Feasibility Study for a Long-Term Solution to address the Acid Mine Drainage associated with the East, Central and West Rand Underground Mining Basins, Gauteng Province

# newsletter

AMD FS LTS

Edition 3 • 2013

This newsletter provides stakeholders with an update on the progress of the Feasibility Study for a Long-Term Solution (LTS) to address the Acid Mine Drainage (AMD) associated with the Witwatersrand underground mining basins. The goal of the Feasibility Study was to investigate options and recommend a feasible LTS to the AMD problems in the study area, in order to ensure long-term water supply security and continuous fitness for use of water in affected river systems.

The study consisted of three phases, namely the Initiation Phase (covered in Edition 1 of this newsletter), the Prefeasibility Phase (discussed in Edition 2) and the Feasibility Phase, which have all been completed. The focus of this edition of the newsletter is to present the results of the Feasibility Phase. All newsletters are available on the Department of Water Affairs (DWA) website, as indicated below.

## STUDY TEAM

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## IN THIS ISSUE...



Comments and enquiries can be sent to Mr Marius Keet at the Department of Water Affairs: keetm@dwa.gov.za
For more information on the feasibility study, please visit the AMD webpage on the Department of Water Affairs website:
**http://www.dwa.gov.za/Projects/AMDFSLTS**

water affairs
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REPUBLIC OF SOUTH AFRICA

## The Feasibility Study Approach

A short summary of the AMD challenges and Prefeasibility Phase was given in the first two editions of the Newsletter. The Feasibility Study was a planning study that aimed to recommend a feasible LTS to the AMD situation, also contributing to the long-term water supply security and continuous fitness for use of water in the affected river systems.

A feasible solution will strive to be one that is technically sound, economically viable, environmentally sustainable, institutionally feasible and legally achievable. As such, the study's focus was not only on the technical aspects (in terms of treatment options) of a LTS, but also on legal, social, economic, ecological, financial and institutional aspects (refer to Edition 2 for the feasibility criteria).

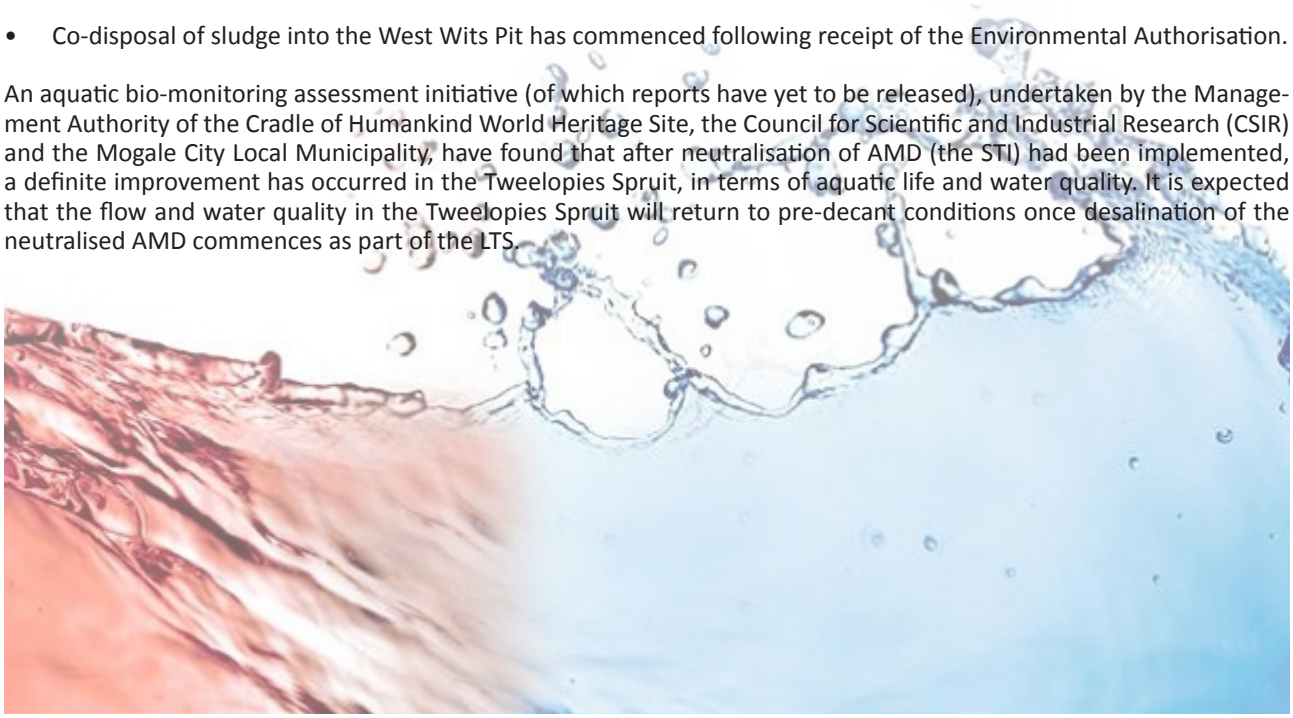
## Progress on the Short-Term Intervention

### Western Basin

The Short-Term Intervention (STI) to address AMD in the Western Basin has progressed substantially and feedback received from the Trans-Caledon Tunnel Authority (TCTA) on the STI includes the following:

- All three trains for AMD neutralisation purposes were successfully upgraded and are operational;
- Uncontrolled decant in the Western Basin has stopped since commencement of the STI, except for a few isolated instances where power failures occurred. In these cases decant has been minimal and lasted only for a day. Reports indicate a major improvement in the water quality in the Tweelopies Spruit, as well as an improvement in groundwater quality;
- Options for the further upgrade of the Rand Uranium plant are under investigation. A design report has been discussed with the DWA and it has been agreed to upgrade the first train to the same standard as the trains built by the TCTA. Further upgrades of the plant have been put on hold until the DWA/ TCTA has evaluated the Mogale Gold proposal recently received. Significant cost savings could be achieved should the alternative be found technically viable;
- The TCTA installed a new temporary pump in Rand Uranium No. 8 Shaft to increase the volume to be pumped from the shaft to 24 Mℓ/day, instead of the previous 8 Mℓ/day;
- DEA issued the Environmental Authorisation on 7 January 2013, which allowed for the handover of the site to the contractor in January 2013 for commencement of construction of the STI infrastructure; and
- Co-disposal of sludge into the West Wits Pit has commenced following receipt of the Environmental Authorisation.

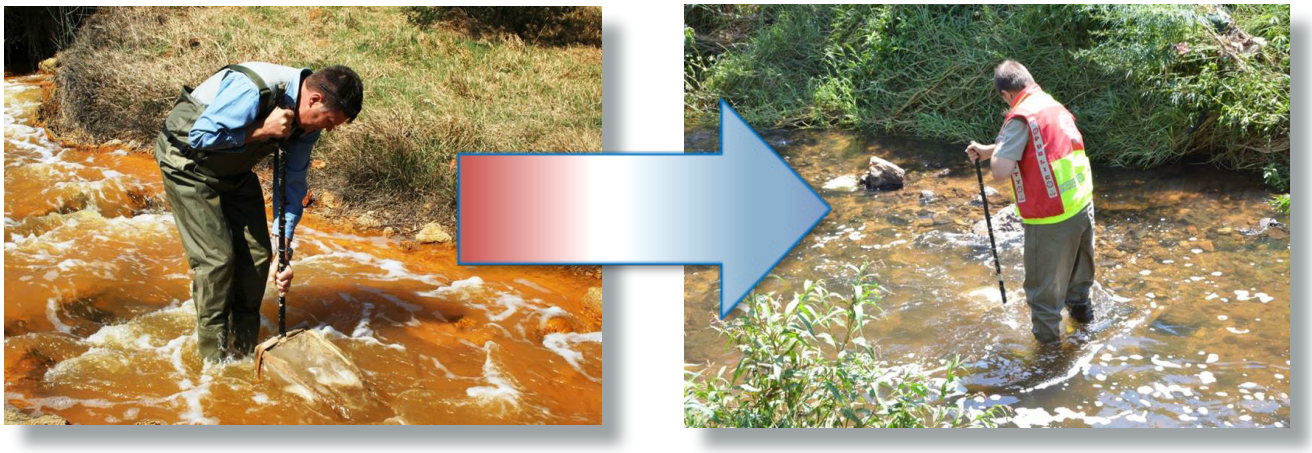
An aquatic bio-monitoring assessment initiative (of which reports have yet to be released), undertaken by the Management Authority of the Cradle of Humankind World Heritage Site, the Council for Scientific and Industrial Research (CSIR) and the Mogale City Local Municipality, have found that after neutralisation of AMD (the STI) had been implemented, a definite improvement has occurred in the Tweelopies Spruit, in terms of aquatic life and water quality. It is expected that the flow and water quality in the Tweelopies Spruit will return to pre-decant conditions once desalination of the neutralised AMD commences as part of the LTS.



The photographs below illustrate the improvement of water quality in the Tweelopies Spruit, which led to the return of aquatic life, since the implementation of the STI:

*October 2011*

*February 2013*



## Central Basin

Construction of the STI infrastructure is progressing steadily. Test commissioning will commence in December 2013 / January 2014 and full operation by February 2014. This will ensure protection of the Environmental Critical Level (ECL) that has been determined for the LTS.

*Construction of a reactor plant for pre-neutralisation and sludge-conditioning chambers*

*Construction of a sludge recycling pump station*

## Eastern Basin

Mine water (AMD) pumping, neutralisation and discharge infrastructure, similar to that of the Central Basin, is projected for development at the former Pamodzi/ Aurora Gold Mine (Grootvlei No. 3 Shaft). Through the TCTA, a bid for this project was recently advertised and mandatory site briefing meetings with potential service providers already convened. A construction contract is planned for award by end-2013 and the project is anticipated for commissioning in December 2014.

# Summary of Recommendations of the Feasibility Study

## Recommended Reference Projects

The conservative benchmarks recommended as Reference Projects for the three basins comprise the following:

### Western Basin

- Abstract AMD at Rand Uranium No. 8 Shaft or at a suitable alternative shaft;
- Neutralise and desalinate AMD, using High Density Sludge (HDS) and Reverse Osmosis (RO) processes respectively, at a treatment location situated near the abstraction point;
- The Ion Exchange process for uranium removal is included, but could be reconsidered in the final design;
- Supply to industrial users, with possible use of a pipeline running to the basin boundary (end user/s are to be confirmed in due course);
- A sludge disposal site close to the proposed treatment works was identified;
- A site for brine evaporation ponds was identified adjacent to the treatment works; and
- Options for the re-use of residue products can be accommodated during the detail design process.

**What is meant by "Reference Project"?**

The term "Reference Project" refers to the option which uses proven technologies, has minimum risk and which is used for financial modelling and budgeting. It is not necessarily the option which will be implemented, but is the conservative benchmark against which implementation proposals will be judged and as such, the Reference Projects for each basin might differ from what is described in the Implementation Phases on Page 5.

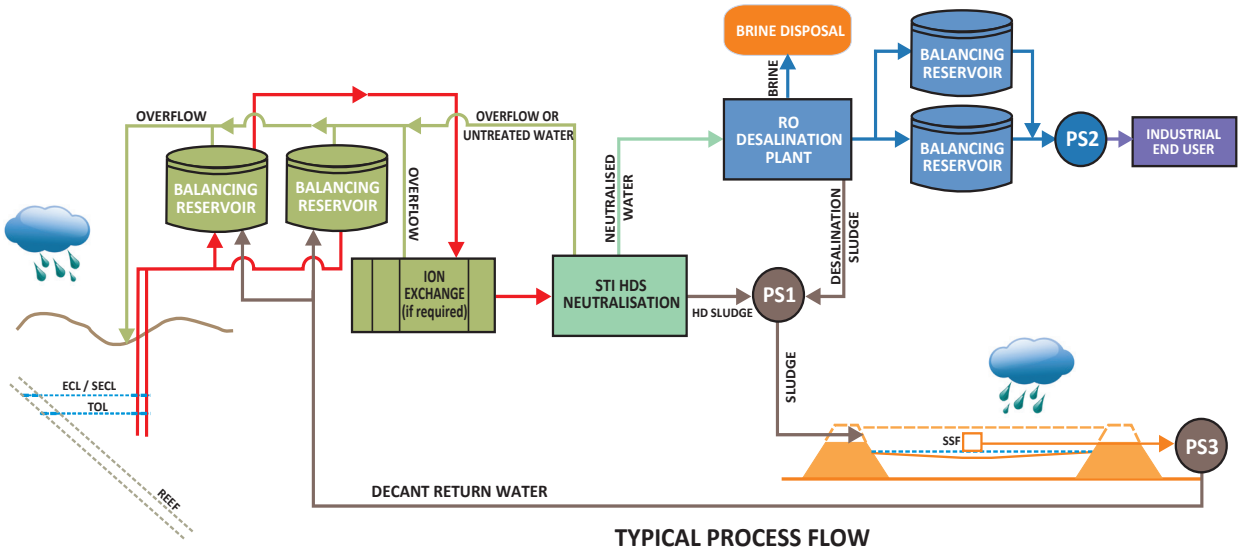
### Central Basin

- Abstract AMD at South West Vertical Shaft. Multiple abstraction points/ boreholes throughout the basin should be considered, pending connectivity between sub-basins within the mine void. The protection of the ventilation shaft associated with the South West Vertical Shaft has been identified and may become necessary for possible future use;
- Neutralise and desalinate AMD, using HDS and conventional RO processes respectively, at the treatment location adjacent to the abstraction point;
- The Ion Exchange process for uranium removal is included, but could be reconsidered in the final design;
- Supply to end user/s from the neutralisation and desalination treatment site, with possible use of a pipeline running to the Eastern Basin's treatment site (end user/s are to be confirmed in due course);
- A sludge disposal site and a site for brine evaporation ponds were identified; and
- Options for the re-use of residue are to be considered during the detail design process.

### Eastern Basin

- Abstract AMD at Grootvlei No. 3 Shaft. Marievale No. 5 Shaft is considered as a good alternative abstraction point and can be used in future should the need arise;
- Neutralise and desalinate AMD, using HDS and conventional RO processes respectively, at the treatment location adjacent to the abstraction point;
- The Ion Exchange process for uranium removal is included, but could be reconsidered in the final design;
- Supply to industrial users, with possible use of a pipeline running to the basin boundary (end user/s are to be confirmed in due course);
- A residue disposal site was identified close to the proposed treatment works. The identified site for the sludge disposal facilities will also serve as a site for the brine evaporation ponds; and
- Options for the re-use of residue are to be considered during the detail design process.

A schematic diagram illustrating the generic Reference Project is included below; however, the specifics for each basin may differ from what is shown in the diagram:




**TYPICAL PROCESS FLOW**

ECL – Environmental Critical Level
SECL – Socio-Economic Critical Level
TOL – Target Operating Level

PS1 – Pump Station 1
PS2 – Pump Station 2
PS3 – Pump Station 3

## Procurement of LTS and Implementation Phases

The objective of the procurement process will be to initiate implementation of the LTS, most likely under a Design, Build, Operate and Maintain (DBOM) contract to procure a fully integrated treatment facility and service for AMD. Below follows a description of the implementation phases that are likely to be followed for each of the basins as envisaged by the Feasibility Study recommendations.

### Western Basin:

- *Phase 1A (STI):* From 2012 - Upgrade Neutralisation Plant to 32 Mℓ/d capacity.
- *Phase 1B (STI):* 2013 – Upgrade neutralisation capacity to ±40 Mℓ/d and install permanent clarifier and permanent pumps. Alternatively implement joint neutralisation process with mining sector, such as Mintails process.
- *Phase 2:* For 5 to 7 years – Construct ancillary works and commission Pilot Treatment Plants (each 5 to 10 Mℓ/d) to develop Innovative Technologies (see heading below – "Pilot Treatment Plants").
- *Phase 3:* 25 years - Procure new operating contract and process with lowest lifetime costs.
- *Phase 4:* 25 years - Procure new operating contract and process with lowest lifetime costs.

### Central Basin:

- *Phase 1A (STI):* From 2013 - HDS for ±46 Mℓ/d.
- *Phase 2:* 2016 - Operating contract for 10 to 15 years with a solution that is likely to include Conventional RO.
- *Phase 3:* 25 years - Procure new operating contract and process with lowest lifetime costs.
- *Phase 4:* 25 years - Procure new operating contract and process with lowest lifetime costs.

### Eastern Basin:

- *Phase 1A (STI):* From 2014 - HDS for ±80 Mℓ/d.
- *Phase 2:* 2016 – Operating contract for 10-15 years with a solution that is likely to include Conventional RO.
- *Phase 3:* 25 years - Procure new operating contract and process with lowest lifetime costs.
- *Phase 4:* 25 years - Procure new operating contract and process with lowest lifetime costs.

## Pilot Treatment Plants

It is recommended that the Western Basin be used to evaluate a number of Service Providers in possession of emerging and innovative technologies that has been shown to work, but not at the scale required to treat AMD in the Witwatersrand Gold Mining Basins.

It is expected that enough AMD for between four and eight Pilot Treatment Plants will be available. Pilot Treatment Plants should be selected in consultation with the Water Research Commission (WRC) and the Department of Science and Technology (DST).

It is recommended that the Pilot Treatment Plants be tested over a 5 to 7 year period, where after proven technologies will be encouraged to bid for the re-issuing of the contracts for the Witwatersrand Basins.

It is recommended that the WRC play a central role during the testing of the Pilot Treatment Plants, supported by the DWA and the DST, and perhaps the Technology Innovation Agency (TIA).

## Cost

The grand total of the estimated Capital Cost (CAPEX), of the LTS Reference Projects suggested for the three basins, amounts to approximately R6.66 billion at March 2012 prices, while the maintenance and Operating Cost (OPEX) of the STI together with the LTS Reference Projects amounts to approximately R990 million per annum.

**How will the Capital Works be funded?**

The Government will take responsibility to ensure that funds are available for the establishment of the works and construction contracts. Some of the mines have contributed land, infrastructure (such as pumps), mine shafts for pumping purposes, etc., while funds will be sourced from the normal Government sources such as the budget, loans etc. for the LTS. The funding of the works should not be misconstrued with cost recovery.

### How will the cost of the AMD works be recovered?

The Department supports the polluter pays principle, i.e. the polluter contributes to the costs for the remedial action taken. Apart from the contributions by the polluter, there are other revenue streams that can also be considered, such as that the water users pay. Water users in the Vaal River System will benefit in two ways, i.e. the treated AMD can be supplied for use and it will also limit the need for dilution releases from the Vaal Dam, which will defer the need to implement other water augmentation schemes. In addition, there may be other beneficiaries (e.g. existing and/ or future underground mining) who may require a static water level in the mine void that is kept below the Environmental Critical Level who will need to contribute. The sources for cost recovery must still be confirmed by the DWA.

## Institutional and Financial Arrangements

A number of institutions will have to be involved in implementing the LTS for the management of AMD. It is expected that the DWA will have the overall responsibility for the implementation and must be supported by the following role-players:

- Department of Mineral Resources (DMR);
- Department of Environmental Affairs (DEA);
- Trans-Caledon Tunnel Authority (TCTA);
- Water Boards (e.g. Rand Water and Magalies Water); and
- Local Authorities / Water Service Authorities.

The institutional options further evaluated in the Feasibility Study were to:

- Manage the project directly, using:
  - Resources from within the Department;
  - Delegating responsibility, through a suitable contract to a managing agent sourced either from a Public Entity or from the Private Sector; or

- Appoint a Public Entity as the Implementing Agent (IA) which would contract with the Service Provider directly on behalf of the Department.

The financial arrangements have by no means been finalised, but the potential sources of funding identified are:

- Government from the Revenue Fund;
- Private Sector or International Funding Agencies directly to Government;
- Private Sector funding via loans to a Public Entity (State-Owned Entity (SOE) or a Water Board), with an implicit or explicit Government guarantee; or
- Private Sector funding to a Private Sector SPV or Service Provider, established to implement a Design, Build, Operate, Maintain and Finance (DBOMF) Public Private Partnership (PPP) project.

## Cost-Benefit Analysis of AMD Management Scenarios

The basic question arose as to why AMD should be treated at a high cost and why its impact cannot be assimilated into the economy instead. An economic cost-benefit analysis was performed to investigate this. The positive and negative effects called benefits and disbenefits to the economy of a few scenarios were quantified at a high level and compared.

The full desalination and treatment of AMD was compared to two "do nothing" options as follows: The first option being the continuation of the release of large quantities of water for the dilution of salinity in the Vaal River, resulting in water shortages that will be experienced in future; The second option being to allow the increase in salinity in the Middle and Lower Vaal, and the impacts of the salinity being "externalised" to downstream users in the Vaal River System.

It was found that the disbenefits of the continued dilution releases are far greater than the disbenefits of the treatment of the AMD. Likewise, the "externalisation" of the disbenefits is more or less similar to the disbenefits of the treatment of the AMD; however, considering the additional negative impacts on the environment and society, it is clear that it is the correct course of action to have the AMD desalinated.

## The way forward after the Feasibility Study

The Department will take an appropriate amount of time to thoroughly consider the recommendations made by the Feasibility Study, after which the necessary actions will commence to implement the LTS.

The Environmental Impact Assessment (EIA) for the LTS, which will include the STI, must commence as a matter of urgency along with land acquisitions of sites identified for the LTS. These two activities are on the critical path for implementing the LTS and any delay in these may delay the LTS.

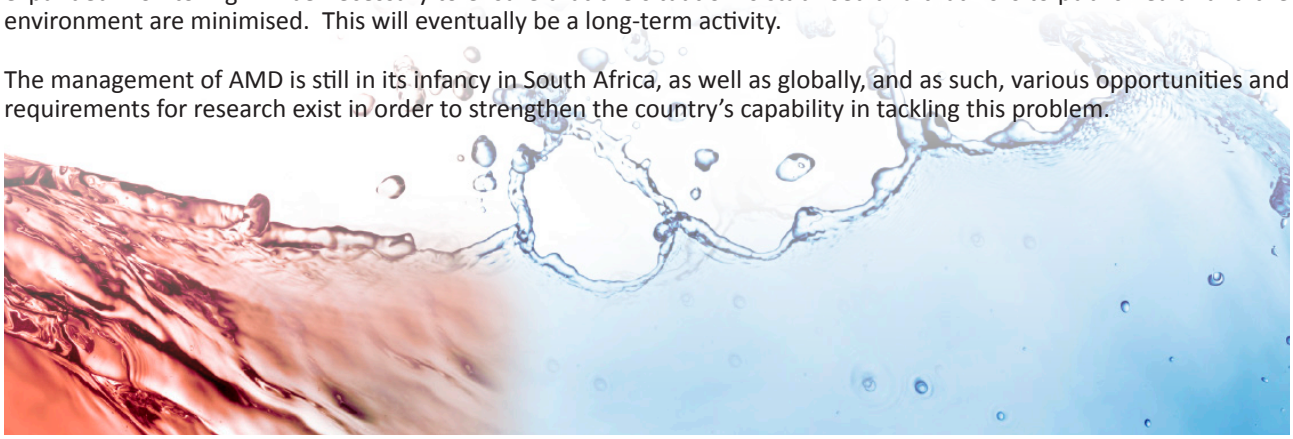
Prior to starting any of the procurement actions, the DWA must confirm the principles (i.e. institutional structure, type of contract and funding arrangements) which will govern the implementation activities and also whether to establish a Special Projects Unit (SPU) and/ or to appoint an Implementing Agent (IA) to manage the LTS for AMD.

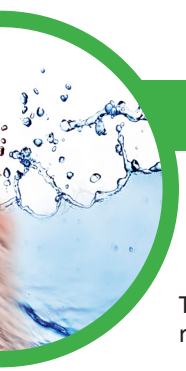
It is also crucial that off-take agreements with the users that have been identified be established as soon as possible. The preparation of procurement documents such as a Request for Qualifications (RfQ) and a Request for Proposals (RfP) for the Central and Eastern Basins will then commence. In the Western Basin, where Pilot Treatment Plants are recommended, the procurement activities will be different, since it is recommended that the Pilot Treatment Plants be implemented as a WRC research project.

Apart from the decisions and actions required by the DWA to implement the LTS, the Feasibility Study identified other requirements for the successful management of AMD. For the three basins within the Witwatersrand, further investigations (e.g. gravity abstraction via tunnel in Western Basin or multiple abstraction locations in the Central Basin) should be undertaken to optimise the projects that are proposed for implementation.

Several activities initiated by the DWA's Hydrological Monitoring Committee (chaired by the DWA) are currently planned and structured. The monitoring program specifically covers the establishment of full-scale mine water monitoring stations. These stations are required to monitor the rise of water in the mine void, as well as the hydro-geochemical characteristics of the water. Following the implementation of the proposed management measures, on-going and expanded monitoring will be necessary to ensure that the situation is stabilised and that risks to public health and the environment are minimised. This will eventually be a long-term activity.

The management of AMD is still in its infancy in South Africa, as well as globally, and as such, various opportunities and requirements for research exist in order to strengthen the country's capability in tackling this problem.





The main area in which research would be focused is treatment technologies, but there is also a need for research in residue management, water use (e.g. saline agriculture), abstraction methods and institutional and financial models.

The DWA may also embark on feasibility studies to address AMD in other mining basins and seek to develop a national strategy for managing AMD. Such a strategy can be improved and updated as new knowledge surfaces and will serve as a benchmark for addressing AMD throughout the country.

In Edition 1 of this Newsletter, it was stated that the aim of the Feasibility Study is to find the most cost effective solution/ combination of solutions that are environmentally sustainable, technically sound, economically viable and institutionally feasible in the best interest of the public.

The DWA firmly believes that the LTS that is recommended for implementation adheres to these criteria, but the successful management of AMD hinges on the stakeholders and public 'buying-in' on the solution that will be implemented. To achieve this, it is recommended that the DWA continues to engage stakeholder groups in line with an overarching communication strategy.

The hope for this study, all the parallel initiatives and the actions to follow are that a water resource challenge will become a water resource opportunity.

## Acknowledgements

The DWA thanks all stakeholders who have participated in the Feasibility Study, especially the members of the Study Stakeholder Committee (SSC), the Study Management Committee (SMC) and the Study Administration Committee (SAC), as well as the members of the Study Team and Professional Services Providers (PSPs), for their commitment to the study, attending meetings, and for providing technical expertise that contributed towards arriving at the LTS.

Municipalities, Non-Governmental Organisations (NGOs), Recreational, Tourism, and other institutions are thanked for their participation during focus group meetings and other inputs provided towards informing the study.

Technology providers are thanked for registering their interest and for providing information on AMD treatment processes towards informing the study.

The wider public is thanked for their participation and for giving DWA the opportunity to inform them on AMD and the progress made during the study.

## Future Communication

General enquiries on AMD in the Witwatersrand can be addressed to Mr Marius Keet at the DWA (keetm@dwa.gov.za). During the implementation of the LTS, further consultation with stakeholders and interested parties will take place in terms of a comprehensive EIA process. For more information on available reports and Frequently Asked Questions (FAQs), please visit the AMD webpage on the DWA website at: http://www.dwa.gov.za/Projects/AMDFSLTS

**Why are some reports confidential?**

The Feasibility Study, being a planning study, did not allow for extensive public participation. Instead, key stakeholders were consulted as the Feasibility Study progressed, while information was made available to the public through newsletters and the AMD website. Wider public participation is foreseen during the implementation stages, including the EIA. With this being said, it must be stressed that there are certain reports that cannot be made public until the appropriate implementation process stages have been reached, as such reports may potentially compromise future procurement and legal processes. Of the 18 reports to be produced, six are considered confidential, and will thus be made available at a later stage.