Water security and engineering innovation for the Southdown Project

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Abstract

An open pit magnetite mine and processing facility is proposed as a part of the Southdown project. The project will require a considerable volume of water for processing and transport of the ore. This paper provides an introduction to the project with a focus on the water demands, water security concerns and water supply opportunities. In particular, the climate independent water supply options of seawater desalination and water reuse are discussed. The paper also provides a discussion about engineering innovations for the single investment water supply option and describes how a smooth pathway towards environmental approval has been achieved.

Keywords: water supply, water security, innovation, desalination, reuse, magnetite processing, environment

Introduction

The Southdown Joint Venture (SDJV) is a joint venture between Australia's leading magnetite producer Grange Resources (70%) and Sojitz Resources and Technology Pty Ltd (SRT) (30%) a Japanese trading house (Grange Resources 2012). SDJV intends to construct and operate a 10 million tonnes per annum open pit magnetite mine in the south of Western Australia. The deposit, which covers a length of approximately 12 km of farmland, is located approximately 90 km east-north-east of Albany.

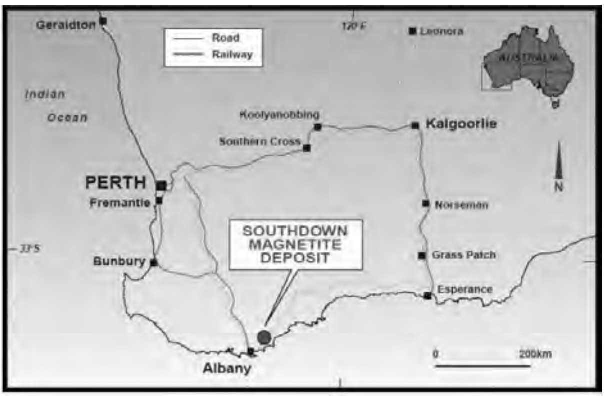

Figure 1 *Southdown project location (Grange 2012).*

The magnetite will be magnetically separated, concentrated, and pumped as slurry via a 100km buried pipeline to new facilities at the Albany Port. Filtration processes will be used to separate the magnetite from the water. Dewatered magnetite ore will be stored for export to Asia while the recovered water will be returned to the mine site for re-use. (Grange Resources 2012)

Water Security

The approved project requires approximately 12 GL/y of water to operate the mine beneficiation, slurry pipeline and port facilities. However, in recent years the Lower South Coast region has experienced shortages in water for public and private supply. Some towns in the region are experiencing potable water shortages, with existing water sources being fully used and, in some cases, temporarily overused. Projected economic and population growth is expected to further increase demand for water, particularly for urban water supply and potentially industrial projects (DoW 2010).

As Western Australians are faced with the effects of a continuously drying climate, planning to identify more sustainable water resources to meet future demands is becoming increasingly important. Traditional sources of water, such as surface water catchments or bore fields can no longer be fully relied upon to face the challenges of reducing rainfall and increasing population and economic growth. New and innovative ways of meeting demand therefore must be progressed. This has an impact not only on the water supplies for residential and commercial areas, but also local government, mining and agriculture. (Water Corporation 2012)

The Southdown Project is no different. Water is an essential element for processing of the magnetite ore. Given the uncertainty of projected rainfall and economic and population growth, identification of a reliable and independent water supply is critical to ensure the success of the project. Although not all options were carried forward, SDJV considered various water supply options including:

- Pit dewatering of groundwater inflow;
- On-site rainwater runoff;
- Brackish water desalination plant to treat local saline groundwater;
- Redmond King Aquifer;
- Treated effluent from Water Corporation’s Albany wastewater treatment plant; and
- A seawater desalination plant at Cape Riche.

Preliminary studies indicated that the use of water harvested from mine pit dewatering, site rainwater runoff and local saline groundwater was not viable if considered in isolation. The water volumes from these sources were too small and/or not available when required. The yield of the Redmond King, a good quality aquifer close to Albany, is also substantially less than the water requirements of the Southdown Project. Furthermore, there is a possibility that this aquifer could be reserved for public water supply thus constraining the supply to the mine. (Grange & Sojitz 2011) Thus, although it is intended to be used for construction water, the Redmond King aquifer will not form part of the long term plans for the project. The study team recognised that there were few traditional water supply options suitable for the project’s needs and recommended that the options of recycled water from Albany and seawater desalination at Cape Riche be assessed in further detail. MAGJV, a joint venture between Amec Minproc and GHD received the commission from SDJV to undertake this study.

Water Reuse

Historically, sewage has been viewed as a waste product. However, with the increasing pressure on freshwater supplies, industry now recognises that through recycling, it can be a valuable resource.

Water Corporation treats raw sewage from the domestic catchment of Albany using an Intermittently Decanted Extended Aeration (IDEA) plant. Secondary effluent is pumped to the Albany Treefarm where it is used to irrigate woodlots. SDJV received information that treated effluent from Albany, received en route to the Treefarm site, could be provided to the Southdown Project.

There is however inherent risk associated with the use of recycled water. *Australian Guidelines for Water Recycling* (AGWR) and associated Western Australian guidelines have been published to provide guidance on how water recycling can be safely and sustainably achieved. (AGWR 2006) Following the guidance of the AGWR, a preliminary exposure health risk assessment (HRA) was undertaken to establish the level of treatment required for the water recycling plant. This risk assessment was necessary to also manage negative perceptions commonly associated with reuse.

Once exposure estimates had been established through discussions and workshops, the design requirements for the plant could be determined. The total annual ingestion exposure was estimated to be around 600 mL per person. This was driven by the potential uses of the water for hose down and fire fighting and the risk of accidental cross connections with potable supplies. This result lead to the calculation of required log reductions of approximately 6.5, 5 and 5 $\log_{10}$ reduction for virus, protozoa and bacteria, respectively.

Although a moderate level of treatment (membrane filtrate and disinfection) was suitable to manage pathogen risks, additional treatment was required to minimise algae growth (odour/toxins) increasing the cost of the recycling plant. It was observed that the treatment levels could have been markedly reduced if a more selective approach was adopted when choosing recycled water end uses. As an example, avoiding the use of recycled water for hose down and fire fighting would have resulted in a lower exposure volume to recycled water and hence less stringent treatment requirements.

Assuming a satisfactory agreement could be reached, the team concluded that Albany treated effluent could provide up to 1.5 GL/y of the Southdown Project's needs. As this is considerably less than the demands of the project, a seawater desalination source would also be required. Although a second source of water was recognised to provide additional redundancy, using the Albany effluent was found to be uneconomical when compared to an equivalent increase in planned capacity for the seawater desalination source. It is possible that the recycled water source would have been more economical if it was able to supply a greater portion of the project needs.

Seawater Desalination

The single investment water supply option for the Southdown Project is a seawater desalination plant at Cape Riche approximately 20km south of the mineral deposit. Seawater will be pumped approximately 4.5km to a proposed plant located on farmland. The plant will have a capacity of 33 ML/d and will utilise reverse osmosis (RO) treatment to produce a treated water of approximately 600 ppm TDS. The treated water will then be pumped to storage facilities at the mine via a 27km pipeline.

Seawater desalination has an increasingly important role to play in providing secure water for the Australian population and economy. Like water reuse, it is a sustainable source of water, resilient to drought and climate change. However, relative to traditional sources, seawater desalination is costly. A key contributor to this high cost is the marine intake and outfall works. Construction costs for conventional intake and outfall structures can be up to 50% of the total plant construction cost.

Initially, the project team proposed to adopt a conventional submerged open intake with a micro-tunnelled seawater conduit. The outfall was proposed to consist of a traditional submerged diffuser with nozzles designed to achieve mixing within the natural environment. The intake and outfall were to be co-located in Cheyne Bay on the northern coast of Cape Riche. During community consultation, concerns were raised about this proposal due to the potential social and environmental impacts for the outfall. Concerns were also raised in relation to the relatively high cost and safety aspects associated with operation and maintenance of the infrastructure. Further concerns were raised in terms of environmental approvals as the area contains extensive sea grass beds, (Federally protected) Australian fur seals and penguin nesting areas all within close proximity to the proposed works.

Having become aware of a seawater desalination intake near Esperance associated with the BHP Billiton Ravensthorpe Nickel project, SDJV requested that a similar concept be considered for the Southdown Project. The proposed intake will consist of an open channel structure to allow seawater to flow via gravity from Cheyne Bay to the seawater pump station. Screening will be undertaken in the intake channel prior to water entering the seawater pumping station. The EPA has recommended to the Minister for Environment that approval be granted. Some points noted in the evaluation included:

Blasting is required for construction: A physical barrier (such as a rock wall) will be required to prevent blasting within open water to prevent impacts on seals (as nearby as 500m).

Entrainment of marine organisms: Additional study is required to identify the characteristics and timing of local coral spawning (located about 600m away) to demonstrate that the amount of coral spawn that is predicted to be entrained by the intake will be insignificant.

Visual impacts: Although the facility will be on private property, the facility may be visible to the public from a nearby camping ground and/or from fishing boats. The project team was requested to limit the height of the facility so as to keep it out of sight below a hill line.

In addition, the project team agreed to consider a brine outfall design comprising of discharge to the ocean via an engineered gutter and a natural fissure on the south side of Cape Riche (several kilometers from the environmental constraints within Cheyne Bay). The proposed system will receive seawater concentrate (brine) from the desalination plant and pump it to the discharge point via a 5.7km pipeline. The brine outfall will consist of a pipe finishing approximately 30 m (10 m above AHD) from the shoreline. From the end of the pipe, the brine will be directed along a channel excavated by accentuating the existing rock fault lines to the shoreline. The brine will mix with the ocean using natural (high energy) wave action.

A shoreline brine outfall is not commonly adopted on desalination projects since the required high energy ocean mixing conditions are not always present. This caused a perception that a shoreline outfall concept would not be acceptable. This perception needed to be managed in order to demonstrate that a favourable environmental outcome would be achieved. Development of a suitable hydrodynamic model for a fissure discharge into a high energy environment was an additional challenge for the project team since the majority of existing models are based on a submerged diffuser concept. Furthermore, access to the marine area to survey the benthic habitat was challenging as the site is extremely exposed and only safe to access for a few days a year. Notwithstanding these challenges, the regulator has recommended to the Minister that the proposal be approved.

Consideration of the above described intake and outfall concepts provided opportunities for the cost of construction of the project to be reduced. At the same time it provided a higher level of inherent safety during construction, maintenance and operation (due to the reduced need for access to the marine environment) and better environmental outcomes.

One of the efforts that assisted with progress of the environmental approvals process is early engagement with the regulators as well as regular and early consultation with the community. This not only allowed for smooth and timely completion of the evaluation activities but also allowed for a collaborative approach such that the concerns of each party could be taken into account.

Conclusion

Sustainable development is about improving well being without compromising the social, economic or environmental situation over the long term. The discussed aspects of the water supply options for the Southdown Project illustrate the great need to consider all aspects of a project rather than unduly focussing only on the impact on the bank account.

It is important that the world's resources are preserved. If innovation does not play a role, water utilities resort to traditional approaches such as surface and ground water sources. However, as our country experiences growth and the climate dries, more water is needed. This means that traditional sources struggle to meet demands and we must innovate to find others such as reuse or desalination.

Innovation is the lifeblood of successful organisations enabling them to work smarter rather than harder. On projects it enables one to look through another lens as a means of accelerating new and different opportunities for reducing cost or enhancing results. The Cape Riche desalination project is a strong example of this. It illustrates that non-traditional approaches can be effectively used to provide more sustainable water supply solutions.

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