REGION 9

SAN FRANCISCO, CA 94105

December 20, 2024

Sent electronically only

Faisal Latif
Technical Manager
Carbon TerraVault Holdings LLC
27200 Tourney Road, Suite 200
Santa Clarita, CA 91355

Re: Technical Review of Application – Supplemental Comments for RAI-2
Carbon TerraVault Holdings LLC (CTV) III Project
Underground Injection Control (UIC) Permit Application
Class VI Pre-Construction Permit Application No. R9UIC-CA6-FY22-5.1-5.6

Dear Faisal Latif:

The United States Environmental Protection Agency, Region 9 (EPA) has evaluated CTV's responses to EPA's initial technical comments on the CTV III computational modeling and identified additional information or clarification needed for continued evaluation of the Area of Review (AoR) and Corrective Action Plan of the subject permit application. The comments included in the Enclosure to this letter supplement the Request for Additional Information (RAI)-2 EPA provided to CTV on October 31, 2024.

Please submit the information requested in the Enclosure by February 14, 2025 (i.e., the extended due date for EPA's RAI-2). If you have any questions about this letter and the Enclosure, please call me at (415) 972-3971, or contact Calvin Ho at (415) 972-3262.

Sincerely,

/s/ December 20, 2024

David Albright
Manager, Groundwater Protection Section

Enclosure: Evaluation of Applicant's Responses to EPA's Comments on CTV III Computational Modeling

CC: Erwin Sison, CalGEM Northern District
Alex Olsen, Central Valley Regional Water Quality Control Board
Jason Dunn, California State Water Resources Control Board

Evaluation of Applicant's Responses to EPA's Comments on CTV III Computational Modeling Class VI Pre-Construction Permit Application No. R9UIC-CA6-FY22-5.1-5.6

On May 24, 2024, CTV responded to EPA's February 20, 2024 request for additional information about computational modeling in the CTV III Class VI permit application. EPA's evaluation of the applicant's responses is summarized in the Evaluation Summary section and provided in detail in the "Reviewers' Evaluation of Company's Responses" column of the table below. Comments provided below in ***bold, italic*** text require additional information, clarification, and/or further work from the applicant. Comments provided below in *italic, underline* text give background information or recommendation for further work.

Evaluation Summary

The risk-based AoR delineation method used by the applicant is not the recommended method for a storage reservoir system that is under-pressured. Page 39 of *EPA's UIC Class VI Well AoR and Corrective Action Guidance*[1] *(the Guidance)* lists Method 1 as the recommended method for calculating the threshold or critical pressure that defines the pressure front used to delineate the AoR for under-pressured systems. ***Please delineate the Area of Review (AoR) according to the four steps described in Box 3-2 on pages 56-60 of the Guidance. Please re-run all the sensitivity analyses to assess the impact on the boundary of this AoR.***

EPA suggests using consistent units (Metric or English) throughout the documents. Another suggestion is to include text in Section 2.1 describing that the CO2 plume map view Figure B-18 is the maximum CO2 at any depth.

See the table below for other comments and suggestions.

[1] https://www.epa.gov/sites/default/files/2015-07/documents/epa816r13005.pdf

#	Section	Comment/Question for company	Report Section Updated	Response	Reviewers' Evaluation of Company's Responses
1	Model Suitability	CTV models the Midland Fault to the west, the Stockton Arch Fault to the east, and the West Tracy Fault as no-flow boundaries. The impact of the three no-flow boundaries is to limit the extent of the AoR boundary to the south while allowing greater extent of the AoR to the north. ***Please provide strong evidence about the impermeability of these faults that would justify their consideration as no-flow boundaries. Alternatively, expansion of the western, eastern and southern boundaries of the modeled domain beyond these faults, and implementation of appropriate properties for these fault zones, could be used to show that these faults are appropriate no-flow boundaries.***	Attachment A Section 2.3.1	Additional analysis of fault sealing was added to Attachment A section 2.3.1	***Please describe, in Attachment A, the shale gouge ratio (SGR) and shale smear factor (SSF) methodology and calculations.*** ***Please provide a figure that shows the results of SGR and SSF.*** ***Please justify why the calculated values of SGR and SSF provided for the Midland Fault, the Stockton Arch Fault, and the West Tracy Fault support that these faults are sealing.***
2	Model Suitability	The model horizontal extent should be larger than the current version. The pressure plume is expected to preferentially extend toward the north, north-east boundary given that combination of no-flow boundaries at the top and bottom and south and west sides. The current boundary location will artificially impose a pressure gradient that will not be reflective of an open flow boundary condition in spite of the use of a large volume multiplier for the boundary blocks. ***To accurately represent the open flow boundary condition, please use GEM's "aquifer" option and test the***	Attachment B Section 2.2.2	Reference Case 1 and Cases 2 to 9, listed in Table B-5 were run using a Carter Tracy Aquifer connected to the Northern and Eastern open boundaries of the Model. The aquifer thickness, porosity, permeability and ratio of aquifer radius to model radius were varied to understand the sensitivity of the Aquifer size and properties. The permeability, followed by thickness of the Aquifer had the most impact on the CO2 plume area volumetric pressure (Figure B-27), but none of them were considered to be significantly different from the reference Case 1. Similarly, the plume area maps (Figure B-26) for all the cases show negligible variability in comparison	***Please justify why the original reference case 1 with the northern and eastern open boundaries is replaced with the new reference case 1 with the Carter Tracy aquifer option.*** ***Please justify why the values for aquifer permeability, aquifer radius to reservoir radius, aquifer thickness, and aquifer porosity used in Cases 2-9 are adequate for determining the sensitivity of the predicted AoR to these parameter uncertainties.***

		sensitivity of the predicted pressure plume (and subsequent AoR) to the parameters used to set up the open flow boundary condition.		to reference Case 1. The originally submitted reference Case 1 used large volume modifiers at the edge cells of the northern and a portion of the eastern boundaries to model an infinite aquifer. A sensitivity run was completed between the originally submitted Case 1 and the Carter Tracy aquifer option described above (new reference Case 1). CO2 plume area volumetric pressure (Figure RtC-1, attached at the bottom of this matrix), and CO2 plume area maps (Figure RtC-2, attached at the bottom of this matrix) between the two cases do not show any significant differences between one another. In response to EPA comment #2 this application will use the new Reference Case 1 with the Carter Tracy aquifer option moving forward. However, since the plume boundary differences between the original reference case and the new reference Case 1 are not significant, the original plume boundary shape is currently used in all maps except for Figure B-26 to best represent the relative CO2 plume boundary differences between the sensitivity cases. Figures RtC-1 and RtC-2 are attached at the bottom of this document.	***What is the threshold for significant difference the applicant considers in these sensitivity analyses, and what about for negligible difference?***
3	Model Suitability	In the absence of site-specific data, the applicant used relative permeability curves measured on cores from a different formation from the neighboring gas field. The residual liquid saturation on this data is rather high. Given that the residual saturation and subsequently the gas relative permeability affect the CO_2 plume extent	Attachment B Section 2.2.2	The reference Case 1 uses end point scaling with an end point of 0.34 for irreducible water saturation and critical water saturation. Hysteresis is modeled in the existing simulation runs using CMG hysteresis option and specifying parameters for end point scaling on the relative permeability curves. Case 11 utilizes the Moke Capillary pressure	***Please provide the capillary pressure value used for Case 11 and justify why the value is adequate for determining the sensitivity of the predicted AoR to this parameter uncertainty.***

		and post-injection migration, it will be important to understand the sensitivity of these to the assumed relative permeability curve parameters. ***Please conduct a thorough uncertainty analysis of relative permeability- capillary pressure-saturation function parameters (ideally also including hysteresis).***		data and Case 13 reduces end points of irreducible water saturation and critical water saturation to 0.25 (Table B-5). Both case variations do not show any change to the CO2 plume extent (Figure B-26) or the pressure in the CO2 plume area (Figure B-27).	***Please justify why the saturation values for irreducible water and critical water used in Case 13 are adequate for determining the sensitivity of the predicted AoR to these parameter uncertainties.***
4	Model Suitability	The applicant has postulated that the target zone is under-pressured due to gas production from the same formation. This implies that there is potential for pressure communication between the proposed injection operations and any active gas production operations within the boundary of the pressure plume. ***Please take into consideration this potential interference and its effect on CO_2 and pressure plumes in the model.***	N/A	The pressure depletion seen in the injection zone is believed to be from historic gas production in the project area. Currently there is no active oil or gas production within the project pressure front.	***Please model, as a sensitivity case, the potential interference due to active oil or gas production in the injection zone within the project area.***
5	Model Design	The approach used to determine the sensitivity of the predicted AoR to porosity and permeability values may not be adequate. ***Please develop P10, P50, P90 realizations of porosity and permeability to assess the sensitivity of predicted pressure and saturation fronts (and related AoR) to those parameter uncertainties.***	Attachment A Section 2.2.2	Sensitivity Cases 16 through 19 were run to address P10 and P90 realizations for permeability and porosity. Refer to response to EPA question #23.	***Please explain how the porosity and permeability multipliers used correlate with the P10 and P90 realizations for porosity and permeability.*** ***Were P50 realizations run for porosity and permeability?***

6	Model Design	The CMG-GEM compositional simulator has capabilities to accommodate site- specific geologic conditions, including faults, and operational conditions such as wells with multiple perforations and varying injection schedules. The applicant simulated known faults that are shown to be barriers to flow, including the Midland, West Tracy, and Stockton Arch faults to define the western and southern boundaries.	N/A	N/A	N/A
7	Model Design	***It is not specified how injection occurs into the well: is there a wellbore model, a source at the top of the well and a large vertical permeability in grid blocks representing the well, or mass sources distributed along the well with strength proportional to permeability-thickness product of the layer?***	N/A	Appendix 4: Operational Procedures was formulated using a wellbore model with the source at the top of the well and large vertical permeability in the injection zone. As mentioned in Appendix 4: Operational Procedures, Petroleum Experts' Prosper was utilized to create this model, taking inputs from the reservoir model to enable the calculation of near wellbore effects of CO_2 injection. Allocation of CO_2 injection within CMG-GEM is based on KH of each layer the well injects into.	This explanation is sufficient to address the question. *Text should be expanded in Section 1.9 of Appendix B pointing to the Appendix 4 for details on this topic. The current language was too sparse to guide the reader to the information.*
8	Model Design	Salt precipitation is not mentioned. Salt precipitation can decrease near-well porosity and permeability, thereby decreasing injectivity. Site-specific relative permeability and capillary pressure curves, and a fine grid around the injection well are required to assess this issue, which should be done when site-specific data becomes available.	N/A	N/A	*Please consider salt precipitation in the model when site-specific data, such as site-specific relative permeability and capillary pressure curves, become available.*

9	Model Design	No temperature changes are shown. Minor effects are expected if CO2 injection temperature is the same as initial reservoir temperature, but injection temperature is not provided.	Attachment B Section 1.9	The anticipated injection temperature at the wellhead is 90 – 130° F.	Acceptable response and modification.
10	Model Design	[see PDF for full text] This calculation indicates that the lateral extent of the current grid may be too small. ***Please provide results of the predicted pressure at the end of the injection and the end of the simulation time.*** Given that three side boundaries and the top and bottom of the injection zone are no flow boundaries, the pressure front will extend unsymmetrically towards the north, north-east side of the model domain and most probably beyond the current model boundary.	Attachment B Section 2.1	New figures B-21 and B-22 have been added to display pore volume averaged pressure in the CO2 plume area; and initial, peak, and delta pressure across the model domain.	Acceptable response and modification.
11	Input Parameters vs. Site-Specific Conditions	Lateral spacing ranges from 50' x 50' around the injectors, increasing to 500' x 500' and to 100' x 100' in the far-field. The grid spacing is probably fine for the bulk of the model, but it is much too coarse to properly resolve near-injection- well effects such as the actual pressure increase during injection, formation of a dryout zone, and salt precipitation. ***Please revise the model to include smaller grid spacing near the injectors.***	Attachment B Section 2.2.2	Reference Case 1 uses a Tartan grid with a local grid refinement (LGR) around the injector well bores. Local grid cells around the injectors have dimensions of 50- by 50-feet. New sensitivity Case 10 was run with LGR around injector well bores with a refinement of 20 grid cells for each grid block, resulting in grid dimensions of 25- by 25-feet (Table B-5). The results do not show any significant difference in bottom hole pressures provided for injectors C1 & C2 (Figure B-28) or pore volume averaged pressure in the CO2 plume area (Figure B-27). Further refinement is not expected to change the near well-bore pressure response.	***Was the new sensitivity Case 10 run for injectors E1, E2, W1, and W2?***

12	Input Parameters vs. Site-Specific Conditions	The injection rate is constant, and the resulting pressure response stays below maximum operating pressure. However, the grid resolution at the injection well is too coarse to properly calculate the near-injection well pressure. Unless the model includes a special well feature that eliminates the need for fine grid resolution near the well (which CMG-GEM has but is not mentioned in the application), then modeled pressure will be too small, possibly enabling injection rate to be too large.	Attachment B Section 2.2.2	New sensitivity Case 10 described in response to EPA question #11 demonstrates that LGR around the injectors results in no significant difference from reference Case 1. Further refinement is not expected to change the near well-bore pressure response.	See Comment 11 above.
13	Input Parameters vs. Site-Specific Conditions	The Western, Southern, and part of the Eastern edge of the model domain, defined by the Midland, West Tracy and Stockton Arch faults are set as no-flow boundaries. The remaining Northern and part of the Eastern Edges of the model domain are stated to be "modeled as open boundaries using large volume modifiers at the edge cells to model an infinite aquifer." However, large volume modifiers make the boundary a constant-property boundary, in particular a constant-pressure boundary. As mentioned earlier, the pressure plume will likely extend beyond the current grid boundary. The predicted pressure response will be sensitive to the value of the volume modifier especially given that the grid used for simulations may not be adequately large. The combination of the grid dimension and assumed volume modifier value will artificially influence predicted pressure. This could dampen the modeled pressure response to injection and make the	Attachment B Section 2.2.2	See response to EPA question #2 for "aquifer" option sensitivity results. The CO2 plume area is the Area of Review of the model; therefore the modeled grid dimension provides sufficient coverage to evaluate incremental pressure in the area.	See Comments 2 and 11 above.

		predicted AoR too small. CMG-GEM has an "aquifer" option available for lateral boundary conditions, which enables the boundary to model an infinite aquifer. ***Please use the "aquifer" option instead of using large volume modifiers. It is recommended to study the sensitivity of the predicted pressure response to both grid dimension and the parameters used to set up the infinite aquifer.***			
14	Input Parameters vs. Site-Specific Conditions	In the absence of site-specific data on the caprock, the applicant has assumed that the caprock (shale) has the same geomechanical response as the target zone (sandstone) and assumed that the fracture pressure of the caprock is the same as that of the target zone. ***Please provide justification for these assumptions.***	N/A	Based on available fracture gradient data, the fracture gradient in the injection zone and surrounding shales appear to be quite similar (Table A-8). No fracture gradient data was available for the upper confining zone, so data from the H&T shale beneath the injection zone was assumed to be analogous for surrounding shales. Fracture gradient for both the injection zone and confining zone will be acquired via step rate test as part of the preoperational testing plan. Core rock mechanics data from both the injection zone and upper confining zone will be acquired as part of the preoperational testing plan. This will help to better assess the assumption of similar geomechanical response between the two formations.	This explanation is acceptable pending collection of site-specific data on the caprock during pre-operational testing. <u>*Consider adding this text to the AoR document or the Narrative.*</u>

15	Description of Computational Modeling Results	Please create plots of CO_2 saturation/pressure vs. lateral distance from the injection wells at various times, CO_2 saturation/pressure vs. time at the distance corresponding to the leading edge of the plume after CO_2 injection is terminated, and distance traversed by the plume for the injection and post- injection periods vs. time, in order to provide further evidence that plume movement has ended and that pressure has stabilized.	Attachment B Section 2.1	Figures B-18, B-21, B-22, and B-23 have been added to provide further evidence that plume movement has ended and that CO2 saturation and pressure have stabilized.	Acceptable response and modification.
16	Input Parameters vs. Site-Specific Conditions	*Please clarify how temperature, pressure, and salinity were populated throughout the model domain.* It appears that the model was run as isothermal at average reservoir temperatures despite its large thickness. The application does not discuss the local geothermal gradient and how much the temperature would vary based on the target injection zone. Given that CO_2 properties including density and viscosity are strongly dependent on the temperature and these properties affect the CO_2 movement and plume extent, it will be important to assess the variability of the temperature over injection interval and subsequent variability in the CO_2 plume extent and migration. *Please clarify whether the initial pressure condition in the reservoir was set based on a hydrostatic equilibrium or constant pressure.*	Attachment B Section 1.8	The temperature is set as variable with depth using a gradient of 0.013 deg/F, approximated from logging run bottom hole temperature data (Figure B-13) and an initial pressure was determined to be hydrostatic less 128 psi which is obtained as RFT pressure data from an analog PGE test injection well (Figure B-14 and Figure B-15). The pressure is defined at a datum depth, from which the reservoir simulation software equilibrates pressure for the model. Salinity of 15,500 PPM was used approximated from water analysis as discussed Attachment A, Section 2.8.2. Refer to Table B-2 for initial conditions summary.	Acceptable response and modification.

17	Input Parameters vs. Site-Specific Conditions	Hysteretic gas-phase relative permeability is claimed to be used, but the plots provided of relative permeability and capillary pressure (Figures 3.10 and 3.11) are non-hysteretic. ***Please provide hysteretic gas-phase relative permeability plots.***	Attachment B Section 1.5	A hysteretic gas-phase relative permeability plot has been added as Figure B-12.	Acceptable response and modification.
18	Input Parameters vs. Site-Specific Conditions	***Please provide the values used for the vertical permeability and the pore compressibility.***	Attachment B, Section 1.4	The permeability in the vertical direction is approximated as 1/5th of the horizontal permeability in the model. Pore compressibility is 3.5e-6.	***What is the horizontal permeability used in the model?***
19	Input Parameters vs. Site-Specific Conditions	The applicant determined the fracture gradient of the injection zone from the results of formation integrity tests in the Mokelumne River formation in nearby wells, and thereby determined the maximum pressure allowable in the storage formation. Plots of average pressure resulting from CO_2 injection suggest that reservoir pressure neared but did not come anywhere close to that value. However, pressure at the wells will be much larger than average reservoir pressure. ***Please verify that the pressure at the wells will be less than the fracture gradient of the injection zone.***	Attachment B, Section 1.10	Comparing the bottom hole pressure of the maximum design rate to the reservoir pressure at the end of the project life yields a difference of less than 110 psi in all modeled wells, which is greater than 1,000 psi below the fracture pressure of the injection zone. Each injectors bottom hole pressure is shown in Figure B-16 and grid block pressures surrounding the injection wells are reported in Figure B-17.	Acceptable response and modification.

20	Description of Computational Modeling Results	The critical pressure calculation was not documented adequately. Figure 3.17 shows that the storage formation is underpressured relative to the deepest USDW. However, the applicant does not use EPA's suggested formula for the underpressured case (EPA 2013, Method 1, Eq-1, Eq-2). Instead, they use EPA's suggested formula (Nicot et al., 2009, Eq. 9) designed for the hydrostatic case, with an ad hoc correction to account for underpressure (Eqs. (1) and (2)), with no explanation or justification. Even if Eqs. (1) and (2) do represent a reasonable approach, the applicant did not show the values for any of the variables that go into these equations except one (the amount of underpressure). They do not show any resulting critical pressure values, only the corresponding AoR footprint. A better approach would be to consider the geometry for which critical pressure will be a minimum (the smallest distance between the top of the storage formation and the bottom of the USDW), and calculate that one value of critical pressure, for which there is one set of input parameters to Eqs. (1) and (2). Then all the parameters should be displayed in a table. Also, as stated earlier the sensitivity of predicted pressure with respect to the imposed boundary condition and grid will affect the predicted AoR. ***Please revise the critical pressure calculation.***	Attachment B Section 3; Appendix 10	Attachment B Section 3 (AoR delineation) and Appendix 10 have been revised to rely on risk-based AoR delineation, and the pressure calculations are no longer used.	The risk-based AoR delineation method used by the applicant is not the recommended method for a storage reservoir system that is under-pressured. Page 39 of EPA's Class VI AoR and Corrective Action Guidance lists Method 1 as the recommended method for calculating the threshold or critical pressure that defines the pressure front used to delineate the AoR for under-pressured systems. ***Please perform the critical pressure calculation using Method 1 outlined in EPA's Class VI Well AoR Evaluation and Corrective Action Guidance for an under-pressured reservoir. Please use one set of input parameter values to Equations 1 and 2 of Method 1 and show these parameters and the resulting critical pressure value in a table.*** ***Please provide a figure that shows the contour line that encompasses the maximum extent of the separate-phase CO2 plume or pressure front. See Figure 3-6 on page 47 of EPA's UIC Class VI Well AoR Evaluation and Corrective Action Guidance for an example.***

21	Description of Computational Modeling Results	***In Figure 3.12, which shows CO_2 saturation at 100 years as a color map, please include values on the color scale.*** This will make it possible to see whether a dryout zone developed.	Attachment B Figures	Figure B-18 has been updated as requested.	Acceptable response and modification.
22	Description of Computational Modeling Results	***In Figure 3.12 and Figure 3.13, please identify the horizon or depth of the cross sections in plan view.***	Attachment B Figures	Figures B-18 & B-19 have been updated as requested.	***In Figure B-19, is this the maximum saturation at any depth? This should be stated in the text in Section 2.1 of Attachment B and on the figure.***
23	Model Calibration and Sensitivity Analyses	A regression relationship between porosity and horizontal permeability was derived from well log and core analysis using 13 data points from two wells located near the AoR. Then porosities from well-logs from about 70 wells within the model footprint were used to create a 3D porosity distribution and then a 3D horizontal permeability distribution. Permeability and porosity values were only varied by 10% from the mean. This is a very low variability and is not really a rigorous uncertainty quantification. ***Please develop P10, P50, P90 realizations of porosity and permeability to assess the sensitivity of predicted pressure and saturation fronts (and related AoR) to those parameter uncertainties.*** This should not be too time-consuming or computationally expensive given that the applicant has already utilized a sequential gaussian based	Attachment B Section 2.2.2	The uncertainty range in porosity was further studied and the range was expanded based on differences between core and log data. This resulted in an uncertainty range of -17% to +10% for porosity. The permeability uncertainty range was also increased and is now -50% to +100%. These changes are captured in sensitivity cases 16 to 19 (Table B-5). These changes to porosity and permeability have minimal effect on the AoR. Changes to the volumetric averaged pressure in the CO2 plume area and CO2 plume area are displayed in Figures B-27 and B-26, respectively. These sensitivity cases do not result in any additional corrective action wells. These are very large ranges, and they should adequately capture the expected uncertainty; CTV expects to narrow down the uncertainty range with site specific data during preoperational testing.	See Comment 5 above.

		kriging approach.			
24	Model Calibration and Sensitivity Analyses	Based on the range of porosity and permeability values, the sensitivity analysis does not represent a conservative approach since the range of variability used by the applicant is too small.	Attachment B Section 2.2.2	Please refer to response to EPA question #23.	See Comment 5 above.
25	Model Calibration and Sensitivity Analyses	***Please perform a mesh refinement sensitivity study.*** The applicant claimed to use 50' wide cells in the injection zone, but these are not shown in the grid figure. Even 50' is too large to properly model a potential water vaporization/dry out region and salt precipitation, and accurately reproduce pressure changes at the well.	Attachment B Section 2.2.2	Please refer to response to EPA question #11.	See Comment 11 above.
26	General Comments	***Geomechanical modeling is needed because of the presence of the faults. A leakage risk assessment for faults and penetrating wells is also needed.***	Attachment A Section 2.3.1 and 2.5.3	Fault sealing analysis and reactivation modeling have been added to Attachment A Sections 2.3.1 & 2.5.3, as requested.	See Comment 1 above.

27	General Comments	Many figures and tables are too low resolution - details cannot be read.	Attachment B Figures	Figures throughout the report have been revised or replaced, as requested.	Acceptable response and modification.
28	General Comments	References for critical pressure calculation are missing: Nicot et al., 2009 and McCutcheon et al., 1993.	N/A	These references are no longer included.	See Comment 20 above.
29	General Comments	The residual liquid saturation (Slr=0.53) is very large, making both liquid and gaseous relative permeabilities rather small. It would be worthwhile trying smaller values of Slr in the sensitivity studies (possibly in conjunction with higher intrinsic permeability), to see if the CO_2 plume moves more post-injection. As it is currently, it scarcely moves at all.	Attachment B Section 2.2.2	The reference Case 1 uses end point scaling with an end point of 0.34 for irreducible water saturation and critical water saturation. Hysteresis is modeled in the existing simulation runs using CMG hysteresis option and specifying parameters for end point scaling on the relative permeability curves. Case 11 utilizes the Moke Capillary pressure data and case 13 reduces end points of irreducible water saturation and critical water saturation to 0.25 (Table B-5). Both case variations do not show any change to the pressure in the CO2 plume area (Figure B-27) or the CO2 plume extent (Figure B-26).	See Comment 3 above.

30	General Comments	The brine density (1010 kg/m3) and viscosity (1.26E-3 Pa-sec) at reservoir conditions (T = 151 °F = 66 °C and P = 19.7 MPa = 2860 psi, salinity 15,500 ppm) both seem too big. Justification for these values is needed.	Attachment A Tables	Table A-15 has been updated to display reservoir condition fluid properties.	***Please provide justification and documented evidence of the values displayed in Table A-15.***
31	General Comments	The lowermost USDW is referred to as "*undifferentiated non-marine sediments*" in one place and as "*the Markley Formation*" elsewhere. Please clarify the inconsistency.	Attachment A Section 2.2.2 and 2.7.3	The lowermost USDW is the Upper Markley Formation. Section 2.2.2 and 2.7.3 and Figures A-12 and B-1 have been updated to clarify the discrepancy.	Acceptable response and modification.
32	General Comments	The file "Att A – CTV III Storage Project_V4.pdf" (Project Narrative), Figure 2.7-4 shows a cross section B-B'. Along the cross-section, intersections with other cross-sections are indicated: C-C' seems to be in the wrong place, D-D' and E-E' are never mentioned, and B-B' does not make sense for a cross-section to intersect itself.	Attachment A Figures	Figure A-48 and A-49 were modified from GEI Tracy Subbasin GSP, Nov 2021, figure 4-10, p.112. Cross sections on Figure A-48 and A-49 have been relabeled to correct the issue.	Acceptable response and modification.
33	General Comments	Some Figures were numbered incorrectly, e.g., Figure 3.2 was used twice on pages 5 and 8 of the "Att B - AoR_CA CTV III V3.1.pdf" file.	Attachment B Figures	The figure was mislabeled and has been updated to reflect the correct figure number, Figure B-4.	Acceptable response and modification.

34	General Comments	On page 20 of the “Att B - AoR_CA CTV III V3.1.pdf” file, the applicant notes that “The results of CTV’s simulation compare favorably against the previous work by LBNL regarding storage capacity and CO_2 plume size.” The applicant neither shows any comparison plot nor cited the LBNL’s study that was referenced.	Attachment B Section 2.2 and References	References have been added to Section 2.2 and the reference section of Attachment B	***Please provide a copy of or a link to the LBNL’s study.***
35	General Comments	On page 20 of the “Att B - AoR_CA CTV III V3.1.pdf” file, Figure 1 should be named Figure 3.15.	Attachment B Section 2.2.1	The figure reference was mislabeled and has been updated to reflect the correct figure number, Figure B-24.	Acceptable response and modification.
36	General Comments	On page 20 of the “Att B - AoR_CA CTV III V3.1.pdf” file, the applicant notes that “The CO_2 plume for Injectate 1 and Injectate 2 is consistent with the plume outline for 100% CO_2 injectate (Figure 1), which was defined by a 0.05 global CO_2 mole fraction for all 3 cases. The 100 year post end of injection plumes for the 3 cases are shown below in Figure 1.”. There is no Figure 1 in the report.	Attachment B Section 2.2.1	The figure reference was mislabeled and has been updated to reflect the correct figure number, Figure B-24.	Acceptable response and modification.
37	General Comments	On page 27 of the “Att B - AoR_CA CTV III V3.1.pdf” file, the applicant states that “Attachment B-3 shows diagrams for the current well configuration and proposed corrective action.” Attachment B-3 is missing.	Attachment B Section 4.5	This reference was mislabeled. It has been updated to reflect the correct name, Appendix B-3.	Appendix B-3 is still missing. ***Please provide a copy of the appendix.***

38	Project Interference with the Pelican Renewables and CTV V Projects	EPA guidance[1] states that "In all cases, EPA recommends that AoR delineation models account for all wells injecting into (including any injection wells associated with other UIC well classes or other Class VI operations) or pumping from the injection zone or any other zones that are hydraulically connected to the injection zone." Pressure plumes follow the principle of superposition, where pressure is additive. Thus, to correctly calculate the AoR for these three close sites, CTV and Pelican should include the pressure buildup of the other sites in their calculations; for example, add an extra injection well to reflect the total injection volume from the other projects in the simulations. Please propose how CTV would like to proceed. Pelican has been provided this information as well, and their application materials can be found on the EPA's website2. If it would be helpful, EPA can facilitate a meeting between CTV and Pelican to discuss this issue.	Attachment B Section 3; Appendix 10	The permit application was revised to evaluate interference from the 3 projects. Case 12 simulation run considers interference from all three projects. Specifically, risk-based AoR delineation accounted for the combined pressure increase from the 3 projects (see Appendix 10).	The applicant states that they ran a sensitivity Case 12 to examine the impacts of pressure interference from Pelican and CTV-V. They state that the addition of these pressure sources did not impact the results from the risk-based AoR delineation. However, as stated in the Evaluation Summary and Comment 20 above, the risk-based approach for AoR delineation is not recommended for an under-pressured storage reservoir system. ***Please re-run the Case 12 simulation based on the AoR delineated according to the four steps described in Box 3-2 on pages 56-60 of EPA UIC Class VI Well AoR and Corrective Action Guidance[2].*** ***Please provide a discussion around the impact on magnitude of pressure increases and AoR boundary without and with the interference of the Pelican and CTV-V projects.*** ***Please provide a figure that shows the pressure difference between the case with and the case without the interference of the Pelican and CTV-V projects.***

[2] https://www.epa.gov/sites/default/files/2015-07/documents/epa816r13005.pdf