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GWI PRIMARY RESEARCH

Water for Mining

Opportunities in scarcity and environmental regulation

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3.2.3.1 Seawater mining projects in Chile

Mines in Chile and Southern Peru are increasingly using seawater which needs to be transported to mines generally located at high altitudes away from the coast. In the majority of the projects the desalination plant operation is located on the coast and desalinated water is conveyed up to the mining site. Some mining operations are designed to have a hybrid solution, such as using raw seawater to a large extent and desalinated water only for the electrowinning process. In these operations, the desalination plant is located at the mine site.

Mining seawater desalination projects in Chile and Southern Peru have a number of common features:

- Intake structure:
- Pretreatment:
- Membrane process treatment of the pretreated seawater:
- Conveyance system:
- Outfall structures and disposal of the concentrate:

Outfall and membrane process treatment desalination components are not applicable to the mining projects using raw seawater.

Figure 3.5 Main mining operations using desalination or raw seawater in Chile

Company	Operation	Feedwater	Capacity (m^3/d)	Investment/Cost ($)	Status
BHP Billiton	Coloso Plant at Escondida	Desal	45,360	$200 million ($50 million for plant and $150 million for pumping system)	Operating since 2006
++ Minerals	Michilla Mine	Use of direct seawater for leaching process	6,500	---	Operating since early 1990s
Antofagasta Minerals	Esperanza	Use of raw seawater for copper flotation	62,200	$2.3 billion (mine project including pipeline)	Started operating in 2011

Source: GWI research

The following projects have submitted an environmental impact study considering the use of desalinated water or raw seawater:

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Figure 3.6 Mining operations considering the use of seawater

Company	Operation	Feedwater	Capacity (m^3/d)	Investment/ Cost	Status/Start Date
		Desal (RO)			Mid-2012
		Desal (RO)			2012
		Desal (RO)			2012-13
		Desal (RO)			2013
		Desal			Studying feasibility
		Desal			Approved
		Direct sea water			2013-14

Source: GWI research

Regarding the projects which are in the pipeline, commented:

> *All these projects are long term projects and they are all in different stages of development. It looks like the majority are considering desal water. If any project can avoid using seawater, for cost reasons they will try to avoid it, but this depends on location and availability of water. Of the existing operations almost all are considering desal because their current installations are not set to run raw seawater.*

Case study: Minera Esperanza (Antofagasta Minerals)

Antofagasta PLC's Minera Esperanza copper and gold mine is located in Chile's Antofagasta region; construction was completed at the end of 2010, with a plant capacity of approximately 97 million kg of ore throughput. What makes Esperanza mine unique is its position as the first large scale project to use raw seawater in its copper flotation process and implement deep thickening technology to reuse water from tailings.

The conveyance system employed at the mine consists of a direct intake mounted with six pumps, which convey the raw seawater to the pretreatment stage. Pretreatment involves electrochlorination and filtration to remove the bulk of the organic matter in the water, and the addition of anti-corrosion chemicals to reduce wear and tear on the pipeline system that takes the water to the mine. Four pumping stations then transport approximately 62,200 m^3/d of pretreated water across 145km to a 50,000m^3 tank situated at the mine site, 2,200m above sea level.

The copper flotation process uses a closed circuit in which all water not lost in tailings is mixed with new seawater and recycled back into the flotation process. The pH of the water is significant in the flotation process; seawater pH is approximately 7.5, while the recycled water has a pH of around 9.5. The process water that is eventually sent to the mill has an average pH of 8, which is increased over two stages through the addition of lime. The reason for the focus on the water's pH is the need to achieve an adequate level of pyrite suppression without impacting adversely on the ore recovery rate.

Whilst the bulk of water needs at the Antofagasta mining site are met by raw seawater, a small 2,400 m^3/d UF/RO plant has been installed in order to provide desalinated water for potable and final wash needs at the site. An estimated 5% of the seawater pumped to the site is used to provide the product water, going through two 2,671 m^3/d UF trains two 2,400 m^3/d RO trains.

The Esperanza project is now officially opened. It has gone through the start up phase and is getting its first experiences in using direct seawater. As a first of its kind, it is estimated that it will take at least two years to fully evaluate the success of the plant.

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Market analysis

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4. Market analysis

4.4 Market division / segmentation

For the purposes of this report we have analysed capital expenditure on mining related water infrastructure in three separate categories:

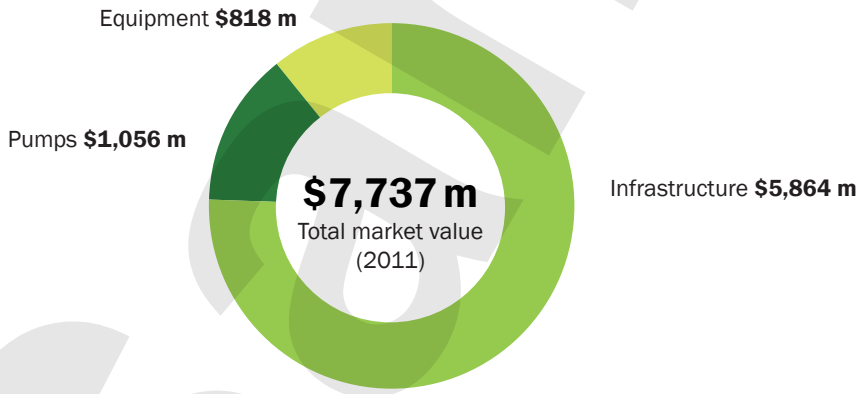
1. **General water infrastructure**: this would include civil engineering, pipelines, and other physical infrastructure spending related to bringing process water to the mine site, and dealing with the discharge of wastewater.
2. **Pumps**: this is the market for pumps used in the mining sector in dewatering, treatment and transport.
3. **Water equipment**: this refers to specialist water and wastewater treatment equipment used in the mining sector. It is broken down into the following categories:

- **Screens / intakes**: primary water treatment equipment.
- **Filtration systems**: all filtration systems including pre-coat filters, media filters, sand filters, UF and other systems used in both process water and wastewater treatment.
- **Presses /clarifiers / thickeners**: technologies used to remove suspended solids and/or dewater.
- **RO / desalination systems**: equipment used to remove dissolved solids including wastewater treatment and seawater desalination systems for process water where relevant.
- **Chemical treatment systems**: chemical feed systems and lime neutralisation systems.
- **Specialist systems**: equipment required to remove or recover specific wastewater contaminants which cannot be removed using standard filtration and RO treatment. Also includes zero liquid discharge.
- **Other equipment**: things such as tanks, control systems, monitoring systems not included in the other categories.

Besides analysing the market in these categories we also provide a breakdown of the market geographically, giving data on the top ten markets for water infrastructure related to mining.

Our best estimate is that water for mining represents a $7.7 bn market in 2011, as shown in the following figure.

Figure 4.1 Global mining water market by expenditure category, 2011



Source: GWI

When the market is broken down by country, the top 10 comprise nearly 80% of the market. Australia is the clear leader, with nearly 20% of the total market.

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[redacted] remarked:

> *I think if you look at it as a whole, the mining industry in South Africa is taking more of the low-grade resources than they have ever had to take, or have ever taken. There are a number of drivers for this, they include economic drivers with China and the Global recovery wanting a lot more resource materials and at high prices allowing mining to let's optimise the reserves they have. There is also the age of some of these mines, where years of mining have only left the 'fringes' of the resources and so facilities which are not un-economical, but have lower grade material, are being increasingly considered and explored. For these reserves to be used, more processing is required which besides requiring more infrastructure and energy, also requires more water.*
>
> [redacted]

[redacted] commented:

> *The ore grades are getting lower and also the geology is getting more complex. And as the geology is getting more complex, the wastewater treatment issues become more complex. Lower grade means larger tonnages. In other words, if the grade is low, you have to build a big mine, which uses a lot of water. So the issue that I see in mining is that the demand of water is increasing, which combined with the scarcity of water, makes it more difficult for mining companies. And as we get in to more and more complicated geological settings, the wastewater treatment becomes quite a challenge.*
>
> [redacted]

There are also technology implications as the increasing water and chemical loads may require upgraded or advanced technologies. [redacted] noted:

> *The lower grade of ore requires you to process more material and this needs increasing quantities of chemicals, so it is going to drive the use of technology further.*
>
> [redacted]

However such implications should not currently be a major issue to the industry but it is likely to become significant in the future. Accroding to [redacted], "despite the grade of the ores being processed and the associated issues the effluent problem will still persist in perpetuity. The issue is so significant that I don't think it is a serious threat to solutions providers in this space for another five or ten decades".

There are cost implications to the mining companies as there will bee additional costs placed on handling the larger volumes of effluent generated. According to [redacted]: "The mining company has to spend more money to develop projects to handle lower grade ores, and that means the companies who are doing the ore processing and effluent treatment, also need more money to do the job. In [redacted] we are working with [redacted] and there is one mine, which has large amounts of arsenic. There are therefore mines, which are more contaminated with impurities than other mines. In earlier times you tried to avoid those mines, unless the price of the metal was rising, then you also need to process those ores".

[redacted] added, "but now what is needed is to have an additional arsenic treatment plant, which is an additional investment. But it is necessary both for the environment and also to take the arsenic out of the ore to get the right concentrate".

6.6.5 The effect of fluctuations in commodities prices on the selection of water management options

Fluctuating commodities prices may have a direct effect on how water management options are selected. According to [redacted]: "I think that commodity prices have a direct effect on the selection of water management projects. The biggest impact it has is on slowing down projects. As the prices fluctuate, mining companies will evaluate cash flow and may decide to not advance developing a mine, or may slow down how quickly they de-water a mine they are restarting. When the commodity prices are low, they tend to be more conservative too".

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He added, "a lot of industrial clients may be more open to looking at ways to cut capital costs when commodity prices are low, but they are also less likely to take a big risk on technologies".

noted:

> *Of course fluctuations in the commodities prices will affect the water management options that are selected. A gold mine with the current gold price can afford much more money to put in water management, compared to a zinc, lead or kaolin mine or other industrial minerals. On the other hand, there are also the regulations that have to be respected. So it goes by metals in that area where the metal has a bigger value, you can make more out of it than in others. The pressure is normally a bit higher to do more investment on the environment.*

According to
"Two years ago when commodities prices dropped precipitously, there was a direct correlation to the amount of work that was going on. As you can imagine, mining companies stopped or slowed down de-watering mines or operating mines that were not profitable. So they cut back on expenditures".

He added, "there is a natural connection between commodity prices and how much the mining companies can spend in the marketplace, on water or on any other aspect relevant to opening or operating a mine.

remarked:

> *Fluctuations in the commodities prices do have an effect as everything has to profitable and operations be cost effective. Mining operations have an 'optimum-market-value life span' so if there are fluctuations in the value of the metal then there is less money to spend on other aspects of the mining operations so there is a domino effect. If prices change and go down then you will see spending being cut and budgets being tightened up, which will eventually affect water and especially the wastewater side of things. However, if there is a legislative push by governments towards better treatment, that will be helpful.*

According to : "Past fluctuations in the commodities prices can influence the water sector. 10 to 15 years ago when commodities prices were considerably lower, there was greater emphasis on the development of secure water supplies and sustainable water management processes".

He went on to mention that "community expectations and social licence to operate pressures around water management have also risen during this period, as water is something that people can easily relate to, so often it is a key focus area. The success of greenfield mining projects is often heavily influenced by the manner in which water is used and treated and how this is communicated to the local communities".

commented:

> *All the solutions and technologies add cost to a mining operation, and what is going to drive implementation is the price of the commodity. In the commodity sector if the price drops, then they will keep the asset in the ground and there won't be a need for water or water management. If the environmental permits and water needs are great, then the price of implementing those technologies will determine whether that mine is economically viable or not. So while the market is potentially significant, it can be challenging because it will rise and fall with the general economic situation in the world and the demand for resources.*

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