534 Delaware Ave, Suite 302
Buffalo, NY 14202
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Joseph M. Dlugolenski
NYSDEC Region 7 Cortland Sub-Office
1285 Fisher Ave
Cortland, NY 13045
DEP.R7@dec.ny.gov

Re: DEC Application ID#0-9999-00075/00001 (Cargill Mine Shaft #4)

Dear Mr. Dlugolenski:

In these comments I indicate that the Negative Declaration for the Cargill Mine Shaft #4 should be rescinded in accordance with 6 NYCRR 617.7(f), and that Mine Shaft #4 should be subject to an environmental impact statement (EIS), because of the associated long-term brine impacts on local groundwater and/or surface water.

As I understand from Cargill's August 30, 2016 Application to the Tompkins County Industrial Development Agency/Tompkins County Development Corporation, the Cargill Mine Shaft #4 *is not a stand-alone project but will enable Cargill's Cayuga salt mine to expand northward in a manner that would not be possible or feasible without the new Shaft #4*. (See particularly Cargill's statements that "Due to the age of the mine, the underground mine workings are currently over 7 miles from the elevator shafts. Because of the distance, providing fresh ventilation air and safe access to surface in the event of an emergency is becoming increasingly more difficult. A new ventilation and access shaft *is required to safely and productively mine the northern reserves*...." and "The new shaft project is *required to ensure long term operations at the Cayuga Mine*...." Quoted from page 4 of Cargill's August 30, 2016 Application, emphasis added.) In other words, the new shaft and additional mining appear to be inextricably linked. Under SEQRA, impacts of the new shaft and additional mining would thus need to be reviewed together in order to avoid impermissible segmentation.

The brine impacts that need to be addressed are from past mining activities as well as additional future mining. Since the impacts from past mining cannot be entirely avoided but would continually increase as additional mining is done, an EIS should identify, document, and seek to mitigate the mine's long-term brine impacts on local groundwater and/or surface water.

The mine's long-term brine impacts, as described below in more detail, will be caused by mine flooding (either accidental flooding or deliberate flooding after the mine is abandoned or taken out of service). Such flooding will dissolve unmined salt within the mine, thereby filling the mine with saturated brine, most of which will eventually and inexorably be squeezed out of the mine. Impacts of this expelled brine need to be addressed under SEQRA.

To the best of my knowledge, this is new information that has not previously been raised in the context of this proposed project.

Discussion

According to Bérest et al. (2004), page 8, "…salt-mine abandonment must be planned thoroughly… The long-term stability of the mine must be discussed – a problem common to all mines, even if it must be kept in mind that, in the case of salt mines, a slow mine closure cannot be avoided." Such closure or convergence, resulting from gradual creep or plastic deformation of the salt pillars in a room-and-pillar mine, is universally recognized as the long-term fate of a room-and-pillar salt mine. There is also widespread recognition that the rate of closure can be slowed but not stopped by flooding the abandoned rooms of a salt mine. As described by Bérest et al. (2004), page 12, "…It is the gap between lithostatic pressure and mine pressure that is the driving force for the convergence rate (as well as for the subsidence rate), and this gap is divided by 2 after flooding takes place…. A significantly slower convergence rate can be expected after mine and shaft flooding has been completed."

Closure or convergence is typically a very slow process of ductile deformation. Bérest et al. (2004), page 2, citing Van Sambeek, say the process will take "centuries or dozens of centuries." For Cargill's Cayuga mine, the likely duration of the closure or convergence process will be centuries rather than dozens of centuries. This estimate is based partly on the ongoing closure or convergence of Akzo's flooded Retsof mine, for which Yager (2013), page 10, refers to an expected duration of "hundreds of years, until the mine cavity closes completely." Given the reasonably similar stratigraphic settings of the Cayuga and Retsof mines, and assuming that the Cayuga mine will eventually be flooded either intentionally or inadvertently, the likely duration of the Cayuga mine's eventual closure or convergence process will be centuries. The process could be somewhat faster if the Cayuga mine remains dry (i.e., is not flooded), or could be somewhat slower if the mine is flooded and if the available pathways for outward flow are less conductive than the pathways through which brine is currently flowing out of the Retsof mine. In any case, the best order-of-magnitude estimate of the Cayuga mine's eventual closure or convergence duration is *centuries*.

Bérest et al. (2004), page 2, assert that a salt-mine closure or convergence process that takes centuries or dozens of centuries is so long "that it has no practical consequences for human activities." This claim of "no practical consequences" may be accepted in some contexts but does not pass muster as a statement of "no significant adverse impact" for purposes of environmental review. Under SEQRA, for example, this claim of "no practical consequences" does not satisfy the "hard look" criterion. The impacts that need to be addressed are not just surface subsidence and other issues resulting from the closure or convergence per se. Another impact – perhaps the most important impact – involves the brine that's being squeezed out as the mine closes.

Salt mines in New York and other locations with similar climates will tend to flood eventually, even if not flooded intentionally. *Flooding, whether intentional or inadvertent, is pretty much "game over" for successful containment or control of the salinity associated with the brine that will inevitably be squeezed out of the mine*. There may be one or more identifiable aquifers into which the brine would predictably be squeezed, in which case the volume available to accept/contain the squeezed-out brine needs to be calculated and documented as part of the environmental review. The volume of brine that will ultimately be expelled from the Cayuga mine in this manner is large – it will be roughly similar to the volume being squeezed out of the Retsof mine, which Yager (2013) indicates may be as much as 13 billion gallons. In assessing the volume, fate, and impacts of such brine, it is important to recognize the large uncertainty about whether the volume of squeezed-out brine will become substantially larger due to mixing and dilution with other groundwater. Mixing and dilution do not resolve the salinity impacts because the brine being squeezed out of the mine tends to be at or near saturation (~26.5% NaCl), roughly an order of magnitude more saline than seawater and several orders of magnitude above thresholds for potability and groundwater pollution. The salinity of diluted brine would thus remain unacceptably high at the same time as its volume grew.

Summary

The fate and impacts of brine displaced from the mine need to be reviewed and addressed in an EIS. In general, for any closed salt mine, there will likely be no successful containment or control of the salinity associated with the brine that is squeezed out of the mine. The impacts will be faster if there's a collapse-induced pathway, or slower otherwise, but in any case the environmental review should use accepted methods of groundwater and contaminant-transport modeling to determine where the salt will go. Can the salinity expelled from the mine be entirely accommodated by one or more adjacent aquifers? What impacts will it have on those aquifers and their use? Will the brine and its salinity overflow such aquifers and move into surface water bodies such as an overlying lake (in this case, Cayuga Lake)?

In the worst case for the Cayuga mine, there would be a relatively open upward pathway due to a collapse, as occurred at the Retsof mine. But even without a collapse, it's likely that the Cayuga mine – like any other salt mine in the northeastern U.S. and adjacent Canada – will eventually flood, if not already intentionally flooded. And even without a collapse it's doubtful that a flooded Cayuga mine could ever be sealed tightly and permanently (such that no net room closure would occur, such that no brine would be squeezed out, and such that the brine would remain sealed in the mine at lithostatic pressure). The brine will tend to find outward pathways from the mine and will flow through these pathways at less-than-lithostatic pressure, resulting in impacts of the type outlined above. See generally Bérest et al. (2004) for the likelihood of mine flooding, and see Yager (2013), especially page 10, for the typical consequence of brine being squeezed back out of the mine as it gradually closes. SEQRA requires that such impacts be addressed for the Cayuga mine.

Thank you for the opportunity to submit comments on this matter.

Sincerely,

Raymond C. Vaughan, Ph.D.
Geologist/Environmental Scientist

References cited

P. Bérest, B. Brouard, and B. Feuga, *Dry Mine Abandonment*, Solution Mining Research Institute (SMRI) Technical Conference Paper, Wichita, KS, Spring 2004 (http://www.brouard-consulting.com/sites/default/files/smri-wichita.pdf)

R.M. Yager, *Environmental Consequences of the Retsof Salt Mine Roof Collapse*, USGS Open-File Report 2013-1174 (http://pubs.usgs.gov/of/2013/1174/)