



FIJI

WATER AND SEWERAGE DEPARTMENT
SIGATOKA (MATOVO) WATER SAFETY PLAN



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Water Supply and Sewerage Department, Fiji

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LIST OF ACRONYMS

ADB	Asian Development Bank
C/E	Central Eastern
DoE	Department of Environment
EEC	Exclusive Economic Zone
EU	European Union
EC	European Commission
EIA	Environmental Impact Assessment
FAC	Free Available Chlorine
GIS	Geographic Information System
GDWQ	Guideline for Drinking Water Quality
GDP	Gross Domestic Product
HACCP	Hazard Analysis Critical Control Point
HTH	High Test Hypochlorite
H ₂ S	Hydrogen Sulphide
IAS	Institute of Applied Science
IEC	Information, Education and Communication
IWRM	Integrated Water Resource management
km	Kilometers
LLEE	Live and Learn Environmental Education
l/p/d	Liter per person per day
ML	Mega Liters
MLD	Mega Liters per Day
MOH	Ministry of Health
MOU	Memorandum of Understanding
NWQL	National Water Quality Lab
Mg/l	Milligrams per liter
NGOs	Non Governmental Organizations
NTU	Nephelometric Turbidity Unit
NZ-MOH	New Zealand Ministry of Health
NZDWS	New Zealand Drinking Water Standards
OHS	Occupational Health and Safety
PICs	Pacific Island Countries
PVC	Polyvinylchloride
pH	Acidity/Alkalinity
ppm	Parts per million
PWD	Public Works Department
RAP	Regional Action Plan
SOPs	Standard Operating Procedures
SOPAC	Pacific Islands Applied geo-science Commission
SCADA	Supervisory Control and Data Acquisition
TWL	Top Water Level
USA	United States of America
WHO	World Health Organization
WEDC	Water, Engineering and Development Centre
WSD	Water and Sewerage Department

WSP	Water Safety Plan
WTP	Water Treatment Plant

1. INTRODUCTION

The Fiji replication commenced after the interest shown by the Water and Sewerage Department (WSD) of the Ministry of Local Government, Urban Development and Public Utilities. A request was made by the Director of Water and Sewerage via a letter to the Director of Pacific Islands Applied Geo-sciences Commission (SOPAC). Through the consultation with Director Water and Sewerage and the Divisional Water Engineer it was resolved that a workshop should be conducted to train and introduce the Water Safety Planning concept in Fiji for Western Division.

Sigatoka (Matovo) water supply system is serving the urban and rural population of 40,000 which depend on the treated reticulated water supply from three sources of surface water catchments namely Sigatoka river, Korotogo Borehole and Qereqere Borehole. There is continuous increase in the urban population growth of the Sigatoka coastal town. Due to the tourism development there is greater demand for the treated piped water supply. The major concern of the Water and Sewerage Department is the efficient supply of drinking water even though there are several constraints such as infrastructure, finance and human resources. The funds have been allocated from the government budget after realization of the extent of developments for both residential and tourism sectors in the area.

It is realised that the importance of improving the water quality in order to eliminate the health hazards and disease causing organisms from the water supply. As such it is ideal to incorporate the Water Safety Planning process in this venture. The expertise and resources will be made available from SOPAC/WHO to assist in the Water Safety Planning programme for Fiji. Greater commitment has been shown by the WSD after the successful completion of the water safety planning process for Suva/Nausori and Nadi/Lautoka zones.

It is anticipated that with necessary training for the staff of Water and Sewerage and Ministry of Health it would greatly enhance the capabilities for formulating and implementing the Water Safety Planning process as a proactive measure in maintaining the drinking water quality and quantity.

The importance of safe drinking water for health and development in the Pacific Island Countries (PICs) has been reflected in many regional action plans and policies. Through the Regional Action Plan (RAP) on Sustainable Water Management (Sigatoka, Fiji, 2002) Pacific Island Countries outlined actions that were needed to achieve sustainable water management through collaborative efforts by water sector authorities and inter-sectoral partners.

The WHO workshop on Drinking Water Quality Standards and Monitoring in Pacific Island Countries (Nadi, Fiji, 2005) developed a Framework for Action on Drinking Water Quality and Health in Pacific Island Countries, designed to support the implementation of drinking water quality actions envisioned in the Regional Action Plan (RAP). The Pacific Island Countries embraced the Water Safety Plan concept during the workshop and this was reflected in the Regional Framework. It was recommended that PICs should use Water Safety Plans to better manage their water supplies to ensure safe quality drinking water for Pacific communities.

1.1 BACKGROUND

The Fiji islands are located between 12 degree – 21 degree south latitude and 176 degree East – 178 degree West longitude (Refer to the Fiji islands Map Below). Fiji consists of more than 300 islands of which about one third are inhabited. With a land mass of 18,272 square km Fiji is third largest state in the region next to Papua New Guinea and the Solomon islands. The Exclusive Economic Zone (EEZ) of the country Covers 1.3 million square Km. the two biggest islands , Viti Levu and Vanua Levu ,have the majority of the total population of about 900,000 ,with about 50% living in urban areas such as Suva (177,000), Lautoka (45,000) and Nadi (33,000). The largest Islands account for 87% of the land area and 90% of the population.

The larger Islands such as Viti Levu and Vanua Levu, Tavueni, Kadavu and the islands of the Lomaiviti group are rather mountainous and of volcanic origin. They rise more or less abruptly from the slow to impressive heights. The south east or the windward sides of the islands record the highest rainfall up to 4000mm annually. The western and northern parts of the major islands are in the rain shadow of the volcanic mountain ranges and may receive an average rainfall of 2000mm. They are therefore much drier and frequently threatened by droughts (Terry and Raj 2002)

The climate in Fiji is dominated by the southwest trade winds. Exposure and topography control the distribution of rainfall on the islands. Average annual precipitation over the Fiji group ranges from 1500 mm on smaller islands to over 4000 mm on the larger islands. Topographic effects mean however that much of this falls within the windward side of the islands'

The wet season from November to April is also the season of tropical cyclones. In the western parts of the bigger islands up to 80% of the annual total rainfall falls during this period. The western and northern parts of the major islands receive only 60-70% of the rainfall recorded in the eastern parts. Here drought conditions are more likely to occur, especially during El-Niño episodes. These drier parts of Viti Levu and Vanua Levu are the centre of Fiji's sugar cane production.

The Sigatoka water supply system comprises of the urban and rural areas of coastal town of Sigatoka extending from Natadola to Korotogo. There are a number of major hotels and resorts on the coasts occupied by the tourist. The water for the consumers is mainly treated and supplied by the three surface water catchments.

About 16 MLD of treated water is supplied to the consumers through the distribution system and multiple storage reservoirs. The conventional water treatment is used with disinfection by chlorine. The water is extracted from the Sigatoka River and two smaller bore fields and after chlorination the water is fed to the distribution system either by mechanical pumps or by gravity. The supply capacity and the infrastructure are sufficient but the need is for improvements in all areas.

1.2 Matovo Treatment Plant

Matovo Treatment Plant receives its raw water supply from Sigatoka River via three infiltration galleries and two flight pumps situated close to the plant on the river bank. The plant is operated in through sedimentation tanks and maze clarifiers. Chlorination is done after rapid sand filtration, or with both clarification and filtration processes i.e full conventional treatment depending on the turbidity of incoming water from the dam. High contents of iron and manganese is common in the raw intake water and since there is no efficient methods to remove the chemicals it causes black stains in the system. Prior to sedimentation low doses of alum (and possibly lime) are usually added to assist the filters to remove the solids and colour from the raw water through flocculation and coagulation process. Aluminium Sulphate (Alum) assists in floc formation and thus removes dissolved solids prior to filtration. Soda ash is added to adjust the pH content of water to about 6.8 as this standard increases the efficiency in treatment processes. The captured solids in the filter are backwashed and removed on a periodic basis. When the raw water turbidity and/or alum dose required is high, the conventional water treatment process is implemented. This includes sedimentation (clarification) prior to filtration. Under this mode of operation, the raw water is always dosed with alum and usually lime. And at much higher doses than for direct filtration.

Water for filter backwashing is stored in the wash water tanks at an elevated level close to the plant. These tanks are filled by the backwash supply pumps. During a backwash, air blowers provide air to scour the filter sand and dislodge the solids that have become captured within the filter beds. Water is then gravity fed from the wash water tanks to the filters. The wash water flows upwardly through the filter sand to flush out the solids to the site sludge thickener which also receives sludge from the clarifiers. The sludge water is pumped to the lagoons located near the plant. Filtered water is dosed with chlorine and lime prior to entry to the clear water reservoirs. From the clear water reservoirs, water is pumped by high lift pumps to the storage tanks and gravity flows to surrounding areas via outlet mains of 300 -500 mm diameter.

1.3. Project Objectives:

The main objective of the Fiji Water Safety Plans Programme is to produce Water Safety Plan and Improvement Schedule for Sigatoka urban Water supply system involving the staff of Water and Sewerage Department and the operators of Matovo/ Nadroga Water Supply. At the end of the programme it is anticipated that the staff of the Department are well familiar in compiling the plans for other supplies by them and have a completed WSP for Matovo supply.

1.4 What is a Drinking Water Safety Plan?

A Drinking Water Safety Plan (DWSP) is a comprehensive risk assessment and management tool that encompasses all stages in the drinking water supply from catchment to consumers. It draws on principles and concepts from other risk management approaches including Hazard Analysis Critical Control Point (HACCP) and the 'multi-barrier approach'. It is more of a pro-active approach whereby continuous monitoring and improvements are done to eliminate any hazard in the water supply system.

The Improvement Schedules are part of the Water Safety plans and compiled after the risk assessment and risk ranking in the water supply system for the specific plant is formulated.

The key objectives of a Drinking Water Safety Plan are to:

- Prevent the contamination of source waters;
- Treat water effectively and efficiently to reduce or remove contaminants; and
- Prevent re-contamination during storage, distribution and handling

1.5 Administrative Support

Administrative support was given by Nadroga Water Supply department for the logistics such as transportation for field work and office space for the consultant. A good commitment was shown by the department as the lead agency in the project. All information was made available with reference to reports, inspections and personal interviews during the consultancy. A mini seminar for the Matovo plant operators were done to brief them on the Water Safety plans concept.

1.6 Sigatoka (Matovo) Water Supply Description

Sigatoka urban water supply system flow diagram and locality plan can be seen in detail below. Since the water is from surface river catchment there is full conventional treatment system in place and thus sedimentation, filtration and chlorination is the necessary process to eliminate dissolved solids, micro-organisms and unwanted natural chemicals from water prior to public consumption. Since the intake is of surface water from the Sigatoka River, it contains impurities and highly turbid therefore full treatment of water is required prior to human consumption.

The pictures below show the maze clarifiers in use at the Matovo treatment plant. The clear water in the Sigatoka is more common in dry season but highly turbid in rainy seasons. The turbidity increases as there is extensive farming in the catchment area alongside the river. Bacterial content of the water is high as well due to pollution by human and animal activities. The catchment area is large therefore it is necessary for regular inspection, monitoring and public awareness. There is a need for other agencies to act collaboratively in this regards.



Horizontal - Maze Clarifier – Matovo Plant



Flight pumps- Sigatoka River Catchment



Borehole Intake at Qereqere - Sigatoka



Borehole intake at Korotogo - Sigatoka

The intake water quality is monitored by the National Water Quality Laboratory (NWQL) staff from Kinoya once a month to detect abnormal presence of bacteria and hazardous chemicals.

The map below shows that the Sigatoka (Matovo) water supply system is located in the western division where it is more prone to natural disasters such as flooding. Secondly the demand is high with large distribution area.



Unmaintained Reservoir – Lawai



Voua Reservoir – Damaged lids

Most of the storage reservoirs were seen to be unmaintained and overgrown with grass. The missing and rusted lids pose a problem of bird and rodent access. Some of the reservoirs were not maintained at the Top water level and no notice boards or proper fence were seen to control public access.

Manual water level measuring is common due to lack of proper telemetry system. The catchment area and bore fields were not fence or protected from natural disasters. It was revealed that two trips are made daily to all reservoirs to measure the water levels.



Manual Water level Measuring - Voua



Unprotected Bore-fields from animal and public access
Sigatoka River intake - Matovo

Figure 1 Map- Fiji Islands- Sigatoka (Matovo) Regional Water Supply

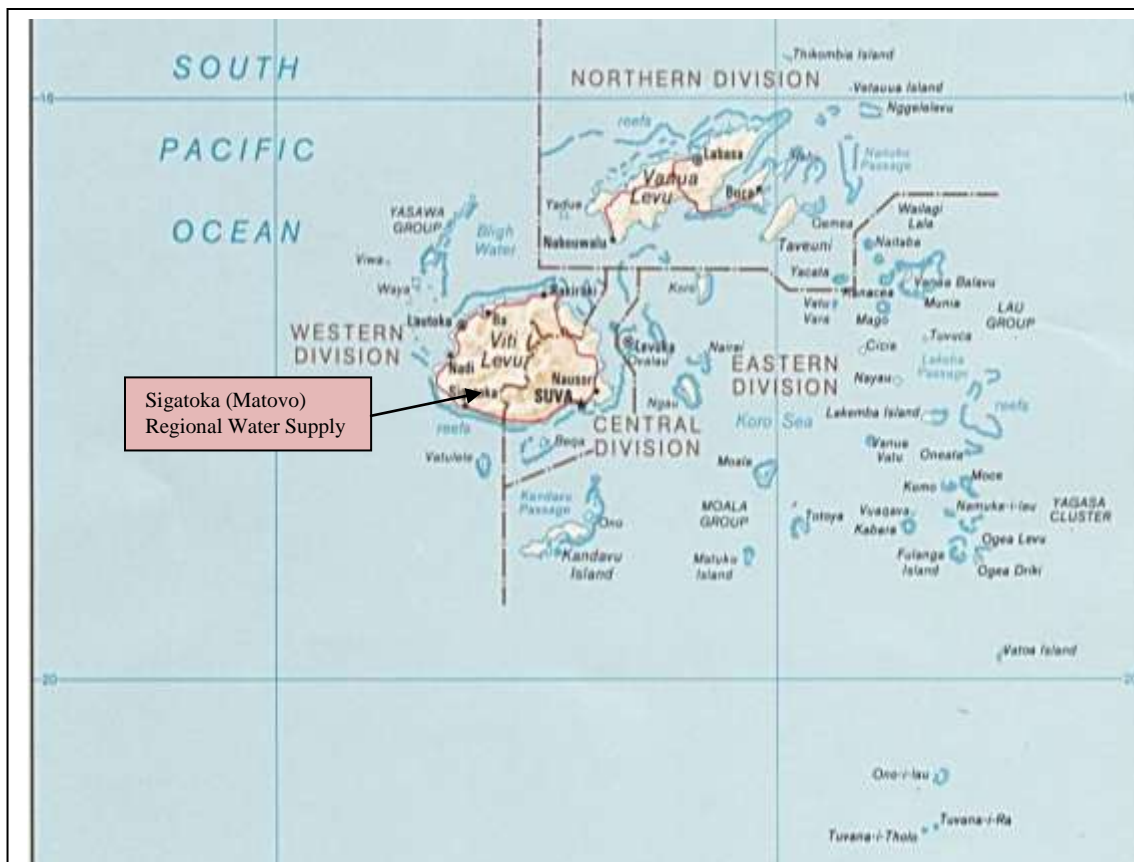
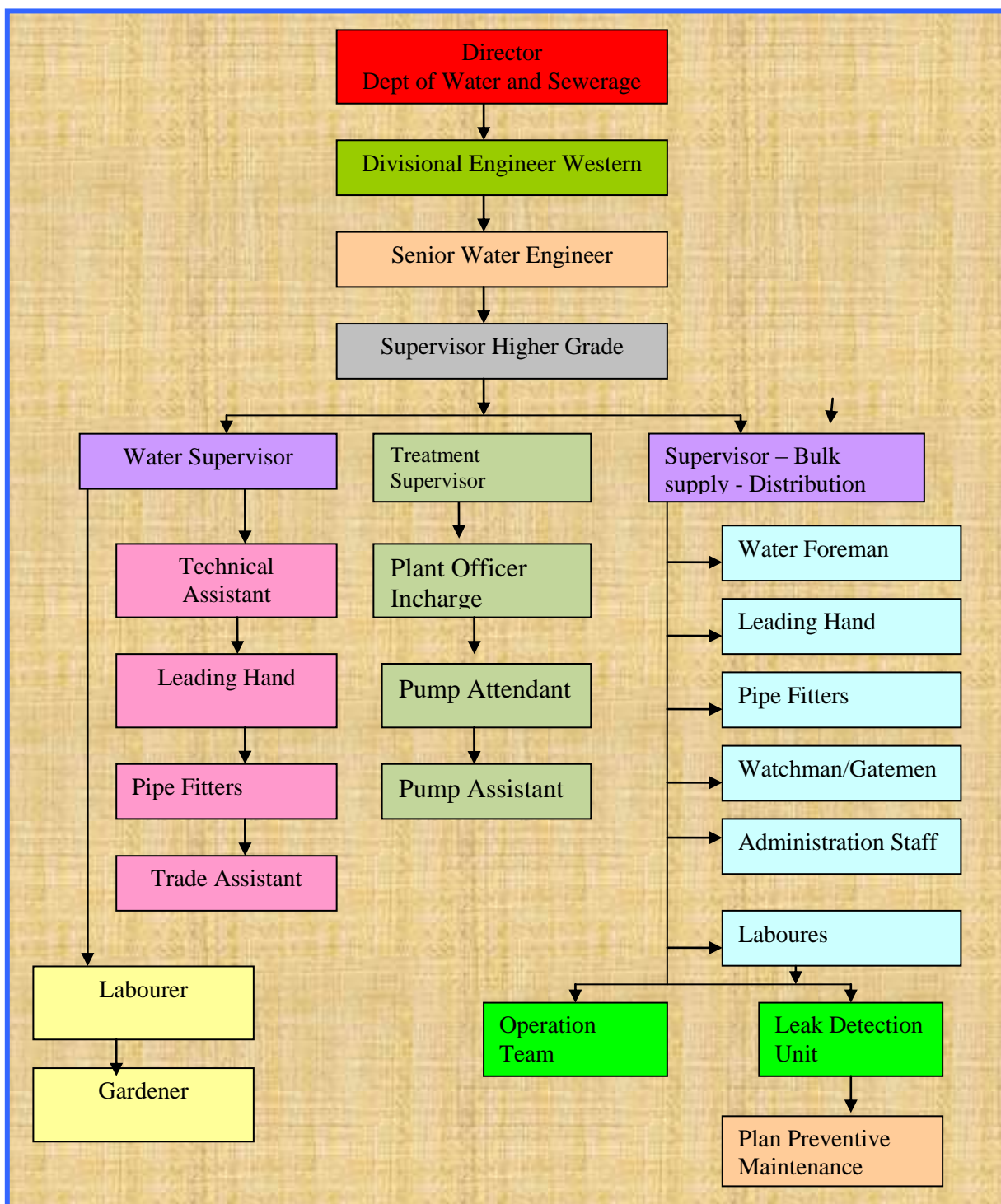


Figure 2- Sigatoka Water Supply Operational Structure



1.7 Water Resource Management

Surface water is used as the main source of supply for all major Towns on the larger, high islands of Fiji, as well as for industries and irrigation. Some small, low lying islands rely exclusively on ground water and may or may not use rainwater. Rainwater harvesting is widespread in Fiji but improvements are required to sustain supply during droughts and prevent the stored water from contamination.

As a result of climate change flooding is currently a very high priority political issue for Fiji. In light of serious flooding which has occurred throughout various parts of the country over the last few years there is loss of life and damage to properties and infrastructure thus causing economic burden. On small low-lying islands, groundwater resources may be very vulnerable due to over-exploitation and contamination. Industrial pollution, urban drainage and sewage are cause of concern for water contamination on larger islands.

Even though 70% of the population has excess to treated, metered reticulated water, continuity of supply is not ideal and maybe in question, particularly in the drier months. Wells on many islands are contaminated with faecal coli-forms due principally to a lack of sanitation and awareness amongst the community. The health of the near-shore environment is of particularly high importance, owing to tourism development along the coast. (IWRM Synopsis - Pacific Island Countries 2007)

Fiji identified the following water resource management barriers:

- A lack of water resources management technical capacity and formal responsibilities
- A lack of public awareness on water conservation and water pollution
- Land tenure and water rights
- Conflicting policies and unclear legislation
- A lack of effective formal coordination
- Adequate planning mechanisms

Table 1- Fiji Essential Data - (Source-SPC data 2000)

Area	18,333 sq km
Population	850,000
Population Density	46 persons/ sq km
Urban Population	46%
Annual inter-census growth rate	2.6%
Annual inter-census national growth	1.6%
Rainfall	2000 – 4000 mm/year
GDP (Gross Domestic Product)	\$5.6 billion
GDP/capita	\$6,200
Land use	Arable land:11%;permanent crops ;4.6%
Water consumption	Urban:200 lpd;semi-rban;150 lpd; rural:100 lpd
Population access to treated water	80%
Island type	Volcanic, limestone, atoll, mixed
Type of water supply	Surface water, groundwater, rainwater, desalination
Key Economic Sectors	Agriculture, clothing, fisheries, sugar and tourism

1.8 Fiji Water Economics

Responsibilities for Fiji's water resources falls within the jurisdiction of the Director of Water and Sewerage in the Public Works Department. The Fiji Public Works Department has responsibility to supply potable water to over 80% of the country's population. The consistent development of water resources and supply strategies in Fiji has been thwarted by a lack of clear and comprehensive legislation compounded by the number of government agencies that are mandated to deal with water at one level or another. These departments include the Ministry of Public Utilities, Ministry of Lands and Mineral Resources, Ministry of Health, Ministry of Regional Development, Housing and Squatter Settlement and Ministry of Agriculture Environment and Fisheries.

Hydrology falls within Public Works Department while the Ministry of Lands and Resources assists in the planning and assessment of ground water resources. Although Fiji is fortunate to have a plentiful supply of fresh water with high rainfall, droughts and floods over the last twenty years have caused major interruptions to the collection, treatment and reticulation of portable water. The symptoms of these impacts have been most noticeable in the towns and cities of Fiji where major water supply shortages and breakdowns have been the norm.

Legislation related to water resources in Fiji is outdated but has generally served the nation well until recent times. There is a need to review various water related legislation to reflect current policy constraints. The commercial use of water from groundwater supplies as well as resource management issues in catchments including logging underlies the need of comprehensive review of national policy followed by legislation. Many of these issues are politically and socially sensitive in Fiji, with the shortage of water supply in towns and cities and need for major infrastructure improvements. (SOPAC Misc Report 554-Carpenter& Jones)

The Water and Sewerage Department operates and maintains 32 Public water supply schemes nationwide comprising of 15 Water Treatment Plants, over 110 service reservoirs and over 2,200 km of reticulation system of 50 -900mm mains. It costs the WSD about \$28 million per annum to produce and supply safe water to the nation. About \$6 million is spent on electricity annually to operate motors and pumps. Chemicals used to purify the water costs about \$2 million a year.

To be connected to government water supply the following fees is charged;

New domestic connection	\$21.95
New commercial meter	\$100.98
Re – connections	\$10.00

The average cost of producing 1,000 litres of water (equivalent to 1 unit on your water meter) is \$1.98 but charges you less than 1 cent per litre. (Water Sewerage Dept 2008)

1.9 Water Quality Monitoring

It is recommended that before a monitoring programme is designed relevant agencies and professionals form a team and discuss various aspects such as risk identification, parameter selection and risk management. A multidisciplinary approach is adopted to ensure that agencies with responsibilities for specific areas associated with water quality are involved. It is important to briefly but accurately describe the drinking water supply for which the monitoring plan is being set up.

It is important to know your role when designing a drinking water quality monitoring plan, whether you are a water supplier or a surveillance agency. The water supplier has a responsibility to ensure that the water they supply is fit for human consumption. Hence they are responsible for monitoring the quality of raw water, treated water and water at storages and distribution system. The surveillance agency is also expected to monitor the water supplied by the supplier to verify that the quality is indeed fit for human consumption. They are responsible for monitoring the water quality immediately after treatment and during storage and distribution. Occasionally they could monitor the source water quality to ensure that the supplier is doing its job of source water protection (SOPAC Tech Report 407, Hassan & Aalbersberg- 2008)

Currently there are four major types of water quality monitoring programmes in Fiji, including those conducted by PWDs National Water Quality Laboratory (NWQL) for urban treated water and the Public Health Department for urban, rural and private supplies. The Institute of Applied Science (IAS-USP) also samples urban and rural water supplies and for private bottling companies. There is no official exchange of information between agencies and results from WSD and USP are treated as confidential and not shared voluntarily with the Health Department.

The critical parameters in water quality monitoring are:

- **Microbial Organisms-**

Monitoring microbiological quality of drinking water is of principal importance because of the acute risk to health posed by bacteria and viruses in drinking water. Microbial organisms that are pathogenic (disease causing) make the largest contribution to water-borne diseases in developed and developing countries. The presence of pathogens in drinking water is usually due to human and animal waste entering the water sources. An indicator organism such as E. Coli-form is always present in large quantities in faecal matter, whether pathogenic organisms are present or not. A high level of indicator organisms in a water sample indicates a high risk that pathogenic organisms might also be present (Mosley et al, 2004)

The table below shows examples of population based sampling numbers and frequencies for microbiological parameters in distribution systems drawn from WHO Guidelines for Drinking –Water Quality (2004)

Table 2 - Water Samples per Population

Population	Sample per month
<5,000	1 sample
5,000 to 100,000	1sample per 5,000 population
>100,000	1 sample per 10,000 pop plus 10 samples

However if the population served is 30,000 then 6 samples are to be taken per month, this depends on the resources as well. It is advisable that the samples from a distribution system are collected randomly over the network instead of having fixed sampling points. This would ensure coverage of the entire network over time.

- **Turbidity**

Turbidity is the measure of “cloudiness” of the water and is often used as a simple substitute for suspended solids. Turbidity may cause rejection of water by consumers, as it is also associated with bacteria survival, as adsorption onto suspended solids by microorganisms is common. Turbidity should always be tested whenever a sample is taken for water quality testing, the standard being no more than 1- NTU for treated water. High turbidity protects micro-organisms from chlorine and other disinfectants and interferes with the maintenance of residual chlorine. An increased turbidity during distribution may indicate leakage or breakage of piped system and therefore an increased likelihood of microbiological contamination (Howard 2002).

- **Residual Chlorine or Free Available Chlorine**

Chlorine is a relatively cheap and readily available chemical that, when dissolved in clear water in sufficient quantities will destroy most disease causing organisms without being a danger to people. However chlorine is used up as organisms are destroyed. If enough chlorine is added, there will be some left in the water after the organisms have been destroyed, this is called free chlorine. Free chlorine will remain in the water until it is either lost to the outside world or used up destroying new contamination. Therefore, if we test water and find that there is still some free chlorine left, it proves that most dangerous organisms in the water have been removed and it is safe to drink. We call this measuring the residual chlorine or free available chlorine (FAC).

Residual chlorine or FAC of above 0.6 mg/L or more causes problems of acceptability for some consumers on the basis of taste, depending on local circumstances. Monitoring residual chlorine where the treated water leaves the plant indicated that the disinfection process is working properly. Measuring at different points in the distribution system is used to check that there is not an excessive chlorine demand that may indicate other problems in the system such as ingress of contaminants.

- **pH**

A common indicator pH is the measure of the hydrogen ions (H⁺) concentration in the water and is an important parameter for describing the likely state of other chemical process occurring. The pH of piped or reticulated drinking water supplies should be regularly monitored as low levels (<5-6) may cause corrosion of metal pipes and fittings, releasing metals into the water. Water with pH > 8.5 could indicate that the water is hard. pH is important as an operational parameter, particularly in terms of efficacy of chlorination or optimising coagulation. Where the pH is >8.5, the chlorination efficiency becomes impaired. The optimum pH for chlorination is between 6.5 and 8.5. Wherever possible, the pH in water should be tested when residual chlorine is measured (Mosley et al 2004).

1.10 Water Quality Monitoring for Sigatoka Water Supply System

There is no on-line water quality monitoring instruments installed at Matovo WTP. There is no automatic control of the chemical dosing pumps. If automatic adjustment of

coagulant dose rate (g/m³) is required, some means of monitoring raw water conditions for controlling the alum and soda ash dosing pumps is also required.

Fiji has no water quality standards and no system for classifying receiving waters therefore ministries adopts their own standards in reference to the WHO standards. The National Water Quality Laboratory at Kinoya test a number of parameters including Free Available Chlorine (FAC) and bacteriological test weekly in the distribution and storage system and provides the results to the water treatment plant operators and the management.

The NWQL has adopted standards for its treated water. These standards have been adopted from a variety of sources and they are equal to or more stringent than, for example the current Australian and New Zealand Drinking Water Standards with the notable exception of Turbidity. However it needs to be noted that the adoption of standards has little effect meaning in the absence of a Non –compliance Procedure or Event Reaction procedure and /or an incentive to comply (ADB Report 1999).

At the Matovo Treatment Plant test on the water quality are done at an interval of 4 hours and the result are recorded for adjustment if chemical dosing and availability of FAC at plant is to be maintained at the required standards. During manual testing, Hach chlorine colour comparator and turbidity meters are used. The plant operators monitor the water quality at various points at the plant and record the results.

The treated water being delivered from Matovo WTP aims to achieve the following water quality objectives;

Water Quality Parameter	Objective Limit
Turbidity	< 1.0 NTU
pH	>6.8
Residual chlorine	1.0 mg/L

Table 3-Treated Water Monitoring for NZDWS 2000 Compliance

Parameter	Method/Location	Frequency	Comments
Turbidity	Online turbidity meters on outlet of each filter	Continuous	Surrogate for protozoa contamination. Must be demonstrably less than 0.1 NTU for more that 95% Of the time and must not exceed 0.2 NTU.
Copper Sulphate	Laboratory methods Drinking water leaving the plant	3 samples per calendar quarter	If dosing of copper sulphate continues: must not exceed 2 mg/l in any sample.
Chlorine	Online chlorine residual monitor	Continuous	Must be sampled after not less than 30 minutes contact time; monitoring plant must not be out of service for more than 1 hour per week; residual in drinking water leaving the plant must not be less than 0.2 mg/l with pH not greater than 8.0 and turbidity always less than 0.5 NTU
pH	Online monitor in drinking water leaving the plant.	Continuous	Required for verification of chlorine residual compliance

(Harrison & Grierson Report 2003)

Table 4-The table below summarizes the dose rates for chemicals

Chemical	Solution Strength	Dose Rate	Pump Rate (at 16MLD)	Comments
Soda Ash	0.5%	20g/m ³	670m ³ /hr	High turndown rate- two operating pumps would be required to achieve range 2 pumps plus standby
Alum	0.5%	10g/m ³	670m ³ /hr	Turndown of 1:5 Difficult to prepare stronger (than 20%) stock from alum kibble. Two simplex pumps or large duplex pump) to achieve capacity) plus standby if using 10% stock
Potassium Permanganate	0.1%	2.0g/m ³	670m ³ /hr	1gm of iron/manganese will react with 0.94 gm of potassium permanganate
Polyelectrolyte	0.1%	0.15 – 0.20 mg/l	255 – 920 L/hr	Turndown OK One pump plus standby
Lime	5%	Max dose of 1.0 mg/L	450 – 920 L/hr	Turndown ok one pump plus standby

(Harrison & Grierson Report 2004)

1.11 Social Analysis

Recent water shortages in Sigatoka areas due to tourism and residential developments have affected many residents as water stoppages were unexpected. There are no alternatives for water supply when the main system is un-operational as few people have rainwater tanks and the nearby creeks and streams are polluted. During water cuts the water is catered in trucks to the residents as there are no water vendors or public standpipes. This may not be possible as the government has announced a 50% reduction in operation cost for all government departments. The carted water is liable to recontamination as tanks are not clean and domestic storage containers are also contaminated by unhygienic handling. Those who experience the adverse consequences are mostly the children and the elderly who rely on others for water.

Over the next five years, it is predicted that the Sigatoka population will increase. Without intervention to improve the current water supply system, it will not be possible to cope with the increased demand. As many businesses rely on water supply as an essential element in their production, thus scarcity of water can mean significant economic disruption. There is also a social and non-monetary cost for the tourism, education and health services sectors when water is not available.

While the overall coverage of the water supply network is good in the area with 70% coverage of piped supply, the unreliability and unpredictability of the system affects virtually everyone. There are a lot of areas in the system that needs improvement.

During the 1996 -2007 inter-censal period, the Nadroga/Navosa area also continued to experience population growth at a rate of 0.7 percent per year. Much of this growth occurred in peri-urban areas. (Census 2007 Report)

Table 5-Population Change 1996 – 2007 Nadroga/Navosa Area

Area	2007 Pop	1996 Pop	Change (number)	Change (%)
Nadroga Total	58,623	54,083	4,540	8.4
Urban	9446	7862	1584	20
Rural	49,177	48,221	2,958	6.25

Source: Fiji Islands Bureau of Statistics –Press Release N0.53, 2007

Although the overall population growth rate of Fiji is 1.62% the areas which grew most rapidly during the last census period were the peri-urban areas of Nadi and Lautoka. These area average growth rates were 2.8% and 2.3% respectively. (Census 2007 Report)

Tourism and Development

During the 1996-2007 intercensal periods, the population of Nadroga/Navosa also increased at about the national average. The substantial increase in the category others is probably related to the relative abundance of Coral Coast freehold leases. (Census 2007 Report- Bureau of Statistics- Fiji, No.45, 2008)

Visitor arrivals in 2004 reached a record of 504,075. This number represents an increase of 17% over the 2003 figures of 430,800 and the first year to surpass the 500,000 mark in visitor arrivals in Fiji. (Statistical News- Fiji Islands Bureau of Statistics- No.12,2009).

Year	2002	2003	2004
Visitor Arrivals	397,859	430,800	504,075

1.13 Health Status

Fiji enjoys a relatively high standard of health compared to many of its Pacific Islands neighbours. Comprehensive health care and immunisation programs, coupled with other initiatives undertaken by the Ministry of Health to promote healthy lifestyles, such as health education in schools, Healthy Islands Concept and health promoting communities project, have contributed to a high health standard.

The average life expectancy has increased from 61.4 to 70.6 years for males and from 65.2 to 74.9 for females for the period 1993-1997. The infant mortality rate is around 22 per 1000 live births (Bureau of Statistics 1999)

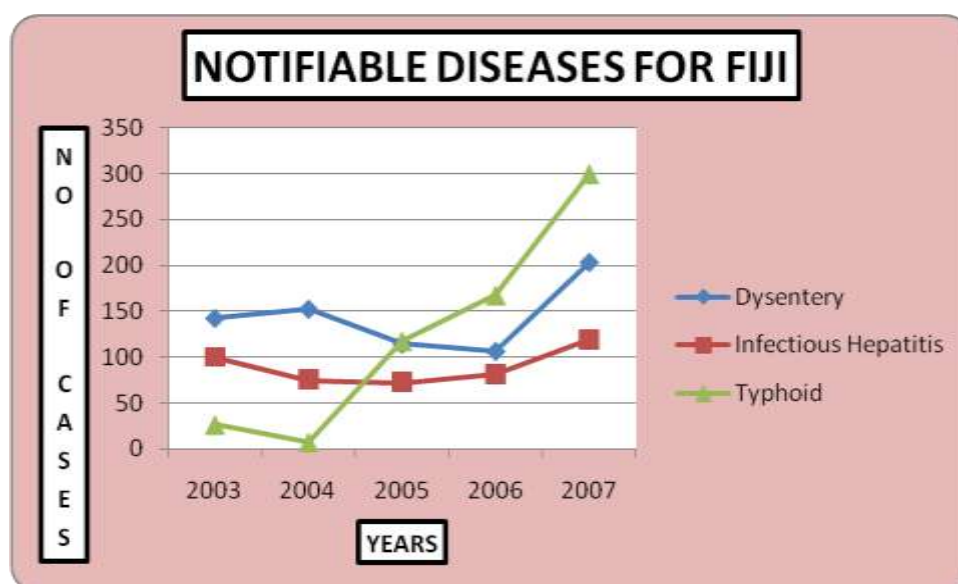
While general health indicators have improved, non-communicable diseases such as diabetes, heart diseases, cancer and respiratory diseases have been on the increase and are the main illnesses of concern in Fiji. The diseases are attributed to changes in lifestyle such as smoking, obesity and diet. Health reports indicate that the main illnesses in the greater Nadroga/Navosa province are diabetes, hypertension and asthma.

Some key diseases, which have been reported to health authorities for the whole of Fiji in the five year period from 2003 to 2007, are presented in table 6 below.

Table 6-Notifiable Diseases for Fiji

Name of Disease	2003	2004	2005	2006	2007
Acute Poliomyelitis	0	0	0	1	0
Dengue	2762	84	27	34	83
Diphtheria	0	0	0	0	0
Dysentery	142	152	114	106	203
Encephalitis	4	0	1	3	1
German Measles	2	2	0	7	0
Diarrhoea	6,103	5,844	6,309	11,411	7,625
Infectious Hepatitis	100	75	72	81	119
Malaria	12	3	5	2	1
Meningitis	47	63	118	107	120
Tetanus	0	4	1	0	0
Typhoid	26	7	117	167	299
Tuberculosis	188	135	133	93	54

Source: Ministry of Health, Fiji – 2007 Annual Report

Figure 2 - Notifiable Diseases for Fiji -2003-2007

The Central Board of Health was satisfied with the quality of mains water supply available in Nadroga/Navosa area. In year 2008 total water samples analysed were 166 and 123 of these were rated satisfactory. Health Authorities informed that the use of rivers and creeks for water is rare in Nadroga/Navosa area and there is a high level of awareness about polluted water and the need to boil before consumption. The media is used to notify the public about unsafe water condition if necessary.

Table 7- Bacteriological Water Sampling for Nadroga/Navosa Area - 2008

Sampling Area	Total samples taken	Number Satisfactory	Number Unsatisfactory	% Unsatisfactory
Bacteriological	48	30	18	28
Chemical	12	10	2	15
Total	60	40	20	33

Source: Ministry of Health- Unsatisfactory samples are mostly from untreated supply.

1.14 Climate Data

The climate in Fiji is dominated by the South East trade winds. Exposure and topography control the distribution of rainfall on the islands. Average annual precipitation for Fiji group ranges from 1500 -4000mm.

Rainfall for the March to May 2008 period was predicted to be average to above average across Fiji. The confidence level of the forecast was generally moderate.

Most parts of the country experienced widespread rainfall with occasional heavy falls during the first three weeks as troughs of low pressure remain at western side causing flooding in January, 2009 in Nadi.

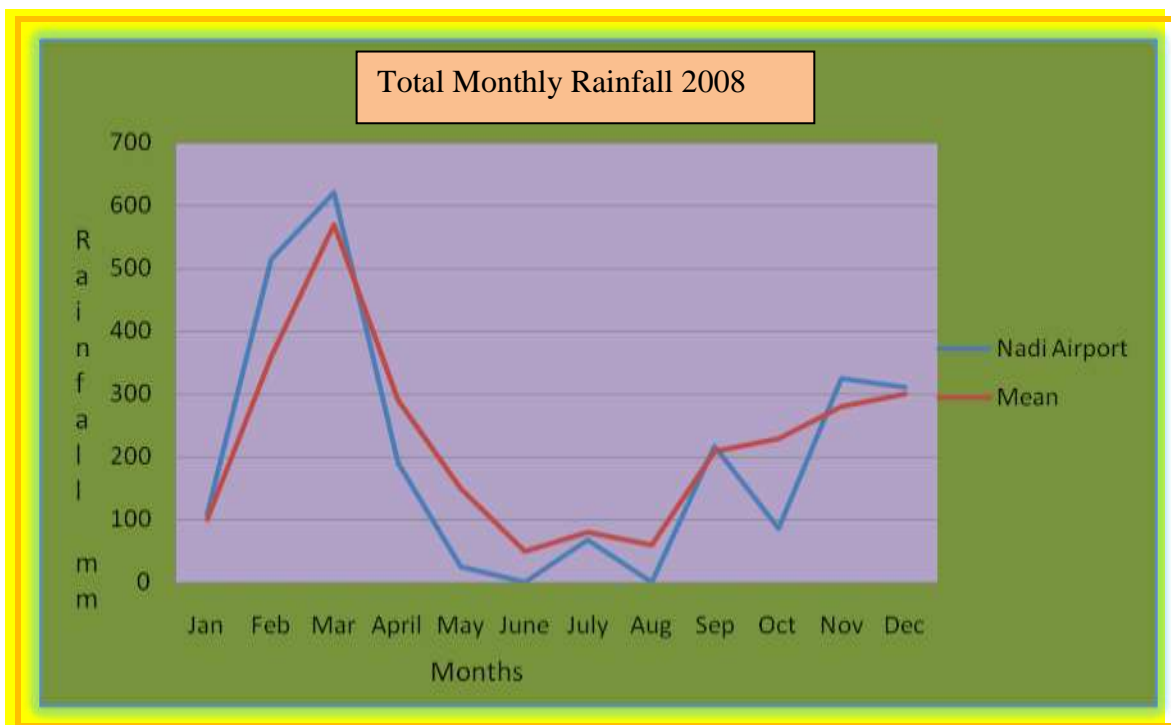


Figure 3 - Total Monthly Rainfall – Nadroga/Navosa for year 2008

Data Source: Fiji Metrological Services – 2008

2. SYSTEM DESCRIPTION MATAVO WATERSUPPLY

Water Supply Information Sheet

Catchments & Intake

Catchment

- Source: Sigatoka River intake (Surface water)
- Waste entering into the catchment from wild animals(pigs/cattle)
- Frequent flooding at the intake during rainy season
- Fish /shellfish and wild water fowls common in the area
- Decaying vegetation around the catchment
- Access of humans/animals into catchment area

Intake

- Intake located on sigatoka river bank (Concrete Structure).
- Korotogo borehole intake pumped to the reservoir.
- Qeregere borehole intake to Voua reservoir
- Borehole intake water is chlorinated and pumped to the reservoirs

Treatment

- Water from Sigatoka River is pumped by mechanical/flight electrical pumps to Matovo Treatment Plant.
- Chemical mixing (Alum, Soda Ash, and Copper Sulphate) is done at the fresh water inlet at the plant.
- Sedimentation and Coagulation is done at the horizontal clarifiers.
- Rapid sand filtration is done) eight filter beds available.
- Chlorine dosing is done via an injector at the main line, prior to distribution.
- Modern with computerised operation

Storage and Distribution

- Treated water is pumped to the storage reservoirs and gravity flows to the distribution.
- Supply rate is about 16 Mega Litres per day of treated water.
- Water is pumped and stored in 7 reservoirs along the distribution network.
- Distribution of mains line is of 150-500 diameter iron and PVC pipes.
- All consumers are metered and water charges are imposed.

Figure 5 – Matovo Water Supply Schematic

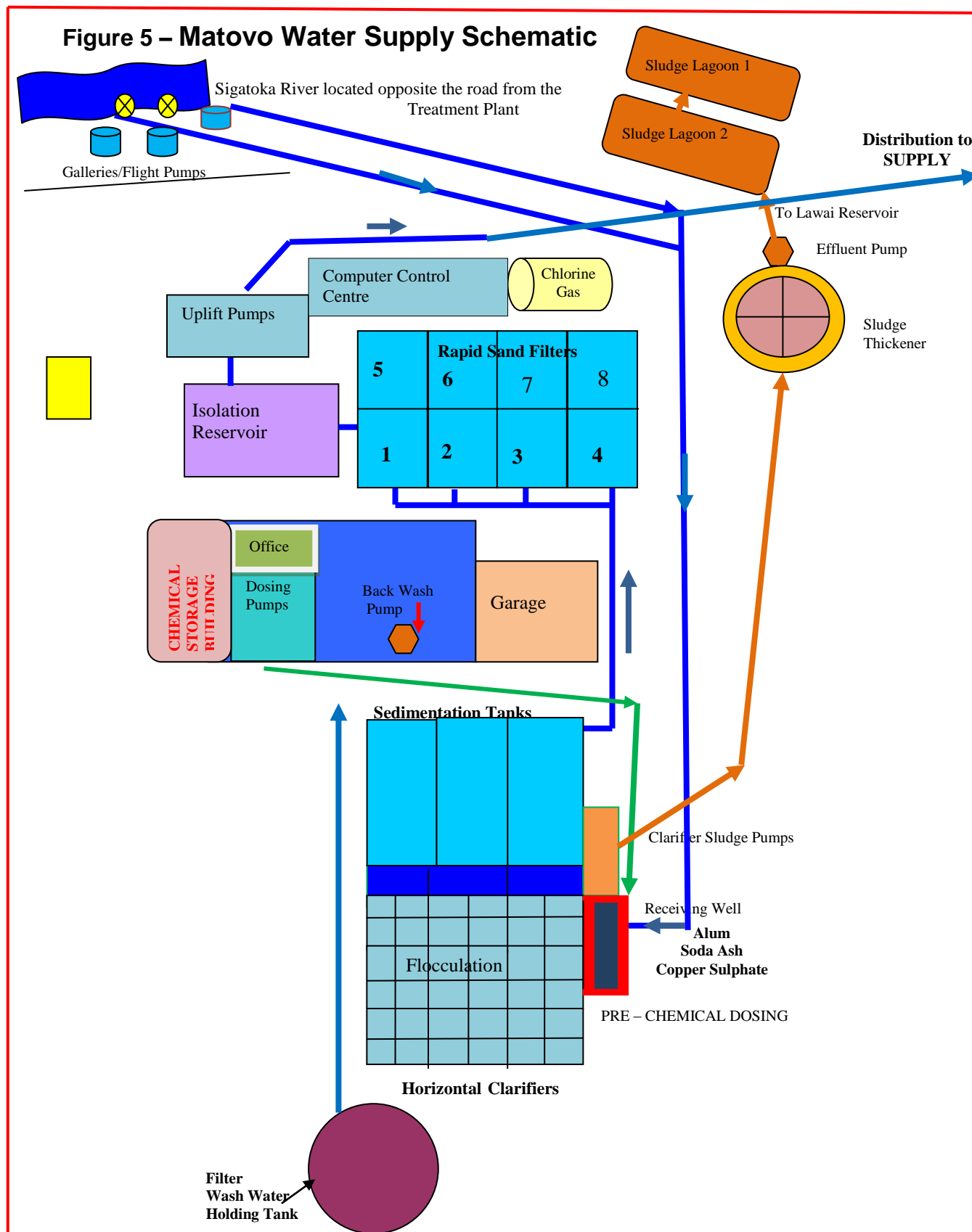


Figure 3: Korotogo and Qereqere Intake and Treatment
(No Treatment except chlorination)

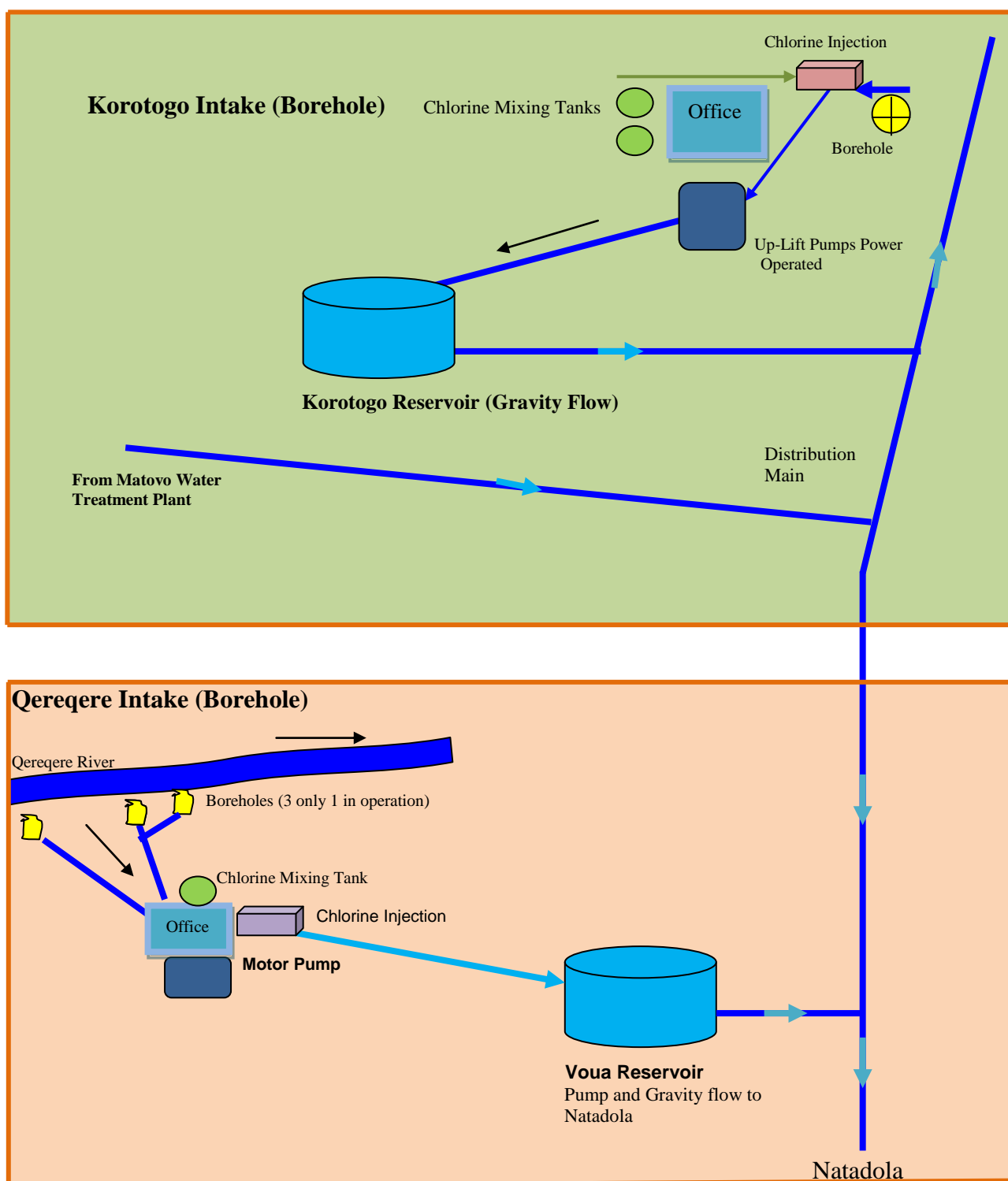


Figure 6 - TREATMENT PROCESS MATOVO TREATMENT PLANT

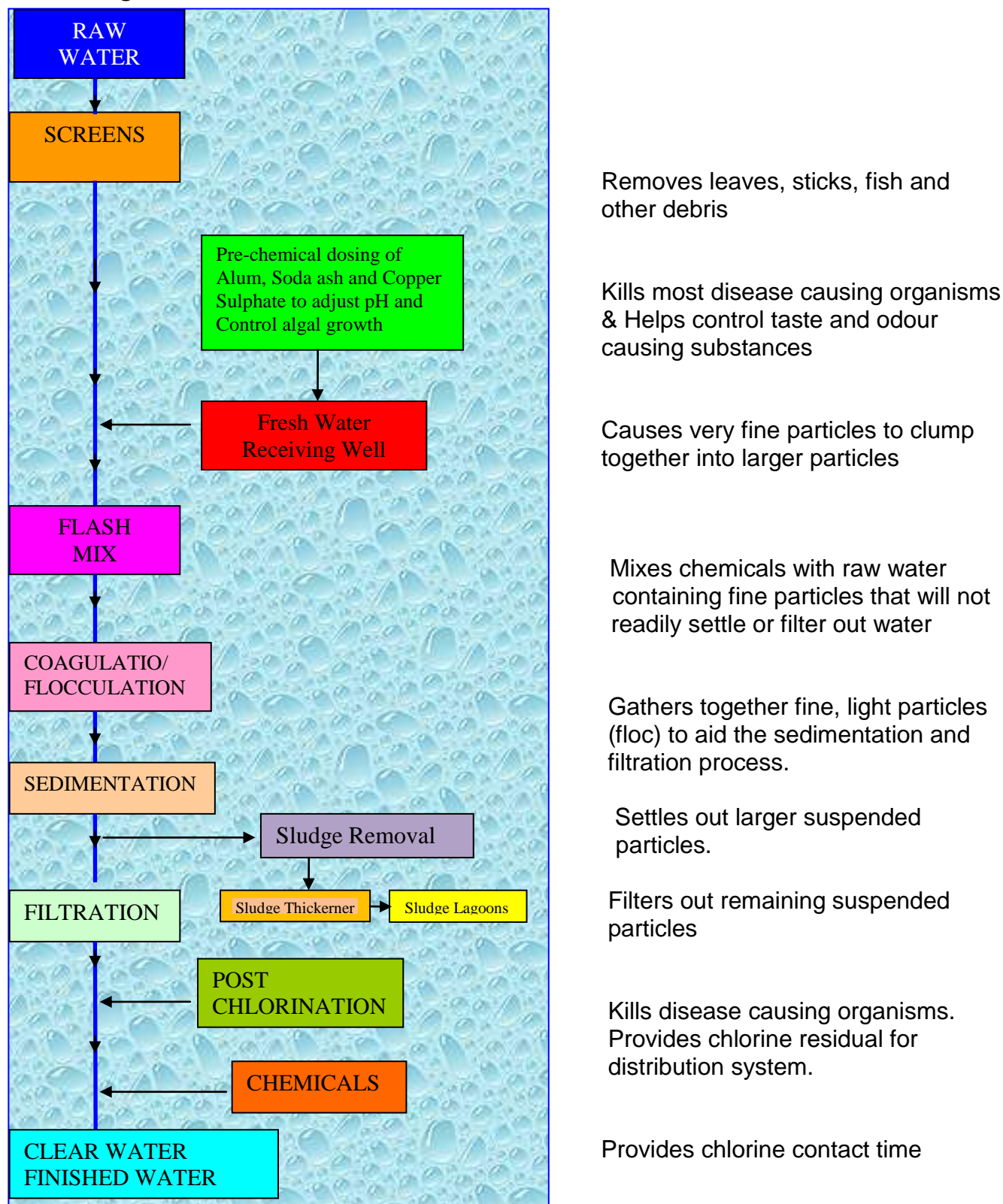
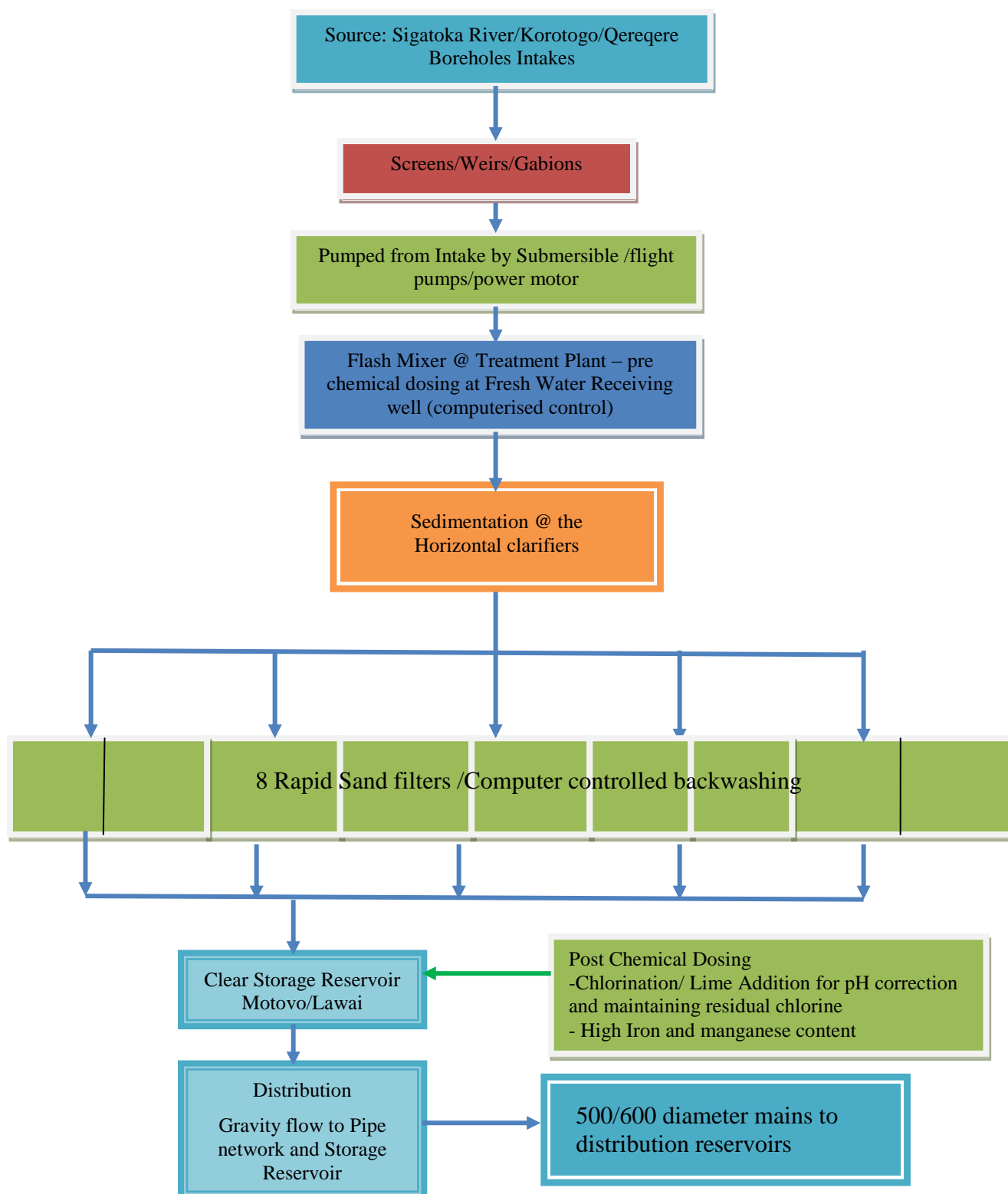


Figure 7 - Flow Chart for the Matovo Water Supply System



2.1 Matovo Catchment and Intake

The source for the Nadroga water supply is the Sigatoka River, which is located on the opposite side of the treatment plant. Additional water is supplemented by two borehole intakes at Korotogo and Qereqere. The water flows by gravity to distribution and booster pumps are used to increase the pressure in the mains. There is extensive farming and human activities in or around the catchment area (Sigatoka River). Some wild animals such as pigs and waterfowl are common and the dam supports fish and shellfish. The intake water becomes turbid due to the shellfish collection by the households in the area.

Due to heavy rains and nature of surrounding soil there is increased turbidity in the dam and the colour of water turns brown. Due to large water capacity and human activities as farming and fishing there is significant change in the water quality. There is no sedimentation in the river due to fast flow and turbulence during floods. Floods are common and the intake galleries are damaged.

There has been no major water problem encountered over the years as claimed by water supervisor. As there is no fencing it is likely that access can be available for some wild and domestic animals.

Surface water that runs off the land into the river has dissolved minerals such as hardness salts, iron and manganese due to the topography and soil structure. However the river can be contaminated by mud from erosion and there is increase in (turbidity) and microbiological organisms. The organic components are a mixture of plant debris and clay which settle down at the bottom of the river.

Korotogo Borehole Intake

A borehole intake is located at Korotogo which supplies addition 1 MLD and it is pumped to the Korotogo reservoir after chlorination. There is one pump attendant who mans and monitors the flow and chlorination. The station needs to be improved in terms of chlorine monitoring and borehole maintenance.

Qereqere Borehole Intake

This intake is located inland in the flats of Qereqere amongst the sugar cane farming area. There are three boreholes in place but only one bore is only used. The other two have the malfunctioning motors. Since all the intakes are located on the banks of Qereqere River they are prone to flooding. Since there is no protection of the pumps and borehole contamination and damage is possible. There is a pump station where chlorination is done and monitored prior to pumping the water to the mains for distribution to Voua and Natadola reservoirs.

2.2 Matovo Treatment Plant Processes

Raw water is delivered to Motovo WTP from Sigatoka River by field gallery submersible pumps and by flight pumps and arrives by twin 600/700 diameter steel pipes. The full conventional water treatment is done at the plants and treated water is pumped to storage reservoirs and distribution by uplift pumps controlled by the computers. The pre-treatment chemicals such as Soda Ash, Alum and copper sulphate are added at the receiving well. The flocculation and coagulation occurs at horizontal clarifies and the sedimentation tanks. Filtration and chlorination is done to the water prior to delivery to consumers through the distribution mains. The clarifiers sludge is disposed into the lagoons after passing through the sludge thickener located at the plant site.

The total flow that has been achieved with all the existing water pumps running (as at 2005) is around 13,200 m³ /day or 550m³/hr. When only one of the gallery pumps is operating the flow is around 450m³/hr¹.

2.3 Raw Water Receiving Well

At raw water receiving well pre-chemical dosing occurs and alum/soda ash and copper sulphate is added. There is an inline static mixer with an injection point for aluminium sulphate (alum). The alum is added as a solution that is made up on site. The alum is a coagulant that will both react with negatively charged colour molecules and then react with the water to form gelatinous particles, or floc. The static mixer provides a high level of turbulence so that the alum is instantaneously mixed with the incoming raw water. The instantaneous mixing is required because the reaction between the alum and the colour molecules occurs very rapidly. Dosing of the alum will lower the pH of the water.

The water flows into the bottom of the inlet channel and then overflows two weirs into two separate channels. Each weir is designed to accept a flow of 8,000m³/day. The pipes from the weir flow to two parallel flocculation chambers and subsequently into two sedimentation tanks. Each of the parallel tanks is designed for a flow of 8,000m³/day and therefore the maximum capacity of the existing plant is 16,000m³/day or 670m³/hr.

2.4 Clarifiers – Flocculation and Sedimentation

The flocculation chambers consist of long narrow channels that the water passes through. These are baffles in the channel that causes gentle turbulence to mix the water. The water is mixed so that floc that are formed in the coagulation stage are encouraged to collide and combine with one another. In this manner they form larger floc that will settle more rapidly in the sedimentation stage.

The channel is split into three separate sections and there is a different number of different sized baffles in each of the three sections. The different sizes and spacing are designed so that the mixing is more vigorous at the start of the channel and less vigorous in the subsequent two sections. The detention time is at least 20 min at maximum flow.

Soda ash can be dosed into the flocculation channel to raise the pH if required. The soda ash is dosed as slurry that is made up onsite. In the sedimentation tanks the water passes under a horizontal baffle and then rises up through some plastic lamella plates. The lamella plates are on an angle of around 60° and about 50mm apart. All the water rising through lamella must pass between two of the plates. In the sedimentation tank, the floc that were formed when the alum was dosed and then increased in size in the flocculation stage – drop towards the bottom of the tank. When the water is passing through the lamella plates the floc has to drop a maximum of 50mm and it reaches the surface of the plates where the upward velocity of the water is zero. The solid sides down the plates and falls to the bottom of the tank.

¹ Information from Motovo Operations and maintenance manual - April 2005, Presently inflow and outflow meters not working

2.5 Filters

The water that overflows the weirs in each sedimentation tanks combines and then flows to the inlet channel for the filters. There are eight individual filters designed for a flow of 2,000M3/day and has a dimension of 6.1m by 2.4m. The flow is split into filters by weirs. The filters have an air scour and a backwash. The air is provided by blowers and the backwash water flows by gravity from the backwash tank.

The water flows down through a layer of filter sand and through the filter floors. The filtered water is collected in a filtered water pipe. There is one pipe for the filtered water from four of the filters and another pipe for the water the other four filters. The filtered water flow is split from this point until it is combined in the wet well for the high lift pumps.

There is a tapping point on each of the filtered water lines. These tapping points convey water to turbidity analysers. In this way the combined turbidity from each set of four filters can be determined. Alarms are raised if high turbidity is detected.

The filters are mono-sand filters. The filter bed depth is 650mm and the sand has an effective size of 0.5mm and a uniformity coefficient of 1.5-6. The filter bed is suspended above a plenum floor. The filter nozzles have a small hole that sits just below the floor that air passes through during the backwash stage and large nozzles at the bottom that water passes down through during filtration and backwash water rise up through during backwash. The flow into each filter is through a penstock gate and during normal operation water flows out the filtered water valve to the contact tank.

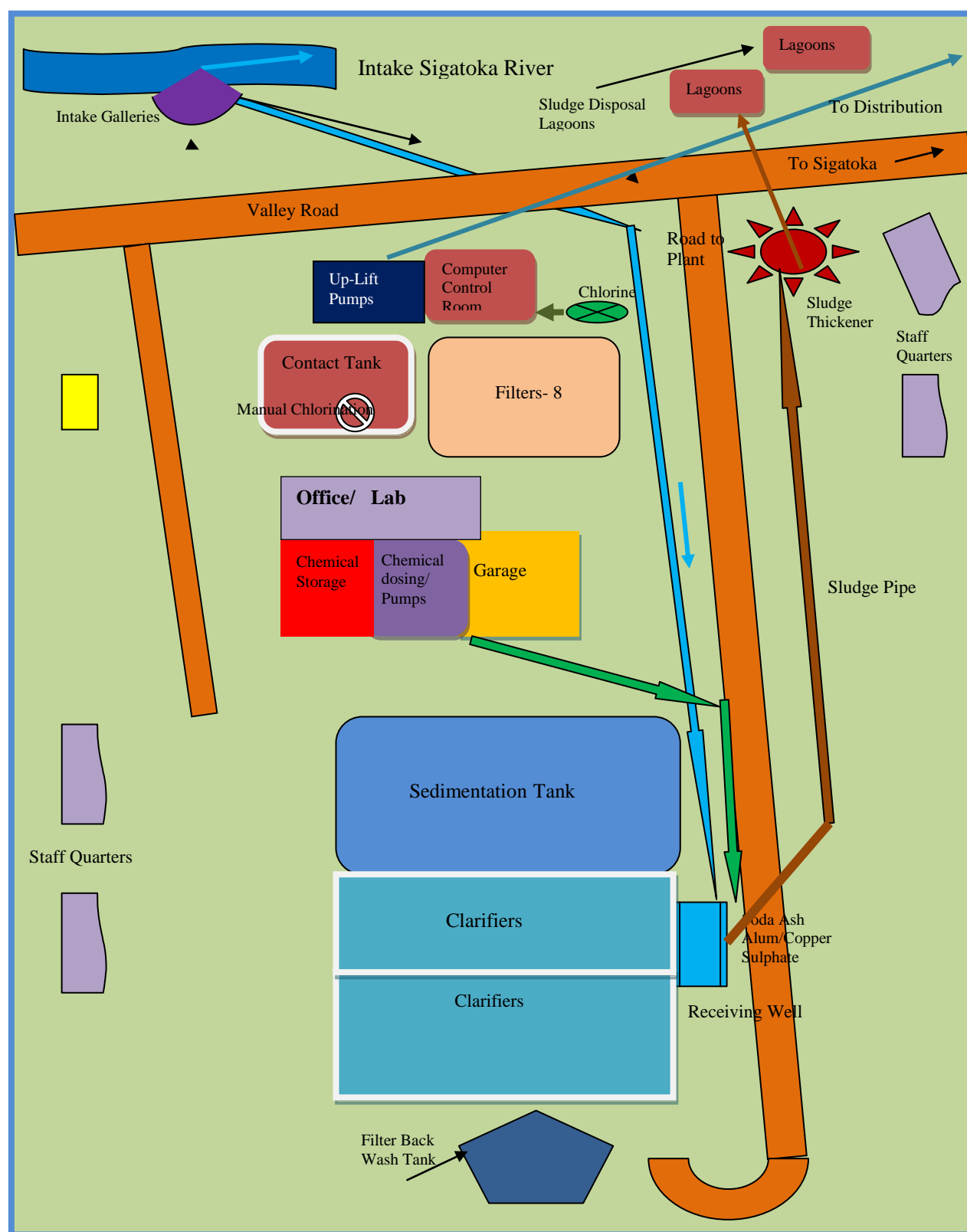
The purpose of the filters is to remove fine particulate matter from the water that comes from the sedimentation tanks. This particulate matter will include floc that has been formed in the coagulation process and also any particle of iron and manganese that have formed by oxidation with potassium permanganate. As the filters collect material the water level above the filter bed will rise. The filter can be cleaned using the backwashing cycle. In the backwashing cycle air and water are forced backwards through the filter to remove dirt and carry it to the drain.

❖ Filtered Water Turbidity Meters

There are two filtered water turbidity meters at the plant .they are HACH 1720E turbidity meters. There is a sampling point on the filtered water line that runs from filters 1 – 4 that feeds turbidity meter 1. It measures the combined turbidity of the four filters. Turbidity meter 2 monitors the filtered water from filters 5 -8.

The turbidity meters are a way that the operators can monitor the performance of the filters. The target turbidity at the plant is less than 1.0 NTU. The operators should the trend of the filtered water turbidity and determine what the plant is capable of producing when it is operating well.

Figure 9 - Site Plan Matovo Treatment Plant





Water Testing for correct chemical dosing



Chemical storage/ mixing tanks



Horizontal clarifiers and Sedimentation Tanks



Rapid Sand filters

The chemical dosing at the Receiving Well is as follows:

Table 8- Raw Water chemical dosing

Chemical	Solution Strength	Dosing Range	Pump Rate (at 16 MLD)
Alum	0.5%	2.g/m ³	670m ³ /hr
Soda Ash	0.5%	10.g/m ³	670m ³ /hr
Copper Sulphate	10%	10kg/100L	Only if algae is present in the raw water
Potassium Permanganate	0.1%	2.0g/m ³	670m ³ /hr

All chemical dosing is automated at Motovo plant. Dosing pumps have constant speed motors and the only adjustment is manual, on stroke length. Thus dosing rate turndown is less than about

6:1. The need for adjustment is determined largely by instinct and judgement of the plant operator in accordance to changes in flow rate and in raw water characteristics.

Dosing of alum and soda ash consists of dribbling chemical solutions onto the surface of the water as it enters the receiving well. The practice is not appropriate as it prevents the coagulant reacting fully with the suspended solids and colloids in the raw water. It also leads to the formation of stable, quasi-floc species which are not able to react with polyelectrolyte and pass through clarifiers and filters. These un-re-actable solids contribute to filter bed degradation through mud-balling and blinding as well as degrading final water quality.

Table 9 - Chemicals added in the purification processes at Matovo Treatment Plant:

Chemicals	Process Benefits
Aluminium Sulphate (Alum)	Helps in the process of Coagulation
Sodium Carbonate (Soda Ash)	Adjusts the Alkalinity and Acidity of Water
Hydrated Lime	pH and acidity of Water
Copper Sulphate	Controls the growth of Algae
Chlorine	Disinfectant – kills germs(bacteria)
Potassium permanganate	Oxidise and removes Iron and manganese

Table 10 - Chemical test done at the Motovo Treatment Plant to monitor Efficiency

Type of Test	Equipments Used
Residual chlorine	Lovi Bond colour comparator with Plain test Tablets
Turbidity	HACH Brand 2100p Turbidity Meter
Jar test	One litre glass jars with alum solution
pH test	Screen methyl orange 10 drops, colour matching Lovi Bond (Nasselerise)



Chemical dosing pumps – Matovo



Chlorine drip injection -Qereqere

2.6 Chlorination

The contact tank is located next to the filter block. It has two compartments, and each serves for four filters. Each side of the contact tank consists of long channels that the water must pass through before it can enter the high lift pump wet well. The contact tank provides a minimum of 30 minutes retention for chlorine contact to satisfactorily disinfect the water.

❖ High Lift Pumps

There are four high lift pumps that are wired up at the WTP. They are hydro-titan 150x125x315. The motors on the pumps are WEG 315/W and are 160kW motors. The four high-lift pumps have manual isolation switches beside them. There is a fifth pump that is not connected. Each pump is capable of pumping over 8,000m³/day.



❖ Gas Chlorination

At Matovo chlorine gas is dosed as a disinfectant for the water. The residual chlorine level of 0.2mg/l at the consumer end is desirable. The plant level dosage is between 1-2mmg/l. The dose applied may be varied according to the need to ensure residual is reaching all parts of the water supply system. Chlorine gas is delivered to the plant in 920 Kg steel cylinders and the injection system is fully automated.

Manual control of chlorine dosing is done. The operator controls the flow of water through the venturi gas educators using manual valves on the water lines. The operators can change the gas flow through the V-notch gas regulators by turning the knob on top the front of the regulators on top. The operator must calculate the required chlorine dose rate by determining the required chlorine dose rate (likely to be around 1.5 mg/m³). The required gas flow rate is determined by multiplying the dose rate by the water flow rate. For example if the flow rate is 500m³/hr and the dose rate is 1.6 g/m³ the total flow of chlorine gas would need to be 800g/hr. If two chlorinators are running this would be 400g/hr each.²



Gas chlorine cylinders -920 kg



Functioning Chlorinator

² O&M Manual for Matovo doc – April 2005

❖ Chlorine Dosing Rate:

Dose Rate Formula - $\frac{\text{Weight of Chemical} \times 1000}{\text{Inflow per shift}}$ = Dose rate

Plant water inflow per shift = 33,600 litres

Method A - Gas Chlorination

- Chlorinator No.1 = 2kg
- Chlorinator No.2 = 4kg
- Total = 6kg/hr
- 6x8hrs per shift = 48kg per shift (Dose rate)

$$\text{❖ } \frac{48 \times 1000}{33,600} = 1.375 \text{ ppm which gives 0.8 residual chlorine}$$

Method B – HTH Powder Chlorine in 40kg Drum –Manual mixing and drip feeding (To Top up if gas chlorination is not providing the required residual chlorine)

$$\begin{aligned} & -10 \text{ kg} \times 60\% \text{ strength} \\ & = \frac{6 \text{ kg} \times 1000}{33,600} = 0.18 \text{ ppm} \end{aligned}$$

Total dosing = Gas Chlorination - 1.375

HTH –Top up - 0.18

1.555 ppm which gives plant level dosing at 1.1 ppm

If the inflow water is dirty then plant dosing rate is increased to 1.5 ppm.

A sample calculation of chlorine dose rate is provided below:

Required chlorine dose rate: 2.2 mg chlorine / Litre of filtered water at a plant inflow rate of 65 MLD

Dose rate: 2.2 mg/L

Filtered water flow: 65 ML/d (Assume Stage 1 has 45ML/d and Stage 2 20ML/d)

Therefore mass of chlorine to be dosed in one Hour:

Stage 1: 2.2 mg/L x 45 ML/d divide by 24 hrs = 4.1kg/hr

Stage 2: 2.2 mg/L x 20 ML/d divide by 24 hrs = 1.8 Kg/hr

Total for the plant = (4.1 kg +1.8 kg) = 5.9 kg/hr



Manual Chlorination Tank on Contact Tank 1

❖ Manual Chlorination

A temporary mixing tank is placed on the chlorine contact tank. The chlorine is taken up and poured and stirred by stick. This only happens when there is no chlorine cylinder. Dose rate will depend upon the strength of hypochlorite solution that is made up in the tank.

2.7 Sludge Disposal

The sludge thickener is located beside the pump house. The sludge thickener consists of a circular concrete tank with a floor that slopes to a sump in the centre and an overflow weir at the top around the outside. There is also a slow rotating scraper that helps to push the solids into the central sump.

The purpose of the sludge thickener is to separate the majority of the solids from the sedimentation tank sludge from the water that is discharged to the roadside drain. The sludge from the sedimentation tank enters the sludge thickener. The time that water spends in the thickener is relatively long. The solids in the sludge will settle in the bottom of the tank. The rotating scraper will push the solids into the sump in the centre. The water that overflows the weir around the side of the thickener will be cleaner than the sludge that entered the thickener.



Sludge Thickener – Matovo WTP

❖ Sludge Lagoons

There are two sludge lagoons for the WTP. They are located across the road from the WTP on the river flood plain as seen in the picture. The water flows into the lagoon from a pipe at one end. At the other end of each lagoon there is an outlet box that includes an overflow weir. The height of the weir can be adjusted to allow the operator to decant water from the lagoon. The water that overflows the end of the lagoons flows out a drain and into Sigatoka River. The purpose of the lagoons is to capture the solids from the sludge the sludge thickener effluent before they are discharged into the Sigatoka River.



3. STORAGE AND DISTRIBUTION

The design capacity for the Matovo Treatment plant is 16 MLD, but due to demand the production capacity may increase in future.

From the Matovo WTP the treated water flows to the Lawai reservoir from where it flows by gravity to consumers. There are two bore well water extractions at Korotogo and Qereqere from here the water is pumped to the two reservoirs located at Korotogo and Voua. Borehole water is chlorinated prior to pumping to the storage facilities and distribution.

Metered domestic per capita consumption varies across geographical regions from 73 l/p/d to more than 200l/p/d. The average metered domestic consumption recorded during 1998 drought

was only 143 l/p/d. However when metering errors and suppressed demand are taken into account, the true average per capita consumption is calculated to be as 185 – 190 l/p/d.

Based on population and development projections in Sigatoka area the demand for average daily water is expected to increase in future. The reservoir tanks are of concrete structure and needs maintenance to eliminate recontamination of the water.

The distribution network needs improvement and maintenance due to water demand stress. The recent flood in the area has worsened the problem and had exposed the mains.

Due to old infrastructure there are leakages and, unaccounted use for water is running at levels of about 30 %. The WSD has established a Leak detection programme and curbing on illegal water connections. The distribution system comprises of about 800km of pipes larger than 50 mm diameter. Discussions reveal that there is a need for leak detection equipments and training as assistance is from Lautoka office.



The common problems noted at reservoirs were the missing and rusted cover lids and the monitoring of the water level. There is no stipulated schedule of the reservoir cleaning and maintenance as this largely depends on the annual budget. Most of the allocated funds are exhausted in the middle of the year and utilised on other important services.

Even though there is a maintenance team at Nadroga water supply, due to the old system and constrained resources many complaints are received and handled accordingly. It is necessary to establish proper staff recruitment and training procedures for the efficiency of the services.

The figures below show the location of reservoirs and pump stations within Sigatoka /Matovo distribution system.

Complaints on Water Services for the Month of July 2009

1.	Total Complaints Received	78
2.	Burst Mains	5
3.	Service Pipes	30
4.	No water (Low pressure)	10
5.	Defective Meter	9
6	Leaking Fire Hydrant	1
7.	Total Complaint Solved	68
8.	Complaints Pending	10

Figure 10 –Sigatoka (Matovo) Water Supply Distribution System

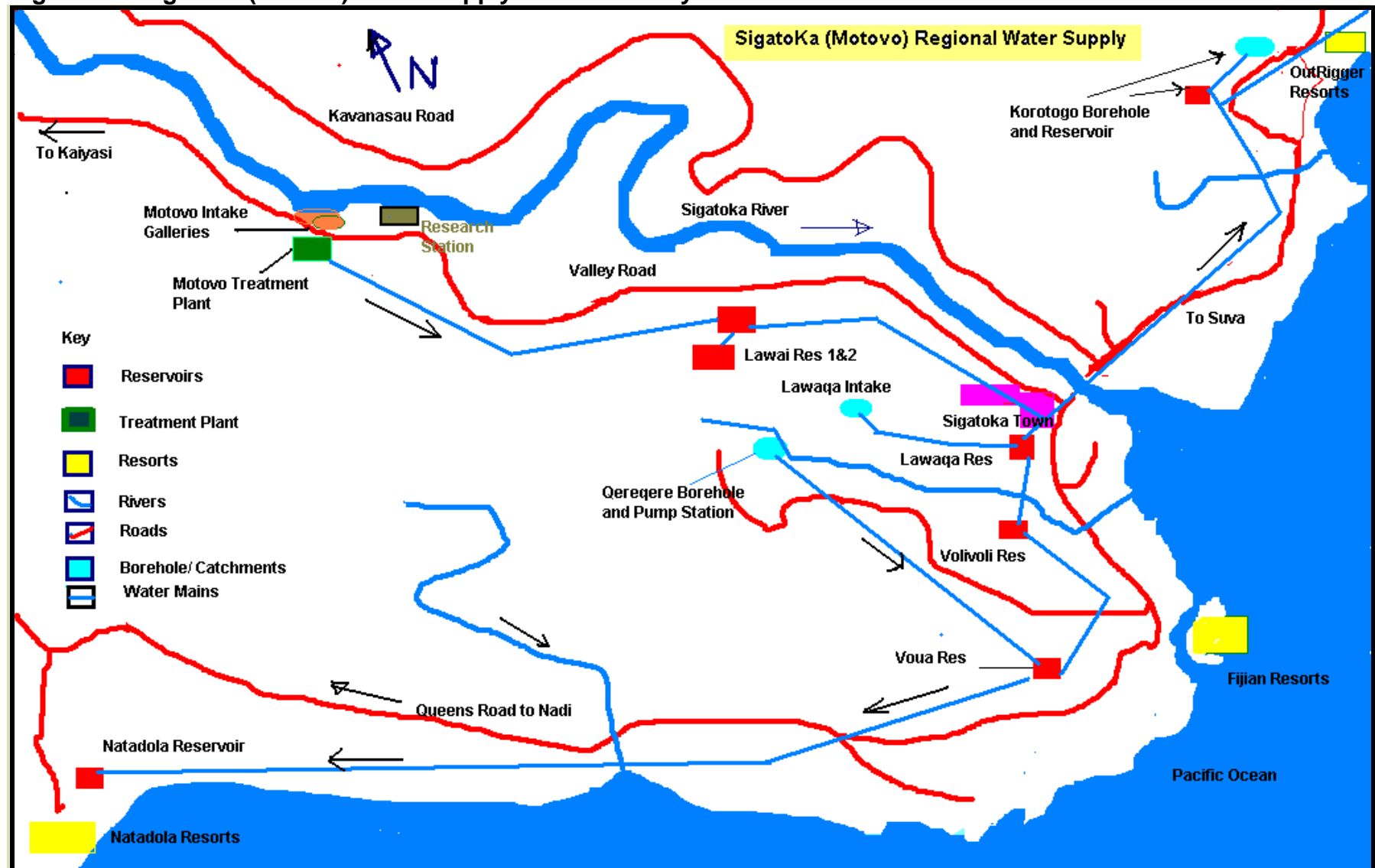


Figure 11 –SIGATOKA (MATOVO) WATER DISTRIBUTION NETWORK

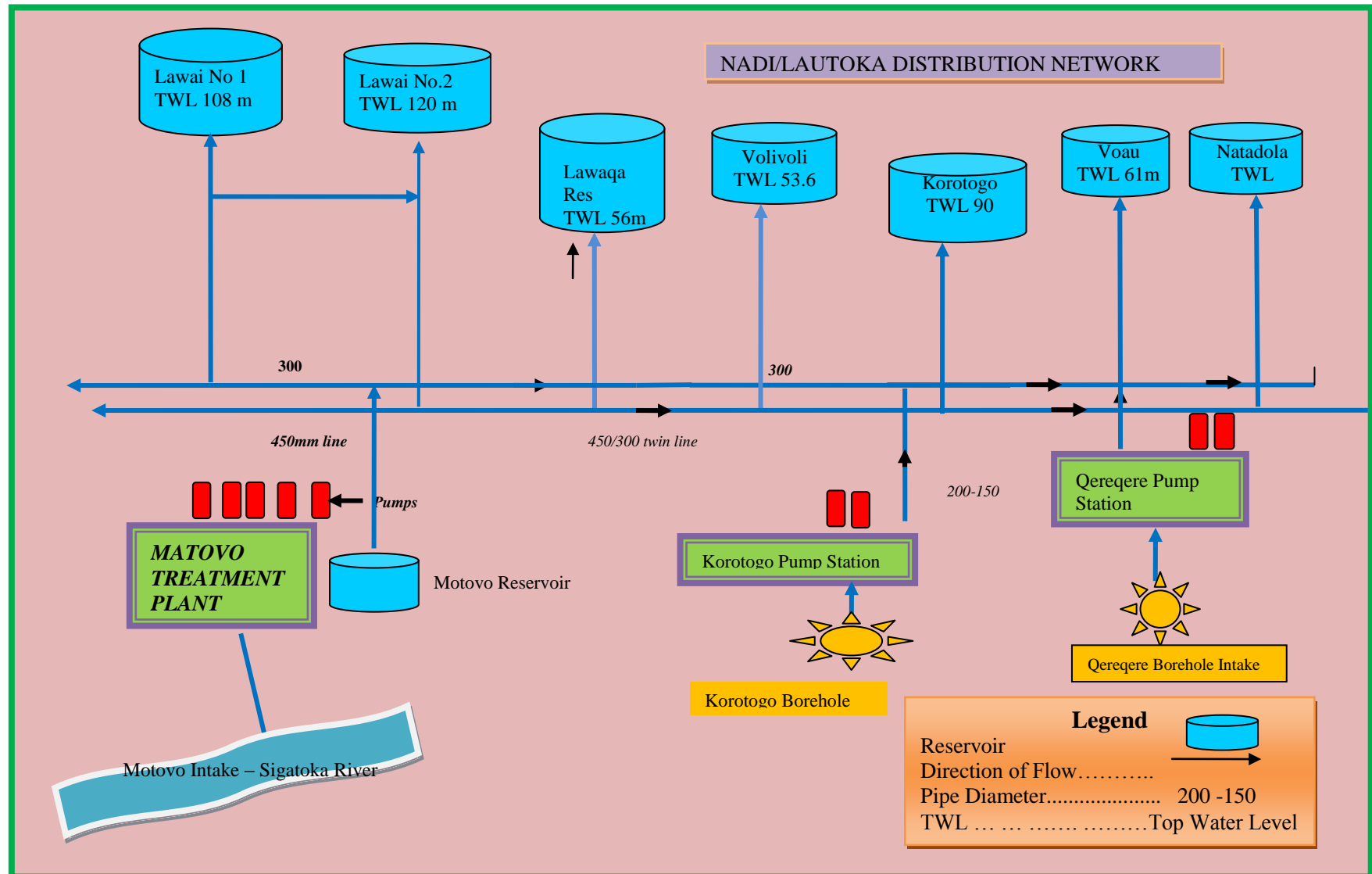


Table 11 - Reservoir Condition and Risk Assessment

Reservoir Location	Type of Tank	Risk Assessment	Capacity Mega litre (cub. m)	Top Water Level (TWL)m	No. days' supply @200 l/p/d
1. Lawai NO.1	Steel//galvanised	Reservoir receives treated water from Motovo and gravity supplies to other reservoirs. Inlet chamber and turn keys well protected. Well fenced no access for animals and people	1818	108	2
2. Lawai No.2	concrete	Old—un o maintained not in use. Overgrown grass and damaged lids.	n/a	120	4
3. Volivoli	concrete	Inlet chamber damaged easy access for rodents and small domestic animals into the tank. Ground level, needs drainage	568	56.3	1
4. Lawaqa	concrete	Partly below ground level. Compound overgrown with grass. Needs drainage. Chamber was seen left open and rusted.	400	56	3
5. Korotogo	concrete	Open and rusted inlets	568	90	1
6. Voua	concrete	Below ground level. Trees close to reservoirs. Inlet chamber open and rusted. Easy access for rodents and domestic animals.	3270	61.2	1
7. Natadola	concrete	Three concrete tanks half underground. Well maintained		166	1



Lawai Reservoir – New -Steel Bolted



Korotogo Reservoir – Concrete and well fenced

Table14 - Reservoir Condition Assessment-Sigatoka (Matovo) Water Supply

Reservoir Location	Type of Tank	Risk Assessment					Ladders
		Fence	Gate	Compound	Chambers	Water level Indicators	
1. Lawai No.1	Steel Bolted on concrete base	Satisfactory	Needs repair	clean	good	manual	satisfactory
2. Lawai No.2	Concrete (not in Use)	nil	nil	Needs cleaning of grass/trees	Rusted/missing	manual	Unsecure/rusted
3. Volivoli	concrete	Needs repair	Needs repair	Compound needs drainage	Rusted/broken inlet	manual	Ground level
4. Lawaqa	concrete	Needs repair	good	Needs cleaning of grass and drainage	Needs cover	manual	Needs repair
5. Korotogo	concrete	good	good	clean	Open /lid missing	manual	good
6. Voua	concrete	good	good	clean	Missing/ Rusted lids	manual	good
7. Natadola	Concrete/circular	good	good	Clean recently constructed	Rusted needs replacement	manual	good
8. Korotogo Intake	Borehole	good	good	clean	Needs repair	nil	nil
9. Qereqere Intake	Borehole (3) one in use	nil	nil	clean	Needs barrier wall	nil	nil



Lawai –Unmaintained Reservoir



Voua Reservoir – Damaged lids

3.1 SIGATOKA WATER SUPPLY DISTRIBUTIONS

The maximum storage capacity of the reservoir within Sigatoka Regional supply is about 3,270 cubic meters. From these reservoirs, treated water is distributed to Sigatoka urban and rural areas via two connected distribution mains. The area experiences water cuts therefore it is recommended that unused Lawai reservoir should be utilised to overcome water cuts due to reduced storage. The reservoirs are located at a maximum height of 108 m so there is good head pressure in the supply system.

Secondly the high- lift electrical pumps are used to supply water to the reservoirs which are located at fairly long distances. The distribution mains are of the sizes of 150mm to 450 mm. The distribution mains are laid alongside the roads and across the farm lands and tramlines in order to have easy access for maintenance. Some reservoirs need major improvements such as fencing and provisions of lids and covers which were seen either rusted or left open.

❖ High Lift pumps and Treated Water Pipelines

From the Motovo WTP four high-lift pumps the water for reticulation. Each pump is fitted with a variable speed drive (VSD). The VSDs on the high-lift pumps are controlled automatically to provide a constant level in the distribution. Two pumps are capable of pumping more than the maximum plant output of 16,000 m³/day. The operator can toggle the duty pumps. There are two standby pumps at maximum plant flow.

The distribution lines running from Matovo WTP are twin lines of 450 and 300 diameters. The 300mm line is over twenty years old. The 450 mm line was constructed in 2000. the capacity of this line is more than adequate to take the full plant flow. The 300mm line is isolated, but water can be pumped up this line as required.

❖ Qereqere Supply System

From Qereqere borehole intake the water is pumped to Voua reservoir by 150mm mains after manual chlorination. This station only supplies about 1MLD of treated water. The plant is manned 24 hrs to monitor flow and chlorination.



Voua Reservoir - Concrete



Booster Pump - Korotogo



Manual Chlorination-Qereqere Pump Station

❖ Korotogo Supply System

Water is extracted from borehole by submersible pumps and after chlorination the water is pumped by one high-lift pump to the Korotogo reservoir located opposite Outrigger Resort. The station supplies about 1MLD of treated water. The borehole needs upgrading to eliminate contamination.

All pumps are motor driven and are of centrifugal types. These have spinning impeller that rotates pushing water to the outside of the impeller and putting it under pressure. The pressure allows the water to go uphill reservoirs or other point of water use.

Interviews with a number of residents of Sigatoka areas revealed that they receive the pipe water but the low pressure is a common problem, secondly when there is a pipe breakage then fine silts are seen in the treated water. The distribution team confirmed this as a problem due to the fact that there

is no drain out chambers in the lower part of the system. The dirty water at the consumer end is normally due to the siltation in the pipes which are not cleaned. It is also the possibility that some dissolved solids may have passed through the filtration system. This events signal that there is a need to improve the treatment and distribution systems immediately to improve the water quality and avoid the recontamination of treated water.

❖ Storage Reservoirs

Treated water is stored at the treatment plant site in galvanised and concrete takes.

Chlorine gas is added as a disinfectant (to eliminate any remaining microbiological agents in the water). Soda Ash is used for pH adjustment.



Korotogo Pump Station



Qereqere –Borehole Intake/Pump Station



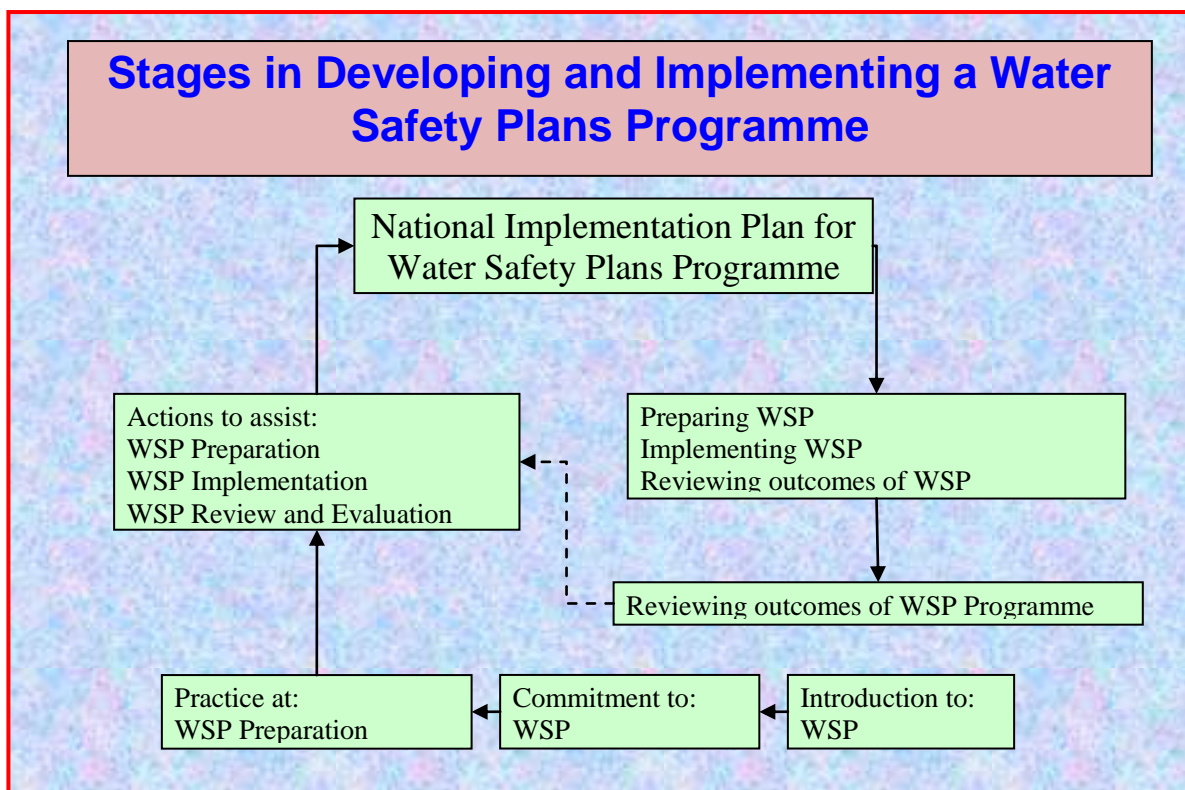
Natadola - Reservoir -New Concrete Structure

Storage reservoirs are regularly visited to monitor the water level. The measurements are done manually. The telemetry system should be provided in order to save time and cost. The storage reservoir covers are rusted or missing. The lids should be of lighter materials such as aluminium which is also rust proof.

4. WATER SAFETY PLANNING

Water Safety Plans (WSP) is the nameplate for WHO's new risk-assessment / risk-management approach to ensuring safe drinking water. This approach was introduced to Pacific island countries in a workshop, Nadi, Fiji, February 2005. The 18 countries and territories present completed a 'Framework for Action on Drinking Water Quality and Health in Pacific Island Countries' to guide future activities and gather donor support. The meeting of Pacific Islands Health Ministers in Apia, Samoa, endorsed this 'Framework' two months later with a statement in the 'Samoa Commitment'. Three Pacific-wide water quality programmes have since been proposed and funded.

Figure 12 - Stages in Development of Water Safety Plans



Prepared during the Pacific Water Safety Training and Planning Workshop 2006



Matovo- Intake Galleries on River bank



Driveway to Matovo Intake –No fence/Gate

Figure 13 - Stages in Implementation of Water Safety Plan

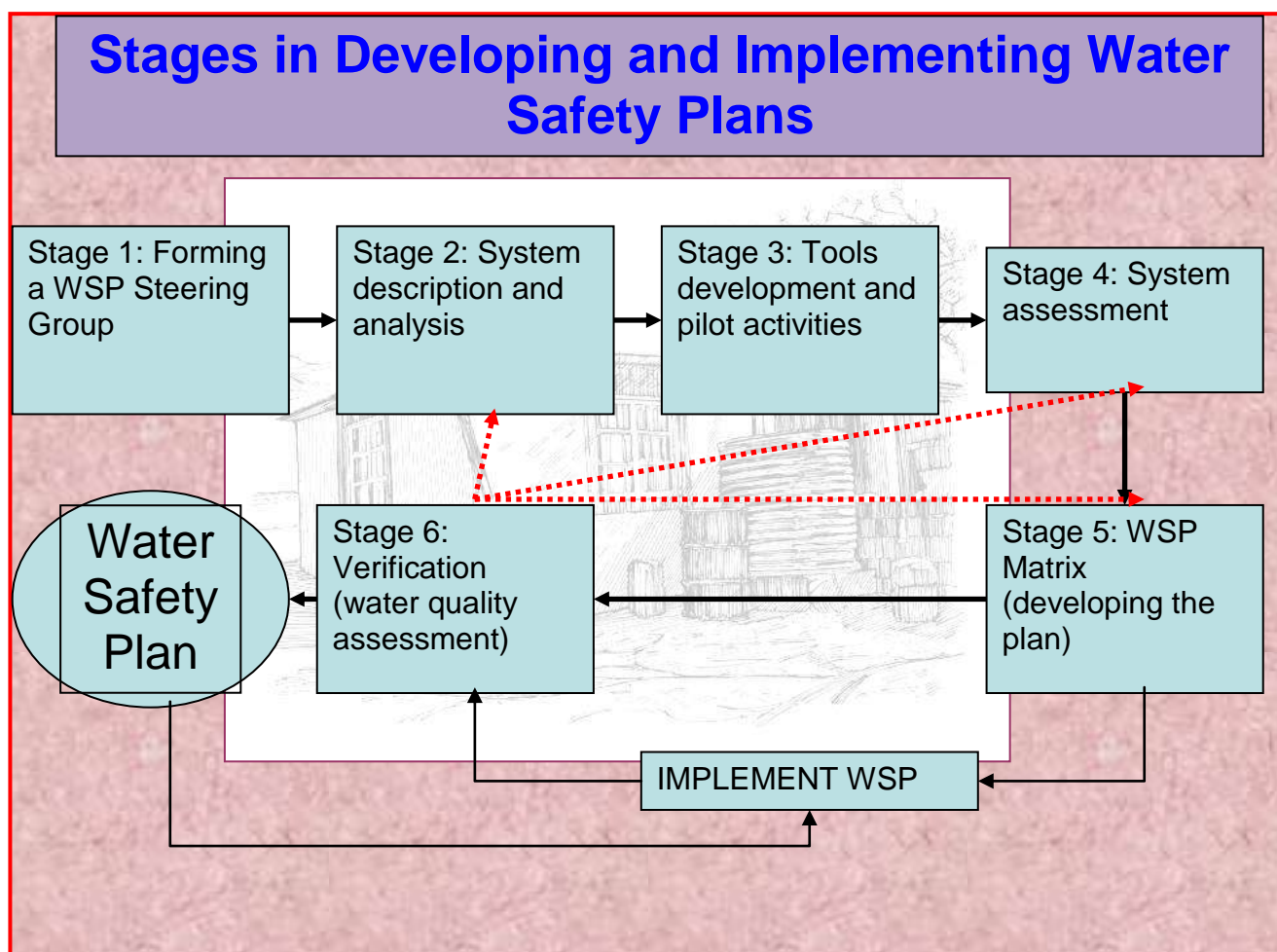


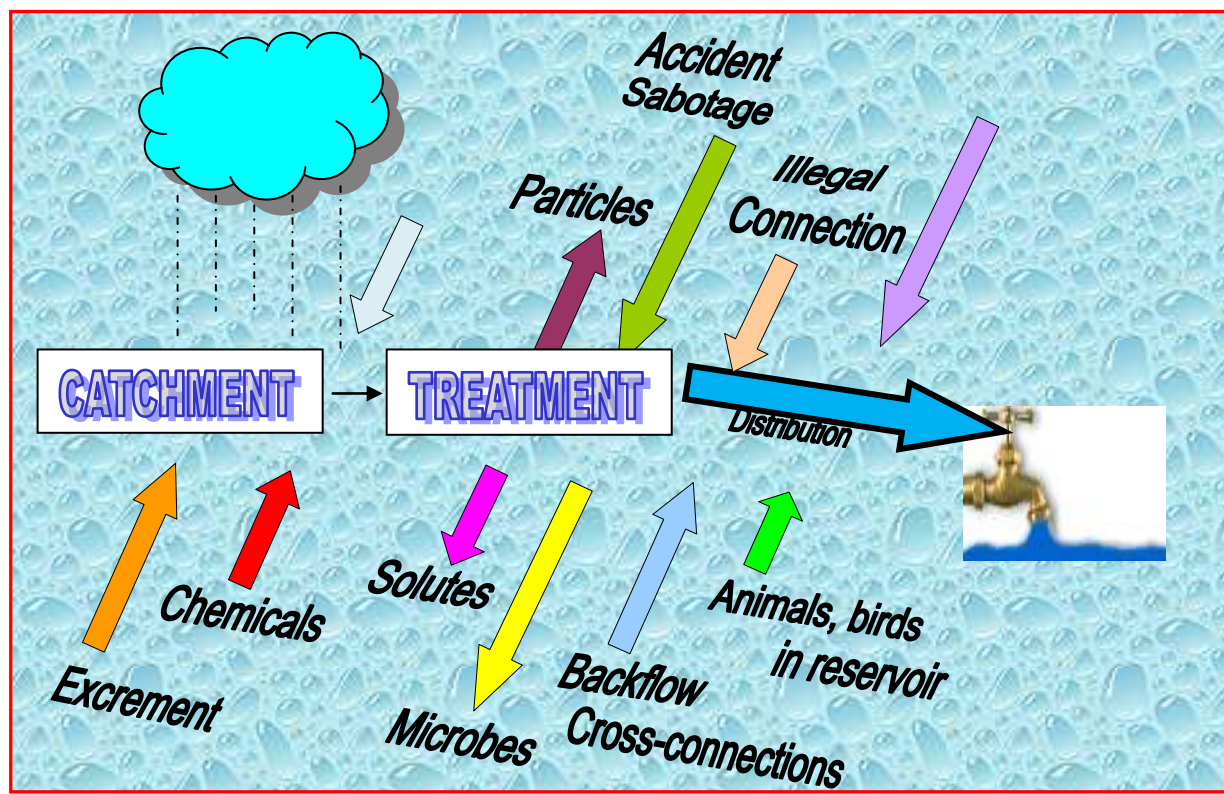
Figure: 9 WEDC Publications 2005

4.1 Improvements Needed

There is a lack of legislation, rules and standards in the water sector and the responsibilities and powers of the authorities are not clearly defined. The Ministry of Health, normally the surveillance agency, has not vigorously conducted any surveillance activity to gather sufficient data. A microbiology laboratory has been set up at Mataika House, Tamavua with necessary equipments but it is under utilised as field samples are not arriving. The field staffs, the Health Inspectors are unable to perform water quality work due to the constrained resources with their ministry. There is little or no co-operation, collaboration or exchange of information between relevant authorities. It is recommended that the Government should establish Fiji Water Authority at the earliest so that necessary strategies are formulated and appropriate management practices are in place. The tax payers are suffering due to mismanagement and high rate of corruption in many of the government ministries. The relevant authorities should establish a monitoring and surveillance scheme to which all of the authorities agree and enforce as this is important due to the re-emergence of such diseases as leptospirosis and typhoid in Fiji.

The Health Department should be responsible for surveillance activities and the overall supervision of the water quality aspects, and should develop a monitoring scheme for the short term including the chemical parameters to be monitored, sampling frequency and inspection regimes. National Drinking Water Quality Standards are required; this will include bacteriological, physical, and chemical quality parameters, and other acceptable levels for drinking water. Standardised sampling methods, sampling frequency and analysis methods should be derived through inter-agency studies.

Figure 14 - Risks in the Water Supply System



Matovo- Raw Water Inlet /Weirs



Matovo Catchment Bore-field – Sigatoka River

5. WATER SAFETY PLANS –MATOVO

5.1. Risk Identification Worksheets

Catchment & Intake

List what could happen that may cause drinking-water to become unsafe (deterioration in water quality)	Is this under control?	If not, judge whether this needs urgent attention. Responsible agent/s for immediate action.
1. Easy access of animals (horses/cattle) to the intake sites (galleries and flight pumps)	No. No fencing or barrier to control animal access. No drainage to control storm water entering the gallery sites	Yes/ Nadroga Water Supply to monitor and post security guards. Erect fence from the road to intake (river).
2. Siltation in the intake is likely due to soil erosion and decaying vegetation	No. No barriers to the intake. Regularly monitoring the intake ,flight pumps and the galleries bottom for siltation	Yes .Nadroga Water Supply. Prepare monitoring schedules for siltation and cleaning.
3. Sabotage / Vandalism	No. Possible intentional sabotage by chemical pollution. Security to be upgraded with provisions of caretaker, security locks and lights.	Yes/ Proper fencing is required at the Intake. Responsible-WSD. This is the major intake for Sigatoka/Nadroga Water Supply
4. Natural disaster (flooding) makes source unsafe – massive occasional erosion and blockage with debris.	No. Water intake galleries and flight pumps located on the river bank erosion is common with mud/debris entering the galleries and intake.	Yes. Use IWRM approach. WSD – hydrology section to monitor data of flooding. Upgrade intake /protect with barrier walls and lids.
5. Pollution from dead wild animals and decaying wood debris.	No. Increase in bacterial pollution - Public Awareness and liaison with authorities and surrounding villages	No. WSD/Plant managers/regular inspection of the dam site Place Sign Boards
6. Some villagers from Naduri and Nakalavo have easy access to the river for collection of fresh water mussels.	No. To inform/educate the villages /put notices in order to eliminate contamination and causing turbidity to the water.	Water Supply Nadroga /Provincial Council/Health Department -Public Awareness

7. Farming alongside the river	No. Erosion use of farm chemicals and pollution from farm animals(cattle/pigs) is common	WSD/MPI and Health Depart to educate people. Signboard, notices and public awareness.
8. Logging in the area	No. Licences permit to be issued on conditions. Logging programme.	Environmental Plan needed/ WSD/Agricultural/Environment Depart
9. Public access and eco-tourism likely to contaminate the river water	No. Public awareness/notice boards to be placed	WSD and Ministry of Tourism to provide information on use of Sigatoka river for picnic, and tourist touring.

Treatment

List what could happen that may cause drinking-water to become unsafe (deterioration in water quality) Risks: Include process/machinery failure	Is this under control?	If not, judge whether this needs urgent attention. Also, identify responsible agent(s) for immediate action.
1.High contents of Iron and manganese in the raw water from the Motovo Intake	No. There are no methods to aerate the water to remove iron and manganese. - Previously Potassium Permanganate was used but it has been stoped.	Yes. Plant operators/ Nadroga Water supply/WSD – to provide aeration methods through waterfall system. -Introduce aeration method to remove iron and manganese
2. Replace malfunctioning flow meters at plants and reservoirs.	No. Water measurement for the inflow will help in calculating the chemical dosing rate	Yes. –WSD /Design engineers Plant operators. -Work on estimation and old records
3. Filter Failures - Matovo has 8 rapid sand filters. - Filter media needs upgrading	No. Reduction in filter media, needs upgrading. - This will also increase the plant chlorine demand to remove bacteria. Passing of dissolved solids will produce harmful chemical reactions.	Yes. WSD / Design and Structures – hydraulics. Filter media needs upgrading/replacement. - Increase backwashing
4. Provision for flow meters to monitor backwash rate and air scouring.	-No, flow meters can contribute to fast backwash rate which can result in loss of filter media. – can lead to mud ball accumulation. To provide redundant air scourers (machine)	Plant managers/operator Install flow meters. -upgrading/replacement of filter media.

List what could happen that may cause drinking-water to become unsafe (deterioration in water quality) Risks: Include process/machinery failure	Is this under control?	If not, judge whether this needs urgent attention. Also, identify responsible agent(s) for immediate action.
5. Mixing of wrong chemical and incorrect dosing	No. No notices to identify the mixing chambers. No SOPs available for chemical mixing	Plants Operators Placing of notices and instruction at the mixing area. Prepare SOPs for each section
6. Chlorine dosing rate may not counteract fluctuation in water quality accordingly.	Yes. Increase dosing rate during period of heavy rainfall. Ensure chlorinator servicing is done on time. Use of backup HTH dosing. -Do Jar test to maintain appropriate chemical dosing	Treatment Section Plant Operators. Monitoring of residual chlorine at plant and consumer end. - Provide SOPs for jar Test and train staff.
7. Accumulation of clarifier sludge. Increase in bacteria/ unpleasant taste and smell of water, reduced retention time.	No. Sludge pumps malfunctioning due to manual operation. De-sludge Thickener	Plant operators to monitor and do regular manual cleaning. Design engineers to replace and upgrade. Reset the computerised system.
8. Algal Growth	No. Regular dosing of required amount of Copper sulphate sludge scrappers/sludge thicker/lagoons	WSD ,Engineers, Plant Operators, -Manual removing to be done when scrapper not functioning
9. Free Available Chlorine (FAC) samples taken randomly at the treatment plant.	Yes, But need a monitoring program for distribution and treatment plant. Need of proper recording of results	NWQL – chemist Plant Operators Senior Treatment Officer C/E Design proper monitoring programme with records.
10. Easy access of animals/pets into the treatment plant compound.	No. Broken fence/open gates and some staff have pets living within the compound.	Plant operator to warn the staff and place notice on the gates. -Remove all pets from WTP compound immediately.
11. Treatment facilities/storage tank/reservoir is damaged by natural disasters such as flooding, landslide, earthquakes.	Establish and follow emergency plans for all natural disaster events. Have standby power generators. Switch to manual dosing treatment if no other option permits. Follow the maintenance schedules for all repair works.	Inspection after natural disaster Water-borne diseases on the rise. Large amounts of water flowing out of the storage and distribution system.

List what could happen that may cause drinking-water to become unsafe (deterioration in water quality) Risks: Include process/machinery failure	Is this under control?	If not, judge whether this needs urgent attention. Also, identify responsible agent(s) for immediate action.
<p>12. Pre Chemical Dosing. Due to plant size needs to be equipped with proper chemical dosing pump for copper sulphate/alum -Plant should maintain residual chlorine of 1.2 g/cubic meter; this will allow an acceptable residual in the reticulation system. - For effective chlorination –one chlorinator is installed at the plant - Provision of backup disinfection is provided by means of Calcium Hypochlorite (HTH) Failure of any above measures will lead to a total collapse of water quality.</p>	<p>No - There is a need to upgrade OHS requirements for handling chlorine.</p> <p>Soda Ash- is added for pH correction in treated water. Inadequate dosing can produce acidic water.</p> <p>- No. the dosing system has to be maintained regularly.</p> <p>Separate storage of chemical is required</p>	<p>Yes. WSD/ Engineer Plant managers/operators Computer operators Check computer settings and manual addition of chemicals to be done during malfunction of computer. -Train staff to use Self contained Breathing apparatus (SCBA)</p>
<p>13. Sampling/Water quality test</p>	<p>No, irregular testing done at plant due to lack of a proper lab and testing chemicals.</p>	<p>WSD/NWQL – Kinoya staff Provide necessary equipments and testing chemicals.</p>
<p>14. Manual Chlorination</p>	<p>No. Should have one mixing tank on a elevated base in line with isolation tank with a shed. - Ventilated area needed. -Provide HTH powder chlorine at all times to supplement the dosing if the mechanical system breakdowns.</p>	<p>Yes, WSD – Plant Operators - Provide instruction and SOPs for manual chlorination</p>
<p>15. Computer Breakdown</p>	<p>No. Lack knowledge of computer operation of the plant. Relocation of the computer room for easy access. Proper record keeping is needed</p>	<p>WSD/Plant operators to train sufficient staff on computer operation.</p>
<p>16. There is no treatment / barrier for protozoa, so it could be assumed that they are present in water.</p>	<p>Upgrade filters media. Soak filters in caustic solution to remove mud balls, slime growth and cracks.</p>	<p>Protozoa analysis of drinking water Upgrade sand filters to increase efficiency</p>

Storage and Distribution

List what could happen that may cause drinking-water to become unsafe (deterioration in water quality) (Risks)	Is this under control?	If not, judge whether this needs urgent attention. Also, identify the responsible agency(s) for immediate action.
1. Rusted and missing reservoir inlet chamber lids. <ul style="list-style-type: none"> ▪ Rodents ,birds and animals can enter the reservoir tanks 	No. -need to cut all trees nearby and remove discarded items from the reservoir. Repair all opening and inlets of the reservoir. - provide iron lids and cover all inlet chambers of the reservoirs. All main valves must be controlled from public access	Yes, WSD/Distribution manager Iron lids to be replace by lighter and rust resistance materials(aluminium) -Staff to follow proper procedures and cover the lids after inspection or taking Water level measurements.
2. Leakages within the distribution network could result in cross-contamination. <ul style="list-style-type: none"> ▪ rusted and old pipes ▪ Breakages in underground pipeline from other activities such as digging for electrical/ telephone cables, construction etc 	Yes. A Leak detection programme has been mobilized by the DWS. No, Place warning sign and make information available. Use leak detector for underground seepage. About 30% is unaccounted water leakages through the system. Some direct connection without permission.	WSD/ Distribution manager Yes//Utility Companies Awareness. GIS /Maps Consent /Approval for development works. Regular Public awareness campaigns to be done.
3. Free available chlorine levels in the distribution system could be low due to increased turbidity after pipe breakages, old pipes and poor end mains.	No. - Current monitoring for FAC is sufficient but sampling points can be changed regularly. - Daily FAC testing to be done at the plant.	WSD/ Engineer –Nadroga Distribution Section. Manager –Motovo Treatment Plant/Bore hole pump attendants
4. Vandalism /Sabotage.	No. Common, as key valves damaged and iron lids are removed by public. - Reservoir/bore field is easily accessible by public so security, gates and fencing is required.	Yes. Police/WSD – Nadroga Water Supply. Provide steel enclosure for key area/ access to reservoir. Provide concrete walls around borehole pumps.
5. Illegal connections could lead to cross-contamination.	A regular monitoring / surveillance schedule for illegal connections. Allocate wardens in each zone/area/community.	Through Public complaints. Low water pressure in affected areas. High water demand.

List what could happen that may cause drinking-water to become unsafe (deterioration in water quality) (Risks)	Is this under control?	If not, judge whether this needs urgent attention. Also, identify the responsible agency(s) for immediate action.
6. Water is contaminated as a result of repair works in the distribution system.	No. - Insufficient flushing and chlorine wash after repair of broken mains. Few wash out system and hydrants available in the distribution system -Use appropriate backflow prevention devices, -No SOPs for repair of mains	Yes/ Nadroga-Distribution Section WSD - Engineer –Distribution Section Install non –return valves Monitoring of the distribution for bacteriological levels and residual chlorine.
7. Drop in water pressure due to high water demand disturbs sediments. ▪ Sediments settle more in mains with low pressure. ▪ Need to clean the distribution system with swabs(pigs)	No. - Numerous reports of insufficient water to parts of the network and dirty water seen at consumer taps. Wash out should be provided. This is a problem and water pressure should be constant to avoid sediments in the distribution.	Yes- Distribution Section. DE/W Use existing reservoirs such as one not in use at Lawai.
8. Damages to the distribution network from natural disasters such as floods, landslides and earthquakes.	No. - Survey teams in place and activated after natural disaster. Establish and follow emergency contingency plans for natural disasters.	Yes WSD-consult with Disaster Management Office for emergency water supply. The water supply department makes costs estimates for the damages and funded by HQ. Use Health Department for Public Awareness and monitoring.
9. Damage to exposed pipelines.	Yes, - Endeavour to bury/protect/encase all exposed pipelines. Have warning signs posted at reservoir and risk areas to inform the public.	Yes WSD- Nadroga /Distribution Section. Train mechanical and maintenance teams.
10. Contaminated storage reservoirs	No, - Regular cleaning of storage tanks. -Mud sedimentation common in reservoir - Old reservoir needs structural maintenance	Yes WSD/ Distribution manager Upgrade and use modern cleaning equipments to remove silts and debris,
11. Borehole Intake Contamination	Likely as no extended head cover, seepage of storm water from flooding. No fencing of bore field.	No, needs head cover /concrete paving and drainage/protective barriers walls.
12. Easy Access of Animals and people to reservoirs	No, Needs fencing of reservoirs and bore fields /place notice	Yes, WSD/Nadroga water Supply.

5.2: Plan to Manage the ‘Needs Urgent Attention’ Catchments & Intake

Risks that ‘Needs Urgent Attention’	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed, reduced or remedied? Who needs to know and how quickly? Who can help?
1.Easy access of animals (horses/cattle)to the intake sites (galleries and flight pumps)	No. No fencing or barrier to control animal access. No drainage to control storm water entering the gallery sites	Yes/ Live and dead animals seen in the catchment area – animal faeces, and water smells .Test reveals high content of bacterial organisms	-Clean the area of dead and live animals -Nadroga Water Supply to monitor and post security guards. - Erect fence from the road to intake (river).
2.Sabotage / Vandalism	- There is no fencing so access is possible by the public. - Possible intentional sabotage of electric pumps. - Caretaker /ranger to be allocated for monitoring at dam and intake pipes. - Security locks and lights needed	-Water smells looks or tastes abnormal. -Pump breaks down and there are signs of sabotage or vandalism, broken infrastructure and presence of offenders on water supply sites.	Existing dam managers should help. Responsible-WSD. Warn the public through the media. WSD/Police Dept Place public Notice at the intake and plant sites.
3. Natural disaster makes source unsafe - massive occasional flooding and erosion and blockage with debris.	Water catchment is large area uphill which has high annual rainfall and lot of other smaller tributaries joins the river. - The system is hampered during natural disasters. Establish and follow emergency contingency plans for all repair works more so immediately after a natural disaster	Change in water colour/taste and suspended matter seen. Seek immediate help of emergency water supply from the Disaster Management Office. Water cartage to the affected public	Use IWRM approach. WSD – hydrology section to monitor data of flooding. WSD/MOH to make contingency plans. Collect all related data for actions when necessary. Monitoring of Water Quality by National Lab/Plant lab Boil water advice to Public given via media.
4. Public access and eco-tourism likely to contaminate river water.	- Public awareness of target population on river care. - use of proper human excreta disposal near catchment sites.	Water smells and solid waste visible in the river. Entry of contaminated water into the intake and WTP.	Educate the people visiting the Vaturu dam for picnicking. Local Health Authority to monitor and raise public awareness

Risks that 'Needs Urgent Attention'	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed, reduced or remedied? Who needs to know and how quickly? Who can help?
4. Siltation in the intake is likely due to soil erosion and decaying vegetation	No barriers to the intake. Regularly monitoring the intake ,flight pumps and the galleries bottom for siltation	-High turbidity readings at plant -Visible change in the colour of raw water	WSD engineers to design dredging plans and erect barriers to exclude debris and silts. Nadroga Water Supply. Prepare monitoring schedules for siltation and cleaning.
5. Some villagers from Naduri and Nakalavo villages have easy access to the river for collection of fresh water mussels.	To inform/educate the villages /put notices in order to eliminate contamination and causing turbidity to the water.	-Turbid Water -colour change of water -Increased back washing and filter load noted	Water Supply Nadroga /Provincial Council/Health Department to raise public awareness
6. Farming alongside the Sigatoka and Qereqere rivers.	Erosion use of farm chemicals and pollution from farm animals(cattle/pigs) is common	.- Change in Water taste -water test reveals presence of chemicals above required standards	WSD/MPI and Health Depart to educate people. Signboard, notices and public awareness
7. Logging in the area increase turbidity in the Sigatoka River	Licences permit to be issued on conditions. Logging programme.	Increase turbidly and change of water colour -increased siltation in the intake. -high sludge content at plant	Environmental Plan needed/ WSD/Agricultural/Environment Depart
8. Pollution from dead animals and decaying debris	-Erect fence and barriers at the intakes. -Public Awareness and liaison with authorities and surrounding villages.	-dead animals and debris seen. -water smells with abnormal taste. - increase in bacterial content of raw water	WSD/Plant managers/regular inspection of the dam site Place Sign Boards -Public awareness and networking with other stakeholders

Treatment - [Plan to Manage the 'Needs Urgent Attention']

Risks that 'Needs Urgent Attention'	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed or reduced? Who needs to know and how quickly? Who can help?
1.High contents of Iron and manganese in the raw water from the Motovo Intake	There are no methods to aerate the water to remove iron and manganese.	Yes. Plant operators/ Nadroga Water supply/WSD – to provide aeration methods through waterfall system.	
2. Replace malfunctioning flow meters at plants and reservoirs.	Water measurement for the inflow will help in calculating the chemical dosing rate. Residual Chlorine level inconsistency. Maintain SCADA system.	Public complains on chlorine taste/ No residual chlorine present when tested.	-Top priority should be given - WSD/ Engineers - Design and structures
3.Filter Failures Matovo has 8 rapid sand filters. - Filter media needs upgrading	Due to cracking and mud balls noted all media to soak with caustic soda. This will eliminate slime build up and accumulation of mud-balls. - This will also increase the plant chlorine demand -No, flow meters can contribute to fast backwash rate which can result in loss of filter media.	Turbid Water, High rate of dissolved and suspended solids. Chlorination is affected. Inspection reveals flow meters not functioning.	Yes. WSD / Design and Structures – hydraulics. Plant managers/operator
4. Provision for flow meters to monitor backwash rate - Improper air scouring	– can lead to mud ball accumulation. To provide redundant air scourers (machine)		

Risks that 'Needs Urgent Attention'	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed or reduced? Who needs to know and how quickly? Who can help?
5. Chlorine dosing rate may not counteract fluctuation in water quality accordingly.	Increase dosing rate during period of heavy rainfall. Ensure chlorinator servicing is done on time. Use of backup HTH dosing. No residual chlorine when tested.	No residual chlorine at consumer end of 0.5 ppm as required by the WHO standard. Treatment Section Plant Operators test indicates less than 1.2 ppm of residual chlorine.	WSD/mechanical section. - Higher chemical dosage is an option.
6. Free Available Chlorine (FAC) samples not taken randomly at the distribution system and treatment plant.	Need a monitoring program for distribution and treatment plant. Presently done in ad-hoc manner. - Train staff and provide equipments and test chemicals	NWQL – chemist- test results not to required standards when tested by Plant Operators and Health Inspectors	- WSD / Design and Structures – hydraulics. - Higher chemical dosage is an option.
7. Manual Chlorination	Should have two tanks and, one mixing tank and one drip tank. existing mixing compartment- .Ventilation Provide HTH powder chlorine at all times to supplement the dosing if the mechanical system breakdowns.	FAC test that the treated water has no less than 1.2 ppm at plant and no less than 0.5 at consumer pipe. No taste of chlorine in treated water. WSD – Plant Operators	Additional testing resources needed at the Nagado plant such as turbidity meter and chemical detectors.
8. Mixing of wrong chemical with wrong dosing/storage facilities	No notices to identify the mixing chambers. No SOPs available for chemical mixing.	Plants Operators Placing of notices and instruction at the mixing area. Prepare SOPs for each section	

Risks that 'Needs Urgent Attention'	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed or reduced? Who needs to know and how quickly? Who can help?
<p>9. Pre Chemical Dosing.</p> <ul style="list-style-type: none"> - Due to plant size needs to be equipped with proper chemical dosing pump for copper sulphate/alum -Plant should maintain residual chlorine of 1.2 g/cubic meter; this will allow an acceptable residual in the reticulation system. - Provision of backup disinfection is provided by means of Calcium Hypochlorite (HTH) - Algal growth in the WTP common 	<ul style="list-style-type: none"> - There is a need to upgrade OHS requirements for handling chlorine. -Training on the Use of Self contained breathing apparatus (SCBA) to be done for the staff -Sufficient Copper sulphate to be added to the raw water. Manually remove all algal growth. - There is a need to train staff on jar-test and to provide testing materials. -The whole dosing system has to be serviced 	<ul style="list-style-type: none"> -Algal growth seen in treatment plant waters. -Test at plant and at consumer end indicates less residual chlorine then the required standard. - Dissolved solids passing to filters causing mud balls and clogging 	<p>WSD/Plant managers. Visual inspection must be done.</p>
<p>10. Treatment facilities/storage tank/reservoir is damaged by natural disasters such as flooding, landslide, earthquakes.</p>	<p>Establish and follow emergency plans for all natural disaster events. Have standby power generators. Switch to manual dosing treatment if no other option permits. Follow the maintenance schedules for all repair works.</p>	<p>Inspection after natural disaster Water-borne diseases on the rise.</p> <p>Large amounts of water flowing out of the storage and distribution system.</p>	<p>Carting of treated water to the affected areas. Send out public health messages through local media informing consumers about possible risk of contamination. Advise them to take necessary precautionary measures e.g. boil or filter water. WSD-Engineers</p>

Risks that 'Needs Urgent Attention'	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed or reduced? Who needs to know and how quickly? Who can help?
11.Accumulation of clarifier sludge	No. Sludge pumps malfunctioning due to manual operation. De-sludge Thickener	Plant operators to monitor and do regular manual cleaning. Design engineers to replace and upgrade. Reset the computerised system.	
12There is no treatment / barrier for protozoa, so it could be assumed that they are present in water.	Upgrade filters media. Soak filters in caustic solution to remove mud balls, slime growth and cracks.	Protozoa analysis of drinking water Upgrade sand filters to increase efficiency	Increase chlorine residual. Give boil water advice to the public. SWD/MOH
13 Vandalism/sabotage.	Provide extra security lights and monitors. Put up a security fence to stop unauthorized access to the water storage tanks/post attendant/watchman at pump and reservoirs.	Low pressure/loss of water Abnormal objects in treatment plant water .other mechanical/electrical not correctly functioning, contaminated water samples.	Security persons posted. Install security alarms. WSD- Production/distribution Section
14.Easy access of animals/pets into the treatment plant	Provide gates and lids -Place notices -Inform staff to prevent access of animals into WTP	Entry of animals and birds into treated water. Water smells. Dead animals and birds seen -Contaminated chemical solutions	WSD/ Plant Operators
15. Algal Growth	No. Regular dosing of required amount of Copper sulphate sludge scrappers/sludge thicker/lagoons	Algal growth seen in the treatment plant. -Water smells and gives green colour - Clogs filters	WSD ,Engineers, Plant Operators, -Manual removing to be done when scrapper not functioning
16. Computer Breakdown	No. Lack knowledge of computer operation of the plant. Relocation of the computer room for easy access. Proper record keeping is needed	Insufficient chemical dosing and filter backwashing stops. -confirmed by test and visual inspection	WSD/Plant operators to train sufficient staff on computer operation.

Storage and Distributions [Plan to Manage the ‘Needs Urgent Attention’]

Risks that ‘Needs Urgent Attention’	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed, reduced or remedied? Who needs to know and how quickly? Who can help?
1. Illegal connections could lead to cross-contamination.	-A regular monitoring / surveillance schedule for illegal connections. Allocate wardens in each zone/area/community.	Through Public complaints. Low water pressure in affected areas. High water demand.	The residual chlorine will provide protection (provided the levels of contaminants are low) until repairs are complete.
2. Rusted and missing lids- at reservoirs. Rodents and animals getting into the storage reservoir tanks.	-Cut down trees growing close to the reservoir tanks and remove discarded items. -All inlets to be sealed properly and rusted lids replaced. -Regular inspection of reservoir.	Rodents die and excrete in and on the storage tanks. Ingress of animals and their excrement noticeable. Dead animals, birds and rodents seen in the storage tanks.	Close all inlets to the tanks Cover the openings with sacks or other flexible materials until repair works are done.
3. Easy access of animals and people to reservoirs.	-All turn keys wheels to be well secured and kept under lock and key. -Provide security grills around reservoir chambers and turn keys.	Decrease in water pressure and cross contamination. Presences of bacteria and other dead organic matter when inspected and analysed.	Security checks. Place security alarms. Notice Board/signs. -Post caretaker.
4. Contaminated storage reservoirs. Accumulation of sediments in storage tank.	-Establish and follow a cleaning/maintenance schedule once a year. - Avoid ingress of dirt during repair of breakages in the mains.	Colour of water changes .water turbidity increases. Water smells. Presence of Bacteria when analysed.	-Drain storage tank water. - Clean the tank. - Improve filtration at treatment plant –Upgrade filter media

Risks that 'Needs Urgent Attention'	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed, reduced or remedied? Who needs to know and how quickly? Who can help?
5. Leakages within the distribution network could result in cross-contamination.	<ul style="list-style-type: none"> -About 30 % water is lost due to leakage and abuse. A Leak detection programme is in place. -Inform public on proper water use and water laws especially the villagers. 	<p>Analysis of mains water will indicate presences of pathogenic bacteria.</p> <p>Colour and turbidity is abnormal.</p> <p>Low water pressure in distribution pipes.</p>	<p>Close the distribution network and clean the system. WSD and distribution manager to act</p> <ul style="list-style-type: none"> - Inform public to boil water through media/radio.
6. Free available chlorine levels in the distribution system could be too low.	<ul style="list-style-type: none"> -Current monitoring for FAC is insufficient. The fluctuation could be due to water demand and major breakages. - Only selected areas tested regularly need to change the sampling point. 	<p>No FAC in treated water when tested.</p> <p>Presence of bacterial organisms in the treated water.</p>	<p>NWQL to monitor FAC/bacterial content regularly and provide report to plant operators to do appropriate chlorination.</p>
7. Water is contaminated as a result of repair works in the distribution system.	<p>Drain contaminated water before reconnection. Control back flow of dirty water. Chlorine- washes of pipes and analyse water for bacterial contents prior to consumption. Refer to SOPs if available.</p>	<p>Water colour and turbidity changes.</p> <ul style="list-style-type: none"> - Increased suspended and dissolved solids in treated water. 	<p>Distribution Section to monitor</p> <ul style="list-style-type: none"> - Inform public to boil their drinking water. - Analyse water for bacterial content. -Formulate SOPs
8. Drop in water pressure due to main breaks and high demand disturbs sediments in pipes.	<p>Keep supply constant to maintain pressure.</p> <p>Monitor usage, maintain average reservoir levels, and throttle supply.</p> <p>Provide additional reservoir.</p>	<p>Reports of insufficient water to parts of the network and dirty water seen at consumer taps.</p> <p>Water colour and turbid water seen at consumer end.</p>	<p>Distribution Section to monitor.</p> <p>Analyze water for bacterial content.</p>
9. Damages to the distribution network from natural disasters such as floods, landslides and earthquakes.	<p>Establish and follow emergency contingency plans for natural disasters during and after an event.</p>	<p>Low water pressure in distribution system.</p> <p>Consumer complains</p>	<p>WSD-consult with Disaster Management Office for emergency water supply.</p> <p>Analyse for bacterial content.</p>

Risks that 'Needs Urgent Attention'	Improvement Schedule: How can you remove or reduce or remedy the cause and by when? Indicate where additional resources will be needed.	Until remedied, how will you know when this is actually causing deterioration towards unsafe drinking water?	What contingency management plan is in place until the cause is removed, reduced or remedied? Who needs to know and how quickly? Who can help?
10. Damage to exposed pipelines.	<ul style="list-style-type: none"> -Endeavour to bury/protect/encase all exposed pipelines. Have warning signs posted to inform the public. – -Regular monitoring of intake and distribution pipes. 	<ul style="list-style-type: none"> -Low pressure/leakages -Contaminated water found in the system on analysis -Visible colour change of the water at consumer end 	WSD-Distribution Section Inform the public Cover the pipelines. Install Signs
11. Borehole Intake Contamination	<ul style="list-style-type: none"> -Flushing of contaminate water (sections only). -Sufficient chlorination at Pump stations -Provide washout valves at the lower end of the distribution system. 	<ul style="list-style-type: none"> -Water smells -Water colour changes -Increase in dissolved solids in treated water at consumer end -Reduced water pressure at consumer end. -High levels of bacteria in tests 	WSD/ Distribution Manager. Establish cleaning programme for the mains.
12. Vandalism/sabotage <ul style="list-style-type: none"> - valve cover lids removed by people. - Unlocked lids and gates 	Cannot stop vandalism/sabotage but can reduce and prevent likelihood of both. If possible lock and secure tools, equipment, enclosures and parts. Upgrade cover method for chambers and reservoir/fence and grills. <ul style="list-style-type: none"> - Place notice/Sign boards/media information 	<ul style="list-style-type: none"> -Low pressure of water in pipes -People seen around storage tanks drawing water or bathing in instances of water cuts 	Police/WSD to monitor regularly. Provide steel enclosure for key area/ access to reservoir

6. IMPROVEMENT SCHEDULE

CATCHMENT AND INTAKE

Risks Identified	Improvement	Priority	Responsibilities and Timeline	Comments and Costs
1. Sabotage and Vandalism.	-Secure intake at Matovo/Qereqere to ensure that vandals do not get access to the intake pumps or galleries/bore holes by fencing and putting sign post caretaker or ranger.	High	WTP/DWS	WSD Cost Fencing and Sign boards \$30,000
2. Public access and farming in the catchment areas Matovo/Qereqere	People/tourist uses the area for picnicking. - Raise public awareness for people staying along riverside on pollution control and farming chemicals.	High	WSD Public Awareness MOH/MAPI Surveys and Workshops	Promote Health and Sanitation /farm advice for settlements/villages \$30,000
3. Natural disasters makes source unsafe from massive occasional flooding and erosion-blockages with debris/silts Matovo/Qereqere	-PWD and Provincial Councils to undertake awareness on land conservation and catchment protection. -Construct barrier walls To exclude debris/silts	High	WSD	Cost of construction of barrier walls- Motovo and Qereqere \$85,000
4.Eassy access of animals (horses/cattle) to the intakes sites (galleries/bore holes) – Matovo/Qereqere	-Erect fence and gates around the bore fields at Matovo and Qereqere. -Provide gates	High	WSD	Construct fence and gates. \$ 80,000

TREATMENT [Improvement Schedule]

Risks Identified	Improvement	Priority	Responsibilities and Timeline	Comments and Costs
1. High contents of Iron and Manganese in raw water from Matovo intake. (Sigatoka River)	<ul style="list-style-type: none"> -There is no security guard -Potassium permanganate was added before but stopped due to cost and health effects. -Erection cascade to be constructed at plant to aerate the raw water prior to further treatment. 	High	PWD NWQL WTP-operators PWD	There is an identified area at the plant site for construction - Submit sketch plans by engineers. Cost; \$40,000
2. Filter Failures <ul style="list-style-type: none"> - Matovo has 8 rapid sand filters. - Filter media needs upgrading - Provision for flow meters to monitor backwash rate - Improper air scouring 	<ul style="list-style-type: none"> -Due to high Turbidity and faulty sedimentation system all media to be soaked with caustic soda. This will eliminate slime build up and accumulation of mud-balls. - Inefficient filters will also increase the plant chlorine demand. -No, flow meters can contribute to fast backwash rate which can result in loss of filter media. - can lead to mud ball accumulation. To provide redundant air scourers (machine). Upgrade filter media (all size) 	High	WSD WTP operators	Repair filters and upgrade filter media. Cost- \$ 110,000
3.Replace malfunctioning flow meters at plants and reservoirs	<ul style="list-style-type: none"> -Plant flow meters are no functioning. -Chemical dosing is on estimation and old records 	High	WSD	Cost \$30,000
4.Manual Chlorination	<ul style="list-style-type: none"> -Should have a separate compartment close to the contact tank. -proper piping and mixing devise to be provided. -Provide HTH powder chlorine at all times to supplement the dosing if the mechanical system breakdowns. -Provide manual chlorine tank and shed. 	High	WSD	Cost \$20,000

Risks Identified	Improvement	Priority	Responsibilities and Timeline	Comments and Costs
5. Chlorine dosing rate does not counteract fluctuation in water quality accordingly. FAC no monitored. -Matovo Plant Lab needs Upgrading.	-Follow monitoring procedures for FAC measurements to confirm a chlorine residual of no less than 0.2 mg/L. Increase measurements during period of heavy rainfall. -Need to have a lockable lab. Area identified at the existing office building. A 3mx3m new lab to be made.	High	WTP operators	Upgrade Existing lab with provision of necessary equipments such as clear glass etc. Cost-\$20,000
6.Vandalism/Sabotage	-Provide extra security lights and monitors. -Put up a security fence to stop unauthorized access to the water storage tanks/post attendant/watchman at pump and reservoirs. -Provide Notice /Sign boards	High	WSD/WT P operators	Cost-\$20,000
7. Easy access of animals/pets in the treatment plants	-Sealing and repairing of all entry points for pets/animals and rodents. -Provide enclosure /lids for clear well to exclude entry of solid and liquid waste. – -Upgrade sanitation of the plant. -Place notice board at the WTPs	Medium	WSD/WT P operators	Upgrade grills and screens in the Plant building and hygiene aspects. Cost-\$10,000
8. Computer Breakdowns	Maintain computer programme and train staff	High		Upgrading and training cost-Cost \$60,000
9.Mixing of wrong chemical with wrong dosing/storage facilities	-Placing of notices and instruction at the mixing area. -Prepare SOPS for each section -Extend storage facilities	High	WSD/Plant Operators	Cost of building and posting instruction at places Cost-\$50,000
10.Accumulation of Clarifier sludge	-Replace sludge scrapper Cleaning of lamella plates -Need for heavy duty water blasters for removing of floccs. -Upgrade sludge removal pipes.	high	WSD/Plant operators	Cost of repair of scrapper and outlet pipes. \$60,000

STORAGE AND DISTRIBUTION – [Improvement Schedule]

Risks Identified	Improvement	Priority	Responsibilities and Timeline	Comments and Costs
1.Vandalism/Sabotage There is easy access for the public into the reservoir compounds. - Unlocked gates and reservoir lids.	- Install security lights and steel grills for the inlet and inspection chambers -Fencing and upgrading of gates for the reservoirs	High	WSD/WTP operators	Upgrade Security at all time. Cost \$30,000
2.Illegal connections could lead to cross-contamination	-A regular monitoring / surveillance schedule for illegal connections. -Allocate wardens in each zone community. -Raise public awareness And enforce Water legislation	Moderate	WSD/WTP operators	Inform via media. Public awareness materials. Brochure- Cost \$20,000
3. Easy access of animals and people into Intake and borehole sites.	-Repair damaged intake chambers. -All inlets to the storage reservoir to be sealed properly. - Rusted lids to be replaced. All ladders to be upgraded - Place notice/sign boards	High	WSD/WTP operators	Cost \$25,000
4.Trees and shrubs around the reservoir provides presence of rodents and birds	-Cut down all trees /shrubs growing close to reservoir. -Remove shrubs/grass and landscape to keep the sites clean. - All valve wheels at the storage reservoirs to be well secured and kept under lock and key.	Moderate	WSD/WTP operators/ PWD	Cost- \$25,000

Risks Identified	Improvement	Priority	Responsibilities and Timeline	Comments and Costs
5. Free available chlorine levels in the distribution system could be too low.	Current monitoring for FAC is insufficient. Design a more rigid monitoring programme with identified sampling points and time period.	High	WSD WTP operators NWQL	Upgrade the existing testing procedures. -No cost
6. Water is contaminated as a result of repair works in the distribution system. Danger of backflow during breakages and low pressure	<p>-Drain contaminated water before reconnection. Control back siphonage of dirty water. Chlorine washing of pipes and analyse water for bacterial contents.</p> <p>-Establish written procedures e.g. SOPs for fixing distribution problems, including hygiene procedures.</p> <p>-Use appropriate backflow prevention devices, double check valve and ensure air gaps.</p> <p>-Education programme for new and existing industry which pose a significant threat if backflow occurred.</p> <p>Backflow prevention devices installed if required valves and valve house</p>	High Moderate	WTP distribution section WTP distribution section	Train staff on Water demand management, leak detection and pipe maintenance. And use SOPs \$30,000
7. Drop in water pressure due to breakages and high demand disturbs sediments in mains.	<p>-Numerous reports of insufficient water to parts of the network and dirty water seen at consumer taps.</p> <p>-Install inlet/outlet meters for all reservoirs.</p> <p>-upgrade the existing reservoir at Lawai</p>	High	WSD WTP operators Distribution Section	Increase the mains size in the areas affected. Upgrade Reservoirs Cost \$40,000

Risks Identified	Improvement	Priority	Responsibilities and Timeline	Comments and Costs
8. Damages to the distribution network from natural disasters such as floods, landslides and earthquakes.	-Establish emergency contingency plans. - Provide water carting -Endeavour to landscape and upgrade reservoir access.	Moderate	WSD WTP operators PWD Regional Development	Avail water cart tanks Cost \$20,000
9. Contaminated storage reservoirs Accumulation of sediments , silt and debris	-Regular cleaning of storage tanks of sediments and chlorine washing before refill. - install floater gauges to measure the water level in the reservoir tanks.	High	WSD WTP operators	Costs- \$ 30,000
10. Leakages within the distribution network could lead to cross contamination. -Damage to exposed pipes. Interrupted distribution or contamination of water due to accidental damage. -Mains scaling and sedimentation.	-Unintentional pipeline damage by companies. -Formulate M.O.U with PWD, Telecom and FEA to repair damages done during their operations -Establish leakage detection measures Encourage public to report for damaged pipes. -Public notices to stress importance of pipelines that are buried or exposed to stop damage. - provide wash out valves at the lower areas of the distribution system to flush out deposited silts. - regular flushing of mains water to eliminate sediments in distribution	High Moderate	WSD WTP operators Distribution section PWD & Municipal, Provincial councils PWD	Public awareness Sign boards. Provide wash out valves and chambers Cost – \$60,000
11. Drop in Water Level in the reservoirs. Leakage in underground pipelines within houses and properties.	-Provide water level measuring gauge. (Telemetry). -Encourage upgrading of old pipelines within houses/properties. -Advise property owners on advantages of using standardised pipes and fittings.	High	DWS to install measuring devise and train staff PWD	Cost of installation and training on data recording \$30,000

6.1 SUMMARY FOR THE IMPROVEMENT SCHEDULE FOR THE SIGATOKA (MATOVO) WATER SUPPLY SYSTEM

IMPROVEMENT REQUIRED	COMPONENT IMPLIED	ETIMATE COST	Tot Cost
Catchment and Intake		Fiji Dollars	FJD
1.Public awareness campaign – villagers/farmers	Surveys and Workshops/IEC materials	30,000	
2.Provide security gates/signboards at –Matovo/ Qereqere	Gates/signboards at the main entrance	30,000	
3.Constructing Barrier Walls at Bore-fields-Matovo/ Qereqere	To protect from flood damages.	85,000	
4.Fencing at Matovo and Qereqere intakes	Fencing to protect access of animals	80,000	\$225,000
Treatment			
5.Construct Aeration Cascade	To remove Iron/manganese in Raw Water	40,000	
6.Upgrade filtration –sand filters	Upgrade/replace mono-sand media	110,000	
7.To upgrade the plant flow recordings	Upgrade and install flow meters	30,000	
8.Upgrade Manual Chlorination	Provide facilities/equipments and shed	20,000	
9.Monitoring of Chemical dosing	Provide test materials and laboratory	20,000	
10.Vandalism/Sabotage	Provide lights/gates and sign post	20,000	
11.Easy access of animals and pets	Provide notice and upgrade screens/grills	10,000	
12.Improve computer system and programming	Improve programming and train staff	40,000	
13.Chemical dosing and Storage	Place instruction and provide storage facilities	40,000	
14.Removal of clarifier sludge	Repair clarifier scrapper and sludge pumps	40,000	
15.Repair sludge pump and provide shed	Repair pump and protect from weather(Sheds)	40,000	410,000
Storage and Distribution			
16.Vandalism/sabotage	Security lights, fence /gates and grills	30,000	
17.Illegal connections	Monitoring/public awareness/employ wardens	20,000	
18.Control access of animals/people to reservoirs	Provide fence/gates/signboards	25,000	
19.Clear reservoir sites	Remove trees, Shrubs from reservoirs	25,000	
20.Backflow /contamination control measures	Prepare SOPs /train staff/control device	30,000	
21. Increase water storage capacity/reservoirs	Provide and maintain existing reservoirs	40,000	
22.Cleaning of Silts and debris in the reservoirs	Remove silts and debris from reservoirs	20,000	
23.Damage of pipes and storage system in Disasters	Cover pipes/post signboards/	30,000	
24.Provision of water level measuring gauge	Install measuring device (telemetry system)	60,000	
25.Damage to distribution system by earthworks	Sign post, public awareness/Formulate -MOU	30,000	310,000
TOTAL	COST -FJD		\$945,000

Table 1: Water Safety Plan Team - Sigatoka

Name	Position	Organization	Responsibility	Phone/E-Mail
Peceli Ravasua	Actg Divisional Water Engineer- Western	Department of Water and Sewerage, (WSD) Lautoka	Overall Supervision of Engineering and Infrastructure for Western Division Water Production and distribution.	PH: 6660563 P.O. Box 56, Lautoka
Govind Naicker	Treatment Supervisor, Western	Lautoka Water Supply	Supervision of treatment Plants for Western Division	PH: 6660563
Sher Singh	Senior Scientific Officer	Kinoya Water Quality laboratory	Supervisor for the Plant treatment process – Western Division	PH: 3392133 shersinghh@connect.com.fj
Joe Ravouvou	Actg Water Supervisor	Nadroga Water Supply	Supervisor Nadroga	PH: 6500139
Vilame Senileba	Officer In-charge	Matovo Water Treatment Plant	Plant Supervisor Matovo	Ph: 6280110
Mereseini Mataluvu	Project Officer	Lautoka Water Supply	Project Planner – Western Division	PH: 6660563
Paula Laqere	Health Inspector	Ministry of Health ,Sigatoka	Rural Water and Sanitation	Health Office, Sigatoka Ph; 6500341
Suliano Turanga	Agricultural Officer	Dept of Agriculture Sigatoka	Division – farming technology	Ph;6500418
Rupeni .N	Leak Detection Officer	Nadroga Water Supply	Leak detection/complains	Ph; 6500139
Joseva Qainicici	Plant Operator	Matovo Water Treatment Plant	Plant Operator	Ph: 6280110

7 RECOMMENDATIONS AND CONCLUSION

7.1. Remarks and Recommendations

1. There is a need for the improvements in water resource management and land use planning in the water shed; therefore it is necessary to have a water authority for the efficient management of the water supply system in relation to human, capital and natural resources.
2. There is a need for the training of staff on raising public awareness in the departments and in the community levels. It is necessary for the continuous up-skilling of staff at all sectors of the organisation due to the advent of new technology and quick staff turnover.
3. Since most of the staff are field workers occupational health and safety provisions should be made for efficient work performance especially in the treatment plant where hazardous chemicals are used. Training of Fire safety and self contained breathing apparatus (SCBA)
4. The Matovo Treatment Plant to be upgraded and improved (filters, clarifiers, chemical mixing and sludge disposal). The request of such improvement is seen in the monthly reports. The plant building also needs improvement and hygiene upgrade.
5. Modern laboratory with equipment to be set at the Matovo Treatment Plant and a field monitoring system for residual chlorine and leak detection procedures made available.
6. All plant operators should be suitably qualified, graded to operate the plants. The department should arrange for the necessary training for the respective staff.
7. Data and record keeping should be improved in order to monitor the resource, demand and water wastage. SCADA telemetry system to be improved where necessary.
8. Existing management plans and strategies to be continuously reviewed with the formulation of contingency plans and standard operating procedures (SOPs).
9. Ministry of Health as regulators should formulate a monitoring plan for the drinking water quality for bacterial and chemical parameters and make relevant information available to Water department.
10. Due to the increase in the population, tourism and industrial activities in Sigatoka (Coral Coast) there is increase in water demand, therefore storage and distribution system to be maintained and upgraded.
11. There are a number of reservoirs in the Sigatoka water supply; unfortunately the inspection reveals that they are not well maintained. Contamination of treated water is likely as most reservoirs are seen with over growth of grass and broken manhole lids /inlets. Ingress of rodents and small animals are possible. The turn key chambers are unmaintained and usually damaged by vandalism. This to be addresses immediately as per the WSP/Improvement Schedules.

12. Remove siltation of dissolved solids which is common in the reservoirs and distribution mains as filtration process at the treatment plant is in-efficient. There are no flush out device for the mains at low lying areas. Siltation also occurs due to the low water pressure during water cuts.
13. Coordination with major stakeholders and networking and information sharing is necessary to promote more collaborative approach in water resource management at watershed and service level.
14. It is vital to enforce Environmental Management Act and Public Health Act to maintain a healthy watershed through elimination of pollution from human activities (point and non-point source).
15. There is lack of data on water resource management and surveillance with major stakeholders such as WSD, Mineral Resources Department and Ministry of Health. This impedes in making proper decisions in many cases such as water demands in specific zones and water loss through leakages (unaccounted water). Department sections to improve data recording and formulating improvement proposals.
16. Proper chemical storage areas should be provided to store different chemicals in confined areas in order to maintain them in good condition and provide efficient methods of application of chemicals without endangering the health of workers and quality of chemicals.
17. The intake bore-field on the Sigatoka river banks needs protection from flooding and damage. Concrete barrier should be constructed to exclude debris /silts and damage to the bore wells.
18. An aeration cascade should be constructed at the Matovo treatment plant site to remove iron and manganese contents from raw water entering the WTP.
19. The Qereqere borehole intake to be protected from floods and animals by fencing the site and constructing the barrier walls to protect borehole pumps.
20. The existing abundant reservoir at Lawai to be upgraded and reused for water storage to avoid water cuts and low pressure.
21. Training should be provided to distribution staff on the water demand management and leak detection procedures.
22. Since the Matovo plant is fully computerised, the staff should be sufficiently trained on computer programming and maintenance. One specialist is required for this job to avoid malfunction of the treatment operations.
23. Since the installation, the uplift pumps are continuously running to meet the water demand as such it is difficult to carry out service and maintenance. Therefore it is recommended that additional standby pumps made avail at plant and borehole intakes.

7.2 Conclusion

The Water Safety Plan was finalized through the assistance of the Matovo Sigatoka Water Supply staff and reference was also made to the outcome of the WSP workshop held at Lautoka Water Supply in December 2008. A mini workshop was also done to brief the plant operators at Matovo since some of the staff did not attend the Lautoka workshop and were not familiar with the Water safety plan concept. Sigatoka Water Safety Plans steering committee is formed which would monitor the future activities necessary for implementing the plan. The Water Safety Plans documents will be presented to the Steering Committee and the Water and Sewerage Department for their initial endorsement as the final document. It is realized that this document is very important for the implementation of the plan and to carry out the improvements in order to remove risks in the water supply system and create a holistic management approach from catchment to consumer. The document would assist in future planning and for the fund allocation in specific areas as per the improvement schedule. The completed Water Safety Plan is an ideal reference document for staff and the decision makers.

The Improvement Schedule was finalised with the assistance of Water and Sewerage Department during the consultancy process. The national budgetary allocation in reference to this document is important for the country to divert further funding in this area. It is anticipated that Fiji Water Safety Plan programme will assist and train the staff of the department in improving the water quality by eliminating the risks in the system. The Steering committee also requested that staff from WSD should be further trained in risk assessment and management in the water supply system. The WSP replication programme for Fiji is well progressing due to the commitment shown by the stakeholders and especially Water and Sewerage Department. Some of the issues raised in the recommendation in necessary to be considered so that early improvements are made to the system.

The Sigatoka (Matovo) Water Supply is under much pressure due to high demand of treated water for consumption by the increasing population in the Sigatoka coral coast area. The Sigatoka Regional Water Supply has authority and capacity to maintain the treatment and distribution system but many constraints such as lack of capital and human resources and deteriorating infrastructure hinders the progress. There are many benefits of improved water quality and quantity such as improved human health and the economic status of the country. It is therefore anticipated that Fiji will surely gain through implementation of this WSP programme.

It is envisaged that Water and Sewerage Department, the Ministry of Health and the Department of Public Works will work together to implement Water Safety Plans for the Water Supply system and replicate the process for the other areas in Fiji. Cooperation between various agencies is necessary to achieve the outcomes, as they have expressed commitment for this programme at the commencement of the Regional Action Plan (RAP) for the Pacific island countries and endorsed by the ministers.

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Drinking Water Risk Assessment Table

Judging Priorities – systematic risk assessment

i. For each hazard event, decide on the likelihood of the event happening

Likelihood	Score	Possible Descriptions
Almost Certain	5	<ul style="list-style-type: none"> Occurs like clockwork Occurs every week, month or season
Likely	4	<ul style="list-style-type: none"> Has occurred more than once before Expected to occur every year
Possible	3	<ul style="list-style-type: none"> Has occurred before Expected to occur every 2-5 years
Unlikely	2	<ul style="list-style-type: none"> Has occurred before Expected to occur every 5-10 years
Rare	1	<ul style="list-style-type: none"> Has never occurred before and unlikely to occur less than every 10 years

ii. For each hazard event, decide on the consequence to people's health if it did happen.

Consequence	Score	Possible Descriptions
Insignificant	1	<ul style="list-style-type: none"> No illness expected in the community or interruption to water availability
Minor	2	<ul style="list-style-type: none"> Very few of the community ill, or some interruption to water availability
Moderate	3	<ul style="list-style-type: none"> Some of the community ill
Major	4	<ul style="list-style-type: none"> Most of the community ill
Catastrophic	5	<ul style="list-style-type: none"> Most (or all) of the community ill with anticipation of some deaths

iii For each hazard event, look up the likelihood and consequence scores in this table to find the corresponding priority (very low, low, medium, high, very high)

Likelihood	Consequence				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Almost Certain 5	Medium 5	Medium 10	High 15	High 20	very high 25
Likely 4	Medium 4	Medium 8	Medium 12	High 16	high 20
Possible 3	very low 3	Low 6	Medium 9	High 12	High 15
Unlikely 2	very low 2	very low 4	Low 6	Medium 8	High 10
Rare 1	very low 1	very low 2	low 3	medium 4	medium 5

(Adapted from NZ MoH, 2007)

Instruction: Using either of the methods outlined above, consider each of the hazard events separately and determine the priority for each. Enter the priority rating into the third column of the DWSP matrix.

ANNEX: 2

RISK ASSESSMENT –MATOVO

Risk assessment was conducted using the following steps:

- i. Identify risks (at each stage of the water supply system)
- ii. Identify control Measures (or barriers)
- iii. Prioritize Risks which are not under control

Semi-quantitative ranking – using the “likelihood” and “consequence” matrices, a semi-quantitative way of prioritizing risks was developed as in the tables below.

Intake/Catchment

RISK	CAUSE	CONTROL MEASURE IN PLACE?	LIKELIHOOD	CONSEQUENCE	PRIORITY
High levels of Faecal Coli-form in raw water	Animal/bird faeces and/or seepage	None	Almost Certain 5	Moderate 3	High 15
High turbidity due to Increased sedimentation and soil erosion	Deforestation / logging	None	Almost Certain 5	Minor 3	High 15
	Farming – land clearing	None	Likely 4	Minor 2	Moderate 8
	Flooding	None	Likely 4	Moderate 3	High 12
	Fishing	None	Likely – 4	Major -4	Very High - 16
Not sufficient water, low water level	Drought	None	Possible 3	Major 4	High 12
Algae in raw water	High nutrient levels in water	None	Likely 4	Minor 2	Moderate 8
Galleries Contaminated by flood	Increased siltation /debris in the borehole intakes.	None	Possible 3	Major 4	High 12
Access by animals to intake galleries	No boundary fence	None	Likely 4	Major 4	Very high 16
Access by people	No boundary fence/notice	None	Possible 3	Major 4	High 12

Pumping Station/Intakes –Qereqere/Korotogo

RISK	CAUSE	CONTROL MEASURE IN PLACE?	LIKELIHOOD	CONSEQUENCE	PRIORITY
Pump Failure	Electrical blackout	None	Possible 2	Major 4	High 8
	Mechanical Problems	Preventative Maintenance programme in place/ No standby pumps.	Possible 2	Major 4	Moderate 8
Vandalism and Sabotage	Low security	None	Likely 4	Major 4	Very High 16
	Easy access to site/No fence and gates	None	Unlikely 2	Major 4	Moderate 8
Contamination from Storm water and flooding	Damaged infrastructure (borehole intake)	None	Possible 3	Major 4	High 12
Low water Intake	Smaller diameter intake pipe	None	Likely 4	Major 4	Very High 16

Treatment Plant -Matovo

RISK	CAUSE	CONTROL MEASURE IN PLACE?	LIKELIHOOD	CONSEQUENCE	PRIORITY
Raw Water Channel					
Sabotage and/or vandalism	Low security. no screens	None	Likely 4	Major 4	Very High 16
	Easy access to site by pets	None	Unlikely 2	Major 4	Moderate 8
Solution strength inaccurate	Chemical dosing affected due to chemical deterioration/No jar test done	None	Unlikely 2	Major 4	Moderate 8
Chemical Under-dosing	Equipment Failure (e.g. improper jar-test or old balance etc)	Calibration by trained technicians and audited by NWQL	Possible 2	Major 4	Moderate 8

	RISK	CAUSE	CONTROL MEASURE IN PLACE?	LIKELIHOOD	CONSEQUENCE
	Fluctuations in turbidity	None	Likely 3	Major 4	High 12
	Fluctuations in flow rate	Flow meters	Possible 2	Moderate 3	Moderate 6
	Improper mixing (low concentration)	Trained Technicians required	Rare 1	Moderate 3	Low 3
Chemical Over-dosing	Equipment Failure (e.g. improper jar-test or old balance etc)	Calibration by NWQL	Possible 2	Major 4	Moderate 8
	Fluctuations in turbidity	None	Likely 3	Major 4	High 12
	Fluctuations in flow rate	Flow meters	Possible 2	Moderate 3	Moderate 6
	Improper mixing (high concentration)	Trained Technicians required.	Rare 1	Moderate 3	Low 3
Contamination from operational activities	Improper safety mechanisms – no railing, slippery surface, poor lighting, poor ladder etc	None	Possible 2	Moderate 3	Moderate 6
Clarifiers					
Overload	High turbidity	Increased dose of coagulant (jar test)	Likely 3	Moderate 3	Moderate 9
Algae in water	Algae in raw water	Increase dosing of copper sulphate	likely 3	Moderate 3	Moderate 9
Malfunctioning	Damage to scarper	No preventative maintenance in place	Almost certain 5	Major 4	Very High 20
Filters					
Filter overload	High turbidity	None	Likely 3	Moderate 3	Moderate 9
	Clarifier failure	No preventative Maintenance in Place	Almost certain 5	Major 4	Very high 20
	Insufficient Backwash	Trained operators	likely 4	Major 4	High 16

	Filter Medium expired (sand)	Changing filters prior to expiry	Likely 4	Major 4	High 16
Protozoa presence in treated water	No Protozoa barrier	No upgrading of Sand filters	Possible 3	Major 4	High 12
Disinfection					
In-sufficient Chlorination	Chlorinator failure/manual dosing	Preventative Maintenance	Possible 3	Major 4	High 12
	High turbidity/high chlorine demand	None-upgrade filter media	Possible 3	Major 4	High 12
Pumps					
Pump failure	Electrical Failure	None	Possible 3	Major 4	High 12
	Power board exposed/no standby pumps Computer Breakdown	None	Possible 3	Major 4	High 12
Flow Meters	Not functioning	Estimation	Possible 3	Major 4	High 12
Contact Well Storage					
Sedimentation	Improper filtration ,reduced filter media	none	Likely 4	Major 4	Very High 16
Accumulation of Filter Media	Damaged filter nozzle allows filter media to enter clear well	none	Likely 4	Major 4	Very High 16
Easy entry of rodents and birds	Open inlets above clear well/manual chlorination	none	Possible 3	Major 4	High 12
Sabotage /Accidents	Open Inlets/no screens	none	Possible 3	Moderate 3	Moderate 9
Entry by Operators to check water level	No mechanical measuring device	none	Possible 3	Major 4	High 12
Chemical Storage					
Chemicals lose strength	Improper Storage	None	Possible 3	Major 4	High 12

Unventilated Chambers	Distract workers	none	Possible 3	Moderate 4	High 12
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Post Treatment Storage - Matovo

RISK	CAUSE	CONTROL MEASURE IN PLACE?	LIKELIHOOD	CONSEQUENCE	PRIORITY
Accidental contamination	Rusted covers and other components	None	Possible 3	Major 4	High 12
	Cracks allow for bacterial access	None	Likely 4	Major 4	Very High 16
	Sedimentation at the bottom of the tank	None	Likely 4	Major 4	Very High 16
Security	Low security	None	Likely 4	Major 4	Very High 16
	Easy access to site	None	likely 4	Major 4	Very High 16

Storage and Distribution network –Sigatoka (Matovo) Supply

RISK	CAUSE	CONTROL MEASURE IN PLACE?	LIKELIHOOD	CONSEQUENCE	PRIORITY
Distribution Pipe Breakages	Old pipes	Leak detection and replacement	Likely 4	Major 4	Very High 16
	Earth Works	None	Possible 3	Major 4	High 12
	Disasters	None	Possible 3	Major 4	High 12
Sedimentation and Scaling in storage tanks and Distribution pipes	Pipe breakages	none	Likely 4	Major 4	Very high 16
	Inefficient filtration	none	Possible 3	Major 4	High 12
Rodents, Birds and animals entering the reservoir tanks	Rusted cover and inlets	none	Possible 3	Major 4	High 12
	Remove tall trees and discarded pipes / fitting	Casual workers	Possible 3	Major 4	High 12
Cross Contamination of treated water	Illegal connections	Meter reading	Possible 3	Moderate 3	Moderate 9
Low water pressure	High demand and low treatment plant capacity	Increase water intake through catchments improvement.	Possible 3	Moderate 3	Moderate 9

ANNEX: 3

WATER AND SEWERAGE DEPARTMENT
NATIONAL WATER QUALITY LABORATORY

P. O. BOX 3850, SAMABULA

CHEMICAL AND BACTERIOLOGICAL ANALYSIS OF WATER

Sample from	Sigatoka(Matovo) Area	Sampled by	Vimanasitajit	Weather	Fine	Laboratory Ref. No.	WFC 050/09
Sample date	28/06/09	Sample time	0805-1300hrs				

DETERMINANDS	UNITS	SAMPLE LOCATION			Standards For T/W	DETERMINANDS	UNITS	SAMPLE LOCATION			Standards For T/W
		1	2	3				1	2	3	
ANALYSIS	Temperature	°C	26.0	26.0	27.0						
	pH	0-14	6.80	7.20	7.20	6.5 to 8.5					
	Conductivity	µS/cm	326.0	315.0	318.0	1000µS/cm					
	Colour	TCU	5	0	0	5 TCU					
	Turbidity	NTU	4.58	0.21	0.18	5 NTU					
ALKALINITY	Alkalinity	mg/L	126.4	120.8	128.8						
	bicarbonate	mg/L	126.4	120.8	128.8						
	Carbonate alkalinity	mg/L	0	0	0						
	Total Hardness	mg/L	124.8	120.6	116.8	200mg/L					
	Calcium Hardness	mg/L	87.4	85.4	81.1						
SOLIDS	Magnesium Hardness	mg/L	37.4	31.2	35.4						
	Total Solids	mg/L									
DISSOLVED	Total Dissolved Solids	mg/L	212	205	208	500mg/L					
	Suspended Solids	mg/L									
GASES	Carbon Dioxide	mg/L									
	Dissolved Oxygen	mg/L									
OTHER CHEMICAL ANALYSES	BOD 5-day @ 20°C	mg/L									
	Total Nitrogen	mg/L									
	Ammonia Nitrogen	mg/L									
	Borinity	ppm	0.1	0.1	0.1						
	Nitrate Nitrogen	mg/L	0.08			50mg/L					
	Total Phosphorus	mg/L									
	Ortho-phosphates	mg/L	0.1								
	Total Sulphates	mg/L				250mg/L					
	Chlorides	mg/L	15.6	12.30	13.90						
	Cyanides	mg/L				0.07mg/L					
Fluorides	mg/L	<0.05	<0.05	<0.05	1 mg/L						
METALS	Iron (Total)	mg/L	0.02	0.01	0.02	<0.3mg/L					
	Iron (Soluble)	mg/L	0.01	0.01	0.01	<0.3mg/L					
	Manganese (Total)	mg/L	0.01	0.01	0.01	<0.1mg/L					
	Manganese (Soluble)	mg/L	0.01	0.01	0.01	<0.1mg/L					
	Aluminium	mg/L	<0.02	<0.02	<0.02	<0.3mg/L					
	Calcium	mg/L	35.00	35.80	32.50						
	Magnesium	mg/L	9.10	7.60	8.60						
	Sodium	mg/L				<180mg/L					
	Potassium	mg/L									
	Copper	mg/L	<0.05	<0.05	<0.05	<1.0mg/L					
HEAVY METALS	Lead	mg/L				0.01mg/L					
	Boron	mg/L				0.7mg/L					
	Lithium	mg/L									
	Zinc	mg/L				3mg/L					
	Cadmium	mg/L				0.003mg/L					
	Chromium	mg/L				0.05mg/L					
	Nickel	mg/L									
	Selenium	mg/L				0.01mg/L					
	Arsenic	mg/L				0.01mg/L					
	Mercury	mg/L				0.01mg/L					
CHLORINE RESIDUALS	Total Available	mg/L	N/A	0.38	0.32						
	Free Available	mg/L	N/A	0.28	0.22	0.5mg/L					
MICROBIO- LOGICAL	Standard Plate Counts										
	Total Coliforms		66	0	0	0					
	Faecal Coliforms		28	0	0	0					
in Col/100mL	Faecal Streptococci										

Checked by : Sher Singh

REMARKS

[1] Mix Raw Water
 [2] Treated Water
 [3] Reducation

Sher Singh
 Senior Scientific Officer

ANNEX:4**NADROGA WATER SUPPLY**
MONTHLY REPORT SHEET**Station:** Matovo WTP.....**Month:** April 2009**Type of Treatment:** Coagulation, pH correction, copper sulphate dosing, filtration, Flocculation, Sedimentation**Attendant:** V.Senileba , J.Qainiuci, Amar Singh, Elike,Eveli, Waisale.**Total Flow:** 245,528 cbu meter**Average daily flow:** 8184 cub meter**CHLORINATION:**

a)Chemical Used (Type)	Alum	Soda,	Chlorine gas,	Copper sulphate
b)Chemical Used (Amount)	5700 kg	700 kg	630 kg	50 kg
c)Dosing rate	31.7 ppm	19.7 ppm	6.7 ppm	0.60 ppm
d)Introduction to chemical to system: Through dosing pumps and chlorinator				

REMARKS OF CHLORINE:

Chlorine is injected into the system for the final disinfection purposes.

FILTRATION:

- a) Type : 8 Rapid sand filters
- b) Filtration rate:
- c) Wash Water rate:

REMARKS ON FILTRATION

All filters operating on manual mode
Backwashing done manually

GENERAL REMARKS:

Matovo is operating normally.
We also have some ups and downs during the month. Breakdown to some of the intake pumps.
Malfunction of high-lift pumps, dosing pumps and most of all the power failures.

OPERATOR_____
SUPERVISOR

MONTHLY COSTS

CHEMICALS

Chlorine Gas (Cl ₂)	630	kg	at	\$ 4.66	cent /kg	=	<u>\$ 2935.80</u>
Chlorine powder (CaOCl ₂)							
Aluminium Sulphate (Al ₂ SO ₄ .18H ₂)	5700	kg	at	0.71	“	=	<u>4047.00</u>
Soda Ash (Na ₂ CO ₃)	700	kg	at	0.90	“		<u>630.00</u>
Miscellaneous (CuSo ₄)	50	kg	at	4.97	“	=	<u>248.50</u>
HTH Powder (Cl)	40	kg	at	3.93	“	=	<u>157.20</u>

FUEL:

Diesel							nil
Lubricating Oil							nil

FEA ELECTRICITY

Meter No.							
83460564	162790		at	0.2214	cents/un		<u>\$36,041.71</u>
83460564	23946		at	0.2214	Cents/un		<u>5,301.65</u>

OTHER STORES:

1. Toilet Paper	50	at 0.22 cents /unit					<u>\$11.00</u>
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LABOUR

Skilled	704	hours	wages paid	4.20/hr			\$ 2956.80
Unskilled	704	hrs	wages paid	3.71/hr			<u>2611.84</u>
Trade Assistant	176	hrs	wages paid	4.46/hr			<u>784.96</u>
Shift allowance	1408	hrs	wages paid	0.05/hr			<u>70.40</u>

TOTAL **\$55,796.86**

ANNEX:4**NADROGA WATER SUPPLY**
MONTHLY REPORT SHEET**Station:** Matovo WTP.....**Month:** April 2009**Type of Treatment:** Coagulation, pH correction, copper sulphate dosing, filtration, Flocculation, Sedimentation**Attendant:** V.Senileba , J.Qainiuci, Amar Singh, Elik, Eveli, Waisale.**Total Flow:** 245,528 cub meter**Average daily flow:** 8184 cub meter**CHLORINATION:**

a)Chemical Used (Type)	Alum	Soda,	Chlorine gas,	Copper sulphate
b)Chemical Used (Amount)	5700 kg	700 kg	630 kg	50 kg
c)Dosing rate	31.7 ppm	19.7 ppm	6.7 ppm	0.60 ppm
d)Introduction to chemical to system: Through dosing pumps and chlorinator				

REMARKS OF CHLORINE:

Chlorine is injected into the system for the final disinfection purposes.

FILTRATION:

- d) Type : 8 Rapid sand filters
- e) Filtration rate:
- f) Wash Water rate:

REMARKS ON FILTRATION

All filters operating on manual mode
Backwashing done manually

GENERAL REMARKS:

Matovo is operating normally.

We also have some ups and downs during the month. Breakdown to some of the intake pumps.
Malfunction of high-lift pumps, dosing pumps and most of all the power failures.

OPERATOR_____
SUPERVISOR

MONTHLY COSTS**CHEMICALS**

Chlorine Gas (Cl ₂)	630	kg	at	\$ 4.66	cent /kg	=	\$ 2935.80
Chlorine powder (CaOCl ₂)							
Aluminium Sulphate (AL ₂ SO ₄ .18H ₂)	5700	kg	at	0.71	“	=	4047.00
Soda Ash (Na ₂ CO ₃)	700	kg	at	0.90	“		630.00
Miscellaneous (CuSo ₄)	50	kg	at	4.97	“	=	248.50
HTH Powder (Cl)	40	kg	at	3.93	“	=	157.20

FUEL:

Diesel	nil
Lubricating Oil	nil

FEA ELECTRICITY

Meter No.						
83460564	162790	at	0.2214	cents/un		\$36,041.71
83460564	23946	at	0.2214	Cents/un		5,301.65

OTHER STORES:

2. Toilet Paper	50	at 0.22 cents /unit	\$11.00
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LABOUR

Skilled	704	hours	wages paid	4.20/hr	\$ 2956.80
Unskilled	704	hrs	wages paid	3.71/hr	2611.84
Trade Assistant	176	hrs	wages paid	4.46/hr	784.96
Shift allowance	1408	hrs	wages paid	0.05/hr	70.40

TOTAL **\$55,796.86**

ANNEX: 4

World Health Organisation (WHO) Drinking Water Quality Guidelines	
Parameter	WHO Guideline value
Faecal coli-form or E. coli	Not detectable in a 100 ml sample
Aluminium	0.2 mg/L*
Arsenic	0.01 mg/L
Ammonia	1.5 mg/L*
Cadmium	0.003 mg/L
Arsenic	0.01 mg/L
Chloride	250 mg/L*
Colour	15 TCU*
Copper	2 mg/L
Fluoride	1.5 mg/L
Hydrogen Sulphide	0.05 mg/L*
Iron	0.3 mg/L*
Lead	0.01 mg/L
Manganese	0.1 mg/L*
Nitrate	10 mg/L
Sodium	200 mg/L*
Sulphate	250 mg/L*
Turbidity	5 NTU*
Total dissolved solids	1000 mg/L*
Zinc	3 mg/L

* May not be toxic but could result in consumer complaints

Source: WHO Guideline for Drinking Water Quality - 3rd Edition