INSTITUTIONAL AND SOCIO-ECONOMIC REVIEW OF THE USE/APPLICATION OF ELECTRONIC PREPAYMENT METER TECHNOLOGY IN THE PROVISION OF WATER SUPPLY SERVICES TO URBAN AND PERI-URBAN AREAS

Report to the

WATER RESEARCH COMMISSION

by

L Marah, M O'Donovan, K Finlayson and D Boberg

Sigodi Marah Martin Development Consultants

WRC Report No 1206/1/04

ISBN No 1-77005-224-0

NOVEMBER 2004

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Printed by Silowa Printers: 012 804 1164

EXECUTIVE SUMMARY

In many municipalities prepayment water meter technology has become a prominent instrument of water management contributing, with other measures, to the sustainability of water provision. This study aims to provide an understanding of the social and institutional context in which the technology fails or succeeds. This understanding is derived from an examination of the available literature, the analysis of surveys and by examining case studies.

The primary objective of the study was to understand how the technology could best be used to ensure sustainable water provision by local authorities. Key objectives were to determine how the changing institutional environment impacted on the uptake of the technology and, similarly, how socio-economic contexts affected its adoption.

The project methodology included:

- Desktop research for a literature study.
- Discussions with relevant stakeholders like DWAF, SALGA, DPLG to gain an understanding of the environment in which water service providers operated.
- Conducting a national survey of water service providers (the NPS).
- Analysing returns from the National Postal Survey (NPS) in combination with data from the Labour Force Survey (LFS) and the DWAF WSSP database
- Analysing eight case studies.

Four threads serve to provide continuity and focus to the report :

- effective water services delivery
- consumer benefits
- institutional arrangements
- public participation.

In the literature study, it is pointed out that South Africa is a world leader in the development and application of prepayment water meters and the related technology. This is reflected in South African dominance of the literature. The Internet revealed a vast number of references to Chinese suppliers of prepayment water meters but little could be found on the social, institutional and economic context in which they employ the technology. The paucity of information on the Chinese experience is undoubtedly due to language issues.

Authors on prepayment technology tend to be either proselytes or detractors with few authors offering "objective assessment. Critic's viewpoints were generally related to their distaste of privatisation and globalisation. The negative impact these forces have on human rights, and on the poor in particular informed much of their criticisms. South African critics emphasise the vulnerability of the poor and women as an argument against the use of prepayment water meters. Unfortunately these viewpoints were generally articulated before the introduction of the Free Basic Water

policy. Even critics writing after the introduction of FBW do not adequately consider the impact of the policy.

Advocates of the technology are often found from amongst suppliers of the instruments and from the local authorities using it. Countries where these meters have been used or are being considered now include Nigeria, Tanzania, Egypt, Curaçao, Namibia and Brazil. The writing of advocates accentuate the technical aspects of the technology at the cost of social and institutional aspects emphasised by critics. Rabe's research in Gauteng is highlighted as a strong contribution to the debate by a water service provider. His positive view of the technology is partly a function of assessing its impact in less in terms of income generation than it terms of minimising waste.

The National Postal Survey revealed a number of key insights including:

- More than half of all South African households fall under a "billed" system. This means that many poor households have to cover the high transaction costs associated with that system.
- When compared to consumers who pay for past consumption those using prepayment meters are charged significantly less for each litre they consume.
- Service providers believed that the vast majority of consumers were positive or indifferent to prepayment water technology.
- household consumption is price sensitive and consumption varies loosely with the price charged.
- The implementation of prepayment meters does not *per se* reduce water consumption of households.
- Although there has been a tendency to install prepayment meters in the dwellings of the poor one third of users had a household income of more than R1 200 per month.

The NPS was biased as municipalities using prepayment meters were less likely to respond than those that were not using the technology. The anticipated uptake of the technology derived from the survey should be seen against this background. After neutralising bias in the responses received a probabilistic model of uptake predicted that:

- The number of prepayment meters would probably increase by 23% in the following year
- Most municipalities that intend implementing them would have less than 100 meters in place one year hence

The Labour Force Survey (LFS) conducted in 2001 by Statistics South Africa (SSA) covered a variety of attitudes and perceptions. This survey proved useful, particularly to identify response bias and assessing the impact of prepayment meters.

The conceptual framework adopted in this report centres on "tariff regimes" under which benefits are associated with particular combinations of costs and sanctions. Five tariff regimes are distinguished: billed, flat rate, prepayment, regulated and communal sources. These are discussed and compared in terms of prevalence, cost and their impact on consumption level. The LFS established that:

- In 2001 only 2,4 percent of all households who had piped water to their dwellings or stands used prepayment meters. These meters tended to be highly concentrated in certain areas, *viz* all meters captured by the survey were in eight percent of the enumerator areas sampled.

- Consumption levels vary according to urban-rural localities with urban consumers using about three times more water per household

The information from the NPS and LFS was combined with data on water charges to unpick the attitudes and perceptions of current users. Aspects considered include perceptions of satisfaction with the technology in general and with cost effectiveness and technical reliability in particular. Prepayment meters in private houses, instead of communal taps, were viewed more critically by their users.

Among service providers there was a strong correlation between technical reliability and general satisfaction with the technology. The role of on-going support for the technology was highlighted by the correlation between support levels and high satisfaction levels regarding the meters in general and their technical reliability in particular. Contrary to popular perception vandalism was not cited by service providers as a particularly serious problem. Somewhat surprisingly service providers indicated that the FBW policy would have a minor impact on anticipated uptake of the technology.

Finally, case studies were conducted in municipalities selected to ensure a cross section of experiences with the technology. The eight municipalities selected were:

- Beaufort West (300) in the Western Cape
- Kannaland (1 400) in the Western Cape
- Swartland (1 500) in the Western Cape
- Letsemeng (1 000) in the Free State
- Mogale City (16 500) in Gauteng
- Nkomazi (1 374) in Mpumalanga
- Polokwane (1 100) in Limpopo
- Umzimvubu (500) in Eastern Cape.

The highest number of prepayment meters in use at any stage appears in brackets behind the name of each municipality. The studies examined the experiences of service providers with the technology. The most salient findings were:

- The drive to introduce prepayment water technology was motivated by a need to combat institutionalisation of non-payment.

- Planning, installation and operation were characterised by many technical problems. However instrument suppliers were initially willing to provide strong technical support.
- In many cases there was an initial lack of public participation. This situation has since improved.
- The Free Basic Water policy has had an important influence on municipalities' installing the technology. The FBW, *inter alia*, altered their perceptions as to where the technology was most appropriately placed.
- Expected future trends were highly varied. Some municipalities planned to expand coverage, while others planned to replace their prepayment meters with conventional ones. The last were generally motivated by high maintenance costs or the unreliability of the instruments.

Recommendations

It is generally concluded that prepayment water meter technology has a valuable role to play in sustainable water service delivery. The major recommendations arising from the study are:

1. Water policy (including free basic water provision and the use of equitable share grant) should be packaged in a manner that enables municipalities to better interpret and apply it.

2. Municipal structures and their agents need assistance to understand and address social conflicts relating to service payment. The impact of indigent policy and the insights gained from case studies need to be more widely shared.

3. A working partnership between stakeholders such as DWAF, SALGA, DPLG as well as WRC, must be generated. This partnership should be used to ensure that policy measures and interventions blend. The resulting shared understanding and application of policy should be communicated to municipalities in an accessible and easily understood manner.

4. Municipal water service providers should be equipped to see the differences between community resistance to payment and the means by which payment is effected. Similarly consumers have to be informed that free-riding is no longer an option – irrespective of the means by which consumers are called to account.

5. Municipal structures must actively educate constituencies as to the implications of "free-riding". This education should highlight the cost of "free-riding" in terms of reduced service delivery in other service sectors. Political representatives should play a more prominent role in articulating the grievances of their constituencies while promoting the decisions of the elected local government.

6. SABS certification of prepayment water meter units should be introduced.

Issues for further research are also identified, including:

i. An examination of the potential of "low level technology" in reducing the cost of water to very low-income communities.

ii. An examination of the impact on households and service providers of an increase in the FBW allocation.

iii. Improved estimation of the full transaction costs associated with fixed rates and "traditional" billing

iv. Estimating the impact of HIV/AIDS on the water demand and the management of water service delivery by municipalities

v. The Chinese experience should be examined by, *inter alia*, site visits which may further our understanding of the social and institutional aspects of the technology.

Acknowledgements

The authors of the report would like to acknowledge the Water Research Commission for funding the research project and would like to thank the following Steering Committee Members for their contributions and guidance:

Mr J N Bhagwan	Water Research Commission (Chairperson)
Mr D Hazelton	TSE Water Services
Mr M Marler	Development Bank of Southern Africa (DBSA)
Mr H Sussens	Department of Water Affairs and Forestry (DWAF) (Alternate)
Mr M Rabe	Johannesburg Water
Mr C Patel	Rand Water
Mr M Bannister	Mvula Trust, Polokwane
Mr D Manyindo	Department of Provincial and Local Government (DPLG)
Mr JJ Eager	Mangaung Local Municipality
Mr M Kolisa	Palmer Development Group (PDG)

The authors would like to thank the personnel of all metropolitan, district and municipal councils which took the time to respond to the National Postal Survey Questionnaire as well as personnel from various organisations and government departments who have volunteered valuable information in the preparation of case studies.

List of abbreviations

APF	Anti-privatisation Forum
CEO	Chief Executive Officer
CMIP	Consolidated Municipal Infrastructure Programme
CSIR	Council for Scientific and Industrial Research
CWSS	Community Water Supply and Sanitation
DBSA	Development Bank of Southern Africa
DPLG	Department of Provincial Affairs and Local Government
DWAF	Department of Water Affairs and Forestry
EU	European Union
FBW	Free Basic Water
ISD	Institutional and Social Development
IT	Information Technology
kl	Kilolitre
LFS	Labour Force Survey
MI (M)	Multiple Imputation (Model)
MSP	Municipal Services Project
NPS	National Postal Survey
PPWM (T)	Prepayment Water Meter (Technology)
PSU	Public Services and Utilities International
RDP	Reconstruction and Development Programme
RDSN	Rural Development Services Network
SABS	South African Bureau of Standards
SALGA	South African Local Government Association
SAMWU	South African Municipal Workers Union
SSA	Statistics South Africa
TLC	Transitional Local Council
VWC	Village Water Committee
WHO	World Health Organisation
WRC	Water Research Commission
WSA	Water Service Authority
WSP	Water Services Provider
WSSP	Water and Sanitation Services Provider

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1. BACKGROUND TO THE STUDY

Just as life requires water, commerce, industry and social development depend on an abundant supply of the liquid. But just as people need abundant water to prosper, water utilities need resources for the operational, maintenance, treatment and distribution facilities that ensure a continued supply to society. Although water is a basic need and, now, a constitutional right modern economic thinking increasingly spurns subsidies dictates that cost recovery is central to the sustainability of any service. To ensure such sustainability water service providers are increasingly looking to prepayment technology for guarantee they are receive the required revenue before the service is used.

For an effective water service to be provided it must be cost effective and affordable. However if the service is provided at an unrealistically low price consumers would develop the opinion that water is cheap and not appreciate its full economic value. Despite this risk recent government policies have promoted the idea that all households should receive a basic allotment of water free of charge. Intuitively, the concept of providing Free Basic Water (albeit in a limited volume) militates against investment in technology that enforces pre-payment from small volume consumers.

A sustainable water service is one in which, at the very least, the cost of providing the service is recovered from consumers. Cost recovery is one of a number of conditions that must be present in order to guarantee the intended benefits are sustained. Yet cost recovery is an aspect that continues to draw an inordinate amount of critical attention. In South Africa early experiences in cost recovery programmes have run headlong into the array of social, economic, technological, and other factors that complicate every aspect of its implementation.[1]

Local authorities (acting as water service providers) need to develop policies in line with government policies while generating the revenue needed to realise the sustained development of their constituencies. Prepayment is widely perceived as a short cut to cost recovery primarily because of past successes enjoyed by prepayment electricity meters.[2] However the conceptual similarity underpinning the adoption of the technology in the water sector belies important differences in implementing the technology. For example, using electricity contains an element of choice as there are alternative energy sources. By contrast water is an essential need with no close substitutes. Many of the more important differences relate to the institutional and socio-economic context in which service delivery takes place. The impact of these factors on the (potential) role prepayment meters play in ensuring a sustainable water service is explored in this study.

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[1] Elliot Sylvester. "Prepaid Water Meters in Pipeline". Cape Argus, 13 March 2002
[2] Elliot Sylvester op cit

1.1 Project Objectives

The overarching aim of this study was to review the institutional and socio-economic aspects of the application of electronic prepayment meter technology in the provision of water supply services to urban and peri-urban areas. The rapidly changing legislative, political, socio-economic and institutional framework is central to understanding the limits of the technology.

The specific objectives of the study deal with:

i. **The institutional aspects affecting the uptake of the technology with particular reference to**

- cost recovery
- water use and sales
- operation and maintenance
- administration
- distribution and management.

ii. **The impact of the socio-economic context on applying prepayment meter technology. Key aspects include**

- user acceptability and convenience
- user benefits and affordability
- impact on service levels
- water use and consumption
- community participation in technology adoption.

1.2 Research project outputs

Two outputs emanated from this project, namely this report:

- *Institutional and Socio-economic review of the use/application of electronic prepayment meter technology in the provision of water supply services to urban and peri-urban areas. WRC Project K5/1206/0/1*

  A report on the case studies (which is only available on CDROM) contains data and findings from the case studies, and the overall findings of the research study and a set of recommendations.

1.3 Research Methodology

Diagram 1 illustrates the approach adopted by this study. The first step entailed the generation of a concept paper titled "A review of Cost Recovery in Water Services". This paper outlines the parameters within which discussions and investigations concerning the use of electronic prepayment meter technology takes place. Issues such as the institutional, social, political, financial and technical factors that are likely to influence the application and use of prepayment water meters were all examined.

A review of the literature is shown as Step 2 however, this step obviously ran parallel to the development of the concept paper.

The literature survey covered writing concerning the context within which prepayment water meter technology is applied. It similarly reviewed the role key stakeholders play in water supply delivery.

In Step 3 the methodological approach to the study was established. In this phase it was ensured that methodological consistency and rigour was applied to all subsequent phases. Having adopted a *modus operandi* Step 4 involved a series of consultations between the research team and key stakeholders including the Department of Provincial Affairs and Local Government (DPLG), the Department of Water Affairs and Forestry (DWAF), South African Local Government Association (SALGA) and selected local authorities. This phase was used to confirm that the *modus operandi* was practical and that the stakeholders "bought into" the study.

The fifth step involved conducting a National Postal Survey (NPS). This survey of water service providers reviewed the institutional and socio-economic aspects of the application of electronic prepayment water meter technology in urban and peri-urban areas. Of particular interest was the extent of the use of prepayment water meter technology and anticipated uptake of the technology. A postal questionnaire was mailed to the Chief Executive Officers (CEOs) of all 284 municipalities countrywide. Responses were received from 127 giving a 45% response rate. Once the data from the NPS was received in step 7 it was analysed after it was coupled to a) data generated by Statistics South Africa (SSA) in its Labour Force Survey (LFS) of 2001 and b) to data supplied from the Department of Water Affairs and Forestry's "WSSP Database". Arising from this quantitative analysis was a set of conclusions.

These findings (from step 9) informed the focus of the next stage of the study – a number of case studies in which the water service provider's experiences with prepayment meters were investigated. Step 10 involved defining the methodology to be adopted in the case studies. This included defining the approach to be followed as well as the criteria to be used in selecting the studies. This resulted in the identification of eight municipalities constituting a cross section of experiences of implementing water prepayment meters. The case focussed heavily on interviews with key decision makers in municipalities.

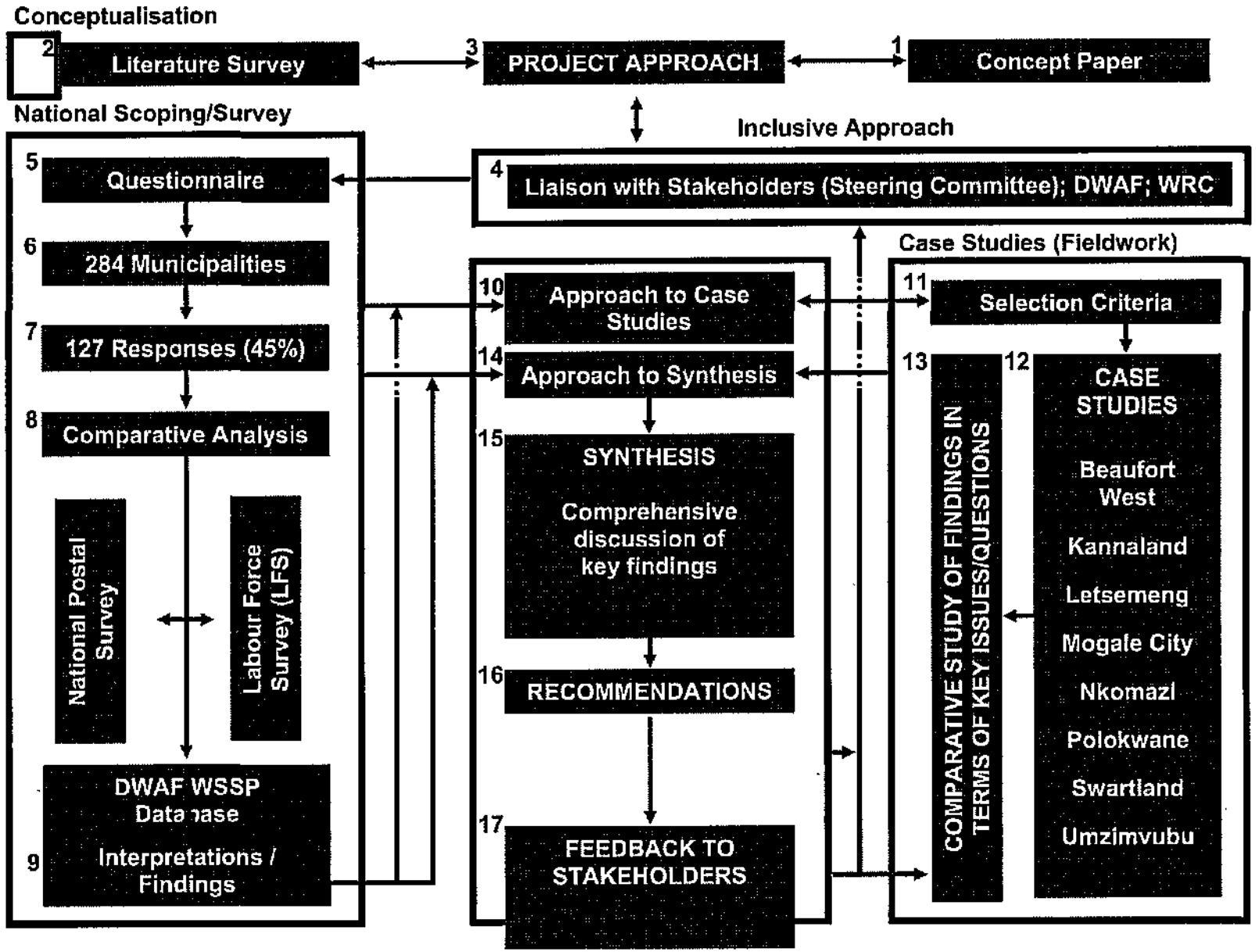
A framework for engagement with key stakeholders was established to guide the investigators. The framework included key questions derived from the NPS. In this way findings from the NPS could be examined (Step 12) in the context of each of the eight case studies.

Prior to visiting the selected municipalities a schedule of interviews was established. However it was not possible to conclude interviews with all the councillors and representatives selected. In these instances the perceptions of key actors were derived from the minutes of council meetings, other documentation and from discussions with chairpersons of committees.

Step 14 involved finalising an approach to synthesising the key findings from the NPS (incorporating the LFS and WSSP data) and the eight case studies. This synthesis is presented as "step 15" in Diagram 1. From this a set of key recommendations was identified.

The final phase of the study involves giving feedback to all key stakeholders including those contacted during the liaison stage (step 4).

Diagram 1: Research Methodology



2. CURRENT UNDERSTANDING OF PREPAYMENT METERS IN WATER SERVICES

This section constitutes a review of current thinking regarding prepayment meters in so far as domestic water services are concerned. It contextualises the dominant thinking regarding the potential and applicability of the technology. The information is derived from two sources, the experiences of practitioners in the field and a review of the literature. Aw it draws on the experiences of practitioners it tends to emphasise the role of the technology in the rural areas. As this study focuses on the application of the technology in urban and peri-urban areas these experiences are sometimes of lesser relevance. The first section deals presents this derived understanding of current thinking. A subsequent section deals more extensively with the available literature.

2.1 Introduction: the emergence of the cost recovery paradigm

In recent years cost recovery has become an increasing concern for all agencies involved in the water industry in South Africa. In both urban and rural contexts water service providers, development finders and state agencies are ever more concerned about the financial viability and sustainability of projects.

Cost recovery has increasingly placed water service providers in conflict with consumers and particularly with poor consumers. For example many rural areas, desperate for improved water services, are characterised by their resistance to anything more than the absolute minimal charge for water. Better organization in urban areas, especially the metropolitan areas, ensures that the disconnection of services to consumers who do not pay for their water have resulted in mass demonstrations and even rioting.[3]

Electricity suppliers have faced the problem of reducing or eliminating non-payment[4], and have successfully tackled the problem through the introduction of prepayment meters. The concept of prepayment has, moreover, been met with a remarkable degree of consumer acceptance. The success of electricity suppliers had led the water industry to consider similar systems. In 1992 the first prepayment water meters were being marketed in South Africa.

Although the concept sounds attractive the implementation of prepayment water metering has presented far greater challenges than those faced by the electricity industry. A key research question then becomes:

Is the concept of electronic prepayment metering for water supply appropriate in South Africa? What are the institutional, social, political, financial and technical factors that are likely to influence the application of the technology?

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[3] DESAI 2002: 67-76.
[4] Ibid pp 91-94

To answer this question some of the specific aspects that need to be investigated include the:

- Contribution of the technology to cost recovery.
- Impact of the Government's Free Basic Services policy.[5]
- Effect of the technology on water demand.
- Administrative requirements.
- Financial viability of the technology and,
- acceptability of the technology among consumers.

Success (or otherwise) in implementing the technology had to be further contextualised with respect to the socio-economic environment of that experience. Typical factors that had to be considered included:

- the linkage between community participation and acceptance of the technology
- the linkage between acceptance of the technology and consumers income levels
- the linkage between acceptance of the technology, service levels and consumers expectations.

2.2 The Background: The evolving political environment and cost recovery

Cost recovery in South Africa still turns on the characteristics of racial defined heritage. This heritage resulted not only in radically differing socio-economic conditions determined primarily by race but even in racially determined administrative experiences regarding the delivery municipal services. In the water sector this is represented by widespread conventional metering and billing among the white population, an almost universal application of flat rate systems in urban black townships, and virtually free water in the "homelands". In the 1980's political resistance inspired widespread boycott of rents, bonds and service payments In black urban areas. While successful in their objective of making black areas 'ungovernable', the tactic engendered a culture of residents not paying for services. To some extent the "culture of non-payment" continues to survive today. Inevitably this poses a problem for the current government and for local government in particular.

After the transition to full democracy in the mid-1990's the scale of the problem was such that the sustained provision of water in both urban and rural areas was placed in jeopardy. One response of the government was to launch the Masakhane

[5] Free Basic Water policy has been introduced by Government (DWAF) to ensure that all households have access to a basic supply of water. Although it is recommended that 6kl be provided free to all households, each local authority will need to determine how much water it can provide free of charge per household each month. The provision of a free basic supply of water is aimed at improving the quality of life of those South Africans who cannot afford to pay for water and constitutes one element in government's poverty reduction strategy.

campaign. This campaign was designed to restore a sense of responsibility among the public and get them to pay for their services. Relying as it did on exhortations and consumers since of civic duty the campaign was, at best, marginally successful. The debts of local authorities continued to rise. In the 26 months before 1998 the debt of local authorities increased from R6,160 million to R11,311 million.[6]

It was in this period that Eskom pioneered and championed the use of prepayment meters for electricity services. The public received this technology well and, consequently, the potential of applying the technology to water provision was then seriously investigated.

The Masakhane campaign and subsequent legislation made it clear that services must be paid for. This message was given expression by the White Paper on National Water Policy (DWAF 1997) and subsequently by the National Water Act and the National Water Services Act (108 of 1997). However while this clear message was being sent to local government and water service providers attention began to be focussed on those who cannot pay: the indigent. Municipalities began to establish data on the indigent with a view to exempting them from some service charges. National treasury facilitated this process by municipalities an "equitable share" of national revenue based on, among other things, on the number of indigent households in each municipality. There was an assumption that the equitable share should be allocated, in the first instance, to offset the cost of providing basic services to the indigent.[7]

Later legislation like the Municipal Systems Act of 2000 further compelled local government to manage their services on the basis of full cost recovery. That act spells out the basis on which tariffs must be constructed. Implicit in the legislation is that between own revenue and the equitable share local governments will cover the costs of all their operations.

Although local government has a wide range of experience in obtaining regular payments for water services[8] there are three basic options open to water service suppliers. If we momentarily ignore the option of providing water free of charge the main mechanisms of obtaining payment are:

Fixed payments per month: This option dictates that consumers are required to pay a stipulated amount irrespective of the volume of water they consume. There are various ways in which this option is manifest including graded flat rates and the distributed storage tanks.

Metered billing systems: Under this option consumers are billed for past consumption. One advantage this option has over fixed payments is that consumers are given an incentive to conserve water. However applying the option does require a relatively developed administrative infrastructure.

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[6] Department of Constitutional Development 1998.
[7] Choma 1999.
[8] Sigodi Marah Martin, Identifying examples of successful cost recovery approaches in low income urban and peri-urban areas, Water Research Commission, 2002

Metered prepayment options: Metered prepayment is a relatively new option that compels users to pay for their service before actually using it. This option promises the administrative convenience of fixed rate systems while offering consumers an incentive to conserve water.

The acceptance of an option in any area depends on a number of socio-economic and technical factors. For example electronic prepayment systems are thought to be suitable for communities[9] with high concentrations of the indigent. Under these conditions a small number of shared connections (with prepayment meters) can be used by communities. This spreads the capital investment costs across a number of consumers. For individual household connections (conventional or prepayment) the capital costs has to be borne by a single consumer which may have low consumption levels. In these instances capital costs constitute an increasing proportion of total costs ensuring that cost recovery results in higher volumetric charges.

In the case of rural areas research has shown that most schemes operate on the basis of recovering a fixed level of costs often sufficient only to power pumps.[10] In some cases, the agreed level of payment was higher than was required for solely for maintenance and operation resulting in surpluses accruing. Frequently schemes have been threatened by disputes between consumers or by the continued use of traditional water sources. In rural areas water schemes operating on cost recovery bases have been threatened by equity considerations. These issues arise when, for example, households are charge the same irrespective of household size or distance from the facility. Many schemes have been weakened by communities continuing to use traditional sources of water such as wells and rivers after prices have been based on all households using the facilities.

Prepayment technology has been applied in both urban and rural areas. While in urban areas it is typically on the basis of one meter per erf in rural areas shared standpipes are more typical. Prepayment technology has often been successful in solving some of the equity problems referred to above, but it has been plagued by a variety of difficulties mostly of a technical nature (DWAF 1998a).

Two important factors have been widely identified in relation to the successful implementation of prepayment meters. The first is where communities have not willingly accepted the concept. In these situations vandalism and similar acts of resistance occur. The high capital cost of the meters make vandalism a particularly serious problem (DWAF 1998b) and an effective resistance strategy.

The second factor relates to the technology. In many circumstances the technology is not sufficiently robust. An evaluation of the technical reliability and robustness of the technology falls beyond the scope of this study except in so far as it is affected by social and institutional dynamics. For example poor reliability manifests itself as a greater or lesser problem ion different circumstances. In rural areas the distance of remote rural areas compounds maintenance costs. In schemes closer to urban centres the impact of poor reliability may be accommodated with relative ease.

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[9] Macdonell

[10] For example see DWAF 1998

However as the distance to the schemes increases the cost of instrument failure makes maintenance increasingly expensive. Low maintenance and robustness thus has different impacts depending on the context in which the technology is applied.

Current thinking regarding prepayment meters is seemingly dominated by a relatively a relatively small number of issues. These are explored briefly.

2.2.1 Cost recovery

The principle of recurrent cost recovery is critical to project sustainability of community water supply projects. According to a WRC report:

"Cost coverage relates primarily to operational activities to meet operation, maintenance and replacement expenses. For water supply projects the main goal is sustainability. The problem of cost recovery - and here the emphasis is not financial loan recovery of commercial banks which include their own expenses and profit margins - but on recurrent cost or expense coverage". (WRC 1991)

Given that existing water infrastructure has not been adequately invested in since the 1980s' and that services need to be extended to many more communities there is an urgent need to increase capital investment in water infrastructure. However the accelerated capital investment must be balanced against the sustainability of water supply schemes, both existing and new. Expecting consumers to pay for what they have already consumed has failed in a large number of schemes forcing resources to be directed away from new schemes to covering the recurrent costs of services provided to existing beneficiaries.

Obtaining payment before consumption is possibly a more viable approach of ensuring payment. Theoretically, prepayment should achieve a high rate of success since it is based on the principle of "no pay, no service". However there are many factors that affect the implementation of the practice. These factors include community and consumer acceptance of the technology. Acceptance, in turn, is dependent of consumption levels, charges, convenient access to pay points, pre-existing level of service and the cost of alternatives. Failure to obtain community buy-in may result in resistance ranging from vandalism and illegal connections to organized protest.

2.2.2 Institutional aspects

In so far as water services are concerned the institutional landscape is in a state of rapid change. The Water Services Act (108 of 1997) provides for the establishment of Water Services Authorities, Water Services Providers, Water Boards, and Water Services Committees. The Municipal Systems Act (32 of 2000) establishes the powers and functions for municipalities at both the District and Local level. Distribution of water is allocated to the District level (although this is under review). DWAF is in the process of transferring its water schemes in the rural areas to the control of the District Municipalities, which have the duty to establish the necessary WSAs and WSPs. Aggravating these changes was a radical re-demarcation of municipalities in 2000.

Notwithstanding these changes for a water supply system and, for that matter, a cost recovery mechanism to function reliably an effective administrative structure has to be established. The sophistication of prepayment technology makes institutional and administrative capacity even more fundamental to its successful implementation. Given the dramatic changes that local government (as the main suppliers of water services) have undergone in recent years it is unsurprising that institutional weakness has been singled out as the main reason for the low level of the application of prepayment technology.[11]

The extent of the changes and the level of capacity that needs to be developed in local government ensures that building capacity to the required levels will still take some years. Until then many consumers and communities will have to live with the consequences of ineffective management which ultimately leads to wasted resources, and the reduced viability of the water supply systems (Birru 1991).

2.2.3 Free Basic Water Supply policy

The Water Services Act (108 of 1997) and the Bill of Rights in the Constitution (Act 108 of 1996) stipulate that no one must be denied the right to a basic water supply even if he or she cannot afford to pay for it. Although the policy solves some problems regarding payments from the indigent, capacity constraints have prevented the application of these rights in many, especially rural, municipalities (Muller, 2003).

Government policy recommends that 6000 litres of clean water be provided free to every household each month, but leaves the implementation of the policy up to local government. In many cases, the Free Basic Water message has resulted in increased non-payment by consumers who consider themselves poor. This is particularly a problem in rural areas where payments to service providers have dried up as consumers anticipate the introduction of the Free Basic Water. The reduced payments have threatened the ability of some water service providers to continue functioning (Martin 2002).

The DWAF guidelines (2002) regarding the suitability of technical options state that if up to 6kl is to be provided free, the need for prepayment communal street tap falls away as consumers using communal facilities are unlikely to obtain more than the stipulated minimum volume anyway. In these instances no payment is due and the billing systems become redundant. However household connections serviced by a prepayment meter can accommodate rising block tariffs. By zero rating only the first 6kl block the technology may remain pertinent in context of the Free Basic Water policy.

2.2.4 Community participation

Apart from cases where water loss is solely attributed to technological problems and system failure, the major negative factors influencing the delivery of sustainable water service are in most part social. Chapter 9 of the Municipal Systems Act 32

[11] DWAF 1998 (b) op cit.

(2000) requires municipalities to involve their communities in their affairs. However international experience in the 1980s and early 1990s has shown that community involvement must, in the case of providing services for which the public must pay, go beyond mere consultation and put the community at the centre of the process as far as possible. Although questions remain with regard to best practices, it is widely accepted that community participation must inform the level of service to be provided as well as amount people can be expected to pay.

According to WRC guidelines (WRC 1991), community participation normally takes three dimensions, namely:

- Involvement of all affected people in decision making about what should be done and how it should be done.
- Mass contribution of the community to the implementation of decisions.
- Community sharing in the benefits of the programme.

These three dimensions, when combined, define community participation as an active involvement by the local population in defining their problems and making decisions regarding projects, as well as in the implementation and evaluation of projects. In many cases community liaison officers are employed to explain options and ensure that civic responsibilities are understood and to secure the support and trust of the communities.

A WHO report states: "The involvement of the population in physical work can hardly be taken as community participation unless there is at least some degree of sharing of decisions with the community. Genuine involvement of the community at all stages of development is therefore essential for the success and sustainability of the projects." (WHO, 1987)

Very often community involvement hinges on the conceptual gap that exists between policy makers, professionals and communities being bridged before meaningful development can take place. Without such community involvement the first two groups, who each have their own objectives, may disempower or ignore communities' needs. It is important therefore that the first two groups recognise that communities know best how decisions impact on their everyday life.

2.2.5 Costs and benefits of the technology

In many cases prepayment technology is introduced in an attempt to stem poor cost recovery rates. The relative expense of the technology, however, both in terms of initial cost and maintenance has been a major factor in its relatively slow acceptance. The concept of 6000 litres free allocation of water every monthly further reduces the economic attraction of the system, in that the device will be used to measure a service that is substantially free in many cases.

Macdonell (2001) states that prepayment meters induce a significant reduction in water consumption. He argues that because the capital cost of the meters is high, significant capital investment which would otherwise be available for bulk

infrastructure and administrative overheads has to be deferred.

With time many problems related to the technology have been resolved, and as it develops further its electronic capabilities will be more fully utilised. This could include real-time readings which, when administered centrally, make it easy to check for major leaks and unaccounted for water usage.

2.2.6 Operation and maintenance of the technology

To a large extent the effective operation of water services depend on the competence of the local service provider. Their ability to maintain infrastructure is often a worthy goal for economic, social and logistical reasons. The successful operation and maintenance of the relevant devices like meters depend largely on:

- The level of technical support required from outside.
- The reliability of the water supply infrastructure.
- The interface match between metering system and existing municipal revenue collection
- The degree of fit between the systems chosen and the technological and administrative capacity in the locality concerned.

According to Birru (2001), the key issues in the operation and maintenance in the water supply sector are:

- Agencies involved in the provision of water should be service oriented. If water is to be treated as a long-term commodity, sustainability will depend on the adoption of a sound and cost effective approach, subject to the same legal and regulatory controls as other resources.
- The principle of effective demand must be the normal basis on which water is supplied to consumers. In other words, the community must define the standard of service it is willing to operate, maintain and pay for in order to ensure adequate public health standards.
- The principle of good business practice must govern the establishment, operation and maintenance of water systems. While forms of management may vary depending on local realities, the responsible agency will be guided by government guidelines. More importantly, the agency will be fully accountable to its customers.
- New programmes must seek to establish the importance of sanitation.

2.2.7 User acceptability and convenience

According to Franceys (1990), as long as water tariffs do not exceed three to five percent of household income and thus the ability of households to pay, low income communities will choose to abandon their traditional water supply in favour of improved systems. However, many reports have refuted this argument. According to Briscoe (1988), willingness, rather than ability to pay, becomes the crucial factor in determining service levels. Factors affecting willingness to pay are believed to be: perceived health benefits, convenience, amenity, time savings and economic benefits, level of service, existing alternative sources, income, price and family size.

The degree of community consultation and the quality of service are considered major factors affecting whether or not the technology is accepted by consumers. Municipalities who employ well-trained staff to communicate with their consumers regarding their choices and responsibilities are likely to find greater acceptance of the technology by the community.

2.3 Literature Survey: advocates and adversaries

Due to its relatively early entry into the field, South Africa is regarded as a world leader in the application and development of the concept of prepayment technology in the provision of water services. The literature is consequently largely dominated by South Africans and by South African experience. International references (in English) tend to cite South African literature and experience rather than the converse. The paucity of the available literature was partly overcome by Internet citations and references. This revealed a large number of references to Chinese suppliers of prepayment meters suggesting that there must be a relatively high uptake of the technology there. Unfortunately the number of suppliers is not reflected in a commensurate body of literature detailing the social and institutional impact of the technology. This is almost certainly due to the language barrier.

This review of the literature is focused on the subject at hand, namely, electronic water prepayment and does not attempt to cover the field of cost recovery as a whole, nor does it cover other methods used for obtaining payment for water consumed. Due to its novelty, the literature on the subject is very limited - particularly in so far as its social and institutional impacts are concerned.

As a rule the available literature tends to be proselytising and, as such, falls into two camps. The first camp considered below is that of critics of the technology. This school is closely associated with radical thought i.e. with solutions that depend on a fundamental shift in social relations and values. The second school of thought reflects the thinking of supporters of the technology. Such supporters include municipal managers and suppliers of the meters.

2.3.1 The Adversaries: the Radical School

The earliest literary references to prepayment water meters arise from the privatisation of water supply services in Britain. Thatchers' privatisation of water services undermined local government's traditional role as the supplier of household services like potable water. As a result the traditional practice of funding water provision by taxing households on the basis of their property values had to be

replaced. Privatisation of water services thus forced the systematic introduction of consumption metering and, inevitably, the introduction of punitive sanctions against those who defaulted on payment. Sanctions included legal action and eventual suspension of services. By 1992 the impact of disconnections was being seen in the deteriorating health of some poor households. Particularly noteworthy was an increase in the incidence of dysentery in almost all major cities (Macdonald and Pape, 2002).

Public Citizen (an advocacy site on the internet, www.citizen.org) offers concise overviews of the UK experience with prepayment meters. It points out how the deteriorating health situation was attributed to the failure of service providers to notify local health services of impending cut-offs as was required by law. The failure of water utilities to conform to the legal requirements was due, at least in part, to the onerous nature of the procedures. Water service providers saw prepayment meters as a way of circumventing the onerous requirements. In a subsequent legal challenge to prepayment water meters by Birmingham City Council, Water service providers were to argue that households using prepayment meters and who failed to pay for their consumption effectively suspended the service themselves. As a result the service provider was not required to notify local authorities of the impending cut off. The court rejected this argument and under that country's Water Act of 1998 prepayment meters were declared illegal in the UK (Public Citizen, op cit).

A short article by Howat (2001) of National Consumer Law Centre in the USA points out how similar constraints on the suspension of services apply in the USA. He declares "a fundamental danger associated with prepayment meters is that they are intended to serve as a means of replacing termination procedures governed by existing regulatory framework". Despite these constraints Howat cites the introduction of prepayment water meters in Arizona, Florida, North Carolina and Kentucky as early as 2001. Somewhat surprisingly, the introduction of prepayment meters in some of these states was associated with consumers paying a premium for the facility. This runs contrary to South African experience where the meters are associated with a reduction in service levels.

The constraints on South Africa service providers' right to terminate supply are not as formidable as those in the UK or USA. Nevertheless, the UK experience in particular has left an indelible imprint on subsequent writing in South Africa. This heritage can be seen most strongly among critics who continue to:

- Associate prepayment with disease and deteriorating health conditions.
- Cite the UK's abolition of prepayment meters as a laudable humanitarian precedent.
- Link prepayment technology with privatisation, and
- imply that advocates of prepayment meters claim that the poor "voluntarily" terminate their service.

These issues have formed the cornerstone of the radical critique of prepayment meters in South Africa. The main thrust of most radical critiques has been the impact the technology has on the vulnerable, in particular on the poor and on women (Amenga-Etego nd, Ronnie 2003 etc.) The gist of these arguments is that poverty forces households to make choices that may result in them not having access to clean water. The resulting impact of using untreated water or of reducing consumption levels necessarily contributes to increased risk of disease.

Deedat and Cottle (2002) link the introduction of prepayment meters to the outbreak of cholera in KwaZulu Natal between August 2000 and February 2002. In a series of outbreaks, at least 113 000 people contracted the disease, 259 of whom died. Had unlimited supplies of clean water been available, households would not have resorted to using contaminated water.

Most of these arguments pre-date or ignore the introduction of the Free Basic Water (FBW) policy. As a rule no attempt is made to assess the impact of the Free Basic Water allocation or to differentiate degrees of poverty. A contemporary criticism of the situation would perhaps focus less on the technology and more on the adequacy of the FBW allocation, how it is estimated or the extent of the failure of water service providers to implement the policy. Furthermore, the radical critics seem to assume that the alternative to "cost recovery" is a free unlimited supply of water, rather than the breakdown of existing infrastructure or the reduced roll-out of services. For them, the provision of a high level of service can be funded by subsidies ostensibly without opportunity costs. By contrast, TSE (2000) indicates how tenuous the provision of water services currently is – particularly in rural areas.

In the main, the problems with which prepayment meters are associated rest on their efficacy as a means of credit control. The secretary general of the SAMWU, Roger Ronnie, states "prepayment meters are by far the most effective form of credit control and debt repayment for those whose primary objective is not the supply of clean and affordable water but cost recovery". (Ronnie, 2003)

Consequently the criticisms offer little insight into prepayment meters and should be better directed at payment, credit control etc. In rare instances, the criticisms are appropriately directed at the instruments through which cost recovery is achieved. These include those citations of instrument failure as a cause for hardship (Deedat and Cottle, 2002).

In developing countries, the criticisms initiated by the English experience are given an added dimension in the form of concerns about globalisation and the role of local elites (Deedat and Cottle, 2002). Concerns about the impact of globalisation are consistently expressed through the distaste shown for the inroads made by Vivendi, Biwater, Suez Lyonnaise etc. into water service provision in South Africa and other developing countries. Concerns regarding the role of local elites in promoting the commodification of water are less pervasive yet probably more important. The Rural Development Services Network declares that the current drive to privatise water supply is not only in the interests of global players but also serves "monopoly capitalist interests in securing water supplies and black economic empowerment" (RSDN, 2002).

Given the small number of critics and organisations involved, the radical critique of prepayment meters could have been taken less seriously if they had not been adopted by organised labour in South Africa and elsewhere. Labour unions in the public sector have, drawing on the association between prepayment meters and privatisation and the further association of privatisation with globalisation, aggressively campaigned against prepayment meters. For example the South African Municipal Workers Union (SAMWU) has strongly opposed prepayment meters citing the deleterious health effects, its impact on the poor and the likelihood of job cuts (Ronnie, 2003).

General Secretary of SAMWU Roger Ronnie and others cite the UK abolition of prepayment meters as a moral precedent worthy of emulation. They justify the abolition in terms of protecting the human rights of consumers. Despite rejecting prepayment meters and payment for essential services, Ronnie promotes the adoption of a flat rate system for the provision of these services. Again he cites the UK experience "indeed, Britain – a foremost 'first world' country – serves to remind us also of the virtues of flat rate water charges being part of the households rate bill." It is indicated later in this report that the flat rate system is probably the least efficient tariff regime (see section 5.2.1.2), notwithstanding the on-going failure of water service and other providers to secure payment from household under this cost regime.

Organised labour's antipathy to privatisation and prepayment meters can also be seen in the response to the prospect of municipal water services being privatised in Ghana. Amenga-Etego (Amenga-Etego, n.d.) recounts the fear of lay-offs and price increases that were expected to follow the privatisation of Ghana's water services. Later references indicate that the privatisation drive was abandoned because the required financial commitment from international companies could not be secured.

The radical school of thought regarding prepayment meters is dismissive of the technology – probably because of its efficacy as a credit control mechanism and its consequent association with privatisation. Prepayment meters are seen as a means of extracting payment from the poor, of promoting the interests of global corporations at the expense of the poor and of keeping labour on the defensive. This school thus conflates a number of issues that are not necessarily related – globalisation, privatisation, human rights and health etc. The payment of services and cost recovery, for example, is not necessarily contingent on privatisation. Neither is prepayment contingent on the adoption of high technology. Prepayment is a common feature of low technology water markets in developing countries (see Water Utility Partnerships, 2000).

2.3.2 The Advocates

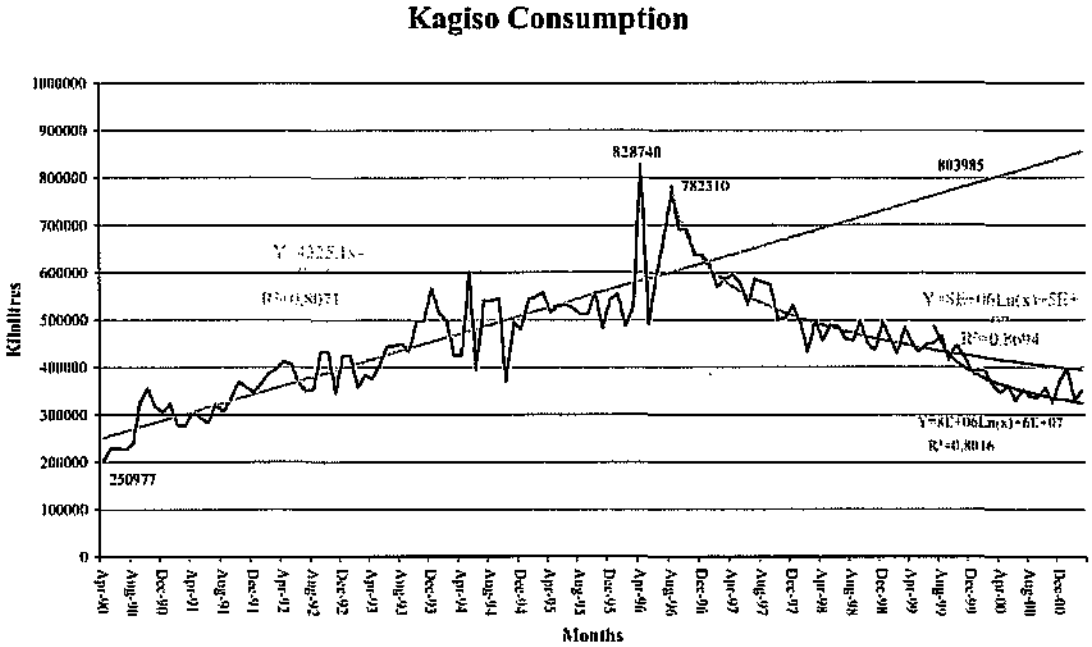
The converse of the radical critique is the writing of service providers and instrument manufacturers who support the technology – primarily from a commercial perspective. The available information tends to concentrate on descriptions of available instruments and promotion by other proselytes. The "Metering International" website serves as a portal where advocates share experiences and ambitions with others in the market. The site shows that interest in the technology is expanding internationally and that South African suppliers are often intimately involved with the process. Countries that are testing (or have tested) the technology

include:

- Nigeria: Lagos and Victoria Island (using Conlog)
- Dar es Salaam, Tanzania (using Conlog)
- Egypt Luxor, Mansoura and Nuweiba (using Severn Trent)
- Curacao (using Atlantic meters)
- Namibia (using Atlantic meters)
- Brazil (using Atlantic meters)

Unfortunately, the emphasis that these publications place on technical aspects, coupled to their advocacy objectives, ensure that they offer little insight into the social and institutional impacts of the technology. One clear exception is the work of Rabe (e.g. see Rabe 2001) who was a prime advocate of the technology in Mogale City and later in Johannesburg. He shows how the implementation of prepayment meters in Kagiso and Orange Farm was only undertaken after extensive community participation. Once the systems had been implemented, the local councils reaped significant benefits through reduced waste of water. His perspective offers a useful counterpoint to Bond who suggests that cost recovery administration incurs more expense than can be squeezed out of low income households. Rabe, by contrast, indicates that the benefits lie less with the revenue earned than the volume of water not wasted.

Graph 1: Kagiso's consumption



(Source: Rabe 2001)

The graph above shows the total purchase of water for the area of Kagiso. It indicates a continuous rise in water consumption from April 1990 up to July 1996, indicated at "A", when major interventions were taken. The intervention adopted,

involved primarily repairing and upgrading reticulation systems followed by a stringent cost recovery programme. This resulted in a drastic drop in water consumption. A further drop was experienced in July 1999 (see B), when prepayment water meters were introduced, as shown. The straight line gives a projection of consumption had there been no intervention. The graph covers the period from April 1990 to October 2000 – about 10 years.

This drop in water consumption is also borne out in the case of the Olievenhoutsbosch project situated in Tshwane Municipality, Gauteng. The average monthly consumption of 9,67 kl per household is compared to 24,3 kl per household in other conventionally metered areas where water flow control devices are used.

2.3.3 Technology

The first analysis of prepayment technology is given in Simes, Lings and Tshivase (1993). It describes the advantages in terms of savings in administration and conflict through the avoidance of water cut-offs. It also claims that the system also allows people to monitor their consumption and thereby to tailor it to their means.

It points out that there if electricity is required to power the water meters, they will fail if the electricity is cut off for any reason. It also points to the problem (referred to above) of water disconnections in the light of the constitutional prohibition on cutting off water supply totally.

The report provides an overview of the technologies, and an evaluation of the systems available at that time. It goes into considerable detail regarding the different types of cards or tokens that might be used, as well as the measuring techniques. The report also discusses the need for a master station, which could be linked to water consumption data, and credit dispensing units. It makes recommendations on dispensing systems, maintenance, and systems to link with electrical metering and supply.

Four years later, another report (DWAF, 1997) covered:

- Manually filled household distributed storage tanks.
- Automatically filling regulated household distributed storage tanks.
- Mechanically operated coupon activated vending units.
- Electronically operated prepayment systems.
- PC Based water utility management systems.

Regarding the electronic prepayment meters five systems were studied.

- ABB Kent/Telbit Halster Talbot
- Schneider Electrical
- Plessey/Control Instruments
- Cumcon, and
- Schlumberger Measurements and Systems.

At that date it would appear that only one water services provider, Bambamanzi, had schemes in operation. Three pilot projects had been commissioned by Umgeni in May 1997. However, the report made no attempt to evaluate the systems.

It also includes an extensive literature survey. This is not limited to the concept of prepayment, but covers matters such as the concept of free water, issues of affordability and willingness to pay, costs and tariffs.

Case studies of four schemes are included in DWAF (2000). The report evaluates four schemes:

- Modderspruit (rural settlement of 2000 families, in NW Province)
- Masakala (1000 families in three rural villages)
- Khutsong (5000 unit township near Carltonville, Gauteng)and
- Koffiefontein (town of 3000 families, 400 metres installed, in the Free State).

Among its important conclusions are:

- The system helps consumers to budget, while also controlling consumer debt and water wastage
- It is difficult to justify the cost of prepayment meters in areas of low demand
- There is a tendency by water services providers to assume that technology will solve problems which are, in fact, social ones.

Concerning the individual schemes, the report noted that the transition from free water previously to a situation where the community would have to pay through prepayment meters, had not been handled well and a minority of consumers still rejected the scheme.

Maintenance problems were experienced in three schemes; in the fourth a high standard had been achieved, but at a high cost. However, newer meters have proved to be much more reliable.

The study concludes that only one in four of the schemes is likely to be financially viable. This is made possible by the fact that it is located in a town which has higher income groups (with individual connections and conventional meters) whose payments can be used for cross-subsidisation. Strictly speaking this conclusion is not accurate as it is not the scheme that is financially viable, but the water provision within that town as a whole.

Three technical systems were evaluated:

- Bateman Water, who are also making the AquaNova range of water prepayment systems (Masakala)
- Bambamanzi (Modderspruit and Koffiefontein)
- Kent (Khutsong).

They also refer to a new system, Atlantic Meters, which was developed for the UK market, and was currently being introduced in the SA market.

A more recent document (DBSA, 2001) addresses the increasing demand by municipalities and municipal structures for financial assistance to install prepayment water meters. It highlights the importance of achieving sustainable water delivery through effective revenue and technology management. It also cites the importance of customers' satisfaction with the service for effective water revenue management and recommends assessing the following conditions for loan applications:

- Customer acceptance in terms of levels of service and user-charges;
- Reliability of the existing service in terms of quantity and quality of water; and
- Affordability to the customer and service provider.

The document also includes a breakdown of salient considerations to be addressed in the appraisal of an application for funding for prepayment water meter systems. These include institutional, social, legal, financial, technical and environmental considerations.

3. NATIONAL POSTAL SURVEY OF PREPAYMENT WATER METER TECHNOLOGY

3.1 Background

This chapter describes the methodology used in a National Survey of water service suppliers. The need for such a survey arose as a result of the radical realignment of municipalities (the primary water service providers) as a result of their re-demarcation and transformation.

Practical constraints limited the information that could be obtained from a national scan of municipalities. One serious limitation that prevented many municipalities involving themselves in the study was their own lack of administrative capacity. However, the data obtained was adequately representative and generalisations could be made with available information.

3.2 The demarcation process

3.2.1 Introduction

One of the key steps in local government reform was the re-demarcation of municipal boundaries. The re-demarcation was driven by political and particularly by equity considerations. The main rationale for demarcation included:

- Some parts of South Africa did not have directly elected local government – they were only served by District Councils.
- Some District Councils, the primary instrument of service delivery in many areas, were so large that they were half the size of provinces. Many residents were therefore too distant for Local Councils to understand and respond timeously to their needs.
- Areas falling under District Councils were often inconsistent with other administrative regions like health and education districts. This misalignment of areas of responsibility was not conducive to integrated development.
- Many local municipalities were not financially viable. A prominent reasons was that many municipal boundaries had not been drawn sufficiently wide to enclose tax bases that could sustain administration and development.
- Rural municipalities were often structures without meaningful powers, financial resources or capacity. It subsequently became important to integrate them into municipalities that did have capacity and resources.
- The internal and external boundaries were drawn along racial lines and often contained dramatically differing numbers of voters. New wards needed to be demarcated to improve equity in representation and to de-racialise political spaces.

In brief, the demarcation of municipalities aimed to ensure they could become economically viable and able to deliver services more efficiently and effectively.

3.2.2 Municipal profiles

The argument for the rationalisation of municipalities followed the line that local democracy is best served by local governments that can effectively promote development and the delivery of services. The re-demarcation of municipalities was completed in 2000 and in the process the total number of local government entities dropped from 843 to 284. These changes were coupled to substantially increased responsibilities. Effective (and more equitable) development and service delivery depends, in turn, on better balancing demands/needs and the existing institutional capacity. The latter had been heavily concentrated in local councils with strong commercial economies and highly urbanised populations. Demarcation sought to better match the existing institutional and economic resources to the developmental interests of a wider population while ensuring better economies of scale.

3.3 Data collection and analysis

The transformation and re-demarcation process ensured that documentation regarding service levels and payment histories were generally not available for analysis. In lieu of this information data available from surveys of end-users (households) was analysed. The Labour Force Survey (LFS) of 2001 proved to be particularly useful, particularly with respect to the impact of prepayment meters. This data allowed for an investigation of the relationship between consumer behaviour and the environment in which they found themselves. The conceptual framework adopted in this analysis centres on the notion of "tariff regimes". A tariff regime links benefits (in the form of services) to particular combinations of costs and sanctions.

As a rule tariff regimes are implemented by service providers rather than opted for by end users. For example, the decision to install prepayment metering rests largely on the expectations and needs of service providers rather than on the demands of the consumer. Soliciting the views of service providers thus became a central additional component of the study. A national survey of service providers which, for the most part are the local governments, was conducted to fill some of the information gaps.

A third source of information was used to supplement that derived from the various surveys. This was DWAF's "WSSP" database which summarizes, by water service provider, price structures. The three main sources of information used were thus:

1. A postal survey of water service providers commissioned for the study

2. The first LFS of 2001. This large, nationally representative survey of almost 30 000 households covered water related services to an unprecedented degree.

3. Data submitted by water service providers in response to requests by DWAF. The most relevant information related to water charges for households.

When appropriate, the three data sets were integrated by aggregating the information to municipality level - as defined by the re-demarcation of 2000. These

municipalities are usually the premier (and often the sole) provider of potable water to households. By integrating the different data, appropriate correlations could be made, for example, between perceptions of end users and the price structure of household water or the attitudes of service providers to non-payment. Whether or not they are the sole water service provider, municipalities are responsible for meeting the minimum service levels with respect to Free Basic Water, thereby making their opinions with respect to facilitating technologies a key issue. The next section of the report reviews and interprets this information particularly in so far as it relates to prepayment meters.

3.3.1 The postal survey

The purpose of the postal survey was to collect information from the re-demarcated municipalities on the social, infrastructural, and institutional context in which they operated and on the extent of their use of prepayment water meters. Of particular interest was the perception of the technology was perceived and the prospects for its future uptake.

The methodology adopted was based on that used by *Sigodi Marah Martin* in their Cost of Water research study (2002b). One of the research instruments was a postal questionnaire that was mailed to the CEOs of all 284 municipalities countrywide. CEOs were asked to complete the questionnaire regardless of whether or not their municipalities currently used prepayment water meter technology. However non-users were to answer only a section on future plans regarding prepayment meter uptake.

The main challenge in postal surveys is to achieve an adequate response rate, since many targeted respondents inevitably choose not to participate. If the realised sample — that is, the set of responding municipalities — is either too small or is unrepresentative of the targeted sample, the value of the survey data will be severely compromised. Experience with surveys of similar samples (including the national survey of cost recovery conducted for the WRC in late 2000) suggests that a 40 percent response rate is a realistic goal. For the prepayment meter survey, this translates into 114 municipalities. Keep in mind that, of responding municipalities, a substantial proportion will most likely not be current users of prepayment water meter technology, meaning that only a few items on the questionnaire will be applicable to them.

3.3.2 Design of postal questionnaire

The sample questionnaire is included in Annexure B to this report. The survey aimed to provide answers on the following issues:

- How many municipalities are using prepayment water meters
- Their assessment of the technology
- The costs of installation
- The percentage of the consumers using the technology

- The income levels of users of the prepayment meters
- Details of the system used, if any, and support provided by suppliers
- Level of satisfaction with the meters
- Advantages for the municipality
- Level of satisfaction with the technology
- Technological problems
- Consumers' attitudes
- Incidence of vandalism
- Impact of free basic services policy on future use of the technology
- Likely trends for the next few years.

4. DATA ANALYSIS

While the analysis below draws heavily on the postal survey conducted at the end of 2002, it also includes other data sources such as the LFS of 2001 and DWAF's WSSP Database. In the section below those data sources indicated above are referred to wherever relevant.

4.1 Introduction

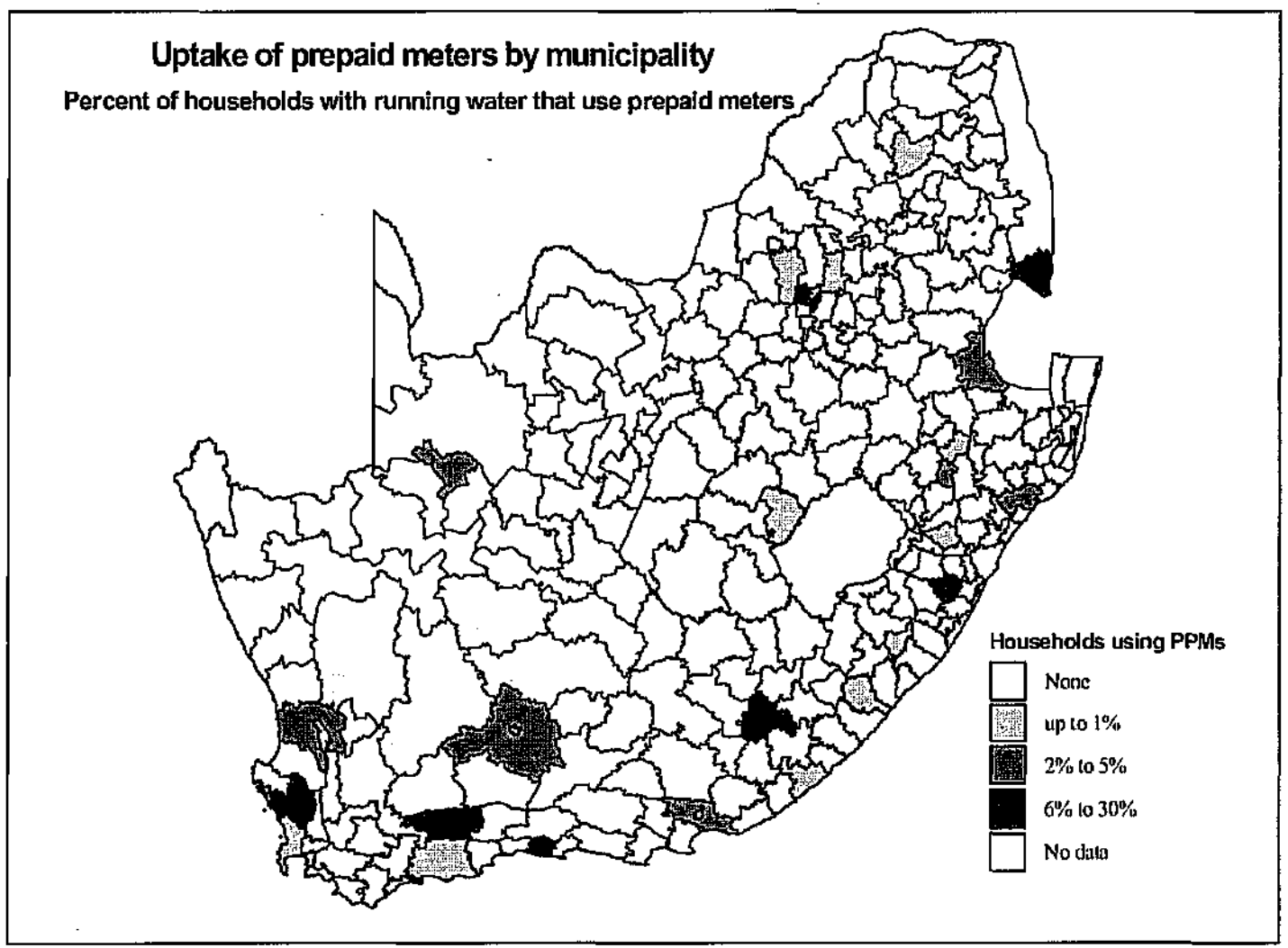
Prior to the implementation of the Free Basic Water policy the future of prepayment meters looked promising. The technology seemingly offered a way of increasing cost recovery, particularly in the sub-economic market, without imposing prohibitive transaction costs on consumers. While ensuring that users paid for services rendered, the technology ensured that users had an incentive to conserve water as it associated increased consumption with higher user cost. The promising future was, however, undermined by the questionable reliability of the meters, vandalism; and the organisation and maintenance capacity and competency of local authorities. The latter seemed to imply that those households best suited to the application of prepayment meters were now to receive most if not all their water free of charge. This, *inter alia*, reduced the incentive for local authorities to install water meters in those households not likely to consume much in excess of the specified monthly allocation. These factors brought into question the extent to which prepayment meters would be taken up by service providers. However, better measurement of the ultimate impact rested on simply asking service providers what their intentions were and how they would respond to the FBW policy.

In the second half of 2002, a national postal survey was commissioned to assess the costs and prevalence of prepayment meters and the future of the technology under the prevailing conditions. A brief questionnaire was sent to the municipal manager in every local municipality with a request that it be completed by the chief engineer or most appropriate person and returned. In total, responses were received from 127 of the 284 municipalities.

4.2 Representivity of the survey

The responses were from a cross section of municipalities – geographically, in terms of population and degree of urbanisation and development. Although the responses were from a cross section of municipalities they did not necessarily represent national trends in terms of current uptake of the technology or, for that matter, envisaged uptake. It does seem that municipalities that currently use prepayment meters were somewhat less likely to respond to the survey than municipalities that did not currently utilise the technology. This differential in participation rates can be attributed to the fact that the questionnaire, (although it was short) was somewhat more onerous on current users than it was on non-users.

Diagram 2: Distribution of Municipalities currently using prepayment meters (according to the National Postal Survey 2002)



The degree to which the responses represent national trends can be illustrated via the prevalence of household prepayment meters. The survey estimated that fractionally less than one percent of households in the responding municipalities uses prepayment meters. This is approximately half the national prevalence rate as derived from the first LFS. Nevertheless, given the geographical dispersion, its coverage of both sparsely populated rural municipalities and of metropolitan councils, and the broad coincidence of prevalence rates, there is little to suggest, a priori, that the responses should not be taken to be representative of national trends. This issue is expanded below.

Given the large sample size and systematic coverage the LFS offers the best measure of the prevalence of prepayment meters. The LFS of 2001 was conducted by SSA in a random selection of almost 30 000 households across the country. In that year 2.4 percent of households who had water piped to their dwellings or stands used prepayment water meters[12]. Although this represents only a small fraction of all households they collective constitute over 213 000 households. The uptake of the technology was nevertheless widespread with some taking place in 39 percent of the municipalities sampled in the LFS. However the use of prepayment meters tends to be highly concentrated in specific geographical areas. The degree of concentration is better reflected by the fact that prepayment meters were in place in only 8 percent of the 3 045 primary sample units (enumerator areas). It is also clear from the data that prepayment meters are not being placed in regions en masse. In those enumerator areas with at least one prepayment meter, there were, on average, 10 households, however slightly less than one quarter of those households (2.4) that used the technology. The majority of households in the selected enumerator areas continued to use other technologies. The uptake of prepayment meters was not as highly concentrated (geographically) as may have been expected.

The responses from the postal survey indicate that only 28 of the 127 responding municipalities currently use the technology. This amounts to 22 percent of respondents – reaffirming that non-users were more likely to respond to the survey. Nevertheless between them, the municipalities that responded have a population of approximately 4.3 million households. In these municipalities there are only about 35 000 prepayment meters in use. The vast majority of these (83 percent) are placed in private households. The balance, approximately 6 000 meters, has been linked to communal and other taps.

According to the postal survey respondents most prepayment meters have, as expected, been placed in poorer households. These respondents indicated that almost two thirds of the meters (64 percent) were installed in households with an income of less than R1 200 per month. Despite the association of prepayment meters with poverty, the data also indicate that a third of households using the technology have incomes in excess of R1 200 per month.

The LFS confirmed the data relating to the postal respondent's perception of prepayment households' income. The LFS indicated that 62 percent of these households earned less than R1001 a month in 2001. Given that the postal survey

[12] Given that almost 20 percent of households do not receive piped water to their dwellings this group constitutes approximately 1.7 percent of all households in the country

respondents had to categorise their estimates into four equally sized categories the match is as close as could be expected. The closeness of the match suggests that the water service providers are clearly attuned to the economic status of their prepayment meter "clients".

Sensitivity to the economic status of the households is derived from concerns about households' ability to pay for the water. Some insight is gained into how much they are expected to pay by matching the responses to the postal survey to the data collected by DWAF. The relevant information from the DWAF WSSP Database relates to the pricing of water. The primary object of concern in this section is the price of one kl of water in the price band immediately above the free entitlement amount. This indicates the price paid by households in the tariff band which prepayment customers are most likely to fall.

The DWAF WSSP data indicate that the average price of one kl of water was R2.87[13] (with a standard error of R1.67). The standard error is large compared to the average price paid indicating that there is great variation in the price demanded of consumers. Further analysis indicates that an important distinction needs to be made between municipalities that charge only a volume-based tariff and those that charge a fixed cost over and above the consumption charge. It transpires that for households in the targeted consumption category a significant part (perhaps a third) of the price was due to the fixed component. On average, an extra R0.98 per kl[14] over and above the volumetric component was charged by those municipalities which charged a fixed rate for water. This component is usually justified in terms of covering overheads – including transaction costs. Transaction costs are those costs incurred in ensuring that payment for services are made. They include the cost of estimating consumption, pricing the sale correctly, invoicing the debtor, receiving payment and crediting the relevant account. It also includes the costs of pursuing late payments and taking measures against those who consistently fail to pay. Although actual transaction costs have not been reliably measured, this selective description as well as the size of the fixed component of cost structures implies that transaction costs are not an insignificant proportion of the total cost of providing the service.

4.2.1 Cost regimes

As indicated above, transaction costs can contribute significantly to the cost of any product. When the provision of an essential service is concerned, such costs can make a difference to a household's sustainability. Over time, strategies have evolved to minimise transactions and other costs associated with the provision of essential services to economically marginalised households. These strategies have evolved into the establishment of cost "regimes" in which levels of service (and thus, by implication, consumption) are linked to particular tariff structures and to sanctions and incentives for payment. These regimes can be thought of as hierarchical in that

[13] These calculations are based not on the declared price of that kl but on the natural log of that price. The log on the price yields a normal distribution.

[14] The size of the fixed component of tariffs varies markedly. The WSSP indicates that in municipalities which do have a fixed component, charges typically range from R20-R100 per month.

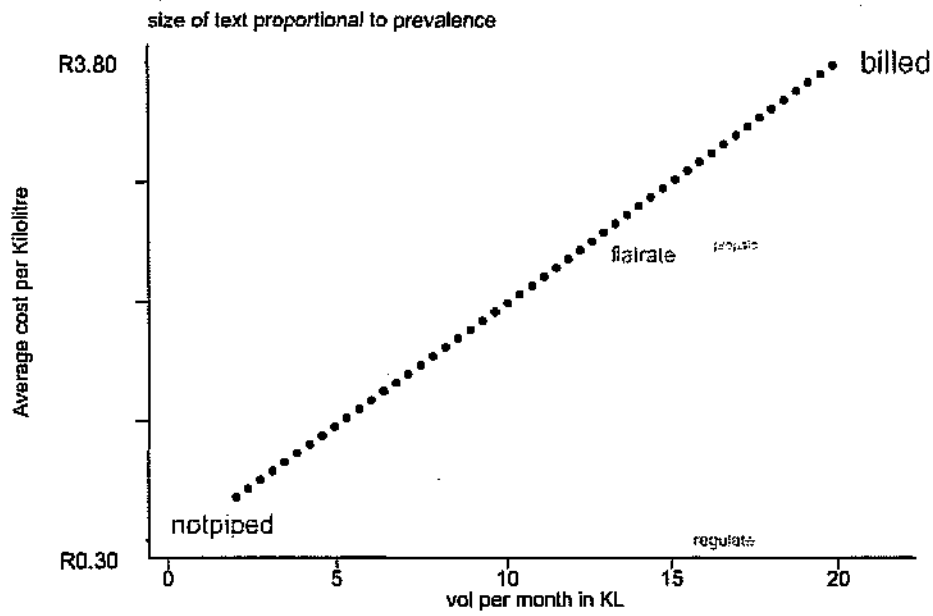
they represent different levels of service with better/worse service levels being easy to identify. As a rule, increased levels of service are associated with higher consumption levels, greater ability to pay, and increased transactions costs.

The association between costs and consumption levels can be illustrated by the LFS survey of 2001. That survey points to at least five[15] different service delivery regimes. In order of decreasing service levels, they are:

1) Billed consumers and metered consumers
2) Flat rate consumers
3) Prepayment metered households
4) Regulated supply
5) Water supplied from communal sources

Under the progressive tariff structures widely adopted by water service providers higher consumption levels (and thus better service levels) are associated with higher per litre costs. The relationship between per litre costs and consumption levels for each regime is illustrated in the graph below. The graph is based on consumption and payment levels reported by the LFS respondents.

Graph 2: Consumption and payment levels



In the graph, the size of the text used to label the tariff regime is proportional to the prevalence of the regime. A large font indicates that there are more households falling under that cost regime. The prevalence of each regime is given in the text

[15] The hierarchies were created by ranking service levels according to the delivery mechanism and tariff structure. Each household would then be placed in the category which represented the highest level of service they received. If a household was billed on the basis of conventional meter reading and also used a prepayment meter, for example, they would be classified under "billed" customer rather than under "prepayment".

below. Approximately half of all households fall into the "billed" category and slightly more than 31 percent fall into the "not piped" category. This indicates that all but twenty percent of households receive either a high level of service (billed) or a basic service (not piped). A minority of households that receive a regulated supply, have to pre-pay for their water or are billed on the basis of a flat rate.

Each regime is discussed briefly below. The figures appearing immediately after the name of the "regime" indicate the percentage of all households falling under that regime. These estimates are derived from the LFS 2001.

4.2.1.1 **Billed and metered consumers** (50.5% of households)

These consumers are billed for their water consumption on a regular basis. The bill is usually based on a periodic meter reading of the household's water consumption. Characteristic features of this regime include:

- High service levels with respect to water and other service delivery
- High transaction costs
- High consumption levels
- Consumers able and willing to pay
- Consumption based tariff
- High per litre costs
- The widespread use of a fixed tariff component.

The high service levels are indicated by the provision of piped water into the dwelling or onto the stand. This makes water highly accessible and is thus conducive to high consumption levels. The high consumption levels are, in turn, conducive to individual billing – which allows for the introduction of progressive tariffs which place the price demanded closer to the actual (full) cost of the service. The progressive tariffs thus induce a greater degree of economic efficiency. The service levels are accompanied by high transaction costs. These costs arise from the need to install and read meters at regular intervals, calculate consumption rates, disseminate bills, etc. The service level has to be associated with a reasonably efficient mail system through which accounts can be delivered. It also depends on an efficient banking or retail sector that facilitates payment. The high consumption levels (and the high tariffs structure) also make non-payment financially more damaging, they thus induce the establishment of credit controls etc. which further contribute to total transaction costs.

Unfortunately estimates of actual transaction costs are not available but, given the above, these are certainly higher than the commensurate costs associated with other tariff regimes.

4.2.1.2 **Flat rate consumers** (12.1% of households)

These consumers enjoy a service level often on a par with that of billed consumers i.e. in-house piped water. Transaction costs are however

somewhat lower as regular reading of consumption meters (and their installation) is not required. Billing costs can be further reduced by packaging the water bill with that of electricity, rates and taxes thereby disbursing costs over a number of transactions. As these consumers are not billed on the basis of their consumption they have a reduced incentive to use water sparingly. They, unfortunately, also have little reason to monitor their consumption levels and thus are prone to misreporting their consumption. Of all the tariff regimes "flat rates" have the highest level of non-payment. The combination of low payment rates, high consumption levels and high transaction costs indicate that this type of service is the least sustainable.

4.2.1.3 **Prepayment consumers** (1.9 % of households)

These consumers bear almost all the transaction costs of their water service. Their service is purchased up front and therefore the service provider is able to shift onto the consumer most of the costs associated with metering, billing, postage, credit control etc. Consumers have an increased burden of purchasing their entitlements (prior to consumption) at a place and time convenient to the provider. The service provider is therefore usually in debt to the consumer rather than vice versa. The quid pro quo is reflected in the lower per litre cost of this service.

Although transaction costs are far lower than those for other tariff regimes they are not negligible. If the tokens or billing devices cannot be sold at local shops then service providers have to establish payment points and subsidise this cost (or pass it on to consumers). This need is usually greatest in the more isolated areas with particularly poor infrastructure. While this form of payment is most appropriate to areas with poorer mail and banking infrastructure the associated isolation further drives up the cost of servicing and repairing the meters (prepayment or otherwise). An additional consideration is the tariff structure adhered to by the municipalities and their ability to grant exemptions to that structure.

None of the survey respondents who indicated they currently use prepayment meters were located in municipalities with a fixed component in the tariff pricing. This may be due to the need to exempt prepayment customers from the component or make the per litre cost of the water prohibitively expensive. Without an exemption the full cost of the fixed component would have to be recovered from the above 6kl consumption. Unless the cost component can then be disbursed across the above 6kl consumed (the amount of which is unknown prior to the consumption) the first kl of water above the 6kl threshold will carry the full fixed component. This litre then becomes exorbitantly expensive.

The implementation of prepayment meters is often seen as an alternative to community-based institutional management of water provision. In the latter, local communities manage water distribution, deal with free-riders and collect revenue. Prepayment meters may be a more viable alternative when communal institutions are weak and infrastructure more developed.

4.2.1.4 **Regulated supply consumers** (4.9% of consumers)

This category of service is loosely associated with those households that receive their water via a tank or a pressure supply mechanism that otherwise limits their consumption. The mechanism ensures that consumption levels are low. More often than not these households consume little more than the free entitlement. Billing for excess consumption then becomes unnecessary or prohibitively expensive.

Households in this category thus receive the lowest level of piped service but enjoy the lowest per litre cost of water. The typical features of this regime are:

- Low service levels with respect to water and other service delivery.
- Negligible transaction costs
- Low consumption levels
- Consumers unable to pay
- Consumption is regulated
- Low per litre costs.

This technology is thus suited to those areas in which:

- Consumption levels are low, (near stipulated free-minimum)
- Users ability/willingness to pay is low
- Postal and banking systems are poor.

4.2.1.5 **Consumers using communal sources** (30.7% of consumers)

This is a broad-based category referring to those households that have to retrieve their water off-site. This defining feature limits the quantity of water consumed by the household to the amount they can carry. As most of this will be within the 6kl free allowance and, given that these households are, almost by definition, extremely poor, this does not constitute a viable market for the sale of water services. The features of this tariff regime are:

- Minimal or no service provided
- No transaction cost
- Negligible ability to pay
- No per litre cost (in terms of financial criteria)
- Strong reliance on community institutions to extract payment.

4.2.2 Tariff regimes and the cost of water

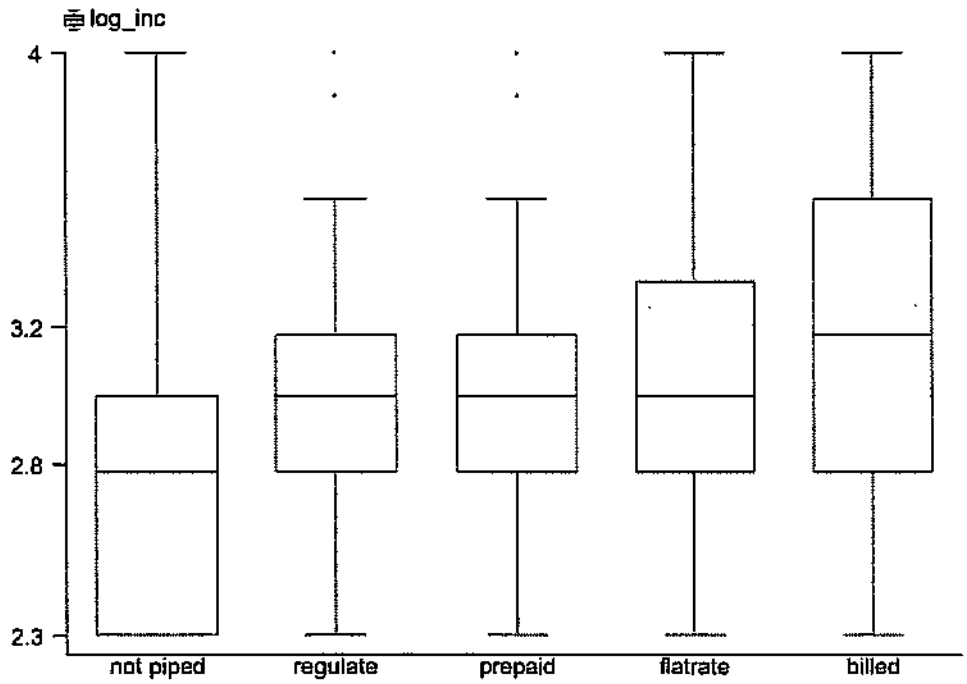
The *per* litre cost of water for each of the service levels suggests that savings made on transaction costs, etc. under each tariff regime are generally passed onto the consumer in the form of lower tariffs. This effect is realised through the implementation of tariff regimes constructed around the ability and willingness of consumers to pay. Consumers willingness to pay, coupled to the imperative of

meeting minimum standards and providing the free basic service, force water service providers to tailor their cost structure to the market. If, as is suggested above, transaction costs constitute a significant component of total cost of water to low volume consumers, then service providers have minimise them. Similar, parallel, strategies have to be adopted to reduce capital expenditure and variable costs. These strategies often limit the quality of the service – such as the pressure at which the water is supplied or the ease with which the service can be accessed. If successful, these strategies reduce the *per* litre cost of water. The reduced volumetric charge will enable households to enjoy a higher level of consumption within a given budget and for the supplier to earn revenue to be earned off a larger volume of water supplied.

Many strategies (like the implementation of prepayment systems) to minimise transaction costs involve shifting these costs onto the consumer. In many situations such a strategy can be highly counterproductive. Wealthier customers, for example, are almost certainly willing to pay a premium in return for greater convenience. Ensuring that consumers fall under an appropriate regime is thus central to an effective cost management system. Unfortunately there is ample evidence that cost regimes are poorly geared to consumers situations. As can be seen in Graph 3 below half of all households which currently receive piped water fall under a "billed" regime. The income of these households overlaps substantially with those under prepayment and other low cost regimes. There is thus, *prima facie*, strong grounds for arguing that an optimal tariff solution would involve the shrinking of the number of people under a billed regime and expanding the use of, *inter alia*, prepayment meters. However this would require that the alternative regimes live up to expectations in terms of reliability, maintenance costs and acceptance by consumers.

Conversely the success of any tariff regime depends not only on the efficacy of the underlying technology but also on how well the regime is matched to the needs of the target group. The current correlation between income distribution and tariff regimes is illustrated in the box and whisker plot in Graph 3 below. Income is indicated by the log (to the base 10) of the average monthly household income. Households with a "log income" of 2 earn R100 per month, those with a "log income" of 3 earn R1000 per month, and those with a "log income" of 4 earn R10 000 per month.

Graph 3: Current correlation between income distribution and tariff regimes



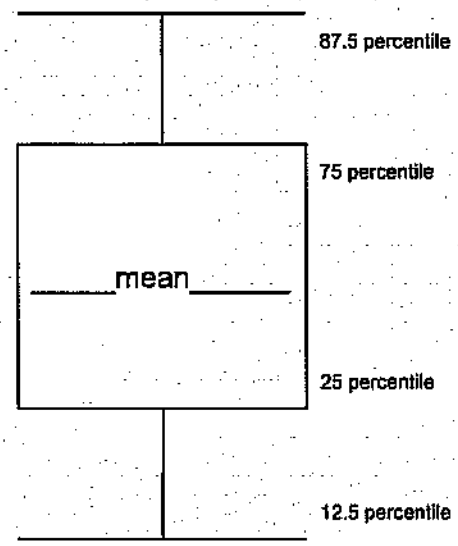
The box and whisker plot shows that the monthly income of three-quarters of households who do not receive piped water (the left most section marked "not piped") is less than the average income of household under other regimes. The plot also shows that customers billed for their water are, on average, significantly wealthier than those receiving other piped water services. However, their income profile is also much more dispersed (the extent of the dispersion is ameliorated in the graphic by the use of a log scale on the vertical axis). The range of income received by "billed" households falling within 50 percent of the regime average fully encompasses the equivalent category of households falling under flat rate, regulated or prepayment regimes. The high dispersion in income of households under the billed regime reflects the predominance of the regime. More than half of all households (and thus a substantial number of poor households) are billed for their past water consumption at regular intervals. When considering the large number of poor households under the billed regime and the associated high *per* litre tariff, it is apparent that a large number of poor households are either paying unnecessarily high water costs (restricting their consumption) or they are being subsidised by other consumers (who, in turn, have to pay higher costs).

The potential for expansion of the cheaper cost regimes is greatest among those inappropriately falling under a billed regime. Low income households receiving piped water and a regular bill may benefit by being placed under another regime associated with lower *per* litre costs. Prior to proposing this, it is necessary to explore the empirical relationships between income, the price of water and the tariff regime. Once again this analysis draws on the LFS survey of 2001.

The following constitutes an explanation of the box and whisker measure used in Graph 3 above.

Box and whisker plots.

These plots represent the distribution of the values observed. The mean (average) is shown by the horizontal line in the box. The upper and lower borders of the box show the values that bound 50 percent of observations (i.e. 25% in each direction). The area above the upper boundary of the box indicates the value beyond which upper 25% of values are excluded. The "whiskers" show the values that enclose another 50 percent of the values not bounded by the box.



Density plots.

These density plots primarily show how much confidence there is that the average value (or "mean") is correct. The mean can be read off the horizontal axis – it coincides with the highest point of the curve. If there is great confidence in the average value the curve drops off steeply on both sides of that point. If there is more uncertainty about the mean the curve will be flatter thereby encompassing a more values around the mean.

4.3 The demand for water, income and tariff regimes

The LFS of 2001 allows for consumption rates to be correlated to the types of tariff regimes. This correlation is reflected in Graph 2, which shows how the different consumption levels associated with each regime. That graphs shows that the average "billed" household consumes approximately 21 kl a month. By comparison households on a prepayment tariff or on a regulated supply consume between 16.6 and 16.9 kl per month – a drop of approximately 25 percent. When Graph 2 is read in conjunction with Graph 3, it appears that the level of consumption is also correlated to household income and other factors. To understand the relationship it is necessary to distinguish between the impact of the tariff regime, of household income and the impacts of household size, climatic differences, cultural practices, *etc.*

The LFS (2001) enables us to examine some of the more important factors like household size and income, whether or not the household is located in an urban or non-urban area, as well as the impact of the price paid for water. While a number of important factors are excluded from the analysis because the relevant measures are absent some can be measured by proxy. For example, if we assume that the provinces, being spatially distinct administrative regions, represent distinct zones in terms of altitude, average temperature, rainfall levels *etc.* then "province" can be considered a (admittedly imperfect) measure of climatic conditions.

Over one quarter of the variance in households' water consumption patterns can be explained by the six most important available variables. Most variance thus has to be explained by other (unmeasured) factors like personal taste, cultural norms, household's age and gender structure etc. The six measured variables used to understand the variance in consumption levels are:

- Province
- Areas type (urban/ non-urban)
- Household income (logged)
- per litre cost of water
- Type of tariff regime
- Average number of household members.

Regressing these variables on the volume of water consumed by the household shows that all the variables other than "area type" are statistically significant (Table 1). This does not mean that area type (i.e. urban versus non-urban) does not affect consumption levels - average volume of water consumed by non-urban households is only a third of that in urban areas. Rather it indicates that the effects of lower income, larger household size, etc. explain the differences in household consumption better than area type *per se* does.

When all other variables are held constant (i.e. "controlled for") the effect of any single factor can be seen and measured. For example, every additional household member increases water consumption by and average of 0.3kl each month. The effects of income is also evident, *ceteris paribus,* water consumption by the poorest households is 4kl less a month than that of households in the highest income groups. This means that poor households use substantially less water than more affluent households and that this difference is not attributable to differences in urbanisation levels, location, water costs, household size or tariff regime.

Given that as higher incomes are associated with better access to water and increasing use of appliances and facilities which consume water, the difference in consumption levels attributable to income is unexpectedly small – only 4kl. While the correlation is in the right direction and of an expected order of magnitude, surprisingly little of the variation is explained purely by income on its own. When consumption is regressed on income (i.e. when the other variables are excluded from the analysis) only about six percent of the variance in consumption can be explained. The vast majority of the variance has to be explained by factors other than income – such as household size and tariff regime.

The weakness of the correlation between consumption and income can be partly attributed to the way in which the LFS data was collected with the extensive use of response categories rather than unbounded estimates. However, a poor correlation between consumption, income and price is not unexpected.

"Years of research about the demand for water in developing countries has revealed that demand is driven by much more than price and income. The availability of substitutes, household preference, the presence of appliances, household size and other factors all affect demand."[16]

In South Africa, as in other developing countries, the low level of consumption directly attributable to income is obscured by the impact of tariff regimes and service levels. Here tariff regimes and service levels seem to have a far greater impact on consumption levels that income does.

When compared to an identical household (in terms of income, household size and location et.) which does not receive piped water, a household billed for their water consumes an extra 15kl per month. The amount of water consumed by such billed households is typically around about 25kl. In terms of average consumption levels households who do not receive piped water are at an automatic deficit of 15kl a month relative to billed consumers regardless of their personal circumstance. The service level coupled to the tariff regime thus explains the bulk of the variation in water consumption patterns. The small effect income appears to have on consumption is partly the product of the correlation between regime type and income (see above).

When compared to households without piped water those under the prepayment tariff regime consume, on average, an additional 13kl of water. When compared to billed consumers with equal income, household size, equivalent location, *etc.* households under the prepayment regime consume only about 2kl of water less each month. However, there is a relatively wide variance in the volume of water consumed and the difference between the two consumption levels may in fact be statistically insignificant. The difference in water consumption between the prepayment and flat rate regimes is even smaller. The table in Annexure F summarises the key regression.

When controlling for income, household size, price and location, the tariff regime has a significant effect on consumption levels. However the major difference in consumption levels lies in whether or not the households receive piped water at all. When attention is focussed only on those receiving piped water, the effect of regime type on consumption is small. Among households who do receive piped water the tariff regime does not impact noticeably on water consumption – the differences in actual volume of water consumed can largely be attributed to household size, income, location and price.

We can conclude from this that it is unlikely that regime type "causes" households to reduce their water consumption over and above a level indicated by their size, location and wealth. However the impact of the price of water is statistically

[16] K Komives and L Prokpy 2000.

significant and by placing households under an unnecessarily expensive regime the consumption levels of indigent households in particular are adversely affected. Matching household income to tariff regime is thus important not because of the regime itself but because of the impact the regime type has on volumetric charges.

The preceding analysis was based almost exclusively on the analysis of household behaviour as derived from surveys. While such analysis can speak to household reactions it remains silent as to whether the uptake of technology like prepaid meters is to be expanded. This is because households are rarely able to choose what technology they are to be confronted with. The application of technology and implementation of tariff regimes is generally determined by the service provider. Improving the uptake of technology such as prepayment meters rests more on the impression it has on service providers than it does on consumers. Thus central to the expansion of any technology are the opinions of service providers, informed as they are by both past performance and by consumer attitudes.

The impressions and intentions of key service providers with respect to prepayment water meters were gauged by a postal survey of municipal authorities responsible for water provision. In section 5.4, the attitudes and perceptions of representatives of the municipalities that currently use prepayment meters, are considered. Focus is placed on their level of satisfaction with regard to the technical reliability and cost effectiveness of the technology. In the final section 5.5 the intentions, attitudes and perceptions of all service providers who responded to the survey are considered – regardless of whether or not they currently use the technology. This latter section points to the possible expansion in the use of prepayment meters in the immediate future.

4.4 Attitudes and perceptions of current users

All the recently constituted municipalities were invited to respond to a brief postal questionnaire regarding their exposure to and attitudes concerning prepaid water meters. Of the 127 postal responses received, only 28 were from municipalities that currently used prepayment meters. As indicated above, this probably slightly under-represents current uptake of the technology – however, the responses are taken to be generally representative of municipal officials' attitudes and perceptions.

A central issue in the survey was the anticipated uptake of prepayment meters in the light of the Free Basic Water (FBW) policy. Although it is not yet universally implemented the FBW policy affords every household a free basic allowance of 6kl each month. One expectation of pundits was that this policy would render prepayment meters redundant as households falling under this tariff regime would not consume much in excess of the stipulated amount.

However, only a small minority (only 15%) of the postal survey respondents were of the opinion that the FBW policy would make the use of prepayment meters less likely in their municipality over the next three years. Slightly more than half (54%) thought that the uptake of prepayment meters would not be affected by the policy whilst the remainder (31%) anticipated that the policy would increase the likelihood their use of this technology would expand. This perception is ratified by the LFS survey which indicated that many of the households using prepayment meters used well in excess of the allotted 6kl. At the consumption levels prevailing at that time many prepayment

meter households would be eligible to pay for at least part of their water consumption.

4.4.1 Level of satisfaction with prepayment meters in general

Perhaps the most notable factor in the survey was respondents' perception that consumers generally supported water prepayment meters. Only 15% percent of respondents believed that current users of the technology were "opposed" or "strongly opposed" to prepayment meters. A majority (54%) thought consumers were supportive of the meters. The balance (31%) of respondents was of the opinion that consumers were largely indifferent to the technology.

This positive perspective can be contrasted to the respondents' own perceptions. More than twice as many respondents (31%) said they themselves were dissatisfied with the impact of prepayment meter technology in their municipality. Only half of the respondents were themselves satisfied with their impact. Respondents were, on balance, still more satisfied than dissatisfied with the impact of the meters, but saw consumers as being more supportive of the technology.

The satisfaction level of respondents can be attributed to three main factors covered in the survey:

- Consumer support for the technology.
- Technical reliability.
- Cost effectiveness of the meters.

4.4.2 Satisfaction with cost effectiveness and technical reliability

Compared to the overall satisfaction levels shown above, respondents tended to be somewhat less satisfied with the cost effectiveness of the meters. Just under half of respondents (46%) said they were "satisfied" or "very satisfied" with its cost effectiveness. A third of respondents (32%) were explicitly dissatisfied with its cost effectiveness. While the figures point to less satisfaction with the cost effectiveness of the technology than with the general level of satisfaction, it must be borne in mind that much of the differences may be attributable to sample error rather than to substantial difference in responses. Small samples like this often suffer by showing large differences that are attributable to sample error rather than to substance.

What is statistically significant (i.e. not attributable to random error) is the relationship between satisfaction levels and perception of the technologies' technical reliability. Slightly more than one third of respondents were "satisfied" (or "very satisfied") with the meters technical reliability – a smaller proportion than those satisfied with the cost effectiveness or with the overall performance of the technology. Another one-third of respondents were dissatisfied (or very dissatisfied) with its reliability.

There is a close relationship between perceptions of technical reliability and impressions of overall performance - suggesting that general satisfaction with the technology is strongly influenced by technical reliability. Respondents who are

dissatisfied with the technical reliability of the meters are almost certain to be dissatisfied with the impact of the technology in general. For example, 89 percent of respondents who were dissatisfied with the technical reliability of the meters were dissatisfied with the technology in general. Similarly 89 percent of those satisfied with the technical reliability were also satisfied with the technology (in general).

There was a less pronounced but statistically significant correlation[17] between technical reliability and cost effectiveness. Three quarters of respondents who were dissatisfied with the cost effectiveness of the technology were also dissatisfied with its technical reliability. This finding is not surprising given that technical unreliability will result in increased repair and maintenance costs and thus in reduced cost effectiveness. However the relationship is not a simplistic one as only 45 percent of those satisfied with the cost effectiveness of the technology were also satisfied with its technical reliability.

The foremost question then becomes: "under what circumstances are the meters likely to be seen as technically reliable or unreliable?" Three avenues of enquiry were pursued:

- The impact of vandalism
- The use to which the meters are put
- Support services.

4.4.3 Vandalism

The vast majority of respondents (81%) viewed vandalism as being a minor problem or not a problem at all. "Only" one in five respondents (19%) saw vandalism as a major problem. Somewhat surprisingly there was no statistically significant correlation between vandalism and perception of technical reliability, cost efficiency or overall satisfaction. This suggests that factors other than vandalism account for negative perceptions of the technology. In the LFS, households were asked for reasons for disruptions in piped water supply. Over two thirds of households in both prepayment and other tariff regimes indicated that their supply had been disrupted (68%). However, there were substantial differences in the level of vandalism reported. Less than one percent (0.4%) of households not under the prepayment regime cited vandalism as the main cause of disruptions. By contrast four percent of prepayment meter users cited vandalism. However the small sample size of prepayment meter users reporting vandalism results in the reported levels being unreliable and the difference attributable to random error.

4.4.4 Usage

Whether or not the meters were located in private households or elsewhere (like communal taps) seems to be important in determining the satisfaction levels. A clear trend is evident – the higher the proportion of prepayment meters placed in private

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[17] Pearson chi2(4) = 7.8223 Pr = 0.098

household taps, the lower the perceived level of technical reliability. Most (60%) respondents in those municipalities in which over 75 percent of the prepayment meters are located in private households are dissatisfied with their technical reliability. In those municipalities where less than 25 percent of the prepayment meters are in private households the level of dissatisfaction with technical reliability drops to 25 percent. Conversely, most (63%) respondents in such municipalities are satisfied with technical reliability. In municipalities in which more than 75 percent of prepayment meters are in private households only 10 percent of respondents are satisfied with the technology. The difference between the sum of the percentage of respondents "satisfied" and "dissatisfied" with the reliability is the percentage of respondents who are neutral on the issue.

4.4.5 Support services

The third consideration with regard to technical reliability was the level of support the technology received. Support for the operation and maintenance of the meters could come from the suppliers of the technology, from external service providers or from within the municipality itself.

Most (64%) municipalities received support from the suppliers of the technology. One third of municipalities receive support from someone other than the suppliers. However there is a significant overlap in the two groups. One quarter of respondents received technical support from both sources and another quarter received support from neither. Those that received support from both categories tended to be the bigger municipalities with a larger number of meters. This group included all the metropolitan municipalities that responded to the survey. Those municipalities that received support from neither category of supplier tended to be smaller, more rural municipalities.

However, satisfaction with the technical reliability of the meters was related not only to whether or not support was received, but also to who supplied that support. Almost three-quarters (71%) of the municipalities that did not receive any support at all were dissatisfied with the technical reliability of the meters. By contrast, less than one quarter of those municipalities that did receive support were dissatisfied with the technical reliability of the meters. With respect to who supplied the support it seems that support from the supplier counts significantly towards the general level of satisfaction with the technology. Such support does not, however, add significantly to the perception that the technology is cost effective.

4.4.6 Support from technology provider

Most municipalities who received support from the supplier (69%) were generally satisfied with the technology. By contrast 20 percent of those that did not receive support from the supplier were generally satisfied. The fact that support from the technology supplier contributes more to general satisfaction than it does to the perception of cost effectiveness or technical reliability can be seen by lower levels of satisfaction with respect to the later issues. Only 47 percent of those that received support from the supplier were satisfied with the technical reliability of the meters.

Similarly only 50 percent of this group were satisfied with their cost effectiveness. Both the latter figures (47% and 50%) are substantially lower than the 69 percent cited above for general satisfaction.

It is helpful to contrast the level of user satisfaction with the type of support received. This information is summarised in the table below.

Table 1: User satisfaction

Satisfaction	Support from supplier (%)	Support from other sources (%)
Satisfied with technology	69	56
Satisfied with technical reliability	47	56
Satisfied with cost effectiveness	50	44

The greater levels of satisfaction among those who receive support from the suppliers of the technology may not be attributable to better service levels. It is likely that supplier support tends to be concentrated on newer meters and technology (particularly those still under warranty). The higher levels of satisfaction may then be attributed to the age of the meters rather than the support by the supplier *per se*.

4.4.7 Own workers

In about three-quarters of the municipalities which make use of prepayment technology, workers have received formal training in the maintenance and operation of the meters. In half of these municipalities the workers have been formally trained by the municipality itself. In only a small percentage of these municipalities (17%) workers have not received any training in the operation and maintenance of the technology.

However, the training, be it from internal or external agents, has little bearing on how satisfied the respondents are with the prepayment meters in general terms or in terms of its cost effectiveness and/or technical reliability. The absence of training has, conversely, little bearing on the satisfaction levels with the technology, reliability or cost effectiveness.

As indicated above, satisfaction with the technology in general appears to be heavily determined by the perception of its technical reliability. These perceptions depend on a number of factors, including how widespread the meters are used in private dwellings, and the support received from other organisations. Support from the suppliers of the technology is important in so far as overall satisfaction is concerned. However, support from this source is not particularly important in determining perceptions of technical reliability and cost effectiveness.

4.4.8 Market in general

From the above it can be seen that most respondents are generally satisfied with prepayment meter technology, and respondents are even more content with the way the technology is supported by consumers. However, the real test of support for the technology lies in whether or not its use is to expand – notwithstanding the impact of the Free Basic Water policy. Given that most municipalities have not yet taken advantage of the technology there is massive potential for growth. However, a better measure of how the sector will grow (or not) can be seen by the intentions of those most familiar with the technology – i.e. with the municipalities who currently use the meters.

If the municipalities that already use them are to broaden their uptake of prepayment meters, it suggests that the benefits outweigh the impediments imposed by vandalism, technical unreliability, cost inefficiencies and the implementation of the Free Basic Water policy. All respondents were asked whether or not they intended to install prepayment meters in the following year. Approximately one third intend doing so – a significant number will be implementing the technology for the first time. However, the strongest determinant of whether or not a municipality intends to install meters in the following year is whether or not they currently have them in place. Most (57%) municipalities which currently use the technology intend to install more prepayment meters in the period. However, a minority (28%) of the other municipalities intend to adopt the technology for the first time. It should be borne in mind that the latter group is numerically far bigger, giving rise to a mere 34 percent of responding municipalities using the technology.

Looking to a slightly further horizon, respondents were asked whether or not they intended to install prepayment meters over the following 3 years. Fifty nine percent of respondents intend doing so. Almost two-thirds (64%) of municipalities which currently use the technology intend to expand their use of prepayment meters. A smaller proportion of the other municipalities intend to adopt the technology in this period. Their intended uptake rate nevertheless rises more dramatically to 57 percent. This suggests that almost 60 percent of municipalities will be using the technology within three years - a significant increase in the current 22 percent indicated by the postal survey.

The respondents also put estimates to the expected number of prepayment meters they intend to install. They indicate that over the following year the number of meters will increase by 35 500 - doubling the current number of meters in the sample. Over the following three years, the expected increase in the number of prepayment meters will be 108 000. If the respondents realise their intentions, the number of prepayment meters in the sampled municipalities will double over the following year and treble over the following three years.

Whether or not this finding can be generalised to the national trends depends on the assumption that the sample is representative of both municipalities that use prepayment meters, those that do not use prepayment meters and that the ratio between the two is correct. This key issue is explored in the next section.

4.5 Generalising responses

As indicated above, the responses suggest that the number of prepayment meters in place in their municipalities will double in the year after the survey. Most of this increase can be attributed to service providers adopting prepayment meters for the first time. Expansion by municipalities that currently use prepayment meters would account for a 19 percent increase in the number of meters in place. Projecting the growth of prepayment meters thus really depends on which of the groups (current users or those taking up the facility for the first time) non-respondents more closely resemble. Some insight can be gained by exploring to what extent respondents are representative of national trends.

According to the LFS, approximately 142 000 households had piped water and prepayment metering. The respondents to the postal survey, which collectively make up just under half (48%) of all municipalities, accounted for about 35 000 meters - one quarter of the number indicated by the LFS. The relatively low number of prepayment meters in the responding municipalities suggests that municipalities who currently use prepayment meters were somewhat disinclined to participate in the survey leading to an under-representation of users. Given that respondents are more inclined not to be users of prepayment technology generalising respondents intentions with respect to uptake may be misleading. This concern gave rise to the development of a more sophisticated model for projecting uptake, albeit, one based on the survey responses.

To extrapolate growth in the uptake of prepayment meter demand, it was necessary to estimate the likely uptake of the technology in every non-responding municipality in the base year (the year of the postal survey) and to then extrapolate future growth from that base. The data required to estimate the number of prepayment meters in the base year was deficient in a number of ways, most prominent was the lack of data relating to water service provider's intentions and experiences. However a model could be built on the available information. The process followed is described below.

The first step in developing this model was to estimate the prevalence of prepayment meters in every municipality that did not participate in the postal survey. As it is impossible to know with certainty how many meters were in place at the time of the survey, any model would have to adequately reflect the uncertainty of any estimates. To deal with this, a "multiple imputation" (MI) model was adopted. A MI model is based on making several estimates of the value in question (in this case the proportion of households with prepayment meters). Collectively these estimates reflect the certainty with which the value is known. The imputed values typically have a mean and variance which reflects that of the available information. In this exercise five estimates were made for each non-responding municipality[18].

[18] The program *Amelia* was used. An EM algorithm was specified with 6 fully observed continuous variables. These variables reflected the number of households with piped water in/to their dwelling, the proportion these constitute of all households, and the income profile of households with piped water. Missingness was confined to the variable of interest.

A central assumption underpinning MI models is that the distribution of the value being imputed approximates a normal distribution. This is certainly not the case for the prevalence of prepayment meters, particularly when measured as a proportion of all households with piped water. The available data indicates that the prevalence of prepayment meters in any municipality is usually at or very close to "0" (and thus to zero percent of households). Despite this proximity to "0" the prevalence rate cannot be negative. This precludes a "normal" distribution from adequately describing what proportion of households in any municipality has prepayment meters. However, the logarithm of prevalence rates approximates a normal distribution more closely and the MI could then be based on the log of the prevalence rate.

However the log of "0" (the most frequently observed prevalence rate) is undefined and thus cannot be incorporated in the MI. The solution to this problem was to impute rates (based on the log of prevalence) for all municipalities as if they all used prepayment meters. This prevalence rate was then modified by a factor representing the likelihood that the municipality used prepayment meters at all. The process of estimating this likelihood is explained in the following paragraphs. This modification would draw on the information from respondents but would be used only to modify the estimates for non-responding municipalities. If the municipality responded to the postal survey and was known to use prepayment meters, the exact number of meters was given. If the municipality was known not to use prepayment meters the take-up rate was, obviously, "0". Estimates of the likelihood of using prepayment meters were then only necessary for non-responding municipalities.

Ideally the estimates of the likelihood of any non-responding municipality using prepayment meters would be based on information regarding the attitudes and beliefs of the water service supplier and a knowledge of the socio-economic situation of residents. However by virtue of being non-respondents, and in the absence of other data, the attitudes of service suppliers are unknown and are necessarily excluded from the model. It was, however, possible to use census data to describe the socio-economic situation in each municipality. The census data used to describe each municipality included:

- The size of the municipality and the average population density.
- The extent of urbanisation.
- The level of unemployment.
- How incomes were distributed.
- What proportion of households were electrified.
- What proportion of households were formal, and
- whether or not households had piped water from a water scheme.

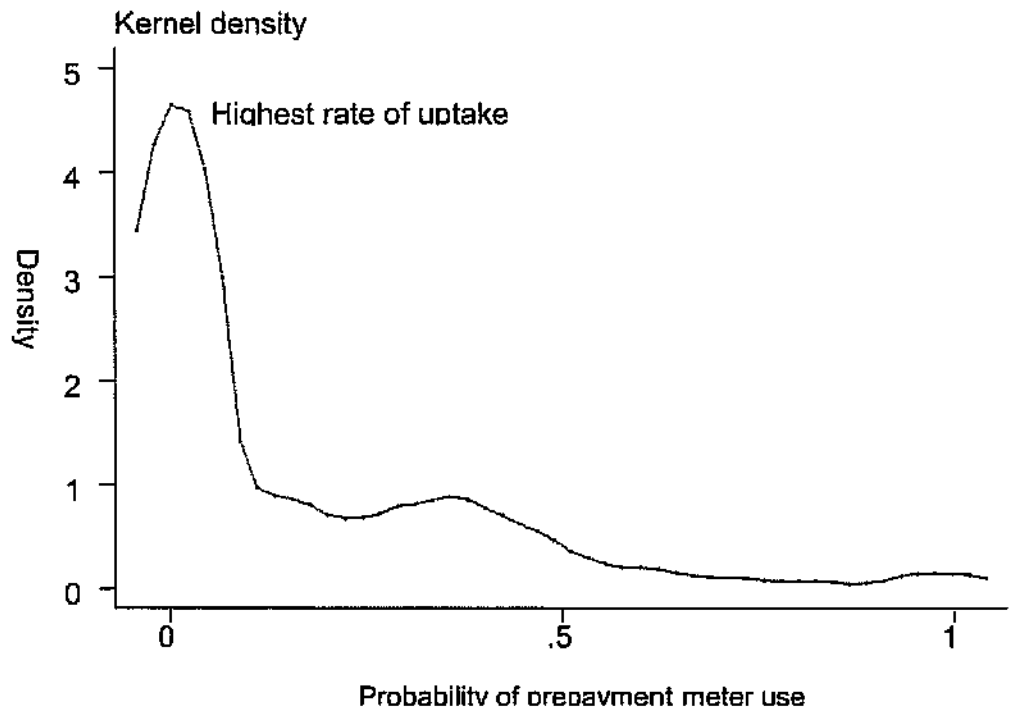
Where appropriate, interactions between these terms were specified and distinctions were drawn between urban and non-urban segments.

These factors proved to be informative of the likelihood that municipalities use prepayment meters. A "logit" model based only on these explanatory variables explains 25 percent of the variance in municipalities' uptake of prepayment meters. The balance of the variance would have to be explained by service provider attitudes, budgets, random deviations, etc. A significant amount of explanatory

power arises from aggregating diverse communities up to the level of the municipality. A logit with the explanatory variables listed above was used to model the likelihood that each municipality used prepayment meters given the general socio-economic situation of its residents.

A schematic representation of the results appears below. The first node indicates that municipalities are most likely not to have any prepayment meters at all. A second node appears at approximately 0.35 and there is a slight fillip at value "1". The second node indicates that the next most likely value a municipality has prepayment meters (i.e. if they do have some) is "one-in-three". The third node points to a small concentration of municipalities that are almost certain to have prepayment meters – most notably the metros.

Graph 4: Probability of prepayment meters used



The logit estimate as derived above was then multiplied by several other factors to derive an estimate of the likely number of prepayment meters in place in each non-responding municipality. The two most important factors were the MI take-up rate (untransformed from the log) and the number of households in the municipality with water piped to their dwelling. The product of the three numbers reflects the "probable number of prepayment meters" in each municipality. As there were five MI estimates of the take-up rate for each municipality the uncertainty in the information was preserved.

Unfortunately surveys are fraught with missing information as respondents fail to answer questions or if responses are unintelligible. When one of the values in

question is an input (or explanatory variable) into a logit or multiple imputation[19], the entire observation has to be dropped from the model - just as they are in regressions. This resulted in a significant number of observations being lost in the modelling. To overcome this, it was assumed (not unreasonably) that the "missingness" was random and, in the end, the data still reflected the population as a whole. Under this assumption the projections could simply be re-weighted to reflect the population.

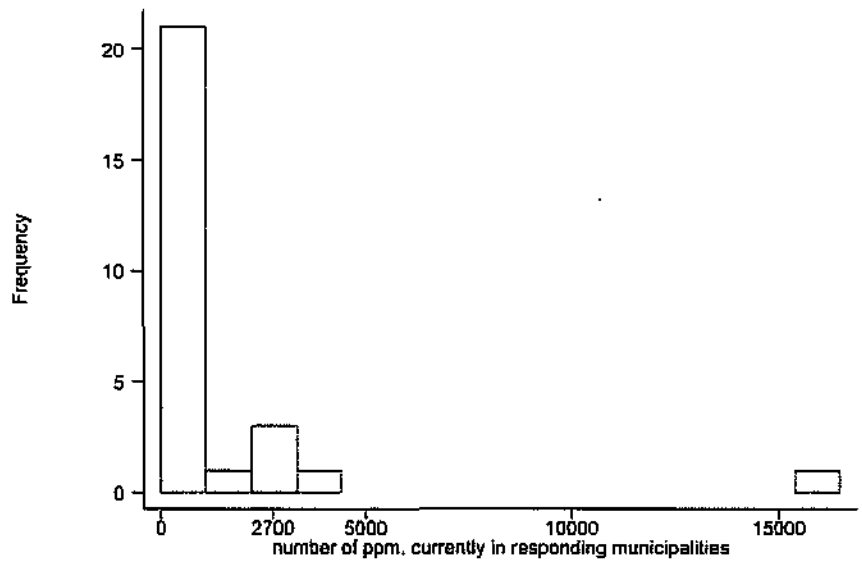
The resulting model speaks to national trends and not just to a simple generalisation of the responses received. A simple generalisation of the responses indicates that the number of prepayment meters in place will double over the next year. However this model indicates that, nationally, the number of prepayment meters in place is likely to grow by only 23 percent over the same time period. Some of this growth will be in those municipalities introducing prepayment meters for the first time and much will be due to the expansion of the number of meters in municipalities already using the technology.

According to the model, those municipalities adopting the technology for the first time are likely to introduce a small number of meters, at least in the beginning. Consequently 78 percent of municipalities would have fewer than 100 meters in place in a year from the time of the survey. This includes those municipalities (48% of the total) which will still not have adopted the technology at all.

Among those municipalities that do use the technology, more than half (58%) will have fewer than 100 meters in place. An extrapolation of the known (and declared) trends thus indicates that widespread experimentation is about to take place on a small scale. It is useful to compare these estimates with the results of the postal survey. Approximately one quarter of municipalities which did respond to the questionnaire and that currently use prepayment meters, will have fewer than 100 in place. The distribution profile of the number of prepayment meters in responding municipalities who currently use the technology, is illustrated below.

[19] Except of course, it is that value which is being imputed in the MI.

Graph 5: Distribution profile of the number of prepayment meters in responding municipalities



The graph shows that if a municipality does use the technology, it is most likely to have a small number of meters. If it has more than a "small number", it may have as many as 16 500 but is more likely to have only about 2 700 prepayment meters in place.

At the beginning of this section, it was asserted that the postal survey responses could be taken as indicative of general attitudes towards prepayment meter technology. The development above, of a probabilistic model of meter uptake, undermines that assertion. By comparing take-up rates of prepayment meters in the LFS with that of the postal survey, it is easy to demonstrate that municipalities which currently use the technology were disinclined to respond to the postal survey. This was explained/justified in terms of the greater effort required of the users of the technology in completing the questionnaire. However, the probabilistic model points to another bias in responses. It appears that the survey disproportionally reflects the opinions of municipalities that do not currently use the technology but intend putting it in place over the following year. The postal survey consequently suggests that the number of prepayment meters in use will double over this period. By contrast, current users will only increase their uptake by 19 percent. The probabilistic model ameliorates the estimates and indicates a sober 23 percent increase in uptake. A comparison suggests that those eager to apply the technology but not yet prejudiced by having to answer the full questionnaire were the most eager participants in the survey. This inevitably skews responses and brings into question the generalisability of the responses.

In the absence of other information, the appropriate way to address concerns about generalisability is to limit extrapolation to those instances where assumptions can be justified. For example, in the preceding sections the responses from current users were generalised to (or taken to be representative of) municipalities that currently

use the technology only. Conversely the collective responses are not taken to be representative of national trends.

4.6 Impact of the Free Basic Water policy

The marked increase in the intended uptake of the technology suggests that the Free Basic Water policy and the other concerns about the technology are not of great importance. Once again the opinions of the respondents are indicative.

Most respondents (54%) felt that Free Basic Water would have no impact on the use of prepayment meters. A minority (15%) of respondents felt that free basic water would decrease the uptake of the meters. However, this perspective was more prominent among municipal representatives who currently use the technology – 30 percent thought the policy would decrease the uptake of the meters in their municipality. Conversely less than one quarter (22%) of respondents from these municipalities thought Free Basic Water would increase the uptake of the technology. A greater proportion (34%) of respondents from municipalities that do not currently use the technology thought the policy would increase the uptake of the technology.

Respondents were also asked how their municipalities' use of the technology was likely to change over the following three years. The strongest response (56%) was that uptake of the technology would increase with 29 percent of respondents, indicating that it would increase substantially. Only six percent thought that their use would decrease or (for those not currently using the technology) was less likely to be adopted. Once again there was a marked difference in the perceptions of respondents from municipalities who currently use prepayment meters and those who do not. Fifteen percent of current users said their use of the technology would decrease or decrease substantially. By contrast, only four percent of respondents from municipalities who do not use the meters indicated that their municipalities' implementation of prepayment meters was now more unlikely. This should not be taken to indicate that current users have grown wary of the technology. The vast majority (70%) of current users said that their uptake of the technology would increase – by contrast only 52 percent of non-users said the same was to happen in their municipalities.

4.7 The benefits of the technology

The different rates of uptake aside, it is clear that there is general consensus as to the future trend in the uptake of the technology. The current users appear more sober in their expectations; however, all indications point to increasing use of the technology. The more sober expectations of existing users can be seen in the perceptions of what the advantages the technology brings. Three quarters of respondents (76%) from municipalities which are current users, cite increased payment rates and reduced water waste as the main advantage of the technology. Only one in ten respondents cite the main advantage as being its ability to monitor Free Basic Water. The impact of Free Basic Water policy on the uptake of the technology is thus marginal, as the policy has not fundamentally altered the way in which the benefits of the technology are seen. The ability of municipalities to use the meters to monitor the provision of Free Basic Water is nevertheless an important

consideration. Respondents were also more likely to cite this function as the second most important advantage of the technology than they were to cite improved payment rates, reduced waste or a reduction in unaccounted water.

Table 2: Advantages of using prepayment meters

Advantage of using prepayment meters	Main advantage (%)	Second advantage (%)
Improved payment	38	23
Reduced waste	38	23
Reduced water losses	10	15
Monitor flow	10	31
No advantages	5	8
Total	100	100

Rounding of percentages may result in the total not adding up to 100 percent.

Several factors point to the expansion of the uptake of prepayment meters:

- A tiny fraction of households currently receiving piped water use prepayment water meters. The market has massive growth potential.

- Water service providers intend to increase their use of technology and many municipalities intend to implement them for the first time.

- The Free Basic Water policy is not likely to have impact on their uptake as current users of the technology tend to consume close to or in excess of the stipulated free amount.

- Increased cost savings may arise by reduced operation costs. Of particular promise is a reduction in transaction costs. For these benefits to be appreciated improved estimates of actual transaction costs are required. The market into which the technology can most readily expand is marked by relatively high per litre costs, which particularly prejudice low income households.

- Militating against a marked increase in the uptake of prepayment meters are a number of other factors:

- The technical reliability and cost efficiency of the technology are of some concern. A significant segment of service providers have been disappointed by these two factors. Although these disappointments have not been severe enough to dissuade service providers from reducing their reliance on the technology, they will affect the uptake of the technology in sparsely populated areas. The costs of maintenance in these areas are exacerbated by distance and the dispersion of population needing support, as well as the higher cost of making the prepayment tokens available.

- Whether or not prepayment meters are cost effective, is not known and will continue to remain this way for some time to come. Innovative interventions are habitually compared to a status quo and judgement is made on how the two stack up against each other. The problem in this instance is that the primary unknown is how much the status quo costs. Operations and transaction costs relating to billing and maintenance are often hidden in general running expenses or in municipal overhead costs. For example few, if any, municipalities are able to disaggregate the component of IT or credit control attributable to the delivery of household water services. Until estimates of the actual cost of the status quo can reliably be made, no judgements as to the relative cost efficiency of the innovation is possible.

4.8 Summary of key findings from national postal survey

The key findings arising from the analysis of the NPS results are presented below.

1. Contrary to popular perceptions, the implementation of prepayment meters does not per se reduce water consumption of households. It merely brings consumption in line with what the household would have used if it had been made to pay for consumption under any tariff regime. If households, prior to being required to pay for consumption above the Free Basic Water allocation, were not paying anything for their water, the introduction of charges results in a dramatic reduction in use.

2. Household consumption is price sensitive and consumption varies with the price charged. Flat rate billing fails to associate consumption levels with charges. This, coupled to low payment rates among flat rate consumers, ensures that this tariff regime is the least sustainable of the available options.

3. In none of the municipalities surveyed did water service suppliers that used prepayment meters have a tariff system with a fixed component. This affirms that prepayment meters are incompatible with tariff systems predicated on a flat rate or on a volumetric charge supplemented by a fixed component. For prepayment systems to be implemented, such tariff systems have to be reconsidered or prepayment customers must be exempted from the fixed component.

4. On average, households using prepayment meters are charged significantly less for each litre than consumers who are billed for past consumption. By implication, households on a prepayment system get more water for every rand spent on the commodity. The lower volumetric charge may be attributable to the lower transaction costs incurred by prepayment meter consumers.

5. More than half of all households fall under a "billed" regime and are periodically billed for past consumption. An examination of the income profiles of consumers under each tariff regime shows that many low income households fall under the "billed" regime. These consumers are accordingly charged higher volumetric rates for their water and, given that consumption levels are price sensitive, have to forgo consumption.

6. Respondents to the national postal survey thought consumers had a better opinion of prepayment meters than they themselves did. They believed the vast majority of users were positive or indifferent to the technology. On balance, respondents themselves were still more satisfied than dissatisfied with prepayment meters in terms of technical reliability and overall impact. This positive impression endured despite the impact of vandalism and high maintenance costs.

7. The survey respondents put estimates to the expected number of prepayment meters they intend to install. They indicate that over the next year the number of meters will increase by 35 500 - doubling the current number of meters in the sample. Over the next three years the expected increase in the number of prepayment meters will be 108 000 among the responding municipalities.

8. However, a bias in responses indicates that the answers received could not be safely generalised to the country as a whole. For example, a comparison between the responses to the postal survey and the LFS conducted by SSA, indicates that municipalities which currently use prepayment meters, were less likely to complete the postal survey than non-users were. In addition those municipalities that used only a small number of meters were less likely to complete the questionnaire than municipalities with a large number of prepayment meters. There is also evidence that municipalities which do not currently use the technology, but were about to implement it, were more likely to respond. For more realistic estimates, it was necessary to develop a probabilistic model of uptake.

9. The derived model indicates that most municipalities that intend implementing the system will have less than 100 meters in place in one year hence. Those experimenting with the technology are apparently doing so with a number of units that will not adequately reflect the possible economies of scale nor expose them to the full range of experiences on which they can decide how best to utilise the technology.

10. The model also indicates that a far more modest growth in the uptake of prepayment meters can be anticipated. Rather than doubling in the next year, as reported by the respondents, the number of prepayment meters will probably only increase by 23 percent in the following year. Similarly, long-term uptake will still be positive, yet less pronounced than implied by the respondents.

11. Consumers who use prepayment meters, absorb many of the transaction costs associated with their service as they bear the burden of purchasing their entitlements, etc. If the savings are passed on to consumers, the technology is most pertinent in relatively poor areas where consumers habitually use their excess of the Free Basic Water allocation. The technology is also more appropriate in areas with poor mail and other administrative infrastructure.

12. Flat rate consumers enjoy a service level often on a par with that of billed consumers i.e. in-house piped water. Transaction costs are however somewhat lower as regular reading of consumption meters (and their installation) is not required. Billing costs can be further reduced by packaging the water bill with that of electricity, rates and taxes thereby disbursing costs over a number of

transactions. As these consumers are not billed on the basis of their consumption they have a reduced incentive to use water sparingly. They, unfortunately, also have little reason to monitor their consumption levels and thus are prone to not accurately report their consumption. Of all the tariff regimes "flat rates" have the highest level of non-payment. The combination of low payment rates, high consumption levels and high transaction costs indicate that this type of service is the least sustainable.

5. SYNTHESIS OF FINDINGS FROM CASE STUDIES

Surveys offer analysts the ability to measure the certainty with which any "response" is known and, thereby render a degree of objectivity to studies. Despite this significant advantage surveys are an inadequate instrument with which to explore the social and political relationships which underpin what was observed. For example, the surveys used in the preceding analysis indicate the correlation between volumetric charges and tariff regimes, they also indicate the (corrected) proportion of service providers who are negative about future uptake of prepayment technology. Despite these insights the surveys do not speak to the social and political dynamics that gave rise to those correlations or impressions. There are even grounds for assuming that surveys are, in general, a poor instrument to explore such relationships and identify causalities. A more useful instrument is the case study. Appropriately targeted and implemented case studies speak better to the dynamics that gave rise to the observed relationships.

In order to better understand the dynamics which underpin the observed correlations a range of water schemes which included prepayment meters were selected as case studies. To avoid a fragmented presentation of the findings from the case studies a number of key issues under which findings can be grouped are identified. Also refer to Annexure E.

Issues underlying the drive to introduce prepayment water meter technology. This includes:

- Rent and service boycotts.
- Poor consumer debt (non-payment) and cost recovery.
- Control of water wastage.
- Service infrastructure in the rural areas.
- Free Basic Water for the poor.

Planning, installation and technical operation:

- Various socio-economic/developmental environments.
- Suppliers.
- Planning phase.
- Investment cost.
- Operation and technical support.
- Appropriateness of technology.
- Technological improvement.
- Consumer satisfaction with technical reliability of the technology.

Prepayment technology and the water consumer:

- Relations between local authorities and consumers.
- Social participation/co-decision-making.

- Education/awareness programmes.
- Affordability.
- User-friendliness of technology.
- Experience of cost recovery measures by consumer.

System management:

- Operation and maintenance.
- Linking of administrative and financial systems.
- Cost and sustainability – cost regimes.
- Detecting fraud/water losses.
- Saving water.
- Environmental impact.

Impact of HIV/Aids

Below the case studies are collectively examined under each rubric listed above.

5.1 Key issues underpinning the introduction of prepayment water meters

5.1.1 Rent and service boycotts

As resistance against apartheid became more widely organised during the 1980s, tools to make local government "ungovernable" were sought and implemented. One of these tools was the non-payment of services, especially water and electricity.

This refusal continued after the political turnabout which culminated in the 1994 elections. The immediate impact on local government of the political transition was negative as heightened expectations and their poor level of preparedeness led to reduced service payments amid increasing demand. Local authorities indicate that the delicate transitional phase had a negative effect on service provision (see annexure E). The second half of the 1990s saw the majority of local authorities, especially smaller ones and those with weak tax bases fall into serious financial difficulty because of continued non payment despite the launch of the Masakhane campaign.

5.1.2 Poor consumer debt and cost recovery

Even as the culture on non-payment took increasing hold the political climate sorely circumscribed local authorities ability to respond punitively to non-payment. Local governments' responses were increasingly confined to social and technological interventions. The Masakhane campaign epitomised a "social intervention" as it sought to convince consumers to change their attitudes to payment. Technological interventions included the installation of prepayment electricity meters and the installation of flow restrictors on water supply. In terms of revenue collection and

social acceptability Eskom achieved a great deal of success with their prepayment meters.

The solution to the water problem seemed obvious and by the second half of the 1990s introduction of prepayment water meters on a significant scale began to take place. By the time the culture of non-payment started being reversed huge amounts of outstanding debt were due to municipalities. Municipalities' attempts to recover this debt met with varying degrees of success (Annexure E) as the financial demands on them continued to escalate. Municipalities had to service growing debts, role out additional services to formerly disadvantaged areas and deal with the consequences of under-investment in existing infrastructure.

5.1.3 The control of water wastage

Because of the widespread non-payment for water due to consumer resistance or poor administration many users were not required to pay for their water consumption. This resulted in few consumers appreciating the full value of their water allowing most to be careless regarding wastage. Water leaks were not reported and communal taps were often left to run even when not in use. Municipal water suppliers seldom had systems to detect wastage in place and often no staff to conduct repairs. Polokwane Municipality reported water wastage in rural areas along these lines as a particularly severe problem (Annexure E 6).

5.1.4 Development of service infrastructure in rural areas

Unequal development left many rural areas without adequate supplies of potable water. Rural areas with bulk water infrastructure and communal standpipes were usually operated in a way that assured the recovery funds sufficient only for maintaining the system and purchasing diesel or electricity. While some schemes were managed well others experienced disputes. Reasons behind the disputes included:

- Equity issues (differing family sizes and varying distances from standpipes).
- Varying water pressure due to topology. For example taps at higher altitudes had lower pressure and ran dry before those lower down.
- Not all households were willing (or able) to pay regularly.
- Some households reverted to using traditional sources like rivers and wells (see Polokwane in Annexure E).

Before the Free Basic Water policy was implemented at scale prepayment water meters at communal standpipes became an attractive option. The communal meters addressed many equity concerns as payment was in proportion to consumption and the technology was introduced in numerous areas at varying scale.

5.1.5 Free basic water for the poor

The introduction of the Free Basic Water policy in 2000 had an important influence on the *raison d'être* for prepayment water meters, especially with regard to combating non-payment practices among the indigent. Prepayment meters were effective in obtaining payment from consumers regardless of their ability to pay for their water. This had an unnecessarily negative impact on the indigent who were then denied access to water. This problem was the addressed by the Free Basic Water policy which compels local government to provide a survival amount of free water to households. In principle the costs of this service was to be recouped from the equitable share grant disbursed by central government.

Some respondents argued that the FBW policy further exacerbated the delicate transitional phase promoting the perception that water provision is cheap. Respondents also reported that the Free Basic Water message resulted in increased non-payment by consumers who consider themselves poor. This adversely affected the income of service providers in rural areas who relied heavily on such payments. Municipal officials were generally of the opinion that the FBW policy eliminated the need for prepayment communal taps as no payment was due from this type of consumer.

The case studies demonstrate a reduction in consumption once prepayment meters were put in place. In some rural areas of Polokwane consumption fell to as little as 1,3kl per household per month. Nkomazi also experienced a massive reduction as consumption fell from an average of 40kl per household to less than 7kl.

5.2 Planning, installation and technical operation

5.2.1 Socio-economic/developmental environments

As shown in Annexure E, prepayment technology is being applied in a wide spectrum of development environments. These vary from densely populated, formal urban settings to remote, low-density, informal rural settlements. Each environment is influenced by different factors like levels of use, affordability and quality of management. Obviously these, in turn, impact on the sustainability of the scheme and their potential to be replicated.

While the rural water provision is typified communal standpipes (particularly when the connection is metered) dwellings in urban areas are far more likely to have one metered connection *per* erf (stand). The communal meters, which may be subject to constant use for fifteen hours or more each day, are required to be more robust than erf meters yet they seem prone to technical problems. These problems arise partly from the high levels of use and partly from the rough handling they receive.

Some environments are accordingly more viable than others. Elements determining a good or bad potential include:

- Integrating the prepayment technology with the existing administrative system.
- Population size and the proportion that is indigent.
- Settlement density.
- Quality of existing or anticipated reticulation network.
- Social climate.
- Capacity of supplier to operate and maintain infrastructure.

There is no general formula for success, since the above elements have internal variations and combine to produce a variety of outcomes. Some elements are fundamentally more important than others but changing contexts also impact on importance. For example, after the Free Basic Water policy came into operation in 2000 the income spectrum of consumers assumed greater significance.

Two examples illustrating the above point are found in Letsemeng and Polokwane. In the former, the municipality promotes prepayment water meters for all consumers and many are from the town's highest income groups. Profits derived from progressive tariffs and large consumers offsets or losses resulting from sales to low volume consumers and those receiving free water. This has also been the experience in Nkomazi.

Polokwane only provides water through prepayment communal taps to the poor. Low usage per household (about 1,3kl per month) and relatively low population densities result in high investment and maintenance costs. The high investment and maintenance costs cannot be fully recouped from the consumer base. "We are not making money," were the words of one respondent.

5.2.2 Vandalism

Vandalism does occur, but as the analysis of the survey responses show it is not regarded as a particularly serious problem. Vandalism takes many forms ranging from "social pathological behaviour" of, for example, like juvenile delinquency, to more organised resistance by alienated communities.,

Two examples illustrate the conflict.

Letsemeng Municipality (Koffiefontein Transitional Local Council at the time) introduced prepayment water meters in a poor area to forestall the institutionalisation of non-payment, but they did so without adequate community consultation. This angered a substantial number of residents who removed their meters and placed them on the steps in front of the municipal offices. The protest action went on for some time drawing considerable media coverage. The municipality had to revisit its approach.

Kannaland Municipality experienced, and still does on a limited scale, cases of individual vandalism where consumers deliberately damage their meters. The municipality follows a strict policy of prosecuting offenders. The first offence results in a R1 000 fine and disconnection. A second offence leads to criminal proceedings. There were five cases pending at the time of the interviews.

5.2.3 Suppliers

It is seen in Annexure A that the first prepayment water meters were marketed in South Africa in 1992. However, installation only started on a significant scale in 1996. In practice, manufacturers are usually also the suppliers/distributors and service agents, handling repairs.

There are currently five main systems:

- Bateman Water
- ABB Kent/Telbit
- Bambamanzi/Conlog/Schneider Electrical
- Plessey/Tellumat
- Schlumberger Measurement and Systems.

The case studies showed that the problems of reliability have been significantly reduced, and that while initially, there were noticeable differences between the water meters, these have virtually disappeared as a result of technical improvements to suit local circumstances.

Municipal officials, however, felt that there is a need to standardise to a greater extent.

5.2.4 Planning phase

Planning should be a comprehensive integrating of all relevant elements while including stakeholders. As far as planning for prepayment water technology is concerned, the main elements are:

- Institutional.
- Social.
- Financial.
- Technical.

Obviously each of these four elements emphasise the importance of a multi-dimensional approach to the process. Ideally each stakeholder should be fully informed of each element and its anticipated consequences. In this way stakeholder take ownership, not only of the elements which affect them, but of the process in its totality.

With respect to implementation of prepayment meters the initial steps in the planning process are:

- An audit of the status quo.
- Identification of the causes and extent of failure in cost recovery.
- Determination of the extent of water loss and system abuse.

These steps can be undertaken by the municipality or, if the municipality wishes, by a contracted service provider. Nkomazi provides an example of the latter. *PSU*

International was contracted by the Nkomazi authorities to undertake an integrated planning process. After consultations with stakeholders, an audit to determine the extent and level of service within the regions of concern was conducted. This audit encompassed affordability levels and attitudes of residents to alternative technologies given the cost implications. When presented with the alternative of a flat rate stakeholder support for prepayment meters was "unanimous". After an intensive process of community liaison, prepayment meters were installed in all households in this township. In the first year revenue from water services increased eleven-fold.

The main stakeholders are:

- Local authority/water authority.
- Consumers.
- Supplier/service provider and, occasionally
- Housing developers.

For stakeholders an integrated approach, when linked to proper community liaison and participation, is to engender in the community a feeling of ownership. That is more than just agreement with the plan on the table. The community should be prepared to "protect" the project or plan when necessary (see Kannaland example in Annexure E). When the community takes ownership residents get the feeling that it is *their* plan and scheme.

There are potential socio-economic spin-offs to the community's full involvement in the planning process. Consumers learn to budget for anticipated water use. This forces them to consider aspects of cost-effectiveness and future demand. However, this activity, which should be typical of urban life, is new to many water consumes who have managed to evade payment. Consumers may further discover that the budgeting and resources allocation process employed with respect to water services also extends to other approaches to life.

At the macro-level planners have to anticipate problems between departments and and even between service providers. Problems, for example, include conflict between the departments responsible for the provision of water and those responsible for energy services. While there is a constitutional prohibition on the total cutting off of water supply there is no such constraints on the suspension of electricity services. Where mains electricity is required to power water meters the suspension of electricity services halts water supply and puts local government in contravention of this prohibition.

5.2.5 Investment cost

Investment cost varies dramatically between environments. Of particular importance is the availability (and location) of bulk services, and housing density.

5.2.6 Operation and technical support

Effective delivery of water services have both an administrative and a technical element. The latter is dealt with in this section.

The national survey information indicated that support for the maintenance and repair of prepayment meters come from:

- Suppliers of the technology (64% - partly overlapping with "other sources")
- Source other than supplier (33% - partly overlapping with "supplier")
- Both supplier and other sources (25% - including larger municipalities with a large number of meters)
- None at all (25% - smaller, more rural municipalities).

The more support a municipality receives, the greater the water service providers' satisfaction with the technical reliability of the meters. In the case studies it is apparent that service providers have vastly differing experiences regarding support. Polokwane Municipality receives support from Lepelle Water and Costcover, a local service and management consultant. In additional DWAF supplies considerable amounts of financial support. Without this support, it would not have been possible for the municipality to supply water to the 145 villages included under the municipalities' jurisdiction in 2000.

By contrast both Letsemeng and Swartland have terminated their supplier contracts. This left them with no support for the technology this, in turn, has resulted in prepayment meters not being repaired and their numbers are consequently decreasing.

The NPS survey indicates that service providers are generally more satisfied with the meters when the meters are supported by the suppliers. However this correlation may simply be due to technology suppliers supporting their instruments when they are introduced and still under warranty.

The technical reliability of the technology is of some concern, especially as far as the uptake of the technology in sparsely populated rural areas is concerned. This issue is addressed in greater depth below.

5.2.7 Appropriateness of technology

With the introduction of FBW prepayment meters have become less relevant for their previous niche - communal connections for low volume users. Electronic prepayment systems are increasingly being seen as better suited to larger urban areas where consumers take more than the FBW allowance and have individual connections.

5.2.8 Technological improvement

In terms of reliability there were initially noticeable differences between the water meter systems. These differences have largely disappeared as the technology improved. Problems were resolved, *inter alia* by the better exchange of knowledge between systems and clients. One example is the planning and experimentation related to bi-directional communication links. These links better utilise the electronic capabilities of the technology enabling, for instance, central real-time readings. This information makes it easier for service providers to detect major leaks and unaccounted water use. Conversely consumers are better able to see their consumption patterns on a real-time basis, thereby improving their personal resource management.

More recent upgraded models of meters are reportedly proved to be much more reliable.

5.2.9 Consumer satisfaction with technical reliability of the technology

According to the NPS one third of consumers were seen as satisfied with prepayment technology, one third were dissatisfied and the remainder were seen as indifferent to the technology. There was however a statistically significant correlation between consumer satisfaction and technical reliability.

Lepelle Water, which is part of Polokwane Municipality's supply structure, reported such a high degree of dissatisfaction with an earlier metering system, that they upgraded the system until they it was able to perform all the functions required of it. The meters were previously seen as inadequately robust and the associated software too limited to perform all the required management functions. They currently manage 1 100 prepayment street taps in a geographically vast rural area.

Beaufort West reported a high degree of satisfaction with their system. They only have 300 prepayment meters, but they are regularly visited by a representative of the supplier and they have their own small workshop where faulty meters are repaired. They also have a supply of spare parts. Serious faults are repaired by the supplier within an acceptable period.

5.3 The consumer and the technology

5.3.1 Relations between local authorities and consumers

As they are elected delegates the mayor and counsellors should keep their constituencies informed of current and future developments. It can also be argued that they have an interest in obtaining the highest possible degree of consensus on policies and proposals. As far as the prepayment water projects are concerned, it seems that these requirements are met to varying degrees.

As a rule good relations are usually created by active elected representatives who take steps like:

- Regularly report-back to the community after council meetings.
- Supplement meetings with newsletters (see Letsemeng case study).
- Hold special community meetings and/or fliers to announce a matter of importance.
- Have an open-door policy concerning service issues.
- Use officials to explain technical aspects at popular meetings (see Kannaland).

The relationship between consumers and the municipality can be further enhanced by additional effort. In Kamhlushwa (part of the Nkomazi case study) PSU International introduced a Customer Care Centre that seems to enhance relationship markedly.

In an environment where accountability and transparency have become popular slogans it seems that most municipalities now realised the importance of good public relations. Where relations between the community and local government are poor conflict centering on the introduction of prepayment technology is more likely. This was the initial situation in Letsemeng (see Appendix E).

5.3.2 Social participation/co-decision-making

Community participation is no longer a voluntary action to be chosen at the convenience of local government and developers. Such participation is prescribed by various legislation and policies like, for instance, in the Integrated Development Plan guidelines. Chapter 9 of the Municipal Systems Act spells out similar requirements. Two aspects of service delivery which are imperative not only for adequate social participation but for the sustainability of any initiative are the level of service and the amount that people are expected to pay.

For social participation to be successful, a process including the three dimensions below has to be followed:

- Involvement in decision making about the what, when and how.
- Implementation of the decisions.
- Sharing in the benefits.

Just as the case studies point to a diversity of experience regarding relations between local authorities and consumers they point to dramatically varying levels of community participation in projects. The case studies suggest that the level of community participation is similarly strongly correlated to the success of prepayment initiatives. The experiences range from Kannaland's recovery of debt to he inadequate community participation in Letsemeng.

In defence of local government with inadequate consultation it must be noted that most prepayment installations were linked to new housing schemes. Consequently

local governments concerned seldom had predefined consumers on which they could focus their consultations. In these cases, the prospective consumers were sold a "package" of which prepayment water technology was a relatively small part. The inclusion of the technology was also a marginal issue in light of what beneficiaries gained– a well-serviced house subsidised by between R15 000 to R20 000 (see Swartland in appendix E).

In undeveloped rural areas consumers benefited by getting more convenient access to water - albeit at high tariffs. Even if the cost of water was high by the standards of urban areas or high volume users are it was, typically, substantially cheaper and more accessible than that charged by water vendors. In Polokwane prepayment water costs about 6% of an equivalent volume bought from a vendor. When the advantages are unambiguous (as above) community consultation and social participation is less vital.

It becomes vital where existing schemes are being upgraded from, for example, conventional meters to prepayment ones. In these instances the manner in which the transitional takes place is pertinent. In Beaufort West the meters of individual poor payers were changed to prepayment instruments. In Nkomazi entire villages were "upgraded" *en bloc*.

Community buy in was most difficult and resistance was strongest in those instances where consumers were accustomed to high service levels and did not pay. Reasons for non-payment reflected the culture of non-payment, poor account administration or organised resistance to payment before infrastructure was upgraded. If there was no money for upgrading the latter resulted in a catch 22 situation. The Mankweng case, (part of the Polokwane case study) no payment had taken place for years, illustrates this point.

5.3.3 Education and awareness programmes

The case studies reveal that many consumers experience difficulty in monitoring their consumption. This is especially important for those unable to afford consumption above the FBW allocation. In the hands of informed consumers the prepayment metering system play a vital role in solving this problem.

In education programmes the focus is on obtaining specific knowledge of the system and how it can best be used. Simple education centres on the operation of the electronic card to obtain credits and how the cards activate the meter. Awareness refers to a broader insight, for instance regarding the value of piped water.

In Letsemeng education programmes were run at schools. Elsewhere they took the form of information sessions or talks when the consumer registered with the municipality - as is the case in Swartland. The education efforts are essential in areas where few prospective consumers had piped water and fewer still had been exposed to prepayment technology. This situation was epitomised in Polokwane.

The creation of awareness is an ongoing requirement. This is usually done by the political representatives who deal with the competing demands of servicing the electorate while managing municipal resources (see Polokwane case study).

Increased awareness among consumers also seems to alleviate social tension. Customer awareness and liaison programmes have also been successfully conducted by Customer Care Centres - as in the case of Nkomazi (Annexure E).

5.3.4 Affordability

Studies on what constitutes an "affordable" water service have produced contradictory results. Willingness, rather than ability to pay, seems to be a more useful approach. Willingness to pay is influenced by a number of factors chief among them is the perception of value.

About two thirds (64%) of the households using prepayment meters were obtaining water in terms of the Free Basic Water policy. Furthermore very few indigent consumers were using more than the FBW allocation. These factors suggest that the price of water was somewhat irrelevant as the free allocation seemed to meet basic demand. Affordability is directly linked to tariff regimes, a concept which is discussed in 4.2.1.

5.3.5 User-friendliness of technology

User-friendliness refers to the ease with which a consumer can obtain water from the available facilities. In so far as prepayment meters are concerned this includes obtaining tokens, activating the meter, interpreting meter readings and regulating consumption.

Although meters are generally user-friendly education programmes, as explained in 5.3.4, help to better acquaint the consumer with the technology. This enhances the ease with which users deal with the technology. In Swartland, for example, consumers who register as users are given a short lecture by a specially designated person on all relevant aspects, including the use of the token.

5.3.6 Experience of cost recovery measures by consumer

A distinction needs to be drawn between the use of prepayment meters as a means of controlling consumption and the use of the technology to recover costs. The thrust of the difference lies in water service providers attempting to recover arrears – a move which inevitable colours consumers perception of the technology.

In the case studies examined there were three basic types of cost recovery options for water services:

- Fixed monthly payments.
- Metered billing.
- Metered prepayment.

As prepayment meters impose the greatest control over consumption the technology has been a most successful means of recovering outstanding debt. In Letsemeng

the water service provider reduced, with the agreement of the community, the FBW allocation from 6kl to 5kl per month. Payment for consumption thus kicked in one kilolitre earlier thereby boosting the service providers' revenue. The municipality benefited not only from increased revenue and by the saving of 1kl per month per household but in terms of reduced capital expenditure. The Letsemeng water service provider has insufficient purifying capacity and the reduced consumption levels allow it to defer infrastructure investment to a later date. For the consumer, the effort of repaying arrears is less severe, since he/she still gets the bulk of the FBW allocation – a matter of give and take. It is important to note that this type of arrangement can only be successful if the community agrees and if the municipality is satisfied that it benefits from the arrangement.

In Kannaland 20 percent of water purchases are set off against the outstanding debt. This is done by the system registering, for example, only R8 of every R10 paid. The R2 difference is set off against the households arrears. While the logic behind these systems is evident they do call for a strong link between the service providers' financial and administrative systems. The link has to, *inter alia*, ensure that households who have eliminated their debts are no longer penalised.

5.4 Managing the system

5.4.1 Introduction

The Municipal Systems Act, 2000, requires municipalities to manage their services on the basis of full cost recovery and prescribes the basis on which tariffs must be determined. Full cost recovery requires not only the appropriate setting of tariffs but on the subsequent economical allocation of revenue derived from sales.

5.4.2 Operation and maintenance

Operation and maintenance of the distribution infrastructure is the responsibility of the Water Services Provider which is generally the local authority. However, not all local authorities have the capacity to fulfil the obligation on their own. This lack of capacity is partly a function of the re-demarcation of municipal boundaries. Re-demarcation increased municipal sizes by, on average, threefold. It further resulted in previously less developed areas with huge service provision backlogs being amalgamated with other better serviced areas. The changes made it logistically impossible for many local authority to perform its functions without outside assistance.

The case studies of Nkomazi and Polokwane provide examples of where external support of the municipality was necessary. Nkomazi made use of consulting firm *PSU International* from the planning phase through to on-going revenue management. Polokwane "inherited" a vast water distribution network, operated by Lepelle Water. That network was already supported by the consulting firm Costcover, and by financial support from DWAF. Despite the support Polokwane Municipality still not does not have the capacity required for it to incorporate this network effectively.

As a rule municipalities need the support of its consumers and residents to ensure the optimum functioning of the system. Consumers are required, for example, to be the municipality's "eyes and ears" to report leakages, vandalism etc. This, in turn, requires consumer having knowledge of the elements of the system and an inclination to support the local authorities. This dependence highlight the importance of education and awareness campaigns important. Several municipalities, including Beaufort West, reported ongoing work in this regard.

The Government's White Paper on a National Water Policy for South Africa (DWAF 1997; 23) states that the price of water will, *inter alia*, include operating maintenance and capital costs. Over the past few years, two changes in particular have challenged local government:

- the introduction of the Free Basic Water policy, and
- service providers tendency to charge for repairing their meters.

At least two municipalities, Letsemeng and Swartland, are reducing the number of meters in their jurisdictions. The reduction of prepaid meters in these areas was only partly brought on by the reduction in revenue collection prompted by the FBW policy. As costs could not always be passed onto consumers the second aspect compounded their difficulties. Unexpectedly high repair costs proved more than their water budgets could bear. With respect to future uptake both municipalities have adopted a wait and see attitude.

5.4.3 Linking of administrative and financial systems

Obtaining payment for consumption hinges on the service provider linking administrative and financial systems. In some instances the link between these systems is weak. An example of a weak link is given by service providers who obtain consumption records from the field and only to feed the data into their financial system at a later stage. Even in purchases of tokens are registered immediately this is inadequate for comprehensive monitoring of the system. As a rule comprehensive monitoring requires a rapid if not immediate reconciliation of consumption and purchases. Immediate reconciliation is offered by the new bi-directional communication systems referred to in 5.2.8.

5.4.4 Cost and sustainability

It goes without saying that prepayment water meter systems must be financially sustainable and recoup operating, maintenance and capital costs. Added to this cost is the price of the water itself. The case studies of Polokwane and Swartland raise serious concerns about the sustainability and financial viability of prepayment systems (see Annexure E).

5.4.5 Detecting fraud/water losses

Speedy detection of faults and water losses is essential to a cost-effective service. However, the lack of bi-directional communication systems regarding consumption

force most service suppliers to rely on consumers reporting faults. Unfortunately this reliance seems greatest in those areas where the infrastructure required for rapid reporting of faults (like telephones) is weakest. Some municipalities, like Nkomazi have, overcome this issue through the random monitoring of meters, periodic audits and through the use of an efficient Customer Care Centre facility.

5.4.6 Saving water

In a semi-arid country such as South Africa the objective of saving water is desirable, this said the reduction of demand by consumers negatively affects the income of the Water Services Provider. The contradiction between these two objectives is most stark when increased investment is required to eliminate leakage. From the perspective municipal revenue, this presents two main problems.

Firstly, most poor households do not consume more than the 6kl monthly FBW allocation. That means that they rarely transfer revenue to the service provider. The only compensation for the municipality is from its generally inadequate "equitable share" allocation. The financial viability of water services then become dependent on the inclusion of an adequate number of high volume consumers.

Where household consumption is very low, as is typical in rural areas, there may be no possibility of gaining a sufficient number of high volume consumers who can bolster revenue. As the equitable share allocations are not particularly generous this situation eliminates the possibility of the municipality even breaking even.

However, revenue is only part of the equation. Had consumption levels not been reduced to the FBW allocation the supplier would have been saddled with higher losses for as long as consumers failed to pay for excess consumption. The impact of prepayment systems (and of any effective billing system) is primarily to reduce the consumption of households to what they are prepared to pay for. In these circumstances prepayment systems save the service provider money by reducing consumption without necessarily increasing its revenue.

5.4.7 Environmental impact

A reduction in wasted water has obvious economic implications for the service provider (fewer resources are spent of services for which not revenue was recouped) and for the economy as a whole (resources can be redirected to those willing to pay for them). However substantial benefits is terms of the environment can also be seen. Once schooled in the true value of water consumers will treat water as a commodity of value. This will result in reduced waste and lower consumption levels. An immediate impact of prepayment meters can be seen in and around Polokwane where consumers no longer let taps run unnecessarily.

Indirectly, the decrease in water consumption has a positive effect as water resources do not have to be as heavily exploited and investment in bulk infrastructure can also be reduced.

5.5 Impact of HIV/Aids on water supply services

The most apparent impact of HIV/AIDS will be on reduced water demand as mortality rates increase. The CIA (2002) and UNAIDS (2000) estimate that in southern Africa the pandemic has reduced population growth rates by up to 50 percent over the past five years.

Dr Peter Ashton of CSIR identified the following six groups of challenges affecting the management of water resources and the application of prepayment water meter systems in particular. These areas are:

- Inaccurate estimates of population growth rates and mortality rates lead to incorrect estimates of water demand in specific geographic areas. Poor demographic forecasts hinders proper planning and prevents construction schedules from matching water demand.

- Socio-economic deterioration in communities receiving services are such that consumers will find it increasing difficulty to pay for services.

- The condition leads to increased staff turnover in all sectors. As accumulated skills are lost to service providers there is a commensurate increase in training required to make up the loss in staff.

- The productivity of staff members infected with HIV/Aids declines dramatically as the disease progresses. Additional losses in productivity arise from workers having to care for sick family members or attend the funerals of dead friends, colleagues and relatives.

- If staff shortages or inadequate financing leads to a decline in water quality public health risks will increase. The overall effect of this scenario will be an increase in the incidence of water-borne diseases and related mortalities. The impact of such breakdowns will be greatest among individuals with weakened immune systems.

- If the dead are buried in areas that are unsuitable for graveyards there is a some risk that local ground water resources may become contaminated. This practice will also prevent these areas from being used for more appropriate purposes. (Ashton and Ramasar, 2002)

Water resource managers will need to establish accurate forecasts of demand for water. They also require "HIV/AIDS informed" socio-economic and demographic profiles of consumers and empolyees. An important consideration noted by Ashton and Ramasar (ibid) is the need for the establishment of robust and reliable water treatment and supply systems that do not depend heavily on support mechanisms – particularly if that support requires a relatively high level of supervision.

To prevent the worst of the envisaged impact service providers should build a critical mass of skilled and semi-skilled workers needed to ensure water services. However the inability of municipalities to rapidly acquire the skills needed for their own administration indicates that doing this will be an enormous task.

5.6 Potential for replication

The acid test for the success of any technology is whether it is expected to expand given the limitation of the system "on the ground". A good indication is given by the intentions of those municipalities which are currently using the technology.

Table 3: Intention to use prepaid water meters in the future

Municipality's position	Percentage of all Municipalities	Intend installing ppwms in the next year	Intend installing ppwms in the next three years
All municipalities	100	33	59
Current users of technology	22	57	64
Not current users	78	28	57

The table above shows that municipalities currently using the technology are almost twice as likely as non-users to expand their use of the technology in the coming year. However in the medium term, the next three-years, the two groups have very similar intentions with sixty percent of all municipalities intending to increase their uptake of the technology .

Municipalities were also asked how many meters they are considering installing. If they realise their intentions, the number of prepayment meters in the sampled municipalities will double over the next year and treble over the next three years. More realistic estimates are given by the model described in section 4.5. According to that model, the expected increase in the number of meters over the next year is "only" 23 percent. This reduced level of uptake reflects the likelihood that most first time users will only experiment with a small numbers of meters. After one year, 58 percent of all the municipalities will be using the technology but most will have fewer than 100 meters in place.

Only 10 percent of the respondents cited the technology's ability to monitor Free Basic Water consumption as a major benefit. Since the policy has not fundamentally altered the way in which the benefits of the technology are seen it may be deduced that it will only have a marginal impact on overall levels of uptake.

There are four factors pointing to the expansion of the uptake of prepayment meters and two points militating against a marked increase. The factors supporting expansion are:

- The market has a massive growth potential, since only about two percent of all households with piped water use prepayment meters
- Many municipalities intend introducing prepayment water technology for the first time in the near future

- The Free Basic Water policy is not likely to have an impact on the meters' uptake as the system reduces waste significantly.
- Most households are currently billed for their past water use and stand to benefit from the lower volumetric costs associated with prepayment
- The market can be expanded to include middle/high income consumers and commerce/industry. This will not only make the system sustainable but also increase income generation and cost recovery.

Factors working against expansion are:

- The questionable reliability of the technology. However given the improvements in this regard this regard this problem may only be of consequence in the most remote areas
- The cost efficiency of the technology. Cost efficiency is a complex matter and it is doubtful whether municipalities are able to compare the true cost of prepayment technologies with more traditional systems in which costs are often inadvertently concealed.

The anticipated uptake of the technology rests increasingly on municipalities taking an integrated approach of revenue management and cost recovery.

6. PREPAYMENT TECHNOLOGY IN WATER SERVICES

6.1 Introduction

Just as surveys are unsuited to unpacking complex dynamics case studies suffer from not being easily generalisable. The schemes used in the case studies were selected in such a way that a cross section of experiences was assured rather than because a general trend could be derived. The real value of this study emerges once the case studies and survey responses are brought together to offer a more nuanced understanding of practice. The understanding of the situation presented below was derived from the combination of the two methodological traditions[20].

6.2 Background

Since the first prepayment meters were introduced in South Africa a decade ago the environment in which they operate has changed substantially. Initially, prepayment meters were, narrowly, seen as a means by which water service providers were assured of sales revenue. Prepayment meters were introduced in response to, *inter alia*, widespread non-payment for municipal services by residents of disadvantaged areas. Despite the changes in the operating environment this association of prepayment meters with disadvantaged consumers has remained.

6.3 The changing operational environment of local government

Perhaps the most obvious change in the environment in which municipalities now operate was the introduction of the Free Basic Water policy. The Free Basic Water policy seeks to guarantee a minimum standard of service for even the most disadvantaged households. Under this policy households are assured of access to a survival line of water without charge. As prepayment meters were initially concentrated in households that have low consumption levels which, it was expected, could be accommodated under the Free Basic Water policy, it appeared *prima facie* that the Free Basic Water policy would undermine the uptake of the technology.

Given other changes to the operating environment this perspective proved to be erroneous. The National Postal Survey indicated that the uptake of prepayment meters is set to continue, notwithstanding the introduction of the FBW policy, reservations about vandalism and the questionable reliability of the meters. Another important environmental change relates to the stipulation by DWAF that water provision services will be required to be "sustainable". In the narrowest sense "sustainability" is an economic condition under which economic costs associated with providing a service are recovered from its consumers at large. In a broader sense, sustainability relates to the use of natural resources in an economically efficient and ecologically sustainable way.

[20] With respect to the NPS the probabilistic model in which response bias was corrected has been used as much as possible.

Cognisant of resource limitations in municipalities and of the fact that many households are unable to afford even essential services, the state introduced a number of programmes to ensure that such services could be made available to them. Predominant was the implementation of the "equitable share grant". This grant is an allocation of funds from the fiscus to municipalities enabling them to finance the provision of services to the poor. The state did not limit its subsidisation of municipal services to the equitable share grant. It also made funds for capital development available under a variety of schemes. Prominent among them are the Consolidated Municipal Infrastructure Programme (CMIP) and the Community Water Supply and Sanitation (CWSS) programmes. Given the limitation of state resources and the depth of poverty, these two interventions were insufficient to ensure universal access to essential services. Another intervention intended to help ensure that local government services are sustainable was the restructuring and re-demarcation of municipalities across the country.

Municipal re-demarcation was primarily informed by attempts to match poor communities to wealthier areas which could act as revenue bases. Revenue bases are typically affluent residential districts, mines, commercial or other industrial developments which could provide the municipality with a sound revenue base over a long term. These tax bases, by implication, could cross subsidise service delivery to other residents.

One principle underpinning the new policies and legislation was greater equity in access to services. As it was unacceptable that service levels could be reduced the equity constraints left municipalities with the onus of expanding service levels typical of urban areas to a poorly serviced (and often highly dispersed) population. One consequence of the new policy and legislative framework was local government finding itself operating with a mandate markedly different from what they were accustomed to and having to do so within a radically different administrative framework. This mandate essentially required a massive expansion of economically sustainable services while reversing the impact of under-investment in infrastructure and poor administration. The Polokwane case study exemplifies these tensions.

The changes wrought by municipal redemarcation need to be taken into account in understanding how the new mandate was to be met. The re-demarcation of municipalities not only served to twin economically disparate regions but to agglomerate areas of equally disparate administrative infrastructure. Inevitably, this placed strain on local government as they sought to amalgamate diverse systems, introduce services to the disadvantaged areas, transform themselves and meet the new mandate within the budget constraints prompted, in part, by the failure of many communities to pay for services. The central features of the new environment were:

- larger municipalities which combined diverse and independent administrative structures as well as areas that were not effectively administered
- a need to markedly improve the level of services, particularly to poorly serviced and impoverished areas
- a requirement that basic services be made available free of charge
- the economic sustainability of the services.

Meeting the new mandate would be difficult at the best of times but accomplishing it

with a local government that was in the process of restructuring ensured that the process would, at the very least, be prolonged. At another level the objectives are incompatible. If municipalities were to improve revenue bases through local investment stimulated by reasonable service charges and low municipal taxes severe constraints would be placed on the level and locus of investment as well as the extent of cross-subsidisation.

6.4 Meeting the local government mandate

With regard to water services, the challenge confronting municipal water service providers was, succinctly, to ensure a sustainable water provision system within the constraints imposed by restructuring and the FBW policy. The challenge to local government is to maximise revenue and minimise losses within the constraints provided by the new social, economic and political environment? With respect to reducing losses, two dominant dimensions emerge - the reduction in the amount of water lost through leakages and the elimination of "unaccounted water". The latter refers to the differential between the volumes of water bought (or abstracted) and the volume sold that is not attributable to leakage. This volume typically accounts for up to 20 percent of water purchased and generally reflects systemic failures in administration. In water, and other services, the limited administrative capacity of local government proves to be a major constraint on local government's ability to rise to the challenge presented to it.

Delivery of a sustainable water service now required, as a first step, that consumers pay for what they consume above the FBW allocation. In the past, a range of potential solutions had presented themselves. These ranged from the periodic billing of households for past consumption to the use of systems that restricted the volume of water supplied to households. Restricting the volume of available water proved unworkable in communities which were accustomed to receiving unlimited supplies of water at full pressure even if they failed to pay for the service. This situation prevailed, for example in Kagiso (Mohale City case study). Because the reduction of service levels to low pressure or defined quantity systems can be seen as "reactionary" it was politically unpalatable in most circumstances. Unfortunately the alternative, billing for past consumption, had already proved unworkable in a wide range of scenarios. Periodic billing required well functioning administrations, as well as consumer co-operation.

The key failure of local government in the period preceding and immediately following the transition to democracy, was its failure to ensure payment for services. The political heritage further ensured that the failure was most spectacular in those areas where accounts were ostensibly easiest to administer – in communities where a flat rate for water services applied. Consumers in these areas received unlimited volumes of water for which they were charged a fixed amount each month. Because municipalities had consistently failed to limit defaulters' services and because communities saw costs as unacceptably high, households in such areas were most reluctant to pay any service charges.

Flat rates for water are premised on the assumption that households in similar categories (in terms of income, location household size etc.) could, with reasonable certainty, be assumed to consume a given volume of water. Under the new environment, this assumption became increasingly untenable as it conflicted with

firstly, individual rights and, subsequently, the essence of the Free Basic Water policy. With the introduction of the Free Basic Allowance any household falling under a flat rate tariff could now claim, without fear of authoritative contradiction that they did not consume in excess of the Free Basic Water allocation and should be exempted from all water charges. The Free Basic Water policy moderated the assumptions that were previously made restricting the administrative latitude local government traditionally enjoyed.

Local governments who continued with flat rate systems, were thus on a tenuous footing with respect to both individual rights and with respect to their adherence to the Free Basic Water policy. Furthermore while on this footing, they have to contend with high consumption levels and with households unwilling to pay for services. To ensure their adherence to the FBW policy some municipalities implemented tariff exemptions thereby placing an additional burden on their administrative capacity. At the same time, consumers' unwillingness to pay was encouraged by the FBW policy which ensured them at the very least a degree of immunity from service suspension. Theoretically, at least, an alternative strategy was for municipalities to abandon the flat rate system, install conventional water meters and periodically bill consumers for past consumption.

In many ways the option of billing for past (measured) consumption is the worst available to local governments. It requires them to incur the capital costs of putting the meters in place as well as meeting the high recurrent transaction costs. These include the cost of reading the meters, billing consumers, reconciling payments, and conducting credit control measures. Moreover the additional administrative burden would have to take place within the constraints imposed by questionable administrative capacity and significant budget constraints. Despite these constraints this was precisely the response of Swartland Municipality. That municipality's ability to eliminate prepayment meters in favour of regular billing was made possible by the fact that 90 percent of households were already being billed periodically and the required infrastructure was in place. The costs of billing the 10 percent of households moving off prepayment meters was disguised by loading it onto the existing administration. Unfortunately there was also no reason to assume that households that had failed to pay for services in the past would now do so merely because the costing mechanism had reverted to a regular billing system.

For any user-pays system to work, the elimination of free-riders[21] is required i.e. those households who failed to pay for a service need to be prevented from benefiting fully from it. In the FBW context this entails ensuring that defaulters do not enjoy more water that the amount allocated by the policy. With few exceptions, local governments had for decades failed to present a credible challenge to free riders. With the political transition local governments that suddenly demonstrated the political will to end free-riding were now stymied by the Free Basic Water policy and court rulings which further restricted their right to suspend services. It is in this drastically altered environment that a now maturing technology – prepayment meters – found itself.

[21] Free-riding refers to the non-payment for services by consumers when required to do so for services consumed above the free allocation level

Within this new environment prepayment technology promised a way of ensuring that a full pressure, unlimited supply of water to which communities were accustomed could be maintained while ensuring that:

- the FBW allocation was accommodated; and
- consumption above the FBW allocation was paid for.

These objectives could be met without rolling back the level of service - and do so without increasing the demands on limited administrative capacity. Obviously there were serious drawbacks to implementing the technology and some of these are examined below. However, there was yet another advantage to prepayment meters in the form of reduced water costs to households. The relationship between tariff regimes and volumetric costs was discussed above (see 4.2.1 and 4.2.2).

As a rule, municipal managers do not or cannot differentiate between consumers on the basis of the real cost of their service. They consequently do not differentiate between consumers on the basis of the value of the capital infrastructure underpinning their service. Neither can they say that a litre of water delivered under one cost regime is more or less valuable than a litre delivered under another regime. However, service providers can differentiate between the transaction costs associated with different levels of services or tariff regimes. As transaction costs are often the sole means of discriminating between consumers, it can become the driving force behind price differentials. With the advent of progressive tariffs, volumetric charges associated with prepayment meters are significantly lower than those associated with billed metering. Consumers with prepayment meters (unlike flat rate and billed consumers) incur no mail or banking charges, there are fewer credit control and litigation costs and account reconciliation tends to be simple and automated. Furthermore, the transaction costs that are not eliminated, tend to be carried by the consumer. For example, the costs of obtaining tokens or additional water entitlements have to be covered by the prospective consumer. Obviously service providers are able to lessen the burden on consumes by providing convenient pay points at shops or, as in the case of Nkomazi, by setting up customer care centres.

The savings with respect to transaction costs enables water service providers to reduce volumetric charges to the relevant consumers. It is apparent from the data supplied by DWAF that water service providers do pass on to consumers the savings associated with prepayment meters. The *per* litre charge paid by a prepayment consumer for a unit of water in the tariff block immediately above the 6kl allocation is, as a rule, significantly cheaper than water in the same block bought by a billed consumer.

6.5 Drawbacks of prepayment meters

As with any innovation, there are the inevitable drawbacks associated with prepayment meters. Although the most widely cited limitation relates to their technical reliability, the social acceptability of the system probably has a far greater impact. The social context into which the technology is introduced, requires that a distinction be drawn between areas with an established level of service and those in which a service is being introduced for the first time. In the latter, the technology is associated with an improvement in service levels. Barriers to the system then rest on

the ability of prospective beneficiaries to afford the service.

When a pre-existing service is in place, norms are different and consumers' expectations hinder the ability of suppliers to put changes in place. If the introduction of a new system is associated with a reduction in service levels or in increased cost, it is inevitable that it will be met with resistance. Consumers often saw the introduction of prepayment technology as a reduction in service levels and resistance was perhaps inevitable.

If, as described above, prepayment meters are introduced to reduce "waste" they also reduce consumption levels. If the technology was effective in reducing free riding consumers who had not been paying for the service inevitably associated the meters with escalating costs. Water consumers who had successfully resisted paying for water services provided to them on a flat rate or billed basis now juxtaposed an effectively free and full pressure service against one that enforced prepayment for water consumed above the FBW allocation.

Given the success many communities had by mobilising opposition on similar issues, it was inevitable that prepayment technology was to be resisted in such areas and that the resistance was more organised than elsewhere.

When consumers are accustomed to a reliable supply of water for which they did not pay the adoption of prepayment meters became contingent on consumers being convinced that free-riding was no longer viable and that alternatives (such as monthly billing) were more expensive. Conversely, if the service provider is unwilling or unable to eliminate free-riding then no tariff regime is likely to ensure cost recovery. The association of prepayment meters with a reduced, more expensive service, must be seen as less a function of the technology than a reflection of a prior breakdown in the administration of accounts and thus in costs recovery.

The case studies point to numerous examples in which service providers have overcome resistance to prepayment meters by introducing them in situations where there were no prior expectation that non-payment was tolerable. In the Beaufort West and Swartland case studies prepayment meters were placed in new RDP housing developments. The home owners were consequently greeted with improved service levels and prepayment meters undermining any expectation they may have had that free-riding was an option. In Mohale City prepayment meters were introduced into areas where residents had an established history of non-payment. The success of the technology in that case hinged largely on an upgrading of service levels, extensive community consultations and, most importantly, the municipalities commitment to eliminate free-riding. The fact that prepayment meters were instrumental in their initial successes turned on the council sending consumers the appropriate signals regarding their insistence that services would be paid for.

6.6 Technical reliability

The demands on the technology made by water suppliers and consumers challenge the prepayment meters particularly in so far as its reliability is concerned. However, the case studies indicate that, if properly managed, even poor reliability can be contained.

If the consumer bears the cost of the breakdown, then the reliability of the technology will adversely affect popular acceptance of the technology. However if the service supplier bears the cost of breakdowns, then consumers will, at the very least, be indifferent to the technology. Under this scenario, and the situation does seem to predominate, the onus of ensuring the adequate maintenance of the meters falls squarely on the service provider. For service providers, breakdowns are associated with repair costs and lost revenue. In several case studies the experiments with prepayment meters failed because the service providers failed to anticipate maintenance and repair costs adequately. For example in Swartland prepayment technology is being phased out in favour of a billed system. In Umzimvubu consumers are reverting to alternative water sources as the scheme collapses meter by meter. A similar situation prevails in Letsemeng.

However, the primary impact of prepayment meters on household water consumption is to bring consumption to a level commensurate with what the household is willing to pay for. As far as service providers are concerned the primary advantage of the technology lies less in the amount of revenue collected than in the volume of water not wasted by households.

As indicated earlier in this paper, prepayment meters do not *per se* reduce consumption levels; they merely bring them into line with what would have been consumed had consumers been paying. A marked drop in consumption levels is evident in several of the case studies. In Kwamhlushwa (part of the Nkomazi case study) household water consumption dropped from 40kl to 7kl – despite the service provider not yet having implemented a FBW allocation.

The extent of the drop in consumption is determined by the interaction of demand and price – largely irrespective of the billing regime. Although the initial benefit of prepayment technology was the collection of revenue, a more substantial benefit can be seen as households' consumption (including "waste") is brought into line with what they are willing and able to pay for.

Conversely, the cost of the technology in areas with a history of non-payment despite high service levels has to be compared not with the revenue gained, but to the revenue plus the value of water that would have been consumed had a free unlimited, full pressure service been available. In this context, the cost of repairing meters becomes more palatable and the technology appears significantly cheaper. This point has been clearly made by Rabe with respect to the Mohale City case study (see section 2.3.2).

The willingness of water service providers to carry the cost of installing prepayment meters and dealing with their unreliability, depends on them seeing the technology in such a holistic way. In this perspective prepayment meters are seen less as a means of generating revenue than a way of ensuring that policy obligations are met, that existing administrative capacity is used optimally, that unnecessary water consumption is reduced and that service standards are maintained. When such a holistic perspective is adopted the technology has been well received. In both the Mohale City and Nkomazi case studies prepayment meters are key to the effective management of municipal accounts.

However, if municipal water service providers do not conceive of the technology as a means of achieving sustainability in service delivery, then the costs of implementing the technology will seem prohibitive. If, for example, a municipality discounts the impact of increasing the burden on a strained administration, it may well appear more cost effective to replace malfunctioning prepayment meters with a flat rate or conventional meters. Similarly, by comparing the cost of installing and maintaining prepayment meters only to the revenue obtained will make the technology appear prohibitively expensive. A more legitimate would be a comparison of the cost of installing and maintaining the system to the revenue derived plus the value of the reduction in unaccounted, wasted and unpaid for water.

If the municipality does not attempt to stop free-riding, because of political expedience or administrative incapacity, it has to accept the loss in revenue. In such situations comparison between maintenance cost and the revenue collected will result in the technology being rejected. If this happens not only will water services not become sustainable, but the costs will be temporarily hidden as funds are misdirected from other services to subsidise excessive water consumption.

If sustainability of water services is genuinely pursued, then the holistic perspective suggests that the technology has only now found its time. It allows for the municipal mandate of expanding service to be met within the constraints imposed by limited administrative capacity. This, coupled to increasing reliability of the latest generation of the technology, bodes well for an accelerated uptake of prepayment water meters.

7. RECOMMENDATIONS

It is generally concluded that prepayment water meter technology has a valuable role to play in sustainable water service delivery. However the technology may not be rolled out in appropriate measure unless the limitations and potential are better understood. For the appropriate adoption of the technology to take place the following is recommended.

7.1 Improved articulation of policy objectives and legislation

Policy formulation and the legislative framework has tended to be more fragmentary than complimentary. It is clear from the variety of ways in which policy is being interpreted and applied that municipalities' understanding of water policy is poorly articulated. The lack of articulation of priorities and areas of discretion leaves room for unintended consequences, grey policy areas and contradictions.

- It is suggested that water policy (including Free Basic Water provision and the use of equitable share grant) be packaged in a holistic manner that enables municipalities to better interpret and apply policy. By reducing the grey areas and explaining priorities, this product will contribute to municipalities meeting their mandate easier.

- Policy measures need to be communicated in such a way that stakeholders have a common understanding of water service delivery policy, together with its constraints and opportunities.

7.2 End to "free-riding"[22]

The practice of non-payment for services (free-riding) affects services other than water service provision. Resistance to prepayment meters is often an attempt to ensure that free riding is allowed to continue. Given how widespread free-riding is solving the problem cannot be devolved to water service providers on their own.

Assistance needs to be given to municipal structures and their agents to understand and address social conflicts relating to service payment. The impact of indigent policy and how the insights gained from case studies need to be more widely shared.

- Municipal water service providers must be equipped to, *inter alia,* see the difference between community resistance to payment and the means by which payment is effected. Similarly consumers have to be informed that free-riding is no longer an option – irrespective of the means by which consumers are called to account.

- Municipal structures should more actively educate constituencies of the impact of "free-riding" in terms of sustainable service delivery and lost

[22] Free-riding refers to the non-payment for services by consumers when required to do so for services consumed above the free allocation level

opportunities. This education should highlight the cost of "free-riding" in terms of reduced service delivery in other service sectors.

7.3 A working partnership of key stakeholders is in place

A "champion" is required to help municipalities address the diverse sets of challenges confronting them. The role of the "champion" is not to promote the use of prepayment meters, but rather the delivery of a sustainable water service.

- A working partnership involving an alignment of stakeholders such as DWAF, SALGA, DPLG as well as WRC, must be generated. This partnership, in the form of a champion, is to ensure that policy measures and interventions blend. The resulting shared understanding and application of policy must be communicated to municipalities in an accessible and easily understood manner.

7.4 Strengthening representation

The institutions of democracy in local government have taken a back seat in articulating interests. These institutions should enable local government to achieve its objectives and carrying out its responsibilities. Elected officials are often less vocal than activists in representing their constituencies.

- Ward Committees to play a more prominent role in articulating the grievances of their constituencies while promoting the collective decisions of local government to those who elected them.

7.5 Adoption of a holisitic approach to cost recovery

Prepayment meters are merely a means of attaining improved levels of cost recovery within the constraints of policy, legislation and budgets. Within this paradigm prepayment meters should not be evaluated on the basis of revenue generated but on the basis of changing consumer behaviour, reduced waste, lifting of pressure on administration systems etc.

- Conduct workshops in which stakeholders involved in the installation of prepayment meters are exposed to best practices regarding cost recovery. This exposure should be used to better explain the role of innovations like prepayment meters.

7.6 Perceptions of unreliability

Due to the perceived persistent unreliability of prepayment water meters, the continued uptake of the technology is threatened. This study is generally silent as to whether or not the technology is reliable. However many respondents in a range of environments have indicated that the problem/perception can be overcome. One way of addressing the situation is through by technical certification.

A SABS certification system of prepayment water meter units be compulsory once the standard level of performance has been set.

7.7 Future research

During the study and subsequent discussions held in the Steering Committee, several gaps were identified as possible areas/subjects for future research.

It is therefore recommended that consideration be given to the following possible research topics:

i. An examination of the potential of "low level technology" in reducing the cost of water to very low-income communities.

ii. A comparison between urban and rural communities in terms of the effect of transaction costs. In certain instances reducing the cost of water by shifting transaction costs onto the consumer may adversely affect households. The impact of such measures needs to be better understood.

iii. An examination of the impact on households and service providers of an increase in the FBW allocation. The FBW recommendation of 6kl per household per month appears to be somewhat arbitrary. It should be investigated if minor deviations from this amount have a material affect on household well being and municipal revenue.

iv. Improved estimation of the transaction costs associated with fixed rates and "traditional" billing

v. Estimating the impact of HIV/AIDS on the water demand and the management of water service delivery by municipalities

vi. The Chinese experience should not be assumed to be irrelevant. An examination of their experience by, *inter alia*, site visit may contribute significantly to our understanding.

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ANNEXURE A: SUMMARY OF KEY FINDINGS FROM NPS AND CASE STUDIES

In establishing the template of issues within which the case studies were to be conducted, it was acknowledged that the key findings from the NPS would also need to be tested during more detailed face to face discussions with relevant stakeholder groups. Accordingly, these issues were listed for use during the interview sessions held with key stakeholders.

The documentation of the eight case studies has been assembled as a separate report; however, a summary of the case studies has been included under Annexure E. To provide readers with an idea of the template of issues discussed with each municipality and related stakeholder groups, a copy of the interview template is included in Annexure C.

To link the key findings from the NPS with the outcomes of the case studies, a comparative summary in the form of a table has been prepared to reflect the interrogation of the key survey findings within the context of each case study. Table 4 illustrates the degrees by which the questions emanating from the NPS match the performance of each prepayment water meter project examined.

Where an issue is identified in the form of a question, a qualification has been added where necessary to provide both context and focus for each question. No level of importance is indicated through the numbering system used.

Table 4: Comparative summary of key findings from both the NPS and the case studies

	Beaufort West	Kannaland	Letsemeng	Mogale	Nkomazi	Polokwane	Swartland	Umzimvubu	NPS*
1. Key question Is vandalism a big enough concern to limit the future uptake of prepayment meters? **Qualification** Has the past experience of the community been managed through consultation, community participation etc. in a way that minimises sabotage etc.?	No. Initial consultation was limited and a few individuals (non and poor payers) objected. Consultation is currently better.	No. Strict penalties applied to incidences, although these are not due to poor consultation or communication.	No. Initially no community involvement followed by visible vandalism. Consultation improved and vandalism decreased to zero.	No. Yes. Project monitored and managed regularly. Involvement of the community.	No. < 1% Regular monitoring and liaison through community care centre.	Yes. Persistent robust use/ misuse of unguarded meters. Technical reliability questionable.	No. Mainly new projects in small towns where information areas were upgraded with subsidised housing.	No. Alternative sources available. Project initiated and run by community.	No. Respondents acknowledge the extent of vandalism and similar activities but do not view it as sufficiently onerous to jeopardise ppm programmes.
2. Key question Is there a fixed component to pricing of water?	No.	No.	No.	No.	No.	No.	No.	No.	No. Fixed component to tariffs incompatible with ppm.

	Beaufort West	Kannaland	Letsemeng	Mogale	Nkomazi	Polokwane	Swartland	Umzimvubu	NPS*
3. Key question How many prepayment meters are in place? **Qualification** Is the scale of implementation large enough to assess the impact of the technology?	300. Scale (3%) too small to assess impact of technology.	1000.	900 prepayment meters being replaced with conventional meters. Down from 900 to 200 as repair costs too high.	16500. Faulty meters regularly replaced.	1374. (30-40% faulty on random sample sites). Number sufficient.	1100 prepayment street meters being replaced with conventional meters. Down from 1100 to about 900.	1500 prepayment meters being replaced with conventional meters. Down from 1500 to 200.	80. No. of meters too small. The majority are not functioning.	Most municipalities probably install too few meters to be able to adequately judge their cost effectiveness at scale.
4. Key question Has the municipality enough capacity to maintain and service PPM?	No. Minor repairs in-house, but major repairs by provider.	Limited, major repairs go to Cape Town.	Initial repair shop for minor repairs, but closed down by provider.	In-house repair (adequate spares and short turn around).	Faulty meters sent to Durban. Some minor repairs done locally.	Current repairs free of charge by provider (Teqnovo), once guarantee period has expired, costs expected to increase substantially.	Repairs by provider, CONLOG. Phasing out due to technical unreliability and cost.	Nil capacity. Mvula Trust in Pretoria responds to maintenance. Teqnova responsible for maintenance and repair.	Municipalities enjoy a range of service levels. Inadequate maintenance is incompatible with ppm programmes.

	Beaufort West	Kannaland	Letsemeng	Mogale	Nkomazi	Polokwane	Swartland	Umzimvubu	NPS
5. Key question How do service providers see community attitude to prepayment meters? **Qualification** Are the PPM associated with an increase in water costs and service levels?	Acceptance. No increase in costs and service levels, since it was a new project.	Keen acceptance since more are being sold individually. No increase in costs and service levels.	Keen acceptance until it was decided to terminate contract. No increases in costs and service levels.	Users acceptance. No increase in water costs but service levels have increased.	Users indifferent but benefit from status quo.	Users are comfortable with status quo (where malfunction exists). Prepayment Meters introduced payment for the first time and there was acceptance since no service previously.	Users are comfortable with status quo. Upgrading of initial meters led to improvement. No increase in water costs and service levels.	Users are comfortable with status quo provided improvement to service takes place.	Water service providers believe consumers are happier with ppm's than they themselves are.
6. Key question Are newer PPMs more reliable than older ones? **Qualification** Are maintenance costs falling as the technology improves?	Not tested Maintenance costs acceptably low.	Yes, the upgraded combined electricity & water meters are more reliable. Yes, maintenance costs not increasing.	Upgrading of initial meters was an improvement, but repair cost was introduced without municipality ready to accept such costs.	Yes Progressive improvement has occurred. Marginally lower as in-house repair capacity exists	Yes, as each problem is overcome but incidents rate remains constant No, transportation costs high.	Some technical improvement on initial meters, but still not resistant to robust use, especially PC boards.	Initial upgrading improved meters to a certain extent, Repair costs keep increasing.	Still using original meters. Unknown.	Very mixed experience with respect to reliability. Municipalities with older meters may be as satisfied with tech. as those with newer ones.

	Beaufort West	Karnaland	Letsemeng	Mogale	Nkomazi	Polokwane	Swartland	Umzimvubu	NPS
7. Key question Have any factors other than price and service levels determined the acceptability of PPM?	The linking of prepayment meters with subsidised housing offered an attractive residential package.	Linking electricity and water prepayment meters offered an attractive package.	None.	No price. Remains to be determined.	The delivery of a reliable service.	The mere provision of water made the difference, but it also eliminated a previously unacceptable system, viz flat rate.	The linking of prepayment meters with subsidised housing offered an attractive package.	Price since all residents are very poor.	Where service levels are not being markedly improved the price of water is key to community acceptability of ppm.
8. Key question Is there any evidence that PPMs reduce consumption more than any other billing method would?	Insufficient evidence on record.	Reduction in consumption reported and strong intention of increasing number of meters.	Reduction amongst higher level consumers – rest constant < 6kl. No increase in uptake, but due to other factors.	User behaviour responds to price.	No. User behaviour responds to price.	Carrying of water from communal taps over long distances reduce consumption levels, hence insufficient evidence.	Insufficient evidence due to low percentage prepayment meters. No increase in uptake, but due to other factors.	Unknown as no means to determine this.	PPM reduce consumption to the same level as it would be under any other regime at that price.
9. Key question Is PPM uptake to increase despite problems?	Yes to increase.	Yes to increase.	No to increase.	Yes to increase.	Yes notwithstanding negative view held by municipality re reliability.	No to increase unless new meter reliable.	No to increase (unless SABS approved).	No to increase unless access to subsidies and house connections encouraged.	Yes. Respondents overstate the uptake rate but modelled results confirm continued uptake.
10. Key question Does the age of the PPMs determine their reliability?	Original batch still in the two years. No, general or increasing rate of failure reported.	Original supplier replaced by another single box system supplier. Too soon to evaluate.	20% original meters still in operation replaced with conventional meters (80% replaced over 7 year period).	An average 3 year life before meter fails.	5 years – 4 models used (failures continue approx. 35%).	After 5 years, reduced by 30%. Failure rate high Robust rural use - experimenting with new meter / supplier.	Over 4 years replaced 20% with conventional meters (policy decision). Current failure rate not very high.	Not necessarily. Only limited number of meters.	Older ppm less reliable but this is possibly due to better servicing of newer meters still under warranty.

	Beaufort West	Kannaland	Letsemeng	Mogale	Nkomazi	Polokwane	Swartland	Umzimvubu	NPS
11. Key question Was there any organised resistance to the adoption of PPM? **Qualification** Did community participation forestall organised resistance to the adoption of PPMs?	None. Isolated cases of protest without specific link to community participation.	None. Probably due to adequate community participation.	Initially a small group of objectors, probably avoidable if adequate community participation was effected.	None. Notwithstanding the uniform policy. Vigorous Masakhane Campaign.	None. Difficult to draw conclusion as liaison is ongoing.	None Situation was one of crisis management.	None Limited initial community participation.	None. No.	NA – not asked in survey.
12. Key question Were PPM ever accepted by communities when a cheaper alternative was available? **Qualification** Was the ongoing provision of free water (without payment) a viable alternative to PPMs?	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial.	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial.	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial.	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial.	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial .	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial.	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial .	No evidence that communities supported ppms when a cheaper alternative is known/ other trade-offs beneficial.	As a rule ppm implemented to combat non-payment. They inevitably increase water cost to consumers.
13. Key question Will FBW increase the uptake of PPM? **Qualification** Are PPM used to limit the supply of unpaid water to the FBW allocation?	Yes increase in subsidised housing schemes. Free basic water included in package.	Yes increase in subsidised housing schemes. Free basic water included in package. Also applied in other sectors of the market.	Not to continue.	No. Uniform policy being implemented.	Yes uptake will improve benefits (less costly than conventional meters); paid for consumption; and opportunity costs.	Yes uptake may increase if reliable prepayment water meters are found.	Not to continue.	Yes uptake will improve benefits (less costly than conventional meters); paid for consumption.	FBW unlikely to reduce uptake of ppms. ppms also best suited to mid-level consumers who use more than FBW allocation.

ANNEXURE B: SALIENT POINTS IN DEVELOPMENT OF PREPAYMENT WATER METERS

Since prepayment water meter technology has only been operative in South Africa for about a decade, it is useful to have a historical overview of the key elements of this development history at the onset of the synthesis.

Historical overview of prepayment meter research

1992		First ppwms marketed in South Africa
1993 Nov	Simes, Lings, Tshivase:	Prepayment of Water Metering of South Africa
	RSA Constitution, Section 27(1)(b) of the Bill of Rights	"Everyone has the right of access to sufficient water"
± 1993	Bateman Water	Responsible for promotion, marketing and installation and after sales support of the Aqua Novo (developed by Teqnovo)
1994	TLC elections	"A better Life for All" political slogan
1995	Teqnovo	Pioneers mechanically operated bulk water ppm
1996	Bambamanzi/Conlog (Conlog acquires Bambamanzi in 1998. Schneider Electrical takes over in 2000)	PPM System launched
1997, Oct	CSIR, DWAF publish booklet on results of a desk study	Implementing Prepayment Water Metering Systems
1997	Water Services Act (No 108)	Provides for establishment of Water Services Authorities, Water Services Providers, Water Boards and Water Services Committees
1998	Kent Measurement	Developed the Kent-Telbit electronic Ppwm
1999	Atlantic meters	Ppwm
2000	Free Basic Water policy kicks in	Nobody must be denied the right to a basic water supply
2000	Municipal Systems Act	Municipalities to manage their services on the basis of full cost recovery
2000, Sept	TSE Water services, DWAF	Site Evaluations: Electronic Prepayment water metering cost recovery systems (evaluates Moddersprult, Masakala, Khutsong, Koffiefontein)
2000, Sept	Editorial, IMIESA	Prepayment Meters: The way of the future
2001, Jan	DBSA discussion document	The role of prepayment water meters for sustainable delivery of water services
2001	SSA, Labour Force Survey of 30 000 households	Water related services
c.2001	DWAF	Data from water service providers on water charges for households
2002	Literature Survey	Section 3 of this document
2002, Nov	SMM for WRC	Postal survey of water service providers (all 284 municipalities) on extent of ppwm technology

ANNEXURE C: SURVEY QUESTIONNAIRE

In designing the postal survey, maximising the response rate is the most crucial consideration and therefore included:

• **A questionnaire that is short, clear, and simple to complete** (Annexure B)—keeping the completion time below ten minutes for the typical respondent. While a longer and more complex questionnaire could, in theory, yield additional information, in practice it is more likely to reduce the response rate and jeopardise the survey's viability.

• **Professional presentation**—including a clear covering letter and a carefully laid-out questionnaire.

• **Practical measures to minimise inconvenience to respondents**—including English and Afrikaans versions of the questionnaire (in the cost recovery survey, roughly half of respondents chose the Afrikaans version) and a pre-printed, postage-paid return envelope.

• **A 'two-plus' mailing strategy**—consisting of an initial mailing to all municipalities, a follow-up mailing within one month to all non-responding municipalities, and a third mailing (supported by faxes if necessary) to municipalities in specific sample strata that remain substantially underrepresented.

The logistics of postal surveys mean that an adequate response rate is never assured, and it is very difficult to predict the response rate in advance. The cost advantage of postal surveys over more 'intrusive' approaches, such as face-to-face interviewing, must be balanced against the risks of low and/or unrepresentative response patterns. By designing the postal survey carefully, the likelihood of success can be maximised but never guaranteed.

The form is reproduced overleaf.

A NATIONAL SURVEY OF
PREPAID METER TECHNOLOGY
FOR WATER SERVICES

Sigodi Marah Martin Development Consultants
for the ***Water Research Commission***

The first few questions ask you to describe your municipality's use (if any) of prepaid meter technology for water services.

1. Does your municipality use **prepaid water meters for any of its consumers?**	Office use
☐ Yes ☐ No **IF "NO," PLEASE SKIP TO QUESTION 19 (TOP OF LAST PAGE)**	1.

2. **How many prepaid water meters** are installed in your municipality?	
_____ (number of meters) Please estimate if necessary.	2.

3. What **percentage of all household consumers use prepaid meters** in your municipality?	
_____ (percentage of household consumers) Please estimate if necessary.	3.

4. Of prepaid water meters in your municipality, what percentage would you say are installed on **private household connections** (as opposed to, for example, public/shared standpipes)?	
☐ 0 to 25 percent ☐ 26 to 50 percent ☐ 51 to 75 percent ☐ 76 to 100 percent Please estimate if necessary.	4.

5. Of households who use prepaid water meters (whether for private or public/shared connections), what percentage would you say have **household incomes of less than R1200 per month?**	
☐ 0 to 25 percent ☐ 26 to 50 percent ☐ 51 to 75 percent ☐ 76 to 100 percent Please estimate if necessary.	5.

Code:

The next few questions focus on the performance of prepaid water meters.

6. How satisfied or dissatisfied are you with the **overall** results of prepaid water meter technology in your municipality?	Office use
☐ Very satisfied ☐ Satisfied ☐ Neither satisfied nor dissatisfied ☐ Dissatisfied ☐ Very dissatisfied Comment (optional)_____	6.

7. Please choose the ***most important*** **advantage to your municipality** of prepaid water meter technology listed below.	
☐ Improved payment for services by consumers ☐ Reduction of unnecessary consumption ☐ Reduction of unaccounted-for water ☐ Monitoring consumption for "free basic water" ☐ There are no advantages ☐ Other (please specify)_____ Comment (optional)	7.

8. Please choose the ***second most important*** **advantage to your municipality** of prepaid water meter technology listed below:	
☐ Improved payment for services by consumers ☐ Reduction of unnecessary consumption ☐ Reduction of unaccounted-for water ☐ Monitoring consumption under "free basic water" ☐ There are no (other) advantages ☐ Other (please specify)_____ Comment (optional)_____	8.

9. How satisfied or dissatisfied are you with the **technical reliability** of the prepaid water meter technology used in your municipality?	
☐ Very satisfied ☐ Satisfied ☐ Neither satisfied nor dissatisfied ☐ Dissatisfied ☐ Very dissatisfied Comment (optional)_____	9.

10. How satisfied or dissatisfied are you with the **cost effectiveness** of the prepaid water meter technology used in your municipality – that is with the extent to which the benefits justify the costs?	
☐ Very satisfied ☐ Satisfied ☐ Neither satisfied nor dissatisfied ☐ Dissatisfied ☐ Very dissatisfied Comment (optional)_____	10.

11. How would you describe overall **consumer attitudes toward prepaid water meter technology** in your municipality?	Office use
☐ Strongly supportive ☐ Somewhat supportive ☐ Indifferent	11.

☐ Somewhat opposed ☐ Strongly opposed Comment (optional)	

12. Have you experienced **vandalism of prepaid water meters**, and, if so, how serious a problem is it in your municipality?	
☐ It is a major problem ☐ It is a minor problem ☐ It is not a problem at all Comment (optional)	12.

The next few questions focus on technical features of the prepaid water meters and issues related to operation and maintenance.

13. What **power source** do the majority of your prepaid water meters use?	
☐ Electricity mains ☐ Batteries ☐ Other (please specify)	13.

14. Does your municipality receive **ongoing technical support** for the operation and maintenance of prepaid water meter system **from the supplier(s) of the technology?**	
☐ Yes ☐ No	14.

15. Does your municipality receive **ongoing technical support** for the operation and maintenance of prepaid water meter system **from an external contractor other than the supplier(s) of the technology?**	
☐ Yes ☐ No	15.

16. Have municipal workers received **formal training** on operating and maintaining prepaid meter technology **from the supplier(s) or from an external contractor?**	
☐ Yes ☐ No	16.

17. Have municipal workers received **formal training** on operating and maintaining prepaid meter technology **from your municipality's own technical staff?**	
☐ Yes ☐ No	17.

18. If municipal workers have received formal training on operating and maintaining prepaid water meter technology, roughly how many municipal workers have received such training?	Office use
_____ (number who have received training) Please estimate if necessary.	18.

The last few questions focus on the future of prepaid water technology.

19. How, if at all, do you think the **"free basic water" policy will affect the likelihood that your municipality will increase the use of (or begin to use) prepaid water meters in the next three years?**	
☐ Increased use of prepaid meters more likely because of "free basic water" ☐ Increased use of prepaid meters less likely because of "free basic water" ☐ "Free basic water" will not affect use of prepaid meters Comment (optional)_____	19.

20. More generally, do you think that during the next three years your municipality's **use of prepaid water meter technology will increase, decrease, or stay about the same?**	
☐ Increase substantially ☐ Increase somewhat ☐ Stay about the same ☐ Decrease somewhat ☐ Decrease substantially Comment (optional)_____	20.

21. Does your municipality have definite plans to **install prepaid water meters during the next twelve months**, and, if so, how many?	
☐ No, we do not plan to install prepaid water meters during the next twelve months ☐ Yes, we do plan to install prepaid water meters during the next twelve months Please specify_____(number of meters) Please estimate if necessary.	21.

22. Do you think that your municipality will **install prepaid water meters during the next three years**, and, if so, what is your best estimate of how many will be installed?	
☐ No, we probably won't install prepaid water meters during the next three years. ☐ Yes, we probably will install some prepaid water meters during the next three years. Please specify_____(estimated number of meters)	22.

23. Do you have any other **thoughts about the experience or potential of prepaid water meter technology** that you would like to share with us? (Please continue on a separate sheet if necessary.)	Office use
Comment (optional)	23. Mun. Code

ANNEXURE D: FORMAT/TEMPLATE FOR CASE STUDIES

1. **INTRODUCTION**
   - 1.1 Municipal structure
   - 1.2 Demographic background
   - 1.3 Cost recovery history
   - 1.4 Reasons for prepayment water meter technology (motivation)
2. **INSTITUTIONAL ARRANGEMENTS**
   - 2.1 Functions, responsibilities and human resource capacity
   - 2.2 Linkage between municipality and community
   - 2.3 Back-up support arrangements
   - 2.4 Outsourcing of support
   - 2.5 Planning and implementation
   - 2.6 Monitoring reporting and evaluation
   - 2.7 Teething problems
   - 2.8 Revenue management capacity
   - 2.9 Operation and maintenance
   - 2.10 Black economic empowerment
   - 2.11 Capacity building provision
3. **SOCIAL**
   - 3.1 Community involvement and consensus in decision-making
   - 3.2 Education and awareness programs
   - 3.3 Options and choices regarding products and services
   - 3.4 Knowledge of and agreement by users of tariff structure
   - 3.5 Role of gender
   - 3.6 Impact of HIV/AIDS
4. **LEGAL**
   - 4.1 All relevant contracts in place
   - 4.2 Conflict management procedures
5. **FINANCIAL**
   - 5.1 Affordability at both the individual and the municipal levels
   - 5.2 Appropriateness of financial systems re: prepayment water meter technology
   - 5.3 Ability of systems to detect fraudulent behaviour
   - 5.4 Comparison of cost effectiveness of technology chosen compared with alternative technologies
   - 5.5 Comparative data before and after introduction of prepayment water meters
   - 5.6 Performance indicators applied

6. TECHNICAL

6.1 Availability of reliable water supply infrastructure

6.2 Quality of water supplied

6.3 Specific technical support required for the selected metering system

6.4 Interface match between metering system and existing or relevant municipal collection and billing system

6.5 User-friendliness of the technological features of the metering and revenue collection system

6.6 Comparative advantages and disadvantages between the various metering systems and degree of fit between the chosen system and local technological and administrative circumstances

7. ENVIRONMENTAL

7.1 Impact of the technology on the environment

7.2 Impact on water resources

7.3 Effect of potable water quality on long-term functioning of the technology selected

8. CONCLUSIONS AND LESSONS LEARNT

8.1 Benefits achieved by municipality and user

8.2 Success indicators and problem areas

8.3 Potential for replication

ANNEXURE E: CASE STUDY SUMMARIES

Introduction

The criteria established to select the eight case studies were that they should include:

- Both large and small population catchments
- A geographic spread of projects
- A variety of histories of cost recovery and reasons underlying decisions to apply prepayment water metering systems
- Different combinations of income groups served by prepayment meters; and
- A mix of housing and settlement typologies and their urban/rural contexts.

One overriding consideration applied in the final selection of case studies was the reasonably easy access to both people involved and information available, and several had to be omitted for that reason. From the final short-list of municipalities selected for prioritisation, the following municipalities were chosen for detailed follow-up meetings, interviews and discussions:

- Beaufort West; Western Cape; (300 prepayment meters)
- Kannaland; Western Cape; (1400 prepayments meters)
- Letsemeng; Free State; (1000 prepayment meters)
- Mogale City; Gauteng; (16500 prepayment meters)
- Nkomazi; Mpumalanga; (1374 prepayment meters)
- Polokwane; Limpopo; (1100 prepayment meters)
- Swartland; Western Cape; (1500 prepayment meters)
- Umzimvubu; Eastern Cape; (500 prepayment meters)

To ensure that a uniform approach would be applied by the research team in conducting each of the case study investigations, a template of considerations was established to act as a guiding framework (Annex C). A full breakdown of these modules is included in the case study report that is available on CD and the internet under the Water Research Commission web site. (www.wrc.org.za)

This summary of the case studies is presented in terms of the four themes which run throughout the report, viz:

- Effective water services delivery including cost recovery;
- Consumer benefits;
- Institutional arrangements; and
- Public participation.

Trends

The effectiveness of the water delivery has been described as a particular problem area by the Umzimvubu and Polokwane municipalities, where prepayment technology is being applied in rural areas. The backlog of basic service provision, limited funding, the vast geographic areas to be covered and the dilapidated

condition of some of the existing infrastructure are factors which hamper effective delivery. The lack of water meters at individual connections in Umzimvubu has been referred to as a further problem. In Mogale City, vast upgrading schemes to improve networks and connections have been undertaken since 1994 to ensure effective water service delivery.

Cost recovery has become problematic in several cases. There are a number of reasons for this – not all directly linked to the prepayment technology. In fact, prepayment meters have made it possible for some municipalities to recover long-outstanding debt, for instance by crediting the consumer's token with R5 if a token worth R6 water has been purchased. On the negative side, in some cases like Swartland and Letsemeng, the cost of prepayment water meter maintenance and repair has exceeded the income collected from consumers. Where this is happening, municipalities are inclined to revert to conventional meters.

Consumer benefits are mainly reflected in increased awareness of the value of water, a more equitable system of distribution and an improvement in personal management capacity, the latter of which was mentioned as a particular benefit in Mogale. In Nkomazi, consumers regarded the switch from a flat rate to prepayment water meters as a benefit.

A greater awareness of the value of water was reported in a few cases, but only as far as consumers of 6kl or more per month were concerned. This awareness was said to be linked to monthly savings. For the less than 6kl consumers, there was not enough evidence for an answer.

The fairness of distribution as a result of the infrastructural design only appeared in Polokwane where lower lying consumers still had water while those higher up often had an unacceptably low pressure or no water from early in the afternoon. The prepayment meters resulted in regulated consumption, which eliminated, or at least ameliorated, the above situation.

An improvement in consumers' overall personal management capacity as a result of the introduction of the technology was an expected consequence, but not sufficiently tested to provide an answer. There was also no evidence that consumers would have supported prepayment meters if a cheaper alternative were known, since the situation to test this did not occur in any of the case studies.

Institutional arrangements include management aspects and the uptake of prepayment water meters. A variety of situations were found. As far as efficient management was concerned, the compatibility of electronic equipment and the frequency of meter reading to detect leakages were the key elements. Most of the electronic systems were not adequately integrated, while nearly all municipalities did not undertake meter readings frequently enough to ensure effectiveness in this regard. Umzimvubu, for instance, reported too little capacity and a lack of sufficient back-up as being problematic. Back-up systems were used in Polokwane (cost cover) and Nkomazi (PSU International), which made a marked difference in institutional capacity in these two municipalities as far as water service delivery is concerned.

Increased uptake was reported by about half the municipalities, but the situation is a complex one. The reasons given by municipalities for not planning to increase coverage were multiple and varied. The effect of the Free Basic Water policy on future uptake could not be tested in sufficient depth to allow a definite answer.

With the exception of Nkomazi, public participation was absent or minimal when schemes were started. That situation has changed, not so much as a result of problems resulting from the lack of communication, but rather because of the perceived increase of the value of public participation in general. It has been reported in several cases that mayors and councillors are particularly active in communicating with the public, supported by newsletters and flyers.

CASE STUDY SUMMARIES

The following case study summaries are based on comprehensive case study reports which are contained in a separate report. These summaries were structured to focus on the four themes identified by the research team as being central to the findings of the research.

In addition to these themes, each summary is introduced with a description of its nature and concludes with its most salient characteristics.

E1. Beaufort West Municipality

The Beaufort West Municipal area is over 9 000ha in extent and includes three towns: Beaufort West, Merweville and Nelspoort. However, in reality it consists mainly of Beaufort West town which has 93% of the population (35 000 out of a total of 37 500). Beaufort West Municipality is on the N1 route from Cape Town to Johannesburg in the Great Karoo, between 400 and 500 km north-east of Cape Town.

It is a poor community (50 % indigents and increasing) with a low population growth rate in a dry area.

300 prepayment water meters have been installed, mainly in a new RDP housing scheme.

The town has sufficient water sources and water service delivery is effective. Cost recovery has been problematic for many years, to a large extent because of poverty. This situation worsened during the 1980s and 1990s, which prompted the municipality to conduct a small experiment of installing prepaid meters, mainly as part of a new subsidised housing scheme. By doing this, the municipality did not have to insure any investment cost, except for the installation of a number of these meters in the existing houses of poor payers. The supplier was Bambamanzi/ Conlog, which assisted the municipality in setting up a small workshop for minor repairs to meters.

The prepayment water meter scheme includes only 3% of all water meters in Beaufort West, but the municipality is satisfied that it served its purpose as far as cost recovery was concerned (interview with Booysen).

It is the municipality's intention to expand the scheme in 2004 when another subsidised housing project is due.

The consumers who moved into the subsidised houses with the prepayment water meters, generally moved from a situation of no payment to one of payment. The benefit which they experienced lay in the total package of receiving a subsidised starter house with prepayment water and electricity meters.

The institutional arrangements in the municipality comprised the creation of a system, parallel to the billing system, in terms of which tokens could be sold to consumers and auditing could be effected to detect faulty meters. Because of the low percentage of prepayment water meter users, this was not difficult.

According to Booysen, no public participation took place before the first prepayment meters were installed. This led to a few dissatisfied poor payers from existing houses. However, these individual protestors soon accepted the new arrangement. In more recent times, public communication and participation has become normal practice.

It can be concluded that Beaufort West, a poor, isolated municipality, has conducted a small experiment with prepayment water meters in new, subsidised houses (including the meter cost in the subsidy amount) and found the scheme so satisfying that it will be extended in a similar scheme in 2004.

References

Beaufort West Integrated Development Plan, 2002

Interviews with Municipal Officials and Other Parties:

J Venter: Interview with official in Department of Civil Services, 2003

J Booysen: Interview with Head, Finance, Beaufort West Municipality, 2003.

E2. Kannaland Municipality

Kannaland Municipality, which is about 4 570 km² in extent, is in the Little Karoo, about 300 km east-north-east of Cape Town. It includes four towns, of which Ladismith is the main one. Its population is about 30 000 of whom nearly a third are living outside the towns.

According to Hartzenberg, the Head of Technical Services, the application of prepayment water technology was necessitated by the non-payment of services, which developed during the 1980s and early 1990s and threatened to become institutionalised. The magnitude of the problem was reflected by the outstanding services debt which reached a level of R10m during that time.

Ladismith and Calitzdorp, which were still different local authorities at the time, reacted by introducing a two-pronged programme: first, a cost recovery programme for those who had outstanding debt and second, the installation of prepayment water meters in new subsidised housing schemes and at the houses of poor payers.

Both cost recovery programmes were successful: the debt had been reduced by about half and the prepayment meters have improved the rate of payment. The municipality maintains a strict payment policy, but, in turn, ensures a good quality service.

Consumer benefits should be seen in a wide context: Because of the improved payment, water services can be extended to or upgraded in the rural areas. As far as individual households are concerned, some that did not pay, now have to pay.

The introduction of the Free Basic Water policy has brought about relief for those poor families who were not in a position to pay for services.

Institutional arrangements are sound and functioning satisfactory. Ladismith is controlling the sale of cards for the combined electricity and water meters, made by Plessey-Tellimat of Cape Town. The consumers have accepted the system and it is operated by the Treasury Department of the municipality. New prepayment water meters are being sold to consumers other than the poorest people. They benefit by paying a lower tariff and saving because of their awareness of the cost of the water.

Communication between the municipality and the public has been taking place for several years, even at the time when the first prepayment water meters were installed. There have been a few cases of vandalism, but these were not because of objecting to the prepayment metering system.

In conclusion, it can be said that the municipality regards the prepayment water meter and electricity meter combination as a success and intends installing more in new subsidised housing schemes and will continue selling meters to other applicants.

References

Kannaland Municipality: Integrated Development Plan, 2002

Interviews with Municipal Officials and Other Parties:

Hartzenberg, W: Interview with Head, Technical Services, Kannaland Municipality, 2003

Nel, H: Interview with Head, Finance, Kannaland Municipality, 2003.

E3. Letsemeng Municipality

Letsemeng Municipality is in the south-west Free State province. It comprises five towns, has an area of about 10 000 km² and a 2003 population of about 38 000, (8000 households), more than a quarter of whom are rural dwellers. The main town, Koffiefontein, is the largest and has the strongest economy, mainly due to an adjacent diamond mine. Only Koffiefontein and a small town, Opperman, have prepayment water meters installed.

Koffientein is a compact town with an efficient municipal staff which ensures the delivery of high quality services, including water (TSE, 2000, p11). The municipality experienced a poor and deteriorating payment for services situation during the early 1990s, as poor as 1% in one section of town in 1994, which prompted it to install prepayment water meters in an attempt to eliminate this problem.

The municipality entered into an agreement with Bambamanzi and invested about R1m in a scheme which saw the number of meters reach about 1 000 in the year 2000 – mainly amongst the poor who happened to be the poorest payers. Despite initial technical difficulties with meters, which Bambamanzi/Conlog repaired and upgraded free of charge, the scheme worked well and improved cost recovery dramatically. However, the percentage of water delivered through prepayment meters never exceeded 6% and the income from this water was only 1% in 2003 (interview with André le Roux, Director of Technical and Administration of the municipality).

Cost recovery became a serious problem for the municipality in 2000 when Conlog was taken over by Schneider Electrical and the municipality had to pay for all repairs.

At that stage, the municipality only had 7% of its operating budget available for all maintenance and debt servicing (DBSA (1), p7). The municipality then decided no longer to have prepayment meters repaired, but to replace them with conventional meters and revert back to a billing system. The result, according to Wolf, is that there were only about 200 meters left in operation by the end of 2003.

Consumer benefits should be seen against the introduction of the Free Basic Water policy in 2000. The policy, which was soon implemented by Letsemeng Municipality, made provision for 6kl of free water per month. According to le Roux, this arrangement covered virtually all those consumers who had received prepayment water meters in the previous year or two. Therefore, these consumers benefited in so far that they no longer had to pay for their first 6kl/month – a saving of about R15/month.

Institutional arrangements include the efficient municipal service mentioned previously in this summary and the electronic system used by the municipality to administer the system. The billing and prepayment systems were not electronically integrated, but cross-referencing and switching a consumer from the one to the other was easy.

Hardly any public participation preceeded the installation of the first meters. Consumers had to switch from a non-payment situation (refusal to pay issued bills) to one of payment. Some resistance was experienced when about 20 consumers removed, returned and in some cases damaged their meters. According to le Roux, the municipality reacted in dual fashion: fining the objectors and instituting a public participation programme which extended beyond prepayment water meters and which is still functioning well.

In conclusion, it can be said that Letsemeng Municipality "inherited" the Koffiefontein/Opperman prepayment water schemes which were started enthusiastically and with great expectations. However, these being phased out because of maintenance costs which were not foreseen and budgeted for by the municipality as well as the introduction of the Free Basic Water policy which nullified the *raison d'être* for the prepayment water technology programme.

References

Development Bank of Southern Africa: Financial Borrower Appraisal of Letsemeng Local Municipality 2003: Midrand (1)

Development Bank of Southern Africa: Institutional Borrower Appraisal of Letsemeng Local Municipality 2003: Midrand (2)

Letsemeng Municipality: Credit Control Policy. 2002: Koffiefontein

TSE Water Services: Site Evaluation – Electronic Prepayment Water Metering Cost Recovery Systems (for DWAF) 2002: Pretoria

Interviews with Municipal Officials and Other Parties:

le Roux, A: Interview with Director of Technical and Administration, Letsemeng Municipality

2003: Koffiefontein

Wolf, M: Personal communication with Chief Executive Officer, Letsemeng Municipality, 2003.

E4. Mogale City Municipality

Mogale City is situated to the West of Johannesburg in Gauteng Province, South Africa. The area is accessible from other major centres such as Pretoria and Sedibeng. Previously known as the Krugersdorp Local Council, Mogale City is named after Chief Mogale-Wa-Mogale. The main locations in the municipality are Krugersdorp, Kagiso, Magaliesburg, Munsieville and Muldersdrift. Mogale City is a mixture of urban and rural areas with some very varied features, hosting a population of about ±300 000 people.

The urban areas reflect different levels of development. The former black townships are a mixture of clearly laid out sections and dense pockets of informal settlements. The formal township is also divided into 'old sections', which house many shacks within their yards and 'recently developed sections' (less than 15 years old) which house the original formal structures, with no backyard dwellings.

Prior to the amalgamation of the municipality, payment levels in the predominately black areas were very low. Payment levels for water services averaged 8%. There were many reasons for this. Chief amongst them were unwillingness to pay for any service by consumers because of political affiliation, inability of consumers to pay, non-billing of consumer due to the absence of meters, inefficient billing of consumers due to inadequate technology and human error, and the lack of proper accounting by the service provider.

When the black townships were incorporated into Krugersdorp in 1994, the number of water connections increased from about 17 000 to 40 000, and the population to be serviced increased from approximately 70 000 to 300 000. Furthermore, the inherited water service network was in bad condition (especially in Kagiso and Munsieville) so substantial capital investment was required to bring it up to acceptable levels. Following upgrades to the reticulation and maintenance, eleven thousand water meters were installed. By 1997 the first phase had been completed whereby almost all consumers were on the same footing with individual fully metered connections.

Of the 23 000 additional connections after the amalgamation, over 16 000 were in Kagiso, a former 'black' township. Approximately half of these connections were unmetered and a further 2 000 meters were not functioning. With the sense of national unity prevailing after the first democratic national elections in 1994, the Mogale City municipal councillors and staff were confident of meeting the challenge of providing quality water services to all customers in an affordable and sustainable manner. However, with water delivered to Kagiso increasing at about 11% per annum whilst revenue stagnated at about 8% of billed amounts, they also realised that sustainability would not be achieved without the introduction of innovative cost recovery measures (Hazelton et al, 2002). A political and economic decision had to be taken on how to address the cost recovery issue.

Thus parallel with an increase in delivery standards, a credit control programme aimed at defaulters was introduced. In an effort to improve communications with customers; the "Masakhane" campaign was embarked upon. It stressed that customers paying for services remained the most critical factor to the long-term sustainability of the Council and its proven desire to supply all customers in all areas with a quality service (Hazelton et al, 2002). After slow beginnings it gradually gained momentum until thousands of households were being targeted for cut-off

every month. These measures created political tensions, and were expensive to implement. There was the further risk – as has happened elsewhere – of mass protests. No councillor likes to be associated with harsh credit control measures, however necessary they may be. Hence the idea of using prepayment meters instead. It was felt that it would reduce the negative political consequences of the present situation, as the consumers would benefit by being in control of their own consumption and expenditure.

In January 1998 it was therefore decided to investigate the use of prepayment meters. Many issues had to be debated before the project became a reality, but by October that year the first consignment of meters had been delivered. In spite of what was, at that stage, considered to be full consultation with the community, the matter was further delayed when community representatives objected on the grounds of insufficient consultation, in about October that year. Further community consultation took another three months, but in January 1999 the first of 16 500 new prepayment meters were installed.

Mogale City found it necessary to set up a policy relating not only to installation procedures for prepayment meter systems but also to service delivery, tariffs, payments, by-laws and categories of consumers that would receive prepayment meters. In the case of new connections, the municipality resolved that all new standard size water connections would automatically receive a prepayment meter without the consent of the owner of the property. In the case of existing consumers with formal connections it was optional to apply for prepayment water meters. Furthermore, the retrofitting would be done free of charge, and the meter would be installed within the property to encourage 'ownership' and prevent vandalism. In addition the capital cost of installation will be subsidised by the council and there would be no 'mark- up' in the cost of water supplied and the same tariff applied as is the case for the conventional meters. Locals were employed to carry out basic plumbing and retrofitting.

In conclusion it can be said that prepayment can be an effective tool to achieve various results including the upgrading of service and water demand management. Furthermore, the application of prepayment water meters in Mogale City has to large extent been a success story. This has largely been possible because of the following; dedicated skill staff, relevant infrastructure, back-up support from the company supplying the meters, Conlog, extensive and regular interface of service provider with customers and a uniform policy of engagement at all levels with customers.

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G Koekemoer, Rand Water Board (previously with Mogale City), 2003

F Breedt, Technical Department, Mogale City, 2003

M De Klerk, Call Centre, Mogale City, 2003

M Martin, C, Call Centre, Mogale City, 2003

E5. Nkomazi Municipality

Nkomazi municipality with a population of 430 500 is an amalgamation of five local councils, namely, Malelane, Komatiport, Marloth Park, Nkomazi East and Nkomazi West. Nkomazi Municipality is located approximately 350km east of Gauteng and consists of a wedge of land between the Kruger National Park (north), Mozambique (east), Swaziland (south) and Hlambela and Umjindi Municipal areas (west).

During 1997/1998 the then Malelane Municipality experienced serious difficulties relating to the supply of affordable water to the town of Kamhlushwa. During discussions with Mr Len Honeybourne of the DBSA, it was learnt that the Malelane Municipality had accumulated an outstanding debt of approximately R1.4m during the period 1996-1998 due to poor revenue recovery.

After initial consultations with the Malelane Municipality and representative structures within the community of Kamhlushwa, PSU International was commissioned to conduct a service audit, to determine both the extent and level of service within Kamhlushwa and the affordability of alternative technical options acceptable to the community. This was to be against a background of a flat rate of R50 a month irrespective of the amount of water consumed. The majority of the residents of Kamhlushwa (90%), supported the prepayment development initiative and consequently, the municipality mandated PSU International to implement a prepayment water metering system involving 1 374 meters. These were installed in houses occupied mainly by households employed in the public service.

PSU international placed the residents of Kamhlushwa at the centre of an extensive liaison programme by appointing local people to manage a Customer Care Office in Kamhlushwa. This assisted in locating the process of revenue collection within the community. The Customer Care Centre sold coupons, addressed queries and complaints, and handled community awareness and liaison.

The introduction of a prepayment water meter system in Kamhlushwa took place before the Integrated Development Planning (IDP) process was introduced. The planning process involving PSU International placed particular emphasis on a solution that was seen in terms of an effective revenue management system and not simply one of a technical solution to cost recovery.

The first batch of prepayment meters all experienced teething problems because the technology was relatively new at the time. To date (2003) four versions of the water meter have been introduced in response to various technological problems being detected. The latest version includes a new valve, locally manufactured by Schneider Electrical (previously CONLOG) in Durban. Untypically it was reported that during the period of contact with the Technical Department of the municipality, approximately, 40% of a random sample of all the 1 374 prepayment meters were faulty due to technical failure.

The introduction of prepayment water meters in Kamhlushwa resulted in a dramatic reduction in the average amount of water consumed by each household from

approximately 40kl per household to less than 7kl. One crucial concern for the future introduction of prepayment water meters is the dual tariff system in operation at the date of this survey. Nkomazi Municipality applies its system in Kamhlushwa and the District Council applies another system in areas adjacent to it. Attention is currently being paid to rectify these anomalies.

The households appreciated the enhanced and more reliable water delivery service, supported by a community liaison service. Interestingly, the policy of free basic water (6Kl) has not yet been introduced in Kamhlushwa and notwithstanding this, the average water consumption per household is ±7kl.

The financial turnaround has been significantly impressive with an annual loss of approximately R540 000 being reversed to an average income gain of approximately R320 000. This has been attributed by officials to be the outsourcing of its revenue management and the municipality only providing technical support.

In conclusion it can be said that with an improved and more technically reliable water meter and an effective and sustainable system of maintenance and repair coupled with a uniformly applied set of institutional arrangements linking rural and urban settlements the future for prepayment technology appears positive.

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Malelane TLC Borrower Appraisal: Social Considerations (DBSA 1998)

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Working Paper: Water Revenue Management, Utilising Prepaid Water Meters

Special Report, Board Summary: Malelane Infrastructure Upgrading 19 November 1999 Len Honeybourne (DBSA 2000)

Interviews with Municipal Officials and Other Parties:

Interviews and discussions were conducted and held with the following officials of the Nkomazi Municipality, representatives of PSU International and Development Bank of Southern Africa (DBSA):

Mr Andre Lubbe; Town Treasurer; Nkomazi Municipality

Mr Christo Smit; Technical Manager; Nkomazi Municipality

Mr Henry Mashele; Town Manager; Nkomazi Municipality

Mr Put v.d. Merwe; Technical Assistant; Nkomazi Municipality

Mr Andrew Shongwe; Customer Care Centre; Kamhlushwa

Mr Paul Smith; Director; PSU International

Mr Manny Van Zyl; Operations Manager; PSU International

Mr Len Honeybourne; Project Manager; DBSA

E6. Polokwane Municipality

The structure and operation of the water delivery services in Polokwane Municipality is complex because of the composition of the municipality itself. The municipality includes two development areas:

- the established towns of Pietersburg and Seshego; and
- the less developed rural areas consisting of 145 villages which are being served by Lepelle Water, assisted by a professional consulting firm, called Costcover.

Effective water services delivery and cost recovery are not the main focus points as far as the installation and operation of prepayment water meters in Polokwane Municipality are concerned. The urgency of getting water to each village was the driving force behind Lepelle's operations and DWAF was providing substantial subsidisation in this regard.

Because of the urgency of getting water to all the villages, cost recovery is often problematic. In some villages there has never been cost recovery; in other areas, like Mankweng which is a town, the inhabitants refuse to pay until the dilapidated services infrastructure has been upgraded. "The magnitude of the task is daunting," says Katzke, director of Costcover, "sometimes you have to attend to an unexpected pipe burst 200 km away. That takes time, labour and money".

Lepelle has been using Teqnovo water meters, but it appears that these meters, especially the PC boards, are not robust enough for the often rough handling and continuous operating with communal street taps. Maintenance cost had escalated to an unacceptable level and faulty meters, the guarantees of which have expired, were being replaced with conventional ones. However, Costcover was looking at the possibility of experimenting with other, more robust, meters.

Consumer benefits, due to the installation of prepayment water meters, which are currently still mainly communal street taps, are varied: for many consumers the mere fact of having a tap within 200 meters was a benefit; for others the increased fairness of getting what you pay for was a benefit compared to the previous flat rate system where topography advantaged some consumers lower down the hill.

It was generally found that consumers were not unwilling to pay, despite the fact that the Free Basic Water policy had not yet been introduced in this municipal area. That will only be done once each village has a reliable and potable water source. The community at large agree with this policy.

As already stated in this report, Costcover is supporting Lepelle Water on the administrative and management side. It has developed an electronic programme, called Flexibill, which is well suited to their circumstances, which includes offices and staff at the said villages, communicating via cellular phone in addition to weekly information downloads in Polokwane.

On 1 July 2003, Polokwane Municipality took over the role of Water Services Authority from Capricorn District Municipality. It is expected that a process will be put in place to make the municipality more directly responsible for the water services in the rural areas. However, DWAF's subsidisation can be expected to continue.

Since the establishment of Polokwane Municipality in 2000, public participation has been intensified through the offices of the mayor and the relevant councillors. To date, there have been no protests against the prepayment water meters.

In conclusion, it can be said that Polokwane Municipality's water provision service is a complicated matter because of the merging of vastly different development regions in one authority, linked to the low level of development in some areas.

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Interviews with Municipal Officials and Other Parties:

Katzke, R: Interview with director of Costcover re software and management, 2003.

Kriel, K: Interview with director of Costcover re implementation and maintenance, 2003

E7. Swartland Municipality

Swartland Municipality is situated just north of and bordering on the Cape Town Unicity municipal area. It comprises eleven towns with an area of about 10 000 km² and a 2003 population of about 65 000 people (16 000 households). The main town is Malmesbury. Prepayment meters were installed at Malmesbury and Moorreesburg before the establishment of the Swartland Municipality in 2000.

The quality of water service delivery in Swartland municipality is generally high: 95% of all households have piped water on their erf or in the house (IDP, p15). During the early 1990s, Malmesbury and Moorreesburg municipalities experienced a serious services non-payment action, which reached its worst level in 1992. Steenkamp reported the development of a strong sub-culture of non-payment and this, they decided, had to be countered.

In 1997, these two municipalities entered into agreements with Conlog which had 1500 prepayment meters installed by 2001 at an investment cost of R1, 8m. Most of the meters were installed in RDP housing projects and the cost recovery rate improved drastically. Minor teething problems were experienced, but Conlog repaired and upgraded these at their own cost.

The scheme worked well until the municipality had to start paying for meters in need of repair. The maintenance cost of the scheme was higher than expected and the municipality decided to terminate the installation of new meters and the repair of faulty ones; these were simply being replaced with conventional meters and the consumers were billed.

At the end of 2003 there were still about 1 000 meters in operation, with the number gradually decreasing.

The introduction of the Free Basic Water policy in 2000 had an effect on consumer benefits. Before the installation of prepayment meters, consumers who did not pay for water experienced a false reality that water was free. However, this was merely deferred payment, since they built up services debt which had to be paid afterwards. The installation of prepayment meters made payment a reality, while the Free Basic Water policy meant no payment was required for most of those who had prepayment meters.

Institutionally, the prepayment meters did not bring about noteworthy changes, since the number of consumers with prepayment meters never constituted more than 10% of the total. Administratively, the offices in Malmesbury and Moorreesburg handle the prepayment meters parallel to the conventional ones. According to le Grange, upgrading to integrate the two systems would be too costly to justify the expense, since the prepayment system is being phased out.

The amount of public involvement preceding the installation of the prepayment meters was minimal. However, the occupants of the new RDP houses, in which these meters were installed, were used to prepayment electricity meters and no public protest was experienced. Since then public participation has increased in general.

In conclusion, the municipalities of Malmesbury and Moorreesburg introduced prepayment meters, believing that it would solve the problem of poor water service payment. Initially, the schemes worked well, but the municipality considered that the Free Basic Water policy removed the need for prepayment meters for the poor. In addition, payment for the repair of faulty meters made it less economical to keep them in operation.

The officials consider that only an SABS approved meter will make them reconsider their current policy of phasing out prepayment water meters.

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Swartland Integrated Development Plan, 2003

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LZ Zikman, Head, Civil Services, Swartland Municipality, 2003

J le Grange, Manager, IT Services, Swartland Municipality, 2003

T Smit, Prepayment Metering System, IT Services, Swartland Municipality, 2003.

E8. Umzimvubu Municipality

Umzimvubu Municipality is situated within the Alfred Nzo District Municipality in the North-West part of the Eastern Cape adjoining Lesotho to the west, KwaZulu Natal to the north and O.R. Tambo District Municipality from the east to the south. The Umzimvubu Municipality consists of the following districts: Mount Ayliff, Mount Frere, Maluti and a portion of Mount Fletcher.

The major problem faced by this municipality is that of collection of income from the major sources of revenue. It should however not be forgotten that this municipality inherited debts from the former Mount Frere and Mount Ayliff Transitional Local Councils. Collection levels are now sitting at approximately 30% of actual amounts billed on a monthly basis. One of the problems that has handicapped the entire exercise of revenue collection in as far as water is concerned is the lack of water meters on most properties. A project that attempted to address this imbalance in revenue collection in a section of the municipality is the Masakala project situated on the periphery of Matatiele.

Masakala project serves three villages (Masakala, Tsepisong and Kholong) located 10km north of Matatiele in the Maluti District in the Eastern Cape. For the programme to have a good chance of survival a back-up service unit centre was established at Matatiele. Matatiele is in KwaZulu Natal and is strategically located on the main route from Kokstad to the former Transkei and Lesotho. The municipality's economy has strong links with these areas and is generally more economically developed than its neighbours. As such, the urban centres in the municipality, particularly Matatiele, offer a higher order of goods and services than the populations in these areas would otherwise have received.

The Masakala project is a pilot project to investigate the suitability of prepayment meter technology in water supply in rural settings. These villages have a total population of about 1 000 families, the majority of whom are poor, living on welfare pensions at an average of R550 per month.

Before the implementation of the project by Mvula Trust, the water situation in the villages of Masakala and the other nearby villages was critical. Springs and other water sources were no longer sufficient to cover the minimum needs of the fast growing population. Coupled with this was the fact that the existing infrastructure was neglected and was not delivering an acceptable level of service. Cost recovery was almost non-existent.

The need for cost recovery played an important role in discussions with the community from the time the facilitator-consultants, Maluti Water and Mattcomm, were approached by the community water committee to prepare a feasibility study. The difficulty experienced in collecting the equivalent of the anticipated monthly charge from future customers, to build up an emergency maintenance fund as required by the project funders, the Mvula Trust, reinforced thoughts of future cost recovery challenges in the minds of the water committee. This was especially the case as they appreciated that the community would have to pay Eskom monthly for the electricity required to drive the pumps in contrast with other local schemes that rely solely on gravity pipelines.

The consultants suggested prepayment meters as a possible cost recovery option. The Mvula Trust considered that the proximity of the project to support organisations in Matatiele, and the early availability of electricity at the community water office to power the computerised management system, could make the project suitable for the early installation of prepayment water meters. The water committee decided on prepayment as a possible option and requested Bambamanzi and TeqNovo to demonstrate their units to the community as a whole. The community strongly backed the committee's initial decision to install prepayment water meters because they saw it as fair way of charging for water whilst providing 24 hour service. The committee selected the more expensive TeqNovo units because of its robust, refined appearance and long life battery system.

The project was designed and implemented based on the Mvula Trust approach and ethos, which has at its core the principles of the demand response approach. This approach attempted to provide the community with the capacity, skills and structure to operate and maintain the project

The Masakala Village Water Committee (VWC) was fully involved in all aspects of the project, including project planning, construction, administration and financial management processes. The Committee in reality acted as the client and was directly responsible for all project procurement, assisted and guided by the Mvula Trust.

The water committee handled and managed all conflicts and was delegated responsibility to employ and supervise staff in addition to managing and operating the water supply scheme. Each employee was appointed on the basis of a written job description setting out the purpose of the job, the basic skills required of the staff member, his/her tasks and responsibilities, working hours and salary per month. These job descriptions helped staff members to know what was expected of them and to guide the relationship between them and committee.

The Mvula Trust also promised to provide the VWC with post project support for a period of 12 months from the date of completion of the works. This included both Institutional and Social Development (ISD) and technical support. The Mvula Trust Project Development Facilitator and Technician visited on a regular basis to assist and guide the committee, provide the committee with post project training and mentorship and to monitor the progress of the VWC to ensure project viability.

The project was plagued with numerous problems, ranging from poor design of the prepayment meter to inadequate training of the operators. As a result of this and the fact that suppliers provided very little support to the team managing the system, a number of prepayment meters and communal taps were not functioning at the time of the study.

In conclusion, it can be said that the main problem was the local municipality's lack of capacity. It was feared at the inception of the project that if the project would not get the necessary support from key stakeholders, it would not be sustainable in spite of the commitment and dedication of the VWC. Critical support and training of local support staff by the manufacturing firm of the system was necessary for sustainability but the training provided was not sufficient or sustained. Further, many of the consumers have access to alternative sources for water.

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J Sarng, Programme Manager, Mvula Trust, Kokstad, 2003

ANNEXURE F: SUMMARY OF THE REGRESSION

```
xi: sw reg  vol_c  log_inc i.meter_h p_numb  Q611Cost  i.prov type, pe(0.000001) i.meter_hier
_Imeter_hie_1-5     (naturally coded; _Imeter_hie_1 omitted) i.province        _Iprovince_1-9
(naturally coded; _Iprovince_1 omitted)
                    begin with empty model
      Source |       SS       df       MS              Number of obs =   13837
-------------+------------------------------           F( 15, 13821) =  334.35
       Model |  1618855.86     15  107923.724           Prob > F      =  0.0000
    Residual |  4461197.47 13821  322.783986           R-squared     =  0.2663
-------------+------------------------------           Adj R-squared =  0.2655
       Total |  6080053.33 13836  439.437217           Root MSE      =  17.966
------------------------------------------------------------------------------
 vol_carried |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Imeter_hi~5 |   14.98916   .4234578    35.40   0.000     14.15913    15.8192
    Q611Cost |   .0438191   .0027519    15.92   0.000     .0384251    .0492132
_Imeter_hi~2 |   15.09127   .8869187    17.02   0.000     13.35279    16.82975
_Imeter_hi~4 |   11.98711    .700451    17.11   0.000     10.61413    13.36009
_Iprovince_9 |  -14.47914   .6716644   -21.56   0.000    -15.7957   -13.16259
_Iprovince_4 |  -13.72832   .7187568   -19.10   0.000    -15.13718   -12.31946
_Imeter_hi~3 |   12.96208    1.27653    10.15   0.000     10.45991    15.46425
       log_inc |   2.838636    .353673     8.03   0.000     2.145389    3.531883
_Iprovince_8 |  -3.884324    .807885    -4.81   0.000    -5.467888    -2.30076
_Iprovince_6 |  -9.857381   .7051177   -13.98   0.000    -11.23951   -8.475255
_Iprovince_3 |  -10.43104   .8146614   -12.80   0.000    -12.02789   -8.834194
_Iprovince_2 |   -8.99808   .6575424   -13.68   0.000    -10.28695   -7.709208
_Iprovince_5 |  -8.053183   .6425859   -12.53   0.000    -9.312739   -6.793627
_Iprovince_7 |  -7.555301   .6730121   -11.23   0.000    -8.874496   -6.236106
    p_number |   .2846427   .0510154     5.58   0.000     .1846456    .3846398
       _cons |   .2864048   1.322932     0.22   0.829    -2.306721    2.879531
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ANNEXURE G: MUNICIPALITIES WHICH HAVE APPLIED PREPAYMENT WATER METER TECHNOLOGY IN SOUTH AFRICA

National Postal Survey (NPS) 2002: Prepayment Meter Technology			
Source	**Code**	**Municipality name**	**No**
NPS	GT411	Mogale City Local Municipality	16500
NPS	WC015	Swartland Municipality	1500
NPS	WC047	Plettenberg Bay Local Municipality	?
NPS	WC053	Beaufort West Local Municipality	200
NPS	NC083	Khara Heis Local Municipality	320
NPS	WC012	Cederberg Local Municipality	246
NPS	WC041	Kannaland Local Municipality	900
NPS	MP324	Nkomazi Local Municipality	2500
NPS	KZ222	Mngeni Local Municipality	12
NPS	KZ284	Umlalazi Local Municipality	340
NPS	EC106	Sunday's River Valley Municipality	300
NPS	WC042	Langeberg Local Municipality	50
NPS	KZ5A5	KZ5A5 local Municipality	750
NPS	EC152	Ntabankulu Local Municipality	22
NPS	MM5	City of Cape Town	134
NPS	MM1	City of Tshwane Metropolitan Municipality	3000
NPS	NW373	Rustenburg Local Municipality	440
NPS	EC125	Buffallo City Municipality	450
NPS	KZ233	Indaka Local Municipality	140
NPS	NP354	Polokwane Municipality	105
NPS	EC134	Lukanji Local Municipality	3657
NPS	FS173	Mantsopa local Municipality	50
NPS	ECO5b2	Umzimvubu Local Municipality	80
NPS	MP303	Mkhondo Municipality	207
NPS	KZ241	Endumenil Municipality	5
NPS	EC157	King Sabata Dalindyebo	250
NPS	KZ212	Umdoni Local Municipality	10
NPS	WC048	Knysa Municipality	2500
NPS	WC011	Matzikama Local Municipality	300