An Overview of Risk Allocation and Delivery mode for Desalinated Water Supply Projects in Mining

Richard Dixon, Metso Outotec

Extended Abstract

Mining requires a significant supply of water. Historically, this water has come from fresh water sourced from underground and surface sources, but that lower cost water has been largely used up. Mining companies have therefore turned to alternative sources of water, such as water recycled from municipal plants, straight seawater, and desalinated seawater.

Future water consumption for Mining is expected to increase substantially over the next decade because of:

- Increased production of Metals: Metals production is growing, and part of the increased water demand can be explained by increases in production from the expansion of existing mines and by completely new projects being built.

- Declining grades: In addition to increased production, there is an important increase in demand of water caused by declining mineral grades at existing mines. Historically, the richest deposits were mined first, as they were less costly to mine. As mineral grades decline, more mineral must be processed in order to produce the same amount of metal. The use of water is proportional to the amount of ore, so it follows that more water is needed to produce the same amount of metal. For example, for copper, if the copper grade is 1.5% instead of 3%, it will be necessary to mine twice as much ore and to use twice as much water to produce the same amount of final copper.

- Process changes: processing of Oxides versus processing of Sulfides (Leaching to Flotation). As a given ore deposit is mined, sometimes a full process change is required to continue to produce copper. Typically, the portion of a mineral deposit that is located closer to the surface is richer in metal oxides, and the portion of the deposit that is deep down, away from the surface, is richer in

metal sulfides. At the beginning of the life cycle of a mine, oxides near the surface are processed first by leaching / solvent extraction / electrowinning, and when the oxides are depleted, the underlying sulfides are processed via milling / flotation.

Unfortunately, the infrastructure used for leaching / solvent extraction / electrowinning and flotation does not have much in common, and the processing of oxides and sulfides requires very different amounts of water. While the processing of oxides in the early stages of a mine typically requires 200 liters of water per ton of mineral or ore, the processing of sulfides requires on the order of 800 liters of water or more per ton of ore. Therefore, when a mine changes in a natural progression from processing of oxides to processing of sulfides, it must increase its water supply, as the water infrastructure that was implemented to process oxides will be inadequate to process sulfides.

As mentioned, this additional demand for water is being satisfied from nonconventional sources, such as straight seawater, desalinated seawater, and municipal effluent plant discharge, all of which often must be conveyed for long distances and to high altitudes.

The last few years have brought major changes in Mining water supply strategy, now including the commissioning of several Desalination plants. For these Mining desalinated water projects, there have also been important differences over time in the way that Mining companies have allocated risk and driven execution. For convenience, we can think of three main phases that have dominated project delivery mode over time:

- Phase 1: The desalinated water supply is only a component of a large EPCM (Engineering, Procurement, and Construction Management) contract, typically encompassing a concentrator plant and other major plant infrastructure.
- Phase 2: The desalinated water supply is an EPCM contract on its own, completely independent of other infrastructure delivery.
- Phase 3: More recently, alternative delivery models are being used, including BOOT (Build, Own, Operate and Transfer) and EPC (Engineering, Procurement and Construction) contracts.

Each of these phases has particular characteristics in terms of Risk allocation and the roles of Mining Company, Water Infrastructure supplier, Engineering Partners and Finance. These will be discussed further below.

Water related risks are typically classified as Physical Risk or Supply Risk when water supply is not enough to meet production plans, Regulatory and Legal Risk when there is a risk of reduced water rights or allocations or the need to prevent or treat contaminated water for discharge, and Reputational Risk, which arises from water quality problems, i.e. discharging contaminated water. This can cause loss of investment value and extend beyond a site to a whole company.

These have been addressed elsewhere in detail (Morgan and Dobson, 2020). In this article, we are mostly concerned with Risks associated with the infrastructure itself, namely, the Project Execution Risk, or risk that the water supply project is not complete in time for the start of a new site, or that the infrastructure does not meet needed water supply targets.

To examine Project risk, it is important to understand how it is that Mining companies make investment decisions.

Mining companies make their investment decisions based on the results of Engineering studies, and often significant sums are spent on projects that never materialize. After a new orebody is discovered, a study is first carried out at a Conceptual stage to provide a rough estimate, often with no better than 50% accuracy, of how much capital will be required to develop the orebody. With that information, the Mining company determines if it is attractive or not to continue with the project, and then commissions further studies which increase the level of detail for the assumptions made, and the accuracy of the level of investment required. The projects that do not materialize do not provide a high enough return on investment and are abandoned along the way. Sometimes, metal prices change significantly, and studies are brought back to life to continue with further evaluations. At the end of the Engineering study process, the Mining company ends up with a study, typically at the 90% level of accuracy, and with very detailed assumptions, which is presented to the Board of Directors for a go / no go decision. When the decision to go is made by the board, the project is often executed immediately with no delay. The overall Mining project is typically composed of many individual major systems, such as Ore mining, crushing and transportation; Process plant (concentrator), Tailings Dam, etc. which can be handled by a single EPCM contractor, but rarely by a single EPC or BOOT contractor.

Similarly, a Desalinated Water Supply Infrastructure project has several components, including the Seawater Intake Structure and Marine Works, the Desalination Plant and its Pretreatment, the Pipeline and Pumping Stations to deliver the water to the mine, and the Power supply for the desalination plant and the water delivery system.

Typically, the pipeline and the pumping stations package is the largest cost of the water supply project, because the water must be pumped great distances, often 200 Km away, and to great elevation, often 3,500 meters. Straight Seawater and Desalination projects have been previously compared (Philippe and Dixon, 2016).

It is also unusual for a single company to be able to supply all of these components under an EPC or BOOT contract, and often these contracts are awarded separately. What is more common is that a single EPCM company is charged with coordinating all of the packages and helps the Mining company award contracts for each package.

Due to the size and complexity of a full-scale Mining project, these projects have historically been carried out as EPCM (Engineering, Procurement, and Construction Management) projects between the Mining company and a very large Engineering and Construction firm. In the EPCM contract, the Engineering firm acts as an advisor and manager for the Mining company and makes its money by charging the Mining company for the hours it uses to advise and manage the project. The EPCM firm does not carry a lot of risk on infrastructure or hardware because it manages contracts between the Mining company and suppliers of individual packages and does not supply infrastructure itself. The individual packages are typically handles as EPC (Engineering, Procurement and Construction) contracts, where the EPC firms deliver physical infrastructure and make their money by taking a margin on the infrastructure and associated Engineering.

Because of the size of Desalinated Water Projects, there has been a change from an EPCM firm handling all of the Mining project including the Water infrastructure, to the Water infrastructure being handled as an EPCM contract all of its own. In addition, a recent trend has been for Mining companies to avoid tying up a very large investment in Water infrastructure, and instead using a BOOT (Build Own Operate Transfer) model, where all the investment is done by a specialist firm that makes money by charging the Mining company an amount per unit of water produced, i.e. dollars per cubic meter of desalinated water delivered to the site. Another advantage is that the BOOT contractor will operate the Water plant, while this has historically been a problem for Mining companies lacking Desalination operations experts.

This is in essence a transfer of the risk from the Mining company to what is in essence a water supply company, much like a utility charges individual customers for their water usage.

Table 1 compiles many aspects of project execution in terms of risk:

Table 1: Risk allocation for several Project Delivery Contract Modes

Issue	EPCM	EPC	BOT
Where do funds come from?	Mining Company / Bank	Mining Company / Bank	BOT Developer
Who pays if estimation is wrong?	Mining Company / Bank	EPC Company or Mining Company	BOT Developer
Who pays if Project is delayed?	Mining Company / Bank	EPC company / Subcontractors	BOT Developer
Who takes Technology Risk?	Mining Company	EPC company / Subcontractors	BOT Developer
Who pays Subcontractors?	Mining Company	EPC company	BOT Developer
Who prepares Technical Specifications?	EPCM company / Mining Company	EPCM company / Mining Company	BOT Developer
Who manages Subcontractors?	EPCM company	EPC company	BOT Developer
Design changes	Easy	Hard	Very Hard
Incentive for Quality	High	Low	Low
Contingency Costs	Low	High	High
Design responsibility	EPCM company / Mining Company	Mining Company	BOT Developer
How do they make money?	Charge lots of hours / add change orders	Pressure subcontractors	Pressure subcontractors
Mining Company Control over Project	High	Low	Very low
Procurement Documents	EPCM company	EPC company	BOT Developer

We now consider some typical sources of problems in Mining Water Supply projects:

- Lack of Mining experience of Desalination plant suppliers: The largest market for Desalination is Municipal, not Mining. Therefore, Desalination plant suppliers are accustomed to projects where when Desalination companies supply a Municipal Desalination Project, the Desalination plant is the major component of the project and the Desal supplier is the main supplier. Because of this,

the Desal supplier has a strong influence on the timing of the project and often manages the whole project. For a new Mining project, the Desal plant is on the order of 5% of the whole project. Therefore, the Desal supplier now finds itself having to accommodate to the way Mining companies run projects, with large demands of specifications, drawings, progress reports, formal document management requirements, and a large owners team controlling everything that the Desal supplier does and demanding top speed of execution.

- Safety Standards: Mining companies are very safety conscious and have developed very sophisticated accident prevention and reporting systems. Something as a speeding ticket on the way to a mine site may disqualify a person from working on a project, so it is important that companies starting supply projects with Mining companies quickly catch up with the particular philosophy, programs, and reporting requirements for the particular Mining company that they are dealing with.
- Speed of Execution: As mentioned above, Mining projects are typically studied for several years before they are executed, and once the decision is made by the Board of Directors to go forward, they are typically executed at top speed and with a strong focus on early completion. This typically catches Desalination plant suppliers by surprise, as Municipal water supply projects do not have these time pressures, at least not as intense as are seen in the Mining industry. The reason for this is that Mining projects attempt to capture revenue from Copper production as soon as possible, and a shortened schedule can mean hundreds of millions of dollars in income, whereas municipal water supply projects are subject to comparably minor penalties for late completion.
- Construction Standards: Because of the focus on low downtime in Mining, construction standards are very high and redundancy is always a consideration, which is not seen as strongly in Municipal projects.

We close with some thoughts on the sharing of Infrastructure between neighboring mine sites. While an outside observer may very rightly think that it makes sense to share Desalination and Water transport infrastructure between neighboring Mines, and better yet, between Mining companies and Municipal water supply utilities, in practice it is quite difficult for this to happen.

As explained above, Mining decision making is a long and sophisticated process, and the chance of an investment decision reaching the board of Directors at the same time for two different mining companies is practically nil. Additionally, Mining companies are very concerned about the stability of their water supply and are very sensitive to water supply risk. Therefore, they do not look upon favorably to sharing infrastructure with others, as they are worried that issues affecting the other company, for

example a strike by the other companies' workers, could affect its water supply and therefore its production. Any downtime by a Mining company is typically measured in thousands of dollars per hour, and Mining companies are not willing to take much risk on their production.

We still retain some optimism for these infrastructure sharing projects, but the coordination and timing challenges are significant.

References

1) Morgan, A.J. and Dobson, R. (2020) *An analysis of Water Risk in the Mining Sector.* Water Risk Filter Research Series Volume 1, WWF.
2) Sal or Desal?. Seawater Supply Options for the Mining Industry, Raymond Philippe, Richard Dixon and Silvana Dal Pozzo, *Water in Mining*, 2010, Santiago, Chile.