ISSN 1818-5614

Fiji national liquid waste management strategy and action plan

By the Ministry of the Environment, Government of Fiji

IWP-Pacific Technical Report (International Waters Project) no. 48

Global Environment Facility	United Nations Development Programme	Pacific Regional Environment Programme

SPREP IRC Cataloguing-in-Publication data

Fiji national liquid waste management strategy and action plan / by the Ministry of the Environment, Government of Fiji. – Apia, Samoa : SPREP, 2007.

viii, 59 p. ; 29 cm. - *(IWP-Pacific Technical report, ISSN 1818-5614 ; no.48).*

ISBN: 978-982-04-0371-0

1. Waste minimization – Fiji. 2. Source reduction (Waste management) – Fiji. 3. Conservation of natural resources – Law and legislation – Fiji. 4. Waste disposal in the ground – Fiji. 5. Refuse and refuse disposal – Fiji. I. International Waters Project (IWP). II. Secretariat of the Pacific Regional Environment Programme (SPREP). III. Fiji. Ministry of the Environment. IV. Title. V. Series.

363.728 4

This report was produced by SPREP's International Waters Project, which is implementing the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States, with funding from the Global Environment Facility. This study was funded by the International Waters Project.

The views expressed in this report are not necessarily those of the publisher.

Cover design by SPREP's Publication Unit
Editing and layout: Mark Smaalders, IWP editorial consultant

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Acronyms

ADB	Asian Development Bank
AGO	Attorney General's office
AH&P	Animal Health and Productivity Division
ANZECC	Australia and New Zealand Conservation Council
BOD	biological oxygen demand
CBH	Central Board of Health
EIA	environmental 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	tributyltin
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

Acknowledgements

The Ministry of Environment is 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, which has made this and other work possible; we also acknowledge the staff of the International Waters Project Fiji, in particular the National Coordinator, Ms. Sandeep Kaur Singh and the Program Assistant, Ms. Lusiana Railogaivao for initiating and coordinating the formulation of the National Liquid Waste Management Strategy and Action Plan for Fiji. The Ministry also thanks stakeholders such as the South Pacific Applied Geoscience Commission, Ministry of Works, Ministry of Fijian Affairs, Municipal Councils, Rural Local Authorities, Ministry of Health and the private sector representatives and other stakeholders who assisted with and contributed towards the formulation of the Strategy. The Ministry thanks the authors from the Institute of Applied Sciences and the Pacific Centre for Environment and Sustainable Development at the University of the South Pacific (USP). The Ministry also thanks UNEP/GPA for providing directions for wastewater management in Fiji during the Municipal Wastewater Management training course held in Fiji in October 2005. In particular, the Ministry wishes to thank Mr. Robert Bechtloff of the UNEP/GPA, who has been working closely with the Ministry for the past 2 years on wastewater management issues.

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 organisations and the private sector which included the resort operators.

This report was prepared by Bill Aalbersberg, Baitiri Hughes and Patrina Dumaru (all from the USP Institute of Applied Sciences) and Melchior Mataki (USP Pacific Centre for Environment and Sustainable Development), with contributions by the following group leaders/facilitators: Andrew Tukana (Ministry of Agriculture), Sandeep Singh (Ministry of Environment), Marika Kuilamu (Ministry of Tourism), Kamal Khatri (SOPAC), and Timoci Young (Ministry of Health).

Figure 1: Location map

1 Executive summary

There is an urgent need to develop better ways to manage waste, and in particular liquid waste, in Fiji, as sanitary and environmental conditions in many areas are threatening both public health and natural resources. There is a need for holistic and integrated planning, especially in the context of Fiji's fragile and limited natural resource base. Accomplishing Fiji's waste reduction and pollution control objectives will require partnerships between government, community, the private sector and non-government organizations (NGOs).

The recently enacted 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 Liquid Waste 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 government will take the lead in implementing the strategy, working in close partnership with local government and other key stakeholders.

Two Liquid Waste Fora were held and five working groups established to obtain information and expertise from various sections of the community (e.g. industry, NGOs, academia, and local government). The working groups were established according to waste types (these were agreed to by all stakeholders in the first forum convened under this strategy). The two public fora provided opportunity for discussion of critical issues and effective ways of managing liquid waste in Fiji, served as a means to solicit viewpoints from all stakeholders. Based on the public forums and working group deliberations, the National Strategy and Action Plan for Fiji was developed. It was then reviewed 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: minimizing the negative human health and environmental effects from liquid waste. Specific objectives and activities to achieve the goal were determined, and lead agencies, key contributing agencies, output indicators, indicative costs and other resources needed were identified. 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 of successful ones; and
- developing the needed human and capital resources to carry out the needed activities.

2 Scope and objectives

2.1 Scope

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).

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 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 human health, including undesirable changes to ecosystems, reduction in the 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 wastewater 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 Environmental impacts

The environmental effects of poor wastewater management are becoming evident in many parts of the country. Coastal environments near urban areas, 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 locations near industry, and there are no major problems associated 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, although mercury and lead levels in shellfish at Lami dump were particularly high (Morrison et al. 2005). For metals in sediments, high concentrations of 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 is occurring around coastal villages, tourism centers, and sewage outfalls, causing concern over the presence of (i) pathogens that could impact human health and (ii) high levels of nutrients that may cause algal growth and degradation of coral reef environments. High levels of algal growth have been observed on many reef areas in Fiji (Coral Cay Conservation 2001); this is a symptom of increased nutrient levels and overfishing of herbivorous fish species (Goreau and Thacker 1994; McCook 1999; Szmant 2002). Extensive algae growth results in competition for space between the algae, coral and other organisms, leading to overgrowth and smothering of coral, and preventing 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 ciguatoxic 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 also smother benthic organisms and clog respiratory structures, as well as tainting commercial species, smothering breathing roots of mangroves, and inhibiting the 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 can cause neuronal damage and inhibit embryonic development and normal metabolic processes in humans (Cripps 1992).

Extremely high levels of tributyltin (TBT) concentrations have been detected in sediments in the immediate vicinity of slipways and boatyards in Suva Harbour, and from mangrove oysters, indicating the latter are highly 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 into the marine environment of inadequately treated sewage effluent from both humans and animals 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 were 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 environments (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. In assessing the incidence of dysentry in Fiji (for the period 1998–2002) it was observed that rural areas with untreated water supplies (e.g. 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 gastrointestinal diseases (Litidamu et al. 2004).

3.3 Economic impacts

The economic impact of poor liquid waste management is often not considered in planning decisions. Health-related costs can include costs due to absence from work, costs of medical treatment and even loss of life. Although such an analysis has not been done for Fiji, such health-related costs are likely to result in losses of millions of dollars per year. In addition, an outbreak of a serious disease like cholera could cost millions in lost tourism earnings.

Costs associated with the environmental impacts of poor liquid waste management can include decreased terrestrial and/or marine primary productivity due to pollution, decreased property values near polluted areas, loss of environmental services if important habitats are degraded, and the cost of clean up. The reduction in quality of natural assets and aesthetic value due to 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 of a 20-km length of coast in Hawaii estimated the cost of algal overgrowth of the coral reef to be USD 60 million per year.

4 Pacific wastewater policy

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) includes wastewater management, and has been endorsed by the Fiji government. A summary of the vision, principles and policies of the Pacific Wastewater Policy is provided below (see SOPAC 2002).

Pacific Wastewater Policy Statement and Framework for Action

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

Guiding Principles	Details of Policies	Proposed Actions
		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 will take into account traditional knowledge and practices.	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 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 Country background

5.1 Size

Fiji consists of more than 300 islands, about 100 of which are inhabited, covering a total land area of 18,376 km^2. The two largest islands (Viti Levu and Vanua Levu) comprise more than 85% of the total area. The islands are largely of volcanic origin and mountainous, confining most development to coastal areas (see Fig. 1 for location).

5.2 Population

According to the 1996 census, the population of Fiji was 772,625. The 2005 estimate was 846,085, with a natural growth rate between 1986 and 1996 of 0.8% per annum (Government of Fiji 2005). Over 90% of the population is located in coastal areas, with about 40% living in the urban areas of Suva, Lautoka, Nadi, Lami and Nausori. Urbanisation is increasing and has led to development of squatter settlements, which lack basic services like water and sanitation; this is believed to be a major factor in a number of disease outbreaks. Estimates of the proportion of the population living in poverty (increasingly in the urban/periurban areas) vary from 20% (Litidamu et al. 2004) to 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 and flooding, particularly between November and April. During El Niño years, droughts can be severe, especially on the western side of islands during the dry season (May to October). On the larger volcanic islands, annual rainfall is relatively abundant, with perennial rivers and numerous springs ensuring a generally sufficient domestic water supply. On the low-lying, smaller and outer islands, there are no perennial streams and fresh water is much more scarce, with water shortages common (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 860,000 ha (ESCAP 1998); the current rate of deforestation is moderate. Fiji's exclusive economic zone (EEZ) covers some 1.3 million km^2 and contains a wealth of 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 gross domestic product (GDP) and 22% of foreign exchange. In 2005, tourism was estimated to provide 30% of GDP. Tourism provides employment (direct and indirect) 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 equalled 430,800, and increased to 550,000 in 2005 (Fiji Bureau of Statistics 2005). Ecotourism and backpacking are important and growing forms 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 the 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, urbanisation, and industrial and economic development have placed growing pressure on coastal resources. Problems include loss of habitat through coastal development, pollution due to improper waste disposal, increased withdrawals from freshwater lenses, and depletion of coastal fisheries (IMR 2004). Coastal habitats are being degraded through 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 coastal zone monitoring 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, and are a relic of the colonial period when environmental problems were limited and clearly sectoral. At least 25 Acts — administered by 14 different ministries or departments, statutory bodies or other agencies — have some role in environmental management. Most of these laws are both old and ineffective in the modern context of environmental management, or suffer from a lack of regulatory enforcement through inadequate staffing, lack of technical resources and funding, and administrative failures (Government of Fiji 2005). The situation has improved somewhat with the passage of the EMA. The regulations to enact it are still being formulated.

6 Existing 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 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, and leachate from dumps and sludge. A review of applicable legislation is provided first.

6.1 Current legislation

The existing legislation listed below applies to liquid waste pollution from industry, tourism and other commercial facilities and from liquid waste being discharged from domestic sources into the environment.

Public Health Act 1955

Under this Act, inspectors have the power 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 2006). The strength of the Act lies in its institutional organisation; 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 environmental regulations related to discharge of waste into the environment. (Kirkwood and Hughes 2005).

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 2006). It is an offence to pollute port areas; the maximum fine is $400.

Water Supply Act 1955

The Water Supply Act states that it is an offence to pollute water if it is used for water supply or is in a declared catchment area (Evans 2006).

Town Planning Act

Permissions to develop are granted by local authorities with approval from the Director of Town and Country Planning. New development approvals often have conditions attached in which appropriate wastewater treatment systems are specified.

Mining Act

Provides powers for the Director of the 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).

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, and addresses discharge of trade waste or industrial waste and domestic waste into the sewerage system.

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 the Water and Sewer Department (WSD) become aware of a property discharging trade wastewater to a sewer without its written permission a penalty of up to FJD 250/day may be imposed until consent is given.

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 establish the need for permission in writing before trade waste can be permitted to discharge to a 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 wastewater to a sewer (Kirkwood and Hughes 2005).

6.2 Sewage waste

The current management practices, problems, and opportunities of sewage wastewater disposal in Fiji are discussed below under two categories: 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 typically conveys the 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, and into waterways and the sea. Septic tanks are often built underground, usually consist of two compartments, and are 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 the tank's 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 (untreated and unfiltered) sewage into the environment. 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 STPs in Fiji collectively serve an estimated 194,700 people (Table 1), accounting for approximately 23% of the country's population. There are 11 public sewerage systems currently operating and most of them service urban populations. There are eight major STPs 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 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 (WSD 2005). These systems collectively cater for approximately 4000 people and will not be dealt with extensively in this section.

Plans are underway to expand sewerage system services nationally. Three master plans are currently in the initial implementation stages and are expected to collectively service an additional 116,000 people. These projects include the Suva-Nausori Water Supply and Sewerage Project (serving 90,000 people), the Labasa Sewerage Scheme (6,000 people), and the Nadi Regional Sewerage Scheme (20,000 people). Most other STPs have completed expansion master plans 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.

Sewage 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 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% (ADB 2000). 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

Maintaining environmental quality and public health and providing efficient service delivery to the public are central aims of the public sewerage system in Fiji. Sewerage-related problems — including threats to human health and the environment as well as to the efficient running of sewerage systems in Fiji —stem predominantly from problems with infrastructure, as discussed below.

Infiltration into the sewer network

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 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 flow of seawater in the Kinoya STP can at times reach 90% at midnight, because of decreased sewage flow at night and increased infiltration due to broken sewer pipes (Gutteridge Haskins & Davey Pty Ltd. 2006). This is a major contributor to the high levels of total dissolved solids (TDS) evident in the wastewater received at Kinoya (Gutteridge Haskins & Davey Pty Ltd. 2006).

The significant increase in wastewater flows because of infiltration has led to overflows of man holes and pump stations (Kirkwood and Hughes 2005). Between January–February 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 poses potential health risks (Kirkwood and Hughes 2005). The Ministry of Health and Suva City Council have received numerous public complaints about raw sewage exposure in residential areas (Gutteridge Haskins & Davey Pty Ltd. 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 January–February 1999, 152 of the 334 complaints made to WSD related to blockages, which are largely caused by lack of awareness and poor sewerage system practices, including:

- 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 all the treatment plants were discharging effluent that exceeded at least some of the standards proposed for EMA. This was particularly the case for treatment plants serving large urban populations and industrial areas, which are functioning at or in excess of their maximum capacity (e.g. 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; Ba and Labasa produce the best quality effluent.

Fecal coliform 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) — negatively impacted primary ecological productivity of the Laucala Bay area.

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

Sewerage plant	Capacity	Pop. Connected	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 1190 m from an overflow pit at the end of the plant. It comprises a 400 m long buried concrete pipeline and 790 m 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 m 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 20,000 additional people has been allocated funding from government; ready for implementation
Lautoka	45,000	35,000	Oxidation	Outfall discharges 2,400 m from the plant into the sea with 60 m diffusers		None currently
Ba	6,500	3,000	Oxidation	Outfall discharges into Ba River		
Labasa	6,000	4,500	Oxidation	Outfall discharges into mangrove then river		Master plan for expansion to cater for 6,000 additional people has been allocated funding from government; ready for implementation
Adi Cakobau Sschool		1,000				
Naboro Prison		2,000				
Wailada		1,000				

Few studies have examined the health implications of sewerage discharge practices in Fiji, so these can only be inferred. Health problems associated with the consumption of water containing fecal coliform bacteria include various gastrointestinal illnesses, with diarrhoea a common symptom. 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 shows that between 1995–2000 over 10,000 incidences of diarrhoea 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 public sewerage system problems outlined above can be reduced or solved by addressing a number of key barriers and limitations relating to regulatory frameworks, consumer awareness, resource provision and infrastructure development and maintenance.

Regulatory frameworks

There are currently no formal regulations pertaining to sewage effluent standards with which WSD must comply. WSD has a set of well-founded in-house effluent disposal standards, which constitute a useful interim measure, but there are minimal incentives to comply with these. Furthermore, the credibility of this system is drawn into question because the data are not accessible to the public or shared with other concerned regulatory bodies (e.g. the Ministry of Environment, Suva City Council, and Ports Authority of Fiji; see ADB).

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 it affects people may improve sewerage use practices and 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, and to expect better environmental management by STPs.

Finance

The Fiji Government currently finances sewerage services nationally, but the funding or tariff provision by government to cover sewerage operation and maintenance costs is insufficient (ADB 2000); the government recovers about 30% of sewerage service costs, which is a major concern. The low level of cost recovery is attributable to the low number of sewerage connections (ADB 2000). For example, many residents in the Suva area prefer to use septic tanks and pit latrines despite having access to sewers. The current Sewerage Legislation does not require property owners in areas served by sewers to connect to sewer lines; consequently, cost recovery for sewerage services may remain low. In addition, 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 condition of the existing sewerage treatment systems influences the quality of effluent discharge and is a key contributing factor to infiltration and overflow problems. This is true 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 Haskins & Davey Pty Ltd. 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 for which sewerage pumps can operate. 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 secondary level only. Effluent quality may be further improved through tertiary treatment; the required technology 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 to be able to discharge wastewater into the environment. 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 FJD 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.

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% of households in Fiji owned a septic tank. As such, the remaining 60% of the population would either be connected to a sewer line or dispose of sewerage waste directly into the environment. Use of a similar distribution ratio for the 2005 estimated population produces the figures shown in Table 2.

Table 2 Estimated Population Distribution According to Sewerage Waste Disposal Systems

Sewage wastewater disposal system	Estimated Proportion of Population (2005)	Estimated number of people (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 Central Board of Health (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), which 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. Furthermore, 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 require village households to install septic tanks. It can be assumed that it is predominantly the rural population that directly disposes sewage waste into the environment.

6.2.2.2 Problems

While septic tanks are an ecologically preferable option for disposing of unsewered waste, they also present problems. For instance, much soil underlying the Suva area is "marl" (a combination of clay and calcium carbonate), which prevents proper percolation of septic tank effluent. In addition, the high rainfall and low evaporation in the Suva areas leads to slow and inefficient natural treatment in septic tanks. Thus the geology of the area, in combination with the climate, results in 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 system

(Tanner and Gold 2004); a filter is important for preventing solids from leaving the tank, while the soak pit ensures a thorough filtering process. Including these items in the design of the septic tanks would improve the quality of effluent discharge into the environment. In addition, it is not uncommon to find below-standard septic tanks in rural areas. Soakage pits comprising two 40-gallon metal drums surrounded by coral rock are referred to as septic tanks in rural areas (Tanner and Gold 2004). The septage removal capability of 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%) of Fiji's population does not use either a sewer or septic tank is also a problem. 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 wastewater containing pathogens (Tanner and Gold 2004). These risks are especially acute in densely populated urban squatter communities, where space is limited and sanitation regulations do not apply. This is particularly the case in Suva, where a survey by the Squatter Resettlement Unit in 2005 indicated that the number of squatters is expected to reach 90,000 by 2006.

The discharge of untreated sewage into the environment is a threat to sustainable development in Fiji. It has already negatively impacted (and has the potential to further affect) the economic, social and environmental resources of both local communities and the nation as a whole. Fiji's coastal areas are home to most of Fiji's population and contain the majority of the tourist accommodation, and significant volumes of sewage wastewater are released into the nearby coast and reefs on a continuous basis (Mosley and Aalbersberg 2003). Wastewater is typically high in nutrients and promotes the growth of macro-algae, which can smother coral and reduce available settlement sites for coral larvae resettlement (Mosley and Aalbersberg 2003). Past studies by Coral Cay Conservation Ltd. (Rowlands et al. 2005) have shown that the death of most of the coral along Fiji's Coral Coast is 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, as well as the marine resources upon which local communities depend for food.

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 centres. 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. The current capacity of most STPs in Fiji has not been fully utilized (see Table 1), and there are plans to develop and build new STPs around the country. This will increase the potential capacity for sewerage wastewater services in urban centres, but 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 centres. 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 environmental and health standards in 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 rural areas stems from 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, including the following.

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 to increase the use of septic tanks in villages; this initiative has included 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 are 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.

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 a 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 begun 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 incorporating modern scientific and engineering approaches, along with local indigenous knowledge, resources, and infrastructure. 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, in Vunisinu village (Rewa) by the Ministry of Environment through the IWP, 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 constitutes liquid wastes from industrial processes or businesses (as distinct from sanitary sewage), and which is discharged to sewers or the environment. Increased industrialization in Fiji has led to the production and need for disposal of industrial wastewater. Industrial activities in Fiji are varied and quite robust for a small country in an isolated location. The main industries with the 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, with significant decomposition-related oxygen demand; 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. Industrial facilities such as sugar mills, fish processing plants, sawmills, slipways, and mines discharge almost exclusively to the environment, whereas most manufacturing and processing industries in the urban areas discharge to a sewerage system.

6.3.2 Extent and quality

6.3.2.1 Industry discharging to environment

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

Significant dischargers (i.e. industry and/or resorts that discharge large volumes of liquid waste, discharge excessively contaminated water, or a mine); or

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)).

There are approximately 30 potentially significant dischargers to the environment nationwide, including:

- 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; and
- large resorts with sewage treatment plants (approx. 15).

Standard dischargers include:

- industrial facilities outside of 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; and
- 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 it is difficult at this point difficult to determine numbers, mainly because little information is available regarding which urban commercial facilities are connected to sewers, and which discharge to the environment.

6.3.2.2 Sugar

Sugar is the second largest industry in Fiji. Cane is crushed at four mills: 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 equipment and floors (which may contain caustic soda). Effluent is discharged to the environment; both the BOD levels and temperature are high, causing considerable reduction of dissolved oxygen levels in receiving water for the six months of the year (generally June to December) that they operate (Watling and Chape 1992). This causes impacts to the aquatic environment, including fish kills in some of the main rivers.

Rarawai mill is located on the banks of the Ba River, into which its 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 the treatment systems were not performing as expected. This could be due to the input loading frequently exceeding the design value, leading to anaerobic conditions in the 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 the 1995 crushing season showed water temperature and BOD levels to be higher, and dissolved oxygen levels lower, than background levels near the FSC mill discharge outlet, which may be the cause of pollution reported in this river (Tamata et al.1996).

6.3.2.3 Sawmills

There are about 20 sawmills with timber treatment facilities in Fiji; Tropik Wood (located at Drasa near Lautoka) is the largest (Litidamu et al. 2004). The main environmental hazard at sawmill sites is the potentially toxic effects of the wood preservative (a copper chromium arsenic solution) 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 to 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 the nearby Teidamu River were similar to background levels (Green 1992).

6.3.2.4 Fish processing

The country's largest cannery is the PAFCO plant at Levuka. Fish wastes are collected and turned into fishmeal, with waste from the fishmeal plant and from the processing of fish discharged into the ocean via an outfall extending out to the barrier reef. The effluent is high in organic matter and very turbid (Watling and Chape 1992). Although effluent leaving the plant is fairly polluted, the outfall (constructed in 1991) is effective in maintaining satisfactory water quality within the port (Tamata and Thaman 2001). However, monitoring of water quality around the PAFCO outfall and of nearby reef health, undertaken between 1990 and 1996 as part of the construction of the new outfall, indicated a proliferation of algae on the barrier reef. Another cannery (Voko Industries at Laucala Beach Estate) produces effluent with fish wastes that is very high in BOD; it is discharged into the sewerage system, greatly taxing the Kinoya STP (Watling and Chape 1992).

6.3.2.5 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 may have unacceptably high concentrations of suspended solids and hazardous levels of cyanide and arsenic. Seepage from the old, no longer used 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., and is used in the 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).

6.3.2.6 Other industry: manufacturing and processing and commercial customers

Most manufacturing and processing activity is concentrated within industrial areas in the urban centres of Suva and Lautoka. In Suva, these areas include 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 (Table 3; Cripps 1992).

These industries discharge industrial wastewater or trade waste into the sewerage system or into creeks or coastal areas. The water pollution from industrial discharges into the coastal environment significantly reduces water quality in the nearshore waters around Suva and Lautoka; 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 port waters or into stormwater drains. Effluent was analysed for nine of the larger industries and all significantly exceeded permissible levels for discharges 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 onsite; however, two of the oil terminals had effluent exceeding the Port's 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), although some of the industries in Suva and Lautoka now discharge effluent into the municipal sewerage system.

Mechanical workshops and car washes include many businesses that often perform their work outside on gravel or concrete or within a workshop; the common practice is to clean floors using a hose, with the water flowing directly into the stormwater drains, contaminating them with oil and grease. Service stations report that waste oil is stored in drums and taken to Casco (now Fletcher) Steel, which utilises used oil to fuel their furnaces; informal observations by the authors at some service stations indicate that oil is often dumped into stormwater drains, and can be observed on the ground in open areas.

Table 3: Types of Industry Present and Wastewater Constituents

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

Some industrial facilities located within sewered areas discharge trade waste directly to the environment. In the Suva-Nausori about 10 facilities have not connected, either because it is not required, or (in the case of Wailada-based industries) because the Kinoya STP cannot accept their trade waste, as it is already operating over its capacity (Kirkwood and Hughes 2005). Many facilities do have permission from WSD to discharge effluent into the sewerage system.

6.3.2.7 Industry discharging to sewerage system

Data from monitoring of influent at Kinoya STP indicates high BOD, an estimated 30% of which is from non-residential customers, in particular the larger food manufacturing industries. Influent analysis at Kinoya indicated high levels of hydrocarbons, 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 industrial and commercial outlets indicated the presence of trade waste such as grease and solids, which affect the efficiency of the system and contribute to blockages of pumps and piping (Kirkwood and Hughes 2005). There is also the potential that hazardous substances entering the sewerage system may be transmitted through plant outfalls and into coastal waters.

There are about 50 significant industrial facilities in the Suva-Nausori corridor connected to sewer system. Of these, 27 discharge trade wastewater into the sewer. Only one (of 10) facilities in Lami discharges trade wastewater into the sewer. Some industrial facilities in the Suva and Lami area discharge domestic wastewater to the sewer but discharge their trade wastewater directly to the environment, which is a concern. Lautoka has some 10 or so large facilities connected to the sewer, only six of which discharge trade wastewater to the sewer; nationally around 50 significant industries are or should be connected to the sewer system (Kirkwood and Hughes 2005).

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

The main components of trade wastewater entering the sewer system from industries include acids and caustic substances (used in cleaning processes and cleaning chemicals), chlorine and other products (used for cleaning factory floors and processing areas), component constituents of products such as paint and moisturizers (introduced through rinsing of containers and/or vessels used to manufacture these products), products used in commercial laundries, and dyes, paint, and oil.

About 50% of significant industrial facilities currently have appropriate pre-treatment. Within the Suva-Nausori corridor, only a small proportion of commercial customers (particularly restaurants) have pre-treatment, which in most cases consist of a grease trap. In Lautoka, all restaurants and takeaways supposedly have grease traps, as it is required by the council, but some traps are small and unable to cater for the volume of grease generated. Most of these grease traps are cleared manually and the sludge dumped in the Lautoka dump. Sludge from the larger grease traps is typically collected by waste collectors (such as Waste Management Ltd. and Waste Car)e and disposed of 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 NWQL at Kinoya conduct sampling of industry in Suva and the west. Around 26 industrial facilities and seven commercial customers are monitored. If the results of past effluent quality monitoring by NWQL are compared to the old trade waste standards set by PWD, only a few facilities would be in violation, and then only for BOD. However, if the results are compared to the effluent standards proposed in the trade waste policy, many would exceed the recommended levels of BOD, total suspended solids (TSS), fats/oil and grease, temperature and pH. This indicates that the major dischargers are introducing effluent of poor quality into the sewer system (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

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 (MOE), Ministry of Health (MOH) and Department of Mineral Resources, which under the Mining Act is responsible for the environmental management of mines (Watling, 2005).

Some pollution management is currently carried out by the health officers attached to the Municipal and Rural Authorities, under the direction of the MOH's CBH, through their regular inspections of industrial and tourism facilities, but pollution found in urban and resort area suggests these inspections are of limited effectiveness. Pollution and waste management problems have intensified in the last few decades. Some of the municipal councils require commercial facilities such as restaurants and butchers to install grease traps as pre-treatment. Many municipal councils have also successfully required many large industrial facilities to divert their discharges from the environment to sewer systems in the last 5 years (Kirkwoo and

Hughes 2005).

The Ports Authority of Fiji undertakes monitoring of urban and industrial pollution in designated port areas, but observations by the authors and communications from ports Authority personnel suggests this has been largely ineffective. Although some monitoring of ports and industrial point sources polluting the ports has been carried out, there have been no prosecutions and/or fines levied. In addition, a National Oil Pollution Committee (Marine Department) was formed in 1991 with the purpose of coordinating the preparation and implementation of a national oil pollution response plan.

In the absence of supporting legislation, the Ministry of Environment acts primarily in an advisory role to other government departments on environment-related issues. They also comment on national environmental issues of importance.

The Water and Sewerage Department in the Ministry of Works and Energy is now the primary body responsible for constructing, operating and maintaining sewage systems throughout the country (Kirkwood and Hughes 2005). Although the Act specifies that permission is required prior to discharging trade waste into the sewer, to date no special arrangement or permit has been issued to industries discharging to the sewer, with the exception of Carlton Brewery; their flow is metered and they are charged sewer rates accordingly. The Kinoya NWQL regularly monitors the effluent of the significant dischargers. Notices are given to industrial facilities if they are below standard, and some progress has been made in improving effluent quality by requiring installation of pre-treatment facilities.

6.3.4 Issues/Limitations

6.3.4.1 Discharge to sewer systems

Issues that hamper existing management of commercial and industrial liquid waste discharges to the sewer system include:

1. **Uncertainty by WSD regarding which customers are actually connected to the sewer system**, including cases where domestic sewage is discharged to the sewer, and trade waste to the environment. Many customers discharging to the 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. These** include:

- Powers of Entry (Section 5), which do not provide for entering sites for the purpose of inspecting trade waste discharges or ascertaining the source of pollution or unapproved discharges to sewer.
- The provisions relating to trade waste, except charging, are contained 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).

Table 5. Summary of non-residential trade waste customers in each area (assumed connected or should be connected to sewer) and number with pre-treatment (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	TOTALS
Commercial Customers									
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 centres	-	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 sewer	~6	5	15	5	1	1	1		34
Number that have pretreatment	~3	~4	6	2	1	1	1		
Number connected to sewer but discharge tradewaste to environment	-	1	5 (4 w/ pretreatment)	2	3				11

4. **Difficulties with monitoring of industrial effluent, including:**

- Most sites have not been set up with trade waste sampling points.
- WSD staff members 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 the sewer system from industrial premises.

5. **Potential increase in the number of trade waste dischargers due to the EMA. Most** industrial facilities currently discharging to the environment in sewered areas are likely to exceed the acceptance criteria to be developed by the MOE, meaning 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 direct trade waste discharges to the sewer system, 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).

6.3.4.2 Discharge to the environment

Issues hampering management of liquid waste being discharged to the environment include:

1. **Capacity of the MOE.** Although now supported by modern, applicable environmental legislation, the MOE currently has minimal human, technical and financial resources to implement the EMA. The Ministry currently has 9 professional and support staff members, 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 MOE 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 the EMA at the local level; government does not seem to be prepared to put sufficient resources into the Ministry to develop its capacity (Watling 2005).
2. **National capacity to handle industrial waste sludge.** The majority of liquid waste currently transported is septic waste, although there some industrial waste is generated (e.g. from pumping out grease traps and industrial waste treatment tanks, undertaken by a number of private contractors and some local councils). Waste is either dumped in sludge lagoons at STPs or in bushes nearby; the former is viable only in areas with a STP. Disposal is largely unregulated. Where STPs are not located nearby, landfills are sometimes used; 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 are 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 pre-treatment for industry.** Local industry is extremely reliant on New Zealand and Australia for 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

work with the government and resorts at present. There are two local manufacturers of pre-treatment facilities for industry (such as grease traps or settling pits), but 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** regarding the number of (and discharge magnitude by) standard or commercial dischargers to the environment, nationwide.

6.3.5 Opportunities and/or options

6.3.5.1 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 (Kirkwood and Hughes 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;
- a monitoring program;
- enforcement procedures; and
- charging mechanisms.

Awareness and capacity

The post of trade waste manager has 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 the sewer system. Some awareness raising was carried with industry in urban areas regarding the proposed trade waste policy and the implications of EMA, as part of an ADB Technical Assistance program in 2005 (Kirkwood and Hughes 2005).

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

Industry initiative

A number of industrial facilities are aware of the impact of their wastewater on sewer systems and the environment, and conduct their own in-house monitoring of effluent quality; one has its own pre-reatment facility.

6.3.5.2 Discharge to the environment

Legislation/Regulation

The recently passed EMA will address 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, with 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 grants waste inspectors a wide range of powers to enter permitted and non-permitted sites (Watling 2005).

The Act will require all commercial facilities (e.g. 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, and are not currently in force. After regulations come into force there will be a two-year phase in period before they are fully operational (Watling 2005).

A proposed permitting system for liquid waste classifies the facilities discharging to the environment into the following categories.

- 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, and resorts that discharge large volumes of liquid waste (>20,000 litres per day), discharge excessively contaminated water, or are having a detrimental impact on receiving waters; mines are also included.
- Livestock discharger: confined livestock facilities discharging liquid waste, such as piggeries, dairy milking sheds, cattle feedlots, and poultry farms.

The classification will determine if a permit is required, and the 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 aAssessment (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 a unit within the MOE; or
2. a waste management authority is established in the MOE to oversee national waste disposal and pollution control, with officers stationed in the local authorities as Environment Officers.

The first option would require government assistance in terms of financial assistance and capacity building. Under the second option, the CBH Environmental Health Inspectors already provide nationwide 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, and issue improvement and penalty notices; local authorities and municipal councils would receive permit applications and forward these to MOE, undertake general and annual inspections, issue notices, and 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),[1] providing information on the trade waste policy, the EMA its implication to industry.

Monitoring

Some monitoring of the quality of the effluent being discharged to the environment is being carried out by major industries, to inform them of the 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 the tourism industry

6.4.1 Problem

An assessment of nutrient (nitrate and phosphate) levels along the nearshore water of the Coral Coast (Mosley & Aalbersberg 2003) and the Mamanuca Island group (unpublished data) showed 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; although nutrient levels were low, fecal coliform levels were particularly high, in some cases exceeding recreational exposure standards, especially near point source of sewage discharges, 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 threat to the coastal environment in Fiji. This will undermine the resource that tourists are coming to Fiji, to see as well as the subsistence livelihood of nearby coastal villages (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, as 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 consist largely of sewage, but also includes greywater (wastewater from laundries, kitchens, pool overflows, showers and sinks). Most of the large hotels have sewage treatment systems, which provide primary or secondary treatment. Across

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[1] ISO 14000 is a group of standards relating to environmental management developed by the International Organisation for Standardization.

Fiji there are approximately 15 large (>100 rooms) and 25 medium-sized resorts (30–100 rooms). Smaller resorts and backpackers accommodations (1–30 rooms) usually have septic tanks; there are an estimated 65 such 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 by means of settling ponds and septic tanks). Only 7% had secondary treatment. This is of concern, 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 in resorts is poor (IAS, 2004). Key findings of the survey, which covered 30 resorts, were:

- About 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 nutrient load. Around 40% of resorts surveyed use low or non-phosphate detergents, which lowers the phosphate content of their wastewater.
- Around 40% of resorts had on-site sewage treatment plants, 40% had septic tanks, and 20% were connected to sewer 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.
- About half the resorts with treatment plants reused treated effluent for irrigation; 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, and a few never desludging. Most (66%) hired a waste management company to remove solids and dispose of these at municipal treatment plants, while the remainder removed solids themselves and buried them on-site. Some 36% of resorts have upgraded their treatment systems recently, with another 36% planning to upgrade (IAS 2004). For effluent discharged to

Figure 1: Types of Sewerage Treatment used by Resorts

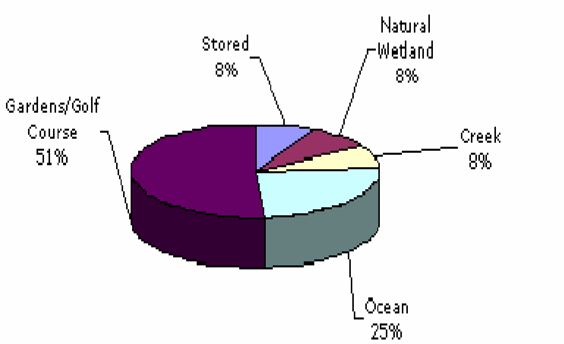
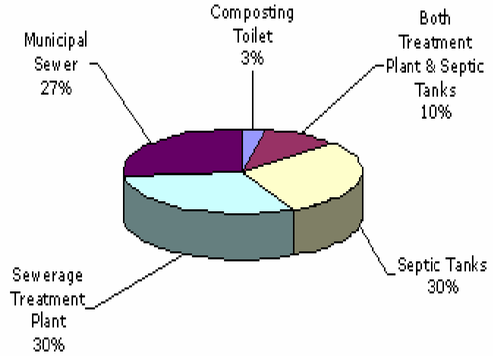


Figure 2: Final Discharge of Effluents from Resorts Sewerage Treatment Plants



the ocean and septic tanks located near the ocean, the 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, the Coral Coast, Nadi, and the 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 Coliform); only four resorts were able to meet at least three of the required standards; and four did not meet any of the standards. Resorts with ponds and/or 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 the nutrients). Those resorts that had effluent that met most of the required standards also met standards for use of effluent for irrigation, but the predicted low removal capacity of coral and sand 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 coastal water (IAS 2004).

6.4.3 Legislation and management issues

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

Proper management of waste depends largely on actions by individual resort owners. However, many resorts are becoming more responsible in the area of 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; consequently, many have opted to upgrade their wastewater treatment plants (IAS 2004).

Other issues include a lack of information and awareness on the part of resort owners and engineers regarding the potential impact of wastewater on the environment, and the lack of local capacity and skills required to advise on and install appropriate wastewater treatment technologies.

6.4.4 Opportunities/Initiatives

6.4.4.1 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 had primary treatment systems with effluent directed to an ocean outfall or irrigation. Treatment was found to satisfy local requirements but not international guidelines or proposed Fiji regulations, and upgrades were recommended. These resorts had upgraded to more advanced wastewater treatment plants by 2004. Two resorts had Enviroflow systems providing 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 (e.g. Naviti and Hideaway). Monitoring of effluent is also undertaken by a number of hotels.

6.4.4.2 Demonstration systems

At the Fijian Resort, Partners in Community Development Fiji (PCDF), a local NGO, has constructed an artificial wetland in partnership with the Darwin Initiative,[2] Cuvu Environment Komiti (Nadroga Province) and the government. This project (referred to as *Waibulabula*, or Living Waters) addresses the problem of nutrient loading that negatively impacts 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. Crusoes Retreat, a small resort on the Coral Coast, has installed a demonstration package wastewater system (AdvanTexTM), which utilizes recirculating textile packed bed reactors.

6.4.4.3 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 has undertaken awareness raising, 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 the 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 of the problem

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

Animal waste normally results in increased nitrogen and phosphorus levels, as well as the release of unpleasant odours. Harmful pathogens could 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, or surface waters, or

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[2] A small grants programme that aims to promote biodiversity conservation and sustainable use of resources; funded and administered by the United Kingdom Department for Environment, Food and Rural Affairs.

indirectly through consumption of contaminated food such as shellfish (Tanner and Gold 2004).

Pigs are raised both formally and informally in Fiji. The 1999 Agricultural survey indicated that there were 92,251 pigs in the informal sector. The formal sector presently produces 36,040 pigs per year. When water is used to flush pig pens without being treated, pig waste goes directly into the environment, increasing nutrient levels in water bodies 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). When 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). There are three large piggeries in Fiji; treatment of wastewater at the Vuda Piggery is by upland irrigation using wastewater.

According to the 1999 agricultural survey, there were 27,583 dairy cows in the country, with seven large dairies. These 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; there is a build up of manure in these areas and flushing with water contributes to environmental pollution. Over several years, the environment around milking sheds can become very polluted (Tukana 2006).

Chickens are the primary poultry reared in Fiji, for the consumption of both eggs and meat. There are approximately 2 million chickens in the country's formal poultry sector at any one time, and some 3.75 million chickens in the informal sector (Ajuyah 2001). Large farms are located at Colo-I-Suva, with around ten nationwide.

6.5.2 Regulations and management

Legislation related to the discharge of liquid waste from livestock areas includes the Land Conservation and Improvement Act, which provides the basis for the 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 2006).

The director of AH&P currently has the power 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, and are including animal waste management systems in promotion of 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 be expensive and expertise is required for proper 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 and use of settling ponds (lagoons) can be cheaper and easier to manage (Tukana 2006).

6.5.3 Opportunities and 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 the 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, due to the low cost, and absence of regulations. These farms are a source of livelihood and employment for the people and 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 the 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

Some ten 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, while 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 and arrangement in place (including at 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 composed largely of sewage waste, but also includes oily waste (from ballast water and engine rooms). In 1999 Suva Port received 20–25 cubic metres of oily wastes. These 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 fishing boats, are believed to discharge their liquid waste at sea, given the strict port regulations pertaining to discharges. It has also been reported that cruise vessels in the Yasawa Island discharge sewage waste into the ocean when going between islands.

6.6.2 Issues and opportunities

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 2006).

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 a focus because of the relatively large portions of land area covered in concrete and tarmac in urban as compared to rural areas, which prevents water from percolating into the soil. The amount of stormwater and the contaminants it transports varies depending on a number of factors (e.g. duration and intensity of rainfall, proportion of impervious surfaces, topography, land use, design, and management of drainage systems). Stormwater flushes various materials (such as litter, dust, soil, fertilisers, nutrients, chemicals, micro-organisms, metals and oils and grease) that have accumulated on impervious surfaces into waterways. Wet weather overflows from sewerage systems are also a component of stormwater. Stormwater is transported separately from the sewerage systems and does not undergo any treatment (ADB 1998).

Stormwater runoff has been recognized as a significant nonpoint pollution source impacting 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 runoff is also a conveyance mechanism for pollutants, including solid waste, into coastal waters and other parts of the cities and towns. By design, sewage 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 runoff has been done for any urban area in Fiji. Given this data limitation, we have tried to illustrate the amount by estimating storm water runoff in Suva City using a simple method outlined from the New York State Storm Water Management Design Manual (New York State Department of Environment Conservation 1992). 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 United States (Box 1). Storm water runoff management is not covered explicitly by current legislation in Fiji.

Stormwater runoff from Suva City was estimated to have a water height of equivalent of 1.6 m/year, 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 runoff will be expected in urban areas that normally experience lower annual rainfall (e.g. Nadi and Lautoka), but the runoff coefficient (determined by land use) also influences the level of runoff.

As the calculation in Box 1 suggests, urban stormwater runoff is voluminous (although not properly quantified), and is currently untreated throughout Fiji.

BOX 1

R = P × Pj × Rv

Where

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 (26,000,000 m^2) = Volume of Runoff (**VR**)

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

VR = 1.6416 m × 26,000,000 m^2 = 42,681,600 m^3 = 4.268×10^{10} litres

6.8 Leachate from sanitary landfill and solid waste dump sites

6.8.1 Extent and management

The new Naboro sanitary landfill is the first for Fiji, covering greater Suva City and the surrounding towns of Nasinu, Nausori, Lami and Navua. The Naboro landfill is the only solid waste repository that 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, or on slopes, and often very close to residential areas. These dumps produce leachate that is often laden with contaminants and not actively treated, apart from natural attenuation. Even if closed (as is the Lami dump), they will continue to produce leachate, as a result of rainwater percolating through the waste, and existing moisture and water within the dumps. An Institute of Natural Resources (now IAS) 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; Chandra 2002). Under the Fiji Persistent Organic Pollutants National Implementation Plan, sites contaminated with persistent organic pollutants (which 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 and management

Raw sludge at Kinoya STP is digested, dried and then stored in drying beds. However, sludge is 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 consists largely of septic tank sludge, but also includes food waste, bilge oil, and industrial waste. Some trucks do not discharge into the lagoon but directly into an adjacent sludge drying area.

Monitoring of primary sludge is carried out by NWQL. If sludge is being reused it is important 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, hydrocarbon levels in tanker waste sludge were fairly high, indicating that other waste (inn addition to septic sludge) was being picked up by these trucks. This highlights the need for control of the disposal of tanker waste at STPs (Kirkwood and Hughes 2005).

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Appendix 1: 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, and lead key and key contributing agencies, output indicators, indicative costs and other resources needed were all identified. 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 human and capital resources required to carry out the needed activities.

Appendix 2: 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 (FJD)**	**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, PC, IAS, SOPAC, PCDF	Ongoing	Report on systems design and standard in Fiji	$20,000	Personnel, information on successful systems used elsewhere
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	Personnel, office space, transport, communications, equipment

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
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 biannual 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					

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
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 management	FAB	6 months	Guidelines amended	N/A	Personnel
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 documentation and	MOE	6 months	Key issues identified Documentation and	20,000	Personnel

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
monitoring methods			monitoring methods identified		
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 in government and industry 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 STPs	MFNP, Donor Partners	36 months	Funding secured to upgrade existing STPs	$50,000	Consultant
Upgrade all existing STPs	MFNP, Donor Partners	60 months (on-going)	Upgrading work completed	$10,000,000	Technical experts

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Resources Needed
On site pre-treatment 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 USP	6 months	Capacity needs and delivery , methods identified	$25,000	Consultant
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					

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Resources Needed
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 (FJD)	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

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
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	5,000	Communication costs

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
			- Brochures/materials on environmental standards developed		
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 the tourism industry	Donor Partners	On-going	Amount of funding allocation to sector	10,000	Consultant
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 (FJD)	Other Resources Needed
Objective 1: Collate and analyse 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 astewater management systems	SPC, MOH, MOE, USP	1 week after collection of result every month	Reports	$10,000	Researcher, communications , transport

Detailed List of Activities	Key Contributing Agencies*	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
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 out duties through spot checks	SPC, NFU	On-going	Spot check reports	$50,000	Human resource, 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

Detailed List of Activities	Key Contributing Agencies*	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
					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	$200,000	Equipment, human resource, transport

Detailed List of Activities	Key Contributing Agencies*	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
			related diseases		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 (FJD)	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					

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
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
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					

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

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
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 minimize contaminants at the source[4]	CBH, AGO	10 months	Appropriate regulation put in place	$10,000	Consultant
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	$10,000	Water quality analysts

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

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
			established		
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 to marine pollution	MOE, Republic of Fiji Military Force (RFMF)	60 months (On-going)	Reduced contaminant levels in liquid waste discharge resulting vessel operators voluntarily comply to dumping regulations	$5,000	-
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	CBH, NOHS (National Occupational Health &	4 months	Identified personnel and laboratories within	$50,000	Trained database input officers.

Detailed List of Activities	Key Contributing Agencies	Timeline (duration)	Performance Indicators	Cost Estimate (FJD)	Other Resources Needed
the landfills and dumpsites as well	Safety)		relevant authorities for monitoring		
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 allow easy information sharing	USP	6 months	MOE having a database with the relevant information	$25,000	Database manager
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

Appendix 3: Participants – formulation of Liquid Waste Management Strategy

Representative	Organization
Marika Kuilamu, Sarah Link	Ministry of Tourism
Lilieta Gavidi	Ministry of Fijian Affairs
Tevita Dawai	Ministry of Finance and National Planning
Timothy Young	Ministry of Health/Central Board of Health
Salaseini Senilagilagi	Auditor General's Office
Andrew Tukana, Alma Taylor	Ministry of Agriculture
Jackie Hughes, Maraia Ubitau	Department of Town and Country Planning
Sher Singh (NWQL), Alan Griffiths, Suresh Kumar	Water and Sewerage Department
CEO invited	Ministry of Public Enterprise
CEO invited	FTIB
Dharam Lingam	Department of Housing
Joe Sanegar	Ministry of Multi-Ethnic Affairs
Apete, Ian Fong	Land & Mineral Resources
Priti Singh	Ministry of Fisheries
Person-in-charge	Maritime Ports Authority of Fiji
CEO invited	Ministry of Education
CEO invited	PM's Office
CEO invited	Solicitor General
Waste Collectors, Disposers and Recyclers	
GM invited	Waste Recyclers (Fiji) Ltd
GM invited	Waste Management Fiji Ltd
Amit Sen	Waste Care Ltd
GM invited	Carpenters Shipping Waste Disposal Services
Tertiary Institutions	
Bill Aalbersberg/ Mohd/ Dr. Koshy/Shaneel, Upma Dutt, Edward Anderson	University of the South Pacific (PACESD & IAS)
Marica Vakacola, Winifereti Nainoca	Fiji Institute of Technology (General Studies)
Fiji Local Government Association	
Town Clerk invited	Ba Town Council
Town Clerk invited	Labasa Town Council
Rajeshwar Raj	Lami Town Council
Rajendra Pratap, Rohit Karan Singh	Lautoka City Council
Anita Murgan	Levuka Town Council
Premila Chandra	Nadi Town Council
Ratnesh Sharma	Nasinu Town Council
Reshmi Karan	Nausori Town Council
Town Clerk invited	Savusavu Town Council

Representative	Organization
Town Clerk invited	Sigatoka Town Council
Town Clerk invited	Suva City Council
Town Clerk invited	Tavua Town Council
Fiji Manufacturers Association	
Ashney Singh	Goodman Fielder (Tucker Group)
Timoci Laqai, Isoa Rokomatu	Fiji Sugar Corporation
Timothy Tavo, Surug Bali	Rewa Dairy
Shailendra Prasad	Coca Cola Amatil (Fijii) Ltd
Peni Puamau	Fiji Industries Ltd (was consulted)
invited	Punjas
invited	British Tobacco
invited	Tropik Woods
invited	Carlton Brewery Fiji Ltd
CEO invited	Fiji Industries Ltd
invited	Pacific Batteries
attended	PAFCO
invited	Voko Industries
Jone Feresi, Deepa Kumar	Emperor Gold Mine
Fiji Retailers Association	
Adam Wade	Hideaway Resort
Daniele B.Vuti	Sea Spray Backpackers Resort
invited	Fiji Hotel's Association
invited (showed grave interest)	Fiji Backpackers Association
invited (through Min. of Agric.)	Fiji Farmers Association
Praneeta Singh	Consumer Council of Fiji
invited	Mc Donalds
invited	Mobil Oil
invited	BP Oil
NGOs	
Iva Bakaniceva	Live and Learn Environmental Education
Kamal Khatri,	South Pacific Applied Geoscience Commission
Mitesh Mudaliar, Steve Iddings	WHO
Merewai Toganivalu, Ken Cokanasiga	Secretariat of the Pacific Community
Seremaia Vuanivono	Partners in Community Development
Mere S.Valu, Alifereti Qauqau	Mamanuca Environment Group
Invited (Nilesh)	Greenpeace
Rural Local Authorities	
	Lautoka Rural Local Authority
Vimal Vikash Deo	Suva Rural Local Authority
	Navua Rural Local Authority
Uday	Nausori Rural Local Authority

Representative	Organization
Paula Laqere	Sigatoka Rural Local Authority
Vasemaca Naulumatua	Nadi Rural Local Authority
invited	Ba Rural Local Authority
invited	Tavua Rural Local Authority
invited	Ra Rural Local Authority
invited	Savusavu Rural Local Authority
invited	Bua Rural Local Authority
invited	Taveuni Rural Local Authority
invited	Labasa Rural Local Authority
invited	Levuka Rural Local Authority
Provincial Offices	
invited	Nadroga/Navosa
invited	Serua/Namosi
invited	Ba
invited	Ra
invited	Kadavu
invited	Lomaiviti
Filimone Ralogaivau	Bua
Other	
invited	Fiji Plumbers Association
Dick Watling	Environmental Consultants Fiji