LEAKAGE REDUCTION PROJECTS UNDERTAKEN BY RAND WATER

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FORWARD

Rand Water's core business, for the past 100 years, has been to purify raw water and to supply bulk potable water to its customers, the municipalities throughout Gauteng and surrounding areas that form the industrial heartland of South Africa. It is estimated that more than 10 million people consume water supplied by Rand Water daily with an average supply in excess of 3 000 Ml/day.

In 1994/95, during a very severe drought, a levy was placed by Rand Water on the water tariff of municipalities that exceeded predetermined water demand quotas and these funds were placed in a separate "drought fund".

In 1996, Rand Water proceeded to establish a new division specifically to assist the municipalities with a variety of expertise. The aim of this division, the Community Support Services Division, was directed outward to interventions in communities including awareness on water matters, education in effective and efficient water use, marketing of products as well as implementing and promoting Water Demand Management.

In order to promote and demonstrate the benefits of Water Demand Management, Rand Water initiated and supported numerous pilot projects with the aim of establishing "best practice" examples in certain aspects of Water Demand Management. A variety of these projects were targeted at leakage reduction in the municipal reticulation networks as well as retrofitting of existing inefficient water endpoint fittings, including old ductile cast iron toilet cisterns, with modern units inside homes on properties. All of the projects involved a high level of community involvement which was considered essential to the success of the projects.

This publication serves to document the efforts in this regard -- efforts costing in the region of US$6 million that were undertaken with funds from the "drought fund". The majority of these projects were a resounding success with consumption reduction averaging 25%. This manual documents all of the efforts, the successes as well as the less successful projects. In the process, the manual provides details which will help water suppliers in implementing such projects and anticipating potential pitfalls.

Rand Water would like to take this opportunity to thank the United Nations Centre for Human Settlements (Habitat), the relevant Local Authorities, the communities and other partners for their contributions in these worthwhile projects. These interventions have highlighted the value and importance of partnerships in capacity building and sharing of expertise.

It is hoped that this document will be of use to water suppliers throughout Africa who may be considering the implementation of various Water Demand Management measures. It is also hoped that it will be widely read and disseminated in order to encourage growth in Water Demand Management initiatives – specifically the management of leakage.

Maggie Letsoalo
GeneralManager : Marketing and Communications
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- *Pipeline Performance Technologies (Pty) Ltd:* Report on Johannesburg CBD Leakage Detection Project
- *PRC van der Merwe* and *Tokiso Projects CC:* Report on the Boksburg Schools Water Loss Project
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- Willie le Roux & Associates CC: Reports on the Johannesburg Inner City Retrofit Project as well as the All-Africa Games Water Efficiency Project.

Executive Summary

Rand Water has undertaken numerous Water Demand Management (WDM) pilot projects to address the problems of water wastage and leakage in the Rand Water supply area. From the analyses of the various leakage reduction projects the following observations and conclusions were made, as shown in **Table 1.**

Table 1: Summary of key observations and conclusions

Project Name	Budget	Objectives	Results/ Findings	Estimated Payback Period (1)
Tlhabane Water Loss Management Project	R 1,1 million ($ 180 000)	To reduce and manage water losses through various WDM interventions, discussed in the report.	The total minimum night flow was reduced by 11.2 m^3/hr through the repair of approximately 11 mains leaks. This represents an annual saving of 100 000 m^3. The repair of internal household leaks was outside the scope of the project.	+6 years
Johannesburg CBD Retrofit Project	R 750 000 ($ 100 000)	To investigate a variety of leak detection methods and select the most suitable for use in CBD areas.	The best approach for undertaking a leak detection exercise is to use a combination of techniques. Some methods like sounding, GPR, Step Testing, Aqualogs etc. are better suited for an initial sweep while methods like LNC and ground microphones can be used to pin-point specific leaks.	N/a
Boksburg Schools Water Loss Project	R 960 000 ($ 60 000)	To retrofit ablution facilities at 48 schools in Boksburg.	Meter readings before and after the project were available for 28 out of the 48 schools. The combined monthly water consumption for the 28 schools was reduced by 7 737 kl. This can be extrapolated to a total saving of approximately 12 000 kl (7 737 X 1.5) for the 48 schools.	± 4 years
Kagiso Schools Retrofit Project	R 625 000 ($ 90 000)	To retrofit ablution facilities at 27 schools in Kagiso in Krugersdorp.	Meter readings before and after the project were available for 15 out of the 27 schools. The combined monthly water consumption for these 15 schools was reduced by 3 000 kl. This can be extrapolated to a total saving of approximately 4 500 kl (3 000 X 1.5) for the 27 schools.	± 6 years

Project Name	Budget	Objectives	Results/ Findings	Estimated Payback Period [1]
All-Africa Games Village Water Efficiency Project	R 570 000 ($ 90 000)	Implementation of water efficient devices in new houses built for the All-Africa Games Village	It was not possible to identify savings due to various external factors, discussed in the report.	N/a
Johannesburg Inner City Retrofit Project	R 1.3 million ($ 240 000)	To reduce water losses through the upgrading of plumbing in 946 flats.	The average water consumption per flat was reduced from 920 l/day to 750 l/day, equaling to a saving of 170 l/flat/day and a total saving of 60 000 kl/year.	±11 years
Kagiso Retrofit Project	R 1.5 million ($ 345 000)	To reduce leakage through retrofitting toilet cisterns in 6 000 houses.	The average consumption was reduced by 280 000 kl/month over the period 1996 to 2000. It was not possible to quantify the savings attributable directly to the project due to a number of other WDM measures that were undertaken simultaneously.	N/a
Odi Retrofit Project	R 4.4 million ($ 800 000)	To reduce water wastage through retrofitting and installation of dual flush toilets in 16 244 houses.	The average monthly household consumption was reduced by 2.9 kl, equating to a total saving of 47 000 kl/month.	± 4 years
Sebokeng Retrofit Project	R 2.1 million ($ 380 000)	To reduce water losses through retrofitting and replacement of inefficient toilet parts in 3 500 houses.	The average monthly household consumption was reduced from 23.4 kl to 14.8 kl, equating to a household saving of 8.6 kl per month and a total saving of 30 000 kl/month.	± 3 years
Soweto Retrofit Project	R 4. 6 million ($ 1 million)	To reduce leakage through retrofitting at 13 235 privately owned houses.	The monthly bulk consumption of Soweto was reduced by 500 000 kl, over the period 1996 to 1997. It was not possible to quantify the savings attributable directly to the project due to a number of other factors, which may have influenced the consumption.	N/a

Project Name	Budget	Objectives	Results/ Findings	Estimated Payback Period [1]
Tembisa Fast Retrofit Project	R 3.7 million ($ 800 000)	To reduce leakage through retrofitting at 14 500 properties.	The average monthly unaccounted-for-water was reduced from 575 000 kl to 290 000 kl. However, a year after completion of the project the monthly unaccounted-for-water increased again to 370 000 kl. Further follow-up investigating are required to assess the true sustainable savings for the project.	N/a
Tembisa West Retrofit Project	R 2.5 million ($ 450 000)	To reduce leakage through retrofitting at 5 000 properties.	The average monthly consumption was reduced by 96 000 kl. The local council also indicated that it repaired numerous mains leaks during the same period and, therefore, some of the savings are not attributable directly to the project. Based on the assumption that 50 % of the savings can be attributed to the project, the saving is estimated to be in the order of 48 000 kl/month.	+ 3 years
Thokoza Retrofit Project	R 670 000 ($ 160 000)	To reduce leakage through retrofitting at 2580 properties.	The average monthly consumption was reduced by 53 000 kl. It was not possible to quantify the savings attributable directly to the project due to a number of other WDM measures that were undertaken simultaneously.	N/a
Slovoville Pressure Management Case Study	R 57 000 ($ 6 600)	To quantify the benefits of leakage reduction by installing a time-modulated pressure controller on an existing PRV.	The daily demand for the zone was reduced by 591 kl, equating to a projected saving of 18 000 kl/month.	± 2 months

Note: ([1]) The estimated payback period was based on the Rand Water selling price in the first year of each project. (R 1.1 / m^3 in 1996, R 1.3 / m^3 in 1997, R 1.7 / m^3 in 1998, R 1.8 / m^3 in 1999, R 2.0 / m^3 in 2000, R2.1 / m^3 in 2001)

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1 INTRODUCTION

1.1 SCOPE OF REPORT

Section I of this report provides an overview of the importance of Water Demand Management in South Africa and highlights the significance of improving water use efficiency with regards to the Vaal River System. The importance of Rand Water in the Vaal River System is explained and the historical and projected future demands for Rand Water's area of supply are discussed. The section concludes with an explanation of how various Pilot Projects are being investigated to determine the possible savings that can be achieved through selected WDM measures as well as to find best practice methods for undertaking such projects. This leads onto the remainder of the report, which investigates the specific leakage reduction projects undertaken by Rand Water and presents detailed information on each project.

1.2 GENERAL

Most parts of South Africa experience relatively low rainfall, which together with very high evaporation rates result in low unit runoff for the country as a whole. South Africa is rated as one of the twenty most water stressed countries in the world and receives an average rainfall of less than 500 mm per annum (well below the world average of 860 mm per annum). Not only is the rainfall low but it is also unevenly distributed throughout the country with most of the rainfall concentrated along the narrow region on the southern and eastern coastline. Figures published by DWAF (1986, Fig 3.3.3) indicate that the combined natural runoff from all of South Africa's rivers is in the order of 53 500 million m^3/a, representing an average depth (unit runoff) over the whole country of approximately 42 mm/a. This is very low compared to most countries and to the world average of 330 mm/a as can be seen in **Table 1-1** which provides some comparative figures from around the world (Gleick, 1993 and DWAF, 1986).

As a result of the rapidly increasing demands for water in many parts of South Africa and the long drought periods (often in excess of 10 years), numerous major inter-basin water transfers have been developed (see **Figure 1-1**). These schemes often involve transferring water over distances of many hundreds of kilometres with pumping heads in excess of 500m. Large reservoirs are needed to store the water and associated transfer schemes are often needed to move the water from the source basins to the areas where it is most required. In this regard, the South African Department of Water Affairs and Forestry (DWAF) has developed a complex bulk water infrastructure which must rank as one of the most sophisticated in the world.

Table 1-1 Comparison of runoff from various continents and countries

Continent / country	Surface area (million km²)	Runoff* (million m³/a)	Runoff (mm/a)
Brazil	8.5	5 190 000	610
North America	24.2	6 945 000	286
Asia	43.5	10 485 000	241
Europe	10.5	2 321 000	221
Africa	30.1	4 184 000	139
USA	9.4	2 478 000	63
South Africa	**1.2**	**53 500**	**44**
Australia	8.9	343 000	39
World	**134.8**	**44 500 00**	**330**

Note: From Gleick (1993) and DWAF (1986).

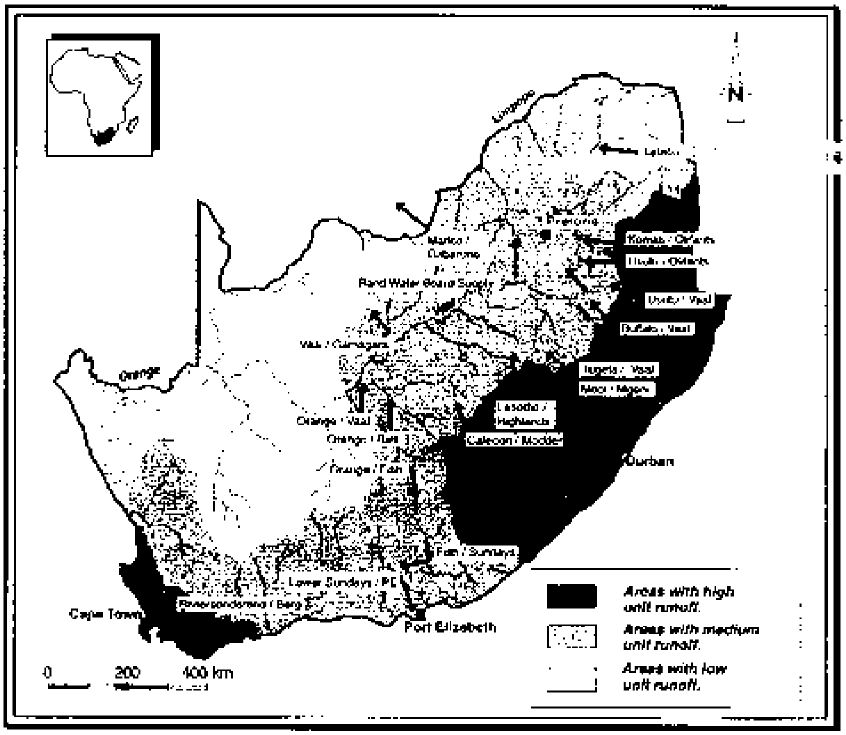

Figure 1-1 Major water transfer schemes in South Africa

1.3 IMPORTANCE OF WATER DEMAND MANAGEMENT IN SA

The requirement for water in South Africa has been growing at between 4 % and 5 % since the 1930s. The historical growth patterns for the three largest urban/industrial centres in South Africa are shown in **Figure 1-2**, from which it can clearly be seen that the demand for the Gauteng area is by far the largest in the country. It should be noted that the Gauteng demands shown in the figure relate only to the water supplied by Rand Water which represents approximately half of the total water supplied from the Vaal River System. The annual demand figures used to produce the graphs and their sources are provided in **Table 1-2**.

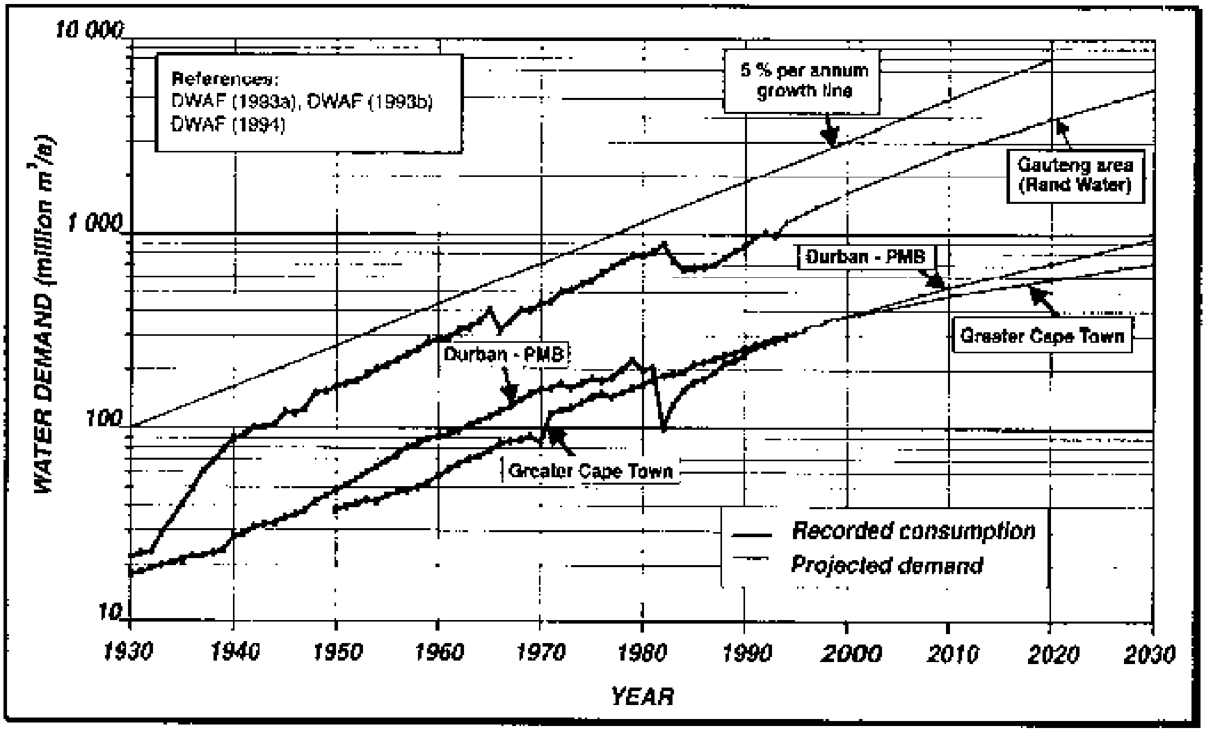

Figure 1-2: Major metropolitan water requirements in South Africa- (as estimated in 1994)

From **Figure 1-2**, and the values given in **Table 1-2**, the historical and projected growths in water requirement can be clearly seen. The decrease in supply, caused by the severe drought experienced throughout most regions of South Africa in the early eighties, can also be noted. The figure also shows the projected demands as estimated in the early 1990s, which indicates a very alarming situation. If the demands for water were permitted to follow the projections shown in the figure, many parts of the country would literally run out of water somewhere around 2050. This was a very important conclusion and was one of the key motivations which resulted in the shifting of emphasis from the development of new water resources to one of WDM and improved water use efficiency.

Table 1-2 Annual demand figures for several demand centres in South Africa

Year	Annual Water Demands (million m³/a)		
	Rand Water	Durban Metro	Cape Metro
1930	22	16	-
1935	41	21	-
1940	89	26	-
1945	120	35	-
1950	163	48	38
1955	212	69	45
1960	285	92	57
1965	402	115	78
1970	434	158	86**
1975	575	180	144
1980	777	199	167
1981	815	206	178
1982	692	101**	187
1983	737**	132	190
1984	655**	156	196
1985	670**	173	215
1986	680**	180	219
1987	700	194	228
1988	760	217	240
1989	825	222	245
1990	871	241	258
1991	980	263	269
1992	1017	273	279
1993	991	284+	291
1994	1145* (1079)	295+	303*
1995	1214* (947**)	310+	315*
2000	1629* (1321)	377+	372*
2010	2692* (2135)	458+	478*
2020	3908* (3000)	558+	585*
2030	5666* (4222)	679+	713*

* Most likely projection scenario
\+ Based on a 4% growth rate as experienced recently in the region
( ) Actual figures up to 1995 & revised estimates due to the recent water restrictions
** Influenced by restrictions

Until recently, the general approach to water management in South Africa was to develop new water projects and transfer schemes in order to keep ahead of the continually increasing requirements caused by the growing population and improved living standards. This type of supply management was justified to some extent by the relatively low financial costs of the initial schemes combined with low interest rates and high inflation. In recent years, however, the situation has changed dramatically for various reasons including the greater awareness of environmental issues, the impact of HIV/AIDS and relatively high real interest rates.

As a result, the emphasis has shifted from the purely supply orientated approach to one of both supply and demand management with the latter receiving priority.

Bold and meaningful measures have recently been taken by the South African Government through the new Water Services Act (Government Printers,1997) and the National Water Bill (Government Printers,1998). They introduce a new approach to water management, one in which demand management, water use efficiency and integrated catchment management are integral to the entire planning of water resource management and development.

In addition, new water supply regulations have been drafted which will effectively ensure that water suppliers evaluate, quantify and manage their Non-Revenue Water. This will involve many measures including proper sectorising, comprehensive metering, night-flow logging as well as swift leak detection and repair. As a result of these measures and others, the future water requirement estimates in many parts of the country have recently been re-assessed and reduced where appropriate. In the case of the Vaal River System, (arguably the most important river system in the country), the projected future water demands have been significantly reduced to the extent that new transfer schemes can now be postponed for many years. The projected 2030 demand of 5 556 million m^3/a as indicated in **Figure 1-2** (the DWAF estimate for the Rand Water demand) has now been revised downwards to approximately 1 490 million m^3/a. This dramatic decrease is due to a complete re-evaluation of the projected future demands for all main demand centres in the supply area based on sound economic and demographic principles. Previous estimates were based on an approach of extrapolating historical trends which assumed that the historical growth of between 4 % and 5 % would continue. In reality such growth in water demand is not sustainable and cannot be justified when analysing the underlying fundamentals. This clearly demonstrates the importance of deriving realistic estimates of future water demands based on demographic trends and economic considerations rather than extrapolation of past occurrences.

THE RAND WATER AREA OF SUPPLY

The Rand Water area of supply (AOS) covers most of Gauteng and extends into many parts of the surrounding provinces. In effect, the water that Rand Water supplies represents approximately half of all water supplied from the Vaal River System . The Vaal River System Supply Area (VRSSA) as shown in **Figure 1-3** is effectively the industrial powerhouse of southern Africa and was one of the first areas in South Africa where the demand for water outstripped local supplies. The area is extremely important from a national viewpoint for the following reasons:

- over 80 % of SA's electricity is generated in the area;
- SA's two largest petro-chemical plants are located in the area;
- numerous large mines (gold, platinum and coal) are located in the area;
- over 50 % of SA's population reside in the area;
- over 50 % of SA's GNP is produced in the area.

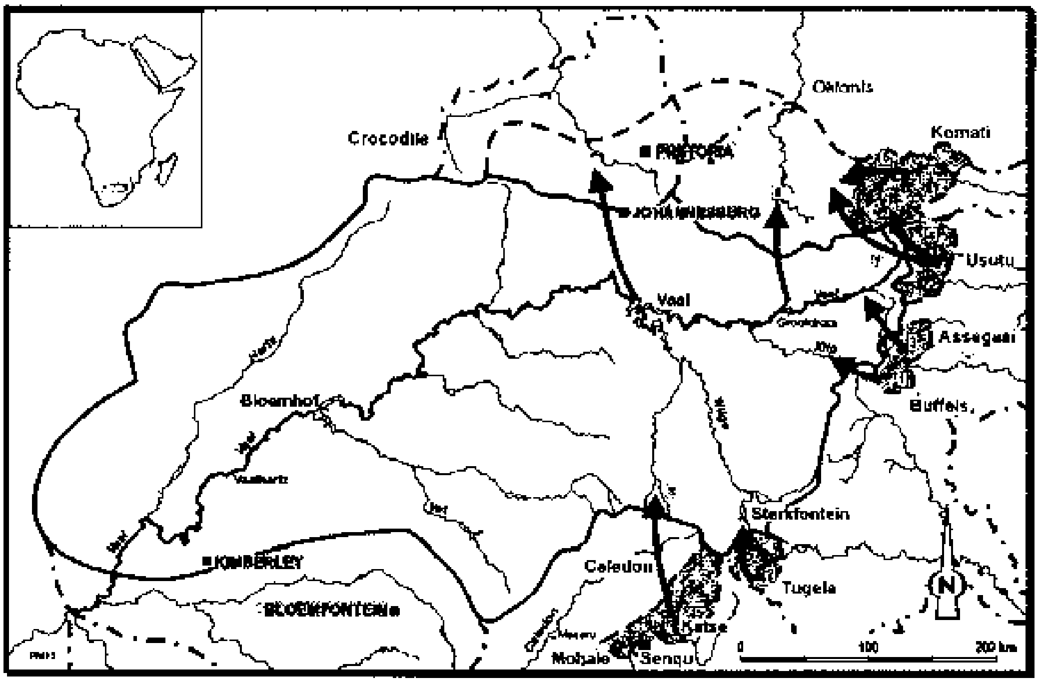

Figure 1-3 Map of the Vaal River System Supply Area

In order to support the water requirements of the area, eight major transfer schemes are already in operation which transfer water from the adjacent catchments into the VRSSA. Various further development options are currently being investigated to provide additional water to the VRSSA. Although the supply is currently sufficient to meet the existing demands, it is anticipated that the demands will eventually outstrip the supply at which time further augmentation will be required. The main issue to be addressed is how quickly the demands will increase and when the next transfer scheme will be required.

A detailed water resources study was undertaken by DWAF in 1991 (Raademeyer et al.) to assess the influence of the reduction in water requirement on the implementation date of the next augmentation scheme in the VRSSA. The results indicated that even a modest 10% reduction in the predicted future water requirements (an arbitrary value selected for analysis purposes) would result in a 6-year delay to the next augmentation scheme. In addition it was conservatively estimated that such a delay would result in savings of almost $1 000 million. The actual savings are likely to be significantly higher since many knock-on factors were excluded from the financial analysis such as costs associated with sewage treatment and the costs of upgrading water works and appurtenant reticulation infrastructure etc. From the study it was clear that WDM measures represent the most cost effective solution to the future water supply problems although it was also accepted that at some point in the future it may still be necessary to consider further augmentation.

In summary, the future water demands in the VRSSA are clearly of national importance and must be curtailed through properly planned and implemented conservation measures. In this regard the Department of Water Affairs and Forestry in association with Rand Water recently completed a scoping study to evaluate the potential for Water Demand Management in the Vaal River System Supply Area. The original objectives of this study were:

- To identify key water users in the study area;
- To compile a broad review of past and current WDM initiatives in SA that can be of relevance to the study area;
- To evaluate the potential for savings through WDM initiatives;
- To develop a framework for a follow-on comprehensive WDM study for the Vaal River System Supply Area.

As part of the main study it was agreed that suitable Pilot Projects would be identified and that the results from such studies could be used to provide an indication of the possible savings that can be achieved through Water Demand Management activities. From the examination of more than 100 pilot projects, it became clear that very few of the studies had been completed to the stage where the true long-term savings could be established. Most of the projects were not documented in detail and it was therefore recommended that this issue be addressed during a subsequent investigation where sufficient time and resources can be used to provide meaningful results. The proper evaluation of pilot projects was highlighted as a key issue requiring attention and the investigation and analysis of the Rand Water Leakage Reduction Projects will assist in this regard.

1.4 INTRODUCTION TO RAND WATER

Rand Water supplies approximately half of the Vaal River System demand and is the largest provider of potable water in the country with an annual supply of more than 1 100 million m^3/a (or over 3000 Ml/day). While the average water supplied by Rand Water is in the order of 3 000 Ml/day, the available peak capacity is approximately 6 000 Ml/d making Rand Water one of the largest water supply companies in the world. The breakdown of the water demands in the Vaal River System is provided in **Table 1-3** (DWAF, 2001) from which the significance of the Rand Water demand can be seen.

There has been a serious discrepancy between the Rand Water projections and those of DWAF with regards to the Rand Water demands for many years. In all of the earlier analyses, the DWAF estimates of the Rand Water demands were significantly higher than the projections made independently by Rand Water. The most recent demand projections for Rand Water indicated in **Table 1-3** include an allowance of 3.3 % for unaccounted-for-water in the bulk distribution system as recommended and used by Rand Water.

If the figures in **Table 1-3** are compared to the earlier estimates as shown in **Table 1-2** it can be seen that the latest projected demands for 2030 are in the order of one third of the previous estimates. In view of this substantial drop in the projected future demands, it was originally thought that this would alleviate the need to implement WDM in the Vaal River System. After further investigations, however, it was found that the importance of WDM is now likely to be greater than before. The same drop in demand will now delay the next augmentation scheme by 20 years compared to only 4 or 5 years when considering the previous demand projections. This conclusion has resulted in a new and concerted effort involving a more detailed investigation into the potential for WDM in the Vaal River System which will be undertaken in 2002 and 2003. The main objectives of the study are to confirm the most likely future water demands and to establish a realistic estimate of the savings that can be made through WDM throughout the Rand Water area of supply.

The remainder of this report provides details of several projects completed by Rand Water to reduce leakage in areas where the leakage was known to be significant. It is only through the implementation and evaluation of such projects that the true potential for WDM can be established with any confidence.

Table 1-3 Summary of water demands and return flows for the Integrated Vaal River System (IVRS)

Description of user		Projected demands in million m³/a 2001	2005	2010	2015	2020	2025	2030	2025 Demand as % of Total Gross Demand
DEMANDS:	Rand Water [1]	1142.41	1263.50	1282.60	1302.00	1363.30	1427.40	1490.20	41.5
	Other towns and industries (Vaal)	159.51	169.44	175.14	181.51	185.33	189.78	195.17	5.5
	Other towns and industries (Zaal)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Midvaal Water Company	44.50	44.00	43.00	42.00	40.00	40.00	40.00	1.2
	Goudveld Water (Balkfontein only)	36.67	35.17	35.22	34.91	33.58	32.29	31.00	0.9
	Sub-total : Urban and small industries	**1383**	**1512**	**1536**	**1560**	**1622**	**1689**	**1756**	**49.1**
	ESKOM	270.21	306.35	336.80	349.51	360.52	370.02	370.78	10.8
	ISCOR	26.00	26.00	26.00	26.00	26.00	26.00	26.00	0.8
	SASOL I	21.18	23.01	29.22	33.00	33.00	33.00	33.00	1.0
	SASOL II & III	97.00	98.00	98.00	98.00	98.00	98.00	98.00	2.8
	Sub-total : Individual large industries	**414**	**453**	**492**	**507**	**518**	**527**	**527**	**15.3**
	Vaalharts/Lower Vaal irrigation	500.00	500.00	500.00	500.00	500.00	500.00	500.00	14.5
	Diffuse demands in Vaal catchment [2]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Diffuse demands in supporting sub-systems [2]	72.05	72.05	72.05	72.05	72.05	72.05	72.05	2.1
	Other irrigation in Vaal catchment [3]	303.18	303.18	303.18	303.18	303.18	303.18	303.18	8.8
	Other irrigation in supporting sub-systems [3]	25.10	25.10	25.10	25.10	25.10	25.10	25.10	0.7
	Sub-total : Irrigation and diffuse	**900**	**900**	**900**	**900**	**900**	**900**	**900**	**26.2**
	Wetland losses [4]	42.02	43.86	45.11	46.40	47.70	48.99	50.24	1.4
	Vaal River bed losses [5]	267.20	267.20	267.20	267.20	267.20	267.20	267.20	7.8
	Mooi River (net losses) [6]	8.40	8.40	8.40	8.40	8.40	8.40	8.40	0.2
									100.0
RETURN FLOWS:	Southern Gauteng (Rand Water)	323.48	356.08	361.23	366.45	382.96	400.21	417.12	
	Midvaal Water Company	1.07	1.06	1.04	1.02	0.97	0.98	0.98	
	Goudveld Water	1.47	1.41	1.41	1.40	1.34	1.29	1.24	
	Other towns and industries	56.33	59.91	65.63	69.19	69.31	69.35	69.29	
	Irrigation	30.36	30.36	30.36	30.36	30.36	30.36	30.36	
	Mine dewatering [7]	135.39	135.21	119.41	137.49	137.49	137.49	137.49	
	Increased urban runoff	96.49	100.40	103.24	106.51	113.32	120.97	129.39	
OVERALL GROSS SYSTEM DEMAND:		**3016**	**3165**	**3249**	**3289**	**3363**	**3441**	**3510**	
TOTAL RETURN FLOWS :		**645**	**664**	**682**	**712**	**736**	**761**	**786**	
OVERALL NET SYSTEM DEMAND:		**2372**	**2501**	**2567**	**2577**	**2628**	**2681**	**2724**	

General notes :

(1) Rand Water's total raw water abstraction includes Sasolburg but excludes Authorised Users (i.e. ESKOM, ISCOR, Sasol I and Small Users (Mining & Industrial)).

(2) "Diffuse demands" includes diffuse irrigation and afforestation demands

(3) "Other irrigation" represents controlled irrigation demands and excludes diffuse irrigation demands

(4) Includes evaporation losses associated with wetlands as well as bed losses occurring within the Suikerbosrand and Klip rivers

(5) "Vaal River bed losses" includes losses of 193 million m³/a associated with releases made from Bloemhof Dam

(6) Mooi River (Wonderfonteinspruit catchment). Net effect of bed losses and decanting from dolomitic eyes resulting from WQT calibration

(7) Based on Amanzi Project information (Includes flow contribution resulting from the tailwater component at Erfenis Dam)
The anticipated temporary termination of mining activities in the Central Basin (from 2006 until 2013) as well as the decline in dewatering expected in the Far Western Basin (from 2000 until 2012) are reflected in the reduced projected flow contributions from the mines in 2005 and 2010

1.5 WDM PILOT PROJECTS UNDERTAKEN BY RAND WATER

Rand Water initiated numerous pilot projects to address the problem of water wastage inside the areas of its clients (various municipalities) in its supply area. The following projects were undertaken between 1995 and 2001 and are discussed in the remainder of this report. The location of each project area is indicated in **Figure 1-4**.

RETICULATION LEAKAGE PROJECTS

1. Tlhabane Water Loss Management Project;
2. Johannesburg CBD Leakage Detection Project;

RETROFITTING PROJECTS

3. Boksburg Schools Water Loss Project;
4. Kagiso Schools Retrofit Project;
5. All-Africa Games Village - New Homes Water Efficiency Project;
6. Johannesburg Inner City Retrofit Project;
7. Kagiso Siyong Amanazi Retrofit Project;
8. Odi Retrofit Project;
9. Sebokeng Emfuleni Retrofit Project;
10. Soweto Retrofit Project;
11. Tembisa East Retrofit Project;
12. Tembisa West Retrofit Project;
13. Thokoza Retrofit Project;

PRESSURE MANAGEMENT PROJECTS

14. Slovoville Pressure Management Case Study.

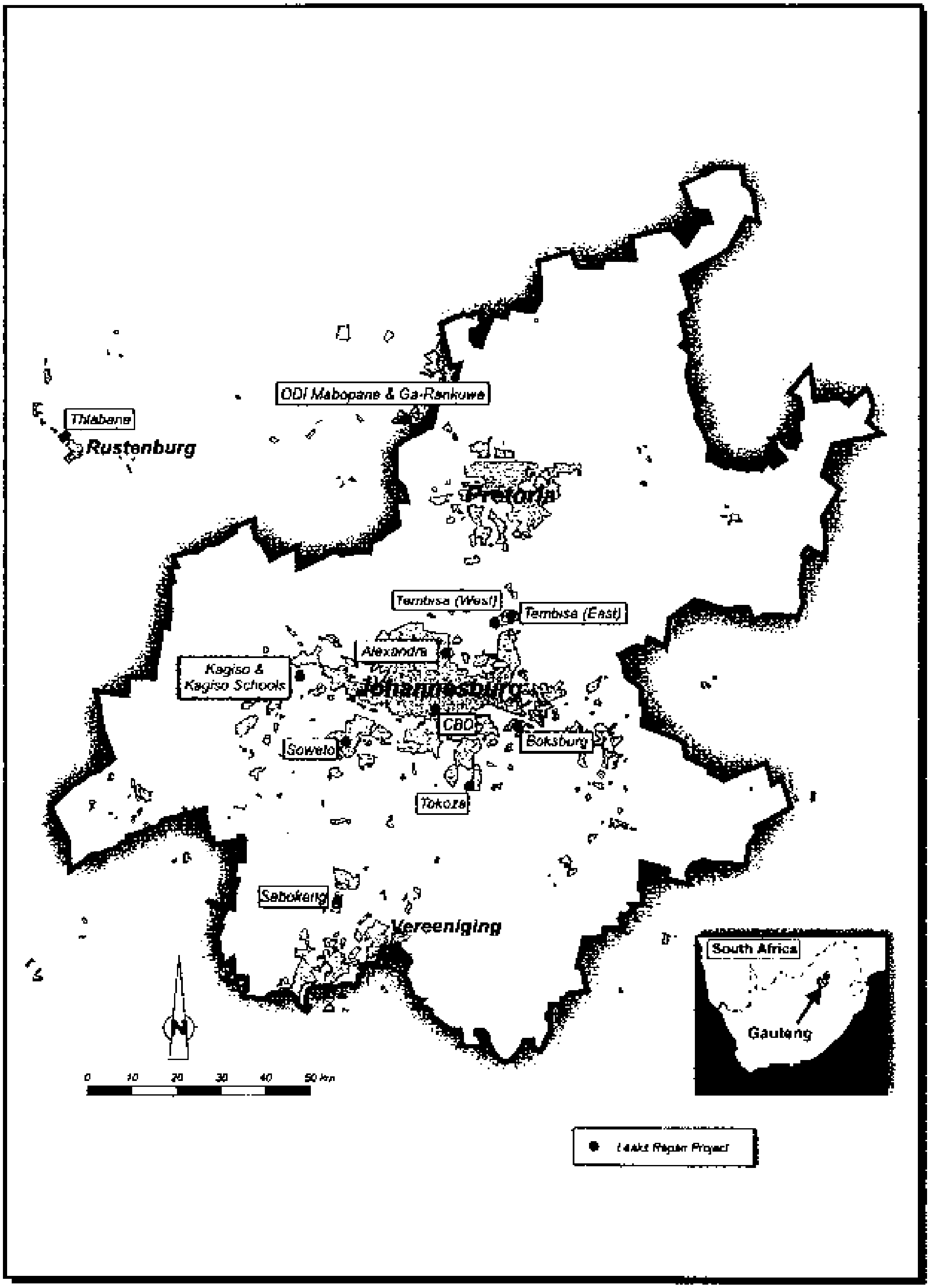

Figure 1-4 Locality Map of WDM Pilot Projects

1.6 REFERENCES AND USEFUL PUBLICATIONS

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- SOUTH AFRICAN BUREAU OF STANDARDS, 1999. **Code of Practice for the Management of Potable Water in Distribution Systems.** SABS 0306:1999; ISBN 0-626-12046-2
- UK WATER INDUSTRY, 1994. The 'Managing Leakage' Series of Reports:

Report A : **Summary Report**. ISBN: 1 898920 06 0

Report B : **Reporting Comparative Leakage Performance**. ISBN: 1 898920 07 9

Report C : **Setting Economic Leakage Targets**. ISBN: 1 898920 08 7

Report D : **Estimating Unmeasured Water Delivered.** ISBN: 1 898920 09 5

Report E : **Interpreting Measured Night Flows**. ISBN: 1 898920 10 9

Report F : **Using Night Flow Data.** ISBN: 1 898920 11 7

Report G: **Managing Water Pressure.** ISBN: 1 898920 12 5

Report H: **Dealing with Customers' Leakage**. ISBN: 1 898920 13 3

Report J: **Leakage Management Techniques, Technology & Training.**
ISBN: 1 898920 14 1

2 RETICULATION LEAKAGE PROJECTS

2.1 TLHABANE WATER LOSS MANAGEMENT PROJECT

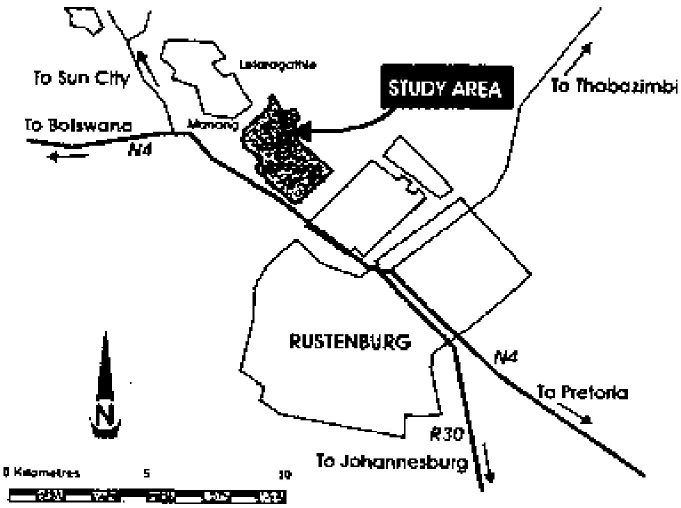

Figure 2-1 Locality Map of the Study Area

2.1.1 Project Overview

Objective	:	To reduce and manage water losses in the distribution network of Tlhabane and to illustrate the financial viability of selected Water Demand Management (WDM) interventions.	
Duration	:	24 Months (August 1998 – August 2000)	
Total Budget	:	R1 .1 million ($ 180 000)	
Project Team	:	Local Authority:	Rustenburg City Council
		Consulting Engineer:	Stewart Scott (Pty) Ltd
		Contractor:	KE Enterprises
		Pipe Location:	PPT (Pty) Ltd, formerly CSIR Mattek
		Flow Measurement:	Mega Measurements (Pty) Ltd

2.1.2 Background

During March 1997 the Rustenburg City Council approached Rand Water for assistance in reducing the water losses in Tlhabane, an area which it inherited from the former Bophuthatswana (see Locality Map, **Figure 2-1**). In this regard, Rand Water appointed Stewart Scott (Pty) Ltd to plan and implement the water loss management programme in Tlhabane.

2.1.3 Methodology

The project was implemented in five phases described briefly as follows:

- Development of a Water Loss Management programme;
- Selection and installation of meters, valves and a monitoring system;
- Implementation of water loss and leak detection procedures;
- Analysis of results;
- Water audit/balance analysis.

A brief description of the key technical tasks undertaken on each phase is provided below. Additional information can be obtained from the report by Stewart Scott (Pty) Ltd (see References).

Develop a Water Loss Management Programme

- Verification of all major pipeline routes and inter-connections as indicated on record drawings;
- Demarcation of districts, sub-districts and zones;
- On-site flow measurements on the main water supply into Tlhabane to determine the sizes, types and location of required management meters.
- Identification of sizes and types of isolating valves as well as their locations on the drawings.
- Hydraulic analysis of the major pipelines of the distribution network as well as limited calibration after flow and pressure data became available during subsequent phases of the project.

Select and install meters, valves and a monitoring system

- Installation of three management meters (**Figure 2-2**) for Tlhabane as well as associated pipework, valves and fittings;

- Measurement and analysis of minimum night flows, to determine leakage levels.

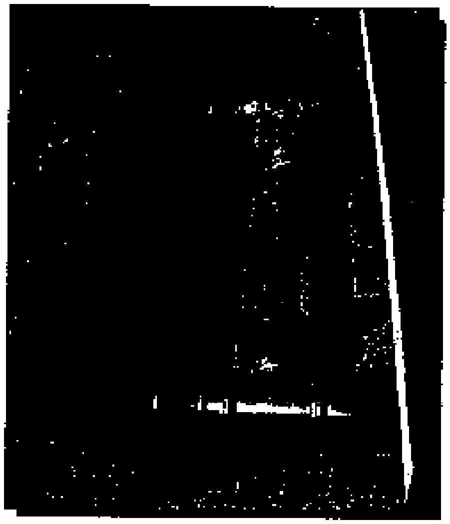

Figure 2-2 New bypass chamber with management meter (Courtesy Stewart Scott)

Implement water loss and leak detection procedures

Various leak detection surveys were carried out in Tlhabane. (More *information on leak detection in the Johannesburg CBD Leakage Detection Project, Section 2-2)* The following techniques were adopted:

- Leak noise sounding surveys;
- Visual surveys;
- Step testing.

Leak detection surveys identified over 140 leaks of which approximately 8 % were in the distribution system and the remainder within properties. All leaks identified in the distribution system were repaired. Repair of leaks within properties was not within the scope of this project (**Figure 2-3**).

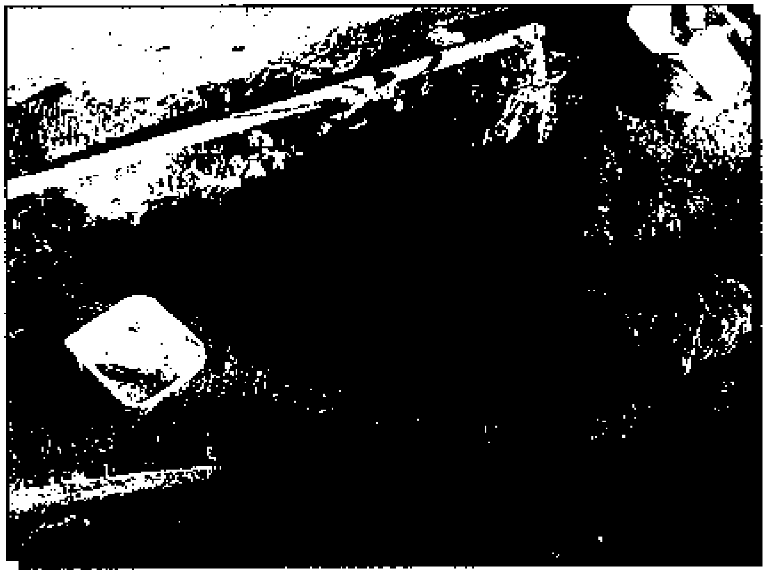

Figure 2-3 Leak on property (Courtesy Stewart Scott)

Analyse Results

The following results were obtained from evaluating the measured minimum night flow before and after implementation of the water loss management project:

- The total minimum night flow was reduced by 11.2 m³/hr (**Table 2-1**)

- According to the Stewart Scott report the annual saving due to leak reduction in the water reticulation system can be approximated at 98 000 m³ or 4.1% of the annual volume of water supplied to the township. (The estimate was based on the assumption that the reduction in MNF is applicable throughout the day and over the full year. This approach may overestimate the savings since it is normal practice to derive the true "hour/day" factor for extrapolating reduced leakage from the MNF. An hour day factor of 20/24 (approximately 0.8) is normally appropriate. (See Slovoville Pressure Management Case Study, **Section 4-1**)

Table 2-1 Evaluation of minimum night flow (MNF) for Tlhabane

Area	MNF @ July 1999 (m^3/hr)	MNF @ July 2000 (m^3/hr)	Reduction in MNF (m^3/hr)	Change (%)
Upper district	33.8	24.0	9.8	-29.0
Lower district	56.8	55.4	1.4	-2.5
Total	**90.6**	**79.4**	**11.2**	**-**

Note: Information was obtained from the Stewart Scott Report.

The reduction in MNF suggests that the implementation of the project has successfully reduced the water losses in Tlhabane. Since the three bulk meters for Tlhabane were installed as part of the project, there were no comparative meter readings for the period before the project with the result that the true reduction in consumption could not be determined.

2.1.4 Lessons Learned

- The bulk meter readings and MNF's should be monitored before and after implementation of such projects in order to evaluate the savings achieved.
- In a project of this nature it is necessary to understand the breakdown of the minimum night flow to avoid overestimating the savings through reduced leakage. If in doubt, the reduction in minimum nightflow can be multiplied by a factor of 0.8 times 24-hours to provide the daily saving.
- Some consumers refused to provide information to the survey teams. This can be rectified by implementing a public awareness campaign and community involvement programme, covering the purposes and benefits of the project.

2.1.5 References

Project Report on the Tlhabane Leakage Reduction prepared by Stewart Scott, October 2000.

2.2 JOHANNESBURG CBD LEAKAGE DETECTION PROJECT

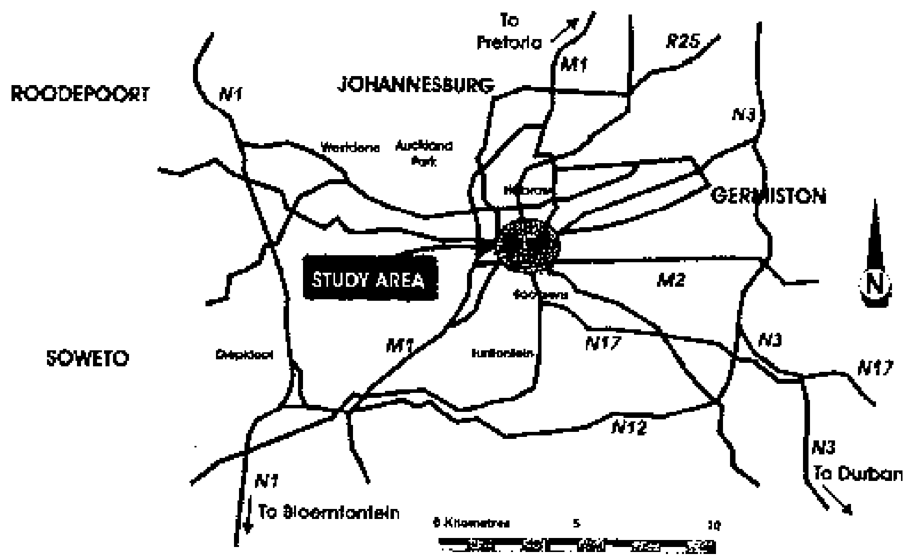

Figure 2-4 Locality Map of the Study Area

2.2.1 Project Overview

Objective	:	To undertake leak detection in a section of the Johannesburg CBD, using a variety of recognised leak detection methods, as well as developing a manual for optimal leak detection methods for use in CBD areas.
Duration	:	2 years (April 1999 – April 2001)
Total Budget	:	R 750 000 ($ 108 069)
Project Team	:	Local Authority: The Greater Johannesburg Transitional Metropolitan Council
		Project Manager and Field Work: PPT Pty (Ltd)
		Ground Radar Testing: RVM Surveys Pty (Ltd)
		Leak Detection Equipment: Radiodetection (Pty) Ltd SA

and pinpoint leaks. It is normally used for an initial sweep of the area indicating noises that have to be followed up using more accurate techniques.

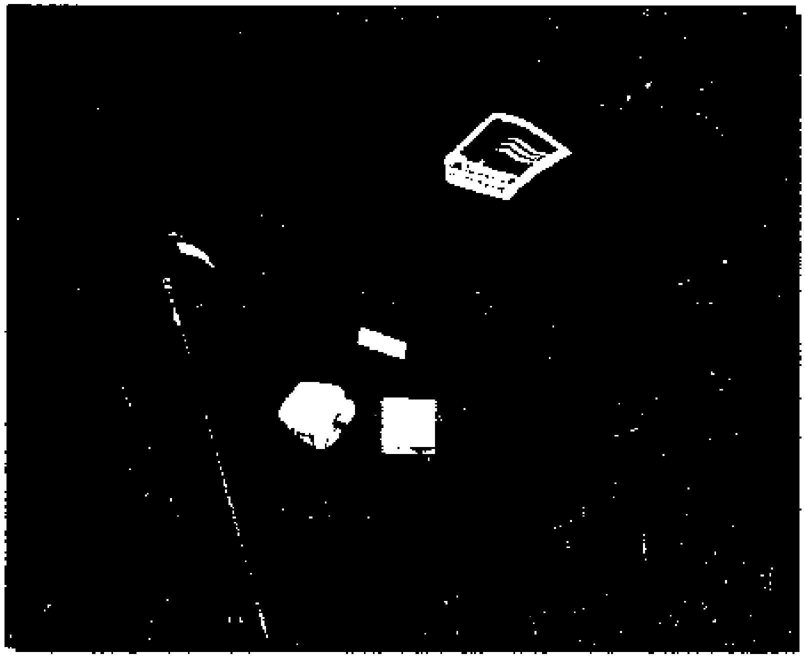

Figure 2-5 Listening Stick (Courtesy Radiodetection (Pty) Ltd SA)

A Geophone (**Figure 2-6**) is an instrument, which comprises a very sensitive microphone, an amplifier and headphones. Water leaks are detected by listening for noises made in pipelines caused by water escaping through the wall of the pipe. Usually there are two types of microphone. The first is a wand-type microphone (or listening stick) to permit contact with fittings such as valves and hydrants. The second type is a ground microphone, which is moved along the ground or road surface on top of the line of the pipe. The leak is pinpointed at the position of greatest noise intensity as detected by the ground microphone.

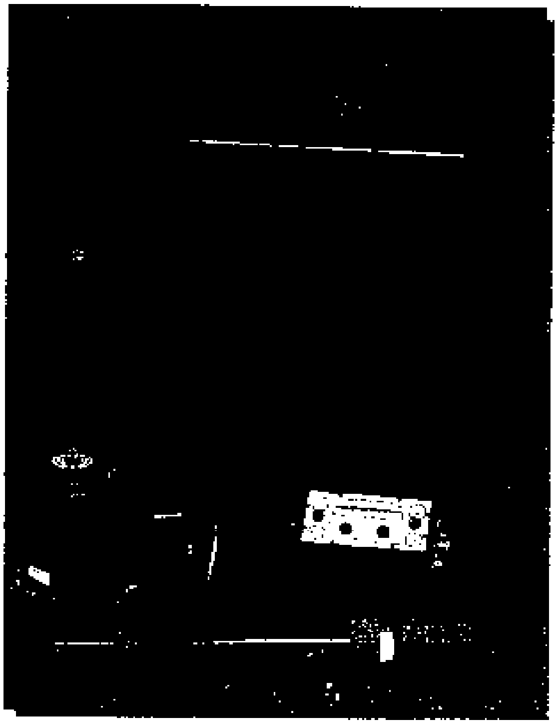

Figure 2-6 Ground Microphone (Courtesy Radiodetection (Pty) Ltd SA)

Leak Noise Correlation (LNC)

The LNC (**Figure 2-7**) is a device that can locate (pinpoint) the position of a leak by measuring, at two different locations on the pipe, the noise that arrives at these points having travelled along the pipe from the leak. Microphones or transducers are placed in contact with the pipeline (usually at fittings). During the correlation scan, the leak noise will reach the closer transducer first and the signal is progressively delayed until the more remote transducer receives a similar leak noise. The time delay, the difference between the times that the leak noise reaches the two transducers, is measured, and the accurate position of the leak can be computed. The LNC is used after the initial sweep has identified a suspected leak along a specific part of the main.

Figure 2-7 Leak Noise Correlator (Courtesy Radiodetection (Pty) Ltd SA)

Step Testing

Step testing is an indirect method of locating leaks that involves the measurement of water flow in discrete areas. The flow in each discrete section is measured and the minimum night flow analysed. If the night flow analyses indicates high leakage levels one of the other techniques can be used to pin-point specific leaks.

Modified Step Testing

The conventional Step Testing method was not suitable for the CBD area due to the difficulty in measuring minimum night flows with the presence of high-rise buildings with booster pumps. The method was, therefore, modified to overcome this problem. The modified procedure involved dividing the test area into smaller sub-areas (typically 2-3 block areas) and then isolating all consumer meters and fire services in each sub-area. This enabled the logging of minimum nigh flows with minimum interference.

Ground Penetrating Radar (GPR)

GPR (**Figure 2-8**) works by emitting a radar pulse through an antenna into the ground. This pulse is reflected back from the various interfaces in the ground. By moving an antenna slowly over the surface, a picture is built up of what is below the surface (**Figure 2-9**). The picture can be viewed on a monitor whilst scanning is in progress. The data can be recorded on tape for further analysis and record purposes. Water in the ground is particularly reflective to radar, which thus enables radar to be used to locate water in the ground. Further investigative work is required to determine whether the water is ground water or leakage from pipelines.

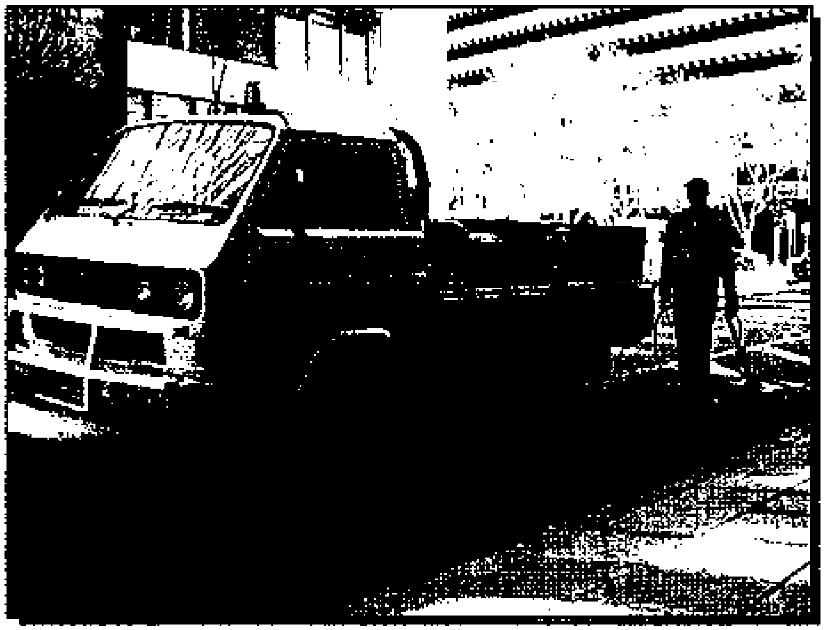

Figure 2-8 Ground Penetrating Radar (Courtesy RVM Surveys)

Below is an image of a leak discovered by acoustic methods and confirmed by GPR. The additional water in the ground is very reflective to radar and shows up as the brighter blue & purple areas, with the main at the top, apparently rising and falling due to the compressed scale of the image.

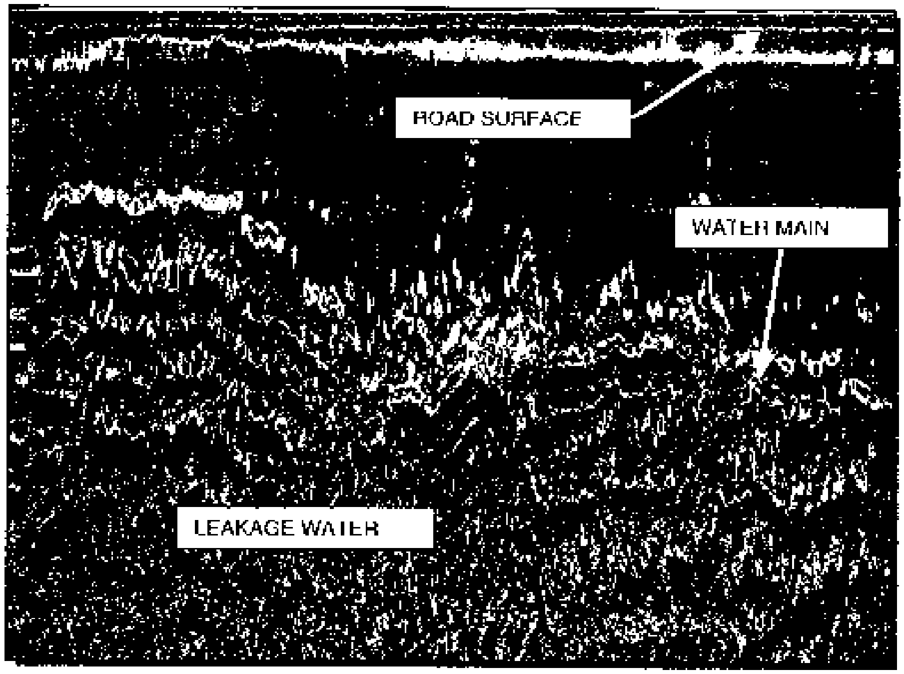

Figure 2-9 Leakage Image created with GPR (Courtesy RVM Surveys)

Aqualogs and Zonescans

In this technique programmed logger units are deployed in a designated area. The units log leak noises for a pre-determined period and are then removed and downloaded into application specific software. The Zonescan (**Figure 2-10**) or Aqualog (**Figure 2-11**) system is not used for pinpointing leaks, but rather for the localisation of leak noises. This requires follow-up with a more accurate technique like the Leak Noise Correlator.

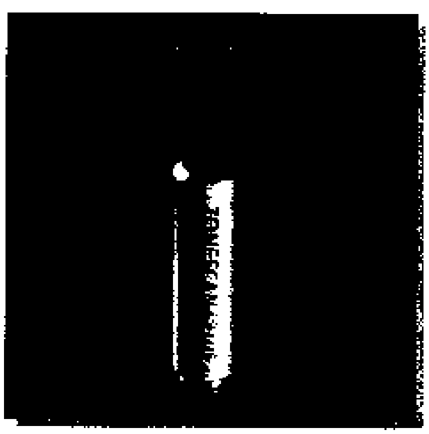

Figure 2-10 Zonescan (Courtesy Gutterman International, Switzerland)

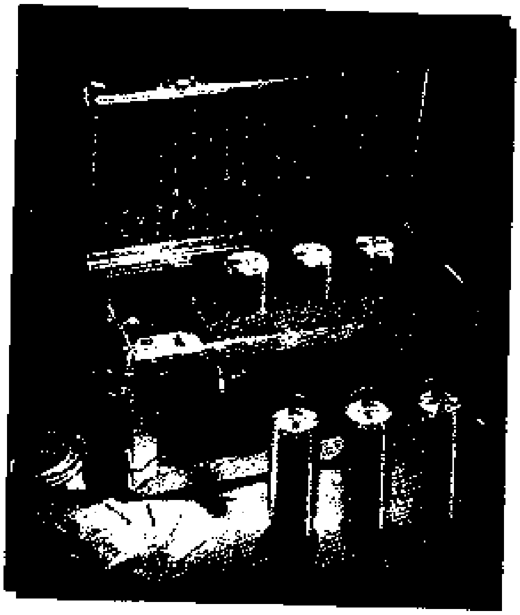

Figure 2-11 Aqualog System (Courtesy Radiodetection (Pty) Ltd SA)

2.2.4 Leak Detection Criteria

The most effective approach for leak detection is to make use of a combination of techniques. In most cases a broad sweep of the area should be undertaken to determine leak noise areas. Techniques like sounding, GPR, Step Testing, Aqualogs or Zone Scans can be used for the first sweep. The decision on which technique to use for the sweep should be based on the following:

- Financial considerations (For example, radar is generally more costly than sounding);
- Interference by overhead powerlines, transformers, traffic etc. (For example, sounding is sensitive to interference while methods like radar and step testing are not.)
- The topography of the CBD area. (For example, it can be difficult to drag radar equipment up and down extreme slopes).
- The size of the test area. (Techniques like step testing, Aqualogs or Zone Scans can be used for larger areas and sounding for smaller areas.)

Duration	:	*Stage 1* - 1999 to February 2000. Implementation of retrofit pilot project.	
		Stage 2 - October 2000. Technical assessment of project by Rand Water.	
		Stage 3 - June 2001. Aftercare project to address problems of pilot project.	
Total Budget	:	Stage1: R960 000 ($160 000)	
		Stage2: Assessment undertaken by Rand Water	
		Stage3: Approximately R60 000 ($ 7 000)	
Project Team	:	Local Authority:	Boksburg Transitional Local Council
		Construction Managers:	Tokiso Projects
		Consulting Engineer:	Mr. PRC van der Merwe
		Contractors:	S.P. Monaheng
			Matjila Home Builders CC
			Kwa Jele Construction CC
			Sebati & Kholopane Contractors
			Khulane Projects
		Aftercare Co-ordinator:	Ayanda Consulting

3.1.2 Background

The Boksburg Local Council approached Rand Water and the Department of Water Affairs and Forestry in connection with penalties imposed on them for exceeding their water allocations in 1998. Following discussions between Rand Water and the Boksburg Local council it was decided to include Boksburg in the pilot water conservation initiatives supported by Rand Water (see Locality Map, **Figure 3-1**). In this regard, Mr. P van der Merwe and Tokiso Projects were appointed as Consulting Engineers and Construction Managers respectively for the Boksburg Schools Water Conservation Project (*Stage 1*). The project identified and addressed 48 of the 56 schools in the Boksburg area and was completed in February 2000.

After receiving numerous complaints on poor workmanship, Rand Water undertook a technical assessment (*Stage 2*) of all the repairs in October 2000. The assessment revealed that various repairs and new installations in some of the schools were in a poor condition. While in some cases the problems were attributed to deliberate vandalism or theft, in others they were due to poor workmanship.

Rand Water identified fifteen schools requiring remedial action. In June 2001, Ayanda Consulting was appointed for an aftercare initiative (*Stage 3*) to correct the problems identified by Rand Water during Stage 2 of the project.

3.1.3 Methodology

The project was undertaken in three stages, each of which is discussed in further detail below:

Retrofit Project (Stage 1)

Pre-implementation Assessment

From the 48 schools identified and assessed for water saving measures the following problems were identified:

- At 12 schools the consumer meter was found to be either inoperative or faulty. Such problems were reported to the Local Council;
- Automatic urinals were identified as the main source of water wastage;
- Leaking taps and taps left partly open, were identified at many schools;
- Several leaking pipes were identified.

Project Implementation

Based on the problems identified, the following intervention measures were undertaken:

- Automatic urinals were replaced with manually operated push button systems;
- Dual flush mechanisms were retrofitted to all toilet cisterns;
- All taps were replaced with push button (demand) taps;
- Water efficient showerheads were fitted.

Documentation on the number and type of repairs undertaken at each school was not available.

The project was undertaken using local labour wherever possible to create employment opportunities within the local community and to inject funds into the area.

Technical Assessment (Stage 2)

In the aftercare assessment by Rand Water the problems regarding the retrofit project and vandalism were identified (**Figure 3-2**). Fifteen schools were identified as requiring some form of remedial action.

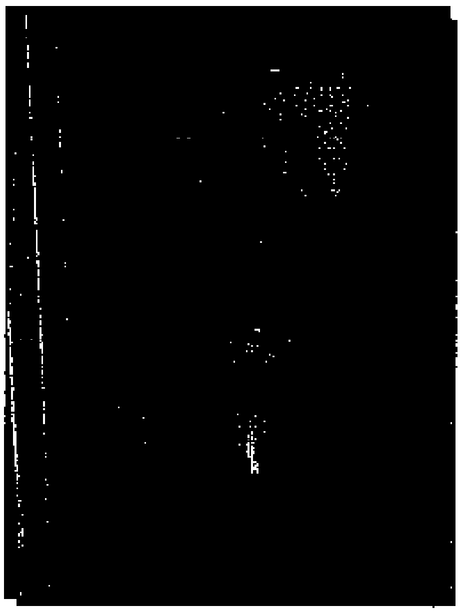

Figure 3-2 Vandalised Toilet Pan (Photo courtesy Ayanda Consulting)

Aftercare Initiative (Stage 3)

The aftercare initiative focussed mainly on the following repair work at the 15 selected schools:

- Correction of all problems regarding poor or incorrect installation of plumbing fittings by the original contractors (**Figures 3-3** and **3-4**);
- Fixing water leaks;
- Providing on site training to the users of the water saving devices.

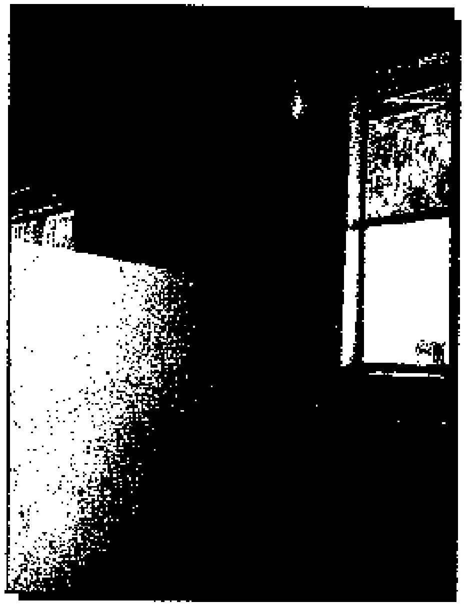

Figure 3-3 Broken urinal push button (Courtesy Ayanda Consulting)

Figure 3-4 Installation of a new push button urinal (Courtesy Ayanda Consulting)

3.1.4 Results

The following results were obtained by evaluating the average monthly meter readings before and after implementation of the project:

- The total saving for 28 of the schools was 7737 kl/month. Meter readings before and after the project were available for 28 out of the 48 schools. (see **Table 3-1**). Only 46 of the 48 schools are listed.

- For a number of schools the meters were either vandalised or missing with the result that no meter readings at these schools were available.

The results indicated that the retrofit project reduced the water consumption at a number of schools. Unfortunately, the data were limited to 28 out of 48 schools and, therefore, it is difficult to realistically evaluate the total savings for the complete project.

Meters readings in the period following the aftercare work were obtained but were not included in the table, as the data appeared to be suspect (i.e. significant deviations in monthly readings).

Table 3-1 Meter readings for schools in Boksburg

No	School	Average meter readings from Council (kl/month)		Saving (%)
		Before Period	After Period	
1	Dithomo Primary	300	128	57%
2	Masithwalisane	1084	165	85%
3	Erasmus Monareng	192	117	39%
4	Ndlelende	261	104	60%
5	Zimele	448	165	63%
6	Fortune Kunene	200	407	-104%
7	Ilinge High	450	218	52%
8	Khayelihle	799	739	8%
9	Vosloorus Com.	780	1377	-77%
10	Thabang	119	93	22%
11	Abinal	1192	311	74%
12	Mthimkulu	200	284	-42%
13	Reigerpark Primary	175	89	49%
14	Wit Deep Primary	400	183	54%
15	Freeway Park	622	281	55%
16	Baanbreker	918	200	78%
17	Oosterlig	1746	548	69%
18	Jongimfundu	-	-	
19	Mampudi Primary	56	43	23%
20	Thulasizwe Primary	-	-	

No	School	Average meter readings from Council (kl/month)		Saving (%)
		Before Period	After Period	
21	Villaliza Primary	-	-	
22	Parkdene	2559	1142	55%
23	Khutlonanong Primary	-	-	
24	Polokong Primary	-	-	
25	Tembakhazi Primary	-	-	
26	Rebontsheng Primary	889	461	48%
27	P.T. Xulu Secondary	-	-	
28	Hennie BassonPrimary	194	216	-11%
29	J.M. Louw Primary	-	-	
30	Voortrekker High	425	156	63%
31	Boksburg High	1070	680	36%
32	Parkrand Primary	-	-	
33	Van Dyk Primary	94	71	24%
34	Summerfield	482	169	65%
35	Lakeside Primary	-	-	
36	Westwood	890	686	23%
37	Nageng Primary	-	-	
38	Bopang-Kgotso Primary	-	-	
39	Witfield	-	-	
40	E.G. Jansen Secondary	-		
41	Sunward Park	795	600	25%
42	Thuto Lesedi Secondary	-	-	
43	Martin Primary	297	267	10%
44	Drommedaris Primary	-	-	
45	East Rand Secondary	-	-	
46	Reigerpark Secondary	-	-	
	TOTAL	**17637**	**9900**	**44%**
	SAVING		**7737**	

Note: Information obtained from the report by Mr P van der Merwe.

3.1.5 Lessons Learned

- The students and staff of the schools should be involved with the planning and implementation of the project to ensure their full commitment. It is the school's responsibility to prevent vandalism.

- It is essential that each school be metered before the implementation of a retrofit project. Without proper flow data before and after implementation of the project, it is impossible to realistically evaluate the success and sustainability of the project.

- An independent inspector with the necessary plumbing expertise should be used to inspect all work completed in each school.

- In future with projects of this nature additional resources should be allocated to the social development aspects of the project. This will help to ensure the sustainability of the projects in achieving both sustainable reduction in water losses through leaks and more efficient water usage in the schools.

- The factotums play a vital role in most schools in the day to day running and maintenance of the facilities. It is essential that these individuals are involved with the repair process.

- Tender assistance to emerging contractors is difficult to provide while maintaining impartiality. A possible solution to this problem is the implementation of a dedicated Tender Support Office organised by the funding body in association with the Local Community.

3.1.6 References

1. Project Closure Report on the Boksburg Schools Water Conservation Project prepared by Tokiso Projects, July 2000.
2. Technical assessment of the Boksburg Schools Water Conservation Project prepared by Rand Water, 2000.
3. Project Completion Report on the Boksburg Schools Aftercare Project by Ayanda Consulting, October 2001.

3.2 KAGISO SCHOOLS RETROFIT PROJECT

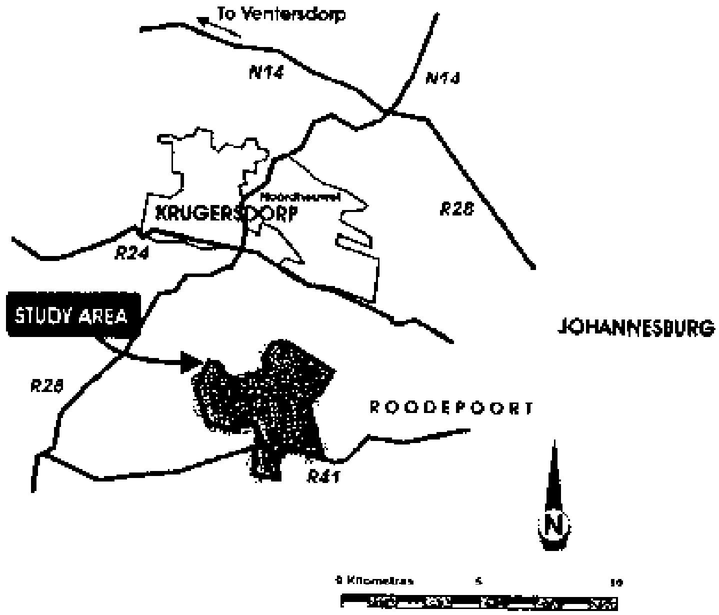

Figure 3-5 Locality Map of study Area

3.2.1 Project Overview

Objective	:	To reduce leakage through retrofitting ablution facilities at 27 schools in the Kagiso area.	
Duration	:	6 months (November 2000 – April 2001)	
Total Budget	:	R 625 000 ($ 90 000)	
Project Team	:	Local Authority:	Krugersdorp Local Council
		Project Steering Committee:	Community representatives
		Project Co-ordinator:	Ayanda Consulting
		Project Staff:	Community members (22 Kagiso Residents)

3.2.2 Background

During the course of the Kagiso Retrofit Project, the staff working in the vicinity of the schools became aware of plumbing related problems in the schools, although such problems were outside the scope of work for that project. Rand Water, therefore, motivated, for the assessment and retrofits of 27 schools in Kagiso, Munsieville and Azaadville (see Locality Map: **Figure 3-5**). The number of schools per region was as follows:

Kagiso (including Swanieville/Lusaka)	:	22 Schools
Munsieville	:	3 Schools
Azaadville	:	2 Schools

3.2.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-implementation Assessment

The leakage assessment revealed that many of the cisterns and taps had been subjected to prolonged use and vandalism. A list was compiled of all the toilets, urinals and taps in need of repair. Most of the problems encountered in the schools related to the following issues:

- Blockages in the toilets due to toilet paper not being used in the toilets and disposal of rubbish and sanitary towels in the toilets by the students.
- Lack of security gates on some of the ablution facilities in the schools resulting in theft and vandalism outside normal school hours.
- Lack of involvement of the school facility caretakers (factotums)
- Poor education regarding the efficient use of water in the schools.

Project Implementation

Technical

The activities of the project concentrated on repairing leaks and reducing inefficient use of water. Details are provided below.

Toilet Pans

Due to the limited number of toilets available in many of the schools, the broken pans were replaced. Cracked pans were also removed and replaced to avoid the risk of injury to the user should the pan break.

Toilet Cisterns

All high level cisterns (generally 13 litre) were removed and replaced with 9/4.5 litre dual flush cisterns (see **Figure 3-6**)

Figure 3-6 Dual flush toilet (Courtesy Ayanda Consulting)

Urinals

Tip tray flush mechanisms on urinals are widely recognised as the major source of water wastage in schools. The tip trays were replaced with push button flush mechanisms (see **Figure 3-7**), which will only flush when activated by a user.

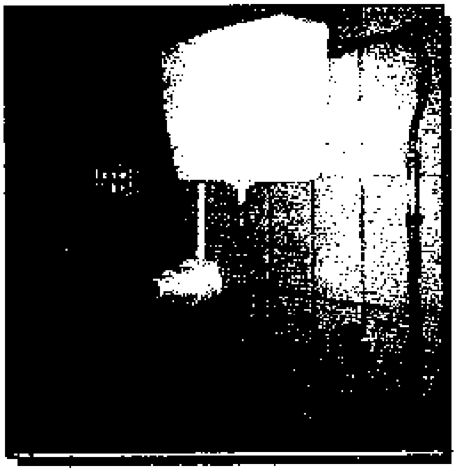

Figure 3-7 Urinal push button (Courtesy Ayanda Consulting)

Taps

Existing push button taps were serviced where necessary, while push button taps of non SABS quality were replaced. Normal basin and standpipe taps used by the students were replaced with approved push button taps (**Figure 3-8**). These taps are often referred to as 'demand taps' and are well suited to use in schools since the tap closes as soon as the pupil releases the button. In this way the taps cannot be left open. There are, however, limitations relating to the use of demand taps with regards to pressure. The taps are not designed to operate at pressures over 3 kPa and in cases where pressures above 3 kPa were found pressure reducing valves were installed on the supply pipe to overcome this problem.

Figure 3-8 School pupil using a push button tap (Courtesy Ayanda Consulting)

New washers were installed in all taps not requiring replacement. Taps leaking at the head were serviced through replacement or tightening of the graphite seal or replacement of the tap head assembly.

Pipework

Repairs to underground piping were undertaken where leaks were found (**Figure 3-9**) Copper pipe was used for all repairs in the ablution facilities due to its resistance to corrosion.

Figure 3-9 Repairs to underground pipework (Courtesy Ayanda Consulting)

The following list summarises the key repairs undertaken as part of the project:

- Approximately 500 taps were replaced.
- 486 dual flush toilet cisterns were installed.
- 50 tip tray flush mechanisms on urinals were replaced with push button flush mechanisms.

Social

- Caretakers were trained in basic repairs and better water usage practice in their schools during the course of the project.

- The communications programme for schools that began during the Kagiso Water Retrofit Project was intensified during the course of the project. The objective of the program was to educate both learners and educators on the importance of saving water and water conservation. The program was implemented by Communication Liaison Officers employed by the project. The Department of Health assisted the Projects Communication Liaison Officers in carrying out workshops in the schools. The Health Communication Liaison Officers focused on Hygiene and Sanitation.

3.2.4 Results

The following results were obtained from evaluating the average monthly meter readings before and after implementation of the project:

- The average saving at 15 out of 27 schools was found to be in excess of 30 % per month. The "before" period was considered to be April 2000 to December 2000 and the "after" period as January 2001 to June 2001. **(Table 3-2)**.

- Unfortunately, the meter readings at 12 of the schools were either not available or found to be unreliable (i.e. significant deviations in monthly readings).

The results indicate that the retrofit project has reduced the water consumption at a number of schools. Unfortunately, the data was limited to 15 out of 27 schools and, therefore, it is difficult to evaluate the total savings for the complete project.

Table 3-2 Consumption for Kagiso Schools

No	School	Average Consumption		Savings (%)
		Apr 00 - Dec 00 (kl/month)	Jan 01 - Jun 01 (kl/month)	
1	Ahmed Timol	205	198	3.41
2	Atlohong			
3	Azaadville Muslim			
4	Boipelo	442	394	10.86
5	Bosele(Tulhuzekani)	260	173	33.29
6	Diphalane	426	282	33.98
7	Dr Yusaf Dadoo	454	277	39.07
8	Enthukuweni			
9	John Martin Catholic			
10	Kagiso			
11	Kaselihle	188	183	3.1
12	Khululekani			
13	Lengau			
14	Madiba	1156	647	44.03
15	Mandisa Shiceka			
16	Matlhasedi	300	146	51.32
17	Mosupatsela	1623	977	39.78
18	Phatudi	1489	1341	9.91
19	S. G. Mafaosa			
20	Sandile	368	196	46.67
21	Setlolamalhe	385	185	51.79
22	Thembile	271	305	-12.67
23	Thusong	771	330	57.14
24	Thutolefa	627	339	46.01
25	Tsakani			
26	Tsholetsega			
27	W. D. Oliphant			
	TOTAL/ AVERAGE SAVING	**8966**	**5972** **3000**	**30.51**

Note: Information supplied courtesy Ayanda Consulting and the Krugersdorp Local Authority.

3.2.5 Lessons Learned

- Regular up-to-date meter readings for each school are required to evaluate the sustainability of the complete project.
- The school facility caretakers (factotums) play a major role in most schools in the day-to-day running and maintenance of the facilities. It is vital that these individuals are involved with the repair process.
- Prior to any school intervention, the basic water meter should be checked for accuracy and replaced if necessary. There is little benefit in implementing remedial measures that cannot be quantified.

3.2.6 References

Project Report on the Kagiso School Retrofit Project prepared by Ayanda Consulting, February 2001.

Table 3-2 Consumption for Kagiso Schools

No	School	Average Consumption		Savings (%)
		Apr 00 - Dec 00 (kl/month)	Jan 01 - Jun 01 (kl/month)	
1	Ahmed Timol	205	198	3.41
2	Allohong			
3	Azaadville Muslim			
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5	Bosele(Tuthuzekani)	260	173	33.29
6	Diphalane	428	282	33.98
7	Dr Yusaf Dadoo	454	277	39.07
8	Enthukuweni			
9	John Martin Catholic			
10	Kagiso			
11	Kaselihle	188	183	3.1
12	Khululekani			
13	Lengau			
14	Madiba	1156	647	44.03
15	Mandisa Shiceka			
16	Matlhasedi	300	146	51.32
17	Mosupatsela	1623	977	39.78
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Note: Information supplied courtesy Ayanda Consulting and the Krugersdorp Local Authority.

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- Regular up-to-date meter readings for each school are required to evaluate the sustainability of the complete project.
- The school facility caretakers (factotums) play a major role in most schools in the day-to-day running and maintenance of the facilities. It is vital that these individuals are involved with the repair process.
- Prior to any school intervention, the basic water meter should be checked for accuracy and replaced if necessary. There is little benefit in implementing remedial measures that cannot be quantified.

3.2.6 References

Project Report on the Kagiso School Retrofit Project prepared by Ayanda Consulting, February 2001.

3.3 ALL-AFRICA GAMES VILLAGE - WATER EFFICIENCY PROJECT

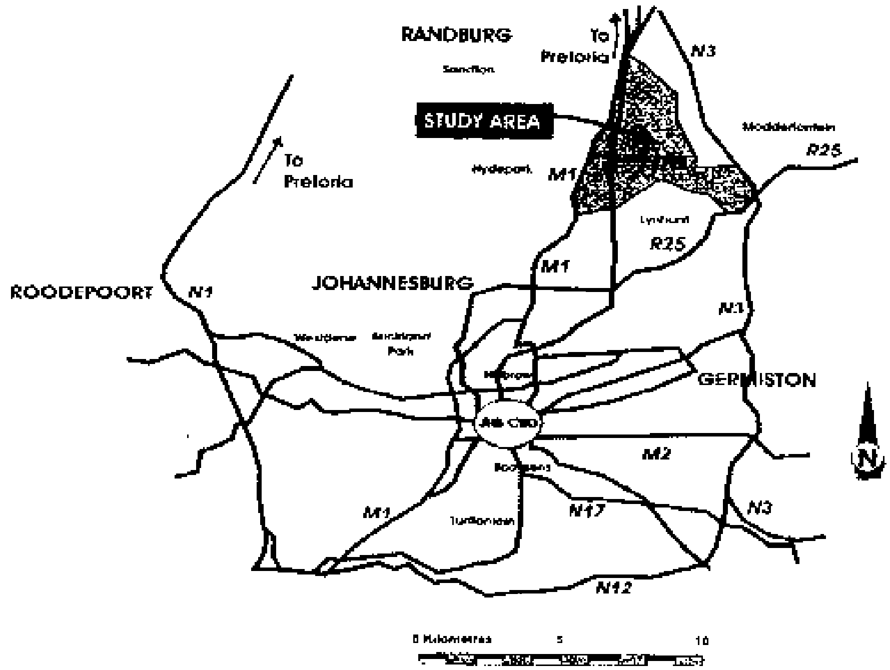


Figure 3-10 Locality Map of study Area

3.3.1 Project Overview

Objective	:	To implement water efficiency concepts to approximately 1 800 new housing units in the All-Africa Games Village in the East of Alexandra.	
Duration	:	12 months (September 1998 – September 1999)	
Total Budget	:	R 570 000 ($ 90 000)	
Project Team	:	Local Authority:	Eastern Metropolitan Local Council
		Water Efficiency Project Manager:	Willie le Roux & Associates
		New Homes Project Manager:	EVN Consulting Engineers
		Contractor	G5 Housing
		Housing Company	Semag

3.3.2 Background

The All-Africa Games Village in Alexandra (see Locality Map, **Figure 3-10**) was developed to accommodate athletes for the All-Africa Games held in South Africa in September 1999 before being handed over to the Gauteng Housing Department for normal housing allocation.

During the initial stages of the housing project, Rand Water approached the developers with a proposal to take part in the project by providing funding for the inclusion of certain water efficient devices in all housing units.

As a result, the New Homes Water Efficiency Project in the All-Africa Games Village was implemented by Rand Water to investigate the effectiveness of implementing water efficient concepts during the development of a new township. In this regard, Willie le Roux & Associates was appointed as project manager.

3.3.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-Implementation Assessment

At the start of Rand Water's involvement to the project, the proposed household plans were evaluated to determine the potential of installing water efficient devices. This was undertaken in conjunction with Eskom who was implementing a similar project to install energy efficient devices in the All-Africa Games Village. The following concepts were considered:

- Hot Water Geysers;
- Pressure Controller;
- Low Volume Showers;
- Dual Flush Toilets;
- Energy Efficient Lighting;
- Thermal Efficiency Design.

A short description of each concept is provided below. Additional information can be obtained in the report by Willie le Roux & Associates.

Hot Water Geysers

It was originally proposed to install flow-through water heaters. Eskom produced evidence that flow-through water heaters, although energy efficient in themselves, contradicted Eskom's overall concept of peak supply demand management because the heaters are used mainly in the already stressed periods of peak power demand.

It was argued that for this type of housing, a standard geyser unit (**Figure 3-11**) at similar capital cost would be more beneficial to the user and to Eskom. The benefits to the user include sustained hot water in the event of a power failure and the potential of adding additional hot water points at a later stage.

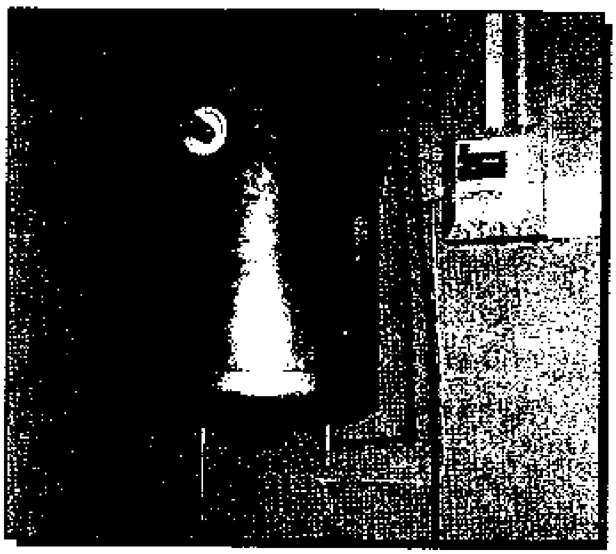


Figure 3-11 Hot water geyser (Courtesy W le Roux & Assoc.)

Pressure Controller

Pressure controllers (**Figure 3-12**) were installed to reduce the pressure below the pressure rating of the geyser. The reduction in pressure has the added advantage that potential leakage can be reduced if the pressure in the water system is reduced. More information on this can be obtained in the *Stovoville Pressure Management Case Study*, see **Section 4-1**.

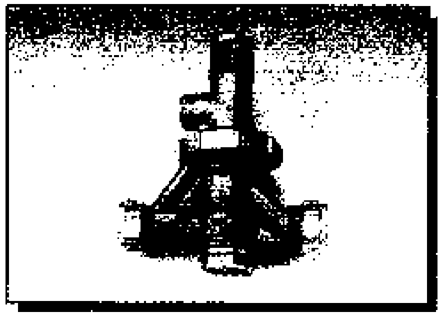


Figure 3-12 Pressure Controller (Courtesy W le Roux & Assoc.)

Low Volume Showers and taps

Low volume shower-heads and taps (**Figure 3-13**) were proposed to improve water use efficiency through such features as improved spray patterns, better mixing of air with water, and narrower spray areas to give the user the "feel" of water without high-volume flows.

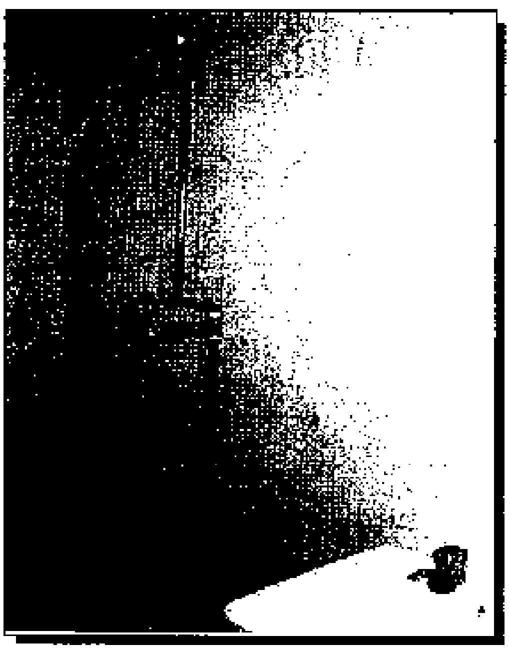


Figure 3-13 Low volume showerhead and taps (Courtesy W le Roux & Assoc.)

Dual Flush Toilets

Dual flush toilet mechanisms (9 and 3,5 litre) were proposed instead of conventional single flush mechanisms (**Figure 3-14**). These units can potentially save significant amounts of water, if correctly installed and used. More information on this can be obtained in the Odi Retrofit Project, see **Section 3-6**.

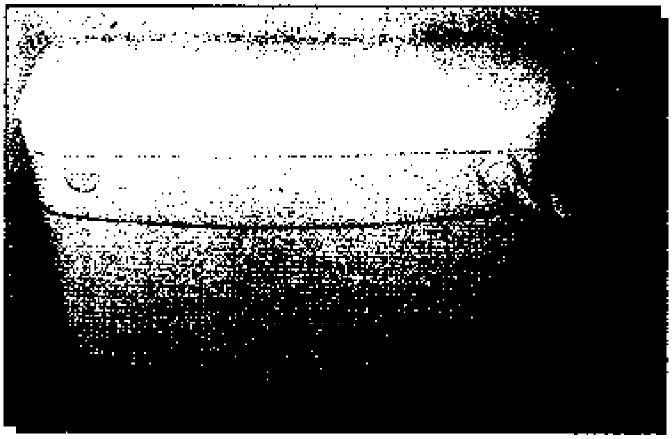


Figure 3-14 Dual flush toilet cistern (Courtesy W le Roux & Assoc.)

Energy Efficient Lighting

Energy efficient lights (**Figure 3-15**) were proposed for all the units. These lights use only 20 % of the electricity required by standard incandescent lamps, widely used in South Africa, and can last up to ten times longer.

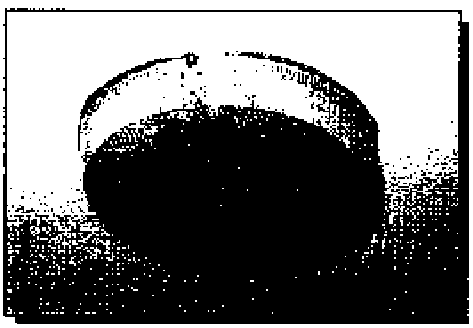


Figure 3-15 Energy Efficient Light (Courtesy W le Roux & Assoc.)

Thermal Efficiency Design

The houses were designed to optimise the use of sunlight (**Figure 3-16**). The biggest facades and windows faced North, aiming to ensure the houses remain cool in summer while retaining heat in winter. This reduces the internal heating requirements of the house which can account for approximately a third of the household's electricity costs in winter.

Figure 3-16 The houses were designed to optimise the use of sunlight. (Courtesy W le Roux & Assoc.)

Project Implementation

The concepts discussed in the previous section were implemented at all of the 1 799 new housing units. Rand Water and Eskom funded the difference in implementation costs between the original design and the water and electricity efficiency design. The additional cost to implement water efficient devices amounted to R 316/house ($45).

3.3.4 Social

The Project Team created a training manual to cover all the aspects of the water and electricity efficient devices installed in the houses. This material was used to train the Community Liaison Officers (CLOs) who in turn presented the material at various workshops held for the community. The communication team also distributed water supply and water saving information pamphlets to homeowners during the course of the project.

As part of the training on the project, the new house owners were introduced to the principles of Water Wise Gardening. The following guidelines were provided for the design and maintenance of such a garden:

- *Design*: A Water Wise design maximises the use of water in a landscape. It takes into consideration the microclimates, functional utilization, and aesthetics.

- *Soil improvement*: Healthy soil is fertile with plant nutrients, holds enough water and air for the plant, and does not compact easily. Poorly drained soils will hold too much water, drowning the plant.

- *Mulching*: Mulch is a layer of material covering the soil surface, preventing wasteful evaporation of water. Grass clippings, bark or plants can be used.

- *Watering*: Always apply water efficiently. Re-use bath water for watering plants and collect rainwater and channel it into the garden.

Rand Water in conjunction with Eskom also decided to make use of a transportable showhouse (**Figure 3-17**) to illustrate to new homeowners the use of the various water and electricity efficient devices. Since completion of the project, the showhouse has also been widely used in other areas.

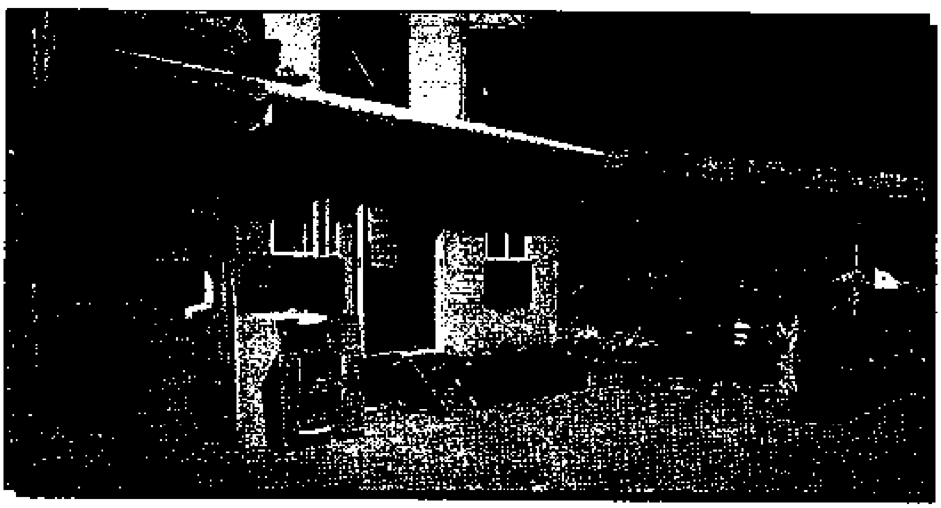


Figure 3-17 Showhouse with water-wise gardening (Courtesy W le Roux & Assoc.)

3.3.5 Results

The following results were obtained from evaluating the bulk and household meter readings in the first year after occupation:

- The individual household consumption increased from 350 litre/house/day in April 2000 to 645 litre/house/day in September 2000 (see **Figure 3-18**).

- The water consumption per household appears to be consistent between the individual and the bulk zone meters suggesting that the figures are realistic. It is clear that the monthly water consumption is not as low as originally anticipated. The monthly consumption increased each time the meters were read and it is not possible to say whether or not the water usage will continue to increase. Additional monitoring is, therefore, required to monitor the water usage.

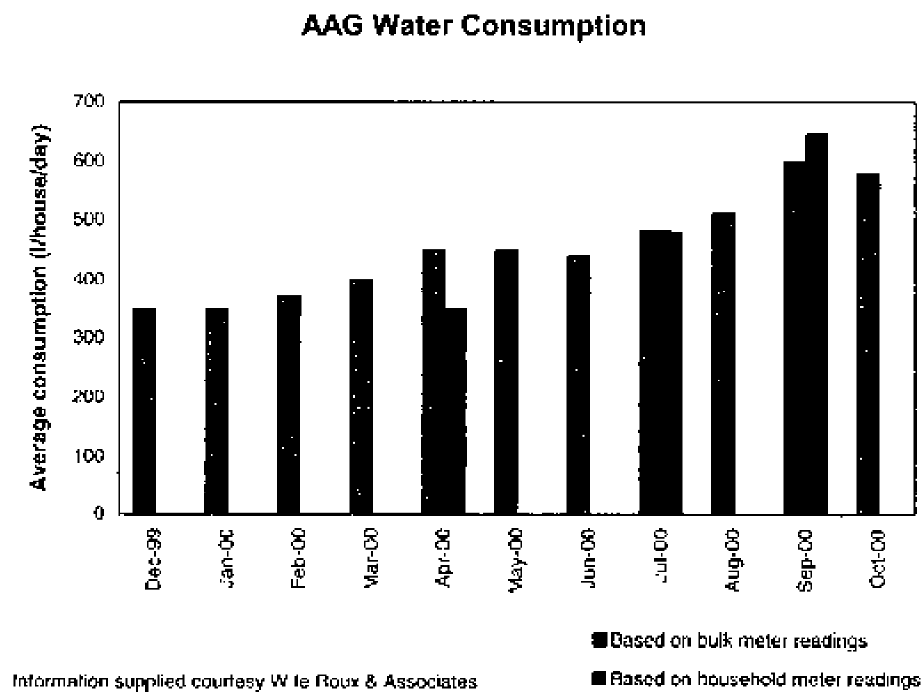


Figure 3-18 Monthly water consumption in the All-Africa Games Village

The increase in monthly consumption over the first year may be due to the consumers creating gardens and purchasing new household devices such as washing machines etc. It is also possible that the consumers may not be utilising the dual flush cisterns correctly resulting in higher than expected toilet water use.

According to a brochure on water-wise practices, a "water-wise family" should use approximately 370 litre/day while a "water-wasting family" uses approximately 780 litre/day. The household consumption measured on the project (645 litre/house/day) falls between these two limits.

Since it is evident that the water demand in the All-Africa Games Village has not yet stabilised, it is not possible to draw any firm conclusions regarding the impacts of the water efficient devices. Further investigation is required to establish the stabilised unit water use and the performance of the water saving devices.

3.3.6 Lessons Learned

- It is clear that the monthly water consumption in the All-Africa Games Village is not as low as originally anticipated. The results demonstrate the importance of carrying out pilot projects to establish unit water use rather than extrapolating figures from other areas.
- The long-term sustainability of the project can only be secured if the local community support the project. This can be enhanced through ongoing workshops on the use of water efficient devices and water-wise gardens.
- Standard information leaflets, as provided by the supplier of water efficient devices and water-wise gardening, should be made available to all homeowners. The operation of water efficient devices and preparation of water-wise gardens should be carefully explained to the customers.

3.3.7 References

1. Project Report on the All-Africa Games Village Water Efficiency Project prepared by Willie le Roux & Associates, 2000.
2. Brochure by Department of Water Affairs and Forestry on good water practices, 2000.

3.4 JOHANNESBURG INNER CITY RETROFIT PROJECT

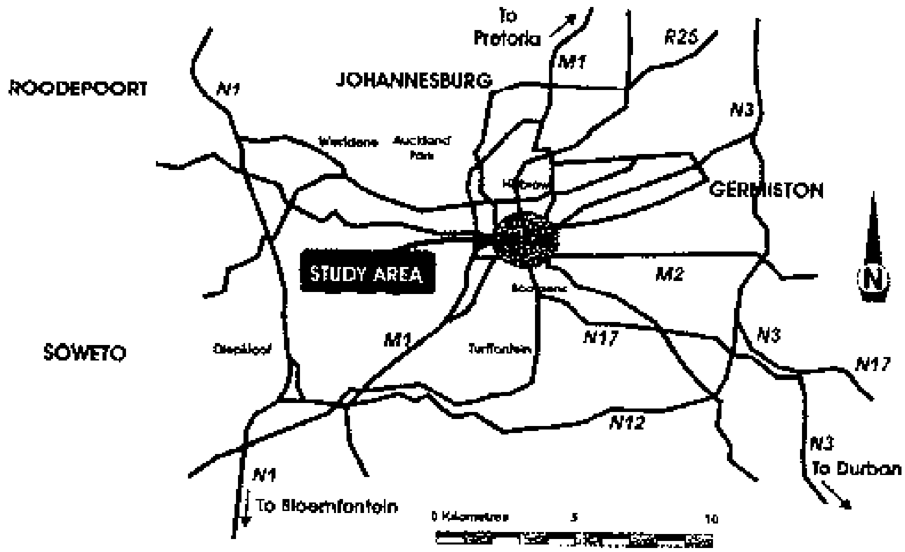


Figure 3-19 Locality Map of the Study Area

3.4.1 Project Overview

Objective	:	To reduce and manage water losses of 13 buildings in the Johannesburg inner city, through the upgrading of plumbing of 946 residential units.	
Duration	:	Approximately 3 years (March 1997 – September 1999)	
Total Budget	:	R1.32 million ($ 240 000)	
Project Team	:	Local Authority:	Greater Johannesburg Transitional Metropolitan Council
		Project Manager:	Willie Le Roux & Associates
		Housing Companies:	Connaught Properties
			7 Buildings Company Limited
			Johannesburg Housing Company
		Contractors:	Uptown Projects
			Utility Consulting Services
			Brencon Plumbing

3.4.2 Background

As part of their Water Demand Management (WDM) strategy, Rand Water initiated numerous water retrofit projects through its Community Support Service. The focus of such projects was to address the problem of water wastage in the Rand Water area of supply.

In 1996 the former Greater Johannesburg Transitional Metropolitan Council (GJTMC) proposed a residential renewal pilot project in the Western Joubert Park Precinct (see Locality Map, **Figure 3-19**). They envisaged the project to include renewal of plumbing and electrical fittings as well as aesthetic alterations. Rand Water agreed to support the project and a total budget of R2 300 000 was allocated for plumbing upgrading.

The project was advertised by Rand Water in local newspapers and building managers wishing to participate were invited to contact Rand Water. Project Application Guidelines were made available and applicants were asked to provide estimates of the financial viability of the renewal project. The proposed renewal of all water systems had to comply with minimum standards as agreed with the retrofit project manager.

3.4.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-Implementation Assessment

Each of the building owners applying for the grant was visited. The general condition of the building and the plumbing was assessed, during the visit, in order to establish the scope of work to be undertaken during the implementation phase of the project.

Project Implementation

The refurbishment work concentrated on the following key repairs:

- All flush-valve toilet systems were replaced with low volume toilet cisterns approved by Rand Water (see **Figures 3-20 and 3-21**)
- Individual meters were installed to all residents (See **Figure 3-22**)
- All leaking taps were repaired or replaced;

- Most of the distribution pipework in the buildings was replaced;
- The internal plumbing in each flat was refurbished (see **Figure 3-23**).

In total, 13 buildings and 946 flats were refurbished.

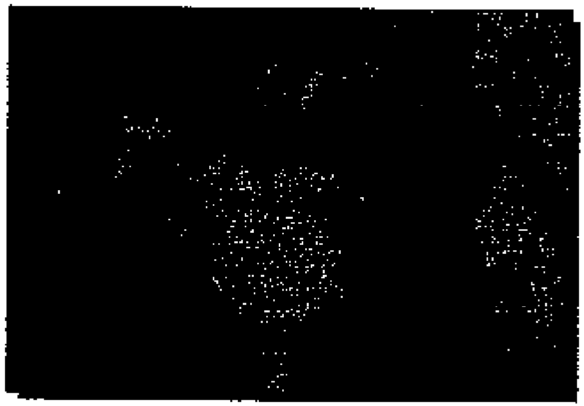


Figure 3-20 Old flush-valve toilet system (Courtesy W le Roux & Assoc.)

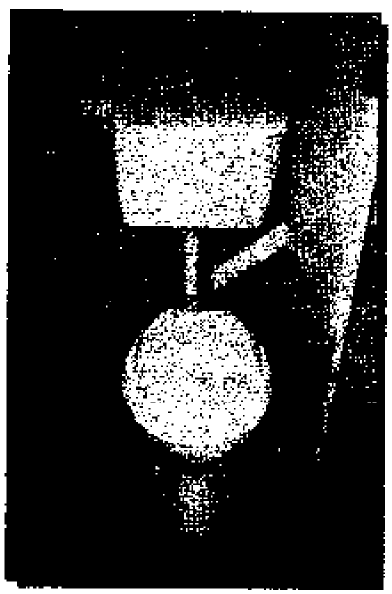


Figure 3-21 New low volume toilet cistern (Courtesy W le Roux & Assoc.)

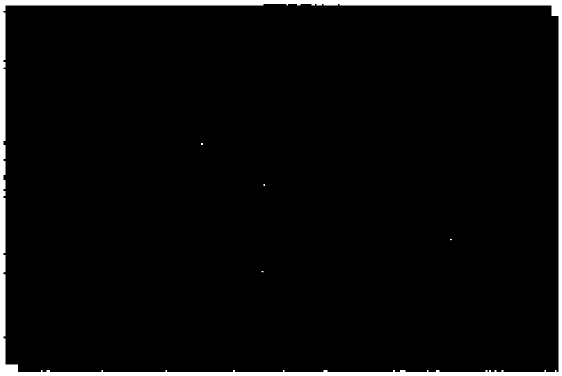


Figure 3-22 Individual water meters for each flat (Courtesy W le Roux & Assoc.)

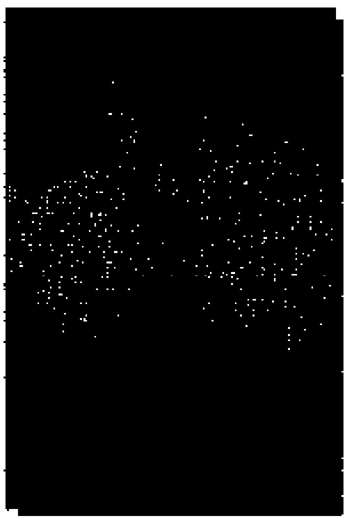


Figure 3-23 Refurbished internal plumbing in each flat (Courtesy W le Roux & Assoc.)

Education and training formed a key component of the project to facilitate and encourage payment for services and ownership of the project

3.4.4 Results

The following results were obtained from evaluating the meter readings before and after implementation of the retrofit project:

- The average calculated saving per flat = 170 l/day (19 %). (**Figure 3-24**)
- In some of the buildings with high leakage problems, the saving was as high as 50 % to 56 %.

The results indicate that the retrofit project reduced the water consumption at most of the participating buildings from an average of 920 litres/flat/day to 750 litres/flat/day. This compares well to the normal expected household water consumption of 780 litres/property/day.

It should be noted that the impact of the individual metering appears to be reducing with time since the unit consumption per flat is rising. This was confirmed through the comparison of the first month's water consumption figures after upgrade to that recorded 12 to 14 months later. The reason for this might be that the flat owners do not take responsibility for fixing leaks on a continuous basis because they do not have either the skills or the equipment. It may also be due to either high levels of non-payment for water or low cost of water. In both cases there is relatively little incentive for the owner to address household leaks.

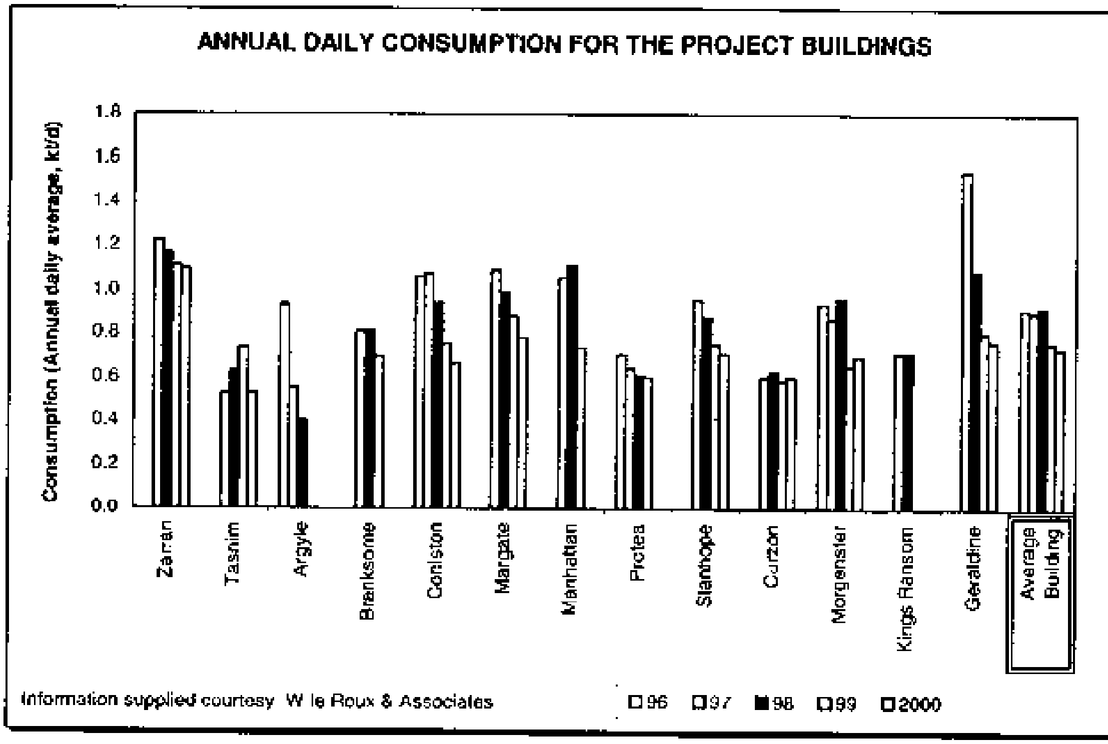


Figure 3-24 Historical water consumption figures for project buildings

3.4.5 Lessons Learned

- The renovation of water and other services can be costly. A more cost effective procedure would be to inspect and maintain services on a regular basis. This can be coordinated by the building managers and the service providers.

- The average consumption figure of water per flat was found to be 750 l/d. This can be used as a demand management figure for supply to older buildings. If the consumption at any given time exceeds this target volume, the matter should be investigated. This monitoring should form part of preventative building maintenance.
- Regular water awareness information forums should be held. These could be presented at the regular precinct meetings, as well as to building managers and superintendents.
- The follow up inspections have proved very valuable in identifying whether or not the initial savings are sustainable. Such follow up should form part of any similar project in future.

3.4.6 References

Project Report on the Johannesburg Inner City Retrofit Project prepared by Willie le Roux & Associates, December 2000.

3.5 KAGISO SIYONG AMANAZI RETROFIT PROJECT

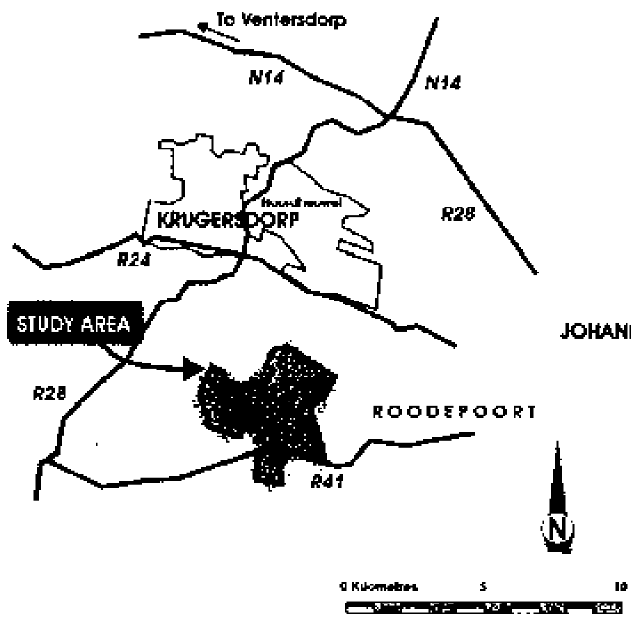


Figure 3-25 Locality Map of Study Area

3.5.1 Project Overview

Objective	:	To reduce leakage levels in the oldest areas of Kagiso, through retrofitting of approximately 6 000 households in Zone 1 and 2.	
Duration	:	16 months (October 1997 to February 1999 and November 1999 to June 2000)	
Total Budget	:	R1.5 million ($ 250 000)	
Project Team	:	Local Authority	Krugersdorp Local Council
		Project Co-ordinator:	Ayanda Consulting
		Project Steering Committee:	Community representatives
		Project Staff:	Community members (28 Kagiso Residents)

3.5.2 Background

Rand Water identified retrofit as one of the options to reduce the high levels of leakage in the Kagiso Area (see Locality Map, **Figure 3-25**). In this regard, Ayanda Consulting was appointed to coordinate the Kagiso Siyong Amanazi Water Retrofit Project

3.5.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-implementation Assessment

A house-to-house leak assessment was conducted at approximately 6 000 properties in zones 1 and 2 of Kagiso. This entailed checking for leaks in the household plumbing system from the meter to the taps and toilet cisterns. Leak assessors distributed information sheets on the project and completed assessment forms for each property visited.

Project Implementation

Technical

The following criteria were used to prioritise the repair work:

- All high level toilet cisterns (± 13 litre capacity) were replaced with low-level dual flush cisterns (**Figure 3-26**)
- If the mechanism in existing low level cisterns (generally ± 11 litre capacity) was found to be faulty, it was repaired.
- If the cistern mechanism could not be repaired it was replaced with a new dual flush mechanism.
- Broken toilet cisterns were replaced with new plastic dual flush cisterns.
- Leaking taps were repaired.

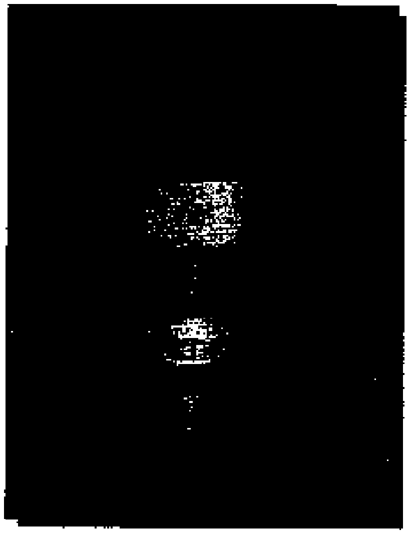


Figure 3-26 Dual flush toilet (Courtesy Ayanda Consulting)

The repair work was split into two parts. The first 3 000 houses were attended to during October 1997 to February 1999 and the remaining 3 000 houses during November 1999 to June 2000. The scope of work in the second part was also extended to revisit the houses dealt with during the first part of the project.

The following key repairs were undertaken in the project:

- Approximately 1 500 taps were replaced;
- Approximately 1 000 tap head parts were replaced;
- 2 046 dual flush toilet cisterns were installed;
- 944 dual flush valves were fitted.

The leak supervisors inspected each of the repairs after the work was completed (see **Figure 3-27**)

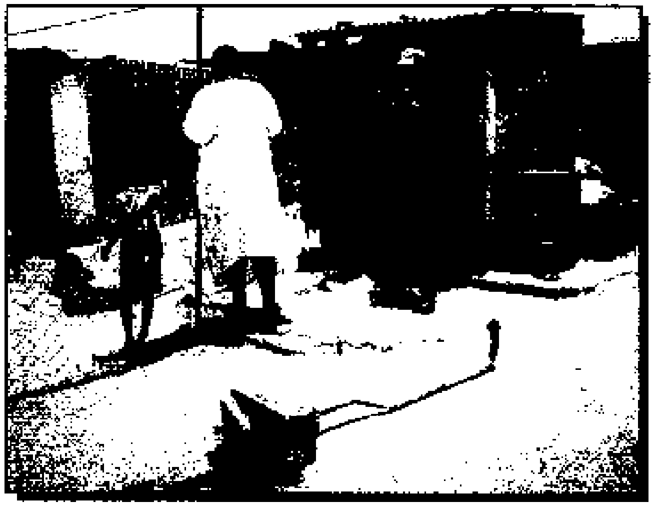


Figure 3-27 Leaks Supervisor inspecting repairs (Courtesy Ayanda Consulting)

Social

The project was undertaken using local labour where possible to create employment opportunities within the local community and to retain as much as possible of the project funds within the community (**Figure 3-28**)

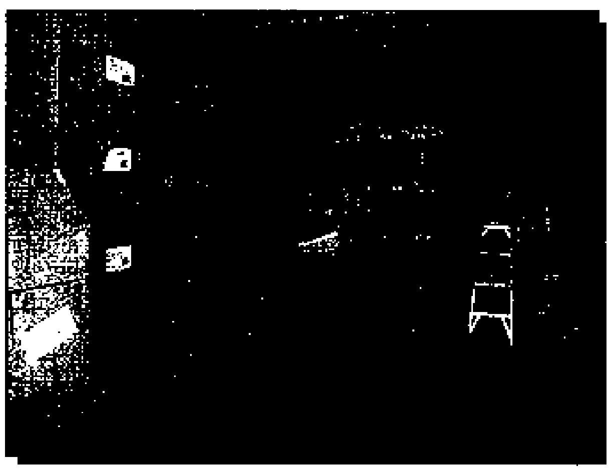


Figure 3-28 Store person taking stock (Courtesy Ayanda Consulting)

Education was a key component of the project, in order to facilitate and encourage payment for services and to promote community participation and ownership of the project (**Figure 3-29**)

Figure 3-29 Retrofiters attending a training session (Courtesy Ayanda Consulting)

Community Liaison Officers were appointed to carry out workshops in Kagiso. Community groups, churches and schools formed the main focus of the workshops. The purpose of these workshops was to introduce the project to the community and educate the community on water conservation and leak detection and repair in their homes.

3.5.4 Results

The following results were obtained from evaluating the consumption for Kagiso over a six-year period:

- The average consumption for Kagiso has reduced by 280 000 kl/month from August 1996 to August 2001 (see **Figure 3-30**)
- The reduction in consumption has continued steadily from 1996 to 2001; indicating the impacts of the retrofit project as well as various other WDM measures.

According to the Krugersdorp Local Authority the following projects or actions have influenced the total consumption for Kagiso:

- June 1996 to present – The Krugersdorp Local Authority indicated that it repaired numerous mains leaks.
- October 1997 to June 2000 – Kagiso Retrofit Project
- 1999 – Pressure reducing valves and zone meters were installed.

- November 2000 to April 2001 Kagiso Schools Retrofitting Project.

The evaluation of monthly water consumption indicates that the retrofit project has contributed to a continued reduction in consumption. It is not possible to determine with accuracy how much of the savings is attributable to the project due to numerous other activities that have resulted in savings. The results do suggest that the retrofit project has had a significant impact on the overall system demand.

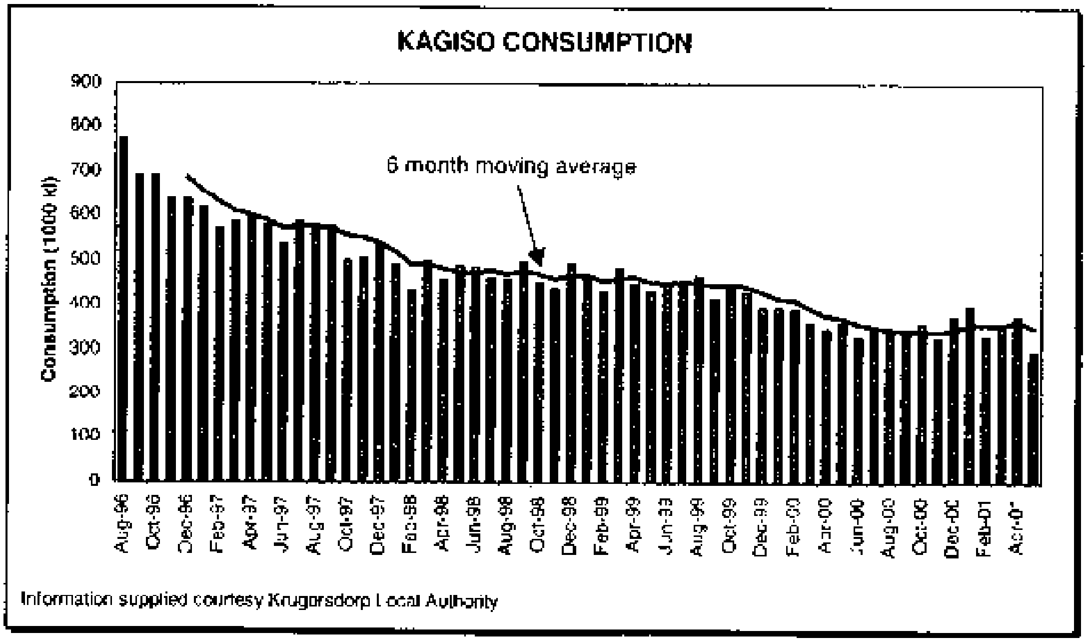


Figure 3-30 Monthly Consumption for Kagiso

3.5.5 Lessons Learned

Female Retrofit Staff

The retrofit team included a larger than usual portion of female members. The female repairers were found to be more methodical with the bookkeeping aspects of the work while their male counterparts tended to be more technically inclined. The teams of both male and female workers were found to operate well and it is recommended that more female applicants be considered for similar projects in future.

Selection of Material Suppliers

As with previous retrofit projects, the main contributing factor to delays in retrofits has been material suppliers not conforming to their terms of agreement. The capacity of material suppliers to fulfil the terms of the contracts should be investigated before contracts are awarded.

Selection of Staff

For future leaks projects, care must be taken when selecting staff, especially for technical positions. Due to the shortages of employment in many of the areas in which the projects are carried out, people are often desperate for employment. It is important to make sure that the credentials of the applicants are genuine and that work experience can be verified. Ideally, applicants with the required aptitude or experience who wish to pursue a career in plumbing should be given preference.

Re-use of Scrap Fittings

All the scrap fittings of the project (i.e. faulty cisterns and taps) should be removed from the project area or destroyed to prevent them from finding their way back into households.

3.5.6 References

Project Completion Report on the Kagiso Siyong Amanazi Retrofit Project prepared by Imbono Consulting, July 2000.

3.6 ODI RETROFIT PROJECT

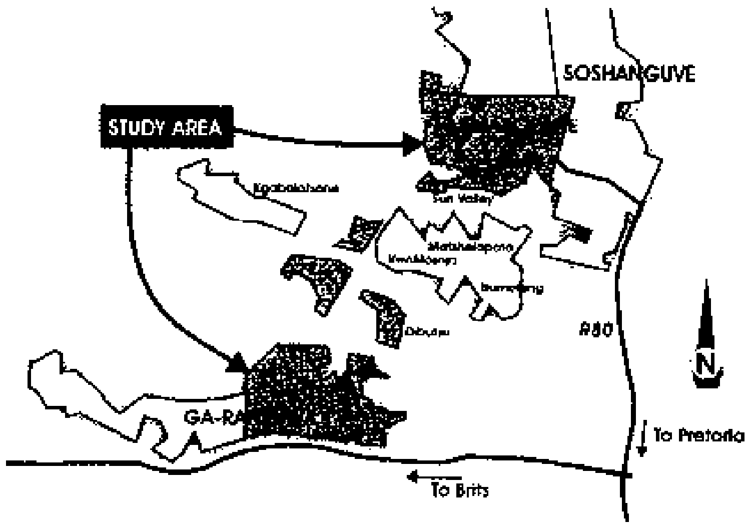


Figure 3-31 Locality Map of study Area

3.6.1 Project Overview

Objective	:	To reduce water wastage resulting from leaks in household plumbing installations and from wasteful water practises in Odi (Ga-Rankuwa and Mabopane), through retrofit and installation of new dual flush toilet cisterns in 16 244 households.	
Duration	:	16 months (March 1999 to June 2000)	
Total Budget	:	R 5,0 million ($ 900 000), final expenditure was R 4, 4 million	
Project Team	:	Client:	Odi Retail Water (Retail Division of Rand Water)
		Project Manager:	Rand Water's Community-based Projects Department
		Project Steering Committee:	Community representatives
		Project Staff:	Community (61 Residents)

3.6.2 Background

The Odi Retrofit Project was implemented by Rand Water to address the problems of excess water consumption and water wastage in Ga-Rankuwa and Mabopane (see Locality Map, **Figure 3-31**). Leaking consumer installations were repaired and dual flush cisterns toilet cisterns were retrofitted to 16 244 houses.

3.6.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-implementation Assessment

A house-to-house leak assessment was conducted at all the stands in Ga-Rankuwa and Mabopane. This involved checking for leaks in the household plumbing system including the water meter.

Project Implementation

Technical

All the leaks and faults recorded by the Leak Assessors were repaired (with the exception of geysers). Unless the owner objected or the existing toilet cistern did not accommodate such, all houses included in the project were retrofitted with a dual flush toilet mechanism or complete toilet cistern. The following summary indicates the key repairs:

- 16 398 water saving dual flush toilet cisterns were fitted **(Figure 3-32).**
- Approximately 5 700 taps were repaired or replaced
- In excess of 1 kilometre of internal plumbing pipework was replaced.
- Approximately 80 000 items of material (including the above) were fitted.

Figure 3-32 Retrofiter at work (Courtesy Graham Nevin)

Social

The project was undertaken using local labour wherever possible in order to create employment opportunities and to retain project funds within the community. Approximately 60 local residents were employed on the project (**Figure 3-33**).

Education was considered to be a key component of the project to facilitate and encourage payment for services and to promote community participation and ownership of the project (**Figure 3-34**)

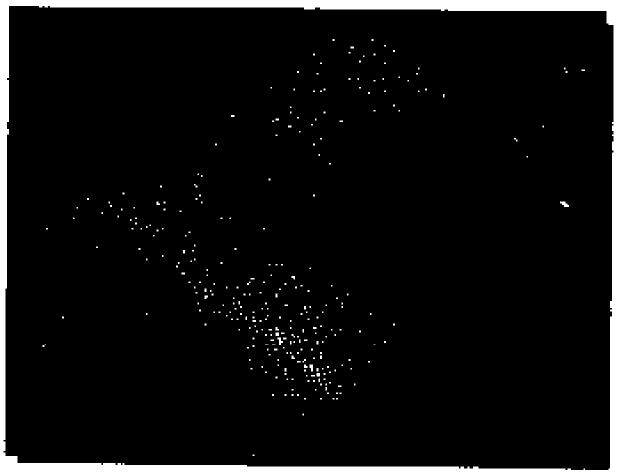


Figure 3-33 Storeman at work using materials management system (Courtesy Graham Nevin)

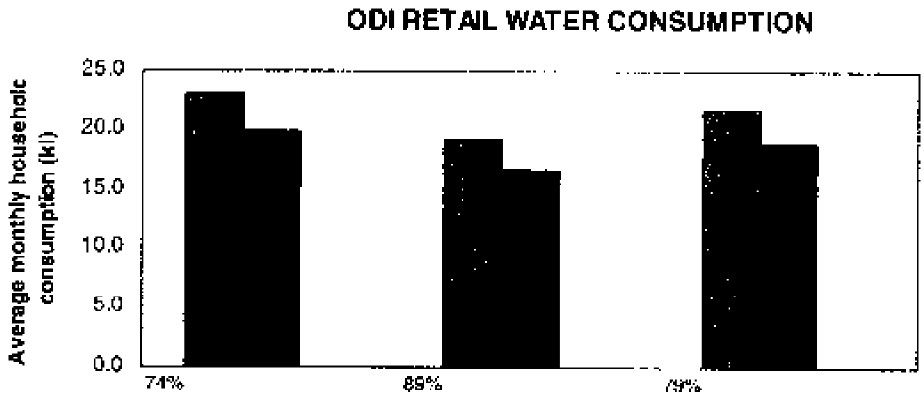
Figure 3-34 Leaks Supervisor engaging local resident (Courtesy Graham Nevin)

3.6.4 Results

The following results were obtained from an evaluation of the monthly household consumption before and after implementation of the retrofit project:

- Overall average reduction in consumption = 2.9 kl/ month/ house (13.1%) (see **Figure 3-35**)
- Average reduction on typical consumer bill = R10,15 /month
- Projected total reduction in consumption = 47 108 kl/month, based on project scope of 16 244 houses repaired.

According to Beith and Horton (*see Reference 2*), the toilet water usage could potentially be reduced by 51 % if an 11 litre full flush toilet is replaced by a 9/4.5 litre dual flush toilet. Few statistics are available on water usage in South Africa but sources (*see Reference 3*) indicate that an average family uses between 190 and 250 litres per day for toilet flushing. If reduced by 51 % it amounts to a saving of approximately 2.9 to 3.9 kl/month. The savings achieved on the project are in the same order as the lower limit (not taking into account the leaks and taps repaired) suggesting that the estimated savings are realistic. Possible reasons why the savings are not higher and towards the upper limit are discussed under Lessons Learned.



	Mabopane	GaRankuwa	Average
■ Before	23.0	19.0	21.7
■ After	19.9	16.6	18.8
% reduction	13.3%	12.7%	13.1%

% houses repaired within scope of project

1) The average monthly household consumption by Zone was calculated based on individual house meter readings taken by the meter reading company (Data available for period November 1997 to November 1999).

2) 12270 Houses were analysed, 7663 from Mabopane and 4607 from Ga-Rankuwa. The houses analysed were those in which repairs were carried out during the period March 1999 to September 1999.

3) "Before" repair consumption is the average monthly consumption for the months preceding the repair month/s, starting November 1997.

4) "After" repair consumption is the average monthly consumption for the months following the repair month/s, ending November 1999. Unfortunately, the data after November 1999 were not obtained due to difficulties experienced with extracting and manipulating the data from the database.

5) Information supplied courtesy Mr G Nevin of Rand Water

Figure 3-35 Odi Retail Water Consumption

3.6.5 Lessons Learned

- The savings achieved appear to be consistent between Mabopane and Ga-Rankuwa, suggesting that the figures are in fact realistic. It is clear that the reduction in water use through the implementation of dual flush toilets may not always be as high as generally anticipated. This demonstrates the importance of carrying out pilot projects rather than extrapolating savings from other areas or other countries.

- The lower than expected reductions can be attributed to the fact that Odi Retail (Water Service Provider) imposes stricter than normal control. Initial leakage levels are therefore lower than usual, since in many cases the stricter control has motivated consumers to repair leaks at their own expense even before the project started.

- Some consumers do not know how to utilise the dual flush cisterns properly and follow-up inspections or instructions may be appropriate.
- The promotion of community participation and ownership of the project can be achieved through the active involvement of the Project Steering Committee, the community staff employed on the project and the execution of the communication programme.

3.6.6 References

1. Executive Completion Report on the ODI Water Retrofit Project prepared by G. Nevin, August 2000.
2. "Water use efficiency of domestic appliances" by I.J. Beith and J. Horton presented in the Urban Water Research Report No.7, 1989.
3. Brochure by Department of Water Affairs and Forestry on good water practices, 2000.

3.7 SEBOKENG EMFULENI RETROFIT PROJECT

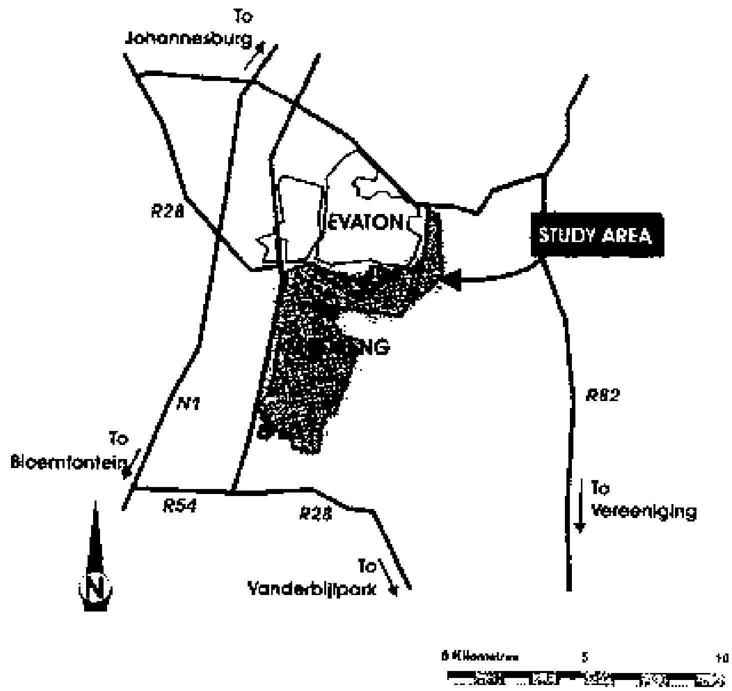


Figure 3-36 Locality Map of study Area

3.7.1 Project Overview

Objective	:	To reduce leakage and improve efficiency of water use in Sebokeng by repairing leaks in approximately 3 500 households in Zone 12.	
Duration	:	14 months (March 1998 – April 1999)	
Total Budget	:	R 2,1 million ($ 380 000)	
Project Team		Local Authority:	Western Vaal Metropolitan Local Authority
		Project Co-ordinator:	Ayanda Consulting
		Project Steering Committee:	Community Representatives
		Project Staff:	Community members (45 Sebokeng residents)

3.7.2 Background

Rand Water identified retrofit as one of the options to reduce the high levels of water consumption in Sebokeng (see Locality Map: **Figure 3-36**). In this regard, Ayanda Consulting was appointed to coordinate the Sebokeng Emfuleni Retrofit project. The project was implemented in Zone 12 of Sebokeng between March 1998 and April 1999.

3.7.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-implementation Survey

A house-to-house leak assessment was conducted in zones 11, 12, 13 and 14 of Sebokeng. Leak assessors distributed information sheets on the project and completed an assessment form for each property visited.

Project Implementation

Technical

Based on the information gathered in the assessment phase, the retrofit project was implemented in Zone 12. The following criteria were used in the repair work:

- High level toilet tanks (± 13 litre capacity) were replaced with low-level dual flush cisterns.
- If the mechanisms in other toilet cisterns (+ 11 litre capacity) were found to be faulty, they were repaired.
- If the mechanisms could not be repaired, dual flush mechanisms were installed.
- Broken toilet cisterns were replaced with new plastic dual flush cisterns.
- Leaking taps were repaired.

According to the then Western Vaal Metropolitan Local Council the following repairs were undertaken in Zone 12:

High level (generally 13 litre) toilet cistern retrofitted with dual flush (9/ 4.5 litre) cistern (**Figure 3-37**):	1 00 houses
Toilet cistern parts replaced:	1 200 houses
Leaking taps and pipes repaired (**Figure 3-38**):	3 530 houses

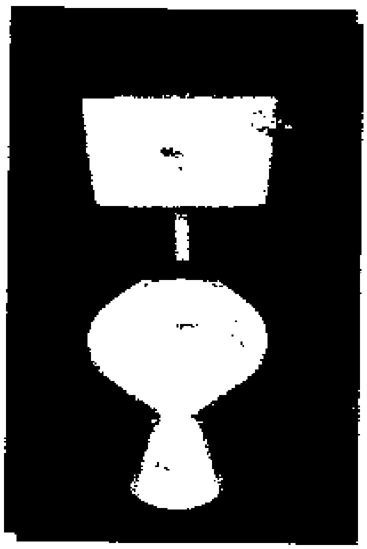


Figure 3-37 A new dual flush cistern fitted at a household. (Courtesy Ayanda Consulting)

Figure 3-38 Retrofit Team replacing a leaking pipe on a property. (Courtesy Ayanda Consulting)

Social

The project was undertaken using local labour where possible to create employment opportunities and to retain funds within the local community (**Figure 3-39**)

Communication Liaison Officers, employed from the local community carried out workshops in Sebokeng for the duration of the project. The workshops targeted schools, churches, community groups and forums in Sebokeng. The purpose of the workshops were to educate the community on the importance of water as a resource and how to save water in the home, schools and place of work. The workshops also served to facilitate and encourage payment for services and to promote community participation and ownership of the project

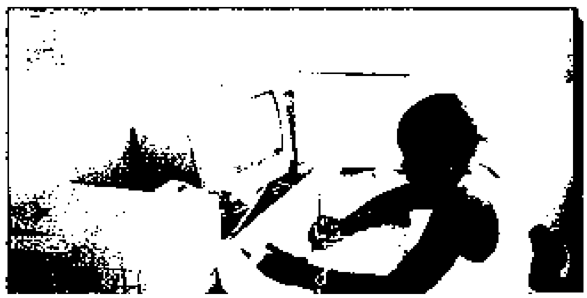


Figure 3-39 Communication Liaison Officer at work (Courtesy Ayanda Consulting)

3.7.4 Results

Due to problems experienced with isolating Zone 12, the bulk meter readings for the area were discarded. The results were based on an evaluation of 180 household meter readings before and after the implementation of the retrofit project (**Figure 3-40**). The meters were read in July and August 1998 and again in August 1999. Since the meters in Unit 12 are not recorded at regular intervals the homeowners are charged a fixed monthly rate for water.

According to the Engineering Department of the Local Council the average saving in water consumed equates to 36,5 % / month/ household. It must be stressed that this figure was based on limited data as shown in **Figure 3-40** and that more data are required to confirm the savings achieved. It is clear, however, that the savings are significant and most likely between 20 % and 40 %.

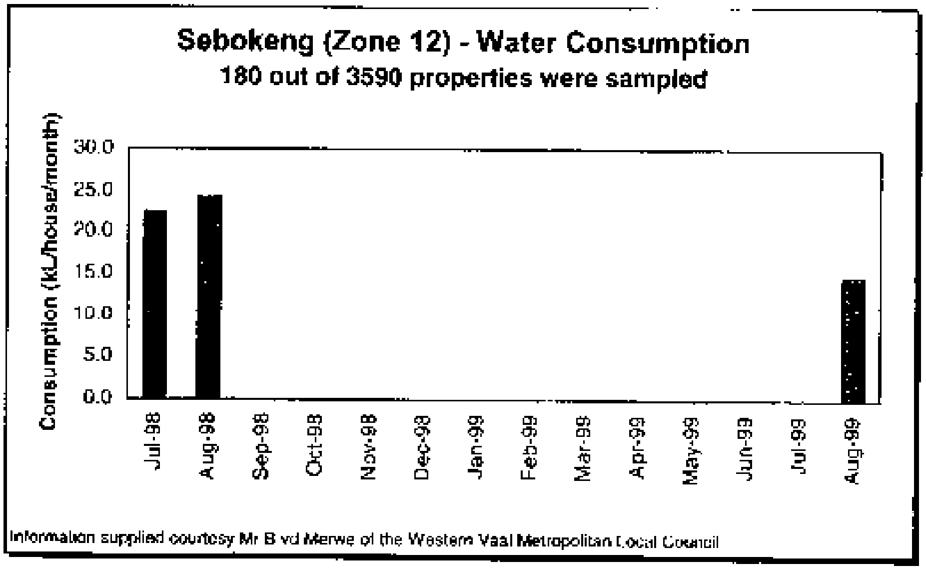


Figure 3-40 Water consumption for a sample of 180 households in Sebokeng - Zone 12

3.7.5 Lessons Learned

- Regular monthly meter readings are required for monitoring the effectiveness of a retrofit project. The limited consumption data for the study area indicate that the project was successful, however a complete set of data from before and after the project is necessary to validate this conclusion.

- Outside plumbers should be employed as inspectors of the repair work. Some of the leak supervisors did not inspect the repairs properly, and repair teams were allowed to proceed before all the problems resulting from poor workmanship were fixed.

- Establishing and maintaining a dedicated Project Steering Committee (PSC) is extremely important to the success of such projects. An agreement between the major stakeholders at the onset of the project enlisting their support for the project, may assist in ensuring their long-term commitment throughout the project.

3.7.6 References

Project Completion Report on the Sebokeng Emfuleni Retrofit Project prepared by Imbono Consulting, June 1999.

3.8 SOWETO RETROFIT PROJECT

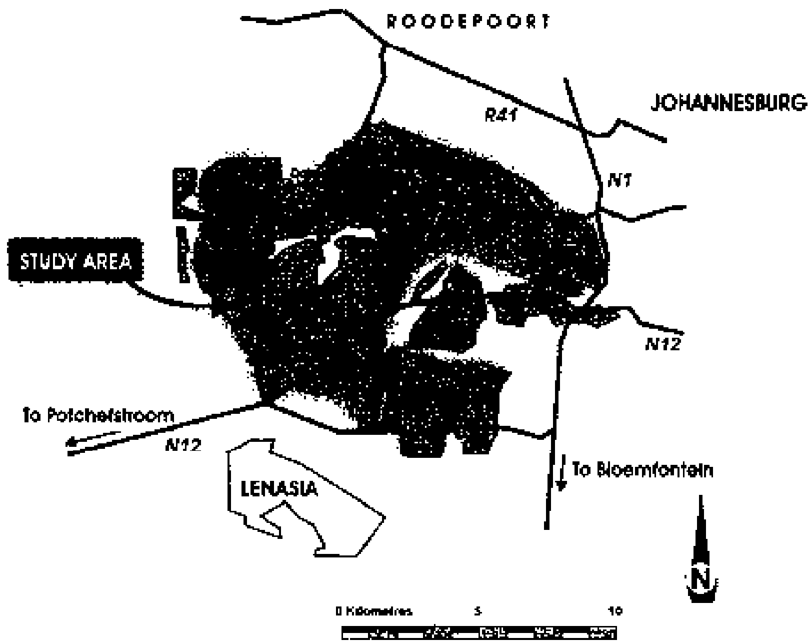


Figure 3-41 Locality Map of Study Area

3.8.1 Project Overview

Objective	:	To reduce leakage and improve efficiency of water use in Soweto by assessing and repairing leaks in approximately 13 000 privately owned houses.
Duration	:	8 months (April 1997 – November 1997)
Total Budget	:	R 5,1 million ($ 1.1 million), final expenditure was R 4, 7 million

Project Team :	Local Authority:		Soweto Administration
	Project Manager:		CBPD
	Consulting Engineer:		BKS Incorporated
	Materials Manager:		Project Management Techniques
	Construction Manager:		DLM Incorporated
	Plumbing	AJ Services	AAG Building
	Contractors:	Doc's Construction	Aubrey's Plumbing
		SM Services	Khari's Plumbing

3.8.2 Background

Rand Water provided funding to complete a free "once-off" community project to repair leaking consumer installations and to fit low volume single flush cisterns in 13 000 privately owned houses in Soweto (see Locality Map, **Figure 3-41**).

3.8.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-Implementation Assessment

A house-to-house assessment of privately owned houses in Soweto was conducted by the former GJTMC (It is not clear how many properties were assessed). This entailed checking for leaks in the household plumbing system from the meter to the taps and toilet cisterns. Both hot and cold water systems were checked although geysers were excluded. A total of 13 800 of the privately owned houses were identified with leaks.

Project Implementation

Technical

All leaks or faults recorded during the above assessment were repaired (with the exception of geysers). A considerable portion of the budget and effort was dedicated to the replacement of the old cast iron 13 litre toilet cisterns with new 9 litre single flush cisterns. The old cast iron cisterns were replaced in all cases whether or not it was leaking. The following summary indicates the number of repairs:

- 8 500 9-litre single flush cisterns were fitted (**Figures 3-42 and 3-43**);
- Approximately 6 384 taps were repaired or replaced;
- Approximately 1 154 pipe repairs were carried out on customer properties.

Figure 3-42 New toilet cistern is fitted (Courtesy Ayanda Consulting)

Figure 3-43 Old high-level cast iron cisterns (Courtesy Graham Nevin)

EDUCATION AND PUBLIC INVOLVEMENT

Education and training formed part of the whole project. This was done to facilitate and encourage payment for services and to promote community participation and ownership of the project

3.8.4 Results

In the absence of reliable zone meter readings for Soweto, an evaluation on the monthly consumption was undertaken based on Rand Water's 1996 and 1997 bulk meter readings. The results shown in **Figure 3-44** are based on the assumption that no other interventions were undertaken in 1997 in Soweto:

- Overall average reduction in bulk consumption = 500 000 kl/ month (6 % reduction);
- Overall average reduction in bulk water purchases = R1 million / month (@ R2 per kl).

The reduction in consumption indicates that the retrofit project was successful to a certain extent. It must be stressed, however, that **Figure 3-44** can only be used to provide a rough indication of the likely savings. The reductions can be influenced by many other factors including weather as well as other WDM measures undertaken during the same time as the retrofit project.

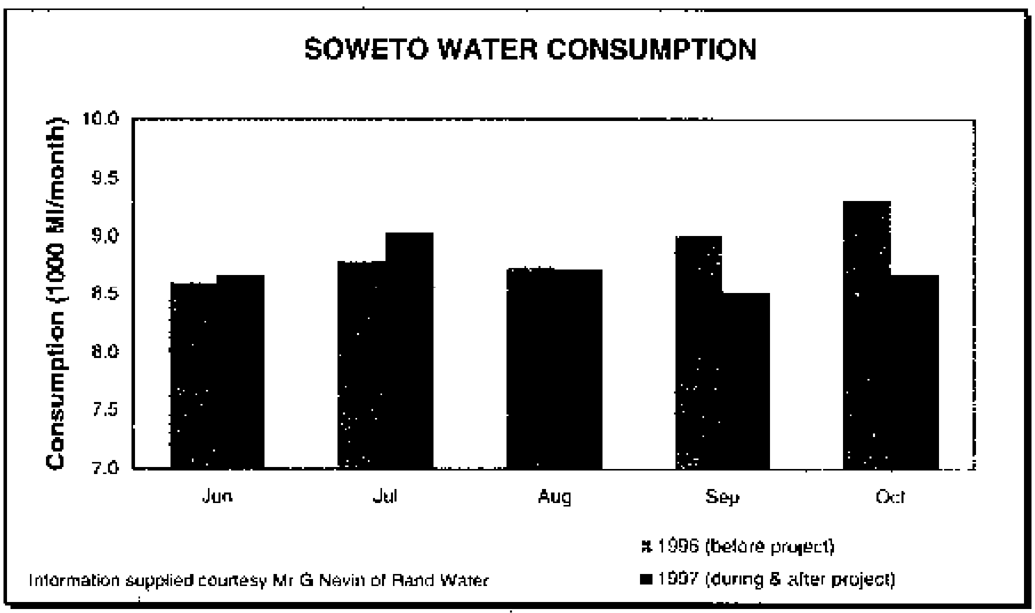


Figure 3-44 Total Water Consumption for Soweto

In most residential areas, the demand is influenced to some degree by the weather especially during warm periods. It would be more appropriate to estimate savings from the minimum night flows together with an analysis of individual consumer meters before and after the repairs. It would also be valuable to check the savings after a period of one or two years to establish if the savings are sustainable.

3.8.5 Lessons Learned

Reduction in consumption

Due to the lack of reliable zone meter readings, before and after the repairs, it is not possible to determine the influence on the total consumption with confidence. It is recommended that proper zone management procedures and regular zone logging be established before and after the implementation of such a retrofit project. This is more difficult in areas such as Soweto where discrete zones often do not exist.

Financial Considerations

The average cost of the project was estimated to be in the order of R348 ($ 75) per house compared to R308 ($ 67) per house for a similar project (i.e. the Odi Retrofit Project). The Odi project was implemented using a "Community Based Approach" which utilised Rand Water's internal management at no cost to the project, in contrast with the Soweto project where a professional team was appointed. This provides an indication of the management component of the work (approximately 15%).

Quality Control

- Independent quality control inspections by suitable qualified persons should be carried out regularly, possibly on a statistical basis, considering the vast number of repairs.

- Early warning mechanisms should be implemented, the most effective possibly being that of engaging the consumers themselves through the establishment of sound communication channels, encouraging rapid feedback to the project staff.

Materials

- SABS approval does not guarantee acceptable or appropriate standard of quality, and therefore, the implementing agent should develop and impose its own standards where necessary.

- Any new products, or products which are to be provided in large quantities or in uncommon applications should be thoroughly investigated and tested prior to installation, and thereafter monitored at regular intervals by qualified personnel.

3.8.6 References

1. Closeout Report on the Soweto Retrofit Project prepared by Graham Nevin of Rand Water, December 2000.
2. Upgrading of secondary water supply in Soweto prepared by Soderlund and Schutte, July 1996.

3.9 TEMBISA EAST RETROFIT PROJECT

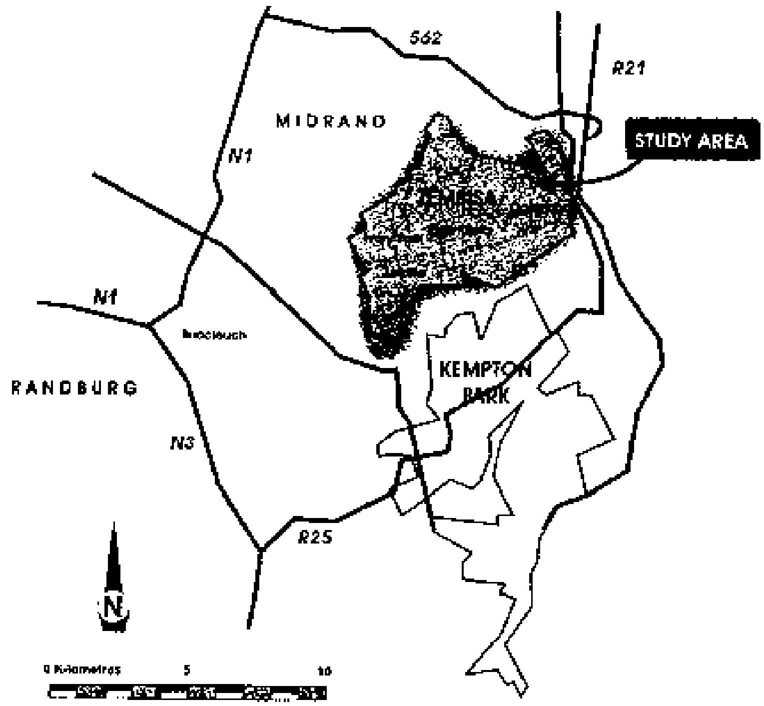


Figure 3-45 Locality Map of study Area

3.9.1 Project Overview

Objective	:	To reduce leakage and improve efficiency of water use in Tembisa East through the assessment of some 24 000 properties and the repair of water leaks to 14 500 properties.
Duration	:	15 months (April 1997 – June 1998)
Total Budget	:	R 4,2 million ($ 900 000). Final expenditure was R 3,7 million
Project Team	:	Local Authority: Ekurhuleni Metropolitan Council)
		Projects Managers: Gibb Africa (Pty) Ltd in association with Semenya Furumele Consulting (Pty) Ltd
		Project Staff: Community Members (38 Tembisa residents)
		Plumbing Subcontractor: Slim Construction cc

3.9.2 Background

The Tembisa East Retrofit Project (see Locality Map, **Figure 3-45**) was initiated by Rand Water as a free "once-off" community project to repair leaking consumer installations and to replace high-level toilet cisterns. In this regard, Gibb Africa and Semenya Furumele Consulting were appointed to coordinate the implementation of the project between April 1997 and June 1998.

3.9.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-implementation Assessment

A house-to-house leak assessment was conducted at approximately 24 000 properties. This entailed checking for leaks in the household plumbing system from the meter to the taps and toilet cisterns. Plumbing assessors distributed information sheets on the project and completed a form for each property visited.

Project Implementation

According to the list of materials used (Gibb Report), the following items were purchased and installed:

- 3 180 standard low volume single flush units (**Figure 3-46**);
- 3 000 dual flush cisterns (**Figure 3-47**);
- 3 629 tap washers;
- Approximately 126 taps;
- 587 standard flush valves.

Figure 3-46 Retrofiter installing a new toilet cistern (Courtesy Ayanda Consulting)

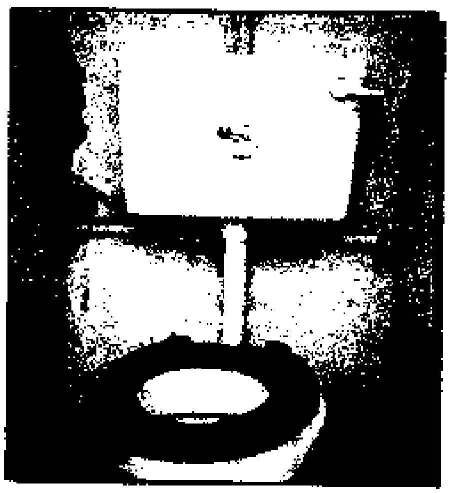


Figure 3-47 Dual Flush Toilet (Courtesy Ayanda Consulting)

3.9.4 Results

The following results were obtained from evaluating the unaccounted-for-water for Tembisa East before and after the implementation of the retrofit project:

- The unaccounted-for-water was reduced from 48 % (575 000 kl) per month (July 1996 to June 1997) to 29 % (290 000 kl) per month (July 1998 to June 1999) (**Figure 3-48**).

- In the following year (July 1999 to June 2000), the average unaccounted-for-water increased to 36 % (370 000 kl) per month.

According to the Ekurhuleni Metropolitan Council, the following actions were undertaken in Tembisa, which may have influenced the total consumption.

- August 1996 to July 1997 – During this period, 1 438 new meters were installed at existing properties not previously metered resulting in a drop in the unaccounted-for-water. In addition, 4 549 of the existing meters were repaired.

- April 1997 to June 1998 – Implementation of the retrofit project.

The evaluation of the unaccounted-for-water for Tembisa East indicates that the retrofit project has contibuted to significant savings in water losses. A year after completion of the project, however, the percentage unaccounted water has started to increase again. This cast some doubts on the long-term sustainability of such projects if proper aftercare initiatives are not implemented.

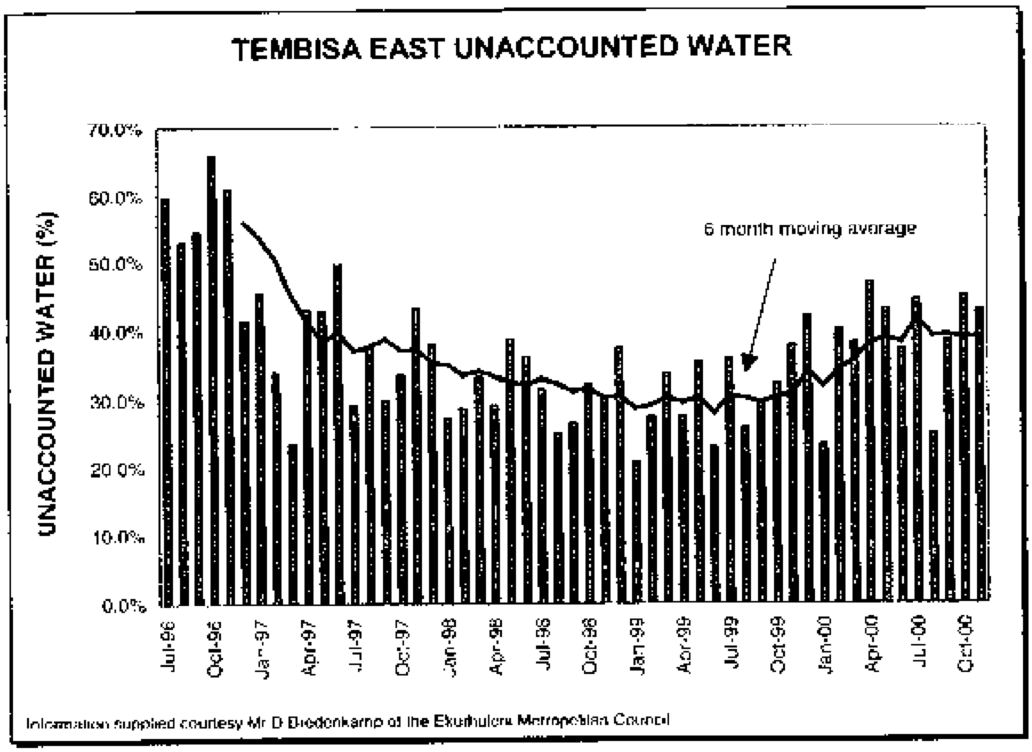


Figure 3-48 Percentage Unaccounted-for-Water for Tembisa East

3.9.5 Lessons Learned

- More research is required on the long-term sustainability of retrofit projects. The level of unaccounted-for-water in the study area started to increase a year after completion of the project and no details are available to explain the increase.

- The procedure for recruiting project staff from the community should be clarified with all parties involved at the start of the project. Problems may arise if this is not addressed properly at the start of the project.

- The presence of a full time Community Liaison Officer played a significant role in the project's success.

3.9.6 References

Project Report on the Tembisa West Retrofit Project prepared by Gibb Africa, March 1999.

3.10.2 Background

The Tembisa West Retrofit Project (See Locality Map: **Figure 3-49**) was initiated by Rand Water as a free "once-off" community project to repair leaking consumer installations and to replace high-level toilet cisterns with new dual flush cisterns. In this regard, Imbono Consulting was appointed to coordinate the implementation of the project in Wards 4, 5 and 6 of Tembisa West between March 1998 and April 1999.

3.10.3 Methodology

The project involved an assessment and implementation phase. Details of each phase are provided below.

Pre-implementation Assessment

An assessment of household leakage was undertaken in Wards 4, 5 and 6 of Tembisa West. From the 5 344 houses examined, 4 839 were found to require some form of plumbing repair. The most common problems identified were faulty toilet cistern mechanisms and leaking taps.

Project Implementation

Technical

The following criteria were used in the repair work:

- All high toilet tanks (± 13 litre capacity) were replaced with low-level dual flush cisterns (**Figure 3-50**);
- If the mechanism in any existing low level toilet cisterns (± 11 litre capacity) was found to be faulty, it was repaired;
- If the mechanism could not be repaired, a dual flush mechanism was installed;
- Broken toilet cisterns were replaced with new plastic dual flush cisterns;
- Leaking taps were repaired.

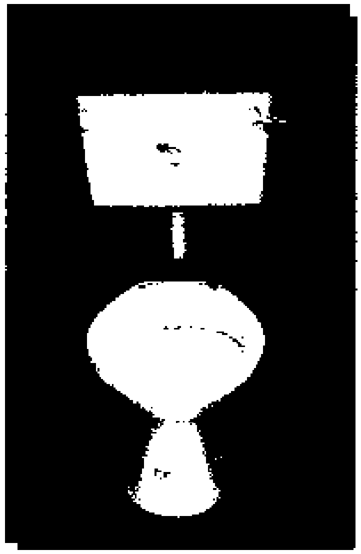


Figure 3-50 Dual flush toilet (Courtesy Ayanda Consulting)

The following key repairs were undertaken in the project:

- Approximately 2 900 taps were replaced (**Figure 3-51**);
- Approximately 3 200 tap head parts were replaced;
- 138 dual flush toilet cisterns were installed;
- 1656 dual flush valves were fitted.

Figure 3-51 Retrofiter fixing a leaking tap (Courtesy Ayanda Consulting)

SOCIAL

A project launch was held at the start of the project with the purpose of introducing the project to the community.

The communication team, consisting of Communication Liaison Officers, was employed by the project from the local community. This team carried out workshops and festivals with local residents and schools in order to promote awareness of the importance of saving water. The Communication team also distributed water supply and water saving information pamphlets to home owners during the course of the project.

3.10.4 Results

The following results were obtained from evaluating the bulk meter readings for Tembisa West before and after the implementation of the retrofit project:

- The average monthly reduction in supply = 95 888 kl/month (**Figure 3-52**). (The "before" period was considered to be August 1997 to July 1998 and the "after" period August 2000 to July 2001).
- The reduction in supply volume per household = 18 kl/month.

The retrofit project (implemented in March 1998 to April 1999) appears to be partly responsible for the significant reduction in total water use in the Tembisa West area. The Edenvale Town Council, responsible for Tembisa West, also indicated that it repaired numerous mains leaks during the same period, which also contributed to the savings. It is not possible to attribute the savings to the different initiatives and it is therefore not possible to judge the true benefits from the retrofit project.

The data do, however, appear to be somewhat irregular at times and should therefore be viewed with caution. A more accurate procedure to monitor the effectiveness of the project would be to evaluate individual household consumption before and after the project. This was not undertaken due to various problems with obtaining the data on household meter consumption.

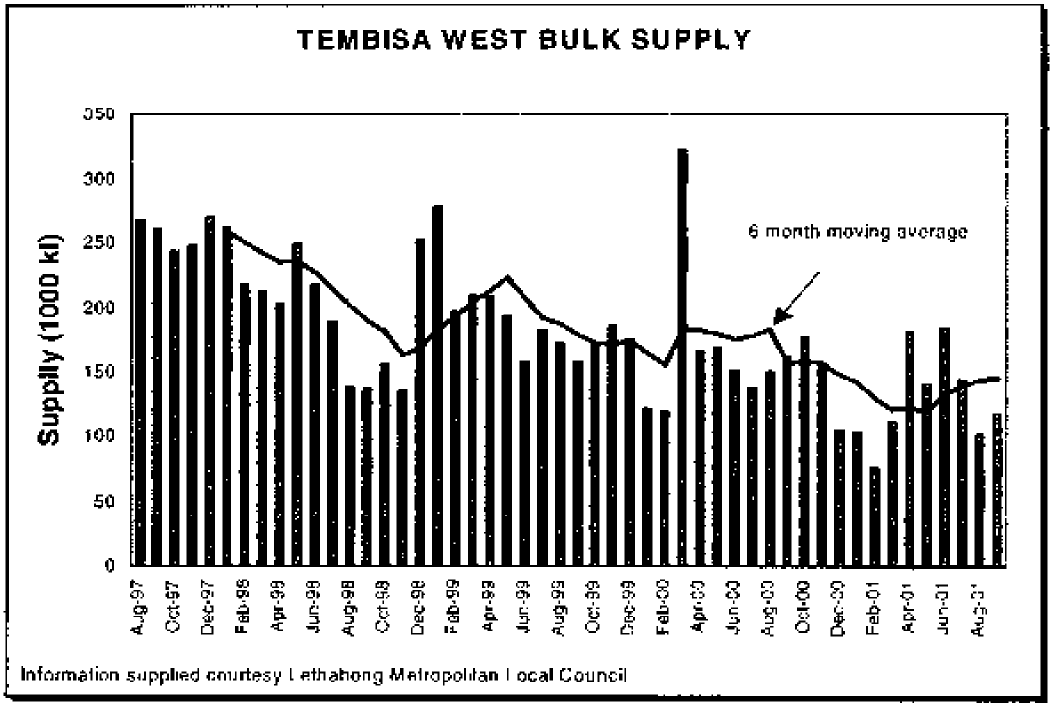


Figure 3-52 Tembisa West bulk water supply

3.10.5 Lessons Learned

- In future projects it is important to audit the savings properly so that the success of the project can be established. This can be achieved through examination of the household water use before and after the repairs. Even a sample of properties could be used for this purpose.
- It is recommended that a follow-up examination be undertaken 12 or 24 months after the repairs have been completed to establish the sustainability of the savings. This aspect is often neglected on such projects and no information on the savings after one or two years can be found in most cases.
- Outside plumbers should be employed as inspectors of the repair work. Some of the leak supervisors did not inspect the repairs properly, and repair teams were allowed to proceed before all the problems resulting from poor workmanship were fixed.

3.10.6 References

Project Completion Report on the Tembisa West Retrofit Project prepared by Imbono Consulting, June 1999.

3.11 THOKOZA RETROFIT PROJECT

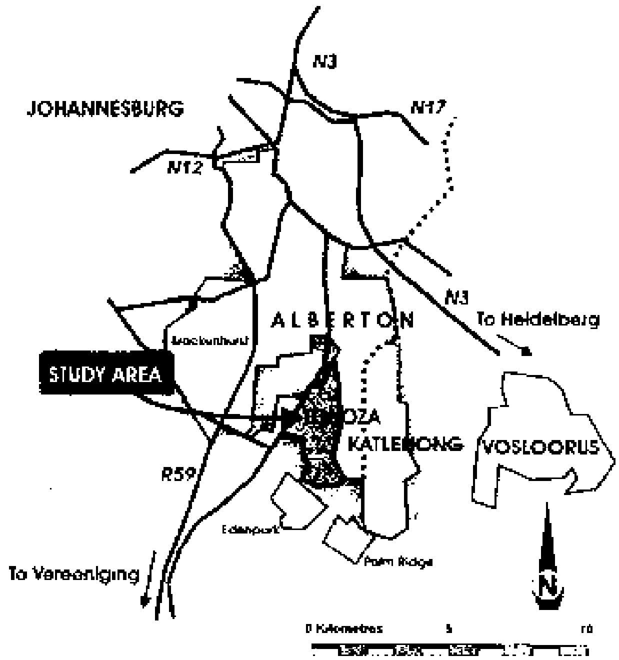


Figure 3-53 Locality Map of Study Area

3.11.1 Project Overview

Objective	:	To reduce leakage and improve efficiency of water use in Thokoza, by repairing leaks in approximately 2 580 households.	
Duration	:	6 months (June 1996 – December 1996)	
Total Budget	:	R 685 000 ($ 160 000), final expenditure was R 670 000	
Project Team	:	Local Authority:	Alberton Town Council
		Project Manager:	Nicholas Sweet & Associates
		Project Staff:	Community Members (25 Thokoza Residents)

3.11.2 Background

The community based retrofit project was implemented by Rand Water to address the problems of excess water consumption and water wastage in Thokoza (See Locality Map: **Figure 3-53**). The purpose of the project was to carry out a free, "once-off" repair to any leak in the water supply system.

3.11.3 Methodology

The project involved and assessment and implementation phase. Details of each phase are provided below:

Pre-implementation Assessment

Leak detection was undertaken by groups of two or three individuals who were allocated a number of stands, grouped together as closely as possible. The teams were issued with leak detection forms giving details of the purpose of the project and enabling the team to place ticks against specific items. Many illiterate leak assessors were also used and were shown how to identify components and complete the forms. The leak detection revealed the following:

- The majority of leaks occurred because of a defective sealing washer in the cistern outlet valve (**Figure 3-54**);
- Other leaks resulted from the cistern inlet valve being faulty and leaks at taps resulting from faulty washers;
- Some leaks were found at the meters and in the supply lines.

Project Implementation

The following repairs were undertaken in the project:

- All faulty cistern outlet valves were repaired;
- All leaking taps were repaired (**Figure 3-55**).

It is not clear from the project report how many cistern valves or tap washers were replaced. The project did not include the repair of broken cisterns or the fixing of leaking pipes, meters or geysers.

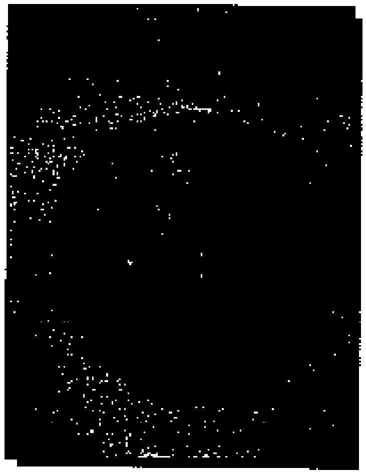


Figure 3-54 Leaking toilet (Courtesy Ayanda Consulting)

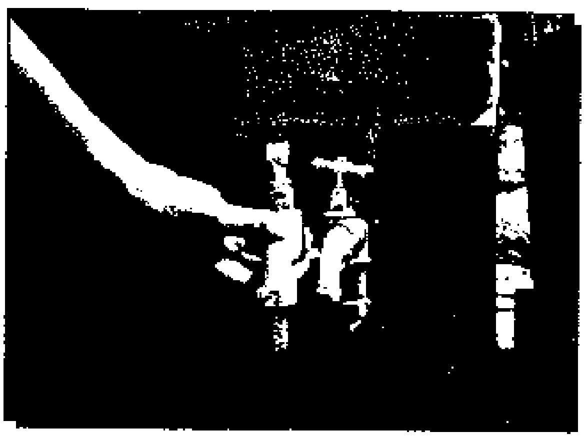
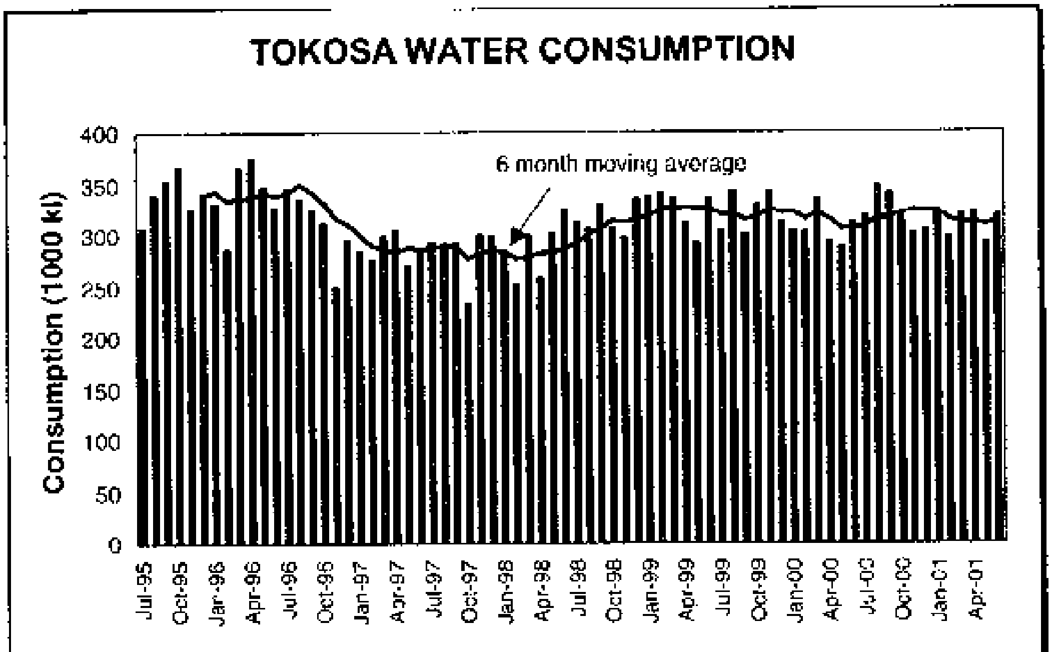


Figure 3-55 Leaking taps were repaired (Courtesy Ayanda Consulting)

3.11.4 Results

In the absence of reliable data to measure the water savings attributable to the project, the total water consumption for Thokoza before and after implementation of the project was evaluated. The following results were obtained:

- The average reduction in consumption = 53 500 kL/month for Tokoza (**Figure 3-56**). (The "before" period was considered to be July 1995 to June 1996 and the "after" period as July 1997 to June 1998).
- In the years thereafter (June 1998 to June 2001) the average consumption increased again by 31 500 KL per month.



Information supplied courtesy Mr J Steyn from the Alberton Town Council. The data between July 1995 and June 1996 was obtained from the report by N Sweet & Associates

Figure 3-56 Monthly water consumption in Thokoza

According to the Alberton Town Council, a number of projects have influenced the total consumption for Thokoza:

- June 1996 to August 1996 – Bradford Conning & Partners repaired leaks on 350 stands where the consumption was 60 kl/ d or higher.
- June 1996 to December 1996 – Rand Water implemented the retrofit project on 2 351 stands where the consumption was between 30 and 60 kl/ d.
- July 1997 to December 1997 - In this period the SABS implemented a Water Demand Management Programme, including leak sounding and repairing and meter installation. The project was, however, not fully completed and hence, the monthly consumption was not significantly affected.
- January 1998 to present – The construction of 4 000 low cost housing units commenced in January 1998 and is still underway (2001). The increase in consumption can partially be ascribed to the increase in the number of properties supplied.

The evaluation of monthly water consumption suggests that the retrofit project achieved some reduction in consumption. It is not possible to determine how much of the savings are attributable to the retrofit project due to numerous other actions that may also have influenced the water use.

In the year following the implementation of the retrofit project, the monthly consumption increased again (see **Figure 3-56**). This cast some doubt on the long-term sustainability of the project, although part of this increase can be ascribed to the construction of new housing units in Thokoza.

3.11.5 Lessons Learned

- From the work undertaken before and after the retrofit project it is not possible to evaluate the true savings attributable to the retrofit project. A better way to measure the sustainability of such a project is to monitor a sample (say 10 % to 20 %) of the individual household meters rather than comparing the bulk consumption before and after the repairs.
- One of the most important aspects of such community-based projects is to enable payments to be made quickly and at short notice. One option is to provide operating capital or "float" in order to speed up payments. Another option is that the funding body initiates a fast track service dedicated to the payment of small emerging contractors.
- Great emphasis should be placed on training of leak detection teams. Tests should be undertaken to ensure that all teams understand the requirements for accurate records to be compiled.
- The long-term sustainability of the project can only be secured if the local communities support the project.

3.11.6 References

Project Completion Report on the Thokoza Retrofit Project prepared by Nicholas Sweet & Associates, 1997.

4 PRESSURE MANAGEMENT PROJECTS

4.1 SLOVOVILLE PRESSURE MANAGEMENT CASE STUDY

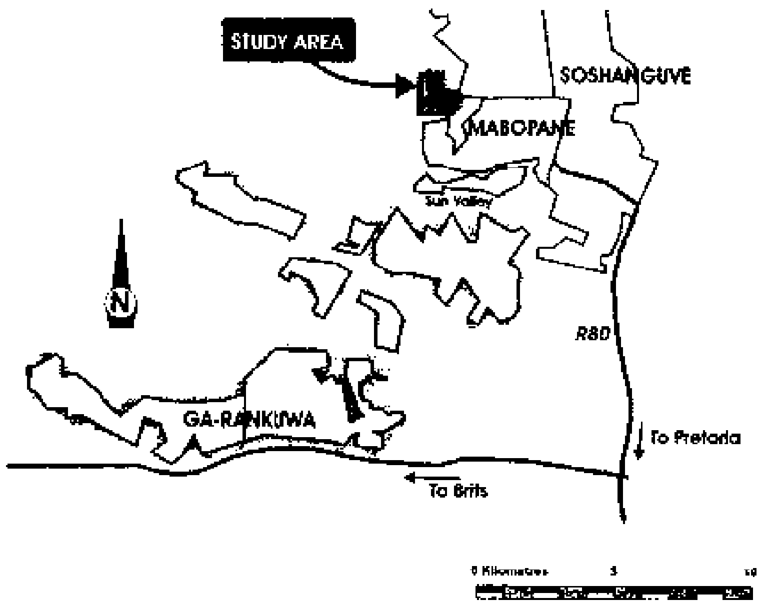


Figure 4-1 Locality Map of the Study Area

4.1.1 Project Overview

Objective	:	To quantify the benefits through of leakage reduction by installing and commissioning a time-modulated pressure controller on the existing Pressure Reducing Valve (PRV) in Slovoville - a district of Mabopane, approximately 50 km north of Pretoria.	
Duration	:	3 months (October 2001 to December 2001)	
Total Budget	:	R57 000 ($ 6 600)	
Project Team	:	Client:	ODI Retail Water (Retail division of Rand Water)
		Project Manager:	WRP Pty (Ltd)
		Controller Installations:	Pressure Management Systems

4.1.2 Background

A study was recently undertaken by WRP Pty (Ltd) to investigate the potential savings that can be achieved through Pressure Management in the urban areas of

Ga-Rankuwa and Mabopane. The study involved various preparatory tasks such as: collection and collation of zone data, the logging of 17 zones in Ga-Rankuwa and 15 in Mabopane as well as flow and pressure analysis of logged data. Potential pressure management zones were identified and likely savings were estimated.

Following the successful completion of the project in Mabopane and Ga-Rankuwa, Rand Water provided additional funds for the implementation of a single time-modulated pressure controller at Slovoville – Mabopane (see Locality Map, **Figure 4-1**)

Slovoville is situated in the North Western part of Mabopane and comprises approximately 2 000 domestic properties with a population of approximately 10 000. There are approximately 26 kms of mains, consisting mostly of uPVC pipes. The terrain is undulating with ground levels varying from 1 145m to 1 189m (amsl). The area is supplied under gravity from the Mabopane Middle Level Reservoir through a single 300 mm diameter main, equipped with a 300 mm diameter water meter and two 150 mm diameter PRVs.

4.1.3 Methodology

The project involved the following phases:

- Pre-installation survey;
- Data analysis;
- Pressure Management Implementation.

Details of each phase are provided below.

Pre-installation Survey

The zone was tested for discreteness after which data loggers were installed to record water outlet pressure and flow at the PRV, as well as water pressure at the lowest and critical points in the zone. Initial analyses of the recorded data indicated a large pressure variation from 89 m to 41 m at the critical point, as well as a maximum system pressure of 120 m at the lowest point. The minimum night flow was 41 m^3/h.

Data Analysis

By using, the PRESMAC model developed by WRP Pty (Ltd) for the Water Research Commission the data were analysed for both time and flow modulation. The time-modulated option indicated a payback period of 2 months based on an initial investment of R57 000.

Pressure Management Implementation

An ECOLOG time-modulated controller was installed on one of the existing 150 mm Bermad-400 series PRVs (**Figures 4-2** and **4-3**). The following pressure settings were used:

Pressure	Time of day
3 bar or 30m	5:00 to 22:00
2 bar or 20m	22:00 to 5:00

Figure 4-2 Pressure Reducing Valve at the Slovoville installation
(Courtesy WRP (Pty) Ltd)

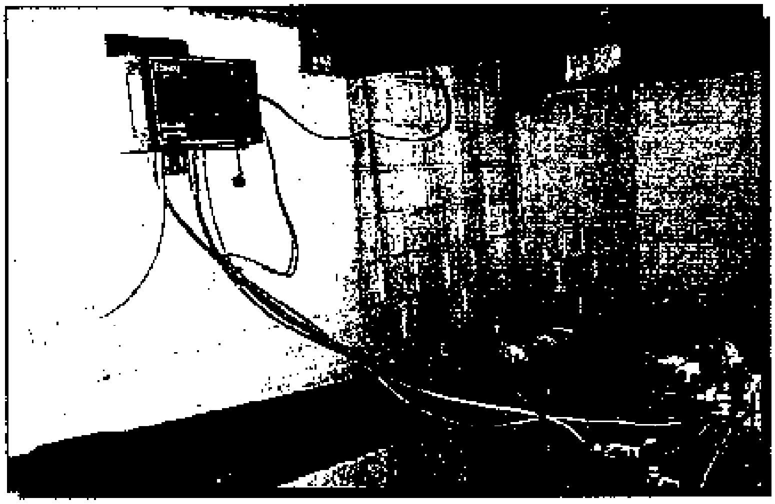


Figure 4-3 Ecolog Controller (Courtesy Technolog)

4.1.4 Results

The results from the study are summarised in the following set of figures and tables. In **Figures 4-4 to 4-6** the reduced zone inflows are indicated for the Open PRV, Fixed Outlet PRV and a Time Modulated PRV. The shaded area on the graphs indicates the reduced zone inflow (i.e. savings) for each alternative.

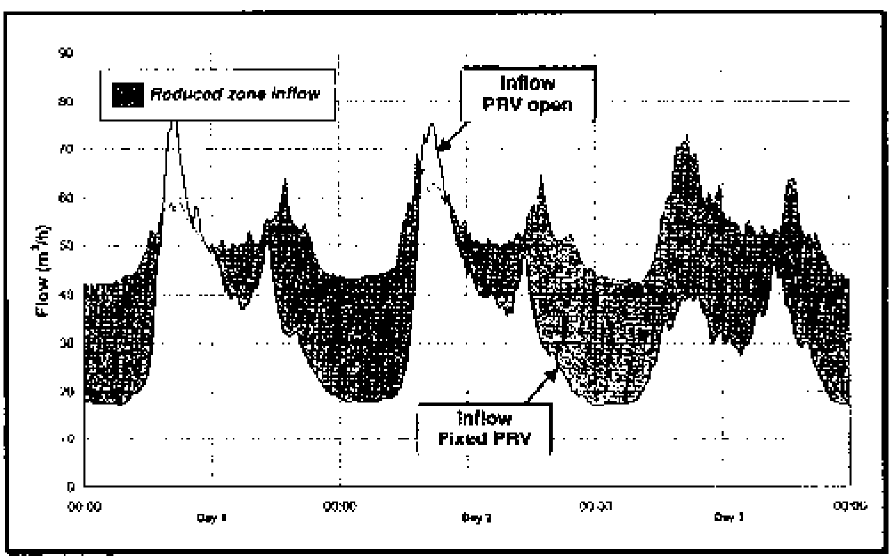


Figure 4-4 Reduced zone inflow using a Fixed Outlet PRV.

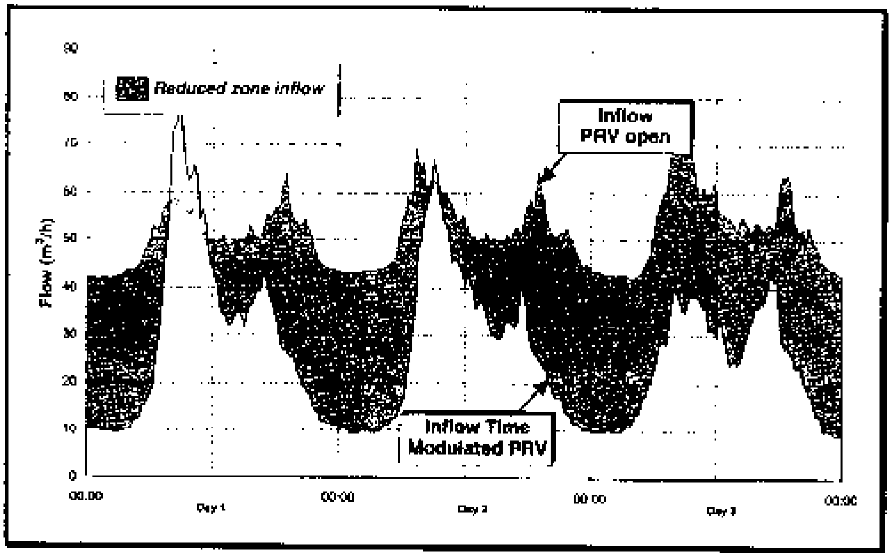


Figure 4-5 Reduced zone inflow using a Time-Modulated PRV

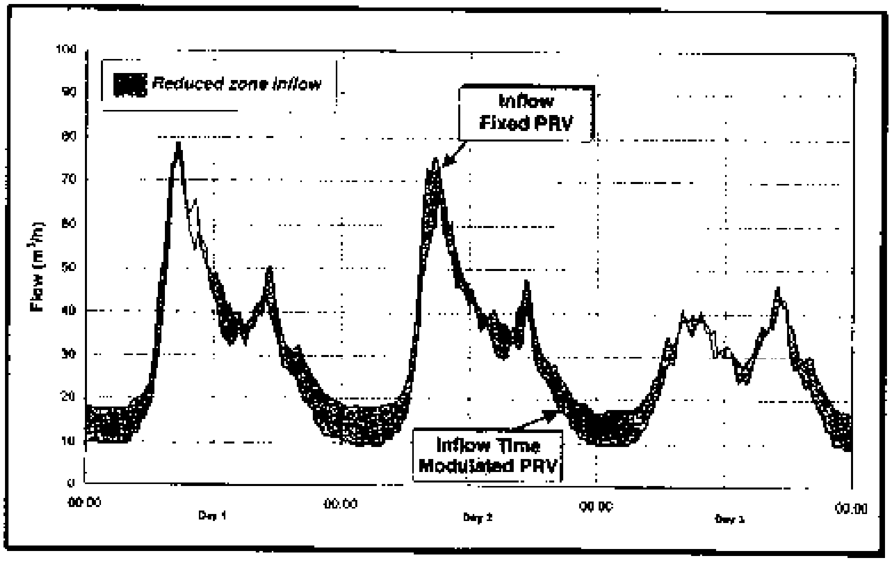


Figure 4-6 Reduced zone inflow from a Fixed Outlet PRV to a Time Modulated PRV.

In **Figures 4-7 to 4-8** the reduced PRV outlet pressures are indicated for the Open PRV, Fixed Outlet PRV and a Time Modulated PRV. The shaded area on the graphs indicates the reduced PRV outlet pressures for each alternative.

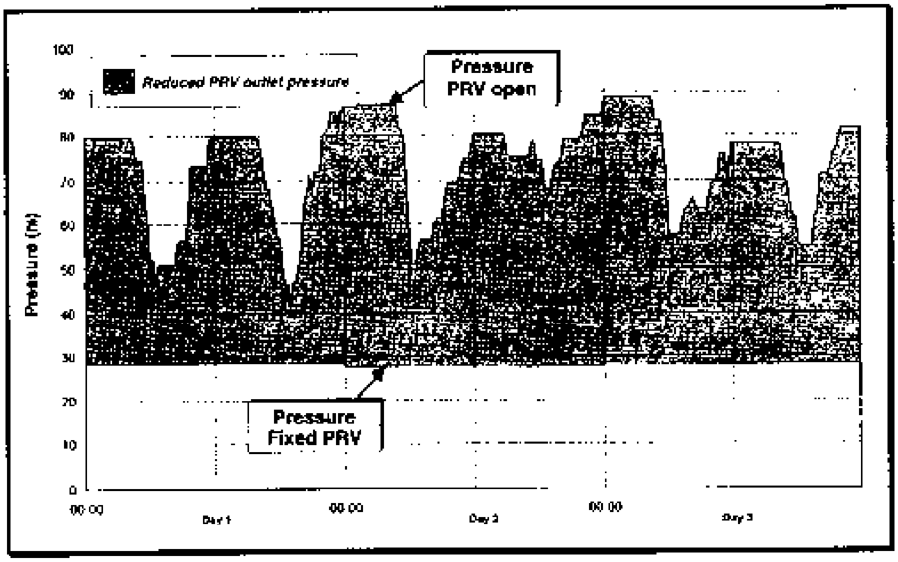


Figure 4-7 Reduced PRV outlet pressure for Open PRV compared to the Fixed Outlet PRV option.

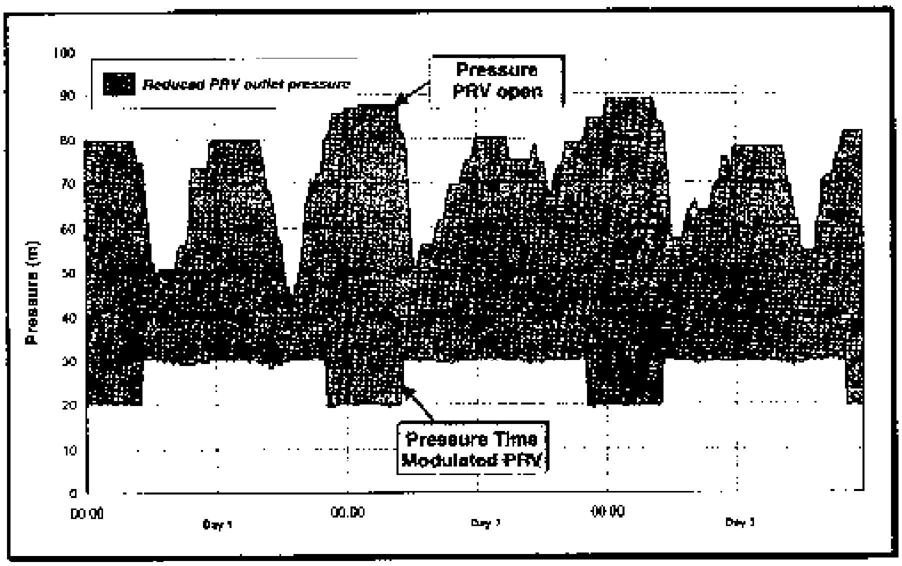


Figure 4-8 Reduced PRV outlet pressure for the Open PRV compared to the Time-Modulated PRV option.

The actual results from the sudy and the predicted results from the pressure management analysis (PRESMAC) are summarized in **Tables 4-1** and **4-2.**

Table 4-1 Flow results from Slovoville installation - Mabopane

FLOW CONDITION	Minimum night flow (m^3/h)	Average flow (m^3/h)	Daily Demand (m^3/day)	Annual demand ('000m^3/year)
Actual logging results				
Open PRV	41	51	1220	445
Fixed Outlet PRV	17	32	775	283
Actual Saving	24	19	445	162
Time Modulated PRV	9	26	629	230
Additional Actual Saving	8	6	146	53
Total Actual Saving	32	25	591	216
Predicted savings (PRESMAC)				
Time Modulated PRV	11	29	702	256
Total Predicted Saving	30	21	513	187

Table 4-2 Pressure results from Slovoville installation- Mabopane

CONDITION	Operating Pressure @ Inlet Point (m)
Open PRV	41 to 89
Fixed PRV	30
Time Mod PRV	20 to 30

The results indicate the importance of setting and maintaining the PRVs at the correct pressure. The savings achieved from changing the open PRV to a fixed outlet PRV are almost 2.5 times as high as the savings achieved from changing from the fixed outlet PRV to the time modulated PRV. The savings indicate the value of pressure management in Slovoville, with and without a controller.

The results also highlight the importance of undertaking a basic pressure management analysis to derive the daily savings as opposed to simply multiplying the reduction in minimum night flow by 24 hours as is normal practice by many engineers. In this case the saving of 591 m^3/day can be compared to a figure of 768 m^3/day which is obtained if the saving on minimum night flow of 32 m^3/hr is multiplied by 24 hours. This highlights the importance of a proper analysis and it can also be seen that the savings predicted by the model agree closely with those actually observed. This gives confidence in the analysis techniques and illustrates that the expected savings can in fact be achieved.

4.1.5 Lessons Learned

- The expected flow and pressure results for Slovoville correspond well with the logged results. The MNF is slightly less than expected. This gives confidence in the analysis techniques and illustrates that the expected savings can in fact be achieved.
- The savings achieved indicate the value of pressure management as part of a general zone management strategy.
- The ECOLOG time-modulated PRV controller can provide a cost effective solution by reducing supply pressure at low flow periods. This reduces excess pressure, cuts background leakage and reduces the risk of bursts.

4.1.6 References

Report on the Investigative Phase of Pressure Management in Ga-Rankuwa and Mabopane by WRP Engineers, August 2001.

5 CONCLUSIONS AND LESSONS LEARNED

The following summary provides key conclusions and lessons learned from the various WDM projects undertaken by Rand Water, as discussed in this report:

5.1 RETICULATION LEAK DETECTION PROJECTS

- The bulk meter readings and Minimum Night Flows (MNFs) should be monitored before and after implementation of such projects in order to evaluate the actual savings achieved.

- Leak detection and fixing should not be regarded as a "once-off" exercise. Different size leaks emits different noise intensities. Small leaks generally emit a higher intensity of noise and are generally picked up first while larger leaks may still be present. Once initial retrofits have been undertaken the area should be tested again to ensure that larger leaks have not been overlooked.

- The best approach for undertaking a leak detection exercise, especially in a CBD area, is to make use of a combination of techniques. Some methods are better suited for a rough first time sweep of an area while others can be used to pin-point the exact location of leaks.

5.2 RETROFITTING PROJECTS FOR SCHOOLS

- The students and staff of the schools should be involved with the planning and implementation of the project to ensure their full commitment. It is the schools's responsibility to prevent vandalism.

- It is essential that each school be metered before the implementation of a retrofit project. Without proper flow data taken before and after implementation of the project, it is impossible to realistically evaluate the success and sustainability of the project.

- The school facility caretakers (factotums) play a major role in most schools in the day to day running and maintenance of the facilities. It is vital that these individuals are involved with the repair process.

5.3 DOMESTIC RETROFITTING PROJECTS

- In future projects it is important to audit the savings properly so that the success of the project can be established. This can be achieved through examination of the household water use before and after the repairs. Even a sample of properties could be used for this purpose.

- It appeares that some consumers do not know how to utilise the dual flush cisterns properly and follow-up inspections or instructions may be appropriate.
- The promotion of community participation and ownership of the project can be achieved through the active involvement of the Project Steering Committee (PSC), the community staff employed on the project, and the execution of the communication programme.
- Female retrofiters were found to be more methodical with the bookkeeping aspects of the work while their male counterparts tended to be more technically inclined. The teams of both male and female workers were found to operate well and it is recommended that more female applicants be considered for similar projects in future.
- Independant plumbers should be employed as inspectors of the repair work. Some of the leak supervisors did not inspect the repairs properly, and repair teams were allowed to proceed before all the problems resulting from poor workmanship were fixed.
- The selection of reliable and suitable material suppliers for water leaks projects is critical for the smooth running of the project.

5.4 PRESSURE MANAGEMENT PROJECTS

- Pressure Management was found to provide a cost effective solution by reducing supply pressure at low flow periods. This reduces excess pressure, cuts background leakage and reduces the risk of bursts.
- The expected flow and pressure results can be calculated with reasonable accuracy using software like PRESMAC developed by WRP (Pty) Ltd for the South African Water Research Commission (WRC).