Wide Bay Water Corporation

The Luganville - Mele Project

Water Loss Management, Sectorisation, Metering and Logging Program

STAGE 1 REPORT - LUGANVILLE

SOPAC

nzaid
New Zealand's International Aid & Development Agency

Pacific Water Association

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Executive Summary

The Pacific Islands Applied Geoscience Commission (SOPAC) has received funding from NZAID for a regional Water Demand Management (WDM) programme being executed as a response to the Pacific Regional Action Plan on Sustainable Water Management (2002). Through the Pacific Partnership Initiative on Sustainable Water Management, the programme aims for sustainable improvement in the management of water supply systems by urban water utilities in Pacific Island Countries. This is to be achieved by building capacity in the region's utilities to produce and implement workable plans for water demand management and by facilitating the exchange of knowledge and experience in this area.

WDM Programme Objectives and Goal

Overarching goal: Sustainable access to safe drinking water for communities in Pacific Island countries.

Objective: Improved capacity for water demand management in Pacific urban water utilities.

The key statistics and performance indicators for the Luganville Water Supply System are summarised in the three tables below.

Water Supply System - Current Performance

Table 1. *Physical Statistics*

Luganville Network Physical Statistics	
Length of water main (Km)	32
Number of connections	3142
Highest system pressure (Meters Head Pressure)	71
Lowest system pressure (Meters Head Pressure)	15

Table 2. *Statistics and Performance Indicators Top-Down Water Balance*

Luganville Water Balance - Top Down	
Item	**ML per Year**
Water Supplied	1506.8
Non-revenue	734.8
Authorised Consumption	772.98
Unauthorised Consumption	150.7
Unavoidable Annual Real Losses	56
Current Annual Real Losses	**538.2**
Recoverable Losses	482.2
Bursts per 100klm/water main	116.8

Note: *No record of main burst or service burst data is kept. The estimate for mains bursts in the Table above was based on anecdotal evidence from the maintenance crew. Similarly the best estimate for service burst frequency, based on conversations with the crew, is approximately 10 to 25 per week.*

Table 3. *Statistics and Performance Indicators Bottom-Up Water Balance*

Luganville Water Balance - Bottom Up	
Volume pumped/day (Kl)	4128.13
Minimum Night Flow (Lts/Sec)	36.99
Minimum Night Consumption (Lts/Sec)*	2.62
Water Losses (Lts/Sec)	34.37
Daily Water Losses (Kl)	2969.84
Average Daily Consumption (Kl)	1158.29
Average Annual Consumption (ML)	422.78
Current Annual Real Losses (ML)	**1083.99**
Recoverable Real Losses (ML)	1027.99

* Based on 3 Lts/ Connection / Hour (a standard commonly used in Australia) however this is probably an overestimate.

Recommendations According to Priority

1. Install three pressure reduction valves (PRVs) at designated points to reduce system pressure, leakage and mains and service bursts.
2. Install two additional bulk meters at designated points.
3. Create three District Metered Areas based on the existing Sakata Reservoir meter and two new meters.
4. Deliver training required for leak detection and PRV operation and maintenance.

Leakage Target

It is recommended that the minimum night flow target for the whole Luganville system should be in the region of 6 Lts/sec. This target allows for a high estimate of night consumption of 3 Lts/sec and 3Lts/sec for background and unreported leakage and should be reviewed once it is achieved.

The key to further improvement in the Luganville water system lies in the strategy of using the initial financial savings gained from pressure reduction to fund further water loss reduction activities such as leak detection and repair. This will in turn further reduce electrical costs associated with pumping water thus freeing up even more funds. This strategy can reverse the current downward cycle of under-resourced asset maintenance and management which results in further losses and asset degradation, and instead lead to an upward spiral of saving, reinvestment and continuous improvement.

Introduction

The Pacific Islands Applied Geoscience Commission (SOPAC) has received funding from the New Zealand Aid & Development Agency (NZAID) for a regional Water Demand Management (WDM) programme. The programme is being executed as a response to the Pacific Regional Action Plan on Sustainable Water Management (2002). Through the Pacific Partnership Initiative on Sustainable Water Management, the programme aims for sustainable improvement in the management of water supply systems by urban water utilities in Pacific Island Countries. This is to be achieved by building capacity in the region's utilities to produce and implement workable plans for water demand management and by facilitating the exchange of knowledge and experience in this area.

Wide Bay Water Corporation (WBWC), acknowledged as an industry leader in water loss management, has provided consultancy services to several countries under the WDM Programme in the Pacific, aimed at improving water demand management strategies.

This report is an assessment of the requirements identified by WBWC consultants as the most cost-effective option for a water loss management strategy for the town of Luganville on Espirito Santo, the largest island in the chain comprising the Republic of Vanuatu.

Luganville has a population of approximately 12,000.

The assessment team (Pankaj Mistry and Graham Cole from WBWC; Chelsea Giles-Hansen from SOPAC) arrived on the island on the 3rd May 2009 and spent the following 5 days assessing the water supply system as a whole and more specifically the capacity for improvement in both the efficiency of the reticulation network and the ability of the available workforce to effectively maintain the water reticulation network. The key to the assessment is the creation of an accurate water balance.

On top of Sarakata Reservoir

Water Balance

A water balance is a summary of the key statistics of a water supply system and can be constructed either from the "top-down" or the "bottom-up". The top-down model is useful where annual production and consumption figures are provided by reliable meter readings. The water loss is then calculated by subtracting the consumption total from the production total with allowance for calculated background leakage, meter under-registration, water theft, etc.

When this data is not available, or the top down model requires validating, a "bottom-up" water balance can be created by logging the flow of bulk water into the system during the early hours of the morning when there is very little water use. Where there is no meter this can still be achieved by measuring the drop in the reservoir water level during the early morning hours. Once this base flow figure is known, a water balance can be "built up" using assumptions and calculations on consumption and background leakage.

The methodology used for this analysis is based on the International Water Association's best practices and standard terminology, as shown below in Figure 1.

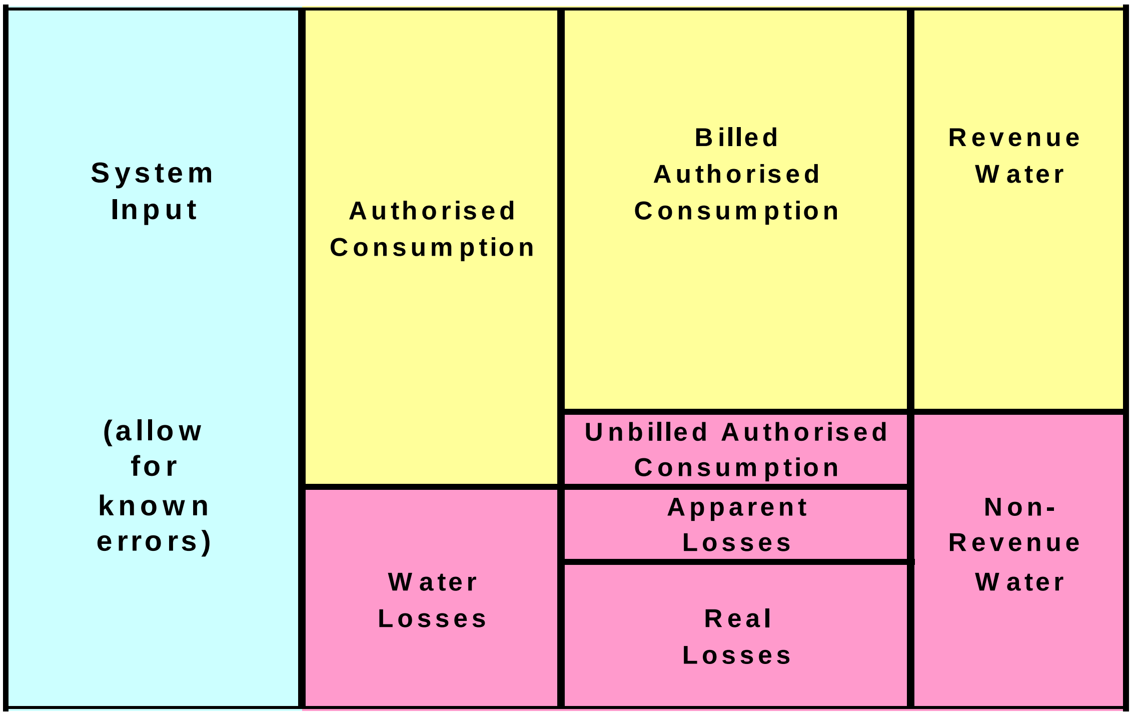

Figure 1. *IWA simplified Best Practice Water Balance*

The International Water Association recommends the following definitions for terms to describe components of water supply, water loss and water consumption.

System Input Volume is the volume of water supplied into a water supply system, usually measured on an annual basis.

Current Annual Real Losses are defined as physical water losses from the water supply system up to the point of the customer meters. The annual volume lost through all types of leaks and bursts depends on burst frequency, flow rates, and average duration of leaks

Unavoidable Annual Real losses – The section of Real Water Losses which consists of small background leakage that cannot be discovered through currently available leakage detection techniques.

Apparent Losses consist of "losses" due to inaccuracies in flow meters, customer meters, water theft, data transfer errors and data management errors.

Authorised Consumption is that proportion of the water supply, metered or unmetered, which is consumed with the knowledge and consent of the water service provider.

The Luganville Water Supply System

Main Points

Bulk Supply

Luganville's water is sourced from a bore which is electrically pumped to two reservoirs, Sarakata and Chapui, which comprise the only bulk storage capacity in the system. These reservoirs are both of steel construction and in reasonably good condition; however there is no facility to take either off line for cleaning or anti-rust maintenance as each reservoir gravity-feeds separate parts of the town.

A chlorine dosing-point exists at the pump station and chlorine is injected as the water is pumped to either reservoir.

The pump station with bore in the background

Bulk Metering

The pumping station at the bore is equipped with an inferential meter which records the total flow pumped from the pump station to Chapui reservoir. This meter is read every day and the flow volume recorded on a whiteboard at the site and on paper for future reference. There is no bulk flow meter on the line to the Sarakata reservoir so flow to this reservoir was estimated on the basis of recorded pumping times.

There are two bulk meters on outlet pipes from the Sarakata reservoir, only one of which was recording flow initially. This working meter was logged and the resulting flow profile can be seen below in Figure 2. The meter not initially working is a Helix 4000 of recent vintage. The team disassembled and cleaned the meter and as a result this meter is back in service.

Inspecting the Chapui Reservoir

No meter exists on the outflow of the Chapui reservoir and the meter on the inflow is out of service. A reservoir drop test was conducted on this reservoir to estimate the minimum night flow (MNF). Results are shown below in Table 4.

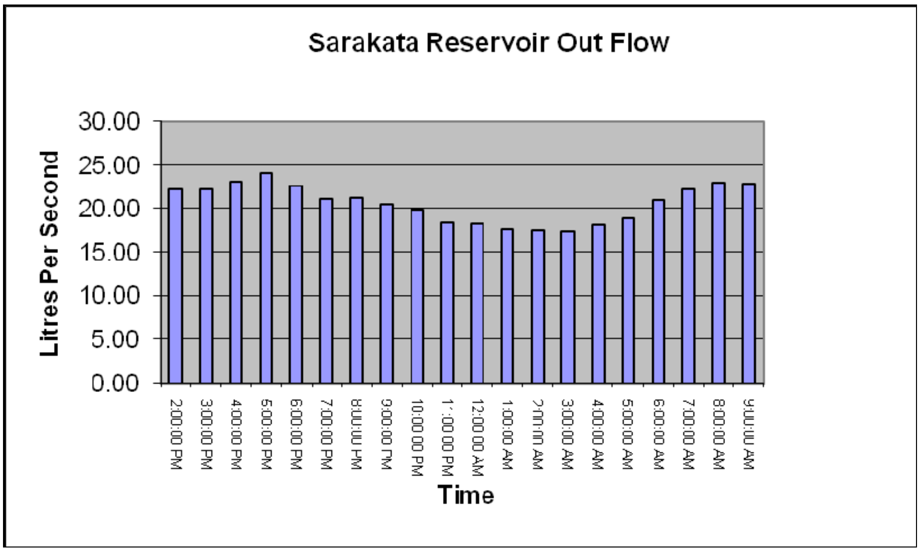

Figure 2. *Sarakata flow profile showing a MNF of 17.9 Lts/sec at 3.00 am*

Table 4. *Results of Chapui Reservoir Drop Test*

Chapui Reservoir Drop Test	
Reservoir Level from Overflow (m) at 11.50 PM	3.77
Reservoir Level from Overflow (m) at 1.45 AM	4.61
Drop in meters	0.84
Time in minutes	115.00
Diameter of reservoir (m)	14
Total drop in cubic meters/volume	131.73
Drop in litres/minute	1145.49
MNF (Lts/Sec)	19.09
Minimum Night Consumption	1.31
Water Losses in Lts/Sec	17.78

The estimated MNF from Sarakata and Chapui reservoirs is 17.9 Lts/sec and 19.09 Lts/sec respectively, giving a combined total MNF estimate of 36.99 Lts/sec.

Each reservoir holds approximately 2 megalitres. Annual pumping volumes to the Chapui reservoir were estimated from the meter readings at the pump station bulk meter. As there is no meter on the bulk line to the Sarakata reservoir pumping times the annual volume of water supplied was calculated from recorded pumping times (Table 5). The annual volume pumped equates to filling each of the reservoirs every day which accords with current daily practice. As the reservoirs are pumped full each day according to a timetable of approximately 19 hours per day there is a possibility that both reservoirs overflow occasionally thus contributing to water losses.

Table 5. *Pump Times to Sarakata Reservoir April 2009*

Date	Pump Off	Pump ON	Hours Pumped
1/04/2009	5:00	9:00	20
2/04/2009	5:00	9:00	20
3/04/2009	5:00	9:00	20
4/04/2009	5:00	10:00	19
5/04/2009	5:00	10:00	19
6/04/2009	5:00	9:00	20
7/04/2009	5:00	9:00	20
8/04/2009	5:00	9:00	20
9/04/2009	5:00	9:00	20
10/04/2009	5:10	10:00	19
11/04/2009	5:00	10:00	19
12/04/2009	5:00	10:00	19
13/4/2009	5:00	10:00	19
14/4/2009	5:00	9:00	20
15/4/2009	5:00	9:00	20
16/4/2009	5:00	9:00	20
17/4/2009	5:00	9:00	20
18/4/2009	5:00	10:00	19
19/4/2009	5:00	10:00	19
20/4/2009	5:00	9:00	20
21/4/2009	5:00	9:00	20
22/4/2009	5:00	9:00	20
23/4/2009	5:00	9:00	20
24/4/2009	5:00	9:00	20
25/4/2009	5:00	10:00	19
26/4/2009	5:00	10:00	19
27/4/2009	5:00	9:00	20
28/4/2009	5:00	9:00	20
29/4/2009	5:00	8:00	21
30/4/2009	5:00	8:00	21
Average Hours Pumped			19.73

The water supplied figure is also supported by using the MNFs gained from logging, the reservoir drop test and working backwards to arrive at an annual water supplied figure.

The estimated total MNF *leakage* of 36.99 litres per second equates to 1083.89 ML per year. Add to this a minimum consumption figure of 80 litres/person/day (half the Brisbane per/head residential usage on level 6 water restrictions) including all commercial, irrigation and residential use for a population of 12,000, and the minimum annual consumption figure adds up to 350 ML per year. This gives an annual total water supplied figure of 1434.29 ML (compared to 1506.8 ML calculated using the top down water balance). There can be confidence that the estimate of annual water supplied is reasonably accurate.

The pipeline from the Sarakata reservoir

Reticulation Network

According to long-serving staff members the reticulation network consists primarily of PVC piping installed in 1975. Given the normal 50 year life span of PVC and the existing high operating pressures throughout the network, the Luganville pipe work may be close to the end of its operational life. The relatively high average burst rate of 2 mains bursts per week confirms this prognosis.

Authorised Consumption Audit

The big difference between the top-down and bottom-up real loss estimates (538.2 ML and 1083.99 ML) is due to the uncertainty around consumption as estimated in the top down model. Of the 3142 connected meters, 1420 have been disconnected due to nonpayment or other reasons. The result is that an average of only 1722 meters was read during the four quarters of 2008. In recognition of this a relatively high estimate of 10% of water supplied (150.7 ML) was used as the “Unauthorised Consumption” component of the top-down water balance. This estimate is based on the 1420 disconnected households using approximately 300 litres per household per day (60 litres/day/person with an average of 5 persons per household).

Real Loss and Consumption Estimates- Data Validation

There is no way of validating consumption data except perhaps by calculating a "residential" consumption figure based on the average residential meter-reading, and extrapolating this estimate across the meters that were not read (assuming these people had to get water somewhere and that they would use the same amount as a metered household). However, the result of this exercise was a consumption figure (1174 megalitres/annum or 37.22 litres/sec) that could not be reconciled with the estimates gained in the bottom-up assessment (422.78 megalitres/annum consumption) that, according to logged minimum night flow data acquired during a period of exceptionally heavy rain, pointed to much higher leakage estimates.

The only data which can be considered with any confidence is the water supplied figure (as it accords with recorded pumping times and meter readings) and the minimum night flow figure (actual flow logged each hour over a 24 hour period). For all other Key Performance Indicators, the best approach is to consider the indicators to fall within a high and low range as illustrated in Table 6 below.

Table 6. *Water Balance Key Performance Indicator Range*

Item	Low Estimate (ML)	High Estimate (ML)
Water Supplied	1506.80	1506.80
Consumption	422.78	923.68
Current Annual Real Losses	538.20	1083.99
Recoverable Losses	482.20	1027.99

This information is not meant to reflect an aggregated summary of either the top-down or the bottom-up water balance, but rather to represent, in isolation, a range within which each component may fall.

Water Supply Operating Costs

The financial costs associated with water supply are either fixed costs (staff, vehicles, buildings, depreciation etc) which are not responsive to changes in water demand. Variable operational costs (electricity for pumping, chemicals etc) on the other hand, are very sensitive to changes in demand. Reducing water losses (demand) directly affects the variable costs associated with the physical supply of water.

In Luganville, the cost of the electricity used to pump water from the bore to the two reservoirs constitutes by far the largest proportion of variable costs. Thus the reduction in electricity costs associated with a reduction in demand will yield the largest financial saving; there will be other much smaller savings (the amount of chlorine used for example) but these are relatively small compared to the savings in electricity costs.

The average monthly electricity cost for pumping water is 2,247,310 Vatu or, at an exchange rate of 80 Vatu to the AUD, approximately $28,091 AUD per month. Table 7 below shows the monthly electricity costs for pumping water from the pump station to the reservoirs.

Table 7. *Water Pumping Electricity Costs*

Electricity Costs - Sarakata Pumping Station, Luganville	
Month	**Cost (Vatu)**
Jan-08	2,462,165
Feb-08	2,150,288
Mar-08	2,195,888
Apr-08	2,181,867
May-08	2,076,442
Jun-08	1,889,666
Jul-08	2,365,507
Aug-08	2,049,721
Sep-08	2,609,486
Oct-08	2,614,179
Nov-08	2,077,095
Dec-08	2,295,422
Total for 2008 (Vatu)	26,967,726
2008 Monthly Average (Vatu)	2,247,310
Pumping Cost per Megalitre (Vatu)	17,897

System Loss Management Plan

There is an immediate need to decrease water losses by reducing pressure throughout most of the system. This may be achieved by the installation of pressure reducing valves on the transmission pipes feeding from Chapui and Sarakata reservoirs. The estimated savings to be gained by pressure reduction are outlined in the two tables below- the first is based on the leakage estimate calculated in the top-down water balance and the second on the leakage estimate calculated in the bottom-up water balance.

These calculations are based on standard current IWA methodologies for predicting water savings by reducing system pressure.

Table 8. *Pressure Reduction Savings Based on Real Loss Estimate from the Top-Down Water Balance*

Target pressure (m)	Savings Ml/year	Saving/Year (Vatu)	Saving/Month (Vatu)
50.0	0	0	0
40.0	149	2,667,843	222,320
30.0	282	5,047,622	420,635
25.0	342	6,114,824	509,569
31.7	**257.6**	**4,610,096**	**384,175**

Table 9. *Pressure Reduction Savings Based on Real Loss Estimate from the Bottom-Up Water Balance*

Target pressure (m)	Savings Ml/year	Saving/Year (Vatu)	Saving/Month (Vatu)
50.0	0	0	0
40.0	303	5,423,118	451,927
30.0	573	10,262,025	855,169
25.0	695	12,432,596	1,036,050
31.7	**523.7**	**9,372,580**	**781,048**

Table 8 and 9 above show an *average* financial saving range from 17% to 35% (384,175 Vatu and 781,048 Vatu respectively) based on a reduction to an average system pressure of 31.7 meters. The volume of savings in each case is almost 50% of current estimated water losses.

Because of the extremely high cost of pumping, the value of these savings (given in Vanuatu currency) in financial terms is very important due to the fact that pumping costs constitute a significant proportion of the Water Supply Division's budget.

Further financial savings can be expected from the decrease in mains and service burst frequency which will result from reduced system pressure. Reduced burst frequency will also free up additional operational resources currently associated with repair and maintenance works.

It should be noted, however, that the many factors influencing the effect of pressure reduction on burst frequency (pipe age, soil type, traffic loading etc) mean that predictions of burst frequency reductions attributable to pressure reduction can only be based on reductions achieved in similar systems in similar geographical locations. All that is certain is that there will be *some* reduction in burst frequency when system pressures are reduced.

Repairing the 150mm meter of the line from the Sarakata Reservoir

System Loss Management Plan Recommended Actions

Priority One
Pressure Reduction
Significant reductions in average system pressure can be achieved with the installation of two pressure reducing valves at the locations outlined on the maps in Appendix One.

Priority Two
Bulk Metering
To achieve adequate bulk metering the Luganville system requires new meters at the following locations:

1. Inside the pump station on the bulk line feeding Sarakata Reservoir (this will allow accurate recording of total water production).
2. On the outlet of the Chapui Reservoir.

Without adequate bulk metering the meter readings essential to monitoring the entire system MNFs will not be available. The reservoir drop test should only be used as a substitute for bulk meters when there is *no* alternative.

Priority Three
Create Three District Metered Areas
The installation of bulk meters will enable the creation of three District Metered Areas (DMAs) based on existing separate or distinct areas. This will allow staff to gather minimum night flow data from these areas and provide the following benefits:

- A planning tool to assist with identifying areas of highest leakage thus allowing leak detection resources to be deployed most effectively.

- The facility to monitor DMAs to estimate the savings produced by leak detection activities and associated repair programs.
- The facility to monitor future leakage levels (left alone leakage will always increase- this is known as the “natural rate of rise”).

It is envisaged that the new bulk meter installed at the outlet of the Chapui Reservoir will also act as the DMA meter for the Chapui District Metered Area. Similarly the existing meter on the feed from the Sarakata Reservoir will act as the DMA meter for the Sarakata District Metered Area (this meter will require a new turbine due to damage caused by an object jamming and breaking the wings of the existing turbine).The third new meter will be installed on the St Michel side of the main bridge just before the water main splits into two separate feeds (by the Digicel sign). See maps in Appendix One for full details of meter locations.

This will allow the creation of three DMAs without the need for augmentation of existing assets (valves or pipeline).

After pressures are reduced, staff should draw up a new pumping timetable based on the reduced pumping requirement. This timetable should not allow the reservoirs’ water levels to increase beyond one metre below the overflow point and would thus eliminate water loss due to reservoir overflow.

Leakage Targets

Given the current high MNF of 36.99 Lts/sec for the system as a whole, a realistic MNF target should be in the region of 6 Lts/sec. This figure allows for a high estimate of night consumption of 3 Lts/sec and 3Lts/sec for background and unreported leakage. Given the existing expertise and resource constraints it will be difficult to get the MNF much below this figure.

Equipment Required

Table 10 provides a list of equipment and costs according to recommended installation priority. This data is presented in such a way as to reflect the cost of each priority category, providing flexibility in the event funding is insufficient for the full program down to priority three. It should be noted, however, that the reduction of current water losses to an acceptable level is dependent on implementation down to priority three.

Table 10. *Equipment List and Costs in $AUD*

Equipment List for Luganville					
Item	Number	Unit Cost	Total	Total Accumulative Cost	
100mm Pressure Reduction Valves (bermad)	3	$2500	$7,500	Priority One	$7,500
150mm Flow Meters (bermad)	2	$1000	$2000	Priority Two	$9,500
100mm Flow Meters (bermad)	2	$800	$1600	Priority Three	$11,100

The total equipment cost comes to $11,100 AUD.

The optional extras outlined in Table 11 below are included because they provide the most convenient way to collect comprehensive pressure and flow data. They are, however, complex and costly technology that require trained operators to operate both the equipment and software. In the event of equipment failure it is not likely that the equipment would be quickly or easily replaced.

So, unless the budget is sufficient and there is a commitment to training and back- up support for this equipment then the simple and reliable low-tech solutions are preferable.

Table 11. *Optional Extras: Logging Equipment and Costs in $AUD*

	Number	Unit Cost	Total
Flow Loggers	4	$1,200	$4,800
Flow Loggers (mobile logging)	1	$1,200	$1,200
Pressure Loggers	3	$1,500	$4,500
Screw-in pressure gauge	1	$120	$120
Total “Optional Extras” Costs			$10,620

Post Implementation

In order to get system leakage down to acceptable levels it is imperative that follow-up sounding surveys and repair schedules are planned and implemented across the whole system. This can and should be done even if funding constraints restrict the implementation of Priority Two and Three (pressure management without new meters).

Resourcing and Funding

The Water Division of the Luganville Department of Public Works is critically under-resourced in both funding for maintenance work and in manpower. Operation and maintenance of the entire water supply system is carried out by a crew of four with an office-based supervisor who also acts as plant operator. This crew is responsible for water treatment and pumping, mains and service connection maintenance and after-hours callouts in a system which is old and subject to high failure rates. There is currently no spare capacity for proactive maintenance.

It is likely that lack of adequate funding contributes to the current level of under-manning, which can be linked to the extremely high electricity costs incurred when pumping water from the bore to the reservoirs.

Constraints

The level of basic knowledge of the field maintenance staff for day-to-day maintenance tasks is very good. However, the introduction of advanced technology in the form of electronic flow and pressure loggers may prove ineffective unless training and guidance is thorough; but even with such training future equipment failure is likely to result in equipment being discarded and data not collected or recorded. For this reason, and more so if budgetary constraints are tight, it is recommended that the technology used to monitor and record flow and pressure data is simple, and easily acquired and maintained.
Minimum Night Flow (MNF) can be monitored on a monthly basis by one of the crew attending the outlet flow meter at 2.00 am in the morning and recording an hourly flow

direct from the meter. Similarly, pressures can be monitored on a monthly basis by using a screw-in pressure gauge at a variety of points around the network. This data can then be recorded on a spreadsheet for further reference.

Training in Leak Detection

The key to further improvement in the Luganville water system lies in the strategy of using the initial financial savings gained from pressure reduction to fund further water loss reduction activities. For example carrying out leak detection activities will in turn further reduce electrical costs associated with pumping water, thus freeing up even more funds. This strategy can reverse the current downward cycle of under-resourced asset maintenance and management which results in further losses and asset degradation, rather leading to an upward spiral of savings, reinvestment and continuous improvement.

In order for this strategy to be fully effective the water system maintenance staff need to be proficient in using electronic sounding equipment. The staff already have access to a Fuji Sounder with ground microphone and "Elephant's Foot" microphone. This equipment has not been used as the staff were not trained in its use. The assessment team was able to provide some preliminary training in leak sounding but the staff needs a half day of supervised training to become familiar with the equipment, particularly in the use of the built in frequency filters and identifying different leak sounds.

Staff practicing with sounding equipment

It can take considerable time to become a fully proficient leak-detection technician as only experience will enable the operator to distinguish and interpret the minor nuances in frequency and noise which is essential to a high success rate in leak sounding surveys. During conversations with the water system management in Luganville a suggestion was made that the staff carry out a leak sounding survey each week in order to gain experience before the implementation of pressure management. If acted upon this should alleviate to some extent the lack of operator proficiency.

Pressure Reducing Valve Operation and Maintenance

Luganville water staff will need basic training in maintaining the pressure reducing valves (PRVs) if implementation proceeds. PRVs require little maintenance aside from cleaning or changing the main filter; however staff will need to know how to adjust downstream pressures of the PRV. This is simply a matter of turning a screw which sets the maximum downstream pressure, where downstream pressure can be monitored with a pressure gauge attached to the PRV during the adjustment operation. An effective leak detection and repair program will tend to increase pressure in the system as leaks are repaired. The PRV set point will need to be lowered periodically to compensate so staff will need training in how to control the pressure at the PRV.

Appendix One

Proposed locations for PRVs and meters.

Bulk meter and possible PRV locations for the Sarakata District Metered Area

St Michel District Metered Area

Possible location of PRV for the proposed Chapui Pressure management Zone (part of the proposed Chapui District Metered Area).

The proposed location of a new bulk meter for Chapui Reservoir outlet. The Chapui Reservoir supply area will then become the Chapui District Metered Area with this bulk meter performing the role of DMA flow meter.