Comments on passive approaches to treating Swansea Waste Rock Dump seeps

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Introduction

Zeehan Zinc needs to treat acidic leachate from the Swansea Waste Rock Dump at the Comstock Mine site. Once water management infrastructure has been constructed, and the processing of ore begins, the seeps will be incorporated into the overall water management plan for the site, and be neutralised by a combination of alkalinity in the tailings stream, and alkali addition.

Between the present and when the mine becomes operational, there is a need to contain and treat the leachate from the Swansea Waste Rock Dump such that untreated water does not enter the Comstock Creek, and sludges are not directed to the polishing pond. Once the tailings storage facility has been constructed, treated water will be directed to this impoundment, with the overflow reporting to the polishing pond and eventually Comstock Creek.

This paper outlines possible short term treatment options for the Swansea WRD seeps, and assumes the following:

- The duration of treatment will be of the order of 3 – 6 months;
- Treated water will be discharged to the Comstock Creek;
- The average water flow to be treated is 3 l/s (based on available flow measurement of 20/01/2006);
- The total annual acidity flux is ~300 tpa (based on 3 g/l acidity, and 3 l/s flow);
- All sludges generated during the treatment will eventually be disposed in the tailings storage facility;
- The average acidity of the water to be treated is 2,700 mg/l (based on average of samples collected between 15 Jan01 and 27 October 2005).

Potential treatment options

The leachate from Swansea waste rock dump contains very high levels of iron, aluminium, zinc and manganese. To remove all of these metals except manganese from solution, a pH in excess of ~7.5 is required. If manganese is also to be removed, then a higher pH (~10) is required, however at this pH, aluminium re-solubilises, so the process either needs to be completed in 2 stages, or the manganese needs to remain in solution. Because this is a short term treatment regime, it is considered that the best approach would be to leave manganese untreated, although this will need to be discussed with DPIWE.

During discussions with DPIWE, the concept of a Successive Alkalinity Producing System (SAPS) was proposed as a means of increasing the alkalinity and pH in the system and retaining the precipitates in 'tanks' until subsequent disposal in the tailings storage facility. Closer examination of the water quality of the Swansea seep indicates that the acidity load is too great for this approach. SAPS have been successful at generating alkalinity of about 300 mg/l, whereas this application requires almost 3,000 mg/l.

Reagent options

Given the very high acidity load and the necessity of consistently treating to pH 7.5 to remove the zinc in solution, the direct addition of a neutralising reagent will be required, with a retention cell or pond for settlement of the sludges. The potential neutralisation reagents include:

- Calcium carbonate (limestone): This reagent is inexpensive, but requires a fluidised bed reactor or large mixer and potentially multiple stages to achieve the required pH. Although there are no sulphate analyses available for the leachate, it is quite likely that the addition of a carbonate would result in the formation of gypsum, which in addition to the iron. aluminium, and zinc floc could lead to the clogging of pipes;
- Hydrated lime: This reagent is more expensive than limestone, but less is required to achieve the target pH value. The neutralisation of acid drainage with hydrated lime requires extensive physical mixing to efficiently release the alkalinity contained in the reagent. The addition of hydrated lime also results in the precipitation of gypsum. The installation of a hydrated lime dosing plant at the Swansea Dump now could potentially be used in the future treatment of historic adit water following commencement of processing, or remain as a secondary alkalinity addition point, as discussed in the conceptual water model;
- Sodium hydroxide: Sodium hydroxide is more expensive than hydrated lime, but mixes quickly with acid drainage which reduces infra-structure cost. The reagent can easily achieve the required pH of 7.5. The hydroxide based reagent does not produce gypsum, but does create gelatinous iron hydroxides which have a very low density, and are difficult to handle. Strong solutions of sodium hydroxide (50%) freeze at ~12ºC, but this can be avoided by using a 20% solution.

Sludge management options

The greatest challenge involved with treating the Swansea seeps is the management of metalliferous sludges generated through neutralisation. The final sludge volume will be a function of the end point pH, the neutralising reagent used, and the efficiency of the sludge removal system. For water treatment to be effective, the sludges must be physically retained and maintained at a pH of >7.0. Because no large scale settling pond is presently available on site, tanks will need to be used. Options include:

- Several large volume tanks. The treated leachate would enter the first tank after being gravity fed in a channel to promote mixing and aeration. To provide sufficient settling time (minium 6 hours), total tank capacity would need to be at least 65,000 l, assuming a constant flow rate of 3 l/s. If winter flows are higher, a greater volume will be required. Three or more 22,000 l tanks could be placed in series, with the overflow from one entering into the next via gravity feed. As sludges accumulated in the tanks, additional tanks would need to be added to ensure retention of sludges. Upon completion of the tailings storage facility and the production of tailings, the sludges could be bleed into the tailings stream. The disadvantage with this approach is that numerous tanks would be required over the 3-6 month period, depending on the volume and nature of the sludge produced. There is also the potential for pipe work to become clogged by the sludges;

- Large tanks filled with high surface area material. This approach is operationally similar to the previous one however the settling tanks are filled with high surface area material, such as hay or gravel. The surface area provides precipitation sites for the metal hydroxides, and metals are contained within the tank. Permeability of the substrate will decrease with time as precipitation occurs, and additional filter-tanks may need to be added to the system. Ideally, similar retention times of 6+ hours would be achieved which would require greater total tank volume as compared to the previous scenario to account for the volume occupied by the substrate. Once the mine is operational, the contents of the tanks will be emptied into the tailings storage facility. If an organic substrate is used, there is potential for iron hydroxides to not precipitate in the tank due to low oxygen conditions. If limestone gravel is used, some additional alkalinity may be imparted to the system if the pH falls below 7, but the coating of the limestone by precipitates would probably reduce the limestone contribution rapidly.
- Temporary pond. If there is a suitable low-lying area within the area to be developed into the tailings storage facility, it could be possible to create a temporary settling pond which would be submerged by / buried by the development of the tailings dam. The area would need to be clay lined and compacted, and have a sufficient retention time to settle solids. This option requires the least amount of infrastructure, but may require a longer establishment time until earth works can be completed.

Additional information required to proceed

Before a short-term neutralisation system can be developed, the following information is required:

- The flow rate of the leachate must be better quantified to allow calculation of appropriate retention tank / pond volume;
- The sulphate concentration of the leachate needs to be determined so the potential for gypsum formation can be assessed;
- The landscape around the Swansea Dump needs to be considered as to what area is available for the treatment facility;

- A suitable water course must be identified for discharge of the treated water which will not affect the construction of the polishing pond or tailings storage facility;
- The available infrastructure needs to be considered in deciding which neutralising reagent is to be used;
- The potential for future use of the alkalinity dispensing infra structure must be evaluated with respect to size and type of neutralisation system implemented;
- The Engineer who designed the tailings storage facility should be consulted about the potential for quickly establishing a suitable settling pond within the area to be incorporated in the tailings storage facility.

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