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Water Management and Treatment in the Closure Phase: Case Studies and the Associated Challenges

A.A. van Coller, V.A. Shaw, G.E. Trusler

Agenda

- Introduction
- Case Studies and Challenges
- Conclusions and Learnings
- Future Directions

Introduction

- Mine rehabilitation and managing water, especially perpetual treatment due to mine waste or regulations, poses challenges for closing mines and legacy sites.
- Treatment of water and the potential social, economic and environmental impacts after operations
- Many of these difficulties stem from inadequate planning and unfulfilled promises made during the pre-mining and operational phases.
- Explore case studies from Europe, Africa, USA, Canada, and South America,
- Case studies include de-risking projects and work carried out at legacy sites as well as mines approaching closure.
- Illustrate the complexities of water management in closure and lessons learned.

- Poor or no closure and rehabilitation planning at design and operational phases
- No planning and design to reduce volumes of water requiring active treatment after closure
- Unrealistic evaluation of true cost of long-term water treatment
- No clear strategy or messaging around mine closure
- Closure water balance not understood or developed
- The norm is rarely challenged

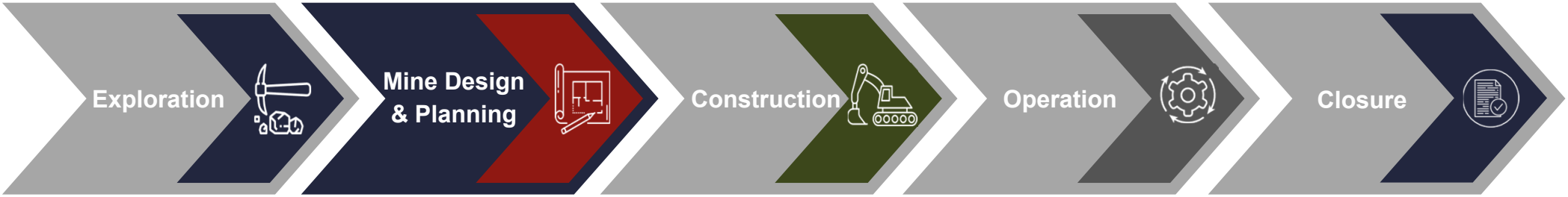
Case Studies & Associated Trends

- Planning
- Implementation
- Financial
- No clear Strategy
- Water balance
- Mine boundaries
- Acceptance of current trends

Planning

- While we know that closure should be planned from the mine design and planning phase through to closure,
- In most cases, detailed closure planning only starts towards the end of the operating life of the mine into post closure.

Poor Planning



- Focus during design and planning phase is on permitting approvals
- Often the only mention of closure plans or concurrent reclamation is in the original ESIA, EMP, Feasibility, or permitting documents and
- Are rarely formalised and updated to the required standard.
- If they are completed and updated, they are often:
  - not practical;
  - no timelines or action plans are included; and
  - concurrent closure planning is not mentioned

Poor Planning

- During the LoM, studies required to substantiate a practical closure plan are not budgeted for, or executed.
- No trials, case studies or test work to base water management practices and revegetation of slopes.
- Inaccurate closure budgets that are generally under-estimated
- No concurrent closure has taken place
- Water infrastructure is often under-designed for closure requirements
- Water treatment in most cases is active treatment with high chemical and pumping costs
- no thought given to reducing volumes and contact water during the operational LoM.
- This leads to much of the work needing to take place at the final stages of LoM when too late for suitable planning
- The result is that team in charge of closure at the end of the LoM are then faced with many challenges

- At a mine site in Peru the poor planning and no concurrent rehabilitation showed clear example of the aforementioned challenges
- From the review, some clear outcomes were that:
  - Concurrent shaping, covering and vegetation of dumps and slopes not in use during the last five years of operation
  - The above-mentioned work could have resulted in the complete removal of one water treatment plant from the post closure requirements
  - If diversion channel designs had been optimised and constructed to closure standards during operation

PERU

$65M

$20M

$7.5M

Total saving
$92.5M

- A study to review the water management practices and infrastructure with closure in mind.
- The mine was 3 years out from closure at the time of the study
- Again, no clear plans for closure were in place
- At the time of the study, various water management infrastructure was under construction (incl. diversion channels and sedimentation ponds)
- These had been designed and constructed to operational guidelines and
- specifications with no consideration that the mine would soon be going into closure
- As a result, infrastructure was designed for lower storm event volumes than would be required for closure
- If the team had planned and considered for closure, much of the additional work leading up to closure and money spent could have been avoided

ARGENTINA

- No clear closure plan
- Designs not fit for closure
- Rework & additional expense

- Lack of, or inefficient communication and planning between key internal teams.
- Significant impact closure planning and costs
- Found that the sustainability team was actively working on closure plans, but no collaboration with planning and operational teams
- Once highlighted the strategy was revised, collaboration improved
- resulted in a potential reduction in closure costs of over US$200 M

Actions that were required:

- unique thinking around pit lake water management,
- water management practices with an eye on reducing the volumes requiring treatment and
- doing as much as possible concurrent rehabilitation for the remaining LoM period.
- Collaboration extended to include authorities during process, resulting in buy in and faster sign off.

NEVADA

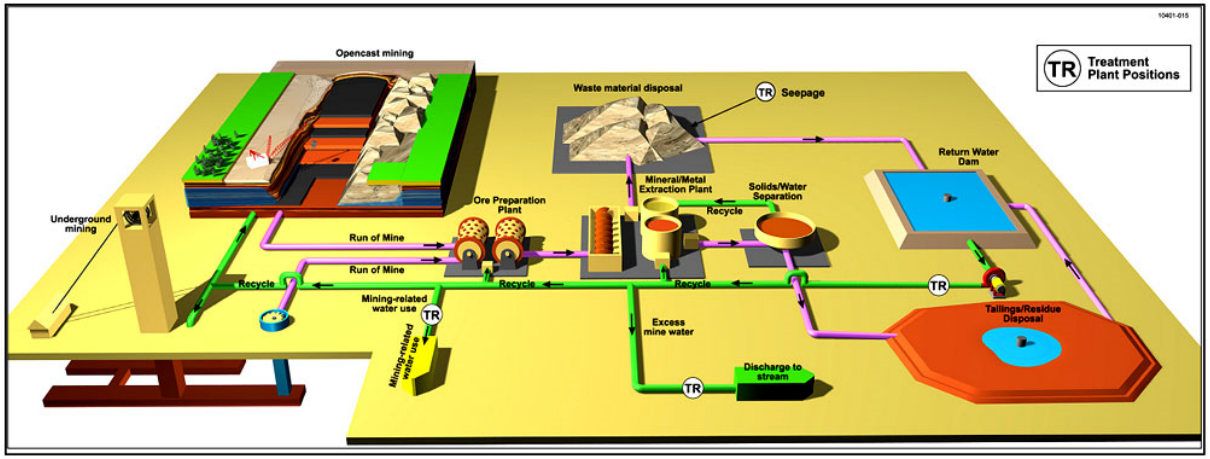
- Challenges:
- lack of communication
- Lack of collaboration

- Once addressed,
- Potential savings of >$200M

France: Importance of a water balance

- A review of a legacy site in France revealed that the site water balance was fully developed or understood.
- The site consisted of a large discard dump used for storage of various waste streams.
- The dump was covered and vegetated however seepage and runoff still required treatment.
- Committed to perpetual water treatment and the design of a water treatment plant to treat water for the next 30 to 40 years was underway.
- However, a review and development of new water balance allowed a clear picture of the various flows on site.
- A more practical, passive solution to the discharge water quality issue could be developed.

IMAGE: (Global Acid Rock Drainage Guide, INAP)



Learnings

Challenges could have been avoided by having:

- clear closure and rehabilitation goals related to closure plans
- and implementation of these plans already during operation

Actions implemented at mines choosing to address the identified challenges:

- Development plans that include annual targets, updated at least every second year by a dedicated, in-house
- This closure task force has an annual strategy session allowing:
- the plan to be reviewed and updated, and
- the roles and studies required of outside service providers to be planned and implemented.
- The strategy and closure plan have clear goals and targets, reviewed quarterly.
- Individual and mine management KPIs and annual bonuses are linked to the concurrent closure and rehabilitation targets

South Africa

Concentrated Mining Areas

- South Africa has extensive mineral resources which are generally concentrated in various regions, as a result of the geological formations and their setting in the country.
- Platinum Group Elements (PGEs) and Copper mines are generally concentrated along the northern part of the country,
- large coal mines in the Mpumalanga coalfields, and
- gold mines in and around the Witwatersrand, where the well-known south African goldfields are located across a vast area.
- Although the above-mentioned extend over vast areas, there are many mines that are in relatively proximity to one another, and hydraulically interlinked,
- And experience similar mine water related issues.

Challenges

- Mining in some of these concentrated regions started in the mid- to late-1800s. Such as the Witwatersrand Goldfields and Mpumalanga coalfields.
- And in both regions, there are significant water management challenges with long-term active treatment as the primary solution.
- There are large legacy mines no longer in operation interlinked with existing mines still operational today.
- There for large volumes of water requiring treatment and discharge, during operation and closure phases.
- In the past these challenges were viewed in isolation and each mine developed and implemented its own strategy for management and treatment of water.
- However, in recent years the benefits of collaboration and joint water management, in most cases basement wide solution, have been acknowledged.

Mpumalanga Coalfields

- Mining was first recorded in Witbank in 1895 and continues today.
- Collaboration has been the greatest, to find joint solutions to the vast volumes of water requiring treatment in perpetuity.
- The value of collaboration and basin wide strategies acknowledged by most parties
- Challenges remain when regional options are assessed, due to:
  - Legal and commercial contracting
  - Defining liabilities and responsibilities
  - Reputational risk and license to operate
- The LoM for some operations extends into 30-50 years
- Opportunities for planned regional mine closure and associated socio-economic opportunities still exist.

Image: https://cer.org.za/news

Witwatersrand Goldfields

- For the Witwatersrand goldfields the problem is not technological, the various solutions can be compared and ranked and the best one selected.
- One challenge is that many of the legacy, abandoned mines are now the responsibility of the government.
- Effective implementation is hindered by the regulatory and governance environment
- Authorities and the mine operators can’t agree on a management structure, in particular a payment and revenue arrangement.
- Whilst these discussions are being held, the mining operations have mostly closed down and the companies are distancing themselves from any liability.

IMAGE: miningweekly.com 10 July 2023

Conclusions and Learnings

- A dedicated closure team, including senior management and consisting of members from all departments.
- Closure strategies and plans to be communicated to the entire organisation and all stakeholders.
- Business performance needs to be linked to closure and rehabilitation performance with clear targets in place.
- Management on board with proper planning and capital expenditure during operation to avoid long-term liabilities associated with perpetual water treatment.
- Cost models need to be truly reflective of the cost which will be incurred in long term water treatment.
- Studies, trials, modelling and construction needs to be carried out the operational with a clear view of what is required at closure.
- More collaboration with other mines in complex / multi-operation mining areas.
- Permitting authorities need to be included in the mine closure and rehabilitation conversation from the start and be made part of the team.

Future Directions

- Potential future topics for study and discussion that can further improve closure, water treatment and rehabilitation efforts include:
  - Proactive measures or strategies for mining companies to address water management challenges and stakeholder commitments during the operational phase.
  - Identifying and studying opportunities for collaboration among mining companies and regulatory authorities at regional levels to address water management challenges collectively, potentially leading to cost savings and more sustainable closure practices.

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