

Open Issues & Bounding Factors for Mining-Induced Salinization of Cayuga Lake

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Bedrock above a mine

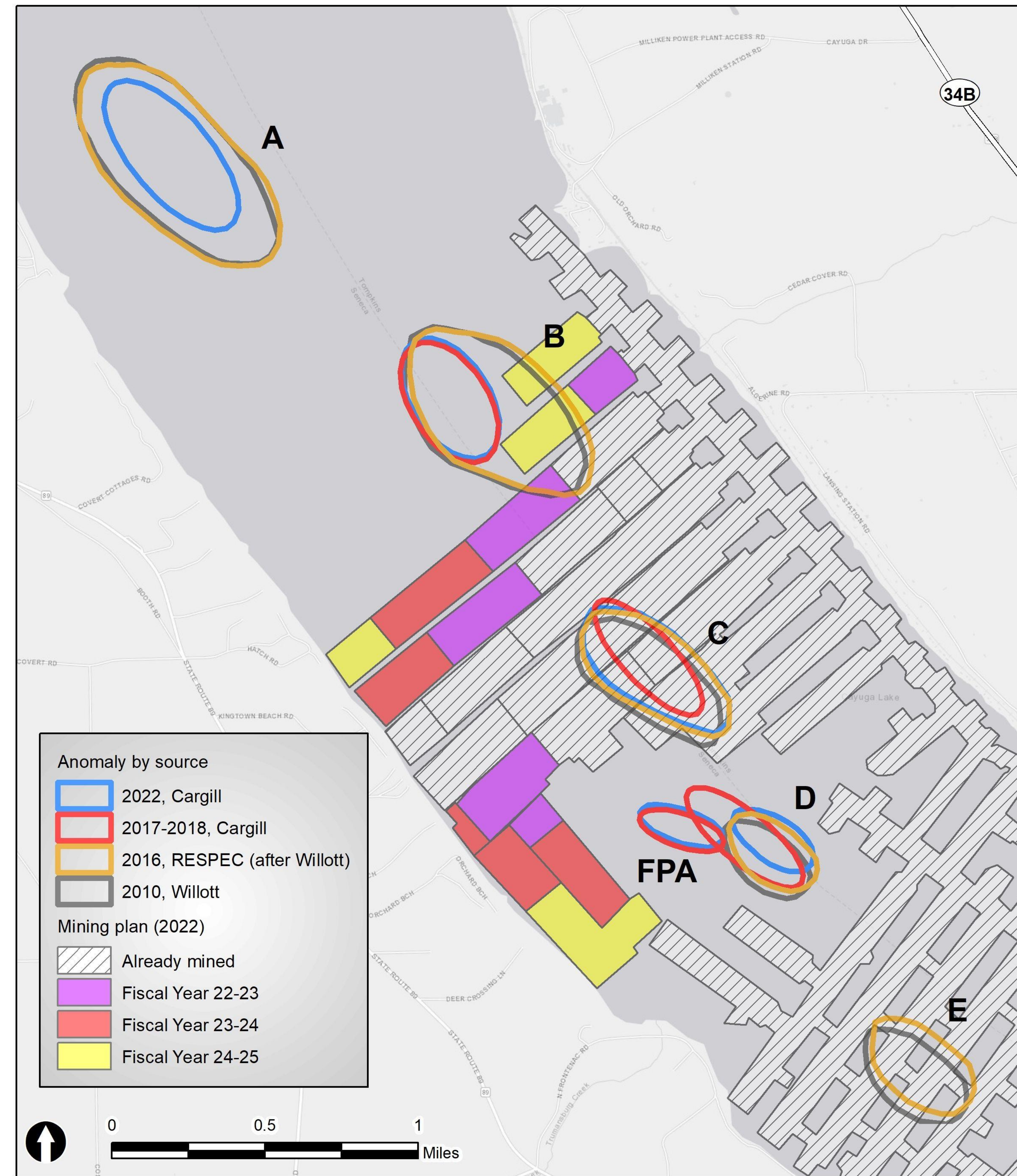
- Rock thickness and strength?
- Presence/absence of thin spots?
- Fractures & the inevitable effects and evolution of subsidence
- Fractures as water pathways and as planes of weakness in rock
- Comparisons of Cayuga Mine (CSM) to Retsof mine re: rock thickness, “Carbonate Beam”, anomalies, etc.

Water & brine: Shouldn't be near a salt mine!

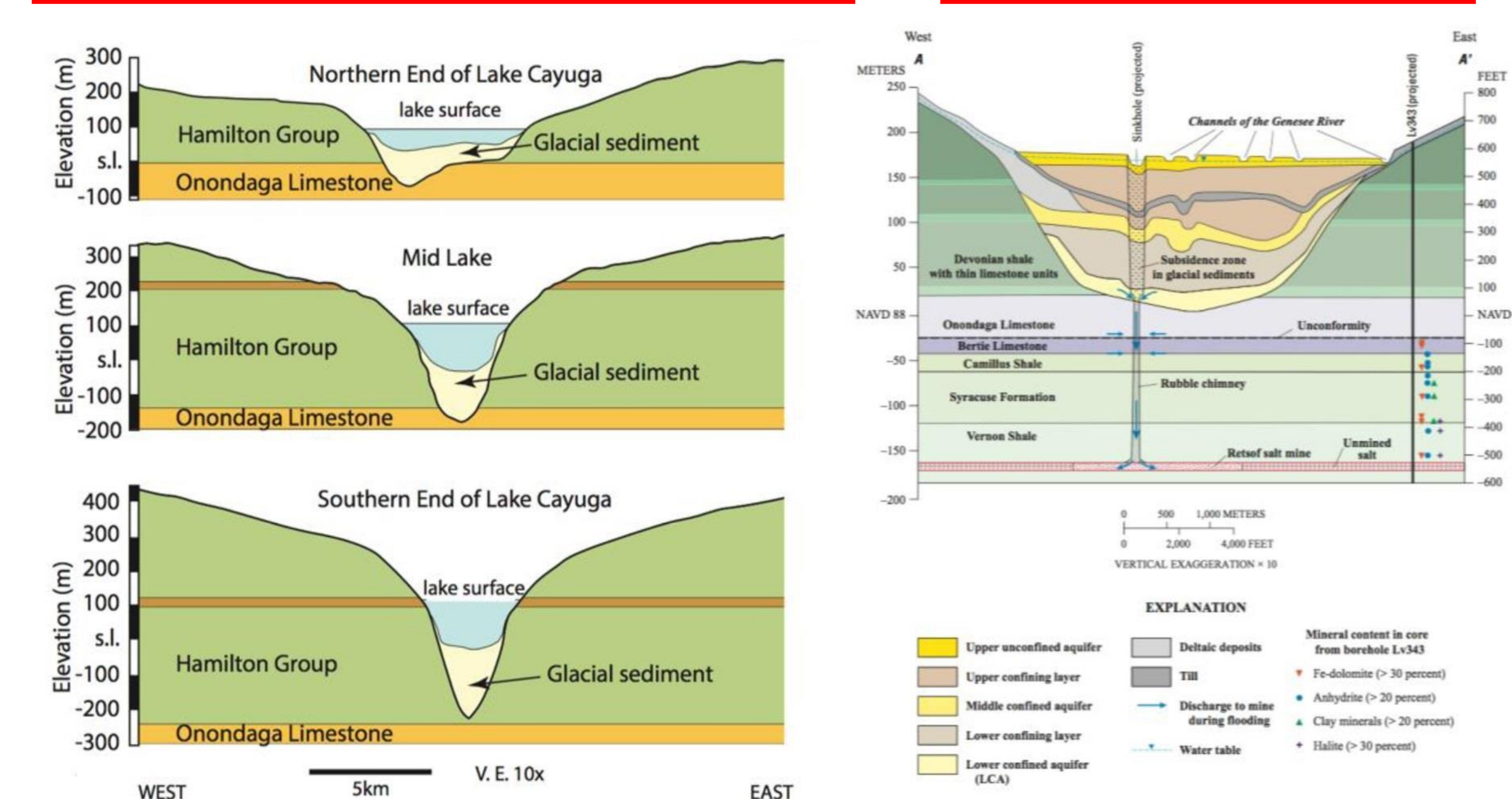
- Aside from the obvious risk (water dissolves salt), there's a risk of pockets or pools of brine in the bedrock above a salt mine
- Several experts note that an undetected brine pool led to collapse & flooding of the Retsof mine in 1994
- One of Cargill's experts (Petersen) has warned against creating a zone of de-stressed rock above a salt mine during “yield-pillar” mining, because this “attracts higher pressure fluids in the rock strata, which given a geological conduit will flow into the de-stressed zone”
- One of CLEAN's experts (Warren) points to evidence at various locations worldwide that glacial meltwater has penetrated deep into rock strata – thus showing, in those locations, that groundwater was able to flow through fractures, faults, or other geological conduits
- Akzo experts Van Sambeek, Gowan, and Payment note that “The brine pool above the [Retsof] mine was formed by the dissolution of salt beds in the Syracuse Formation of the Salina Group. The salt was dissolved by groundwater that was apparently circulating downward through fractures or faults...”
- These factors, combined with the difficulty of detecting brine pockets, show the need for careful investigation of brine pockets and whether/where they may exist above the Cayuga Mine (CSM)

(Un)availability of data: Problematic!

- Since about year 2000, almost all investigations and studies of CSM, including seismic data and interpretations, have been withheld by Cargill as confidential information



CAYUGA MINE (CSM) RETSOF MINE



Left Figure: East-West Cayuga Lake sections from *Technical requirements needed to approve construction of Shaft #4 in the Cayuga Salt Mine, New York State* by Dr. John K. Warren (after Mullins et al., 1995).

Right Figure: Stratigraphic section A-A' depicting rubble chimney above collapsed room in salt mine, Livingston County, N.Y. from *Brine Migration from a Flooded Salt Mine in the Genesee Valley, Livingston County, New York: Geochemical Modeling and Simulation of Variable-Density Flow*, Richard M. Yager et al. 2009.

Long-term mine closure & subsidence are inevitable; mine collapse is a possibility

- To flood or not to flood?
- Does it matter? Is flooding inevitable? If there's long-term management, by whom?
- Is slow closure better (more manageable) than collapse? If so, who would manage?
- Flooding may slow the closure rate & reduce collapse risk by supporting mine ceiling -- or may accelerate closure & increase collapse risk by dissolving salt pillars
- Monitoring of closure rate may provide warning of collapse. Who would monitor?
- Mine closure important re: both squeezed-out brine and surface effects of subsidence
- If any surface effects of subsidence, who's responsible? What oversight/management?
- Surface effects of CSM subsidence to date – minimal based on Cornell InSAR data?
- Underground monitoring of CSM closure rate to date: Smaller than at Retsof, as per Cargill

If/when water floods the mine, saturated brine will inevitably be squeezed back out (expelled)

- Where will squeezed-out brine go? Into lake? Or into deep or shallow aquifers?
- At what rate will brine be squeezed out?
- Will brine either be diluted sufficiently or remain deep enough to avoid salinity impacts?
- To date, salinity impacts have not been detected from Himrod mine on Seneca Lake
- If salinity impacts do occur from CSM, what will they be? Human health and/or ecological?
- Where? Lakewide or localized “hot spots”?
- Aside from the direct effects of salinity, will the density of expelled brine interfere with seasonal turnover of the lake?
- Who's responsible? What oversight & management? What roles for DEC or OGS?