CONSULTING ENGINEERS

A Model Solution

SRK models sustainable solutions for brine from tailings

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SRK Consulting's Cape Town office, together with its Vancouver office, has conducted preliminary groundwater modelling to assist a South American mining client in finding an environmentally sustainable solution for tailings-based brine management.

SRK principal hydrogeologist and specialist groundwater numerical modeller **Sheila Imrie** commented that the management of waste brines was a common challenge for mines; the client was investigating the options for disposing of sodium chloride (NaCl) brine over a 23-year mine life and potentially after closure.

"A number of brine management options were evaluated for the project to consider at prefeasibility stage," noted Imrie, adding that all of them had to take into account the relevant environmental regulations as well as the geological setting and conditions in the mining area.

These options included brine evaporation in surface ponds or in a brine concentrator, and discharging brine into surface water.

Surface evaporation was considered unfeasible, owing to the climatic water surplus of the region, while a brine concentrator would incur the excessive cost of a necessary lengthy high-voltage power transmission line. Moreover, the subsequent disposal of concentrated brine would still need to be managed.

Additionally, Imrie noted that, although discharging to surface water was practised in other jurisdictions, it was not favoured for this project, despite the high natural attenuation potential in the region's rivers.

"Brine injection into surface infiltration basins was also considered, but did not appear feasible owing to an increased potential for affecting shallow groundwater resources – and potentially surface water – in the vicinity of the infiltration ponds," she said.

Thus, the option deemed most practical was the injection of brine into a deep aquifer using injection wells.

The solids discharged from the horizontal belt filter are conveyed to the tailings management area (TMA) developed over the life of the mine and through the postclosure period.

Some of the tailings are sent underground and used as backfill in mined-out panel rooms, while the rest of the tailings are stored in two tailings facilities on surface and, upon settling of the solid material, the resultant brine needs to be removed and disposed of from the tailings dam.

Situated on plastic and clay composite liners, the tailings would consist largely of waste NaCl salt, with some impurities such as other salts, sand, silt and clay.

Rainfall would progressively dissolve the salt, leaving a small residue of insoluble material. Brine generated through this process and from the recycling of brine from the process plant would collect in lined settling ponds at the base of each TMA.

"The potential options for managing waste brines depend very much on having the right geology and hydrogeology," Imrie said.

She added that the project's particular aquifer conditions – where there were sufficiently low permeability near the surface and higher permeability with depth – allowed SRK to identify an aquifer about 400 m deep, which would be a potentially good injection site.

While quite unusual, these conditions presented a good opportunity for further study to ensure that vertical movement of the brine would be limited. This would allow the brine to attenuate horizontally over time without finding its way to groundwater receptors.

Imrie explained that a preliminary evaluation of brine injection feasibility – in line with the early-stage evaluation of the project as a whole – had been undertaken through a combination of numerical groundwater and geochemical modelling.

While the groundwater modelling evaluated the likely pressure increases and brine plume migration associated with injection, the geochemical modelling focused on the potential for chemical precipitation resulting from the interaction of oxygenated brine with anoxic brackish groundwater.

"I was appointed to assist with the prefeasibility numerical groundwater modelling scenarios to simulate the potential impact of multiple injection wellfield designs," said Imrie.

SRK developed a two-dimensional, axisymmetric radial groundwater flow model to evaluate pressure effects and plume migration, as well as model density-driven groundwater flow.

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"We evaluated numerous brine injection scenarios, and a range of sensitivity analyses was undertaken to help address inherent uncertainty in the knowledge of hydrogeological conditions."

The next stage of investigation would include follow-up drilling, installation of test wells, piezometric monitoring and hydraulic testing to confirm the injection horizon continuity and hydraulic characteristics.

The installation of deep, nested vibrating-wire piezometers to provide reliable piezometric head profiles would also be necessary, as would the optimisation of the injection field design – including monitoring points and programme details based on the outcomes of the investigations.

"This will allow the remodelling of expected pressure response and brine migration on the basis of the updated information," Imrie said.

She added that numerical groundwater models were essential tools for investigating the behaviour of aquifer systems in time and space. "By ensuring that each phase of model development is appropriately designed to meet current project objectives, we provide our clients with a cost-effective and defensible means to evaluate system responses and potential impacts of current and future groundwater-related management options under consideration."

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