Request for Additional Information

[GCS Hackberry (R06-LA-0007)] - [Request #A-4]

Instructions: Populate the "Response" column with answers/responses to each comment/question below, then upload the completed responses to Field #3 in the "Information Requests" reporting module of the GSDT. If necessary, upload attachments or references in Field #4 of the module and/or update information within other GSDT modules. *To allow reviewers to quickly locate and review changes/updates, clearly identify the location within the application where edits for each response were made (e.g., Site Characterization, Section 2.7.4, p. 53, updated paragraph 2).*

Item #	Associated Regulation(s)	Comment/Question	Response
Modeling			
1	40 CFR 146.82(a)(3)(iii)	**Background:** A summary table of the values for porosity and permeability used in the model is shown below (referring to table 2-1). Using the same core data, vertical permeability in the sand was shown to be 91% of the horizontal permeability. This relationship is applied throughout the model. **Comment:** Please clarify the response to EPA's question for the Plume Model, p 2.4 -2.5. The response does not address why 91% was applied to the entire model. The question was repeated above for reference.	
2	40 CFR 146.82(a)	**Background:** Provide justification for applying the relative permeability relationships found for the sand across the entire model. Since there is no site-specific core data, provide an explanation of why using the relationship throughout the model is appropriate when sediment particle sizes, sorting, and packing, and sedimentation patterns and stratigraphic relationships from deltaic environments of deposition and marine sedimentation patterns are complex and change over short distances. In addition, provide any related information from regional or local geologic studies, if used for Section 2, that support the assumption of applying the relative permeability relationships found for the sand across the entire model. **Comment:** Please clarify the response to EPA's question for the Relative Permeability and Capillary Pressure, p. 2-5 from the NOD sent in May 2022. The response does not address why the relative permeability relationships found for the sand should be applied across the entire model. The question was repeated above for reference.	

Item #	Associated Regulation(s)	Comment/Question	Response
3	40 CFR 146.82, 83, 84 (c)	**Background:** Explain why applying the capillary pressure result from a single sand sample, and the capillary pressure result from a single shale sample, is appropriate for all sand and shale layers in the model. It does not appear reasonable to EPA to assume that 63' of core, from cores 3 and/or 4, which represents approximately 1.1% of the entire vertical injection interval, can represent all lower Miocene sand layers over an approximately 5607' vertical distance. Since there is no site-specific core data, provide a justification based on the known environments of deposition, patterns of sedimentation and stratigraphic relationships from regional and local geologic studies that explain why the same capillary pressure can be applied for the entire vertical distance. **Comment:** Please clarify the response to EPA's question for the Relative Permeability and Capillary Pressure, p. 2-7 from the technical NOD sent May 2022. EPA recognizes the difficulty in obtaining core samples because of the unconsolidated nature of formations and the intentions of HCS to conduct further evaluations and collect data. However, EPA is asking why it is appropriate to apply the same values to all the sand and shale layers in the model? The question is repeated above for reference.	
4		**Comment:** Figures 2.1.A and Figure 2.1.B are labeled with the same times (both say Dec. 1, 2120). Re-label the times as appropriate.	
5		**Comment:** Clarify what Arrow 4 shows on Figure 2.1.B.	
6	40 CFR 146.84	**Background:** This question is in reference to the following HCS response to the technical NOD sent May 2022: *While the core samples showed 92% water, 100% water saturation was used for all model layers, as discussed on Page 2.8. The low percentage of oil values modeled does not materially change the outcomes.* **Comment:** Without having analyzed model sensitivities, explain how Hackberry knows that the low percentage of oil values modeled does not materially change the outcomes.	
7	40 CFR 146.84	**Background:** HCS response to the technical NOD sent May 2022 for Section 2.11 .	

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		Comment: Please clarify if the stated changes are the only changes that will be made. For example, will other changes possibly be needed such as the positions of boundary conditions or boundary values, model layer continuity or pinch-outs, injection interval elevations (not just thicknesses), the amounts to be injected, or other changes?	
8		**Background:** Figure 1-3 does not have a map scale. **Comment:** Provide a map scale on Figure 1- 3: Overview Map of Project Area.	
9	40 CFR 146.84	**Background:** **Comment:** Explain how model sensitivities will be examined with respect to porosity and permeability.	
10	40 CFR 146.82, 146.83, 146.84	**Background:** Based on the position of the West Hackberry Salt Dome in Figure 1- 3: Overview Map of Project Area, it appears that no-flow cells would extend further north on the eastern side of the domain, and further west on the southern side of the domain than is shown on Figure 2.16. **Comment:** Explain why the no-flow cells on Figure 2.16 of the HCS response are assigned as they were.	
11	40 CFR 146.82, 146.83, 146.84	**Background:** **Comment**: Explain if boundary conditions can be assigned to the SE part of the domain that would provide a gradational change from no-flow cells to infinite acting cells, and if that would it make a difference?	
12		**Background:** Our review teams are still having access issuing the model files listed in Attachment 2.	

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		Comment: Provide the section and page number of the application, and the one-drive folder and file name, where all of the information may be found for each of the .pdf links on the attachment. For example: Simulator Description/Documentation: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0007/Phase1-PreConstruction/AoRModeling-01-03-2023-1554/CBI--Page--1.pdf [place section and page number here; place one-drive folder and file name here]	
Well Construction			
13	40 CFR 146.86(b)(5)	**Background:** 40 CFR 146.86(b)(5) indicates that all cement and additives must be compatible with the CO2 stream and formation fluids to maintain integrity over the design life of the project. **Comment:** The application discusses the use of NeoCem 104 cement. Please provide a discussion regarding the compatibility or resistance to CO2 of this cement. The application also mentions the use of additives. Please provide details regarding the proposed additives and their compatibility with CO2 and formation fluids.	
14	40 CFR 146.86(b)(1)	**Background:** Casing and cement or other materials used in the construction of a Class VI well must have sufficient strength and be designed for the life of the geologic sequestration project. All well materials must be compatible with fluids with which the materials may be expected to come into contact and must meet or exceed standards developed for such materials by the API. **Comment:** Please specify what type of materials and cement will be used for the proposed conductor casing.	
15	40 CFR 146.90	**Background:** The applicant mentions the installation of downhole gauges and potential limitations that may occur as a result of the instrumentation. **Comment:** Will gauges be installed? What are the anticipated limitations and how would these limitations be mitigated?	

16	40 CFR 146.86	**Background:** **Comment:** EPA recommends that HCS provide an injection well construction plan that is consistent with the "Injection Well Construction" template that is available in the GSDT. The plan should provide details about casing, tubing and packer specifications in a tabular format and include a schematic.	
Pre-Operational Testing			
17	40 CFR 146.87(b)(c)	**Background:** 40 CFR 146.87(b) requires that the applicant take "whole cores or sidewall cores of the injection zone and confining system and formation fluid samples from the injection zone(s), and must submit to the Director a detailed report prepared by a log analyst that includes: Well log analyses (including well logs), core analyses, and formation fluid information." **Comment:** Appendix F-1 includes plans for fluid sampling but very few details are provided. Please indicate which zones will be utilized for formation fluid sampling and what parameters will be analyzed.	
18	40 CFR 146.87(b)	**Background:** 40 CFR 146.87(b) requires that the applicant take "whole cores or sidewall cores of the injection zone and confining system and formation fluid samples from the injection zone(s), and must submit to the Director a detailed report prepared by a log analyst that includes: Well log analyses (including well logs), core analyses, and formation fluid information." **Comment:** Does the project plan include specific coring and fluid sampling at each of the specific injection intervals within the injection zone? If sampling and coring is not planned for each injection interval please provide a demonstration of homogeneity within the injection zone to substantiate these plans.	
19	40 CFR 146.87(c)	**Background:** 40 CFR 146.87(c) indicates that the applicant must record the fluid temperature, pH, conductivity, reservoir pressure, and static fluid level of the injection zone(s). **Comment:** While it may be inferred please indicate that the applicant will measure and record the reservoir pressure within the injection zone prior to operation.	

20	40 CFR 146.87(b)(d)	**Background:** 146.87(d) indicates that the applicant must determine or calculate physical and chemical characteristics of the injection/confining zone lithology and formation fluid. Formation fluid analyses generally include major anions and cations, pH, temperature, pressure, alkalinity, TOC and total inorganic carbon. Injection/confining zone analyses typically include (but are not limited to) lithology, thickness, grain size, fracturing, permeability and porosity. **Comment:** Please indicate what parameters will be analyzed to further constrain the properties of formation fluid and injection/confining zone geology.	
21	40 CFR 146.87 (f), 146.91(d)	**Background:** 40 CFR 146.87 (f) indicates that the owner operator must submit a schedule of such activities to the Director 30 days prior to conducting the first test and submit any changes to the schedule 30 days prior to the next scheduled test. **Comment:** While the applicant discussed the timeframe for reporting the results of sampling and testing, there was no mention of informing the EPA of planned testing schedules. The applicant should indicate that they are aware of this requirement.	
22	40 CFR 146.88, 40 CFR 144.41	**Background:** 40 CFR 146.88 defines types of permit modifications that would fall under a minor modification. All other modifications qualify as major modifications, which require an additional public comment period. **Comment:** EPA recommends that the applicant provide a “draft stimulation plan” to act as a placeholder for future modifications. A well stimulation plan added following the initial permit to construct would result in another public comment period. Such a plan would include the stimulation fluids to be used (including additives) or diverting agents and a step-by-step procedure that would be employed during stimulation.	
23	40 CFR 146.82	**Background:** We were unable to confirm the depth of the USDW within this section with the depths provided in the narrative. **Comment:** Please confirm that the depth of 2,400’ is consistent with the rest of the narrative.	

24		**Background:** **Comment:** At what intervals/frequency will deviation checks be performed during drilling on all holes?	
25	40 CFR 146.87	**Background:** **Comment:** *Please clarify or update the FLP to ensure that it conforms with the pre-operational testing requirements at 40 CFR 146.87 as follows:* ○ *Specify that resistivity, spontaneous potential, and caliper logs will be run before and upon installation of the surface and long string casings;* ○ *Include porosity, gamma ray, and fracture finder logs to be run before the long string casing is installed; and* ○ *Include a variable density log and temperature log to be conducted after the surface casing and long string is set and cemented. (The plan only specifies cement bond log and does not specify the timing.)* **Background:** **Comment:** Please describe the MITs that will be performed on the injection well.	
Plugging Plan			
26	40 CFR 146.92	**Background:** **Comment:** Please revise page 6-4 of the IWPP to show the correct number of cement plugs to be used for plugging the injection well.	
27	40 CFR 146.92	**Background:** **Comment:** Please revise the abandonment schematics to match the plug number designations within Tables 6-3 and 6-4.	
28	40 CFR 146.92	**Background:** **Comment:** Please explain how the first five feet of casing will be cut after the final cement plug is in place. Alternatively, will the casing be cut prior to cementing to the surface?	

29	40 CFR 146.86, 146.92	**Background:** Class VI guidance recommends providing construction schematics and plugging plans for all monitoring wells to ensure that the same requirements set forth by 40 CFR 146.86 are met for monitoring wells. **Comment**: EPA recommends that HCS provide a plugging plan and construction schematics for the monitoring well.	
Testing and Monitoring			
30	40 CFR 146.90	**Background:** Pg 5-1 says, "Any evidence that the injected VO2.." **Comment:** Please correct to CO2.	
31	40 CFR 146. 86, 146.90	**Background:** The applicant did not provide specifications for equipment used in the testing and monitoring plan. **Comment:** Recommendation: Provide specifications for all equipment used in the provided testing and monitoring plan.	
32	40 CFR 146.92 (b),	**Background:** The applicant has not provided adequate details regarding the plugging plan and construction for the single monitoring well. **Comment**: EPA recommends that HCS provide a plugging plan and construction schematics for the monitoring well.	
33	40 CFR 146.87(a), 40 CFR 190 (d)	**Background:** Baseline data should be used to detect deviations in monitoring data. **Comment:** Specify what will be your baseline data, and what changes will be made to the testing and monitoring plan (sampling frequency, additional sampling, shut-in time, time analyzed) if results deviate significantly from baseline data.	
34	40 CFR 146.90 (k)	**Background:** A Coriolis mass transmitter meter will be used to measure the mass flow rate of CO2. **Comment:** Explain the accuracy and precision of the Coriolis Transmitter meter. Include maintenance and calibration procedures, and the sensitivity to detect changes from permitted conditions.	

35	40 CFR 146.88 €	**Background:** Various methods are possible to utilize monitoring data for the calculation of injection volumes. **Comment:** Explain how the injection volume will be calculated and provide formulas.	
36	40 CFR 146.90	**Background:** **Comment:** Recommendation: A table with operational parameters, including methods used, locations, and minimum sampling and recording frequencies.	
37	40 CFR 146.90 (j)	**Background:** **Comment:** Specify what changes in injection rate and annular pressure will trigger a change in monitoring/testing frequency.	
38	40 CFR 146.88(e)(2)	**Background:** **Comment:** Narrative does not mention the installation of alarms and shutoff devices to alert operator when parameters deviate from permitted ranges per 146.88 (e)(2).	
39	40 CFR 146.90	**Background:** **Comment:** Specify what changes will be made in monitoring/testing frequency if samples have signs of corrosion, or significant weight reductions.	
40	40 CFR 146.84 (c), 146.90	**Background:** The placement of the monitoring well was justified by being in the updip direction of the injection structure and above the modeled plume migration. However, the narrative does not explain why one well is enough to monitor ground water quality in the AOR. **Comment:** Please provide an explanation as to why a single monitoring well is sufficient to meet the criteria of 40 CFR 146.90	
41	40 CFR 146.90, 146.91 (a)(7)	**Background:** Table 5-3 states ground water quality parameters will be measured every five years. **Comment:** At a minimum EPA recommends wells to be initially sampled at a quarterly basis and submit ground water monitoring results in semiannual reports.	

42	40 CFR 146.89(c), 146.90	**Background:** Was not able to find the location of the temperature log test mentioned in the report. **Comment:** Please provide the location where the temperature log will take place in the narrative portion of the testing and monitoring section. 40 CFR 146.89(c) and 146.90	
43	40 CFR 146.89(c), 146.90	**Background:** Only one paragraph concerning the temperature log is included in the testing and monitoring plan. **Comment:** Please include a description of the proposed Temp Log that includes the following 1) The specific procedure that you plan to use 2. Information on the gauges or equipment, range, precision, etc. 3) Define the criteria for pass or fail. 4) MIT's in monitoring wells (please include in a table) 5) Any additional data that shows no significant leakage	
44	40 CFR 146.90 (f)	**Background**: EPA was not able to find the location of the pressure fall-off test mentioned in the report. **Comment:** Please provide the location where the pressure fall-off test will take place in the narrative portion of the testing and monitoring section.	
45	40 CFR 146.90	**Background:** **Comment:** Please read the Class VI Guidance document for Well Testing and Monitoring Section 3-5 (Pages 50-52). Make sure that the description for pressure fall-off testing includes the items mentioned in the guidance document. This is especially the case with the bullet point list in the Reporting and Evaluation section on page 52 of the guidance document. Please make sure that all the bullet points in this list are addressed in the narrative description for pressure fall-off testing in the Testing and Monitoring section of the application. The guidance document for Well Testing and Monitoring can be found at https://www.epa.gov/sites/default/files/2015-07/documents/epa816r13001.pdf_	
46	40 CFR 146.90 (g) (1)	**Background:** The applicant indicates that the vertical seismic profile will be utilized as a direct monitoring method.	

		Comment: The Vertical Seismic Profile is not considered a direct pressure or plume front tracking monitoring method. Seismic is considered an indirect pressure or plume front tracking method. Direct Pressure Monitoring is stated as, "Measurement of in situ fluid pressure that may be achieved using transducers placed within monitoring wells in the injection zone, behind casing gauges, or through direct measurement of fluid depth through a perforation. It is required to track the presence or absence of elevated pressure within the injection zone 40 CFR 146.90 (g) (1)." Direct Carbon Dioxide Plume Monitoring is stated as, "Use of monitoring wells in the injection zone to substantiate the presence or absence of carbon dioxide by geochemical methods. It is required to track the extent ot the carbon dioxide plume if the UIC Program Director determines that indirect methods are not appropriate 40 CFR 146.90 (g) (1)." Indirect geophysical monitoring is stated as, "Seismic, electrical, gravity, or electromagnetic techniques. Required to track the presence or absence of elevated pressure within the injection zone and the extent of the carbon dioxide plume, unless the UIC Program Director determines that such methods are not appropriate 40 CFR 146.90 (g) (2)." Please provide both direct and indirect methods for both pressure and plume front tracking based on the above definitions. The guidance document for Well Testing and Monitoring can be found at https://www.epa.gov/sites/default/files/2015-07/documents/epa816r13001.pdf	
47	40 CFR 146.90	**Background:** **Comment:** Please provide a table listing concerning the plume monitoring location and frequency that has the following information 1) Type of method (Direct or Indirect) 2) Formation 3) Activity 4) Location 5) Special coverage 6) Frequency.	
48	40 CFR 146.90	**Background:** **Comment:** Please make sure to provide the following list of items for each method under the pressure and plume front tracking 1) Quality Assurance and Surveillance Plan 2) Specific schedule for the monitoring 3) Continuous Monitoring including how the samples are collected and recorded 4) Mixed location/frequency or adaptive 5) Triggers and timeframes 6) Maps for locations 7) Depth/elevation of each interval 8) Output data 9) Gauges or other equipment (range, precision, etc.) 10) Processing methods for	

		geophysical methods 11) Deviation from baseline 12) Proposed combination of direct and indirect monitoring.	
49	40 CFR 146.90(h)	**Background:** The Director may require surface air monitoring and/or soil gas monitoring to detect movement of carbon dioxide that could endanger a USDW. **Comment:** No section for Air or Soil Gas surface monitoring was included in the Testing and Monitoring portion of the application. A plan for this may be required in the future based on whether the director finds that Air or Soil Gas surface monitoring may be needed due to potential risks to the USDW that could arise within the AOR. Please refer to 40 CFR 146.90(h).	
50	40 CFR 146.90(k)	**Background:** 40 CFR 146.90 (k) requires the applicant submit a quality assurance and surveillance plan for testing and monitoring requirements. **Comment:** Please include a quality assurance and surveillance plan for all of the testing and monitoring methods similar to what was included in the pressure fall-off testing and groundwater quality monitoring sections. Please refer to 40 CFR 146.90(k).	
PISC/SC			
51	40 CFR 146.93(a)(2)(i)	**Background:** Following the cessation of injection, threat to USDW's will decrease as a result of decreasing pressures. **Comment:** Please provide expected decline rate as part of modeled data for the monitoring well. Please refer to 40 CFR 146.93(a)(2)(i)	
52	40 CFR 146.93	**Background:** Specifications of testing and monitoring and PISC should match across sections. **Comment:** Please make the PISC and Testing and monitoring sections match up with each other based on the deficiencies provided in both sections.	
53	40 CFR 146.93	**Background:** A quality assurance plan should be provided **Comment:** Please provide QASP for all required sections in the application. Please refer to https://www.epa.gov/sites/default/files/2016-	

		12/documents/uic_program_class_vi_well_plugging_post-injection_site_care_and_site_closure_guidance.pdf_	
54	40 CFR 146.93 (c)	**Background:** A 10-year alternative PISC will not meet the EPA's requirement based on 40 CFR 146.93(c). Applicant has not provided a detailed description making their case for a 10-year PISC. Also, the applicant does not have any site-specific data to back up this argument. **Comment**: Please provide a detailed description making the case for a 10-year PISC. Please refer to 40 CFR 146.93(c) for guidance on the alternative PISC.	
55	40 CFR 146.93(b)(2), (3)	**Background:** One paragraph detailing the non-endangerment of USDW's will not suffice. **Comment:** Please provide a detailed description for the non-endangerment of USDW's based on 40 CFR 146.93(b)(2) and (3).	
56	40 CFR 146.92 (e), 146.93 (f)(1)	**Background:** The applicant should provide a specific plugging plan for the monitoring well. **Comment:** Please provide a separate plugging plan for the monitoring well in the PISC section. Please provide a detailed site closure plan that describes the site restoration and explicitly references state and local regulations.	