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Memorandum

To: John V Dennis, PhD

Cayuga Lake Environmental Action Now (CLEAN)

From: Andrew Michalski, PhD, CGWP, PG, LSRP

Date: 5/24/2017

Re: **Supplemental Hydrogeology Comments on Proposed Shaft #4**

In my earlier comment-letter to the NYSDEC dated January 31, 2017, I was puzzled by a very low potentiometric water level of a major inflow to CH-18 wellbore that occurred at the Onondaga/Oriskany contact at a depth of 1490 ft. The initial/static water level in the inflow was reported at a depth of 502 ft (elevation of 282 ft msl), which was approximately 100 ft below the Cayuga Lake level. As the Lake provides an ultimate natural regional groundwater discharge level, this 100 ft difference can only be explained by groundwater leakage into the Cayuga Mine, the only known sink lower than the Lake.

My subsequent review of the Cargill's Annual Reports indicates that it was the inflow to two existing Cayuga Mine shafts (#1 and #2) that likely created this 100 ft of drawdown at the CH-18 location approximately 20,000 ft from the shafts. A combined inflow to these shafts of 40 gpm was reported in the Annual Report submitted in November 2014. The report states that "The shaft water inflows have been increasing over the past 10 years and have become a concern." This statement is inconsistent with inflow records provided in Annual Reports for the 2008-2013 timeframe that showed the same combined inflows to the two shafts of 30 gpm for each of the five years.

Such a large (>20,000 ft) radius of drawdown influence created by inflows to the shafts is typical of thin, laterally extensive planar features like an enlarged bedding fracture or a regional unconformity at the Onondaga/Oriskany contact that hosts an aquifer. A very low storativity (S) of this aquifer combined with its decent transmissivity (T) results in a high diffusivity value (T/S). This in turn produces a fast and distant propagation of drawdown effects. Thus, the very low potentiometric level measured in the Onondaga/Oriskany inflow at CH-18 attests to the likely presence of large drawdowns, both in terms of their magnitude and lateral extent, due to operation of the shafts.

May 24, 2017

The planned construction of Shaft #4 will increase the amount and lateral extent of the existing drawdown. The large drawdown in the Onondaga/Oriskany aquifer likely propagates upward into the overlying bedrock through leakage along the joints. Cargill is yet to recognize the potentially extensive changes of bedrock groundwater flow regime due to existing and future mine inflows and their impacts on water levels and yields of existing bedrock wells and bedrock springs in the area. There is no monitoring program to measure mining induced drawdowns within the large potentially impacted area.

The groundwater inflows into the shafts are undersaturated with salt, indicating that meteoric water constitutes a significant percentage of in the inflows. Disposal of this water to the Level 4 mine working in the old mine portion has caused dissolution and undercutting of the pillars near the injecting points. RESPEC expressed a concern that this practice can possibly result in mine collapse, which would have a significant effect on Cayuga Lake's shoreline and the mine shafts (John TBoyd's letter dated March 18, 2015, p. 12). Water from Shaft #4 would be disposed of into the new mine portion beneath the Lake. The disposal can undercut the pillars there, and an increased humidity will increase closure rates.

Reportedly, hydraulic fracturing conducted in 1962 in International Salt Corporation wells at Myers created a hydraulic connection between the brine wells/cavities and Shaft #1, causing a brine leak into the shaft. The connection was confirmed by a dye tracing. One can reason that this hydraulic connection occurred within the upper salt beds or along the salt/Camillus contact. If so, the continued inflow of brine and hydraulic connection of the shaft to the former solution cavity would lower the water level in the cavity. The lowering of water level (pressure) inside the cavity increases the effective stress on the cavity walls, stimulating instability of the cavern and its surroundings.