

# **REVIEW OF THE ROTUMA WATER SUPPLY AND DISTRIBUTION SYSTEM FIJI ISLANDS**

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## INTRODUCTION

During a trip made by one of the members of the SOPAC Water Resources Unit to Rotuma in December 2000 – January 2001, a request was made that a survey be made of the water supply system of the island. The trip was not an official SOPAC visit, and the work does not come under any specific SOPAC task profile. The SOPAC water specialist's stay on the island, however, provided a good opportunity to investigate and give an independent evaluation of the state of Rotuma's water system.

This report and the recommendations contained within are intended:

- to educate the community of Rotuma and inform them about the state of their water supply;
- as a guide for the Public Works Department on upgrades and work that should be undertaken in Rotuma to improve the state of the water supply system; and
- to be a document for government officials of Rotuma interested in lobbying the Fiji government for funding to improve the standard of life on their island

The survey involved visiting two of the three water-supply boreholes and storage tanks, and an interview with the director of the Water Supply office in Rotuma. Interviews with individuals involved in the original drilling of the water-supply boreholes by the Mineral Resources Department were conducted later on in Suva. The Health Officer in Rotuma at the time of a Hepatitis A outbreak was also interviewed later in Suva.

Rotuma is a relatively young volcanic island, having a total area of 46.6 km<sup>2</sup> and consisting predominantly of olivine-basalt lavas as the underlying bedrock. The centres of population are entirely coastal, the rest of the island being used for agricultural purposes. The current population of Rotuma is estimated at around 2400.

The average annual rainfall for Rotuma is about 3550 mm. Drought periods of up to three weeks duration have been known to occur. There is no surface water on Rotuma, therefore high infiltration to the groundwater system has been assumed. The Mineral Resources Department estimated an annual recharge of 83 000 000 m<sup>3</sup> to the groundwater system. The high permeability of the Rotuma basalts means that saltwater intrusion of wells sited too close to the coast is likely (Simpson, 1978). It also means other contaminants could have a direct route into the groundwater system.

By no means is this a comprehensive investigation into water supply issues in Rotuma, but from having visited the area and talked to people (users and operators) about the water supply system, a fair picture has been drawn.

## RECOMMENDATIONS

Following is a list of recommendations concerning the state and management of the water-supply system in Rotuma:

- All three storage tanks in Rotuma are in a similar state of dilapidation. Rehabilitation of the 20-year-old tanks is an option, but the better solution would be to replace them. Plastic or polyethylene tanks are known for their relatively low cost and long life expectancy, and are commercially available in a variety of sizes. In the meantime, rusting roofs and screens keeping out pests need to be replaced.
- Farmers should be encouraged not to use pesticides or fertilisers on crops within 100 m of the borehole sites.
- The access roads leading to the Lepjea and Sumi boreholes are in poor condition and make maintenance and operation of these two sites difficult. Transportation to these sites is generally by motorbike. The roads leading to the boreholes are in need of upkeep, or else the water-supply staff in Rotuma should be supplied with a more rugged form of transport.
- Since the three water-supply boreholes in Rotuma were drilled in 1977-78, they have received no maintenance at all. Over the past 23 years it is likely that there has been considerable corrosion of casings and incrustation of screen intakes. Flushing of the boreholes is recommended. In the case that corroded casings or screens have to be withdrawn and replaced, it may be cheaper to simply construct a new well.
- Correct records of bulk-flow meter readings, pump operation, and diesel consumption need to be kept by the individuals responsible for the boreholes. The uninstalled flow meter in the Lepjea pump house should be installed immediately on the outlet pipe from the tank.
- It is recommended that funds be sought to fix or build a new headquarters for the Rotuma Water Supply in Ahau. The leaking roof could potentially damage hardcopy records and electronic equipment.
- The dependence of the Rotuma water-supply system on manual operation leads to inconsistent service. The water supply is only as good as the individual operating it. Control switches that will turn the borehole pumps on when water levels in the tank fall below a certain level, and off once the water level is at 2 m, should be installed immediately. This will regulate the operation of the pumps and maintain storage levels in the tanks so that supply will be regular.
- Arrears in water payments should be collected immediately or else water services to these consumers cut. Water is free, but the infrastructure that pipes it into the home costs.
- Water-quality test results from by the Department of Health should be made available to the Public Works office.
- Key water-quality indicators, including conductivity, pH, turbidity, total coliforms, faecal coliforms, and nitrates, should be included in this regular testing and monitoring of the Rotuma water supply. A portable test kit is recommended.
- The leak-detection team from the Central Division main office in Suva should travel to Rotuma to do a comprehensive leak-detection survey and perform repairs upon main distribution lines.
- A house-to-house survey of tap fixtures and toilet cisterns should be performed by the Rotuma water-supply staff to fix household leaks.
- Leaks, once identified, should be repaired immediately.

- Spare parts and materials for fixing leaks, both on mains and common household fixtures, should be purchased and stored by the Public Works office in Rotuma.
- Household rain-catchment systems should be encouraged by the Public Works office as a secondary source of water.
- Water quality testing by an independent organisation such as SOPAC should be conducted to confirm the results of testing performed by the Ministry of Health. In addition to testing for total and faecal coliforms, tests should also be performed for turbidity, conductivity, pH, TDS, nitrates, hardness and chloride.
- Investigations into the capacity, depth and flow regimes of Rotuma's fresh groundwater lens should be made. Such investigations could be carried out by SOPAC, preferably during a dry season.
- Treatment of the water supplied should be considered by the Fiji Public Works Department to deal with turbidity problems and waterborne disease-causing organisms obviously present in the water supply. The most suitable method of treatment would be some combination of physical and chemical treatment such as filtration and disinfection through chlorination.

### Motusa Water Supply

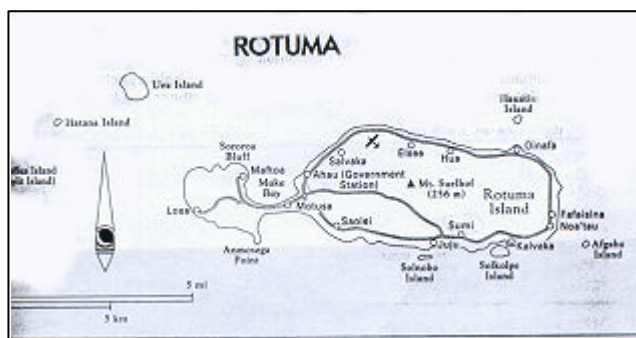


Figure 1: Map of Rotuma.

### Borehole

The Motusa borehole was originally drilled by the Mineral Resources Division (now Department) of Fiji in 1977. The Motusa borehole has the following characteristics:

<i>Approximate Elevation</i>	54 m
<i>Total Borehole Depth</i>	59.7 m
<i>Struck Water</i>	55.8 m (bgl)
<i>Maximum Recommended Pumping Rate</i>	300 L/min

The borehole is constructed of a concrete apron at the surface, 20 m of 8 inch casing and a 6-inch casing slotted over an unknown open length at the bottom.

Complaints about the quality of water from this borehole were raised in 2000 when several members of the community fell sick. The doctor in the case determined that the common link causing these illnesses was the water supply. Water samples from both the borehole and the tank were taken by the Ministry of Health for analysis.

The borehole is located on the Central road that is infrequently used. There are no houses or toilets in the immediate vicinity, or other signs of human activity, e.g., pig pens or crops, which might lead to direct contamination of the borehole water.

### *Pump*

In 1999 the old Motusa crank pump was replaced with a new motor pump. A new pump house was also constructed to house the pump and generator. The pump is diesel run and is manually operated by the warden, Edward. Generally, the pump is running all night so that the tank is full in the morning. During the day as water demand increases, the water level in the tank decreases, and the pump goes on again at night to refill the tank. The warden checks the reservoir daily. He also checks the bulk water meter daily, looking at how much water is being drawn from the Motusa borehole. He then sends a weekly log to the Public Works office in Ahau. The bulk water meters are recently installed Kent m<sup>3</sup> meters.

The Warden of the Motusa water supply was encountered at the site during the survey. He was chosen because the borehole and tank are on his land. He is paid a salary from the PWD to operate the water supply.

### *Tank*

The tank is the original reinforced-concrete tank constructed in 1981. It is a circular 40 000-gallon (181.84-m<sup>3</sup>) tank with a maximum water level of 2 meters. The tank has a slightly slanted corrugated-iron roof of fairly recent date which is still in good condition. There is a meter or so gap between the tank and roof which is covered by a black mesh to keep out insects, lizards and other pests. The mesh is still in fair condition, however lizards are still found in the tank occasionally.

The tank is fenced off and chained to keep trespassers out. Operationally, the tank has been known to overflow and to run dry, but not recently. The Warden also cleans the tank out twice a year in June and December with chemicals provided by the Public Works office.

The base of the tank is obviously leaking from several small cracks and fissures in the concrete. The majority of the iron bar reinforcements circling the tank for increased support have also rusted away.

- All three storage tanks in Rotuma are in a similar state of dilapidation. Rehabilitation of the 20-year-old tanks is an option, but the better solution would be to replace them. Plastic or polyethylene tanks are known for their relatively low cost and long life expectancy, and are commercially available in a variety of sizes. In the meantime, rusting roofs and screens keeping out pests need to be replaced.

There is another bulk flow meter connected to the 100-mm cast-iron pipe leading from the tank to the users in the community. This flow meter is also read daily. There is a fire hydrant located next to the supply tank that has never been used to the memory of the Warden who has been looking after the site for the past 30 years.

## Lepjea Water Supply

### Borehole

The Lepjea borehole dates back to 1977 when it was drilled by the then Mineral Resources Division of Fiji. It has the following characteristics:

<i>Approximate Elevation</i>	35 m
<i>Total Borehole Depth</i>	44.5 m
<i>Struck Water</i>	37.2 m (bgl)
<i>Maximum Recommended Pumping Rate</i>	300 L/min

The borehole is constructed with a concrete apron at the surface, 18 m of 8-inch casing and a 6-inch casing slotted over an unknown open length at the bottom.

The Lepjea borehole is located off an access road that begins at Hou village, continuing south and then west into the interior next to a dalo patch. The access road is in poor condition, which makes the water supply difficult to get to. The farmers in the area frequently use pesticides and fertiliser in growing their dalo crops. Users have made complaints of turbid water from this borehole.

- The access roads leading to the Lepjea and Sumi boreholes are in poor condition and make maintenance and operation of these two sites difficult. Transportation to these sites is generally by motorbike. The roads leading to the boreholes are in need of upkeep, or else the water-supply staff in Rotuma should be supplied with a more rugged form of transport.
- Farmers should be encouraged not to use pesticides or fertilisers on crops within 100 m of the borehole sites.
- Since the three water-supply boreholes in Rotuma were drilled in 1977-78, they have received no maintenance at all. Over the past 23 years it is likely that there has been considerable corrosion of casings and incrustation of screen intakes. Flushing of the boreholes is recommended. In the case that corroded casings or screens have to be withdrawn and replaced, it may be cheaper to simply construct a new well.

### Pump

A new diesel-run pump was installed at this borehole in 1999, and a new pump house was built to store it in. A bulk flow meter is connected to the pipe leading from the borehole, but it is obviously not being read although records of some sort are being kept. There was also a new Kent bulk flow meter sitting on the floor of the pump house, not installed at the time of the visit.

- Correct records of bulk-flow meter readings, pump operation, and diesel consumption need to be kept by the individuals responsible for the boreholes. The uninstalled flow meter in the Lepjea pump house should be installed immediately on the outlet pipe from the tank.

The Warden of the Lepjea water supply was encountered at the Water Supply office in Ahau during the survey. In general, he is not at the borehole site during the day. He will check the tank and turn the pump on as required and then go back to the village.

## Tank

The tank in Lepjea is a circular reinforced-concrete 40 000-gallon (181.84 m<sup>3</sup>) tank. A corrugated iron roof with obvious rust spots covers the tank. The gap between the roof and the tank wall is covered by mesh that is both torn and dirty.

There is no bulk flow meter indicating how much water the community is using from the tank.

The Lepjea tank is the one that most frequently runs dry. During a stay in Noa'tau of 4 weeks, a full day without water was experienced in December. Noa'tau is served by the Lepjea water supply.

## Sumi Water Supply

A visit to the Sumi water supply was attempted, but the borehole and tank site were not located in the labyrinth of side roads behind the village. Access to this site is difficult as the road can more accurately be described as a track.

The Sumi borehole dates back to 1978 when it was drilled by the then Mineral Resources Division of Fiji. It has the following characteristics:

<i>Approximate Elevation</i>	62 m
<i>Total Borehole Depth</i>	71.9 m
<i>Struck Water</i>	62.8 m (bgl)
<i>Maximum Recommended Pumping Rate</i>	200 L/min

The borehole has a concrete apron at the surface, 34 m of 8-inch casing and a 6-inch casing slotted over an unknown open length at the bottom. The Sumi borehole is the closest to the coast and the most likely to suffer from saltwater intrusion.

The infrastructure and operation of this water supply are similar to those of the other two water supplies. The tank is the original 40 000-gallon reinforced-concrete tank from the early 80's, and the borehole pump was similarly replaced with a new diesel one in 1999. The Warden of the Sumi water supply resides in the village nearby.

## Distribution System and Management

The Rotuma water-distribution system is the responsibility of the Central Division of the Public Works Department water-supply section. The current manager in Rotuma is Henri Vafoou, who has been in the position for the past 10 years. Eight people work for the Rotuma water-supply office, including the three site Wardens, an electrician and a mechanic. The main office in Rotuma is at the government station at Ahau. It is a shack-like building that doubles as an office and a storage warehouse. It is in poor condition and the roof leaks.

- It is recommended that funds be sought to fix or build a new headquarters for the Rotuma Water Supply in Ahau. The leaking roof could potentially damage hardcopy records and electronic equipment.

Recent upgrades by Public Works to the system saw the instillation of three new diesel-run borehole pumps in 1999. These new pumps are equipped with sensors that monitor the drawdown levels in the boreholes. If the operator leaves the pump on and the groundwater level



falls more than 4 feet (1.2 m), the pump will automatically switch off. The Public Works also has plans to install the control panels, currently stored in their office, that will automatically regulate pump operation.

- The dependence of the Rotuma water-supply system on manual operation leads to inconsistent service. The water supply is only as good as the individual operating it. Control switches that will turn the borehole pumps on when water levels in the tank fall below a certain level, and off once the water level is at 2 m, should be installed immediately. This will regulate the operation of the pumps and maintain storage levels in the tanks so that supply will be regular.

The Public Works office stores hardcopy records of water usage from the 804 individual household meters, and the tank and borehole bulk flow meters. Household meters are read every three months. Water charges go straight to Suva, and rates are similar to those in the rest of Fiji. Currently a large number of water users owe money.

- Arrears in water payments should be collected immediately or else water services to these consumers cut. Water is free, but the infrastructure that pipes it into the home costs.

The population of Rotuma is normally around 2400, except during Christmas time when numbers can go over 3000. The Motusa water supply has the most users. The Sumi water is the most saline, but still within acceptable standards. The Health Department conducts testing of the water roughly every month. Results from these tests are not given to the Public Works. Besides the outbreak of sickness attributed to the water in 1999, the most frequent complaints to the Public Works are about the colour or turbidity of the water, and the inconsistency of the supply.

- Water-quality test results from by the Department of Health should be made available to the Public Works office.
- Key water-quality indicators, including conductivity, pH, turbidity, total coliforms, faecal coliforms, and nitrates, should be included in this regular testing and monitoring of the Rotuma water supply. A portable test kit is recommended.

Estimates of leakage from Rotuma's water-distribution system are at 20-30 %, possibly higher. An eye is kept on pumping hours to detect the occurrence of leaks in the system. Leak detection on the island is very rudimentary – looking for patches of extra-prolific vegetation. The majority of water loss is thought to be from household fixtures, especially leaking toilet cisterns. A leak from a water meter was observed in Ahau during the survey.

- The leak-detection team from the Central Division main office in Suva should travel to Rotuma to do a comprehensive leak-detection survey and perform repairs upon main distribution lines.
- A house-to-house survey of tap fixtures and toilet cisterns should be performed by the Rotuma water-supply staff to fix household leaks.
- Leaks, once identified, should be repaired immediately.
- Spare parts and materials for fixing leaks, both on mains and common household fixtures, should be purchased and stored by the Public Works office in Rotuma.

The distribution system is 20 years old and is a combination of cast iron and PVC piping. For each water supply, the main runs from the storage tank to the coast, and then along the road. Household connections are made to the main along the road.

Although it is not official policy, the water-supply office in Rotuma quietly encourages people to have an alternate water source. This includes roof-catchment tanks and the preservation of old wells. With the three tanks at maximum levels, there is enough storage to provide each person in Rotuma with approximately 227 L a day. Per-capita consumption in Suva is 135 L/d (McIntosh and Yniguez, 1997).

- Household rain-catchment systems should be encouraged by the Public Works office as a secondary source of water.

### **Hepatitis A Outbreak of 1999/2000**

Details in the following summary of the outbreak of Hepatitis A in Rotuma during 2000 were gathered during a phone conversation with Eric Rafai, the Medical Officer for the Ministry of Health in Rotuma at the time.

Concern over the water supply in Rotuma originated from the outbreak of Hepatitis A that occurred over 2000. The primary source or carrier in the outbreak has never been identified as pathology testing confirming Hepatitis as the cause of the sickness were not conducted till early 2000. Incidents of sickness occurred as early as the latter part of 1999, but no tests confirming the cause of the sickness as Hepatitis A were carried out at that time.

Hepatitis A is both a water-borne and faecal-oral-transmitted viral disease. This means that it is spread through drinking water or by direct contact of human or animal faeces to the mouth. Often this occurs through the unsafe preparation of food and beverages, personal contact or a contaminated water source. Symptoms of Hepatitis A include flu-like symptoms, fever, gastric pain, vomiting and jaundice. A person infected with Hepatitis A is infectious for a period of around four weeks, and able to spread the virus through faecal discharge.

From the beginning of 2000 to the present, there have been over a hundred cases of Hepatitis A in Rotuma. The outbreak started in the high school in Malhaha near the airport. The high school has its water supply from the Motusa borehole. The outbreak has not been confined to a certain part of Rotuma, however. Cases have arisen from in parts of the island and through all age groups. The peak of the outbreak occurred in July and August of 2000. Two more cases of Hepatitis A were also reported during January of 2001.

The assumption that the outbreak was linked to the water supply was made because water-quality tests performed by the Ministry of Health looking at total-coliform and faecal-coliform counts indicated high counts of both during this time. WHO guidelines for drinking water recommend a limit of 1-10 total coliforms/100 mL and 0 faecal coliforms/100 mL (McGhee, 1991). As the Hepatitis A virus is transmitted primarily through the faeces of an infected person, faecal-coliform testing gives a good indication of the presence or absence of such infectious pathogens.

Water samples are taken every two to three months in Rotuma from all three boreholes, the tanks, and from random end users in the distribution system. They are taken to the CWM pathology lab for testing of total and faecal coliforms only. During the time of the outbreak, high faecal-coliform counts (over 1000 col/100 mL) were present in the Sumi and Motusa boreholes, as well as in the tanks and general distribution system. This contamination was present in the water system for a period of around six months during which users were advised to boil their water. Total coliforms have been present in the water supply since 1995.

From the above account several conclusions can be drawn. They are as follows:

1. High faecal-coliform counts in the water supply indicate that direct contamination of the groundwater by human and/or animal wastes occurred.
2. Transmission of the Hepatitis A virus has been through both water-borne and faecal-oral routes.
3. There is a direct link between the initial outbreak point and one of the contaminated water sources.

The question then arises – how did faecal matter make its way into the water supply? Several possibilities are likely:

1. Contamination from leaking septic tanks, privies or drain tile fields infiltrated through the ground into the groundwater lens beneath Rotuma – the island's water source. Infiltration might not be harmful if the direction of groundwater flow keeps the contaminant “downstream” from the borehole screen intake. It is interesting to note that of the two contaminated boreholes, Sumi is closest to the inhabited coastal zone. Septic tanks are most likely to contribute to groundwater contamination in areas where (1) there is a high density of septic tanks, (2) the soil layer over permeable bedrock is thin, and (3) the water table is less than a metre below the land surface (Fetter, 1994). All criteria are apparent in Rotuma in the area surrounding the Sumi and Motusa boreholes.
2. Contamination resulted from the close proximity of a leaking water main to a leaking septic tank or privy. Leaks in the distribution system can permit sewage to enter from the soil when the pressure is off or during periods of high demand when pressures are low.

Documentation of over 100 cases of Hepatitis A in Rotuma within a year constitutes an epidemic. Evidence indicates that the spread of the virus has been in part through the water supply. Serious attention therefore needs to be given to the state of Rotuma's water supply and distribution system.

- Water quality testing by an independent organisation such as SOPAC should be conducted to confirm the results of testing performed by the Ministry of Health. In addition to testing for total and faecal coliforms, tests should also be performed for turbidity, conductivity, pH, TDS, nitrates, hardness and chloride.
- Investigations into the capacity, depth and flow regimes of Rotuma's fresh groundwater lens should be made. Such investigations could be carried out by SOPAC, preferably during a dry season.
- Treatment of the water supplied should be considered by the Fiji Public Works Department to deal with turbidity problems and waterborne disease-causing organisms obviously present in the water supply. The most suitable method of treatment would be some combination of physical and chemical treatment such as filtration and disinfection through chlorination.

## REFERENCES

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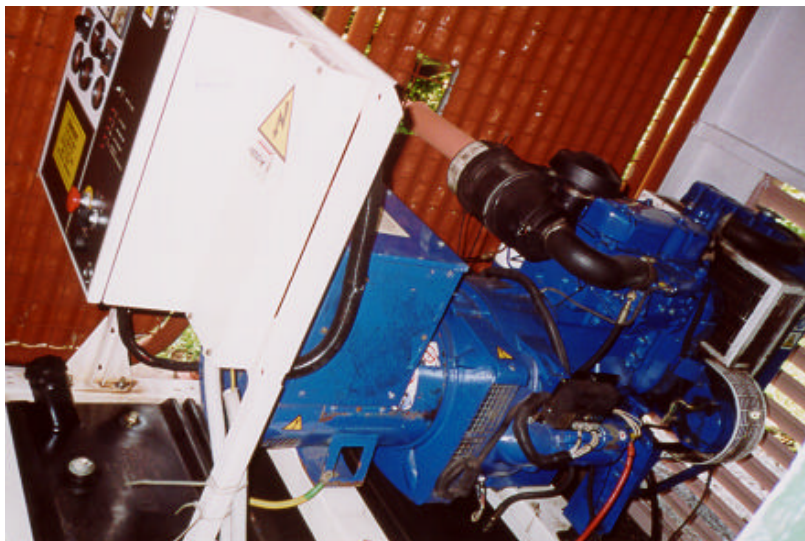
## **Appendix A:**

*Pictures of the Rotuma Water Supply*



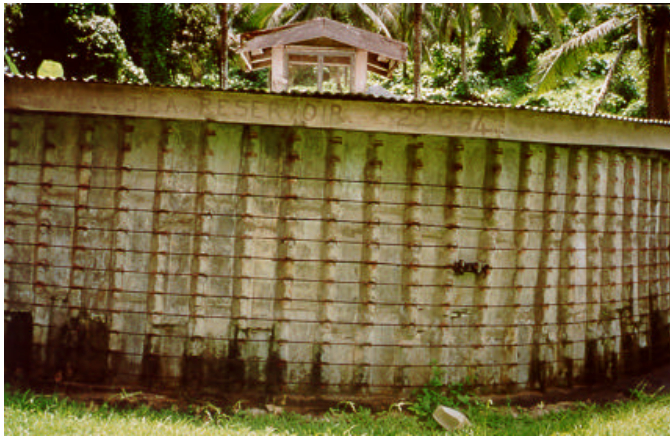
**Picture 1:** Motusa borehole. Bore pipe leading into the pump house is painted red to protect it from the sun.

**Picture 2:** The Lepjea pump house recently constructed to house the new diesel-run pumps installed in 1999.



**Picture 3:** The Lepjea diesel powered bore pump and control panel. The pump was installed in late 1999. The control panel is manually operated by the site Warden. The pump will automatically shut down when there is over 4 ft (1.2 m) of drawdown in the groundwater level.





**Picture 4:** The Lepjea tank, built in 1984 as can be seen by the inscription on the roof beam. The brown stains on the bottom indicate leakage from the tank. The slight slant of the roof to prevent pooling of water on the roof is not apparent from this angle.

**Picture 5:** Edward, the operator of the Motusa water supply. The tank is fenced off to prevent trespassing.



**Picture 6:** The leaking base of the Motusa tank. Small cracks and fissures are evident from the brown stains. The poor condition of the reinforced concrete tank is evident. Many of the reinforcements have rusted away.



**Picture 7:** A rust hole through the roof of the Lepjea tank. The black mesh to keep pests out of the tank is dirty, torn and sagging between its supports.





**Picture 8:** Inside the Motusa tank. The water level is indicated from the red markings on the support. The maximum water level is 2 m. The slight elevation of the roof is apparent.



**Picture 9:** The bulk flow meter coming from the Ahau/Matusa tank. Readings are taken every day to give an idea of user consumption.



**Picture 10:** Henri Vafoou in the water supply office in Rotuma at the government station in Ahau. Meter records are kept here. The roof leaks.

**Appendix B:**  
*Figures from Simpson, 1978  
of Borehole Location and Details*



Figure 1. Geology and Borehole Details

