INFORMATION REQUEST RESPONSE

EA No: 0809-001 **Information Request No: Review Board #05**

Date Received:

February 14, 2011

Linkage to Other IRs

Review Board IR #7

Date of this Response:

May 31, 2011

Request

Preamble:
Any impacts of a controlled thaw, should it be required in the future, would potentially result from the proposed freezing. It may be necessary or desirable to thaw the frozen block at some point in the future, for example due to emergence of new remediation technologies or the development of different uses for arsenic trioxide. Item 2 of the Dec. 13th 2010 deficiency response generally suggests some of the existing risks, but does not examine these in sufficient detail. The response suggests that impacts of a controlled thaw would be the subject of a future environmental assessment. However, the risks of controlled thaw arise because of the proposed freezing, and must be assessed before it is frozen.

Because of the perpetuity conditions stated in the DAR, the possibility and potential consequences need to be assessed, particularly with regards to the thermal, mechanical, and hydraulic characteristics of the thawed arsenic trioxide and the stability of bulkheads and crown pillars.

Question:
1. Please provide a detailed description of the preferred methods for a controlled thaw of the frozen block should the need arise.
2. Please describe the risks of a controlled thaw, examining the probabilities and severity of associated impacts. This should include an assessment of risks of potential failure of crown pillars and bulkheads, and settlements associated with thaw consolidation, among others.
3. Please describe the potential opportunity costs of saturating the dust and filling in voids below crown pillars, in terms of limiting future options for arsenic removal (e.g., pneumatically, mechanically).

Reference to DAR (relevant DAR Sections):

S. 6.2.8.2 Thawing and Climate Change
S. 6.2 Arsenic Trioxide Dust Storage Areas

Reference to the EA Terms of Reference

S.3.3.1 Arsenic Containment – Detailed Description of Frozen Block

Summary

An example implementation of a controlled thawing program is presented and assessed. Assumptions about the context and conditions of the controlled thaw are based on extraction alternatives considered in the 2002 "Giant Mine Arsenic Trioxide Management Alternatives Final Report".

Before any controlled thawing would be initiated, the risks associated with each step in the thawing process would be thoroughly examined. Consideration of the example based on Alternative G1 from the 2002 report indicates that the thawing program would in fact offer opportunities to reduce risks versus extraction of unfrozen dust.

Previous studies have concluded that the dust would need to be wetted during extraction. So wetting the dust in the freezing program adds no cost to a future extraction. Backfilling the voids above the dust could add cost to a future extraction, unless the backfill is designed to withstand the future mining.

Response 1

Selection of a preferred method for controlled thawing would depend largely on the intended dust treatment, which would determine the rate, and conditions at which dust needs to be supplied, and therefore the required rate of thawing. Another consideration would be the duration of time since the initial freezing, which would determine the level of difficulty associated with accessing the underground drifts and re-using the underground part of the freezing system. These examples illustrate why, in order to address the information request, we need to make assumptions about the context and conditions of the controlled thaw.

Assumed Context and Conditions for the Controlled Thaw

For the purposes of responding to this Information Request, it is assumed that the future thawing of the dust would be undertaken in order to extract it from the stopes and chambers for some form of re-processing.

The most thorough review of options for managing the arsenic trioxide dust was the "Giant Mine Arsenic Trioxide Management Alternatives Final Report" prepared by the Technical Advisor in 2002. That report considered several options that would involve taking the dust out of the chambers and stopes. After reviewing all available mining methods, a three-step dust extraction process was selected:

- The upper roughly 90% of the dust in each stope or chamber would be extracted by borehole mining. A borehole mining machine would be lowered into the dust from surface through a large borehole. These machines have a high pressure water jet that would be used to cut into the surrounding dust and create a water-dust slurry. The slurry would then flow back towards the machine, where it would be collected and pumped to surface.

- The complex geometry of drifts, cross-cuts and ore passes at the base of many of the chambers and stopes would make borehole mining impossible, and it was concluded that conventional mining methods would be needed to recover the last 5-10% of the dust. To minimize safety risks, the void created by the borehole mining would first be backfilled. Areas containing residual dust would then be accessed by remotely operated machines travelling via the original mine workings.

- Even at the time of writing the 2002 report, it was recognized that the stability of the lower areas of some of the stopes and chambers would not be sufficient to allow access. The extraction plan therefore included a third step whereby some of the stope and chamber bottoms would be completely "re-stoped". In other words, the surrounding rock, the access tunnels and any contained arsenic dust would all be removed. The mixed material would then need to be washed to separate the arsenic trioxide, which would again be recovered as a water-dust slurry.

Based on the analysis from the 2002 report, it is estimated that a five-year period would be required to complete the extraction effort. This can be further broken down into three years to construct the "reprocessing facility" (as defined by the emergent technology) and prepare the chamber and stope areas for dust extraction, and two years to extract the dust.

The 2002 study also concluded that, once the dust extraction was completed, a period of intensive minewater collection and treatment would be needed to recover any arsenic trioxide that was left behind or that escaped the immediate areas during borehole mining. It was estimated that ten years of active pumping and treatment of high-arsenic water would be required.

Thereafter, the alternative would look very much like the frozen block option. To prevent arsenic release from the rest of the mine, water treatment would continue at the same rate as in the frozen block alternative. The site would continue to be managed in perpetuity.

Controlled Thaw for Dust Extraction

In the context of the extraction method described above, a thawing program could involve the following steps. In general, the approach would be to preserve the frozen shell as long as possible, in order to prevent escape of water during the borehole mining.

During the three-year preparation period, access to the underground workings would be re-established and the underground freeze pipes inspected and if necessary replaced. A small active freezing plant would be procured and the necessary piping, power and control systems re-established.

Immediately prior to initiation of the borehole mining in each stope or chamber, the small-scale freeze plant would be connected to the area's underground freeze system and turned on.

Dust extraction would be initiated by drilling a large borehole into the top of the frozen dust. The borehole mining machine would be installed and the water jet initiated. Tests of borehole mining machines have shown that their water jets are capable of cutting through rock with strengths of 20-50 MPa, which is more than ten times the strength of most frozen soils. The machine should be easily capable of cutting through the frozen dust.

The cutting action would initially produce splinters or chunks of frozen dust. The water-dust-ice slurry would flow to the extraction ports on the mining machine and be pumped to surface. The temperature of the water used for the jetting would need to be controlled to ensure that the mixture did not freeze in the borehole machine or any of the surface pipes. Controlling the inlet temperature could also allow control of the thawing process. An optimal level of heating would need to be defined, but the thawing would probably begin in the stope or chamber and only reach completion once the slurry is on surface. It is worth noting that borehole mining machines can also jet air or steam, if for some reason more thawing was desired.

Once the top layer of dust, say 5-10 meters in thickness, was extracted, the machine would be lowered and the next cut initiated. This process would continue until the bulk of the dust was removed.

During the entire borehole mining process, the freeze plant would be used to cool the rock below the chamber or stope, and the perimeter thermosyphons would continue to cool the chamber or stope walls. In this manner, the initial frozen shell would be preserved and escape of any of the dust slurry would be prevented. There are many permutations of that approach. For example, it might be necessary to initiate active freezing in the thermosyphons or, conversely, monitoring might show that the rock is sufficiently cold that no active freezing is required even below the chamber or stope. (Here again, uncertainties about the actual conditions prevent us from defining the method details.)

At the end of borehole mining in a chamber or stope, the bulk of dust would have been removed and a basal layer of frozen material would remain. That layer would provide an ideal base for backfilling the void left by dust extraction. To facilitate subsequent mining of the remaining dust, some form of cemented backfill would be required.

Once the cemented backfill is in place, removal of the remaining dust could commence. For stopes and chambers that were shown to be stable enough to allow access through the original drifts, remote mining methods could be used. It would be necessary to remove the drift plugs constructed as part of the initial freezing. The mining equipment would then proceed along the drift, removing any arsenic dust that is encountered. Two options would need to be examined. One would require the entire area to be thawed prior to mining. That could be accomplished by disconnecting the active freezing plant and switching to a heating system that would pump hot water through the underground pipes. But a second option would be to keep the surrounding rock frozen and only thaw material immediately ahead the extraction. The thawing could be accomplished by installing small heating tubes into the mine face. For example, after each day's mining, the crew would use a jackleg drill to push several pipes into the frozen face, and then connect them to a hot water circulation system that would thaw the material overnight, making it ready for the next day's mining. (Again the details would vary depending on circumstances.)

For stopes and chambers where the rock was not stable enough to allow access, the re-stoping method would be used. In those cases, thawing might be unnecessary as the dust and surrounding rock could all be mined while frozen. In fact, there might be advantages to keeping the dust frozen. For example, it would reduce the risk of dust release when the surrounding rock was blasted. In that case, the thawing would take place on surface when the mined material was washed to remove the arsenic trioxide.

As discussed above, the next step in the dust extraction alternatives would be ten years of intensive water collection and treatment to recover any residual or escaped dust. Maintaining the frozen shell during the dust extraction process would allow complete control of the water-dust slurry, and minimize the escape of any dust into the surrounding rock. That might significantly reduce the time and costs associated with the intensive water collection and treatment. It might be possible to maintain the frozen shells during the intensive water collection and treatment. The pattern of water circulation around each chamber and stope would be much easier to control, perhaps resulting in a further shortening of the treatment period.

Response 2

Before any controlled thawing would be initiated, several phases of investigation, assessment and design would be required. That work would be similar in complexity to the ten years of study that have gone into the currently proposed freezing program, and the risks associated with each step in the thawing process would be thoroughly examined.

To continue with the example developed above, the general risks associated with the dust extraction alternatives were assessed in the 2002 report, which concluded that the proposed dust extraction method was entirely feasible, but that there would be elevated worker safety risks during the last two steps. The discussions above show that, although the thawing process would add to the complexity of the dust extraction process, it would also add opportunities to better control many of the steps. Worker exposure to arsenic dust, for example, would be significantly reduced if the dust were kept frozen during blasting and/or only extracted as a recently thawed slurry.

Other changes in the extraction risks would be traceable to the initial freezing. The freezing process could cause or enhance fracturing of the rock mass around the chambers and stopes, making it more likely to fail during dust extraction. Three failure modes can be envisaged, but all have reasonable mitigation options:

- Collapse within an access drifts. As noted above, there would be at least a three-year preparation period prior to the start of dust extraction. That would allow sufficient time for any underground access to be re-established and appropriately supported.

- Failure of a crown pillar during borehole mining. At least two options exist to mitigate that risk. The first would be to backfill each cut level immediately after mining. The second would be to cut from the bottom up, maintaining a zone of frozen dust between the extraction level and the crown pillar.

- Failure of a sill pillar during the remote mining. As noted in the 2002 report, this risk is already present and is the reason why re-stoping, which would be designed to take out all of the at-risk material, is included as an option. So the only consequence of freezing-induced weakness would be to increase the preference for re-stoping over remote mining. Again the three-year preparation period would allow the re-stoping geometry and methods to be defined. And backfilling of the void left by borehole mining dust extraction would provide a stable "roof" for the re-stoping.

We conclude that the thawing program, when put into the context of the dust extraction program defined in prior alternatives analysis, does not add any unmitigable risks. The ability to control the rate of thawing appears to allow some of the dust extraction risks to be mitigated, leading to an overall decrease in the risks that would be associated with any future re-processing of the arsenic dust.

Response 3

Wetting of the dust would not lead to additional costs in dust extraction.

- In all of the dust extraction methods analyzed in 2002, worker health and safety risk associated with exposure to arsenic dust was a significant concern. Prior wetting of the dust will help to reduce that risk.
- Mechanical removal of the dust could be accomplished by many methods. As noted above, a thorough review of dust extraction options in 2002 led to a conclusion that wet mining methods are preferred. Prior wetting of the dust would only simplify those methods.
- Pneumatic removal was ruled out of consideration early in the 2002 assessment of mining methods. It is only practical on dry materials, and portions of the arsenic dust are thought to be saturated already and other portions have become moist during the dust's many years in the humid underground environment.

The dust extraction plans developed in 2002 included backfilling of the void left by borehole mining of dust from the stopes and chambers. Backfilling of the upper voids prior to freezing could be beneficial to extraction if the fill is capable of withstanding the jet boring. If not, the fill would be mobilized along with the dust and mixed into the water-dust slurry.

If the dust was being removed for cement stabilization, the consequence would be an increase in the volume of material that would need to be cement stabilized. The unit cost of cement stabilization cost was estimated in 2002 at slightly less than $300 per tonne. Assuming 50,000 tonnes of backfill, the added cost would be $15,000,000. Other methods to treat the dust, for example, autoclaving, might require that the backfill be separated from the dust which could entail higher costs.