 20% connected to sewerage system. One had composting toilets. Commonly used types wastewater treatment systems were activated sludge plants, aeration and settling ponds, wetlands, and trickling filter systems such as Enviroflow. Thus around 50% of resorts had primary treatment (includes septic tank) and 23% secondary treatment. Around 50% tested effluent quality.

- Around 50% that had treatment plants reused treated effluent for irrigation and four resorts directly discharged treated sewage effluent direct to ocean or creeks.

Septic tanks with soak pits are the most commonly used wastewater treatment units for small resorts. The frequency of sludge removal varied with around 50% desludging at least once a year to a few never desludging. Most (66%) hired a waste management company to remove solids and dispose at

municipal treatment plants whilst the rest removed solids themselves and buried them on-site. 36% of resorts have upgraded their treatment systems recently with another 36% planning to upgrade (IAS, 2004). For effluent discharged to the ocean and septic tanks located near the ocean overall treatment standard is unlikely to be sufficient to protect coral reefs from harm from high nutrient levels and to not pose a health risk to tourists using coastal waters for recreation (IAS, 2004).

Analysis of quality of wastewater effluent from 18 resorts in Suva, Coral Coast, Nadi, and Mamanuca area was compared to international standards. Of the 11 resorts with sewage treatment plants, none met all the 5 standards (for BOD, TSS, Total Nitrogen, Total Phosphorus and Fecal Coliforms), only 4 resorts were able to meet at least 3 of the required standards and 4 did not meet any of the standards. Resorts with ponds/wetlands at the final treatment stage produced the best quality effluent. This is because ponds offer further settling of particles in wastewater and allow bacteria further time to breakdown organic material thus lowering values of BOD, suspended solids and in some cases nutrients if there are plants or algae present to take up nutrients. Those resorts that had effluent that met most of the required standards also met standards for use of effluent for irrigation, however, the predicted low removal capacity of coral/sand type soils in coastal areas of Fiji and algal growth around many resorts that irrigate their land with wastewater, indicate that nutrients are probably leaching through into groundwater and into coastal water (IAS, 2004).

Figure 1: Types of Sewerage Treatment used by Resorts

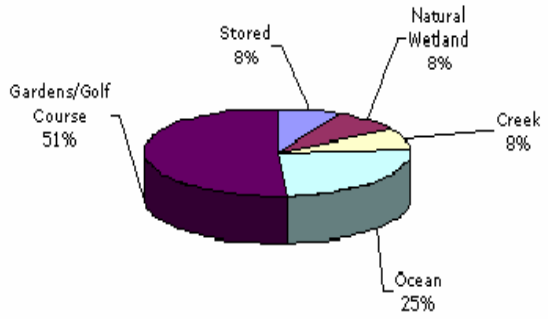
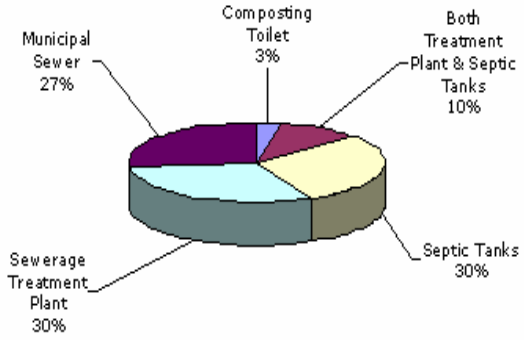


Figure 2: Final Discharge of Effluents from Resorts Sewerage Treatment Plants



6.4.3 Legislation / Management / Issues

Currently there is a lack of legislation that regulates the discharge of wastewater from tourism facilities to the environment. Although Environmental Impact Assessments (EIA) have been practiced for many tourist developments since the mid-1980s many resorts were constructed prior to this time when the need to minimize or prevent sewage effluent, whether treated or not, being discharged into coastal waters was little appreciated. There is also no independent agency consistently monitoring water quality around Fiji's coastal waters or monitoring effluent being discharged by resorts.

It is largely up to the individual resort owner/company whether they choose to commit to proper management of their waste. However, many resorts are becoming more responsible when it comes to waste management and recognize that it can in fact enhance a resort's occupancy if they acquire a reputation for being environmentally friendly. Although installing advanced sewage treatment systems can be expensive, the long-term cost to a resort of a degraded environment could potentially be much higher thus, many have opted to upgrade their wastewater treatment plants (IAS, 2004).

Other issues include lack of information and awareness of resort owners and engineers on potential impact of wastewater on environment and lack of local capacity and skills required to advice on and install appropriate wastewater treatment technologies.

6.4.4 Opportunities / Initiatives

Assessment of Wastewater Treatment Systems, Upgrades and Monitoring
In 1998, the Mamanuca Hoteliers Association commissioned Sinclair Knight Merz to investigate effluent management systems at selected resorts in the Mamanucas. A few had basic treatment consisting of septic tanks and others primary treatment systems with effluent directed to an ocean outfall or irrigation. Treatment was found to satisfy local requirements but not international guidelines and proposed Fiji regulations and upgrades were recommended. These resorts had upgraded to more advanced wastewater treatment plants by 2004. Two resorts had Enviroflow systems that provided treatment, which satisfies local requirements and is in accordance with international guidelines (SKM 1998). Other resorts on the Coral Coast have also upgraded their sewage treatment plants to advanced treatment in the last few years (Naviti, Hideaway). Monitoring of effluent is also undertaken by a number of hotels.

Demonstration Systems
At the Fijian Resort, Partners in Community Development Fiji (PCDF), a local NGO, has constructed an artificial wetlands in partnership with (UK) Darwin Initiative, Cuvu Environment Komiti (Nadroga Province) and Government. This Project (referred to as Waibulabula or Living Waters) addresses the problem of nutrient loading negatively impacting coral reefs and marine ecosystems through innovative and appropriate wastewater technologies. Lalati Resort on Beqa Island also sets a good example utilising composting toilets as their method of wastewater treatment. Lastly Crusoes Retreat, a small resort on the Coral Coast has installed a demonstration package wastewater system AdvanTex^{TM,} which utilizes recirculating textile packed bed reactors.

Awareness and Information

The ICM Fiji project has produced booklets that include information on appropriate wastewater management by resorts and backpackers. These include "Making Small Hotels and Resorts Environmentally Sustainable A Simple Checklist for Fiji Operators" and a booklet in Fijian for village-based small operators. In addition, a booklet was produced from the JICA study "Improving Wastewater Management in Fiji's Tourism Industry: A Booklet for Resort Operators" as well as an awareness workshop for resorts held on the Coral Coast on the impact of wastewater on the environment and the standard of wastewater quality among resorts in Fiji.

Resort Support, a local marine consulting firm, together with the Ministry of Environment also has undertaken awareness, training and monitoring of the environment at Robinson Crusoe Island to demonstrate how small resorts can build capacity to undertake their own environmental monitoring.

The Ministry of Tourism is also developing a local environmental certification system, which will grade tourism facilities depending on environmental management they undertake. It will include wastewater management.

Through the National ICM Committee some communication and discussion between government departments on wastewater problems and solutions has been carried out.

6.5 Animal Wastewater

6.5.1 Extent / Problem

Livestock farming in Fiji involves piggeries, dairies, beef, poultry, goats and sheep which fall under the supervision of the Animal Health & Production Division (AH&P) of the Ministry of Agriculture. Piggeries, dairies and poultry are the main concern at present in terms of waste management practices as they are normally concentrated in small areas of land often causing environmental pollution and the risk of spread of zoonotic diseases. Other classes of livestock, such as cattle, goats, and sheep are normally dispersed over large areas of land thus their feces do not normally contribute to pollution of the environment in those areas. The practice of rotational grazing also maintains the environment in such areas (Tukana, 2006).

Animal waste pollution normally results in the increase of nitrogen and phosphorus in the environment and unpleasant odours being released into the environment. Harmful pathogens could also be present in and around production sites (Tukana, 2006). Pathogens and parasites can be readily be transmitted to humans through direct occupational exposure to waste or contaminated land, groundwater, surface waters or indirectly through consumption of contaminated food such as shellfish (Tanner and Gold 2004).

Fiji's pig herd is currently divided into two sectors, the formal and informal sectors. The 1999 Agricultural survey indicated that there were 92,251 pigs in the informal sector. The formal sector presently has 1700 sows or 36,040 pigs in a year. Most pig waste goes directly into the environment when water is used to flush pig pens without being treated thus increasing nutrient levels in waterbodies and increasing risk of zoonotic diseases such as leptospirosis. Studies done on the Coral Coast indicate that piggeries are contributing up to 28% of the nitrogen load to coastal areas (Tanner and Gold, 2004). If treated

pig waste can be valuable manure that could improve crop farming. The manure could also be converted to methane gas and utilised for cooking and lighting (Tukana, 2006). Large piggeries nationwide are around 3. Treatment of wastewater at the Vuda Piggery is by overland irrigation of wastewater.

According to the 1999 agricultural survey, there were 27,583 dairy cows in the country. Large dairies number 7. The numbers are expected to increase in the next few years as a priority area for AH&P is to increase output of whole milk in the country. With dairies, the concern is with bail up or milking sheds where cows are brought in twice a day for milking meaning there is a build up of cattle dung in such areas and washing with water contributes to pollution of the environment. Over several years, the environment around the milking shed can get very polluted (Tukana, 2006).

In Fiji, chickens are the major poultry reared for the consumption of eggs and meat. The poultry sector in Fiji is divided into the formal and informal sector. In the formal sector, there are approximately 2 million poultry in the country at any one time. Together with the informal sector, there are 5,784,468 poultry in the country at any one time (Ajuyah, 2001). Large farms are located at Colo-I-Suva, with around 10 nationwide.

6.5.2 Regulations & Management

Legislation related to the discharge of liquid waste from livestock areas include the *Land Conservation and Improvement Act* which provides the basis for government to act on farming-related impacts such as erosion and pollution caused by livestock husbandry. Where the board deems it necessary for conservation or improvement of land or water resources, conservation orders may be issued to prohibit, regulate, or control most agricultural practices (Evans, 2004).

The director of AH&P currently has the powers to close a farm which is polluting the environment excessively, but normally this is not regulated due to lack of manpower and resources. Nevertheless, the division is well aware of the impacts of animal production systems thus are including animal waste management systems whilst promoting livestock production, particularly in intensive farming practices (Tukana, 2006).

Currently the AH&P is promoting the use of biogas digesters as an animal waste management system. Biogas digesters can also be expensive and expertise and is required for operation and maintenance. Some 26 biogas digesters have been constructed in livestock farms around Fiji with a significant failure rate due to lack of expertise on part of the farmers. Other waste management systems such as composting, use of settling ponds (lagoons) can be cheaper and easier to manage (Tukana, 2006).

6.5.3 Opportunities / Initiatives

Composting piggeries are being promoted through a project coordinated by the Secretariat for the Pacific Community with a trial piggery at Votua village and at Ministry of Agriculture. IAS is also trialling composting piggeries through its ICM project on the Coral Coast.

The EMA will allow the Ministry of Environment to regulate the pollution being produced by commercial livestock farms. An issue of concern is that many semi-commercial and commercial farms have been polluting the environment

for years since it has been cheap and unregulated. These farms are source of livelihood for the people and are means of employment thus will be difficult to close down. Awareness and consultations with all stakeholders to come up with strategies on animal waste management on existing farms needs to be conducted prior to enforcement of EMA. New farms should also be required to have animal waste management systems (Tukana, 2006).

6.6 Marine Shipping

6.6.1 Extent and Management

Around 10 different pieces of national legislation including the Environmental Management Act and the Ports Authority Act apply to pollution from marine shipping activities. The principal shipping ports (Suva and Lautoka) cater for both international and domestic ships, Malau in Labasa is mainly used for domestic ships. A number of private marinas are also catering for both local and international pleasure boats. The demand for liquid waste reception facilities in the major ports is relatively small according to the country report prepared by SPREP four years ago (SPREP 2002). Most international vessels have on-board facilities to store and treat liquid waste, even if they discharge liquid waste, they have to follow established protocols including the use of accepted liquid waste reception facilities at the major ports. The major ports do have liquid waste reception facilities/arrangement in place, and even at the private marinas such as Denarau and Vuda. At the Ports Corporation operated ports (Suva, Lautoka and Malau), waste from domestic vessels is received and the cost is covered through port fees.

Liquid waste from vessels is largely sewage waste but also consists of oily waste (from ballast water and engine room). Suva port in 1999 received 20-25 cubic metres of oily wastes. These wastes were collected by oil tanker trucks (arranged by shipping agents) and used as fuel at the Carpenters Steel Mills (SPREP, 2002). Domestic vessels and international vessels especially the fishing the fishing boats probably discharge their liquid waste at sea, given the strict regulations pertaining to discharges enforced at the ports. It has also been reported that cruise vessels in the Yasawas discharge sewage waste into the ocean when going between islands.

6.6.2 Issues & Opportunities

Issues include:

- Enforcement of regulations pertaining to discharges at the ports and open sea needs to be strengthened.

In addition, a *Marine Pollution Prevention Bill* for the control of vessel-sourced pollution and dumping of wastes at sea within Fiji waters has been proposed (Evans, 2004).

6.7 Urban Stormwater

6.7.1 Extent and Management

Urban stormwater refers to runoff from urban areas during and following rain as well as dry weather flows (ADB, 1998). Urban areas are being focussed on because of the relatively larger portions of land area covered in concrete and tarmac (compared to rural areas) which often prevents water percolating into the soil. The amount of stormwater and the contaminants it transports varies depending on: duration and intensity of rainfall, proportion of impervious surfaces, topography, land use, design, and management of drainage systems. Stormwater flushes materials such as litter, dust, soil, fertilisers, nutrients, chemicals, micro-organisms, metals and oils and grease accumulated on surfaces into waterways. Wet weather overflows from sewerage systems is also a component of stormwater. Stormwater is transported separate from the sewerage systems and does not undergo any treatment (ADB, 1998).

Stormwater run-off has been recognized as a significant non-point pollution source to the coastal waters in Suva (ADB, 1998) and by extension other cities and towns in Fiji. The pollutants can be in solution or more often associated with sediments. Stormwater run-off is also a conveyance mechanism for pollutants including solid waste into the coastal waters and other parts of the cities/towns. By design, sewerage lines are often connected to drainage systems and this can result in cross-contamination especially during intense and/or prolonged rainfall episodes.

No rigorous quantification of stormwater run-off has been done for any urban area in Fiji. Given this data limitation, we have tried to ***estimate*** storm water runoff in Suva City to illustrate the level of run-off using a simple method outlined by the *New York State Storm Water Management Design Manual* (1992). The estimated storm water run-off for Suva was carried out. In this case, we have used the total average rainfall per annum from 1961- 1990, and a coarse estimate of the imperviousness of Suva City land-use zones (residential, commercial, and industrial) based on data from the US. Storm water run-off management is not covered explicitly by current legislation in Fiji.

Stormwater run-off from Suva City was estimated to have a water height of equivalent of ***1.6 meters per annum***, which when multiplied by the land area of Suva and the Run-off coefficient is equivalent to ***4.268 *10^{10} litres***. Lower storm water surface run-off will be expected in urban areas which normally experience lower annual rainfall such as Nadi and Lautoka, however the fraction of imperviousness (determined by land-use) can also influence the level of run-off.

R = P * Pj * Rv

R = Annual run-off (mm)
P = Average Annual Rainfall (mm)
Pj = Fraction of annual rainfall events that produce run-off (estimated as 0.9)

Rv = Run-off Coefficient (estimated at 0.6)

NB: R * Land area of Suva (26,000,000m^2) = Volume of Run-off (**VR**)

R = 3040mm * 0.9 * 0.6 = 1642mm =1.6416m

VR = 1.6416m * 26,000,000m^2=42,681,600m^3=4.268 *10^{10}.Litres

6.7.2 Issues

Urban stormwater run-offs are *voluminous* (although *not quantified properly*) and currently *untreated* throughout Fiji

6.8 Leachate from Sanitary Landfill and Solid Waste Dump Sites

6.8.1 Extent & Management

The new Naboro sanitary landfill is the first for Fiji, covering greater Suva City and the surrounding towns, Nasinu, Nausori, Lami and Navua. The Naboro landfill is the only solid waste repository, which has a leachate collection and treatment system. The pond/wetland system of treatment is in the "stabilisation phase" and being monitored.

The rest of the country including large urban centres such as Lautoka, Nadi and Labasa are still using dumps as repositories for all solid waste. Most of these open dumps are inappropriately situated either on the coast, by riverbanks, slope lands and often very close to residential areas. All these dumps produce leachate that often laden with contaminants and not actively treated apart from natural attenuation. The dumps even if closed such as the one in Lami, will continue to produce leachate as result of rainwater percolating through the waste, and existing moisture and water within the dumps. An IAS (formerly known as Institute of Natural Resources-INR) study of the Lami dump in 1989 concluded that the area around the dump is significantly polluted microbiologically, and trace metal concentration near the dump were relatively higher than sites further from the dump. Another study by Chandra (2002) of sediments within Lami dump also showed elevated levels of trace metals. Both studies indicated that leachate from these open dumps are contaminated and therefore should be considered for better management (INR, 1989 and Chandra, 2002). Under the Fiji POPs National Implementation Plan, POPs contaminated sites which also include a few solid waste dumps were earmarked for remediation. However, the long-term goal to allay concerns with leachate contamination from solid waste dumps is to plan for more regional sanitary landfills with leachate treatment capability.

6.9 Sludge

6.9.1 Extent & Management

Raw sludge at Kinoya STP is digested, dried then stored in drying beds. However sludge is still also stored in sludge lagoons, which when full are emptied into drying beds, some of which are just adjacent to the mangroves. Farmers were known to use small amounts of the dried sludge as soil conditioners. Industrial facilities such as fuel tank farms, sugar mills, alcohol and food-processing factories produce sludge that is discharged directly to the environment after minimal treatment.

Waste trucks from Waste Management, Waste Care, and the Suva City Council also dump waste into these sludge lagoons. The waste largely consists of septic tank sludge but also at times food waste, bilge oil, and industrial waste. Observations indicated that some trucks do not discharge into the lagoon but directly into a sludge drying area adjacent.

Monitoring of primary sludge is carried out by the NWQL. This is important if sludge is being reused to ensure heavy metals are not present. Some monitoring of primary, digested, and tanker sludge from Kinoya STP was undertaken by IAS in 2005. It was found that metals were at levels consistent with domestic sewage. However, hydrocarbons level in tanker waste sludge was fairly high indicating that other waste apart from septic sludge was being picked up by these trucks thus the need for control of the disposal of tanker waste at the sewage treatment plants (Kirkwood and Hughes, 2005).

References

Asian Development Bank (ADB). 1998. *City Profiles*, last accessed from www.**adb**.org/Documents/Environment/FIJ/fij_**suva**_nausori_water_supply.pdf –27th March 2006

ADB and Government of Fiji. 2000. *Water and Sewerage Project Fiji: TA FIJ-3055 Suva-Nausori Water Supply and Sewerage Project*, Final Feasibility Study Volume 1 – Main Report, Gutteridge Haskins and Davey PTY Ltd in association with PNG-Pacific Consultants PTY Ltd and Wood & Pepsen Consultants.

Ajuyah, A. 2001. *Poultry production Course Book 2*, Alafua Campus, USP, Apia.

Anderson, E. and Lloyd, B. 1995. *Monitoring Performance of Effluent Treatment Systems at Fiji Sugar Corporation Rarawai Mill and Labasa Mill*. IAS Technical Report 94/07. IAS, USP, Suva.

ANZECC 2000. *Australian and New Zealand guidelines for fresh and marine water quality.* Australian and New Zealand Environment and Conservation Council.

Chandra, S. 2002. *Investigations into the Lami municipal dump as a source of heavy metal contamination*, in *Department of Chemistry*.. The University of the South Pacific: Suva (Fiji), MSc Thesis. 164p.

Coral Cay Conservation. 2001. Mamanuca Coral Reef Conservation Project-Fiji 2001: Pilot project final report. Coral Cay Conservation Limited, U.K.

Crenan, L. and Berry, G. 2002*. A synopsis of information relating to waste management, pollution prevention and improved sanitation with a focus on communities in the Pacific Island Region.* Volume 3 IWP Technical Report 2002/3. SPREP, Apia.

Cripps, K. 1992. *Survey of* the Point Sources of Industrial Pollution entering the port waters of Suva. Ports Authority of Fiji, Suva, Fiji.

ESCAP. 1998. *Integrating Environmental Considerations into Economic Decision-making Processes at the National Level in Fiji*. ESCAP

Evans N. 2004. *Natural Resources and the Environment in Fiji: A Review of Existing and Proposed Legislation*, A Report for the Fiji Department of Environment and the International Waters Programme of the Secretariat of the Pacific Regional Environment Programme.

Fagan, L. Cakausese, N. and Anderson, E. 1995. *Water quality in the Ba River and Estuary: Environmental Effects of Multiple Resource Use*. IAS Environmental Report No 95/81. IAS, USP, Suva.

Feacham. R.G., Bradley, D.J., Garelick, H. and Mara, D.D. 1989. *Sanitation and Disease: Health Aspects of Excreta and Wastewater Management.* John Wiley and Sons, New York.

Fiji Bureau of Statistics. 2005. *Visitors Statistics*, accessed from (http://www.spc.int/prism/Country/FJ/stats/index.html).

Goreau, T. J. and Thacker, K. 1994. Coral reefs, sewage, and wastewater quality standards. Proceedings, Caribbean Water and Wastewater Association Conference, Kingston, Jamaica.

Government of Fiji 2005. *Strategic Development Plan: Rebuilding Confidence for Stability and Growth for a Peaceful, Prosperous Fiji (DRAFT)*, National Planning Office, Ministry of Finance, June.

Government of Fiji 2002. *20-Year Development Plan (2001-2020) for the Enhancement of Participation of Indigenous Fijians and Rotumans in the Socio-Economic Development of Fiji*, Parliament of Fiji, Parliamentary Paper No.73.

Green, D.D. 1992. *1991 Environmental Monitoring Programme for the Tropik Wood Drasa Sawmill.* IAS, USP, Suva.

Greenpeace 1997. *Measuring Up – Report on Waste Management Practices in the Tourism Industry of Fiji*. Greenpeace, 1997.

Gutteridge Haskins & Davey Pty Ltd. 2006. *Suva- Nausori Water Supply and Sewerage Master Plan*, Volume 1 – Final Report, Town Hall Road, Suva, Fiji.

INR. 1989. *Environmental Survey into possible pollution caused Lami Dump*. INR Environmental Studies Report No C43, USP, Suva

IAS. 1991. *Effect of Rarawai Mill Effluent Discharge on the Ba River.* IAS Report 91/15. IAS, USP, Suva.

IAS. 2004. *A Review of the Standard of wastewater treatment in Fiji's Tourism Industry*. IAS, USP.

IMR. 2004. *Priority Environmental Concerns in Fiji*. Institute of Marine Resources. USP.

Kelly, D.J. 1994. *The Effects of Domestic Waste on Marine and Groundwater Quality in Tarawa Atoll, Republic of Kiribati*. IAS Environmental Report No.72. Institute of Applied Sciences, University of the South Pacific, Suva.

Kirkwood, A. and Hughes, B. 2005. Trade Waste Capability Study. TA 4270 Water & Sewer Department, Ministry of Works and Energy, Suva, Fiji. KBR for ADB. Unpublished report.

Litidamu, N., Young, T. and Valemei, I. 2004. An assessment of health impacts from environmental hazards in Fiji.
Maata M. 1997. TBTs in Fiji Marine Sediments, Ph.D. thesis, University of the South Pacific, Suva, Fiji

McCook, L. J. 1999. Macroalgae, nutrients and phase shifts on coral reefs: scientific issues and management consequences for the Great Barrier Reef. *Coral Reefs* 18, 357-367.

Morrison, R.J., Ganagaiya, P., Garuimella, S., Singh, S., Maata, M., and Chandra, A. 2005. *Contamination of Suva Lagoon*. Unpublished paper, Suva Lagoon Symposium, USP, Suva, March 2005.

Mosley, L. and Aalbersberg, W. 2003. *Nutrient levels in sea and river water along the Coral Coast of Vitilevu, Fiji*, South Pacific Journal of Natural Science, University of the South Pacific, Suva.

Naidu, S. and Morrison, R.J. 1988. *Pacific Lagoonal Study*. Interim Report. Institute of Natural Resources, USP, Suva.

New York State Department Environment Conservation. 1992. *Storm Water Tool Box*, last accessed from http://www.dec.state.ny.us/website/dow/toolbox/simple.pdf – 23rd March 2006

NSFC (National Small Flows Clearinghouse). 2006. *On-site wastewater disposal and public health*. (accessed fromhttp://abe.www.ecn.purdue.edu/~epados/septics/disease.htm)

SKM. 2004. Review of Effluent Management Systems (Different Resorts in Mamanucas). Sinclair Knight Merz.

SOPAC. 2002. Regional meeting of stakeholders in wastewater management 10-15 October 2001, Majuro Marshall Islands. SOPAC Miscellaneous Report 451.

South Pacific Regional Environment Programme 2002. Pacific Ocean Pollution Prevention Programme – Improving Ships' Waste Management in Pacific Island Ports, Apia, Samoa

Stewart, C. and Mora, S.J. 1992. Elevated tri(*n*-butyl)tin concentrations in shellfish and sediments from Suva Harbour, Fiji. *Applied Organometallic chemistry* 6:507-512.

Szmant, A.M. 2002. Nutrient enrichment on coral reefs: is it a major cause of coral reef decline? *Estuaries* 25, 743-766.

Tamata, B., Kubuabola, S.and Fung, C. 1996. *Water quality in the Qawa River during the Sugar Cane Crushing Season of 1995*. IAS Environmental Report 82. IAS, USP, Suva

Tamata, B. and Lloyd, B. 1994. *Environmental Assessment of the Effect of the FSC Rarawai Sugar Mill on the Ba River.* IAS Environmental Report No. 73. IAS, USP, Suva

Tamata, B. and Thaman, B. 2001. *Water quality in the Port of Fiji – Survey of Various Ports and Industrial Point Sources of Pollution.* IAS Environment Studies Report C103. IAS, USP, Suva.

Tanner, C. and Gold, A. 2004. Review and recommendations for reduction of nitrogen export to the Coral Coast, Fiji. NIWA Client Report HAM 2004 –085. NIWA, Hamilton.

Tawake, A. 2004. Human impacts on coastal fisheries in rural communities and their conservation approach: a case study on kaikoso (Anadara spp.) fishery in Verata District, Fiji, USP, Suva

Tukana, A. 2006. *Animal waste management in Fiji. Information paper provided for background paper*. Animal Health and Production Division, Ministry of Agriculture, Suva.

Water and Sewerage Department (WSD). 2005. *Interview with Mr. Suresh Singh* conducted on 15 March, Suva.

Watling, D. 2005. Implementing the Environmental Management Act – An implementation plan for regulations for liquid waste discharges. Draft Document. ADB Technical Assistance Project 4270.

Watling, D. and Chape, S. (eds.) 1992. *Environment: Fiji. The National State of the Environment Report*. IUCN, Gland, Switzerland.

Strategy for Pollution Prevention

The plan is divided into five sections, one for each working group topic. The strategy outlines the goal, which generally ***aims to minimize the negative human health and environmental effects from liquid waste***. Specific objectives and activities to achieve the goal were determined, also identifying lead agencies, key contributing agencies, output indicators, indicative costs and other resources needed. In general, the objectives and activities fall into categories coherent with regional waste strategies:

- Identifying existing liquid waste management activities and their effectiveness to determine best technologies and practice,
- Developing a regulatory framework that effectively encourages adoption of best practice and monitors change,
- Creating awareness and willingness of people ready to achieve goals,
- Implementing pilot projects and up-scaling successful ones,
- Developing the needed human and capital resources to carry out the needed activities.

Action and Implementation Plan

THEME 1: SEWAGE WASTEWATER

Goal: To provide the most efficient, environmentally friendly and culturally appropriate sewage management system

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate[2] ($FJ)	Other Resources Needed
Objective 1: Decision-makers aware of sewage wastewater management options and best practice **Lead Agencies: MoH and MPUID**					
Collect baseline information on different sewage waste management systems	MC (Municipal Councils), RLA (Rural Local Authorities), PC (Provincial Councils), NGOs, FBoS (Fiji Bureau of Statistics)	3-6 months	Baseline Report on current sewage management systems in Fiji	$50,000	Personnel, communications, transport, relevant data
Identify appropriate, cost effective and environmentally friendly systems for villages and settlements (considering different environmental/geographical settings)	FAB (Fijian Affairs Board), SPC, PCDF, IAS, SOPAC, MoE, MMEA	6-12 months	Feasibility study report	$10,000	Personnel, communications, transport, relevant data pilot sites
Determine appropriate design of systems and standards for different systems	CBH, MoCI (Ministry of Commerce and Industry), MMEA (Ministry of Multi-Ethnic Affairs), MoE	Ongoing	Report on systems design and standard in Fiji	$20,000	Personnel, information on successful systems used elsewhere

[2] The cost estimates are based on costs for similar activities under the Fiji National Implementation Plan (NIP) for the Stockholm Convention on Persistent Organic Pollutants and the Consultant's expert judgement

	PC, IAS, SOPAC, PCDF				
Develop standards for discharge	CBH, MPUID, MoCI MMEA, MoE, PC, IAS, SOPAC, PCDF	6 months	Report on systems design and standard in Fiji.	Being done as part of EMA Regulations	Personnel, information on successful systems used elsewhere
Develop database for Asset Management	MC, RLA, PC, NGOs, FBoS	Long term	Mater Plan designed for asset management	$100,000	Personell, office space, transport, communications, equipment
Develop mechanism for networking and collaboration with relevant stakeholders to increase awareness of options	MC, RLA, FAB, PC, NGOs, FBoS, MC, MoE, MMEA	On-going	Minutes of Bi-annual meetings	N/A	Personnel, transport, communications
Objective 2: Upgrade infrastructure for improved sewage and wastewater management **Lead Agencies: MPUID**					
Perform cost-benefit analysis of infrastructure development options (e.g. urban vs. tourism area)	MFNP	6 months	Report	$100,000	Consultant
Connect villages, settlements and private properties that are within the sewered areas	MC, RLA FAB, PC, MoH, NGOs, MMEA, MoE	Long term	Sewer line connections	$500,000	Personnel, capital, equipment, communications, transportation
Pilot system of communal septic tank, wetland and compost for communities where sewer line is not available	MC, RLA, FAB, PC, MoH, NGOs, MMEA, MoE	Ongoing	Introduction of pilot systems	$200,000	Personnel, equipment, land space, communications transportation
Extension of the sewer line to/within urban areas presently not covered	MC, RLA, FAB, PC, MoH, NGOs, MMEA, MoE	Long term	Master Plan in place	$3,000,000	External Funding

Explore options for hotel and community partnership on sewage waste management in rural and peri-urban areas	MoE, FHA, MC, MoTT	6 months	Project developed	$25,000	Personnel, transport, communication
Maintain and upgrade of existing sewerage systems	TC, RLA, FAB, PC, MoH, NGOs, MMEA, MoE	On-going	Maintenance and upgrade reports	$500,000	Personnel, equipment, transport, communication
Objective 3: Develop and enforce a regulatory framework that is effective in sewage and wastewater management **Lead Agencies: MoH and MPUID**					
Make it compulsory for houses to be connected to sewer lines if within sewered areas and the capacity of the sewerage plants	CBH	12 months	Policy developed	$6,000	Personnel
Develop standards for design & discharge	MC, RLA, FAB, PC, NGOs, MMEA, MoE	12 months	Standards development	$25,000	Personnel, communications
Enforce fines for nuisance in relation to sewage management	MC, RLA, FAB, PC, NGOs, MMEA, MoE	On-going	Number of fines	$10,000	Personnel
Amend relevant sections of the Fijian Affairs Act, Regulations and By-Laws to reinforce the use of sustainable liquid waste management in Fijian villages	FAB	24 months	Revised by-laws developed	$25,000	Personnel
Amend policy guidelines for funding assistance to Fijian villages to incorporate sustainable liquid waste	FAB	6 months	Guidelines amend	N/A	Personnel

management					
Solicit the assistance of the 'Vanua' in the introduction of sustainable liquid waste management in Fijian villages	FAB, PC, NGOs	On-going	Number of systems installed	$10,000 plus costs of systems	Personnel, equipment
Objective 4: Sewage system owners and general public are aware of key issues related to sewage and wastewater management **Lead Agencies: MoH**					
Develop a communications plan (should include key messages, communication tools, indicators, responsible agency etc.)	NGOs, MC	6 months	Messages developed	$10,000	Personnel
Objective 5: Document and monitor important sewage and wastewater management **Lead Agencies: MoH and MPUID**					
Determine key issues to document and monitor, and the methods to document and monitor	MoE	6 months	Key issues identified Methods to document and monitor identified	20,000	Personnel
Set up system to document and monitor	MoE	On-going	System set-up and working	50,000	Personnel
Objective 6: Develop the skills of sewage and wastewater managers **Lead Agencies: MoH, TPAF and MPUID**					
Conduct a training needs assessment	MC, NGOs	6 months	Needs and delivery identified	25,000	Personnel
Implement training	MC, NGOs	On-going	Training carried out Capacity increased	50,000	Personnel
Objective 7: Ensure appropriate resources to carry out priority areas of the strategy plan					

Lead Agencies: MFNP					
Evaluate appropriate subsidy level of sewage provision	MoH, MoE, MPUID	6 months	Level determined	10,000	Consultant
Implement new subsidy level	MPUID	6 months	Implementation of new subsidy level	10,000	Consultant
Increase number of collaborative projects with NGOs/IGOs	MoH, MoE	On-going	Number of new projects	10,000	Consultant
Increase government allocation to this sector	MoH, MoE, MPUID, NGOs	On-going	Proposal submitted Amount of funding	10,000	Consultant
Secure large aid financing (EU, GEF, etc.)	MoH, MoE, MPUID, NGOs	On-going	Proposal submitted Amount secured	25,000/year	Proposal writer

THEME 2: INDUSTRIAL WASTEWATER

Goal: To reduce the negative effects of industrial waters on the natural environment and human health

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Resources Needed
Objective 1: Decision-makers at Government and Industries aware of the industrial wastewater management options and best practice **Lead Agencies: MoE, Industries, CBH and MPUID**					
Collect baseline information on major industries' liquid waste management systems	MC, TPAF, RLA	3 months	Report on current liquid waste management systems at the major industrial facilities in the country	$15,000	Personnel, transport, communications, access to information
Identify the cost effective and appropriate industrial liquid waste treatment system for the major industries	TPAF, USP, Donor Agencies	24 months	Treatment options and improvements to minimize liquid waste identified	$50,000	Personnel, transport, communications, access to information
Develop operational guidelines for the major industries to minimize liquid waste generation	TPAF, WHO UNEP	24 months	Guidelines developed	$25,000	Consultant
Set up standards for industrial wastewater discharges (*significant and standard dischargers*) under EMA	USP, FSM WHO	12 months	Standards developed	15,000	Consultant
Objective 2: Upgrade liquid waste treatment infrastructure at significant industrial wastewater dischargers **Lead Agencies: MoE and MPUID**					
Secure funding to improve all existing Sewerage Treatment Plants	MFNP, Donor Partners	36 months	Funding secured to upgrade existing STP	$50,000	Consultant

Upgrade all existing STP	MFNP, Donor Partners	60 months (on-going)	Upgrading work completed	$10,000,000	Technical experts
On site pretreatment of industrial liquid waste to levels required by agreed standards for discharge to the environment and sewer lines.	FTIB, Fiji Manufacturer Association, Donor Agencies	60 months (On-going)	75% compliance by local industries	$1- 2,000,000 (will vary for every industry)	Technical expertise on treatment systems for major types of industry in Fiji
Objective 3: Develop and enforce a regulatory framework that is effective for industries **Lead Agencies: MoE, MoCI, MLIRP and Industries**					
Legislate the standards and operational guidelines developed under EMA	AGO	36 months	Regulations gazetted	$2,000	-
Legislate the Trade Waste Policy.	AGO	24 months	Trade waste policy gazetted	$2,000	-
Objective 4: Industries and other relevant stakeholders made aware of key issues related to industrial liquid waste management **Lead Agencies: MoE, MCI and MLIRP**					
Develop a communication Strategy (outlining key messages, communication tools, indicators, responsible agency etc.)	TPAF, NGOs	1-6 months	Key messages developed for major industries.	$5,000	Consultants
Implement and monitor awareness raising activities under the communication strategy	NGOs	On-going	Awareness activities implemented	$15,000	Personnel
Objective 5: Train industry personnel on appropriate industrial liquid waste management issues **Lead Agency: TPAF**					
Conduct a training needs assessment	MoE, MLIRP	6 months	Capacity needs and	$25,000	Consultant

	USP		delivery , methods identified		
Implement identified training	USP, UNEP	On-going	Training carried out	$50,000	Personnel, Consultant
Objective 6: Ensure appropriate resources are made available to carry out the suggested activities under this strategy **Lead Agency: MFNP**					
Evaluate options (current & new) for subsidies and other incentives that can be applied to improve environmental performance of industries	MoCI, MLIRP MoE	1-5 months	Subsidies and other incentives identified and evaluated	$50,000	Consultant
Legislate and implement the subsidies and incentives	MoCI, MLIRP MoE	1-24 months	Subsidies and other incentives legislated	$2,000	Consultant
Secure large financial resources from major development partners and donor agencies to improve sewerage systems and plants	MoCI, MLIRP MoE	On-going	Amount of funds secured	Varied	Consultant

THEME 3 TOURISM WASTEWATER

Goal: To minimize the amount of liquid waste discharged by the tourism industry.

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate ($FJ)	Other Resources Needed
Objective 1: Gather data on current tourism waste management practices and to evaluate and identify more sustainable options **Lead Agencies: MoE, MoH, MoTT, MC and RLA**					
Collate and compile existing data on current liquid waste management and evaluate the environmental, social and economic sustainability of each option	FHA	3 months	Monthly Bills (water/sewage) Onsite testing (USP/PWD baseline) Central Database developed	$6,000	Human Resource, Transport, Equipment, Communication
Gather information on other potential methods of sustainably managing tourism wastewater in Fiji	FHA	3 months	Report	$3,000	Researcher
Objective 2: Develop and enforce a regulatory framework that is effective in tourism wastewater management **Lead Agencies: MoE, MoH, MoTT, MC and RLA**					
Develop regulation for standards on tourism wastewater management	CBH, MPUID, MoCI USP, NGOs, FHA	1 year	Regulation drafted and formalised	$50,000	Consultant
Establish a mechanism for monitoring and enforcement of tourism wastewater discharge	USP, FHA	1 year	Monitoring and enforcement mechanism established and operational	$50,000	Consultant

Update legislation and policies to cater for new wastewater management technologies	AGO, FHA	Immediate action and on-going	Updated legislation	Included in above cost (i.e. $50,000)	Consultant
Objective 3: Promote the use of appropriate wastewater management systems in hotels and other tourism accommodation enterprises. **Lead Agencies: MoE, MoH, MoTT, MC and RLA**					
Develop a communication Strategy (outlining key messages, communication tools, indicators, responsible agency etc.)	USP NGOs	2 months	Messages developed	$5,000	Personnel
Implement and monitor awareness raising activities under the communication strategy	USP NGOs	1 months	Activities implemented Stakeholders more aware of the key issues	$60,000	Personnel
Enhance dialogue between key stakeholders and the Government	NEC, FHA	On-going	Quarterly meetings for key stakeholders	$2,000	Communication costs
Inform potential overseas investors of domestic environmental standards	FTIB	On-going	New investor aware of environmental standards Brochures/Materials on environmental standards developed	5,000	Communication costs
Objective 4: Ensure appropriate resources to facilitate the improvement of tourism wastewater management and monitoring. **Lead Agencies: MoE, MoTT and MFNP**					
Increase government allocation to improve wastewater management in	Donor Partners	On-going	Amount of funding allocation to sector	10,000	Consultant

the tourism industry					
Secure large aid financing (EU, GEF, etc.)	Donor Partners	On-going	Proposal submitted Amount secured	25,000/year	Proposal writer

THEME 4: ANIMAL WASTEWATER

Goal: To reduce the effect of animal wastewater on the environment and human health

Detailed List of Activities	Key Contributing Agencies*	Timeline (duration)	Performance Indicators	Cost Estimate ($FJ)	Other Resources Needed
Objective 1: Collate and analyze appropriate information on animal wastewater management **Lead Agency: Ministry of Agriculture, Sugar and Land Resettlement (MASLR)**					
Conduct baseline study on different animal wastes management systems	SPC, MoH, MoE, USP	1 Year with monthly monitoring	Baseline Reports	$6,000	Researcher, communication, transport
Document results of trials of animal wastewater management systems	SPC, MoH, MoE, USP	1 week after collection of result every month	Reports	$10,000	Researcher, communications, transport
Objective 2: Develop and enforce relevant legislation through the monitoring and evaluation of animal wastewater management **Lead Agency: MASLR**					
Develop adequate regulations on proper animal waste management standards	MoE, MoH	Immediate	Animal waste water management regulation developed	$10,000	Regulation drafter, communications, transport
Enforce legislation on proper animal waste management practices	MoE, MoH	On-going	Number of reported offences	$50,000	Human resource, transport, communications
Ensure farm operators carry	SPC, NFU	On-going	Spot check reports	$50,000	Human resource,

out duties through spot checks					transport, communications
Establishment of Livestock Farmers Union to oversee the implementation of animal waste water management systems	NFU	Within a year for farms that haven't been establish	Constitutions, Membership lists	$20,000	Human resource, office space, transport, communications, office equipment
Liaise with the relevant approving authorities to regularize farm approvals	MoH, MoE, CBH	On-going	Guidelines for approvals, Number of license approvals	$15,000	Human resource, transport, communications
Regularize monitoring of water quality in the pilot areas	SPC, IAS, WSD, MoH	On-going	Water Quality Data	$50,000	Human resource, water quality monitoring equipment, laboratory services, transport, communications
Objective 3: Raise the levels of awareness of farm operators on animal wastewater management best practices **Lead Agency: MASLR**					
Develop a communication Strategy (outlining key messages, communication tools, indicators, responsible agency etc.)	NGOs, SPC, MoH, MoE, MoEd (Ministry of Education)	On-going	Communication Plan developed	$10,000	Human resource, communications, transport
Implement and monitor awareness raising activities under the communication strategy	MoH, MoE, SPC, MOEd	On-going	Posters, TV ads, Radio Campaigns, Workshop Reports, Documentary etc.	$100,000	Human resource, awareness materials, communications, transport
Farmers/stakeholders attitudes towards animal waste water management to be changed through PLA exercises	MoH, MoE NGOs, IAS	On-going	Workshop Reports	$10,000	Human resource, communications, transport, workshop materials

Objective 4: Ascertain best practice systems through the conduct of pilot trials **Lead Agency: MASLR**					
Trialing of (on farms) different animal waste water management systems (bio-gas/composting)	SPC, NGOs, MoE, Farmers	12 months	Reports	$100,000	Equipment, human resource, transport, communication
Identify and implement proper husbandry practices	SPC, Farmers	On-going	Number of farms that have improved husbandry practices, number of animal waste water related diseases	$200,000	Equipment, human resource, transport communication
Farmers/stakeholders to include sustainable practices in their development plans	Farmers, MoH, MoE, SPC, Farmers Union	On-going	Guidelines for sustainable practices	$10,000	Human resource, transport, communication
Utilize animal feed with no or low/acceptable levels of heavy metals	Farmers	On-going	Feed Stock inventory	$10,000	Equipment, human resource, communication, transport
Objective 5: Ensure appropriate resources to facilitate the improvement of tourism wastewater management and monitoring. **Lead Agency: MASLR**					
Increase government allocation to improve animal wastewater management	MFNP	On-going	Amount of funding allocation to sector	$10,000	Consultant
Secure large aid financing (EU, GEF, etc.)	MFNP, MoE	On-going	Amount secured	$25,000/year	Proposal writer

THEME 5: OTHER WASTEWATER

Goal: To minimize the environmental and health impacts of sludge, urban stormwater run off, marine vessel discharge and landfill/dump leachate.

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate ($FJ)	Other Resources Needed
Objective 1: To ensure that industrial sludge is treated or re-used before it is discharged to the environment **Lead Agencies: MoE and MPUID**					
Increase sludge holding capacity in the Sewage Treatment Plants (STP)	Donor Agencies/MPUID	60 months	Each of the regional STP has capacity to meet current and future (next 15-20 years) sludge levels	2M	Technical expertise (internal and external)
Fiji Sugar Corporation (FSC) to find mechanisms to increase reutilization of baggase and mill mud	FSC	60 months On-going	By month 60, 30-50% of mill mud and baggase reutilized	$500	-
Register all Septic Balers and industries, and raise their awareness about best practices in sludge treatment and use	NWQL MC RLA	10 months	National Register of all Septic balers compiled Documented discharge of sludge at the STPs	$10,000	Awareness Raising Materials
Include regulations for all STP and industrial sludge[3] to be treated onsite, and determine the minimum discharge standards for sludge under the EMA	AGO, MoE	10 months	Sludge EMA regulations gazette	$12,000	Consultant

[3] Sludge from industries including fuel and oil storage facilities

Research/pilot possible uses and markets for sludge and other related materials such as sugar mills' bagasse (currently used as fuel) and mud (used as fertilizers)	USP, NWQL, FSC Fiji Sugar Cane Growers Council	36 months	Sludge use and market profiles identified	$15,000	Consultant
Publicize and communicate results (pilot with a few farmers) to relevant stakeholders and the public	USP, NWQL, FSC	36 months	Pilot Farmers beginning to use the "new sludge refortify products" as soil conditioner	$5,000	Awareness materials
Objective 2: Assess the level of stormwater run-off, and coastal/surface water contamination in the main urban centres as a result of stormwater run-off, and implement appropriate interventions. **Lead Agencies: PWD, Town and Country Planning (TCP), MoE, RLA and MC.**					
Cease direct discharge of priority contaminants identified under the characterization of urban stormwater	CBH, TCP	60 months	Reduce contaminant levels in storm water discharge	$5,000	Inspectors
Map out all urban drainage system in a GIS platform with all municipal council areas including squatter settlements	CBH, USP, SOPAC	60 months	Readily available GIS maps available to municipal councils and other stakeholders		
Pilot some of the stormwater management systems	Donor Partners, USP, Private sector	50 months	Management options piloted in 3 municipalities	$300,000	Technical experts on stormwater treatment
Develop regulation under EMA to enable stormwater run-off monitoring at the municipal level, and to	CBH, AGO	10 months	Appropriate regulation put in place	$10,000	Consultant

minimize contaminants at the source[4]					
Using established methods, accurately estimate the seasonal urban stormwater run-off profiles within urban centres	MRD (Mineral Resources Department), Fiji Meteorological Service	6 months	Urban storm run-off for all the urban centres accurately estimated Storm water profiles for each Municipal council developed	$10,000	Hydrology experts
Characterize urban storm water run-off in terms of its contaminant levels (materials flow) and sources	USP, TCP, MoE	6 months	Storm water contaminants and sources in selected municipal councils established	$10,000	Water quality analysts
Objective 3: To minimize the environmental and health impacts of wastewater discharge from marine vessels **Lead Agencies: Ports Corporation, Fiji Islands Maritime Safety Authority (FIMSA)**					
Reinforcement of existing legislation maritime regulations pertaining to marine pollution	AGO, MoE	60 months (On-going)	Intentional dumping within ports is reduced by 30%	$10,000	-
Identify the main sources and pollution level caused by liquid waste (oil, oil discharge, and sewage) from vessels.	MoE, private sector	6 months	Types of liquid waste from marine vessels identified Pollution levels determined	$10,000	Consultant
Identify ways to increase partnership between regulatory bodies and marine vessel owners to better the enforcement of marine legislation pertaining	MoE, Republic of Fiji Military Force (RFMF)	60 months (On-going)	Reduced contaminant levels in liquid waste discharge resulting vessel operators voluntarily comply	$5,000	-

[4] e.g. construction sites, earth works, residential and industrial areas

to marine pollution			to dumping regulations		
Develop technical capacity for regulatory bodies to enable them to better enforce existing and any new legislation under EMA	MoE, AGO	48 months (On-going as new developments take place)	Capacity increased and more resources available to monitor liquid waste dumping from marine vessels	$100,000	Extra manpower within FIMSA
Objective 4: To ensure all municipal solid waste leachate is treated before it is discharged to the environment. **Lead Agencies: MoE, CBH, MC and RLA**					
Establish standards for leachate quality under EMA	USP, AGO	8 months	Municipal Solid Waste Leachates standards under EMA Gazette	$30,000	Consultant
Set up a monitoring system with the relevant authorities for leachates and the landfills and dumpsites as well	CBH, NOHS (National Occupational Health & Safety)	4 months	Identified personnel and laboratories within relevant authorities for monitoring	$50,000	Trained database input officers.
Register all landfills and solid waste dumpsites in compliance with EMA	NOHS	3 months	All EMA compliant dumpsites and Landfills registered with the appropriate authorities	$2,000	-
Convert existing solid waste dumps in major urban centres to accommodate leachate control and treatment	MFNP, Donor Partners	60 months (On-going)	2 major solid waste dumps upgraded	$1,000,000	Landfill experts
Set up a database system with relevant information about solid waste dumps, landfills and leachates to	USP	6 months	MoE having a database with the relevant information	$25,000	Database manager

allow easy information sharing					
Develop regulations under the EMA for the treatment of all municipal solid waste leachate	AGO	8 months	Municipal Solid Waste Leachates regulations EMA Gazette	$2,000	-
Develop regulations under EMA for the construction and operational guidelines for sanitary landfills and existing dumps	USP AGO	12 months	Landfill and Solid Waste Dump Construction and operational Guidelines developed	$2,000	-
Identify alternative use/rehabilitation measures for current municipal solid waste dumps	USP	18 months	Alternatives identified for existing municipal solid waste dumps	$10,000	Consultant