During our last meeting with them (DNR), they said they understood our conceptual groundwater flow model and the primary concern was understanding the mounding in the southeast corner of the site. As a result, we proposed to complete an additional well or two to confirm information from the most recent well installations. Instead, this letter goes back to earlier discussions concerning karst, the need for bedrock coring, and more geophysics. Some of our thoughts are shown below:

Karst Conditions:

According to the Wisconsin Geological and Natural History Survey, karst is a landscape created when water dissolves rocks and can create caves and other conduits that act as underground streams. However, it is a "landscape" that may have deep bedrock fractures, caves, disappearing streams, springs, or sinkholes. Investigations and site inspections by numerous geologists over the past 35 years (both consultants and WDNR staff) have not observed any of these deep bedrock features that would indicate the presence of any underground conduits for groundwater flow. Instead, the data collected has refuted the presence of karst outside of secondary porosity from localized bedrock fractures and small isolated dissolution cavities. Evidence is provided by:

- Completion of more than 100 soil borings completed at the site.
- Significant thickness, up to 100 feet, of weathered bedrock (saprolite and residuum) that cannot create karst features.
- Evidence of weathered bedrock (unconsolidated clays and sands) below the perched water table as well as the regional water table indicative of deep weathering without karst.
- Primary karst-forming bedrock containing dolomite which is more resistant to dissolution.
- Site topography includes a ridge that limits the areal extent and time of travel for precipitation to infiltrate and dissolve bedrock minerals.
- Topographic surface that promotes surface runoff of precipitation and minimizes the potential of any precipitation (enriched with the atmospheric carbon dioxide necessary to form carbonic acid for the dissolution of carbonates) to infiltrate below ground surface.
- Installation of more than 28 monitoring wells across the site some having been sampled for 35 years.
- Significant depth to groundwater (perched water table) of over 75 feet which minimizes the potential of any precipitation (enriched with the atmospheric carbon dioxide necessary to form carbonic acid for the dissolution of carbonates) to infiltrate below ground surface.
- Repeatable and sustainable horizontal hydraulic gradients for 35 years at the perched water table, the regional water table, and deeper potentiometric surfaces; these hydrostratigraphic units represent the preferred "groundwater" flow paths at the site.
- Repeatable and sustainable vertical hydraulic gradients for 35 years between the perched water table, the regional water table, and deeper potentiometric surfaces.

- In-situ hydraulic conductivity testing of 28 wells resulting in reasonable hydraulic conductivity values for the non karst geologic units; the screened intervals of these wells, especially the perched and regional water table wells, are representative of preferred “groundwater” flow paths at the site.

It is our opinion, that conditions at the site are not conducive to significant karst to generate and those conditions have been that way for thousands of years.

Bedrock Coring:

The DNR has reviewed and addressed the need for coring several times over the past 35 years as part of Alternative Geotechnical Investigations Request:

- 1990: WDNR approved coring of only 2 borings on-site (MW-7 and MW-10) on February 17, 1989. Coring at MW-7 and MW-10 was successful and indicated discontinuous fractures and vugs throughout most of the rock with only increased fracturing occurring in the vicinity of the perched water table and the regional water as would be anticipated.
- 2003: WDNR did not require coring and accepted data from Rotosonic borings. During the drilling, some competent rock was observed above the perched water table in the unsaturated zone, but the rock became less competent at the perched and regional water tables and seen in cores from MW-7 and MW-10.
- 2022: WDNR acceptance letter recognized some site limitations to bedrock coring stating that “in lieu of bedrock core samples, downhole geophysical logging should be used…” Therefore, to attempt to address the WDNR’s questions, the County has completed the following efforts to address the challenges of bedrock coring at the site:
    - Cored at one location where bedrock was most likely to be competent (MW-14WT) resulting in some core confirming previous observations and the loss of equipment in the borehole due to incompetent bedrock.
    - Completion of Rotosonic borings to provide better core recovery; the presence of competent and incompetent rock confirmed previous observations.
    - Conducted natural gamma geophysical methods on new and existing monitoring wells to establish marker horizons across the site for confirmation of lateral continuity of geologic units.

In the attached file, we have laid out the boring profiles for all wells on site to compare drilling conditions and results across the site. Note that in the southeast corner of the site where the WDNR indicates their greatest concern on understanding site conditions, the geologic material is primarily weathered bedrock that would not be conducive to any bedrock coring method other than Rotosonic.

Geophysical Methods:

Because the bedrock is unsaturated to depths exceeding 80 feet, several borehole geophysical methods (electrical and resistivity type methods) cannot provide useful data. Similarly, because of the prevalence of incompetent bedrock (requiring drilling mud to hold the borehole open), methods like video logging would not be useful for the site; the limited applicability of geophysical methods was confirmed by applying the Fractured Rock Geophysical Toolbox Method Selection Tool (USGS, USEPA, and USTCP, 2015). That only really leaves caliper logging, which is more often used for determining fractures for the development of water supply wells.

Recommendations:

In reference to the WDNR letter and our discussion above, the County has limited options. SEH cannot guarantee that the WDNR will approve the Feasibility Study with any additional work. It is clear that the County really only have three options:

1. Withdraw the expansion project.
2. Appeal to elected officials (which we really can't address). Even with support of elected officials, we can't change the WDNR's process and dealing with public opposition.
3. Complete our proposed field work to address groundwater concerns in the southeast corner as planned, submit Addendum No. 2 (including more written responses to their letter), and hope for the best.