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# Acid mine drainage

# Managing the pilot phase

IN THE PAST HUNDRED YEARS, the South African mining industry was responsible for much of the country's development and riches. Unfortunately, mining activities have not always been subjected to, and measured against, the strict environmental and health standards of today. The legacy of mining is with us today and evident in extensive mined-out areas, mine dumps and polluted water containments.

With the development of technology and science, we now know a lot more than our forefathers about the impact of our mining endeavours on terra firma. We also have access to technology that can be applied to reduce, limit or, better still, prevent us from adding to the legacy and leaving it to our progeny.

To respond to the potentially life-threatening challenge created by mining, the development and implementation of new and innovative projects has become a necessity. A pilot project for acid mine drainage (AMD) falls in this category. It was successfully commissioned in April 2008. The pilot project contained all the challenges associated with the upfront phases of any large capital project, such as technology selection and testing, investment decisions, funding decisions, scaling, flexibility and patience.

Despite all the excitement and challenges inherent in such projects, it is especially rewarding to be involved in a venture that attempts (and in my opinion will succeed) to aggressively address one of the most lethal remnants of the mining industry of the past hundred years, while at the same time reducing the negative effect of current and future industrial activities.

## BACKGROUND

To have some appreciation of the intricacies involved in the project, it is necessary to provide some background to its origin.

Underground voids were created as a result of gold-mining operations in South Africa's Witwatersrand basin in the past. These voids have since filled with water and the presence of sulphur and heavy metals have given rise to a hidden threat called AMD. This has had a dramatic impact on the groundwater conditions northwest of Johannesburg. If the AMD was restricted to low underground levels, action would probably have been limited to monitoring. Unfortunately AMD had started to decant (surface) and now poses a very real threat to residential and agricultural communities relying on the streams and rivers in the area as a source of potable water and irrigation.

Many of the original mining houses have ceased operations or no longer exist. The responsibility to find an effective and sustainable solution now rests with the few who have active interests in the area. In the Petroleum and Resource Development Act, 2002, the principle of 'the polluter pays' is entrenched and this is being enforced in a directive by the Department of Water Affairs and Forestry (DWAF). The directive states that the mining houses will not be permitted to close any further operations in the area until the affected water had been satisfactorily rehabilitated.

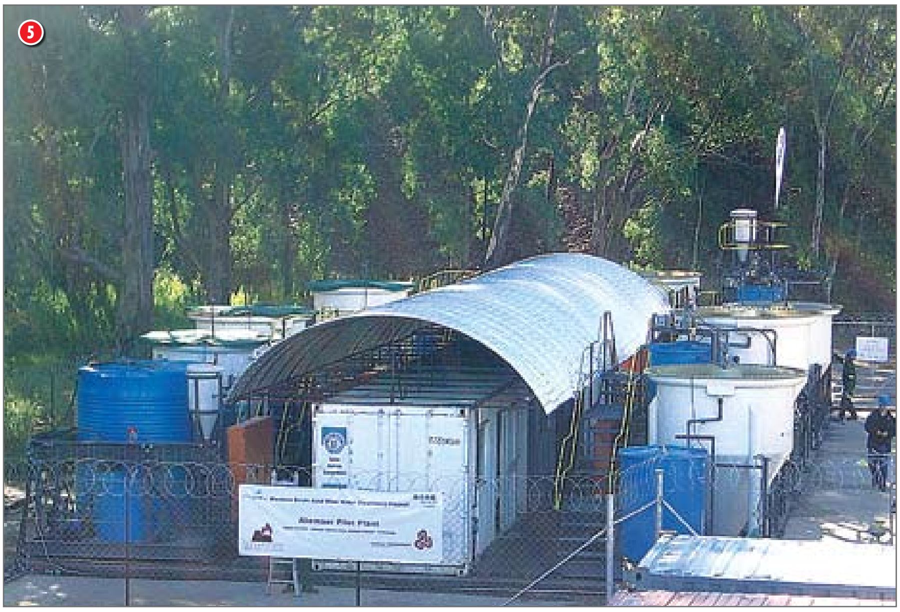

1 A barren site, July 2007
2 Site clearance and civil works commence in November 2007
3 Storage and office space arrive on site in late November 2007
4 Plant construction well under way in late January 2008

The mining houses that are currently active in the region (Mintails, Harmony Gold Mine and Durban Roodepoort Deep) have accepted the challenge to deal with the AMD problem. Among them a not-for-profit entity, namely the Western Basin Environmental Corporation (WBEC), was established. The intention is for WBEC to register as water services provider, thus entitling it to remove the water associated with its own mines, treat it to a specified quality and 'sell' it to the industry.

To ensure sustainability of the process, the Western Utilities Corporation (WUC) was established to develop and implement technology on a commercial scale that will address the AMD problem and render a service to WBEC.

## OBJECTIVES

The ultimate objective of the WUC is to establish, implement and manage a self-sustaining process which will recover AMD, clean it to 'grey water' (usable in industrial applications) and sell it to industry users via the WBEC. This will lower the AMD in the area to an acceptable level, thus terminating decant thereof and subsequently maintaining it at a pre-determined level. The available cleaned (grey) water will further relieve the growing pressure on existing potable



5 The Atomaer-constructed pilot plant during an open day in April 2008
6 Curious visitors on the CSIR plant during an open day in April 2008

and industrial water resources. In addition to this, the WUC will identify and consolidate other sources of water to ensure a continuous supply to the treatment works.

Among the major issues considered during the pre-feasibility phase is the capital cost of a plant, the scale of which will ensure that enough industrial quality water can be produced and sold to:

- Recover the capital outlay
- Fund the operational cost, and
- Provide a risk-reward incentive to attract suitable investors

Another requirement is to recover useful by-products in the cleaning process, which can either be re-used in the process or sold commercially, thus limiting (eliminating, if possible) the production of waste products.

The objectives set by the WUC were from the outset, and remain, challenging. However, the business case developed in the pre-feasibility phase convinced investors to commit the required funding for the feasibility study and the subsequent pilot plant.

## PROJECT DESCRIPTION

Technologies to clean the various forms of polluted water exist and have been proven under laboratory conditions. However, before a commercial-size plant will be funded, it is required to (among other objectives):

- Test the processes under real conditions
- Improve the processes to adjust to the variation in the composition of AMD
- Confirm and improve (if possible) the quantity and quality of grey water produced
- Confirm the quality and quantity of by-products
- Minimise (or eliminate) waste production, and
- Determine plant footprint dimensions, energy and chemical requirements

For this reason, it was required to construct a suitable pilot plant and testing facility, within a limited budget and in the shortest possible time period in the feasibility phase of the project.

The decision was made to test two main technologies for the cleaning of AMD, namely the GypSLiM (gypsum, sulphur, lime, magnesium carbonate) process of the Council for Scientific and Industrial Research (CSIR) and the Mintek-patented Etteringite process. Sludge recovery was to be tested under the auspices of the CSIR.

## CHALLENGES AND INNOVATIONS

The challenges involved in establishing such a pilot project are similar to other industrial projects, yet in many ways also unique.

It was obvious that the closer the location of the plants to the plant feed, the less cost and risk would be involved. After some discussion, a site was made available by one of the WBEC shareholders, Harmony Gold. The site was right next to an old mine shaft, near the town of Randfontein. By lowering a pump 50 m down the shaft, AMD could be accessed, pumped out and made available to the two plants. Another advantage was that electricity was already available at the shaft, which, with some adjustment, could be utilised for power supply to the plants.

The utility supply preparation, included in the outside battery limit (OBL) works, required careful consideration of the requirements of the individual technology suppliers. Feedwater, power, air and potable water supply arrangements had to be duplicated and installed with individual measuring devices to allow comparison of usage. This was necessary with a view to the calculations that would be required to size and cost the commercial plant.

Product water had to be measured and tested individually and then disposed of in an environmentally friendly manner. This was addressed by pumping into an existing pipeline leading to the nearby Harmony Gold water treatment plant.

Other issues were related to the construction of the two individual water treatment plants. While the construction

### Project Team

- **Client** Western Utilities Corporation (WUC)
- **EPCM Contractor** ProjectWay Consulting and Contracting
- **Engineering Consultants** Africon, Golder and Associates
- **Technology Vendors** CSIR Consortium, Mintek, Atomaer

of one of the plants was done on a turnkey basis and, for the most part, occurred off-site, the other was designed and constructed in collaboration with the technology supplier.

The latter proved to be quite a challenge. Detail design drawings were not readily available (and in most cases did not exist) and much of the design took place during on-site construction. Decisions had to be based on the available process flow diagrams (PFDs). This open-ended approach, although ideal for the research and development situation, would under commercial plant circumstances be a feast of claims with any mainstream contractor, resulting in delays and cost overruns. The relatively small scale of the structures and piping made it possible to offset the risk of claims by procuring all equipment upfront and then make use of local, smaller-scale, yet reputable electrical, civil, steel and plumbing contractors for construction. The appointments were kept simple and were done in small-scale purchase orders. The decision was soon vindicated by the admirable performance and flexibility of these contractors.

Since the pilot phase of any industrial project is technologically complex and intensive, the selection of a knowledgeable and reputable engineering manager is of utmost importance. Even more so is the need for the engineering manager to be involved from a very early stage (long before construction commences). The quick establishment of close working relationships with the technology suppliers and contractors proved invaluable.

The life-cycle of the pilot plant was always going to be limited and one might be forgiven for an inclination towards accepting inferior quality products and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equipment in an attempt to save money and time. However, the importance of the outcomes of the pilot study required trustworthy equipment and installations. These two opposing considerations made for some interesting debates and decision-making. Eventually the typical drive by the engineer for continuous improvement and best quality was managed by a mixture of strict financial control and the flexibility and commitment of the smaller businesses.

The factors that we as project managers always desire during the early phases of any project, namely good engineering management, client support and swift decision-making, were the keys to the successful construction and commissioning of the pilot plants.

## PROJECT STATUS

The project is now well into the feasibility phase. The pilot plants are operational and results are being evaluated. The conceptual design of the commercial plant is taking shape. An environmental impact assessment is under way. The WUC has since successfully investigated applying the business model to the other basins namely the Eastern Basin, Central Basin and Far Western Basin. This will ensure a continuous supply to the ambitious commercial plant, which is planned to process 75 Mℓ of AMD per day.

## CONCLUSION

The historical legacy, combined with the potential to make a sustainable positive impact on current environmental threats and to tangibly reduce pressure on scarce water resources, makes this a truly unique project. The key requirements for successful pilot projects were all met on the AMD pilot plants, setting the tone for the establishment of a sustainable solution of AMD. □