Water is key issue at Elko Roundtable 2007

Representatives from several mining operations in three western states left their mines behind for a day in February to discuss with their peers the issue of water.

The event was Knight Piésold and Co.'s Roundtable 2007, held in Elko, NV. It was third such event put on by the company. The issue this year was site-wide water considerations.

Attendees included more than 24 representatives from mining operations in Utah, Nevada and Arizona. Knight Piésold representatives included Bryan Ulrich and Rick Frechette, from the company's Elko office; Barbara Filas, Cynthia Parnow and Jim Kunkel, from Denver, CO; Harvey Dew, from Vancouver, British Columbia; and Kerry Lahti from Cajamarca, Peru.

The roundtable forum provides a much less inhibited format for discussion, compared with traditional conferences and symposia. Discussions are encouraged in the roundtable format.

This was the third annual Elko Roundtable. The first (Roundtable 2005) pertained to heap leach pad design, construction and operation. Roundtable 2006 centered on design, construction and operation of tailings storage facilities.

The 2007 topic, site-wide water considerations, was also deserving of a day's discussion, since water flow, water storage and water impacts are associated with many of the numerous mining facilities at any given site. One attendee said that environmental coordinators at the corporate levels are tasking their staffs with ensuring that future closure obligations are better quantified than they are today. Water considerations are brought especially to the forefront when the focus is upon mine (or facility) closure. Thus, this Roundtable was well-timed.

A geomembrane lined tailings facility.

Subtopics for Roundtable 2007:

- Back to basics: A review of concepts such as phase relationships, unsaturated zone hydrology and unsaturated soil mechanics, acid rock drainage, water monitoring, data collection and environmental management systems.
- Heap leach pads: Leaching, rinsing and draindown prediction.
- Tailings facilities: Tailings management and deposition planning.
- Ground water: Drawdown prediction, fate transport models, monitoring wells and pit lakes.
- Closure water handling systems: Evaporation, evapotranspiration, passive reactive barriers, conventional treatment and discharge to pit lakes.
- Water balances: Input parameters, design driven models versus operational models, site-wide water balances and closure issues for water balance models.

Since there is considerable overlap between these topics, the conversations frequently wandered from topic to topic and back again. The following is a synopsis of the content discussed during Roundtable 2007.

Following a well-received presentation on the basic considerations involved in site-wide water issues, the conversation turned toward environmental matters. It was stated, and generally agreed, that the industry's focus on acid rock drainage (ARD) is moving toward stopping its production, rather than treating it after its occurrence. This requires considerable efforts to be made in early characterization of the various rock sources associated with a mine and requires a forward-looking approach.

It was mentioned that risk modeling can be a useful tool when dealing with large amounts of data, or highly variable host rock, since complete characterization can be impractical. However, extra effort to gain additional characterization data early in a

Bryan Ulrich and Rick Frechette

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project can be a key to the success of heading off ARD issues before they manifest. One way to achieve this goal would be for mining companies to commit to do the characterization in conjunction with the exploration program. This would significantly increase the number of characterization test results available for use in modeling.

Also discussed was store-and-release reclamation covers for waste rock facilities. It was said that, in general terms, areas receiving more than 510 mm (20 in.) of annual precipitation with a ratio of potential evaporation to precipitation less than 2 might have a poor chance to eliminate or minimize meteoric infiltration. This is because the seasonal evaporation may not be able to keep up with the rainy season precipitation.

In such cases, geomembrane covers may possibly be the only effective cover to protect against ARD.

Wedge welding an HDPE geomembrane.

It was also noted that the best test available is actual experience and observation of existing reclaimed waste rock piles. One proactive procedure that can be used to avoid ARD is to add lime to waste rock material as the waste rock is placed. When liming waste rock, the goal seems to be to maintain the infiltrating precipitation in a basic pH, which should avoid acid production. Performance data for this methodology is not yet readily available.

The production of ARD is highly dependent on the mineralogy of the material, not just the presence or absence of sulfides. There may be very little sulfide needed to produce acid. The net neutralization potential (NNP) might have to be as high as 20 in some cases to ensure neutralization.

The need for improved predictive models was voiced by several participants. Improved tools would help corporate decision makers to make better educated decisions early in the life of an operation. One example of a poor (but serendipitously favorable) prediction was for a closed heap leach facility in Nevada that should have produced ARD, but failed to do so even 20 years after closure, despite good modeling efforts.

The topic of closure water handling systems sparked keen interest, as several operators are closing facilities that produce draindown fluids. There are several options currently being used and assessed to handle draindown fluids. They include evaporation cells (E cells), evapotranspiration cells (ET cells) and passive treatment, such as passive reactive barriers (PRBs), as well as active treatment methods such as reverse osmosis (RO). It was generally agreed that open bodies of water for evaporation are not permittable as a long-term solution.

Both ET cells and E cells have been used successfully for handling low-flow draindown solution emanating from heap leach facilities. One example of a tailings facility closure was cited that successfully employed an E cell for draindown solution. Participants voiced a general consensus favoring E cells over ET cells to avoid ongoing maintenance obligations and to mitigate ecological risk. However, E cells may require larger acreage due to their possibly lower evaporation rates than ET cells. Permitting can also be simpler with E cells, given the sometimes

The effects of freezing in a culvert.

Natural water course in a mining area.

poor sustainability issues associated with ET cells.

Pit lake discharge as a long-term solution for draindown management was raised as a viable, sustainable alternative. One participant mentioned a study he is involved with that would discharge 15 to 19 L/min (4 to 5 gpm) into a 454-GL (120-billion gal) pit lake. Impacts at such a dilution rate would be expected to be minimal. Larger flow rates may not be so desirable. But, in this specific example of a very large pit lake, a considerably larger discharge rate may still have no net adverse impact to the pit lake water chemistry. The impact on a small, juvenile pit lake could, however, be significant. So the timing of such a discharge would have to be assessed.

At the other end of the spectrum, some operators have voluntarily backfilled pits to avoid issues associated with pit lake chemistry.

Very low flows, perhaps in the neighborhood of 151 L/min (40 gpm) (ideally 38 L/min or 10 gpm or less), were said to be handled well with passive systems. However, RO is still frequently used at active mines, sometimes requiring around the clock staffing.

Pit lake evaporation

Ground water topics, especially closure modeling, made for lively conversation. Pit lake evaporation was discussed. The difficulty of accurately estimating pit lake evaporation can be complicated by factors such as the depth of the pit lake, the shadowing effect on wind, and radiation and geothermal conditions of the ground. This can be important in modeling.

The current trend is moving toward taking a more conservative approach in estimating evaporation. If evaporation still exceeds inflows, the lake is a hydraulic sink and ground water contamination would not be anticipated. One operator indicated that his operation has been able to accurately model the historic declining and rising water levels that they have been observing with variable pit dewatering rates. This should be useful in establishing their pit lake rebound model, especially since regulators typically examine the calibration of the model to ensure that it accurately portrays the field conditions.

The effects of geology/structural geology on hydrogeology can be significant and complex, and defining the boundaries can be one of the most important factors. The consensus was that ground water model programs are reasonably reliable and a number of useful programs are available. The positive benefits of making periodic updates to the ground water model to make a more robust solution were discussed.

Heap leaching

When the discussion turned toward heap leaching, a majority of the conversation revolved around draindown modeling. Lots of data, it was said, makes for a more robust model. Many modelers use history matching to calibrate their models. History matching is a calibration technique that modelers use to assess whether their models can accurately calculate historical performance where operational data is already in hand. History matching is now almost considered a requirement in order to build a reliable model. Attendees generally agreed, though, that it could be difficult to make two different models produce the same result.

Aging effects on materials in a heap leach facility (and likewise a waste rock facility) can have a significant impact on their ARD and unsaturated behavior. Aging effects important to such modeling include mineralogical changes and hydraulic conductivity changes. Although early testing is still important, the effects of material aging in a heap or dump should not be overlooked. The time-consuming procedure to produce weathered rock for laboratory testing early in a project was discussed.

Tailings in a tailings storage facility often exist in a saturated state. So accurate modeling can be easier compared with heap leach and waste rock facilities. Since the materials in heap leach and waste rock facilities are generally unsaturated, models can be sensitive to minor changes in moisture that can produce dramatic changes in unsaturated hydraulic conductivity, depending on the shape of the soil moisture characteristic curve for the materials involved.

Also discussed was the application of heap rinsing prior to closure. Many viewed this process as largely turning clean water into contaminated water. Or they were skeptical of the true effectiveness of rinsing due to the occurrence of flow within preferential flow paths. Some attendees indicated that rinsing may and may not work for their site. Given the right circumstances, rinsing can be effective, thus it was stated that technologies should not be dismissed prematurely.

Tailings storage

Discussions pertaining to tailings storage facilities revolved primarily around tailings management. Discussed were the benefits of depositing tailings using a thin-layer, managed deposition method, also known as the

sub-aerial method. If properly designed and operated, this method can result in a relatively stable tailings mass at closure that is amenable to reclamation.

It is not uncommon for some operations to increase their tailings production rates after the tailings facility is designed and constructed. This can lead to an increased tailings accumulation rate that can negatively affect the deposit. Designers and operators should consider such possibilities early in the design process in order to develop a facility that allows some flexibility in mill throughput. Such a design may require more land area, but should also require lower perimeter dams to contain the tailings. Management of moisture content and achieved density relate directly to allowable flexibility in the reclamation and closure approach.

Tailings deposition.

The use of cyclones for gold tailings deposition is gaining some interest in the U.S. Typical use of cyclones creates a broad outer zone of coarser material, which forms the containment structure, and the finer fraction is spigotted behind the dam. The coarse/fine separation between the sand fraction and contained fines provides a natural pathway along which seepage water travels. An interceptor drain is typically built at the base of the facility at the coarse/fine interface to intercept this seepage and convey it to a holding pond. A cycloned tailings dam is particularly at risk to increases in the position of the phreatic surface. Precautions to guard against and/or monitor such occurrences are usually practiced.

Water balance calculations

The roundtable culminated in conversation pertaining to water balance calculations, especially site-wide water balance calculations. There are various forms of water balances. They range from simple, static water budget estimates to elegant, comprehensive, site-wide water balances. Each type of water balance has its appropriate applications.

The International Cyanide Management Code, formed under the guidance of the United Nations Environmental Program, requires that signatories of the code develop and maintain a water balance program that protects against unintentional cyanide releases. According to the Code (Standard of Practice 4.3, Item 1), the water balance must furthermore be comprehensive and probabilistic, taking into account the uncertainty and variability inherent in the prediction of climatic patterns.

As part of the roundtable, discussion was presented regarding the program Goldsim. Goldsim is used by a number of mining companies to establish various types of water balances. Several participants indicated that their companies have used or are using Goldsim.

In addition to discussing Goldsim, a demonstration was given of Knight Piésold's proprietary, Internet-based probabilistic water balance called "Knight Piésold WaterMindersm." The demonstration was well-received by the audience. This program has been developed during the past decade specifically for mining clients. It has been employed for clients in North and South America. Its success, especially as a platform for site-wide water balance calculations, was highlighted. As an Internet-based application, the program can be accessed anywhere in the world. This allows users to assess various scenarios and periodically input climatological and operating data. In addition, the author of the program can likewise periodically access the program to make updates and modifications as conditions warrant, to maintain the program as a reliable and useful predictive tool.

Following this presentation, attendees recognized the necessity of using high-quality data for input for water balances and also the difficulty in obtaining high-quality, long-term climotological data in remote areas. It was therefore recognized that operators should establish meterological stations as early as possible to begin collecting data for a water balance. Some regions of the world have particularly high intensity, short duration precipitation events that may necessitate the examination of the effects of hourly precipitation (or even 15 minute intervals) on a water balance.

The need to periodically update the water balance model was voiced by several attendees. In particular, the nature, size, location and operation of the various facilities over time can have an impact on the actual water balance at a mine. These changes should be reflected by the water balance model. For example, waste rock material actually produced at a mine may vary significantly from the assumptions employed in the model. Such a deviation could cause the model to produce misleading and perhaps erroneous results.

By the end of the afternoon, an impressive amount of information had been shared. It was agreed that the time was spent productively. By all accounts, Roundtable 2007 was successful for all the participants. Next year, Knight Piésold will again be hosting a Roundtable discussion in Elko. The planned topic of next year's discussion will be "Closure Considerations." ■