



Republic of Palau

Water Supply System Description Koror/Airai



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Water Safety Plan Programme
Republic of Palau
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1. INTRODUCTION

Republic of Palau is chosen as one of the four pilot countries for the Pacific Water Safety Plans programme which is for two years and focuses on the provision of safe drinking water to the community. A one week scoping mission and workshop was successfully carried out with the commitment of national government and all other stakeholders for the water supply. Two pilot sites were chosen from the urban and rural supplies for the implementation of Water Safety Plans and it was envisaged that replication will follow within the country for all the remaining water supplies.

The importance of safe drinking water for health and development in the Pacific Island Countries 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.

The Pacific Island Countries (PIC) 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.

The Pacific Water Safety Plans Programme is a joint initiative of the Pacific Applied Geo-science Commission (SOPAC) and the World Health Organization (WHO), Suva Fiji.

Funded by AusAID, the programme is a response to the regionally endorsed Framework for Action on Drinking Water Quality and Health and will be implemented over the period 2006-2007. Water Safety Plans (WSP) as promoted by WHO in the Guidelines for Drinking Water Quality (Third Edition), are tools that allow for proactive measures to ensuring safety of a drinking water supply. It uses risk assessment and risk management approaches to identify risk of contamination of water supply and allow for sufficient mechanisms to manage these risks. The primary objective of a Water Safety Plan is to minimise contamination of water sources, and prevent or remove contamination during treatment, storage and distribution. These objectives are equally applicable to large reticulated water supplies; smaller community managed systems and as well as for individual household systems.

This WHO/SOPAC scoping mission was proposed to determine the scope and interest and secure the commitment of key government counterparts including the Bureau of Water Works, Ministry of Health (MoH), Environment Quality Protection Board (EQPB) and other potential partners including Non –governmental Organization (NGO's). The government of Republic of Palau has applied to WHO/SOPAC for support under the Pacific Water Safety Plans Programme.

There is strong interest from key authorities such as Bureau of Public Works, Ministry of Health, Environmental Quality Protection Board and NGOs to work together to establish Water Safety Plans pilots in Palau. The most likely structure can be referred in Fig 1 which also indicates the position of the lead agency and the steering committee. The lead agency is Bureau of Public Works and the steering committee consists of relevant authorities both government and non-government.

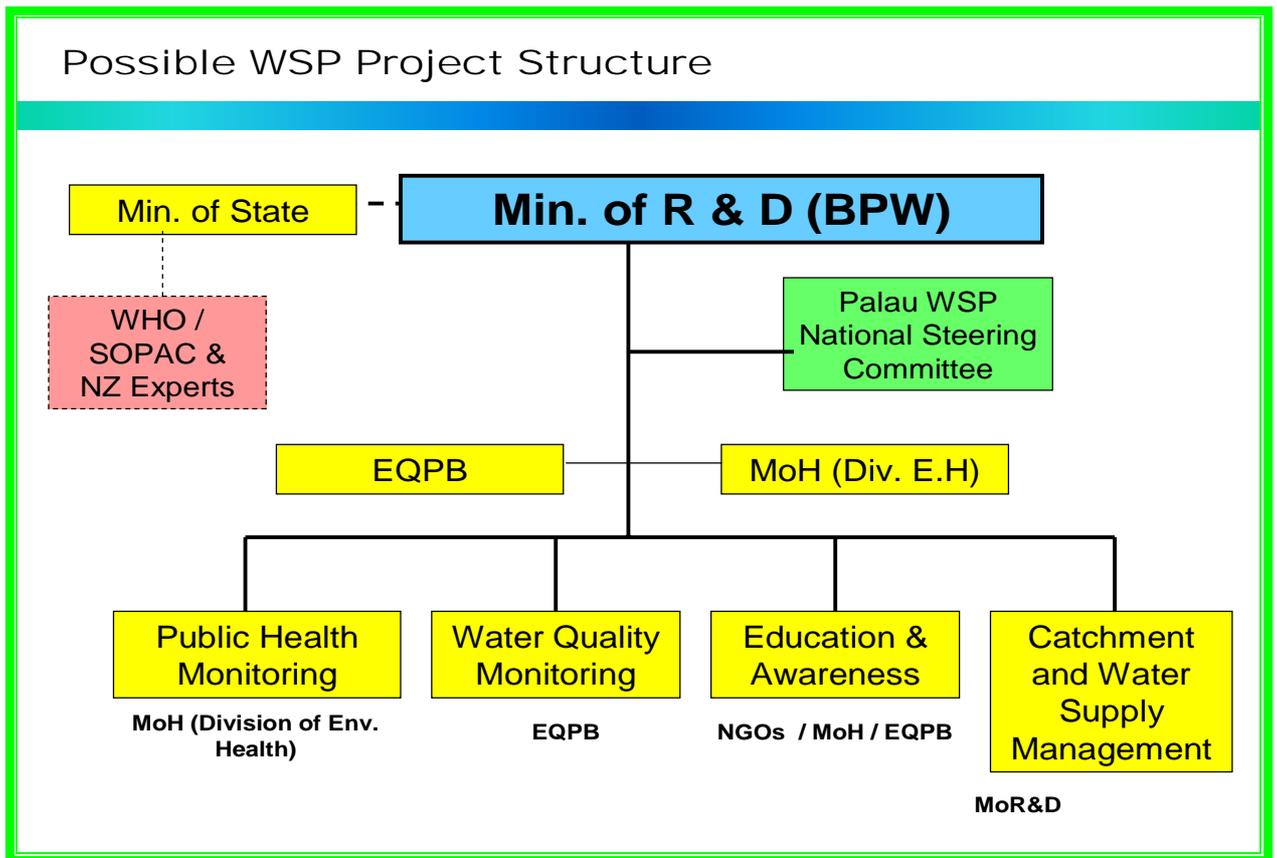


Fig:1 Lead Agency and Steering Committee

1.1 BACKGROUND

The Republic of Palau is the most western island of the Caroline islands and is an archipelago consisting of approximately 350 islands located in the south western Pacific ocean about 500 miles north of the equator and at 7° 20" north latitude and 134° 28" east latitude. The nearest neighbouring islands are Guam, the Philippines and Papua New Guinea respectively.

The main archipelago is approximately 100 miles in length and 16 miles across and includes the seven major islands, all of which are populated. The largest island is Babeldaob with an area of 153 square miles. Ten of Palau's sixteen states lie on Babeldaob. South of Babeldaob is the island of Koror State. Stretching south of Koror for about 20 miles are hundreds of tiny mushroom shaped uninhabited islands known as the rock islands. At the end of the chain of rock islands are the two inhabited islands of Peleliu and Anguar.

The majority of Palau's population lives in Koror State which serves as the commercial and business centre of the nation. Koror state is urbanised with modern infrastructure and services, paved roads and traffic. Babeldaob and the other remaining islands are rural and undeveloped. The total population of Palau is around 20,000 of which about 14,000 live in Koror. The largest sectors of the economy are services, tourism, fisheries and agriculture. Palau's total land area is 488 sq km with 629,000 sq km of EEZ.



Map: 1 Republic of Palau

1.2 CLIMATE AND GEOLOGY

The tropical climate of Palau is warm and humid with an average of about 150 inches of rainfall per year. The average temperatures in Koror vary from 27 to 28 degrees and the relative humidity averages 82% throughout the year. Palau has an abundance of surface water streams and rivers on the main island of Babeldaob, which supply the majority of the public drinking water systems. The island Lake Ngradok is the largest in Micronesia.

Geologically the Palau Islands are made up of four main types: volcanic, high lime stone, low platforms and atolls. Babeldaob, Arakabesan and Malakal are volcanic. Peleliu, Angaur and other islands of the south west are either raised or low coral platform, while Koror is a combination of several types.

1.3 Water Resources and Supply Status

The secondary supply of source of water for the public water systems is ground water. Although the potential exists for more ground water use, it has not been extensively developed because of well maintenance problems, water quality problems (chlorides, iron, manganese and taste and colour) and limited wells yields in certain areas. However on the volcanic islands ground water is obtained from deeper wells screening weathered fractured basalt above the dense basalt formation.

Many of the homes in Palau have their own private individual rain water catchment systems to provide drinking water. Presently, it is estimated that over 95% of the population of Koror and Airai states and about 80% of the rural states are served by Public Water Systems (PWS).

The Koror/Airai system is supplied by two surface water sources both of which are located in Airai State in southern Babeldaob. The main source is the 20 million gallon capacity Ngerimel Dam and Reservoir. Water from the dam is supplied to the treatment plant by gravity main. The second source of water is from the Ngerikill river pump station that can pump water either into the Ngerimel dam or directly to the treatment plant through two mains.

In 1998, the Koror/Airai water treatment plant was upgraded to a 4.5 million gallon per day conventional filtrations plant. Treatment process at the plant include the chemical addition of alum, soda ash and powder activated carbon ,followed by coagulation, flocculation and sedimentation, rapid sand filtration and finally disinfection with hypochlorite solution.

Treated water is pumped from the treatment plant into the distribution system by four pumps, at 4 million gallon per day, a high demand of service area population of only 14,000 people. The high rate of demand is due to leakage, lack of water conservation and the misuse and wastage of water. It is subject to service distribution, water shortages and low pressure caused not only by high demand, but also by a range of other factors including the need of adequate financing, the need for improved operation, maintenance, management and planning of the system.

There are currently 15 small public water systems serving the rural areas. This public water serves populations from 20 to 600 people. Eleven systems obtain their water supply from impoundments of surface water streams and three obtain their water supply from ground water well with one system supplied by both ground water and surface stream.

All of the surface water systems are required to treat the raw water by automatic backwashing; gravity fed rapid sand filtration and disinfection by hypochlorite solution while the ground water supplies are only disinfected with hypochlorite. All systems are equipped with water storage tanks to meet peak demands.

An estimated 80 % of the population living in rural communities are served by public water supply systems. The residents primarily use the water supplied by the public system for bathing and washing, and use their own private water catchment for drinking water. Some islands obtain their water solely from rain water catchments and will also use very shallow dug wells during drought periods.

Service disruptions and water shortages are common in the rural public water supplies. They occur because many systems need to have unserviceable equipment replaced and improved operation and maintenance. Most of the chlorine metering pumps used to disinfect the water is out of order or not used. Rural public water system financing, management and operator training need to be improved.

Palau Urban Water Supply System- Koror/Airai

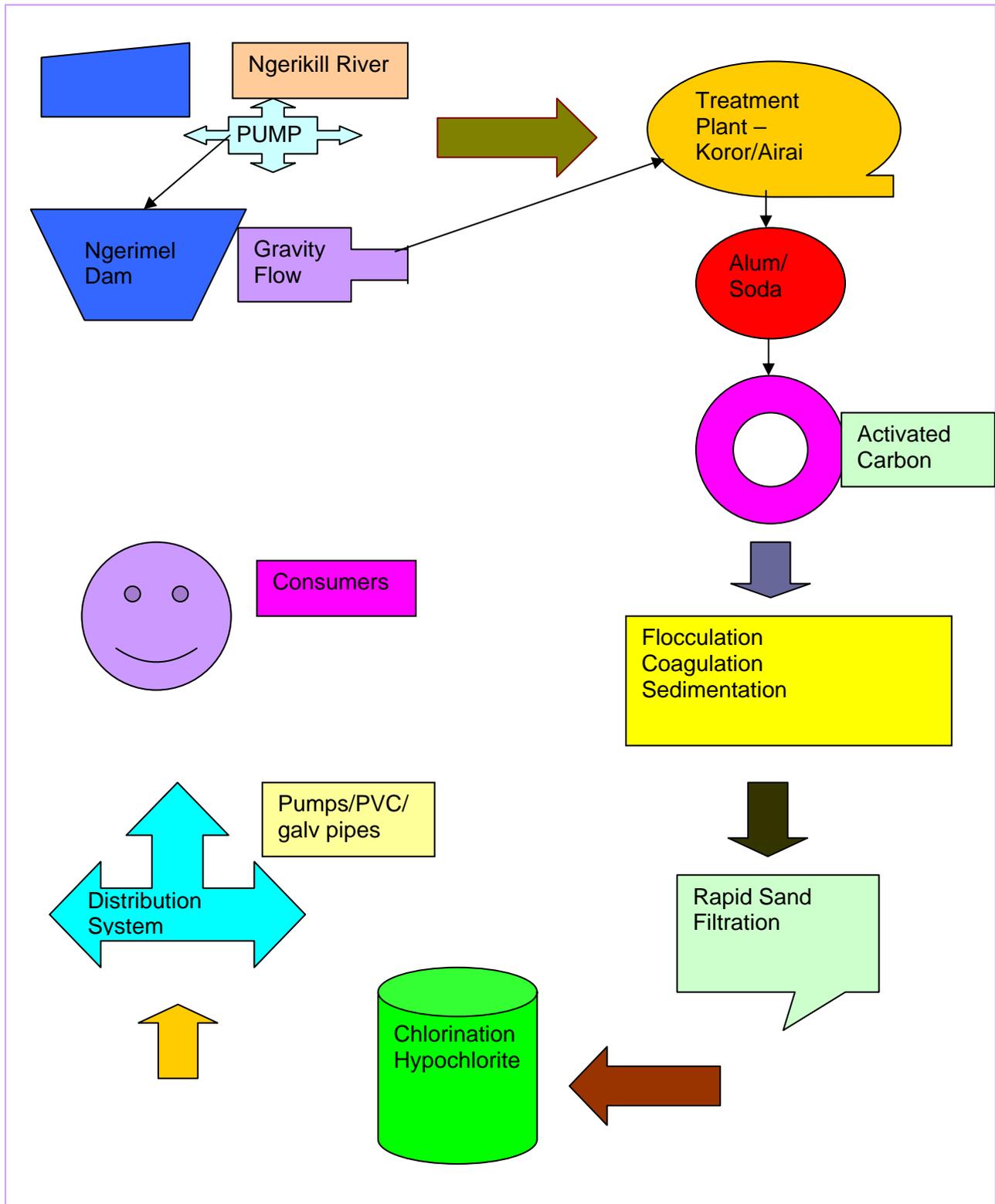


Fig:2

2. Water Resources Monitoring

A description of the Water Resources of the Palau Islands based on monitoring of rainfall and stream flows in a 14-year period (1968 - 1982) is available in the main report produced by Otto van der Burg 1984 (US Geological Survey 83-4140). Few water resources data have been collected prior to the Trust Territory Government and USGS although rainfall data has been collected since 1901 with an over 60-year record available for Koror.

The data collected consist of surface-water data including daily discharges from continuous-record stream-gauging stations, systematic measurements of discharge at partial-record stations, and measurements of discharge at miscellaneous sites. Water quality data include surface water temperature readings and results of chemical analysis.

For most of 1970-77 groundwater levels were recorded continuously on Well 5, Peleliu and at the Page Communication Well, Ngerekebesang.

The hydrological monitoring network existed initially of 5 gauging stations on Babeldaob and several partial-record stations on Babaldaob, Malakal and Ngerekebesang.

Of the five gauging stations established on Babeldaob, one was located on the Ngerimel River, below the diversion for the domestic water supply of Koror to gauge unused flow and one each in the northern, southern, western and eastern part of Babeldaob to record natural stream flow. The Ngerimel station was abandoned in 1978 and transferred to Kmekumel since it was under consideration by Public Works as additional source for the Koror water supply.

As part of the Compact Agreement the USGS provided continued support to the Ministry of Resources and Development to operate the monitoring stations on cost-share bases with annual agreements between USDOJ and the Ministry. However, the monitoring was discontinued after October 2005 and all instrumentation have been removed.

The Cooperative programme in 2005 included 1) operation and maintenance of six continuous record flow stations, 2) one continuous-record lake station, 3) five continuous-record rainfall stations, and 4) assisting Ministry personnel with computation of daily suspended sediment and annual load for the five stations where both stream flow and sediment data are collected for monitoring Compact Road construction. Due to increased expenses and limited available funds the programme was downscaled 1) to three continuous record flow stations, 2) one continuous-record lake station, 3) two continuous-record rainfall stations, and computation and publication of records.

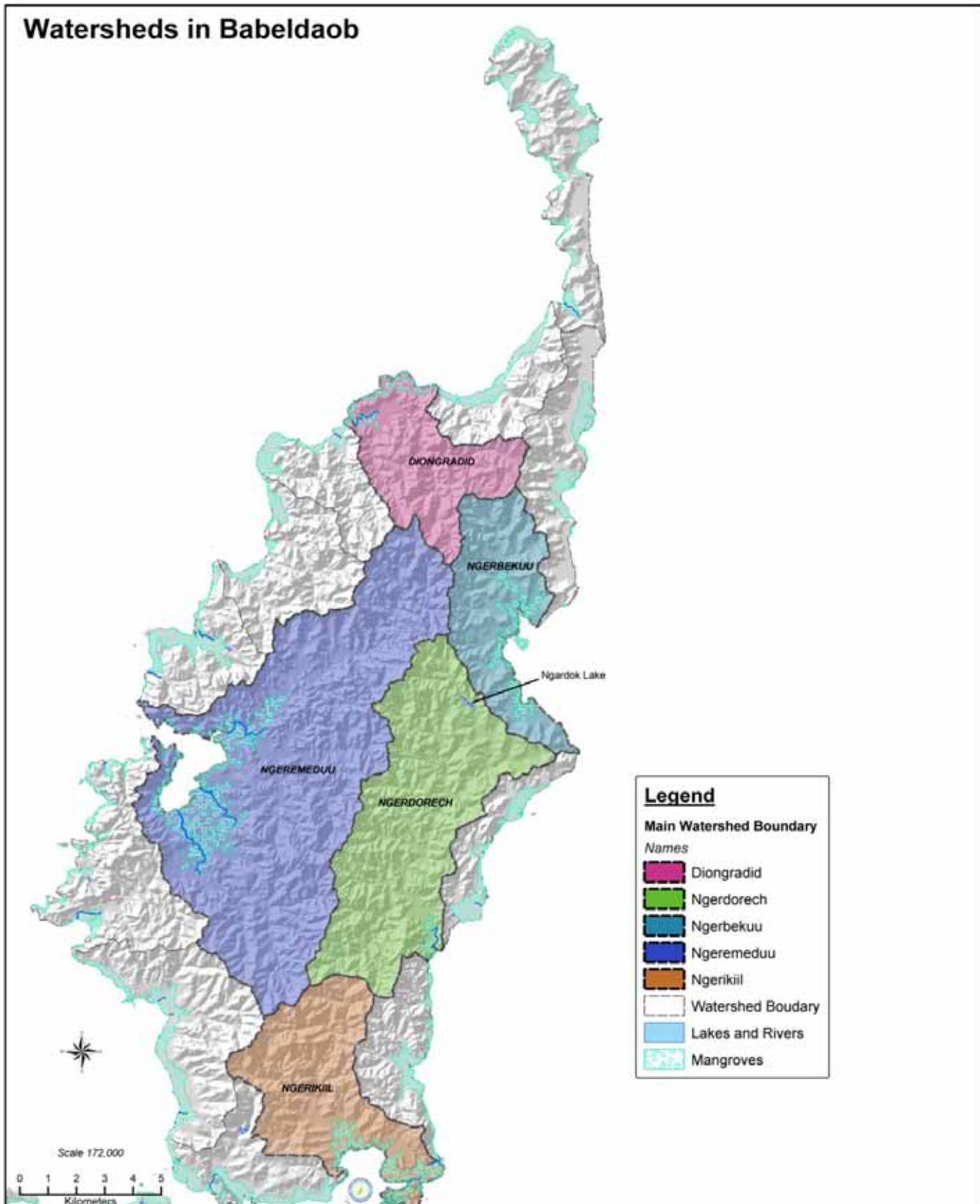
2.1 Integrated Management for Critical Watersheds

An integrated watershed management plan is considered as one of the key environmental management strategies in Palau. Catchment or watershed management research and activities have been supported to a great extent by the Palau Conservation Society (PCS) and The Nature Conservancy (TNC) with various community groups on Babeldaob.

The watershed of Ngerikiil is the most important with regards to the public water supply to Koror. Protection of this watershed is thought to be essential to providing safe water to the majority of Palau's citizens.

Extension of the water supply to Koror through an additional intake, treatment and supply system from the Tebercheding River is being considered.

Other watersheds that are considered critical are Ngeremeduu and Ngerdoch in terms of the threats by inappropriate development activities including adverse effects on water quality, ecological integrity, vegetation cover, rare and endemic species and mangroves and freshwater swamp cover



Map: 2 Watersheds in Babeldaob

3. WATER SUPPLY SYSTEM DESCRIPTION

3.1 KOROR/AIRAI SUPPLY

3.1.1 Catchment and Intake

The supply receives its freshwater from the Ngerikill River and from Ngerimel dam. The total production is 4 million gallons per day (1 million gallons-Ngerikill river, 3 million gals from Ngerimel dam). The Ngerimel Dam has a storage capacity of 20 million gals of water and the catchment consists of forest vegetation dominated by trees, shrubs and grass. The intake is located at a dam situated in a valley surrounded by high mountains. The catchment is fairly well protected and there is minimal human activity within the catchment area. Since the catchment is not fenced off, animals such as chickens, goats, pigs, cattle and /or horses could access the catchment and/or the intake.

Ngerikill River is a freshwater stream running through a catchment that is widely used for residential and /or agricultural purposes. The catchment consists mostly of forest vegetation dominated by trees, shrubs and grass. The natural vegetation is disturbed in parts by extensive clearing for cultivation of crops. The catchment is not so well protected and there are considerable human activities within the catchment area. Since the catchment is not fenced off, animals and birds have the access to the area. The Ngerikill River is known to supply water even during periods of prolonged drought, although the water level does tend to drop.



Photo: 1 Ngerikill River - Intake



Photo: 2 Ngerimel Dam

3.1.2 Storage and Treatment

A total of 4 million gallons of water per day is fed into the Koror/Airai water treatment plant located in Airai State. One million gallon of water is pumped to the treatment plant from the Ngerikill River while the remaining 3 million gallons is gravity fed into the treatment plant from the Ngerimel Dam. Water from both intakes is collected in a chamber called the wet well. Alum, lime, and activated carbon are added at the wet well and then pumped into a series of clarifiers for the removal of suspended solids. The sludge from the clarifiers is diverted to a series of drying beds. From the clarifiers the water is then divided into a series of five automatic Gravity Valve-less (AVG) filters. Filtered water is collected in a separate chamber called a clear well. At the clear well, water is chlorinated before distribution.

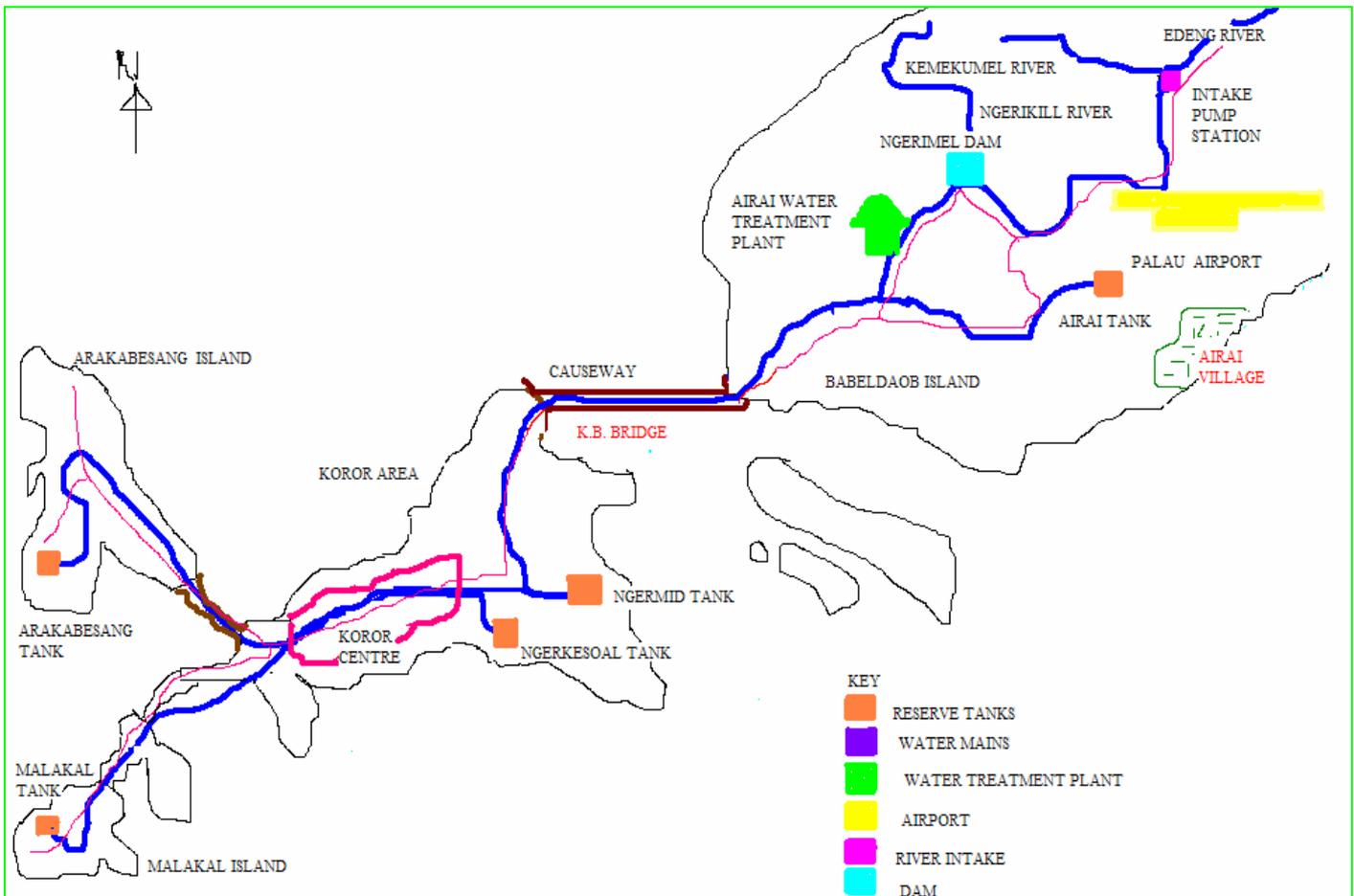


Photo: 3 Water from the two sources is collected at the Wet Well.



Photo: 4 Automatic Gravity Valve-less filters

Map: 3 KOROR-AIRAI WATER DISTRIBUTION- LOCALITY SHOWING MAINS AND TANKS



3.1.3 Distribution

The Koror-Airai system supplies water to the Koror and Airai states through a gravity fed distribution network. Some households supplement the reticulated supply with rainwater catchment and also have holding tanks. There are five reserve tanks (ref map 3 above) located along the distribution system to create head pressure and acts as storage tanks.



Photo: 5 Clarifiers



Photo: 6 Sludge drying bed



Photo: 7 Treatment plant with an AGV filter in the foreground and the typical vegetation around the catchment in the background)



Photo: 8 Cultivated land areas in close proximity of the water intake

4. WATER QUALITY SURVEILANCE AND MONITORING

The Water Branch, Bureau of Public Utilities, Ministry of Resource and Development, which is the part of the National Government, are the responsible owner and operator of the Koror-Airai Public Water Supply.

The Environmental Quality Protection Board (EQPB) is the national regulatory agency responsible for setting drinking water quality standards and the establishment of water treatment and disinfection requirements. The board issues permits to construct, modify and monitor public water systems for compliance and establishes notification and record keeping and operator certification requirements.

The Division of Environmental Health & Sanitation, Ministry of Health keeps a record of diseases outbreaks and regulates the cost of private water companies. Current water pricing does not raise sufficient funds to cover the total cost of the Koror-Airai system, which must be subsidised by the national government and some customers do not pay their water bills but remain connected to the system.

In 1993 Palau adopted the EQPB public water supply system regulations, which regulates public water supply. The Division of Environmental Health is also delegated certain regulatory authorities regarding food and health which includes regulating private bottled water companies.

The current regulation is modelled on the United States drinking water regulations contained in the Code of Federal regulations issued by the Environmental Protection Agency. However, certain sections of the regulations are not practical and appropriate to the conditions in Palau. An assessment needs to be made of the existing drinking water regulations to determine the changes necessary to make them more relevant to Palau, particularly regarding the monitoring requirements for certain inorganic and organic contaminants.

Existing Legislation authorises the EQPB to issue and enforce primary and secondary drinking water regulations, and other such regulations as necessary to carry out the purpose of the United States Safe Drinking Water Act. The EQPB is also authorised to establish regulations and a permitting systems to regulate the discharge of pollutants to the air, land or water, which indirectly acts to protect water supply sources from environmental pollution.

Existing Water Quality and Monitoring

The EQPB tests the 20 public water systems on a regular basis for coliform bacteria, chlorine residual, and turbidity. All of the rural water systems regularly test positive for bacteria and only the Koror-Airai systems complies. Currently all of the surface water systems have rapid sand filters, however some filters are not operational and others are in need of maintenance and repair.

Although most of the public water systems have been provided with chlorination system, many are used irregularly or are out of service. Only the Koror-Airai public water system has been tested for inorganic, organic and radionuclides contaminants which are required under the regulations adopted by EQPB.

The Koror-Airai system is sampled and tested for coliform bacteria at 13 locations twice a month and chlorine residual measurements are taken at 13 locations on a daily basis and samples collected from system are tested for lead and copper levels. Samples of treated water from the Koror system were tested twice for the full scan of pollutants, and showed no contaminants present.

Since upgrade to the Koror-Airai water treatment plant were completed and the pre-treatment units went into operation, treated water quality has improved greatly and complies with the WHO Guidelines for drinking Water Quality. Average effluent turbidity levels range from 1-4 NTU,

coliform bacteria routinely tests negative, and chlorine residual is maintained in the distribution system.



Photo Gallery: Environmental Quality Protection Board Labrotary in Koror

Water Supply Improvement Needs

The recommendation for improvements of drinking water quality is aimed at two main target groups, the water service providers and the EQPB regulatory agency.

Over recent years Palau has been developing rapidly. To support this development adequate infrastructure, public drinking water systems are needed including implementation of drinking water planning. Plans need to define the improvements and upgrades necessary to meet future water demands that comply with water quality standards.

Funding from government budgets for operations and maintenance has a low priority, and therefore the water sector receives inadequate funding. There is an opportunity to combine and restructure public water systems into a self –sustaining independent public utility, which would also serve to improve the management and accountability of these systems.

To make this sustainable, legislation and regulations would be required to give authority to extract water, build infrastructure and secure fees for drinking water provision. The fees should be sufficient to cover proper operating and maintenance of the facilities including a process to train operators of water treatment and supply facilities for both public utilities and rural water systems operators.

The Environmental Quality Protection Board is an independent agency responsible for regulating public water supply systems and conducting routine water quality monitoring. To strengthen its operations needs to increase the frequency of monitoring of both water quality of supply sources and water quality and a classification scheme for water sources needs to be improved. When there are violations, provisions should be in place for enforcements of legislations and corrective measures for the water supply system.

Inter-agency cooperation and coordination should be expanded to include the sharing and management of data and information through professional and regional networking. Training should continue and expand in parallel with public education programs devoted to the health benefits of good quality drinking water, water conservation and the protection of supply source.

5. 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 (PICs) in a February 2005 workshop in Nadi, Fiji. That gathering of 18 countries and territories also 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.

The 'Pacific Water Safety Plans Programme' began in late 2005 under AusAID funding to SOPAC and WHO. This two-year joint programme will pilot Water Safety Plans in at least four PICs. Vanuatu was among the four PICs selected according to the programme's selection criteria and is the only Melanesian country of the four.

This WHO/SOPAC scoping mission was proposed to determine the scope and interest and secure the commitment of key government counterparts including the Ministry of Lands and Natural Resources (MLNR), the Ministry of Health (MoH), the Ministry of Infrastructure and Public Utilities and other potential partners including NGO's. The MLNR applied to WHO/SOPAC for support under the Pacific WSP Programme and requested the scoping mission.

There is strong interest from key authorities such as Environmental Quality Protection Board ,Bureau of Public Works and Ministry of Health to work together to establish WSP pilots in Palau.

A Water Safety Plan (WSP) is an improved risk assessment and management tool designed to ensure the delivery of safe drinking water to consumers. It identifies:

- hazards that the water supply is exposed to and the level of risk associated with each;
- how each hazard will and/or can be controlled;
- how the means of control will be monitored;
- how the operator can tell if control has been lost;
- what actions are required to restore control; and
- how the effectiveness of the whole system can be verified.

Developing a Water Safety Plan

The development of a WSP involves a systematic approach for:

- preventing the contamination of source waters
- treating water to reduce or remove contaminants; and
- preventing re-contamination during storage, distribution and handling of treated water

In order to do this, the water authority or supplier needs to:

- assemble a team that understands the system;
- identify risks, hazards and hazardous events;
- identify means for controlling these risks, hazards and hazardous events;
- establish a monitoring system to ensure consistent supply of safe drinking water; and
- periodically review the Water Safety Plan.

To develop and establish a WSP, some essential prerequisites are required such as getting commitment from Government, Managers and Executive Officers.

Once commitment is achieved, a WSP steering committee is established (consisting of relevant stakeholders such as health and environment professionals as well as the water supplier), the water supply system is described and risks identified, control measures are identified and monitoring systems developed.

Stages in Developing and Implementing a Water Safety Plans Programme

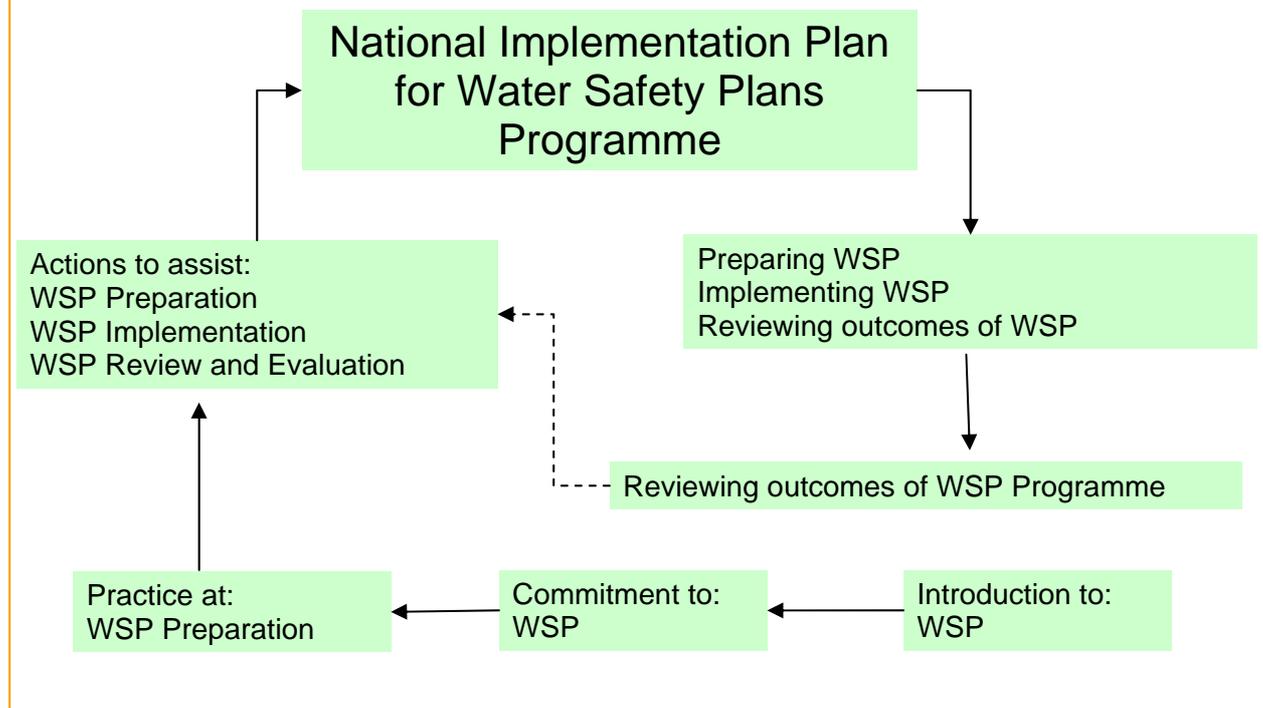


Figure: 7

Outcomes

Draft Water Safety Plans for Koror-Airai–Urban Supply

Supplies water to about 12,000 people, located inland; there is a chance for improvement of the intake. Catchment and water storage can be increased due to the increase in water demand. It is a necessary measure to be taken to reduce contamination at source.

Draft National Implementation Plan

This is seen as a working document to help prepare the initial 'Water Safety Plans'. It describes the organizations involved, responsibility matrix, national water resource and supply status, actions for the preparation and implementation of the water safety plans, review and evaluation and replication.

Palau National Implementation Plan

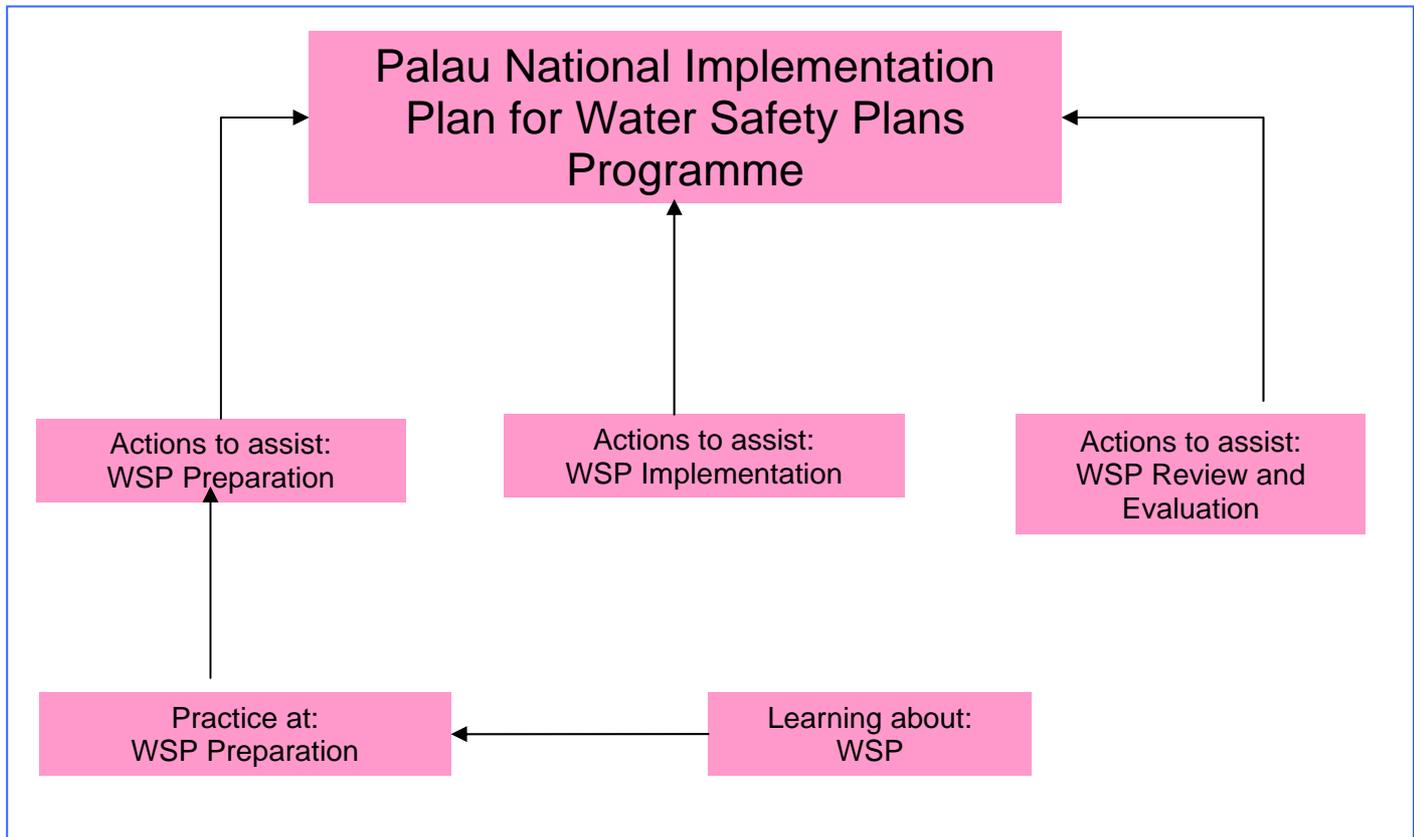


Figure: 8

Who needs to be involved?

The following agencies have a key role to play in the further development of the WSP programme in Palau:

- Bureau of Public Works
- Ministry of Health
- Environmental Quality Protection Board
- PALARIS
- Palau Conservation Society
- Bureau of Marine Resources
- Natural Resources Conservation (US Department of Agriculture)
- Palau Meteorological Service.

Stages in Developing and Implementing Water Safety Plans

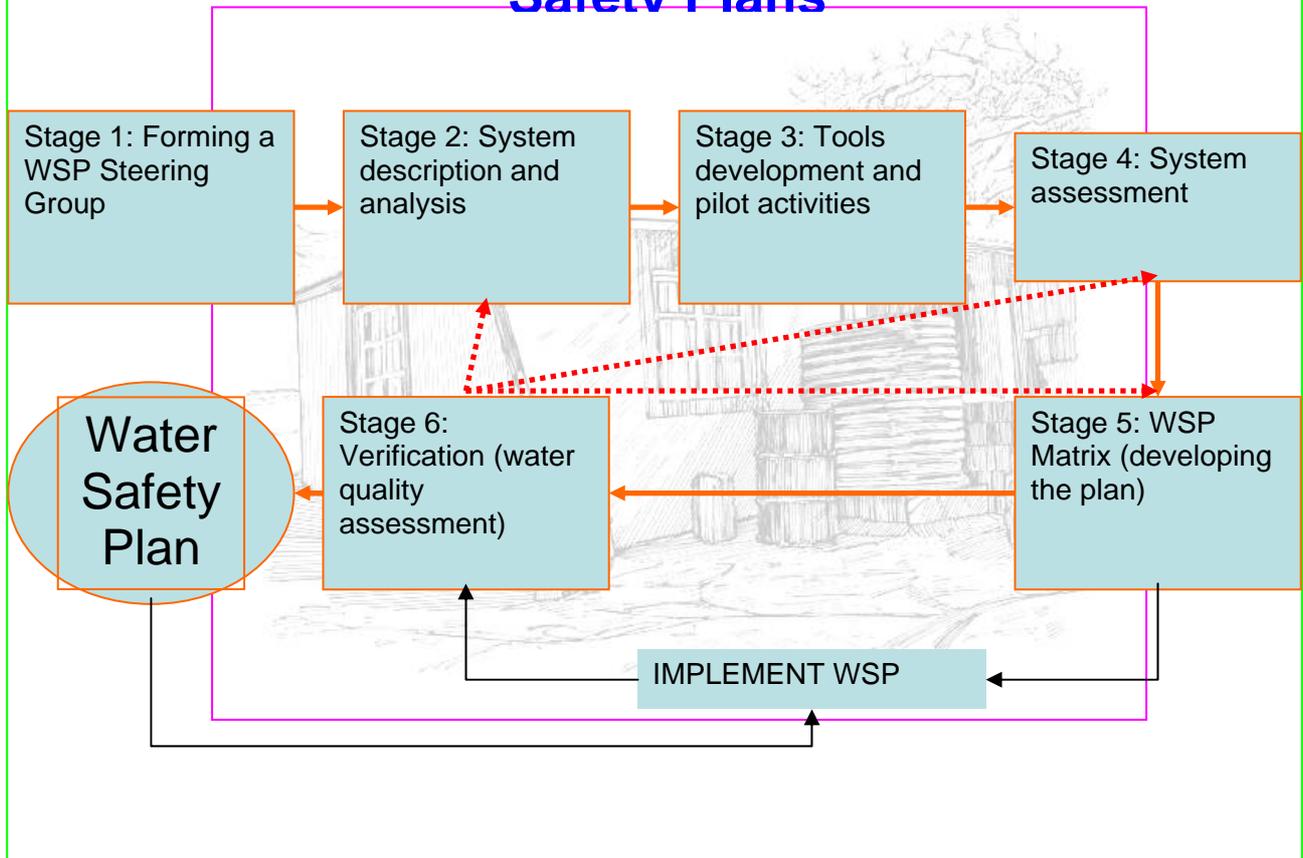


Figure: 9 WEDC Publications

Risks in the Water Supply System

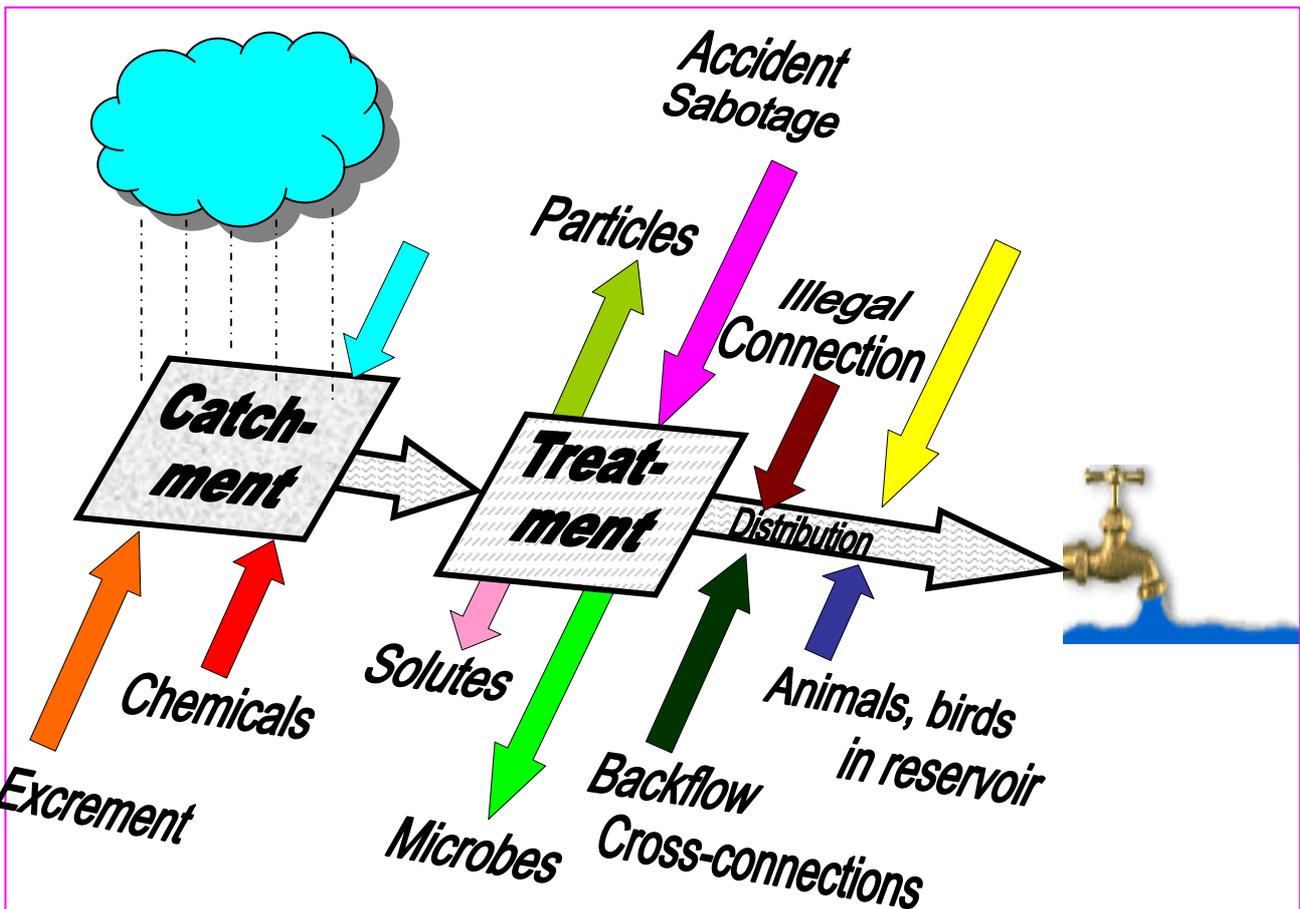


Figure: 10

6. Improvement Needed

There is a lack of legislation, rules and standards in the water sector and the responsibilities and powers of the authorities are not closely defined. The Ministry of Health, normally the surveillance agency, has not much involvement or powers in the water sector and currently does conduct some surveillance activity. There is little co-operation, collaboration or exchange of information between relevant authorities. It is recommended that the government should appoint the Ministry of Health as the National Surveillance Agency giving them the necessary administrative power to perform surveillance activities. The legislative basis should be provided and then all the relevant authorities can establish a monitoring and surveillance scheme.

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

7. Conclusion

There is adequate quantity of drinking water in Palau for both Urban and rural areas and a conventional water treatment is utilised at major supplies. The other rural supplies need improvements as there is possible chance of contamination from human and animal activities around the catchment since there is no fencing and farming is common near the catchment. There will be increasing demand for drinking water on Babeldaob Island as the government infrastructure and residential development will increase. Cooperation of all the agencies is necessary as they also expressed interest towards this programme and the government funding commitment.

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