UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1201 ELM STREET, SUITE 500
DALLAS, TEXAS 75270-2102

November 4, 2022

VIA Electronic Mail

Benjamin Heard
Gulf Coast Sequestration
2417 Shell Beach Drive
Lake Charles, Louisiana 70601

Re: Gulf Coast Sequestration (GCS) – Required Resubmittal of Project Minerva Area of Review (AoR)/Corrective Action Section

Dear Mr. Heard:

The U.S. Environmental Protection Agency (EPA) is providing this notification that the agency is suspending its technical evaluation of the AoR/Corrective Action section in the Project Minerva Class VI permit application until the agency receives additional technical information. In reviewing the permit application, EPA has identified substantial information gaps regarding well, or artificial penetration (AP), records such that EPA cannot complete the technical review of the AoR/Corrective Action section of the permit application. Specifically, EPA has determined that the application's AoR/Corrective Action section does not meet the basic requirements of 40 CFR 146.82, 146.84(c), and 146.84(d). EPA also requires additional information on the computational modeling and geology before it can proceed (comments enclosed).

EPA's *Underground Injection Control (UIC) Program Class VI Well Area of Review Evaluation and Corrective Action Guidance* document (EPA 816-R-13-005, May 2013), which supports 40 CFR 146.84, discusses two critical narratives that detail the technical efforts for: (1) identifying all wells in the area of review; and (2) the well records data collection process associated with the AoR wells to assess their conditions concerning the impact of the proposed Class VI action. The Project Minerva application needs to include information for narratives (1) and (2) for reviewers to understand how the AoR well locations were found and how each well's records were compiled. The procedures and protocols for this are discussed in Chapter 4 of the guidance document. See: https://www.epa.gov/sites/default/files/201507/documents/epa816r13005.pdf). The agency cannot proceed without this information.

For all wells within the AoR, the Project Minerva application must contain records of all wells found in Louisiana's Strategic Online Natural Resources Information System (SONRIS) Database and the Texas Railroad Commission's (TRRC) online database, as applicable, as well as any other well records that exist and can be attained elsewhere. The applicant must provide all well records for all the wells in the AoR in order to determine if they penetrate the confining zone. The Louisiana Department of Natural Resources (LDNR) has confirmed to EPA that well records exist outside the SONRIS Database, such as a comprehensive library of microfilm/microfiche well records kept by LDNR. Well records pulled only from SONRIS do not satisfy 40 CFR 146.84(c)(2) and 40 CFR 146.84(d).

Because the review of the AoR/Corrective Action section is critical to the overall assessment of the Project Minerva application, the extent of missing information will require GCS to re-submit the AoR/Corrective Action section of the application. Thus, EPA is unable to continue its review of the AoR/Corrective Action portion of the

Project Minerva application until such information is provided in full. Upon submitting the requested additional information, EPA requests that GCS split the well records into one well per pdf file instead of having everything in one pdf appendix file. Following re-submission of the relevant sections of the application, Region 6 will be able to provide a project decision schedule with target dates.

EPA looks forward to continuing discussions with GCS on the permit application and appreciates the many meetings agency reviewers have already had with GCS. EPA remains available to respond to questions concerning permit application submissions and also continuing to coordinate permit application reviews with LDNR.

Sincerely,

for Charles W. Maguire
Director
Water Division

Enclosure

Enclosure

Comments on Computational Modeling and Geology: Pre-Construction
Additional comments may be provided.

Computational Model

1. The phase transition of CO2 was not included.
2. An uncertainty analysis was not included.
3. The model did not account for the Joule-Thompson effect, the dynamic evolution of brine salinity, long-term mineral trapping from resulting from CO2 sorption, mineral precipitation and dissolution reactions, and other geochemical reactions. Justifications are needed or these reactions should be included.
4. It was assumed that both the top of the [redacted] formation representing the top model boundary and the boundary between the [redacted] formation and [redacted] Formation [redacted] (a low-permeability sandstone-shale zone) representing the bottom boundary were impermeable to vertical flow (no-flow top and bottom boundary). No justifications were provided supporting the top and bottom no-flow boundaries assumption.
5. Reviewers noted that the modeling scenario run by GCS is a conservative scenario, in that, with the potential for vertical pressure migration beyond the top and bottom boundaries, it is possible that the pressure-based AoR may actually be smaller than the current prediction. The review suggests re-running the model assuming constant pressure boundaries at the top and bottom of the model domain, in addition to the no-flow top boundary. This will give two end-member results and may indicate the need to include permeability above the current top boundary to generate results that are less conservative with respect to pressure buildup and more likely to reflect a realistic outcome. These end-member analyses should consider the upper-bound permeability value for the [redacted] formation.
6. The lateral extent of the model appears to be sufficient; however, to confirm this, it would be helpful if the maximum lateral extent of the CO2 and pressure plumes could be superimposed on Figure 3.16, which shows the simulation grid.
7. While the injected CO2 plume is not predicted to extend towards the larger outside blocks, it is not possible to ascertain, based on the figures, whether the plume extends beyond region 1 of the Tartan grid where the aspect ratios could potentially lead to numerical errors. If that is the case, a grid sensitivity study may be warranted.
8. A potential issue is the effect of production activity in the [redacted] field which appears to be producing from the zones within the [redacted] Formation and [redacted] Formation on the horizontal pressure gradient. GCS states that history matching exercise focused on the [redacted] field were performed, but no

details have been given as per how the history matching was performed and how much lateral communication was observed between the [redacted] field and the proposed injection operation. Further, a vertical cross-section between proposed injector locations and the [redacted] field is suggested.

9. A sensitivity analysis is needed. The application does not provide any results of sensitivity analysis but does discuss a potential sensitivity-analysis methodology that will be implemented in the future.

Errata

1. Figure 2.2.12.2-7 caption is truncated.
2. Figure 2.2.12.2-9 caption is truncated.
3. Figure 2.2.12.2-17 caption is truncated.
4. Figures 7.2.1-1 through 7.2.1-8 are not referenced or discussed in the text.
5. Figures 7.2.4-1 through 7.2.4-8 are not referenced or discussed in the text.
6. Table 2.2.11-1 should be labeled 2.2.11.2-1.
7. Table 2.2.15-1 is not called out in the text.
8. Table 2.2.15-2 is not called out in the text.
9. Many of the fonts are too small on figures.
10. Figure 2.1.3-1 No indication of m or ft. Figure not labeled with figure number.
11. Figure 2.2.2-6 is blurry.
12. Figure 2.2.2-7 is small and blurry.
13. Figure 2.2.2-9 and Figure 2.2.2-10 axes not labeled
14. Figure 2.2.2-8 Figure not labeled
15. Figure 2.2.3-1 Permeability units not defined on figure
16. Figure 2.2.3-3. Axes too small to read
17. Figure 7.1.2-1 AoR envelops [redacted] Field and the [redacted]) GENERAL – Need cross section from [redacted] to both 1,2 and 3,4 injectors. (E-W from 3,4 may be OK for this purpose)
18. B.10.2 Typo on page 1, next to last paragraph. Delta P is shown as Grad P.
19. B.12.1 Typo on page 10 “such as the surface of the pores
20. B.12.1 Equation 2.1.2.1 Qp is NOT the flow speed. This is the volumetric flux. The actual velocity (or speed) of the fluid is Qp/porosity.
21. B.12.1 Page 15 next to last paragraph. Mass flux has units of mass per area per time. What you are presenting is a mass flow rate with units of mass per time.
22. B.12.1 Page 15 next to last paragraph. This sentence does not seem correct, because there can be net accumulation/loss in other directions that could basically divert mass flow to other faces. “It cannot be diverted out of the other faces of V.” It is the net accumulation/loss of mass that leads to the mass balance in each cell.

23. B.12.1 Page 15 last paragraph. Flux, with units of either volume or mass per area per time is a vector. Mass per time is not a vector. Please fix this section. See Flux Flummoxed, Groundwater 2006, or Bird Steward and Lightfoot (Transport Phenomena, Revised 2nd Edition 2nd Edition, 2002). The easy thing to do is to just say you are conserving mass, and that the divergence of the mass flow rates into your numerical cell (ρfQpA) is equal to the accumulation/loss from each cell. Flipping the vector to the area term does not really make sense. The vector is defined in the volumetric flux (Qp) by the direction of the gradient.
24. B.12.1 Page 17 Darcy velocity is a misnomer this should be called volumetric flux (volume per area per time) and is a vector.
25. B.12.1 Equation 2.1.2.9. The heat flux should be energy per area per time (J/(m2 s) or W/s) and should have the same form as the Darcy equation, with Heat flux = - ThermalCond Grad (T). What you have written here is the divergence of the heat flux which gives the energy accumulation. See Bird, Stewart and Lightfoot (Transport Phenomena, Revised 2nd Edition 2nd Edition, 2002).

Geology Comments

1. Clarify the difference between the [redacted] Group and the [redacted] Formation.
2. APPDX F contains more data than is shown in Figures 2.85-87.
3. Add the estimated fracture gradient value to the text of Section 2.3.4.2.
4. Determine capillary pressure; information on fractures, stress, ductility, rock strength, elastic properties; and in situ fluid pressures within the confining zone (e.g., based on core sample analysis) to support the values cited for the confining zone integrity and injection zone viability in the application.
5. Section 2.3.2, pg. 44 states that 21 earthquakes have occurred; however, Figure 2.71 and Table A.1 of Appendix D show more than 21 events.
6. Table 3.2 and Table 3.3 reference well [redacted] not labeled in Figure 2.53.
7. Obtain a complete water analysis in the injection zone to provide inputs to support the geochemical modeling and to confirm CO_2 stream compatibility with the mineralogy and geochemistry of the injection and confining zones.
8. Confirm mineral compatibility for minerals and injectate in the injection and confining zones (per § 146.84(a)(7)(iv)) based on evaluation of cores (and using benchtop geochemical tests if needed).