PAPER 12

Operating and maintaining a forgotten system:
The story of NMBM's bulk water maintenance

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ABSTRACT
The city of Port Elizabeth started developing in 1820 but until 1880 no resident had water on tap unless they could afford rain water tanks or source natural water in the area. The Van Stadens River works was the first major water project, which the city desperately needed to secure its development into what it is today. Many capital projects followed and the bulk water treatment works have been on a well-planned refurbishment plan for many years, however the pipelines that convey this water from the outreaches of the city consist of mostly the same components as were installed some more than 100 years ago. The Bulk Supply System has seen little to no proactive maintenance in the last 10 years.

This paper will highlight the problems which cause these situations to occur, the problem identification process and how the Municipality addressed these challenges. It will also highlight case studies that prove simple maintenance to infrastructure can often be a cheaper source of increased water supply than the augmentation of new water sources. Teams were left leaderless after vacancies were left unfilled for many years, this caused all processes to disappear over time leaving maintenance teams unacquainted with their required routine. Teams were mobilised and a back to basics approach was used. Pipeline inspectors had to ask simple questions while inspecting the pipelines and the answers to these questions resulted in a comprehensive condition assessment.

This condition assessment then forms the basis of work packages which included access control, bush clearing and refurbishment. This information was recorded in spread sheets that make it easier to prioritise certain sections, which allow each point of interest on the pipe to be geographically referenced as well as hyperlinked to photos, clearly showing condition. This information was further imported into Nelson Mandela Bay Municipality (NMBM) water management system which allows the creation of automated maintenance schedules as well as updates the asset management system.

The paper will further indicate how the Municipality went from a lack of systems to futurism, using tools, like automation, to improve the way the bulk supply system operates with all this information still feeding into the maintenance schedules.

1. INTRODUCTION
The Nelson Mandela Bay Municipality (NMBM) is a Category A Municipality with a population of 1 343 911. Current potable water production is approximately 280Mℓ per day, reduced from a peak of 340Mℓ per day through a comprehensive water demand management program. The NMBM's water assets consist of the following:

- 8 dams
- 8 water treatment works
- 74 reservoir sites
- 36 pump stations
- More than 50 staff houses
- 4 766km total length of water mains, including 700km of bulk mains

Water management and Bulk supply resides within the Infrastructure and engineering directorate and is mandated with the responsibility of water resource management, catchment management and the operational and maintenance aspects of Bulk water assets.

The bulk supply pipelines have an estimated value of well over R5.5 billion. The pipelines are up to 100 years old, vary in size from 225mm to 1 400mm in diameter and consist of a number of different pipe materials. These pipelines are crucial to the supply of water to residents and businesses in the NMBM as well as the neighbouring Kouga municipality.

1.1 RESOURCES

1.1.1 Organogram
Since the formation of the NMB Metro in 2000, there has been no review of the institutional arrangements of the organization. The environment has changed significantly in terms of water demand and geographical extent

FIGURE 1: NMBM Bulk water resource map

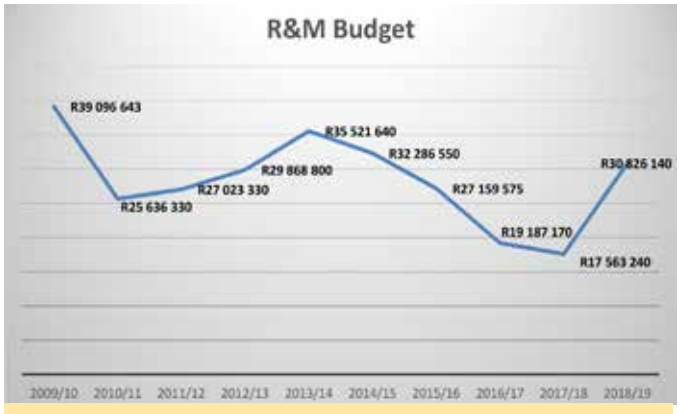


FIGURE 2: Repairs and maintenance budgets for all Bulk Water Assets for the last 10 years

FIGURE 3: Before and after photo of the Linton store, inventory management, crucial to maintenance

but due to a moratorium on filling of vacancies, the staff compliment of the Bulk Water Supply Division has dwindled overtime. The death, retirement and high turnaround of staff due to natural attrition and better opportunities has also contributed to the decline in staff since 2000.

The approved organogram dated June 2005 indicates that there are 211 positions approved and 98 vacant posts in the Bulk Water Supply section. This represents a 46% vacancy rate in the section. However, even at 100% occupancy, the organogram will not be able to satisfy the needs of the current system. A work study will have to be undertaken to establish future requirements as the current organogram has no scientific significance.

1.1.2 Budget

Repairs are executed via the Operating and Maintenance budget. Figure 2 indicates the total budget available for Repairs & Maintenance to all bulk water assets including WTW and Dams. As can be seen there were periods where competing priorities trumped the importance of maintenance and funds were relocated. During the 2016/17 financial year, the Bulk Pipeline Maintenance vote had R2.178 mil available for maintaining the 700 km of pipeline. With the cleaning up of budgets and prioritisation, the 2018/19 budget for maintenance to pipelines is more than R9.5 mil. This is a tremendous improvement but still inadequate to eradicate the backlog. CIDB created maintenance budgeting guidelines in terms of National Government's infrastructure maintenance strategy, these recommend that NMBM should have an annual maintenance budget of at least R220 mil for bulk water pipelines.

1.1.3 Fleet

The Bulk Water Supply section relies on a corporate fleet for the supply of vehicles, plant and equipment. Due to old age and challenges in the corporate fleet, the fleet related needs are not always met and this results in service delivery challenges. This is a clear indication of the silo mentality problem municipalities face, discussed in more detail in the latter part of the paper.

1.2 MAIN PROBLEM STATEMENT

Many factors contribute to the systematic failure of a maintenance unit or ultimately failure of the infrastructure itself. Ironically a lack of systems is a large contributor. This was certainly the case in NMBM.

The Linton Grange pipe yard is the main storage site for all Bulk supply materials. The storage building was however found to be in a state of utter neglect, used mainly as a place to discard unwanted clutter. This indicated a clear lack of system implementation, the storage space should indicate flow ability of work. A neglected storage space means that repair materials are presumably only purchased when needed if not found after a long search through the clutter. This delays repairs, which in turn increases the frustrations felt by consumers experiencing a disruption in supply.

Firstly the historic documentation was collected and put into archive, scrap and rubbish was removed and the entire space cleaned. A stock list was created based on repair methods of each pipe type under the division's responsibility and sufficient stock levels were procured for a minimum of at least two repairs for every pipeline at any given time. This ensures that repairs can be done almost instantly as there are no waiting times for materials. Repairs are also executed in a less stressful environment.

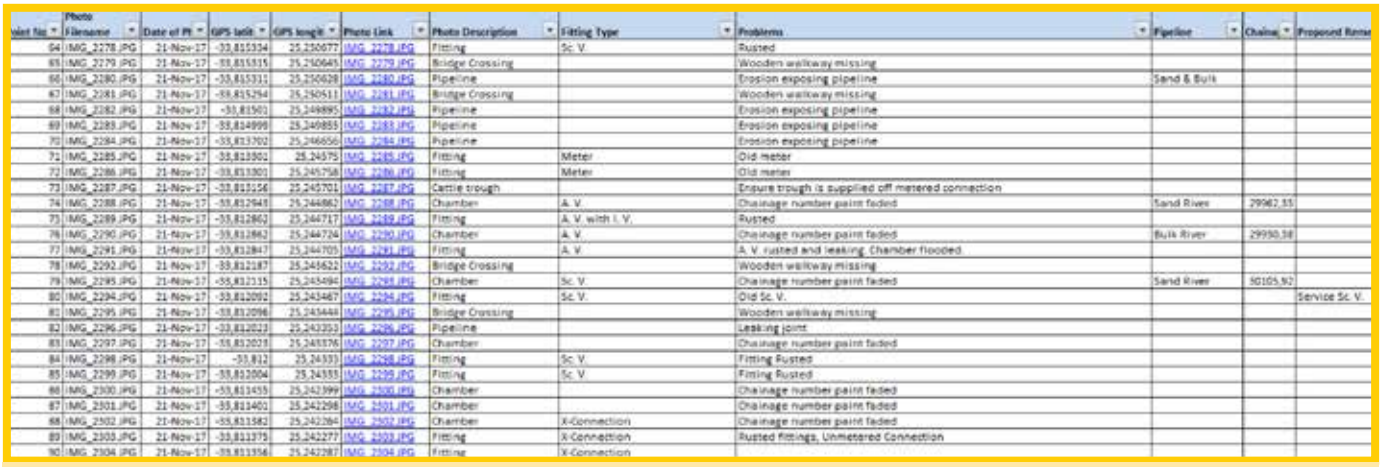
One would ask why there were no systems implemented and that someone should surely be responsible for this task. The answer, in short, is that the majority of the problems experienced stem from a single place; 1st level management.

The previous incumbent was a hard worker with a firm awareness of responsibility. Problems would be sorted out without involvement from senior management. The processes were in place to ensure adequate resources for maintenance teams to perform duties, even routine ones. This position became vacant in 2008, with subordinates taking over in a rotational acting capacity. Senior management became used to a well operating maintenance system with little needed involvement. This is a dangerous comfort that easily beguiles a manager already besieged by a heavy workload due to the outdated organogram and high vacancy rate. The acting incumbent's were left to assume full responsibility, however their performance was never tracked. Teams had no direction in terms of any process or daily routine. The recruitment process for this vacancy is currently underway.

Often these problems start small. Two people that are unwilling to have a mutual discussion end up in a group grievance which requires senior management's involvement to resolve. Too often management end up treating the symptoms and not the causes, which snowball into a dysfunctional unit within the municipality.

2. LETS START WHERE WE LEFT OFF 10 YEARS AGO

Where does one start fixing a system that has been completely reactive in their operations? With a maintenance backlog in surplus of 10 years it could seem like a daunting task of restoring glory to these precious lifelines, some have been serving the city for more than a hundred years. Maintenance teams would have routine duties, like meter readings and inspections, however, spades would only hit the ground once reaction has called upon it. Pipe bursts and disruptions to supply were the alarms for duty. Similarly to the majority of municipal infrastructure in South Africa, very little was replaced proactively (CSIR, cidb, 2007), before the component



Valve No	Photo Filename	Date of Pi	GPS latit	GPS longit	Photo Link	Photo Description	Fitting Type	Problems	Pipeline	Chainag	Proposed Remed
64	IMG_2278.JPG	21-Nov-17	-33,815334	25,250677	IMG_2278.JPG	Fitting	Sc. V.	Rusted			
65	IMG_2279.JPG	21-Nov-17	-33,815315	25,250645	IMG_2279.JPG	Bridge Crossing		Wooden walkway missing			
66	IMG_2280.JPG	21-Nov-17	-33,815311	25,250628	IMG_2280.JPG	Pipeline		Erosion exposing pipeline	Sand & Bulk		
67	IMG_2281.JPG	21-Nov-17	-33,815294	25,250611	IMG_2281.JPG	Bridge Crossing		Wooden walkway missing			
68	IMG_2282.JPG	21-Nov-17	-33,81501	25,249895	IMG_2282.JPG	Pipeline		Erosion exposing pipeline			
69	IMG_2283.JPG	21-Nov-17	-33,814999	25,249855	IMG_2283.JPG	Pipeline		Erosion exposing pipeline			
70	IMG_2284.JPG	21-Nov-17	-33,813702	25,246656	IMG_2284.JPG	Pipeline		Erosion exposing pipeline			
71	IMG_2285.JPG	21-Nov-17	-33,813302	25,24575	IMG_2285.JPG	Fitting	Meter	Old meter			
72	IMG_2286.JPG	21-Nov-17	-33,813301	25,245758	IMG_2286.JPG	Fitting	Meter	Old meter			
73	IMG_2287.JPG	21-Nov-17	-33,813126	25,245701	IMG_2287.JPG	Cattle trough		Ensure trough is supplied off metered connection			
74	IMG_2288.JPG	21-Nov-17	-33,812948	25,244862	IMG_2288.JPG	Chamber	A. V.	Chainage number paint faded	Sand River	29982,33	
75	IMG_2289.JPG	21-Nov-17	-33,812862	25,244717	IMG_2289.JPG	Fitting	A. V. with I. V.	Rusted			
76	IMG_2290.JPG	21-Nov-17	-33,812862	25,244724	IMG_2290.JPG	Chamber	A. V.	Chainage number paint faded	Bulk River	29950,38	
77	IMG_2291.JPG	21-Nov-17	-33,812847	25,244705	IMG_2291.JPG	Fitting	A. V.	A. V. rusted and leaking. Chamber flooded			
78	IMG_2292.JPG	21-Nov-17	-33,812187	25,243622	IMG_2292.JPG	Bridge Crossing		Wooden walkway missing			
79	IMG_2293.JPG	21-Nov-17	-33,812115	25,243494	IMG_2293.JPG	Chamber	Sc. V.	Chainage number paint faded	Sand River	30105,92	
80	IMG_2294.JPG	21-Nov-17	-33,812092	25,243467	IMG_2294.JPG	Fitting	Sc. V.	Old Sc. V.			Service Sc. V.
81	IMG_2295.JPG	21-Nov-17	-33,812096	25,243448	IMG_2295.JPG	Bridge Crossing		Wooden walkway missing			
82	IMG_2296.JPG	21-Nov-17	-33,812023	25,243353	IMG_2296.JPG	Pipeline		Leaking joint			
83	IMG_2297.JPG	21-Nov-17	-33,812023	25,243376	IMG_2297.JPG	Chamber		Chainage number paint faded			
84	IMG_2298.JPG	21-Nov-17	-33,812	25,24333	IMG_2298.JPG	Fitting	Sc. V.	Fitting Rusted			
85	IMG_2299.JPG	21-Nov-17	-33,812004	25,24333	IMG_2299.JPG	Fitting	Sc. V.	Fitting Rusted			
86	IMG_2300.JPG	21-Nov-17	-33,811455	25,242399	IMG_2300.JPG	Chamber		Chainage number paint faded			
87	IMG_2301.JPG	21-Nov-17	-33,811401	25,242298	IMG_2301.JPG	Chamber		Chainage number paint faded			
88	IMG_2302.JPG	21-Nov-17	-33,811582	25,242284	IMG_2302.JPG	Chamber	X-Connection	Chainage number paint faded			
89	IMG_2303.JPG	21-Nov-17	-33,811375	25,242277	IMG_2303.JPG	Fitting	X-Connection	Rusted fittings. Unmetered Connection			
90	IMG_2304.JPG	21-Nov-17	-33,811356	25,242287	IMG_2304.JPG	Fitting	X-Connection				

FIGURE 4: Condition assessment sheet of Sand and Bulk River pipelines

ultimately failed. A corroded bolt only becomes a problem once you have to remove it. Shutdown periods are prolonged because bolts can no longer be removed the traditional way. This makes repairs more expensive, also increases safety risks.

The easiest place to start was at the beginning. Often the words 'back to basics' are used but followed by an intricate program. NMBM's philosophy was very simple. Pipeline Inspectors were once again mobilized and had to ask simple questions while inspecting the pipelines. The answers to these questions resulted in a comprehensive external condition assessment.

- Can you access the servitude?
- Can you drive on the servitude road?
- Is the chamber locked?
- Are there visible leaks?
- Any corrosion of pipe, valve or fittings?
- Does it function?

3. PROBLEM IDENTIFICATION

Problem identification is a crucial step in engineering. Once we have the information we can manipulate it in any way necessary. Certain elements can be abstracted and grouped together. For instance if the assessment shows a recurring problem it can be highlighted and prioritized. Documenting standard procedures assist in preventing problems from repeating themselves. Pipeline Inspectors carry a file in their vehicle containing many important documents, schematic plans and condition assessment sheets.

As mentioned previously, these sheets are very basic, a tick list. Too much writing would create extra challenges with staff that already have low morale. A simple yes or no to the right questions will give more than enough information to have a detailed idea of the current condition of the asset in question. There is an added benefit when technical staff accompany the inspectors, more often than not they are in possession of a smart phone with the ability to pin point locations of chambers or problems as well as photographically documenting what is observed. The technical staff also assist in the capturing and sorting of this information once the assessment is completed.

With such a big backlog in maintenance, the answer to the first question often prevents you from continuing with the assessment. Can you

	A	B	C	D	E	F	G	H	I	J	K	L	M
	Meter ID	Chamber ID	Point ID	Meter Serial	Reading	Description	Condition	Accessible	Factor	Number Of Digits	Meter Type	Supply Size	Has Submeter
1	1	1	1					YES					NO
2	61	61	60	37149	37897		No attention required	YES	X1	5	Mechanical	15mm	NO
3			62	37165	97732			YES	X1	5	Mechanical	15mm	NO
4	66	66	63	93410864	22396		No attention required	YES	X1	5	Mechanical	15mm	NO
5			65	37148	02471		No attention required	YES	X1	5	Mechanical	15mm	NO
6			66	40153985	20399		No attention required	YES	X1	5	Mechanical	15mm	NO
7			67	342491	48019		No attention required	YES	X1	5	Mechanical	15mm	NO
8			67	342491	48019		No attention required	YES	X1	5	Mechanical	15mm	NO
9			68	3410867	14823		No attention required	YES	X1	5	Mechanical	15mm	NO
10	82	82	72	37167	55611		No attention required	YES	X1	5	;Mechanical	15mm	NO
11			75	FSC402	03952		No attention required	YES	X1	5	Mechanical	15mm	NO
12			75	38719	07763		No attention required	YES	X1	5	Mechanical	15mm	NO
13			76	13404	4165		No attention required	YES	X1	4	Mechanical	15mm	NO
14			76					YES					NO
15			76	533759	00140		No attention required	YES	X1	5	Mechanical	15mm	NO
16			77	38346	28620		No attention required	YES	X1	5	Mechanical	15mm	NO
17			78	342354	19112		No attention required	YES	X1	5	Mechanical	15mm	NO
18			82	457380	8832		No attention required	YES	X1	4	Mechanical	15mm	NO
19			83	327705	04299		No attention required	YES	X1	5	;Mechanical	15mm	NO
20	100	100	89		05182		No attention required	YES	X1	5	Mechanical	15mm	NO

Point Gate Chamber Valves Meters

FIGURE 5: Excel gives one the ability to sort information effortlessly

access the servitude? When the answer is "no", then a project needs to be initiated to secure access. How can someone maintain something they cannot access?

Once this has been dealt with the assessment can continue, all one has to do is visually inspect and answer the questions on the sheet.

Figure 4 is from one of the most successful assessments done on a NMBM Bulk supply system to date. The Sand River pipeline officially opened in December 1905 is still in use today. Many components that reached Port Elizabeth via ship from England, during construction, are still currently functioning elements of the pipeline. This pipeline in conjunction with the Bulk River pipeline transport raw water to the Linton water treatment works which is situated right at the end of the pipeline with many consumers and a small WTW along the way. The works has a design production of approximately 15 Mℓ/day, however it was only possible to produce 6 Mℓ at the works each day without disrupting the supply to consumers. The upgrade of this system became one of the recent drought interventions as every drop produced from it resulted in a direct saving from the drought stricken western sources. The assessment of the pipeline was essential to determine where the restriction occurred.

As seen above each point is well detailed as well as hyperlinked to a photograph. This gives the user the ability to sort the information or manipulate it in any way necessary. The spreadsheet is prepared beforehand and is based on the schematic drawing of the pipeline. One benefit of transient mains is that they are usually in a straight line, for most parts, so chambers are easily found if not buried.

The assessment was carried out, with the entire section of 23.9km having to be done on foot as there was no vehicular access to the pipeline servitude. It was evident that the pipeline was not in a favourable condition. Severe corrosion, leaks, old meter and erosion were some of the comments noted. Access in terms of bush clearing had been well managed by the maintenance team. The ultimate recommendation arising from the investigation was that all air valves required replacement, as a majority of them were not properly functioning and causing frequent bursts. There were also low points identified without scour valves, on a raw water pipeline this can create problems as water contains more sediment.

The assessment also exposed that the majority of meters on the pipeline were much older than the recommended replacement age of billing meters. Figure 5 is a clear example of how the sort function within Excel easily grouped the metered connections together. This can then be handed over to the Municipality's meter workshop to execute the replacement of these meters, without having difficulties locating or identifying the meters. The identification of illegal connections was actioned by their immediate disconnection.

The successful implementation of the recommendations stemming from the assessment resulted in an increased flow of 3Mℓ/day minimum. The project cost was approximately R3 mil which included the replacement of 70 air valves, 5 isolating valves, the rehabilitation of 2 river crossings and installation of a scour valve. At a million rand per Mℓ it was by far the cheapest option of supply source augmentation available.

4. PROBLEM SOLUTIONS

As previously mentioned the assessment can be put on hold depending on the access conditions. Certain sections of pipeline track have not seen a vehicle in almost 20 years. It is a wonder how these essential lifelines have been able to vitally serve the city whilst being completely forgotten about. Triennial bush clearing contracts are needed to bring the alien vegetation back to a manageable state, where maintenance teams can use basic equipment to keep the servitude clean.

FIGURE 6: The chamber on the left indicates pipeline location, almost disappearing in the bushes

Although access is essential, it must also be regulated. Vandals will strip valves and chambers of any metal they can. Servitudes as well as chambers must be locked at all times. Investigations indicated a large problem with open chambers, which required refurbishment contracts as per figure 7 and 8.

The assessment, for instance, might indicate that all the air valves on a pipeline must be replaced. This is a costly exercise and understandably not always affordable to action at once. However, this information enables the manager to plan these repairs proactively by splitting them in more manageable tasks, before they become reactive maintenance. When a large capital refurbishment contract is not available one should for instance budget to replace 5 air valves a year until complete.

Figure 9 not only indicates neglected fittings but also a neglected chamber. The valve is badly corroded and the balls being "down" indicates that the valve is isolated and not performing its required function. The pipe is in danger. Wind erosion has damaged the chamber and undergrowth displays a lack of maintenance. Figure 10 indicates a newly replaced air valve, teams must now focus on maintaining this valve and chamber. Many

FIGURE 7: Repairing a broken chamber

FIGURE 8: Raising a chamber submerged by a sand dune

examples can be shown as above, but the fundamental ideology is that NMBM uses the assessment information to develop work packages, which are actioned internally as well as with maintenance contractors, to ultimately satisfy the recommendations from the assessments.

5. ASSET MANAGEMENT

The water management system, also known as EDAMS (Engineering, Design and Management System) and has been used since 2005. EDAMS supply the data necessary for input into the SDBIP, RPMS, WSDP and IDP, data on costing of different capital and maintenance work and links the GIS and the billing system. EDAMS provide the information required for annual audits, questionnaires, complaints statistics, Council reports, asset management as well as Blue Drop, Green Drop and No Drop requirements. All interventions feed into the EDAMS system.

The system possessed the functionality and now the assessment provided the only thing lacking, information. This was all captured and transformed into a network data modelling system through the association of element topology and zoning characteristics. The difference can clearly be seen when comparing figure 11 with figure 12. This detailed information

FIGURE 11: Before information was captured, only the pipeline location was available

FIGURE 9: Air valve chamber

FIGURE 10: Newly replaced air valve

can give the engineer performing a desktop study the feeling of being on site as entire external condition is captured and visible.

Another additional benefit NMBM gained from this exercise was the ability to now generate maintenance management reports. These automated job cards are predefined and will ensure that the pipeline receives routine maintenance and does not return to the state it had been before this project.

The asset values and existing useful life of the pipeline could also be updated, all valuable information for the maintenance manager.

6. ADDITIONAL PROBLEMS

6.1 Loss of intellectual assets

One of the largest contributing factors to a lack of maintenance is the loss of intellectual assets, better known as skilled individuals. As highlighted in the main problem statement when these positions remain vacant or are filled by less qualified individuals, it leads to a breakdown in services. The consequences of the departure of experienced staff is a loss of mentors, skills and institutional memory, the latter is critical when it comes to water infrastructure as pipelines are mostly buried and bad record keeping of plans could see the pipeline location lost. This is often exacerbated by no career path or succession planning which results in low staff morale.

6.2 Silo approach in municipality

This is one of the most frustrating issues to a municipal engineer as he is aware of the problem but lacks the ability to fix it. Major inefficiency is witnessed in the overall operations of the municipality when this constriction in information exists, as different divisions are working with completely different understandings of project outcomes.

For instance consumer billing has a large effect on Non-revenue water

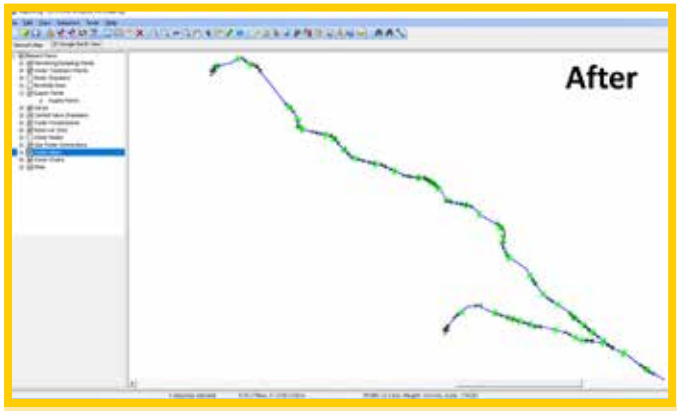


FIGURE 12: After capturing, pipeline is filled with detailed data including links to photographs

(D Raymer, J Tsatsire 2018), however this function usually resides in the financial department. Financial managers have no NRW KPI's linked to their job descriptions and therefore have no obligation to report on figures such as estimates, billed volumes or volumes written off. This leaves technical departments solely responsible but not completely in control, negatively affecting morale to continue with projects as one bad billing month could skew interpretations of physical victories.

6.3 Budget

In South Africa, Operating budgets are usually the biggest cause of financial distress. It is relatively easy for municipalities to acquire capital funding however operational issues cannot be rectified with national government funds. NMBM submitted a drought emergency business plan to National treasury to seek funding assistance for the recent drought. Ultimately, more than R300 mil was allocated to the Metro for the augmentation of new groundwater sources and R20.6 mil for optimization of reservoirs. Of the total amount NMBM applied for, a shortfall of R80.4 million was requested for the betterment of operational aspects, this would in turn have a great saving to water loss. Unfortunately, no funds were granted for these items.

Sadly the political landscape in South Africa rather sees the expenditure of funds on investment than pushing resources into recurring expenditure. (L Boshoff, S Peters 2014/15) The launching of new infrastructure is very attractive to voters.

In the 2018 budget review National treasury indicated that R118.2 billion would be spent on water and sanitation alone over the next 3 years. A large portion of this will be new infrastructure that will be handed over to municipalities who simply cannot afford to maintain these assets. Larger municipalities have the ability to generate revenue however smaller rural municipalities often have to rely on equitable share. This is linked to population size which also does not count in their favour. After examining the budgets of rural municipalities it was noted that over 75% of their income comes from national grants and subsidies. (CSIR/ CIDB, 2007)

In the last 10 years, the Nooitgedagt Low level water project alone has increased NMBM's bulk water assets by R1.1 billion, without a corresponding increase in its maintenance budget (Figure 1). Financial managers usually set maintenance allocations as a percentage of the operating budget which is an unsound method as it does not consider the current condition of assets or what is needed for the asset to achieve its expected useful life (L Boshoff, S Peters 2014/15).

6.4 Procurement

During the 2013 IMESA conference the local organising committee prepared a questionnaire, which was used to facilitate the panel discussion. Interestingly, municipal engineers indicated that supply chain management was their number 1 issue when it came to executing their duties. Abnormal amounts of queries and a lack of responsibility can easily see formal contracts taking more than a year to be awarded.

Project managers are sent from pillar to post when systems like signatory or procurement requirements regularly change. This requires that technical staff start executing nonsensical administrative duties to simply process a payment. This is a large contributor to the underspending of budgets.

6.5 Vandalism

Assets are vandalised for various reasons, majority of the time metal is stolen for resale at a scrap dealer. A R250 000 valve becomes useless once the spindle's head has been sawn off. Hard work for a small reward. The Motherwell Chelsea pipeline, which is mentioned later in paper, was hit the hardest with vandals attacking the pipe while not pressurised. Top slabs of chambers were moved and complete air valve installations were removed. This ultimately led to the pipeline's 10-year dormancy.

The chambers that were not closed were used to discard rubbish in and then set alight, completely ruining the corrosion protection on metals.

Other instances were pure malevolence where chamber lids were lifted and dropped into the chambers by community members, staying along the servitude. These actions ultimately led to the loss of life when a child fell into the chamber.

7. FROM A LACK OF SYSTEMS TO FUTURISM

7.1 Internal condition assessment/Non-intrusive surveys

The budget is depleted by the obvious maintenance requirements, which leaves little to no money for the underlying, unforeseen issues that these technologies help expose. They can assist in identifying weak spots, which could be repaired, proactively, as well as budgeted for. In the case off NMBM, it was that plus more.

The Motherwell Chelsea pipeline is a large system that transfers water from the northern side of NMBM to the west, ultimately feeding the largest distribution system in the city. It consists of various pipelines ranging from 450mm dia Fibre cement to 800mm dia steel. Part of this was a section of 500mm dia steel pipeline that had been laying dormant for approximately 10 years. With pressures reaching close to 20 bar less than 20m away from RDP housing, it was viable to commission these inspections to understand what the risks were of pressurising this dormant line. DCVG, soil resistivity, chemical analysis was implemented and certain spots were highlighted where point repairs were carried out. These were spots that had corroded through and would have led to a serious leakage if pressurised. The pipeline was successfully commissioned and has improved flow conditions drastically, as well as increased redundancy.

7.2 Telemetry/SCADA

With maintenance teams constantly facing reactive duties, it becomes a disturbance to repeatedly react to the operations of a dynamic system as well. A clever control system can sometimes assist when faced with a lack of human resources.

The Chatty pump station is a relatively low lift pump station that transfers water from a reservoir to a tower. The pump station and the tower are 880m apart. Before commissioning the Chatty pump station, the tower was supplied directly from a bulk water supply line. The increasing demand on the bulk water system resulted in the tower frequently being starved due to recurrent pressure loss. The tower has a capacity of approximately 1Mℓ, which supplies an area with an average demand of 4Mℓ/day. This relates to a storage duration of approximately 6 hours, which is severely unpredictable and stemmed unrest in the community.

Therefore, one of the primary objectives of the pump station was to ensure high reliability with minimal human interaction. The high reliability ensured that the consumer's demands were met and the minimal human interaction permitted the workforce to focus on other essential services. The objective was achieved by implementing an automated control system with smart instrumentation solutions. The instrumentation provided the opportunity to create algorithms that verified and cross-examined the performance of the equipment. This ensured that the control system protected all infrastructure and allowed the system to automatically reset non-critical faults, when suitable system conditions resumed, without the need for human intervention.

The control system continually supervises and monitors the pump station and provides the information to the control room SCADA via

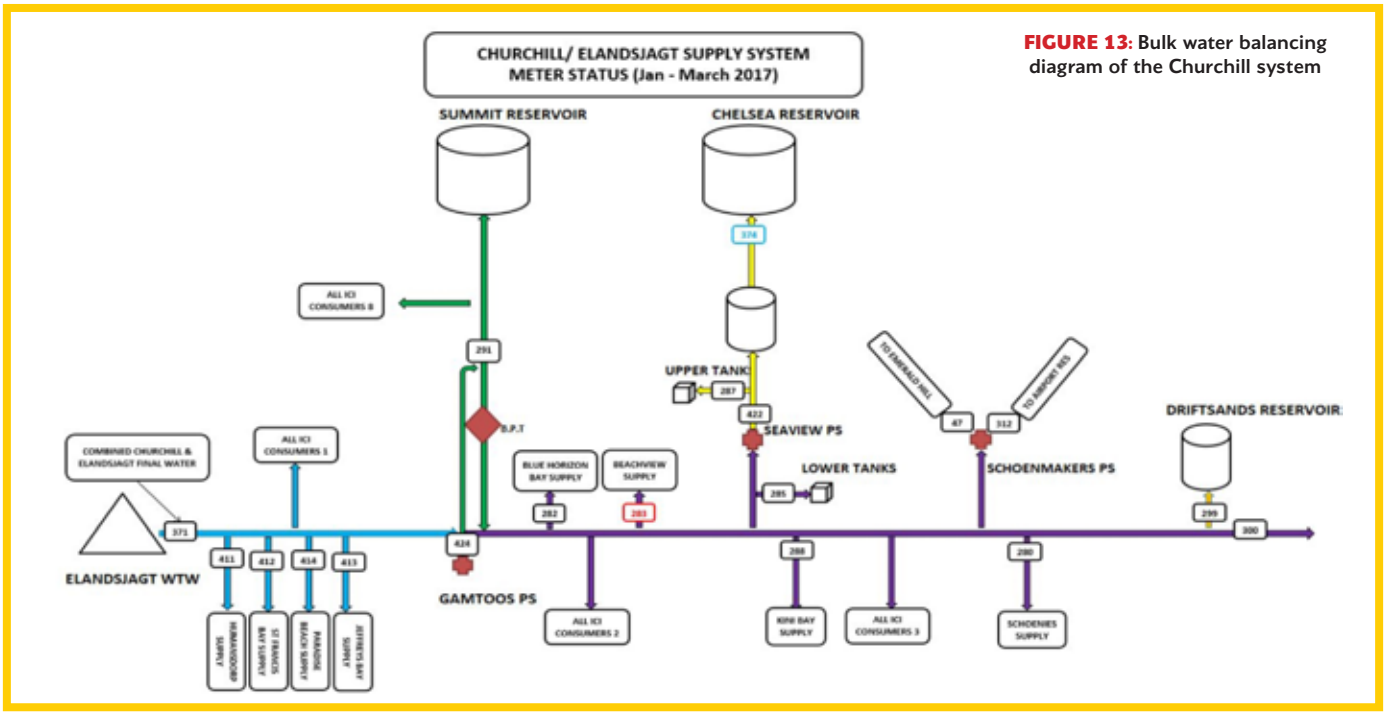


FIGURE 13: Bulk water balancing diagram of the Churchill system

a fibre optic network and telemetry network. The SCADA ensures that the process controller is alerted to critical events and alarms, while continuously storing all data historically for reporting and management purposes.

NMBM executes most of its monitoring and operating functions of all reservoirs and pump stations via the control room SCADA server, situated at a water treatment works, where a process controller monitors it constantly. For the most part the system functions reactively, upgrades are required for increased functionality. A link has been created between the water management system and the SCADA system, which creates the ability to generate a wide variety of reports.

7.3 Bulk Metering

A Task Team was set up to expedite the installation of bulk meters. These are used to establish losses on the bulk supply systems and for developing water balances. The water balance compares the treatment works output volumes with the volume entering the Metro's main supply reservoirs taking into account the usage of all consumers and storage on route. This calculation determines the volume of unaccounted water between the Treatment Works and the Metro's distribution system. Initial balances indicate losses of about 5.5% with a target of 3%.

Work is still ongoing and the number of meters currently in operation is 85 out of 107. With more metering, problem sections can be pin pointed and prioritised for maintenance. A specific problem section was identified on the Loerie bulk water system, this initiated a condition assessment which in turn raised a number of concerns, ranging from illegal connections, faulty meters and leaks.

8. CONCLUSION

It is evident that a large Maintenance backlog exists in South Africa. National Government is focused on expanding infrastructure and services. This becomes a burden for smaller municipalities that are required to achieve expected useful life out of the asset, with little assistance in terms of maintenance. National Government launched the National Infrastructure maintenance strategy in 2008, however the effects of this strategy cannot be felt by personal on the ground or consumers.

NMBM has shown that simple methods can be used to achieve great results by using internal work force. However, it is essential to obtain a stable workforce by retaining skills and having clear career paths. Succession planning is crucial, policy makes this difficult as a position can only be advertised once vacant.

To maintain an asset requires the buy in from all departments within a municipality, goals should be united.

Inventory management, record keeping and document management should be done according to an approved quality management system such as the ISO:9001. Municipalities must harness the 4th industrial evolution in water network management and control. NMBM's organogram has been unable to keep up with technology. Last updated when the Nokia 3310 was released, todays smart phones will attest the stagnant growth of the municipalities technical and technological capabilities.

Communities all over South Africa that have been forgotten are increasingly turning to violent protesting to get their voices heard, similarly these pipelines will continue to protest with bursts and disruptions, reminding us that we have forgotten them for too long.

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