ABSTRACT:

South Africa has seen a number of evaluation and monitoring initiatives in the last five years. There is a tendency, however, to embark on or promote ambitious monitoring programmes, with scores of indicators, and this is simply not sustainable in practice (which is evident from the fact that at present very little monitoring happening). It is better to start with something simple, and to build up from there. In reality the only successful ongoing rural water supply monitoring programme which has been observed in the field is that which was conducted from 2001 to 2005 by Service Support Agents under contract to the Alfred Nzo Municipality. A further programme that shows great potential as a management tool is the District Information Management System (DIMS), which has been piloted by the uThungulu District Municipality, and is at present being rolled out in a further ten municipalities in KwaZulu-Natal and the Eastern Cape (see www.dims.org.za).

The three most important indicators of a water supply scheme’s health are:

- water quality [where the basic questions are: does it look good? does it taste good? does it smell good? and is it disinfected? / is the source protection in order?]
- reliability [measured as working tap days as a percentage of the maximum possible]; and
- source sustainability [where this is an indicator showing either the level in the dam, the flow in the spring or the level in the borehole, relative to some minimum allowable level].

1. INTRODUCTION

In November 2000 The Mvula Trust produced, on behalf of the Department of Water Affairs and Forestry, a publication entitled “Developing Community-based monitoring and Evaluation Tools for Rural Water and Sanitation Projects” (1). This study contains very useful, practical methods for field management of rural water projects. However, perhaps the most useful insight provided by the report is conveyed in the following quotation:

The water committee felt that the tools were important aids with which to identify issues or problems that needed to be followed up. For example, they discovered that the bookkeeper had stopped completing records, due to the fact that the committee was not looking at the books.
That aptly illustrates the saying, *people don’t do what you expect, they do what you inspect*. But if you are going to inspect, then what do you inspect, how do you inspect, and how do you report on your inspection? If the inspection system is too onerous or burdensome, it will be ignored, or the inspectors will tend to return spurious information. If the system is too superficial, the results will be meaningless.

The management of the operation and maintenance of water systems is the function of local government, and over much of South Africa local government is only now starting to feel its way into that new responsibility. Staff have been hired, capacity is being built, and funds are being made available. Water Services Managers must now start to monitor the Key Performance Indicators on their water systems, so that they know whether they are working reliably and delivering the right quantity and quality of water.

There are scores of different Performance Indicators that are encountered in government reporting systems. The problem is that these are typically too numerous and varied to help the harried council official who needs to know the answers to simple but critical questions like:

- what is it costing to supply one kilolitre on this project, and what is the trend in this cost?
- how reliable is this supply and is it getting better or worse?
- can the water source sustain the demand that is being placed on it?
- is the water quality on this scheme acceptable?
- how much water is being lost, and are losses getting better or worse?
- how much water is being consumed, and is it getting more or less?

In the author’s experience in studying rural water supply projects all over South Africa, very few water supply authorities can answer these questions with ease or with confidence, and yet all would agree that this should not be so. There is thus a need for simple but effective monitoring and benchmarking systems for rural water supply.

The challenge is therefore to develop simple and effective reporting systems, easily understood by rural water committees, which they can be expected to use to report to their own communities, as well as to the relevant authorities. The set of KPIs must pictorially depict trends (good or bad) in strategic areas such as service performance, financial health and accountability. With such a system in place, monthly management reviews can become more effective occasions for communication, problem identification and problem solving.

2. KEY PERFORMANCE INDICATORS AND BENCHMARKS

The provision of water is vital to all communities. Water Service Authorities/Providers are generally not subject to market competition, therefore, it is important that water provision is independently monitored to ensure that the performance of service providers is at an acceptable standard. In South Africa, the water service sector has significant financial constraints and it is thus imperative that supply is effective and efficient if it is to be sustainable (2). This is formally supported in South Africa through the Water Services Act (No. 108 of 1997) which requires annual performance reporting to the Department of Water Affairs and Forestry.
2.1 Key Performance Indicators (KPIs) and Benchmarks as a management tool

Key Performance Indicators (KPIs) and Benchmarks are management tools for monitoring and improving the performance of people, systems, processes and organisations. Depending on the context, there may be some overlap in the definition between KPIs and Benchmarks. However, for the purposes of this paper, Key Performance Indicators and Benchmarks are defined as follows:

Benchmark: A benchmark is a measurement describing a key aspect of an entity that is being studied. It is typically an aspect that changes little with time, if at all. For example, the length of water pipe per customer served is a benchmark which will vary according to housing density and to level of service. The number of Water Service Provider staff per 1000 customers served would be an indicator of WSP efficiency, and so on. Benchmarks are useful for comparing the performance of entities at the same time.

KPI: A Key Performance Indicator, or KPI, is a measurement that describes how well an entity is meeting its objectives, or the health of an entity, and may vary significantly with time. For example, the volume of water which cannot be accounted for in a system is a measurement that can vary significantly with time, depending on the frequency and the seriousness of leaks, and the length of time it takes to deal with those leaks. The balance in the operating account would be another example of a time variable indicator.

This paper deals only with KPIs.

Indicators that vary significantly with time cannot be interpreted meaningfully when viewed at and isolated point in time. Such indicators have to be monitored regularly in order for the trend in the indicator to be established. For example, a tap or set of taps might not be operational on the day of an inspection, and one might conclude that the whole system is “not working”. What one really needs to know is, how many taps of the total are not working, how long has this been the case, and how often does this occur? To answer these questions requires a system of continuous monitoring, much like the heart rate and blood pressure charts which are hung at the end of every patient’s bed in well a run hospital.

2.2 Current KPI initiatives in South Africa

Water supply in South Africa is not short of KPI systems and initiatives, for there are many organisations involved in the various water supply programmes. A selection of these initiatives is described below:

- The Human Sciences Research Council (HSRC) (3)
  The HSRC has undertaken an evaluation of 23 water schemes in KZN for the Department of Water Affairs and Forestry. The projects were classified in one of four categories: not working; problematic, but working; functioning; and sustainable. To qualify as sustainable a project had to meet the following seven criteria: regular supply in all standpipes; regular operations and maintenance; standpipes within 200 metres of households and 25 litres per person per day available; income covering costs of running project; inclusion of the poorest in the community; free water provision; consistent support and planning from the District Municipality. As far as project evaluation tools are concerned, the HSRC’s evaluation criteria are concise and relevant.
• **Mvula Trust (1)**
In 1999/2000 the Mvula Trust published a report on behalf of DWAF entitled “Developing Community-based Monitoring and Evaluation Tools for Rural Water and Sanitation Projects”. The report includes useful flowcharts and monitoring sheets such as: the cost recovery flowchart; the bookkeeping flowchart; the daily fault reporting monitoring sheet; and four flowcharts under the title of “Healthy Taps” – each exploring one management question (Is water flowing out of the taps when required? Have there been indications of water loss in the past few weeks? Is the pump or engine in good working order? Is the reservoir in good working order?) These flowcharts provide a good basis for the training of the staff who operate water schemes, whether they are community members or municipal employees.

• **Pybus/ Water Research Commission (2)**
A report titled “Guidelines for the Implementation of Benchmarking Practices in the Provision of Water Services in South Africa” was completed for the Water Research Commission by Pybus in 2002. The guidelines are targeted at all sectors of local authority involved in water and sanitation services (although it will be more useful to the larger utilities). One of the products of the study is a list of 101 suggested KPIs which fall into five categories: service delivery; financial credibility; technical effectiveness; human resources; background information. Although the list is extensive, Pybus emphasises that not all the indicators are necessary. The list is comprehensive and is intended to cover all levels and types of water services.

• **The District Information Management System (DIMS)**
The District Information Management System (DIMS) is an Internet-based programme management system which may well be the future of municipal governance in South Africa. It can be viewed at [www.dims.org.za](http://www.dims.org.za). It has been developed by the Pietermaritzburg based IT company Intermap, who have been working closely with the Department of Local Government and Housing and the Development Bank of Southern Africa. Piloted in the uThungulu District Municipality in 2002 and 2003, it is now in the process of being rolled out to the rest of KwaZulu Natal’s District Municipalities as well as two in the Eastern Cape. The system handles information under the main categories of Integrated Development Plan (IDP), Project Management, Performance Management, Asset Management, Finance, Procurement and Human Resources. The system will enable municipal managers to keep their fingers on the pulse of every aspect of their organisation (provided the system of data collection and entry is sound - which will only be the case with active verification and good management). The category which deals with the monitoring of completed projects (of any kind) is “Asset Management”. The data fields under asset management are, however, specific to the type of project which is being referred to, and to the requirements of the municipality.

• **The Alfred Nzo District Municipality - KPI and Benchmarking in Practice in rural SA (4)**
From 2001 until August 2005 the Alfred Nzo District Municipality (ANDM), which is located in the northern part of the Eastern Cape, operated and maintained most of its rural water projects using three Services Support Agents, each contracted to look after a group of village water schemes. A total population of 390 000 were served by 130 schemes which range in size from small standalone schemes to large regional schemes. The Services Support Agents (SSAs) used Community Based Organisations (CBOs) to fulfil as many of the operation and maintenance tasks as possible, including some reporting (Illing and Gibson, 2004). A monthly operations
and maintenance report was one of the basic systems at the foundation of the SSA programme. This report was simple enough to be filled in as part of a routine monthly meeting, and the SSA could use it to compile a monthly report to the ANDM.

The SSA then combined the reports for all the villages under its supervision into one summary report, which was submitted to the ANDM on a monthly basis. This report in turn has summary sheets which combine all the information in one page per ward, and in one line per village. That summary gives the following headings per village:

- Population
- Quality (e-coli/100 ml), if sampled in the month
- Quantity (% of FBW)
- Continuity (% operating)
- Cost of service (as % of budget allowed)
- Repairs (key items described)
- ISD (good, acceptable, problematic)
- Incidents
- Sanitation (if anything is happening)

The fields were colour coded, to enable the reader’s eye to immediately pick out where the service is acceptable, and where it is not.

In essence the ANDM SSA system functioned on a 3 level system. At the ground level, simple data capturing was practised, and most of this did not need to be done by technical staff. At the SSA, this data was analysed and a more sophisticated, but still easily assimilated, village report was produced. That was the second level. The third level was the compilation of the monthly progress report for the group of villages under the SSA’s care. This combined the village level reports into tables, colour coded so that problems were flagged for the ANDM’s attention.

Since August 2005 the ANDM has taken over the management of all its water schemes. It is not known if they have kept up with the monitoring and reporting system described above.

### 2.3 Reporting systems to capture KPIs

Section 2.2. above has shown that there are many approaches to the evaluation and monitoring of water schemes, but there are three indicators which stand out as being of prime importance. These are water quality, the reliability of the service, and the sustainability of the source. If a scheme is failing on any of these three indicators, then urgent action is required. It is therefore worth discussing how these indicators can and should be monitored in the field, for it is one thing to agree that an indicator should be monitored, it is another to agree on how to go about it.

#### 2.3.1 Water quality

In the case of the large urban utilities (e.g. Rand Water) water quality is tested at the delivery side of the treatment works on an hourly basis. In the case of rural water supply the best that can be achieved (due to cost and time implications) is one test per month – and in most cases not even this is done. A once per month test is a very uncertain indicator of water quality. How then, can an authority put in place a useful monitoring system which gives at least a daily indicator of water quality?
A system which is proposed and which has been tested in the field is to use a set of 31 glass bottles, one of which is filled at a tap in the scheme every day. The scheme administrator is given a record sheet with four blocks to fill in for each calendar day. The administrator takes a sample for that day, which is stored in a glass bottle which is marked with that day’s date. The first three blocks on the sheet are for the simple look, taste and smell criteria. Does the water look good? Does the water taste good? Does the water smell good? The fourth block is for disinfection status, or source integrity.

How can one practically test for disinfection status in the field? One method is the “colilert” test. A small amount of agar is placed in a 5 ml test tube, and this is filled with a sample of the water that is to be tested. The sample is then incubated using body heat for 24 hours, after which time it is inspected. A clear yellow colour means there are no faecal coliforms in the water, while a black colour means there are faecal coliforms. The test is crude, not being able to distinguish between a water which has, say, less than 10 e-coli per 100 ml, and one which has, say, 1000. The main problem with the test, however, is the methodology. A dedicated researcher might be prepared to sleep with test tubes strapped to his body, but the average village water operator or council official cannot be expected to do such a test routinely. The colilert test is therefore not very practical or useful in the field. Equally crude, but much simpler and more practical is the H₂S strip test, which is available from the CSIR. With this test a strip of paper impregnated with H₂S is placed in a 100 ml plastic bottle containing the water sample. Without incubation the sample turns black if the water is contaminated, and stays clear if it is not. However, even the H₂S test is not the final solution. It is relatively cheap (R20/test), but even at that price it is too expensive for frequent use by a community-based Water Service Provider. Cairncross has indicated that the most effective method for community level surveillance of water quality is to test for residual chlorine (5). If the water is not being disinfected, there is no point in testing for coliforms, because there will definitely be coliforms. If the water is being disinfected, however, the presence of coliforms is unlikely. A simple swimming pool type test kit is all that is required for residual chlorine testing in the field. If there is no chlorination (or other form of disinfection) taking place, then a routine inspection of the source for signs of contamination is recommended. If the source is a protected spring or a protected borehole, and there has been no deterioration in the integrity of that source, then the water quality can be assumed to be good until a laboratory test proves otherwise.

For water quality to be considered acceptable on a day, all four of the quality criteria (look, taste, smell and source integrity/disinfection status), must be acceptable. For a simple visual check the blocks of the control sheet can be coloured in by the system administrator – red for not acceptable, and green for acceptable. The water quality indicator for the month would be the percentage of days with acceptable water.

2.3.2 Reliability
Reliability is not a simple indicator to assess, and yet in terms of customer satisfaction, there is probably nothing more important. But how is reliability assessed? For example, if the pump is off for two days, but the reservoir is large enough so that there is still water at all the taps for the duration of the pump problem, then there is no impact on reliability. If the pump is off for two days but the reservoir is too small and all the taps are without water on day two, then the pump problem is felt by the consumers. If a pipe breaks, and 5% of the taps are affected for a week while the repairs are being done, that is an issue for the customers affected, but most customers are still happy with the service. If another pipe breaks (say the rising main), and all the taps are without water for the week, then that is a much more serious problem.
To enable the reliability indicator to be measured intelligently therefore, a control sheet should be filled in on a daily basis, with one block to indicate the number of taps in the scheme on that day, and another to indicate the number of taps which were actually working on that day. At the end of the month a percentage score can be worked out to indicate how reliable and effective the scheme has been in that period. The percentage is calculated by summing the actual “working tapdays” and dividing by the potential total number of working tapdays.

For example, say a scheme has 40 taps, and for 20 days in the month in question, all of them worked. For the other ten days in the month, only 25 of the taps worked, because there was a problem with the bulk pipeline feeding one area with fifteen taps and the supply had to be switched off there while it was being fixed. In this case:

Working tap days = 20 days x 40 taps + 10 days x 25 taps = 1050
Potential working tap days = 30 days x 40 taps = 1200

Therefore the reliability index for this scheme for the month is 1050 / 1200 = 87.5%

An example of reliability monitored over a period of 27 months at the Nhlungwane water scheme is shown in Figure 1.

Figure 1: Example of reliability indicator expressed as tap working days as a percentage of the maximum that would be achievable. This data was collected at the Nhlungwane scheme from August 2001 until November 2003. During 2002 and 2003 the scheme experienced problems with two of its storage reservoirs, which affected reliability.

### 2.3.3 Source Vulnerability

In many cases the water scheme is reliant on a dam, a spring or a borehole, which must be monitored to ensure that it is not over exploited. If this is so, then a crucial indicator is the water level in the dam or borehole, or the flow in the spring.

A good example of the monitoring of such an indicator has been provided by the CSIR’s groundwater programme (6), who have assisted with the monitoring of a borehole in the Northern Cape (see Figure 2 below). The record of the water table fluctuation over several years, plotted in conjunction with the volume of water abstracted from the borehole, shows clearly the effect of the over-exploitation of this particular source.

Monitoring of boreholes is not that simple to do, although a little planning ahead at the design stage certainly helps. The borehole must be constructed with a piezometer tube
strapped to the riser column, and this tube must be easily accessible at the head of the borehole. The internal diameter of the tube must be at least 25 mm in diameter in order to allow the piezometer (commonly known as a dipper) to be lowered down the borehole to measure the water depth. Electrical conduit, uPVC pipe, LDPe and HDPe pipe are all suitable for piezometer tubes. The tube should extend down the borehole to just above the pump.

If there is no easily accessible duct through which a dipper can be lowered, it is not possible to measure the level in a borehole without removing the pump head, which is not a simple operation. If there is no conduiting provided right down to the pump level, the chances of the dipper probe being lost in the borehole are good.

Assuming that access has been provided for a dipper, the next question is when to measure. The water level in a borehole drops when the pump is running, and “recovers” when the pump is not running. Whether or not the level recovers fully will depend on whether the well is being exploited at a sustainable rate, or not. If the borehole is being exploited within its sustainable yield, but only just, it may take several hours after the pump has been switched off before the water table recovers completely. If it is a very strongly yielding well that is being exploited at only a small fraction of its sustainable yield, then it will typically recover fully in less than an hour.

Therefore the water level one finds when checking a borehole will depend on whether the pump is on or off, and if off, then it will depend on whether it has been off for a few minutes or a few hours. If the borehole pump is controlled by a system which regulates pumping according to the state of the main reservoir (via a signal cable, or a pressure switch, or telemetry), then the pump will not be on at exactly the same times every day.

There are two possible ways to deal with the uncertainty in borehole water table monitoring. The one is to require the person doing the measuring to record simply whether the pump was on or off at the time of the measurement. As one will not know if
the pump has been on or off for minutes or hours, one will expect to see a fairly wide spread in the data. With enough data one will be able to detect trends in the upper and lower limits of the readings, i.e. a data envelope should become apparent. If the upper and lower limits of the envelope are level or stable, then it means that the borehole is being exploited sustainably. If, however, the upper and lower limits are dropping, then it means that the borehole is being exploited unsustainably and the pumping hours will need to be reduced.

The second option, and one which is preferable if one can afford it, is to have a remote monitoring system installed. Instrumentation is put in measuring whatever one is interested in (e.g. water level in the well and the flow through the water meter), and these readings are transmitted either via the cell phone network or via satellite to a receiver which is operated by the company which did the installation. With this equipment one can monitor the well from any internet connected computer anywhere. One can then not only see the detailed trend in the water level fluctuations, but one can see whether the pumps are running the expected number of hours per day. If they are not, for example if they are running 24 hours per day, then one knows that something has gone wrong with the pump control system (e.g. a burst rising main, a broken control valve at the reservoir, a broken signal cable, or faulty electronics in the pump control panel).

2.3.4 The importance of time-based graphical information

When one is confronted by a page of numbers, in small print, the tendency is for one’s mind to switch off. Unless one knows exactly what to look for, the tendency is to see nothing in particular. However, when data is shown graphically, the eye can take in a whole sequence, with hundreds of data points, at a glance. For example, Figure 3 below shows the trend in Unaccounted for Water at Emayelisweni, measured as a percentage of the bulk water purchased. The graph shows over three years of information.

![Figure 3: Three year trend in Unaccounted-for Water at Emayelisweni](image)

During 2000 and much of 2001 the level of Unaccounted for water was very high, being between 50% and 80% of the total water supplied. In the second half of 2001 an intensive
training and education programme was launched to motivate and enable the community water services provider to detect and address leaks in their system. This programme worked well, and by 2002/2003 the losses had reduced to between 15 and 35% of total water purchased. This programme has been described by Ross-Jordan (7).

Thus the conversion of data into images enables the reader to absorb, at a glance, the range and the trend in a particular set of data. This is far more effective than a table of numbers.

Note that percentage losses, as shown in Figure 3 above, are of use only in examining trends in a particular scheme over time. In order to assess whether the losses are reasonable, a far more meaningful and useful indicator is the Infrastructure Leakage Index (8).

2.3.5 KPI charting at community level
From the discussion in the section above it should be clear that data should be converted into images wherever possible. How can this be achieved at the level of community level staff, who seldom have the luxury of computers and printers with which to process data, assuming they had the skills to use them?

One method is to use a simple standard charting sheet. This sheet has twelve columns, to enable data to be recorded for each of the twelve months in a year. It has 20 rows, with no scale marked on the Y-Axis. The scale is worked out with the person responsible for charting in the field. For example, one might need to show the number of taps in the scheme, and for this one might need a scale of 0 to 50. On another sheet one might want to show income, and for this one might need a scale of 0 to 1000. On another sheet one might want to show supply reliability, and for this the scale would read from 0 to 100%.

Each chart can be given aids to interpretation, such as a red line to show that the boundary of an undesirable region, and a green line to show the boundary of a healthy region. This could be used for example if one was plotting costs per kilolitre of water supplied versus the tariff being charged or the subsidy being received.

The community clerk then uses wax crayons or koki pens to fill in the data month by month. The graph is displayed on a notice board in the water office, where it can be seen by all. If a number of the most important graphs are on the wall, the history and status of the water project can be taken in at a glance.

3. CONCLUSIONS
In South Africa we have spent over ten billion rand since 1994 on the task of getting water supply and sanitation to people who previously had no services in rural areas. However, without monitoring, we cannot say whether the ten million people served since 1994 are getting a reliable service. Therefore, we cannot say whether the money has been well spent, and we will not learn from our mistakes. More importantly, without an effective monitoring system in place, basic management of the ongoing operation of schemes is not possible.

South Africa has seen a number of evaluation and monitoring initiatives in the last five years. There is a tendency, however, to embark on or promote ambitious monitoring programmes, with scores of indicators, and this is simply not sustainable in practice (which
is evident from the fact that at present very little monitoring happening. It is better to start with something simple, and to build up from there. In reality the only successful ongoing rural water supply monitoring programme which has been observed in the field is that which was from 2001 until 2005 conducted by Service Support Agents under contract to the Alfred Nzo Municipality. A further programme that shows great potential as a management tool is the District Information Management System (DIMS), which has been piloted by the uThungulu District Municipality, and is at present being rolled out in a further ten municipalities in KwaZulu-Natal and the Eastern Cape (see www.dims.org.za).

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