ESG & Mine Water: A Procedural Approach to Support Setting Water Savings Targets in the Mining Sector

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Abstract

Mining companies are challenged to reduce water consumption as part of their Environmental, Social, and Governance (ESG) commitments. A process was developed to engage mine site stakeholders and multi-disciplinary industry practice leaders to assess the best potential options for integrated water savings and improvement of water recycling and reuse efficiency. This paper outlines this procedure to identify and prioritise water use solutions so that investment can be focused based on cost per megalitre saved or other appropriate criteria. A compiled list of water savings technologies is presented including a description of general considerations for applying them to such a study.

Keywords: Sustainability, ESG, mine water use, water efficiency, mining hydrogeology and hydrology practises, water saving targets

Introduction

Mining companies are facing increasing competition for limited water resources and therefore increased challenges to reduce water consumption and to improve their water use metrics as part of their Water Stewardship and Environmental, Social, and Governance (ESG) commitments (ICMM, 2022). Although traditional efforts to overcome these challenges have focused on interrogating the site water balance and site water management plan, it is recognized that solutions to this complex challenge are likely to be found from a more holistic and multidisciplinary review of the site and its environment.

A water savings project focused on a global portfolio of mine sites with priority in water scarce regions was undertaken by WSP for a confidential mining client. As part of the project, a process was developed to bring together mine site stakeholders, WSP's global industry practice leaders and a large global team of WSP's mine water professionals to assess the potential options for water savings and improvement of water recycling and reuse efficiency across their portfolio of mining and mineral processing sites. At the start of the assessment all the operations had water balances and a global Power Business Intelligence (Power BI) data base containing all water accounting data, which was curated by consultant partner ERM (2022). The study considered technologies currently available or in development and across a multitude of disciplines. Conceptual level engineering, water balance modelling, and significant workshopping along with the presentation of the results in a visual database were tools used as part of the study process to rationalize options in terms of costs per water savings (cost per megalitre saved) and determine the best potential options per site or portfolio.

While the outcomes of the water savings study were site specific and unique to the client's diverse portfolio (copper, base metals, diamonds, platinum), a similar process can be applied to other mining client portfolios or individual sites. In addition to very site-specific solutions, the project also allowed the identification of a list of water savings technologies applicable for use at mine sites or mineral processing sites that are currently available to those in the industry. A compiled list of these water savings technologies including description of general considerations for applying them to such a study is presented.

Approach

WSP worked together with the client to produce a workflow procedure that would allow the project to evaluate all potential water savings and efficiency opportunities, to develop engineering and modelling supported investment decisions, to document the evaluation and selection process, and allow acceptance of the proposed solutions by the site and company stakeholders at both mining and mineral processing sites. The procedure was developed over the course of the project and included the following steps:

1. Identification of priority sites/portfolio.
2. Benchmarking exercise for water use and water recycle-reuse efficiency.
3. Data review and engagement with site stakeholders.
4. Interrogation of site water balance and water management plan.
5. Long Listing exercise of potentially applicable technology options.
6. Short Listing exercise and ranking.
7. Development of concept level engineering.
8. Evaluation of potential water savings using modelling.
9. Cost estimation and evaluation of results based on cost per ML saved.
10. Presentation of results in a graphical Power BI project to support investment decisions.

This process is represented graphically as Figure 1 with each step discussed further in the following sections.

Identification of Priority Sites/ Portfolio

The sites within the portfolio were chosen based the current most challenging water use and efficiency performance amongst sites located in water stressed regions. This allowed the study to focus on sites where gains were likely to have the greatest positive impact on the local stakeholders as well as the greatest impact on the company's water use metrics.

Benchmarking Exercise for Water Use and Water Recycle-Reuse Efficiency

Using publicly available data, a benchmarking exercise was undertaken to develop an

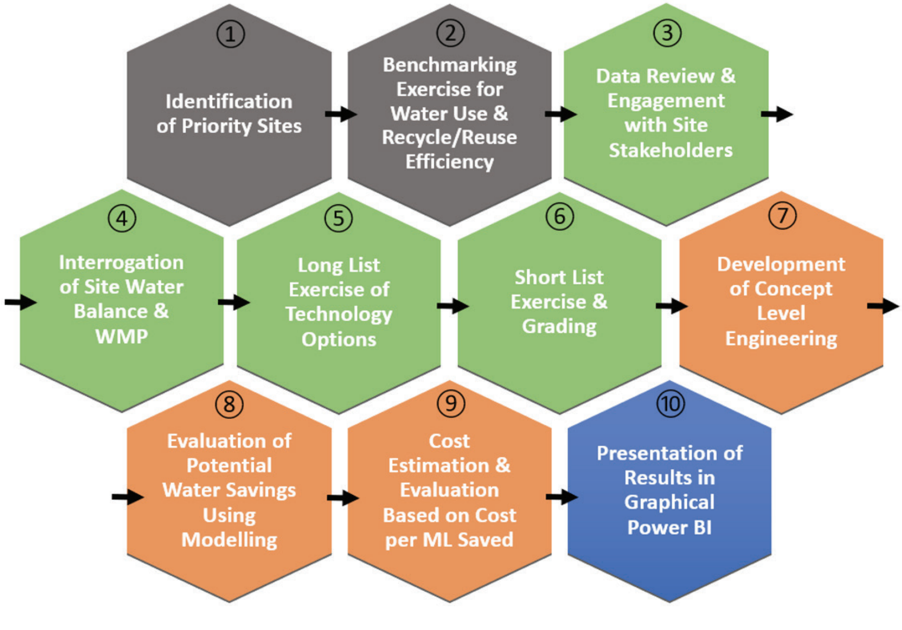

Figure 1 *Workflow Procedure (steps organised as: grey = sites/portfolio selection, green = option development, orange = assessment of prioritised options, blue = presentation of results).*

understanding of water use metrics at similar mines and mineral processing facilities (comparing factors as described in the list below). Sustainability reporting was the primary source of information in this exercise. In practise data were difficult to obtain to the appropriate level of detail to allow useful numbers to be produced for comparison. Understanding was applied to estimate parameters from some of the public information available. Benchmarking data from mineral processing sites were the most challenging to obtain.

Benchmarking comparison metrics included the following:

- Operation type – Open-pit mine, underground mine, mineral processing facility, or a combination of these;
- Climate – Arid, Equatorial, Warm Temperate;
- Region – Delineated by Continent;
- Commodity – Primary commodity produced; and
- Type of Tailings Storage Facility – conventional, thickened, filtered, mixed (if known).

Once developed, this information was presented in a graphical power BI database allowing comparison of the client's portfolio of sites against other similar operations globally. This assessment was then used to further prioritise the focus of the study within the selected portfolio.

Data Review and Engagement with Site Stakeholders

Data review was progressed through provision of a detailed Request for Information (RFI) with information collected primarily through targeted engagements with site stakeholders including but not limited to professionals responsible for water management, processing, tailings management, mine planning, permitting, new project development, and community engagement at the sites. Site visits were undertaken to clarify and refine data collection where possible. Integral to the review was development of an understanding of stakeholder concerns, site constraints, future projects and previous studies.

Data review focused on both existing operation and future planning including:

- Existing water management systems, water balance and site reticulation reports and supporting data sets, water balances, and climate data including predictive water balances if available;
- Previous water savings studies, status of extent of evaluation and implementation of identified options (For example: Concept, Prefeasibility, Feasibility);
- Current and projected ore production and tailings production;
- Process circuit/water circuit information, processes, water quality and water treatment information (if relevant);
- Metrics and definitions for the site;
- Major projects planned at the site; and
- Any relevant change in water balance or inflow predictions that can affect water consumption demand or discharge and reason for water balance change. For example, permit requirements, mine plan, tailings deposition methodology changes required to facilitate permitting renewal.

Interrogation of the Site Water Balance and Water Management Plan

The site water balance for each site was reviewed so that all current metrics were understood and a baseline of water metrics was set as a comparison point from which the outcomes of the study would be measured. The occurrence of unusually dry or wet years was considered and avoided in the selection of the baseline water metrics.

The predictive water balance was also interrogated alongside the site water management plan to understand the anticipated effects of planned major projects, expected climate change, and any planned increase or decrease in production in relation to the baseline metrics. A summary of the key aspects of the existing site water balance along with key challenges of the site water management plan was presented to the site stakeholders in engagement workshops.

Long Listing Exercise of Potentially Applicable Technology Options

Interactive sessions were held with site stakeholders to present the results of the data review and a summary of the existing site water management completed in the previous step of the process. These sessions were used to produce an opportunities Long List focused on water savings and water recycling reuse efficiency options potentially applicable at each site. Sessions were integrated and attended by stakeholders of different technical backgrounds.

The format was run as a brainstorming session and considered technologies currently available or in development and across a multitude of disciplines. The purpose of the session was to develop a full and complete list of potential opportunities and any key information as to the applicability of these opportunities at the site.

The Long list opportunities development was progressed to capture the complete list of potential options/technologies with may be applicable at the site considering previous efforts/studies by the site and technical expert review of application of the technology to the site.

Short List Development and Ranking

The Long list of opportunities developed in the previous task was then progressed through a short listing and ranking exercise. This included a high-level feasibility assessment of each option based on agreed screening criteria to prioritise the opportunities based on suitability to site requirements and high-level implementation metrics as agreed with the mine site and the mining company's corporate goals.

The short list development and ranking exercise was progressed as follows:

- Develop high level screening criteria to be applied to the Long List (e.g., percentage change/general assessment of effectiveness, community needs, alignment with corporate targets etc) and progress initial screening of options.
- High level evaluation including high level costs if possible.
- Internal workshop with technical leads to assess options, refine list, and revised metrics with focus on priorities set out in the screening criteria.
- Workshops with stakeholders to present results of assessment and agree on the Short List.

Agreement of the final short list by all site stakeholders was a key aspect of the success of the project. The short list was refined to include the top priority options per site, which were progressed to the next stage of evaluation.

Development of Concept Level Engineering

Concept level engineering was progressed on the top priority opportunities identified in the Short List grading session. Engineering was progressed to the extent required to (1) support the evaluation of the potential water savings (timeline, footprint, energy use, throughput, etc.); and, (2) to allow concept level cost estimation. Where available information was insufficient to allow progression to full concept level engineering, experience and benchmarking were used to estimate relevant engineering parameters and costs.

Evaluation of Potential Savings Using Modelling

Output from the concept level engineering was used to inform the forward-looking predictive modelling of the site water balance designed to evaluate the potential for water savings in relation to the baseline metrics. While individual runs were progressed for some options, it was recognised that water savings options are most often interconnected and are not best evaluated individually.

The true prediction of potential water savings is more accurately evaluated by running the predictive water balance as a site focused collection of the most likely water savings opportunities implemented on a realistic schedule given that the combined savings are unlikely to be the same as the additive savings realised from model runs assessing individual options. Where possible it was helpful to collect model outputs on a yearly timestep so that the timeline of potential savings could be evaluated.

Cost Estimation and Evaluation of Results Based on Cost per ML Saved

The concept level engineering was used to develop concept level CAPEX and OPEX estimates for the proposed water savings opportunity. Net Present Value/Cost (NPV/NPC) was calculated over an annualization period of 20 years or the life of mine (LOM) whatever is shorter. In some cases, opportunities included a revenue stream, which was also factored into the calculation.

The cost estimates were combined with the results of the predictive water balance modelling to produce a basic cost per ML saved over 20 years (or LOM) for each of the water savings opportunities or package of water savings opportunities. Where it was not possible to estimate OPEX, CAPEX only was used in the calculation of cost per ML saved and this was indicated.

Presentation of Results in a Graphical Power BI Project to Support Investment Decisions

Results of the study were presented in a graphical power BI project, which was designed to be fully integrated to allow for evaluation of options individually or as a combination of portfolio metrics. The output was used to compare the opportunities on a cost per ML saved basis and against other metrics relevant to the company (e.g. water stewardship). This output was used by the client to set their medium-term targets and to focus immediate investment. The Power BI project was set up to allow for it to be updated with new data as the options are implemented to support the next wave of investment decisions and realistic operational target setting.

Water Savings Technologies

As part of the process undertaken in the project described above, technologies were identified that could allow for improvements in water saving or efficiency at mining and mineral processing sites. A compiled list of some of these water savings technologies including description of general considerations for applying them to such a study are included in the list below. This is not an exhaustive list however presents a selection of the technologies available which may be broadly applicable at many sites:

1. **Evaporative Covers:** There are three different types, floating photovoltaics, floating covers, solid covers. The covers are well understood however overall cost effectiveness and efficiency depends on site specific factors such as the site's weather condition.
2. **Dust Suppression Additives:** Technology is well understood however overall cost effectiveness and reliability should be verified at the site.
3. **Treated Sewage Effluent Reuse:** Reuse of treated sewage effluent from the mine or from the surrounding community in the mine water circuit replacing the need for higher quality water. The water will likely require additional treatment prior to reuse.
4. **Water Reuse Assessment:** Requires detailed water quality information from all the reticulation points and understanding of reuse tolerances to assess suitability of water streams for reuse with no or minimal treatment. Lack of data is a significant hurdle in applying this solution.
5. **Underground Mud Management:** Settling underground to avoid surface settling ponds and associated pumping and evaporation losses. Suitable underground space is required and recovered water can be reused underground. Underground water temperatures would also need to be considered.
6. **Filtered Tailings:** Requires site specific laboratory testing to determine how much water can be recovered by filtering. Costs are high and the solution is difficult to implement in areas of high rainfall.
7. **Operational Tailings Management:** Reduce amount of water sent to tailings facility by increasing tailings density. Costs and savings are highly dependent on technology selected and site-specific laboratory testing.
8. **Underground Storage of Tailings:** To limit evaporation from the tailings by limited exposure to climate. Requires identification of underground mine voids which could be used for storage.
9. **Gland Seal Water Replacement:** Conversion to pumps using mechanical seals eliminating the need for high quality gland seal water. Commercial success to date in mining are limited however widely adopted in other industries.

10. **Electrocoagulation:** Treatment technology to reduce the volume of makeup water in mineral processing cooling towers. Emerging technology likely requires a pilot programme to confirm savings and costs.
11. **Waterless Scrubbers:** Alternate scrubbing technologies in mineral processing facilities could reduce or eliminate the use of water to remove particulate material and gasses prior to release. Requires a site-specific sampling programme to assess and would be implemented at high CAPEX and OPEX cost.
12. **Waterless Cooling:** Waterless cooling at mineral processing sites such as mechanical refrigeration could eliminate the need for cooling water in smelters. Design and approach will be impacted by seasonal variations in climate and temperature. This is a high cost and high energy solution.

Evaluation of the potential effect on water metrics versus costs of these technology options is site specific for most of these options and must be progressed through concept level engineering, cost estimation, and predictive water balance modelling as described above to properly evaluate.

Conclusions

Mining and mineral processing companies need to be proactively evaluating their water use, efficiency, and stewardship programs to meet ESG commitments at their sites and across their portfolio. Regardless of a site's current water position, it is reasonable to assume that competition for water will increase, and proactive management of water related investments through a defensible program is needed to protect social license and ability to operate.

The procedure outlined in this paper has been tested and shown to provide a comprehensive evaluation of opportunities to improve water use and recycling/reuse efficiency water metrics on mining and mineral processing sites. Benchmarking of water metrics based on publicly available information is challenging however can be used to further focus the project. The appropriateness of opportunities, potential savings and costs are highly site specific and must be evaluated on a per site basis. Evaluation of the top ranked Short List opportunities through concept level engineering, cost estimation, and predictive water balance modelling allows for comparison of the opportunities on a cost per ML saved basis. Water balance modelling is best advanced considering a combination of opportunities at one site given the integrated nature of water metrics. A list of water savings technologies potentially applicable at mining and mineral processing sites has been presented. Presentation of the study results in a graphical Power BI project supports evaluation of the results by multiple metrics and across a portfolio which allows for targeted focus of investment decisions by mining companies.

Key success factors of the process were the close collaboration between the mining company technical water team, the consultants, and engagement of all relevant site stakeholders as well as multi-disciplinary industry leading professionals to allow for the development of a comprehensive opportunities Long List and for agreement and buy-in of the ranked Short List. Appropriate selection of a baseline against which improvement metrics can be compared is also a critical step in the study. This paper presents a robust process by which a defensible water savings, water efficiency, and/or water stewardship program can be developed. This type of focused investment and informed target setting has the potential to speed the mining industry's progression to achievement of ESG goals.

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