Lonmin Integrated Water Resource Management System

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Abstract

Since the early late 1990's water shortages experienced in the Rustenburg area sparked considerable focus by all water users to find sustainable water solutions. Lonmin's approach followed the best practice guideline route by first exploring Water Conservation and Demand Management (WCDM) opportunities before introducing additional water supply into the region. A systematic approach was followed where water quality and demand requirements for various mining processes were used to develop first a static water balance model and then later followed by a dynamic water balance model. The dynamic water balance model incorporated detailed information of all the water circuits on the Lonmin mining area with time dependent water quantity and quality data. Based on the outcome of the dynamic water balance model numerous current and future operational and development scenarios were explored and compared with the current water use as a base case.

The dynamic water balance formed the basis of the resource management system and was constructed in such a way that water sources and points of consumption could be added in conjunction with various WCDM. It was shown that significant water use improvements were possible through the implementation of various WCDM strategies and that the incidental environmental overflows and the water purchases from external services providers could be reduced by as much as 46%.

This paper will demonstrate how the development of the integrated dynamic water balance was used to accurately model the *status quo* of the Lonmin network and establish the interventions required to achieve the significant improvements in water use efficiency and achieve Lonmin's key strategic objectives.

Keywords: Water use, water reuse, water conservation, mine water, integrated water resource

Introduction

During the late 1990's a number of water augmentation projects were developed and implemented to satisfy the increased demand for water to the growing platinum mining industry and the associated domestic water demand created by the influx of people into the area. At a very early stage it was realised that the water shortage cannot be addressed by individual mines, but that a collective effort will have to be made to address the water shortages in a coordinated manner. Municipalities, established a PPP to address some of the urgent water and sanitation issues. The mining industry also took hands and jointly sponsored a study exploring regional solutions to the water supply problems. This led to the establishment of the Western Limb Water Forum where planning of future water systems were coordinated between stakeholders. One action plan that was identified from these collaborations between the mines and stakeholders was the accelerated implementation of water conservation and demand management (WCDM).

The Lonmin water system spans a distance of about 30 km delivering water to and from numerous mines, concentrators, storage dams and pipelines. Not only does Lonmin supply and distribute water for their own needs, but Lonmin also act as a Water Services Intermediary by distributing water to surrounding communities. The burden to comply in all respects to the relevant legislation is significant and further complicated by the vast area covered by the Lonmin operation and complexity of the water systems. A primary aim of the project was to improve the legal compliance by implementing the basic principles contained in GN704 and the best practise guidelines and to improve overall water security.

Lonmin at the time took the lead in their approach by following best practise guidelines in exploring WCDM opportunities before introducing additional supply into the region. In 2012 Lonmin commenced with the development of a dynamic water balance and also exploratory drilling to establish the potential of local anthropogenic aquifers. This culminated in a detailed dynamic water balance indicating significant WCDM opportunities. The agreed strategic objectives of this WCDM programme was to ensure sustainable supply of water, strive toward sustainable water use, improve compliance and be a good neighbour. The WCDM results informed the development of the Lonmin integrated water resource management system.

Methodology

Overall WCDM development process

The development of the dynamic water balance model (DWBM) involved a number of clearly defined steps including; the establishment of water demand for specific mining plans, the identification of water sources and the development of various WCDM strategies. The DWBM was developed for each of the three mining areas in the Lonmin operation and later integrated into an integrated DWBM including the Karee, Western and Eastern areas. The initial DWBM was developed for a base case representing the status quo at the time as closely as possible. The gradually implementation of various WCDM strategies led to a number of WCDM scenarios. From these scenarios various WCDM projects were identified, scoped at a conceptual design level and prioritised based on return on investment and the strategic objectives of the WCDM programme.

Water demand assessment

The water demand projections, derived from the production projections formed the basis of the water DWBM. The mining production figures and the unit water consumption figures were used for each of the mining areas. The split between the water quality types required was estimated after the total water was determined. The split was determined from historical metering exercises and where metered information was not available informed estimates were made. After translating the mining production figures into water use figures a calibration was done using current mining and water use figures. There was general agreement between the figures apart from a few minor anomalies.

After defining the base case a number of scenarios were developed to assess the impact of various WCDM strategies. A unique water demand input set was developed for each model scenario based on different levels of internal recycle and grey water use. This resulted in a much reduced external top-up requirement from Rand Water. It was shown that a significant amount of potable water demand circuits could be substituted with grey water. Potable water circuits that were not changed to consume grey water are offices, ablution facilities and underground drinking water. The water circuits that were switched to grey water circuits included; gland service water, fire water, washwater, cooling water top-up, grout plant, workshop (washing),

Water sources

The Lonmin mining operation has evolved over time and has as a result sourced water from a number of different locations. Traditionally four sources have been recognised, but two additional sources have recently been quantified to be a significant local resource, i.e. anthropogenic aquifers and local water reuse. The key conventional water resources included Rand Water via the Barnardsvlei reservoir (~ 33 Ml/d), Buffelspoort irrigation canal (~2.5 Ml/d), Hartbeespoort canal in the Eatern area (~1 Ml/d) and Brits WwTW (~ 6.5 Ml/d). Each of these sources have their unique water quality and supply challenges. The more unconventional water sources included the potential yield from anthropogenic aquifers that have for many years been vastly underestimated (often accounted for as fissure or sub-surface environmental discharge). About 30 anthropogenic aquifer boreholes were identified with a potential yield of 12 Ml/d. The other unconventional source included the use of local water for reuse in a number of process that in the past used potable water.

WCDM strategies

The generally accepted principles of WCDM include: avoid, reduce, reuse, recycle and dispose. Lonmin interpreted and contextualised these principles and developed their own unique set of strategies based on the challenges and constraints. These strategies included; reduce losses through seepage and overflows, separate water circuits, regional integration of water systems in Karee, Western and Eastern mining areas and treatment of available dirty water to a higher standard to improve water reuse.

In order to assess the potential impact of the each of the WCDM strategies various infrastructure upgrade scenarios were developed. These infrastructure scenarios were captured in the DWBM and the outcomes tested against pre-determined success criteria. An example of the intricacies included in the DWBM is shown in Figure 1.

WCDM scenarios

The DWBM encapsulated time dependent elements of stochastic rainfall, water sources (quantity and quality), water demands (quantity, quality and timing), infrastructure capacity (eg. pipeline, pump and storage capacity) and operational rules currently practised by Lonmin. Using the above data the DWBM was developed to assess the entire Lonmin hydrological cycle for a 10 year planning horizon. The Base Case model primarily improves the basic understanding of the water cycle and also enables Lonmin to identify WCDM opportunities. The following scenarios were incorporated into the dynamic water balance model:

- Reduce spillage by de-silting RWDs and increase balancing storage (Scenarios 1a);
- Reduce seepage from RWDs and PCDs (Scenario 1b)
- Transfer water from water surplus areas to water deficit areas (Scenario 2a);
- Utilise borehole water from rehabilitated

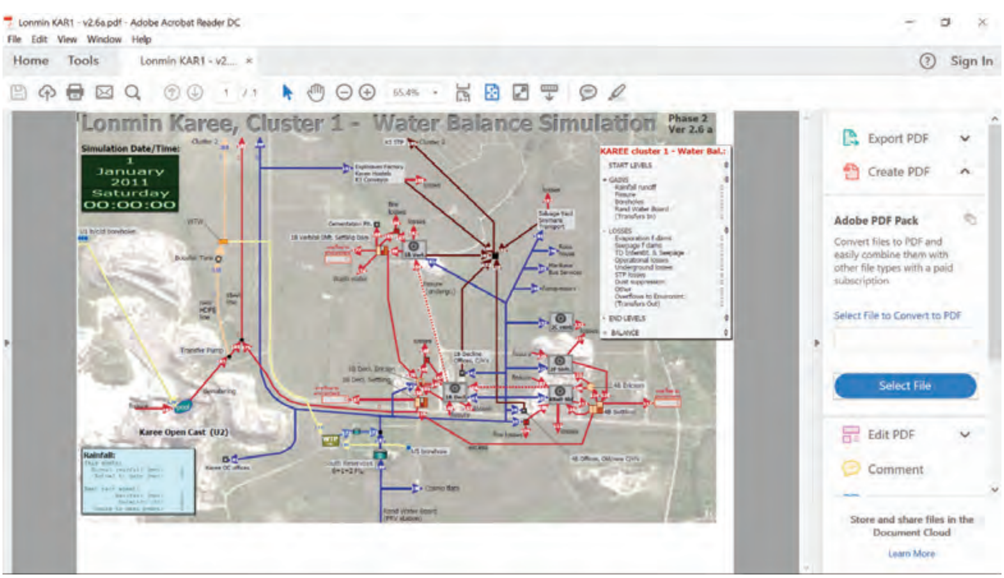

Figure 1 – Example of DWBM sub-areas water circuits

open cast areas for grey water (Scenario 2b);

- Import additional external grey water sources from Hartbeespoort Canal (Scenario 2c)
- Madibeng STW (Scenario 2d);
- Import from Buffelspoort canal and treat to potable standards (Scenario 3a);
- Import from Madibeng STW and treat to potable standards (Scenario 3b)

It became evident that no single scenario addressed all the success criteria determined earlier and that some of these scenarios may have to be implemented in a cumulative manner in order to achieve the strategic objectives. Based on the insight gained from scenarios 1 to 3, the following aspects were therefore added in the cumulative scenario:

- Buffelspoort water source was utilised for local potable water treatment
- Grey water use was enhanced through the development of selected open cast pit boreholes and grey water treatment facilities in the Eastern area.
- Replace potable water use at concentrator facilities with local grey water
- Complete development of the East to West transfer pipeline to address projected water shortages in the Karee area.
- Improvements to operational rules to prioritised grey water in areas where grey water can replace potable water use. Discharge surplus grey water into local storage for later use and to prevent Rand Water top-up with potable water.
- Lining of channels and dams to reduce losses.

The cumulative scenario demonstrated that a significant improvement can be realised in relation to the base case. It was evident as shown in **Table 1** that the Rand Water use could be reduced by a significant 4.2 million m3/a (~ 11.6 Ml/d) (a reduction of 46%). This was primarily as a result of the planned Buffelspoort WTW and the utilisation of boreholes for grey water instead of using external potable water. Apart from the reduced water use and water purchases, the environmental discharge could also be reduced significantly mainly as a result of the reduced external source import (via Rand Water) by approximately 0.6 million m3/a (a reduction of 39%). This was achieved through increased use of local ground water sources and the increased development of grey water sources.

The outcome of the optimised WCDM scenario was subsequently used as a new planning benchmark upon which the long term WCDM programme was based. A number of projects were identified, scoped, costed and prioritised based on project outcomes. Lonmin developed a long term WCDM programme to implementation of a number of these projects toward achieving the optimised WCDM scenario and improve the water security for the mining and neighbouring communities.

Conclusions

Through the development of the dynamic water balance it was possible to accurately model the *status quo* of the Lonmin network and establish the interventions required to achieve the key strategic objectives, demonstrate the effect of the interventions required and en-

Table 1 *– Optimised WCDM scenario*

Mining Area	Water use aspect	Base Case (m3/a)	Optimised Scenario (m3/a)	Change (m3/a)
Karee	Rand Water use	3 192 552	999 297	
	Environmental discharges	788 547	391 191	
Western	Rand Water use	3 446 155	2 205 578	
	Environmental discharges	328 292	220 307	
Eastern	Rand Water use	2 598 896	1 795 918	
	Environmental discharges	524 307	386 499	
Total	Rand Water use	9 237 603	5 000 793	4 236 810 (46%)
	Environmental discharges	1 641 145	997 997	643 148 (39%)

sure a sustainable water system meeting the long term mining demands. The potential water savings that could be realised through the optimised WCDM scenario would not only reduce Lonmin's water use, but also the purchases from Rand Water (at the time estimated at about R 35 million per year). At the same time the water savings could also enable Lonmin and Rand Water to address community water supply needs as a result of the reduced potable water use. Last, but not the least the incidental environmental discharges that occurred primarily during the rainy season would also be contained to a much larger degree and reduce the environmental impact.

The project demonstrated how revisiting an existing mine water system and critically assessing historic practises can be turned around from a long term crisis into a long term opportunity and a win-win for stakeholders affected by the mining operation. It is hoped that all mines will in future follow the example of Lonmin.

Acknowledgements and disclaimer

The opportunity provided by Lonmin to participate on this interesting project is greatly appreciated. It should be noted that the mining quantities and water uses have changed significantly as a result of the institutional and structural changes implemented at Lonmin since the completion of the project. The focus of the paper was not on the quantum of water used, but the manner in which the water use could be improved. The input of Water Hunters in the development of the DWBM are also acknowledged.