Review of CTV's responses to EPA's technical questions on the site characterization narrative in their CTV-III permit application

EPA reviewed CTV's site characterization for the CTV III Class VI project and provided technical questions to the applicant on 2/20/24. CTV responded on 5/24/24 and provided an updated narrative (V5). EPA's evaluation of the responses is in the far-right column of the table below.

Section	Q #	Comment/Question for CTV	Text Section Updated	Response	Evaluation of Response
Maps and Cross Sections of the AoR [40 CFR 146.82(a)(2), 146.82(a)(3)(i)]	1	*Please indicate the delineated AoR on Figure 2.2-3.*	N/A	Figure A-11 (former figure 2.2-3) was updated to display the delineated AoR.	The map was updated as requested.
	2	*Please provide a single map that contains all of the elements required at 40 CFR 146.82(a)(2).*	Attachment A Section 2.2	New Figure A-8 and corresponding Tables A-1, A-2, and A-3 have been added and are referenced in Section 2.2.	Figure A-8 shows all of the required items, except mines and quarries, which the text states are not present in the AoR; the faults described in the application are not shown on the map. ***Follow-up request: For completeness, please include the faults around and within the AoR on Figure A-8.***
Faults and Fractures [40 CFR 146.82(a)(3)(ii)]	3	*Was 3D seismic data available to confirm the locations of the bounding faults and confirm whether they are connected in the corners of the AoR?*	N/A	3D seismic data were not available to confirm whether the bounding faults were connected. Section 2.3-1 describes the rationale for connecting the faults and the basis of fault traces. Additionally, connecting these faults at their corners as a closed boundary creates a maximum pressure build up and most conservative case when considering fault stability (Section 2.5.3) and pressure front in our analysis and modeling. Refer to updated Figure A-11 to view the AoR relative to the available seismic data.	See #5
	4	*It appears, based on Figure 2.3-2, that the normal fault within the plume boundary completely transects the upper confining zone. What formation-specific evidence is there that this fault would not interfere with containment in the Capay Shale upper confining zone, per 146.82(a)(3)(i) and the confining zone is "free of transmissive faults or fractures" to contain the CO_2 per 146.83?*	Attachment A Section 2.3.1	An Allan diagram, shale gouge ratio (SGR) and shale smear factor (SSF) analysis were completed for the normal fault within the plume boundary. New figure A-19 displays the Allan diagram and shows a Capay shale overlap ranging from 98-feet to 198-feet along the length of the fault. The SGR and SSF analysis demonstrate that the fault is sealing. Section 2.3.1 has been updated.	See #5.

Section	Q #	Comment/Question for CTV	Text Section Updated	Response	Evaluation of Response
	5	*Is any site-specific evidence available (other than the offset and thickness of the upper and lower confining zones) to demonstrate that the normal fault in the boundary of the CO_2 plume is sealing? See Section 3.5.2 of EPA's Class VI Site Characterization Guidance for acceptable lines of evidence and associated data, (e.g., Allan charts for unit juxtaposition; capillary pressure and permeability measurements for fault leakage, catalysis, or diagenetic sealing; shale gouge ratio; and pore pressure measurements for pressure compartmentalization).*	N/A	In regards to the sealing nature of the normal fault in the upper confining zone, see response to EPA question #4 above. A lower confining zone is no longer defined in this application; therefore, a response is not required.	CTV provided the requested information for the 3 major faults that bound the AoR. For the Midland Fault, an Allan diagram is based on a cross-section centered on well Pagano 2-4 is shown in Figure A-20. CTV references SGR and SSF values of 100% and <1, respectively. An Allan diagram for the Stockton Fault is shown in Figure A-21; CTV calculated a SGR range of 31% to 67%, and a SSF less than 1. Figure A-22 shows the West Tracy Thrust Fault Allan diagram based on seismic interpretation and the Mokelumne Formation as identified in well Souza 1 on the hanging wall. The SGR and SSF analysis show values of 18% and 1, respectively. The update provides a data set consistent with the Site Characterization Guidance recommendations; however, the calculations and supporting data were not provided. Based on a literature review, SGR values of 15–18% are consistent with adjacent fault blocks having small pressure differentials (<1–2 bar) and values of >18% correspond to significant seal (ca. 8 bar). https://www.sciencedirect.com/science/article/abs/pii/S0928893797800100 ***Follow-up request: Please provide supporting data and calculations for the SGR and SSF analyses.***
	6	*When and where was the "current" 1,200 psi pressure measurement taken? If it was not within the past 2-3 years, please discuss how field operations since the pressure measurement may have affected current pressures in the reservoir.*	Attachment A Section 2.3.1	The Winters pressure reference has been removed and replaced with an Allan diagram, SGR and SSF analysis. The sealing nature of the Stockton Arch Fault is discussed in Section 2.3.1.	See #5. While the applicant provided other lines of evidence of sealing as requested, it is unclear why the applicant no longer presents pressure compartmentalization as evidence. ***Follow-up request: Please clarify why pressure compartmentalization is no longer presented as evidence of sealing.***
	7	*Does CTV have core data from drilling any wells in the McDonald Island Gas Field or Union Island Gas Field or from any other research on GS in the state of California that can provide porosity, permeability, capillary pressure, pore pressure, mineralogy, etc., data about the injection or confining zones to increase the number of data points on which the site characterization is based?*	Attachment A Section 2.4.1 and 2.4.2	Section 2.4.1, including Table A-5 were updated to reflect the inclusion of the Citizen_Green_1 well in the Mokelumne Formation minerology analysis. Section 2.4.2 including figure A-9 and A-30 were updated to reflect the Mokelumne core data used for the comparison of log porosity and permeability data of the Injection Zone. Table A-6 which lists the core samples	Per Table A-5, minerology analysis results were different than in the other wells; however, they show similar percentages of total clays and feldspar. Table A-6 porosity (~27-31%) and permeability (averaging 72mD, removing outliers) values are similar to those reported elsewhere in the

Section	Q #	Comment/Question for CTV	Text Section Updated	Response	Evaluation of Response
				has also been added.	application. The well is located about 15 miles north of the AoR; however, the response addresses the request and is acceptable pending site-specific data collection.
	8	*If no site-specific data exist to address the above questions, what pre-operational testing does CTV plan to address these data gaps?*	Attachment I	Attachment I: Preoperational Testing plan lists the pre-operational testing that is planned to be performed, including for the parameters noted.	Acknowledged. The pre-operational testing plan describes geomechanical testing, including principal stresses, pore pressure, and other petrophysical parameters.
	9	*On page 40, the application states that "the small normal fault within the plume does not breach confining zones;" however, Figure 2.3-2 shows that the fault does appear to transect these confining zones. Please clarify the discrepancy.*	Attachment A Section 2.6.2	The small normal fault within the plume is not vertically transmissive and therefore does not diminish the sealing effectiveness of the Capay Shale Upper Confining Zone. Refer to the response to EPA question #4 for details on SGR, SSF and offset analyses. The text in Section 2.6.2 has been updated to provide clarity.	The referenced section discusses hazard mitigation and merely states that the formation is non transmissive in the Capay Shale. However, there is added discussion of the sealing nature of the fault in Section 2.3.1, including an Allan diagram (Figure A-19), and SGR and SSF analysis show values of >90% and <1, respectively. (See #5.) Note that Figure 2.3-2 is now Figure A-18. The response is acceptable.
Injection and Confining Zone Details [40 CFR 146.82(a)(3)(iii)]	10	Cores collected during construction will need to confirm site-specific properties, including porosity, permeability, capillary pressure, pore pressure, mineralogy, etc.	Attachment I	Attachment I: Preoperational Testing plan lists the coring program planned	Acknowledged; the purpose of the statement is to document the need for the testing and what EPA will expect it to provide. Attachment I describes a suite of tests that address EPA's requests or objectives; however, it does not identify the wells in which formation testing will be performed. *As noted in the evaluation, EPA recommends testing be performed in each of the injection wells to provide coverage across the AoR.* ***Follow up request: Please identify the formations to be evaluated by the various testing methods described in the pre-operational testing plan.***
>> Confining Zone Properties (H&T Shale [Lower Confining Zone])	11	*Where are the two wells (described on pg. 24) that are the source of the core data used for the permeability transform?*	Attachment A Section 2.4.2	RVGU_209 and RVGU_248 were used to develop the permeability transform and provided location in Fig A-24. Section 2.4.2 has been updated.	Per Figure A-24, the two wells are about 20 miles northeast of the AoR; the response is acceptable pending site-specific data collection.
	12	*What site-specific evidence is available to support the statement on pg. 31 that variability in the thickness and depth of the injection or confining zones will not affect containment?*	Attachment A Section 2.4.6	In addition to well log data, site specific depth and thickness information for the injection and the confining zone is also available from seismic data. As shown in Figure A-11, 3D and 2D seismic data provide good coverage over the AoR. The coverage of these data and the well	The requested information was included in the narrative and is consistent with other findings of the review. The response is acceptable.

				control in the structural model area provide confidence in the thickness and continuity of injection and confining zones. Computational modeling results discussed in Attachment B: AoR and Corrective Action Plan show that the structural variability in the Capay and Mokelumne River Formations caused by the Meganos submarine canyon erosional event do not impact confinement. Section 2.4.6 has been updated with these details.	
	13	*Where is the Meganos Submarine Canyon relative to the AoR? For clarity, please denote this feature on Figure 2.2-4 and other relevant figures.*	N/A	The Meganos Canyon trends southwest-northeast through the northern portion of the project area. Figures A-12 and B-1 (former figure numbers 2.2-4 and 3.1) have been updated to display the Meganos Submarine Canyon. Mokelumne River and Capay Thickness and Structure maps have also been updated (Figure A-13 and A-32). New figure A-46 also displays the Meganos Submarine Canyon.	The feature is about 2 miles outside of the AoR; the response addresses the request and is acceptable.
	14	*Please explain why the Winters Formation is considered to be a representative analog for the proposed injection zone within the Mokelumne River Formation.*	N/A	Following initial submission, the Citizen_Green_1 well located in the nearby King Island Gas Field was discovered to contain capillary pressure data from the Mokelumne Formation. A sensitivity analysis (Case 11, discussed in Attachment B: Area of Review and Corrective Action Plan, Section 2.2.2) was run using the Citizen_Green_1 data. Results indicated negligible changes to the AoR, CO2 plume, and pressure field. Therefore, the winters data from Sonol_Securities_5 is adequate for modeling purposes until site- and zone-specific data can be obtained as part of the pre-operational testing program.	The application now references the Citizen_Green_1 well (15 miles north of the AoR); however, it does not appear to provide actual values from the well, and Figure A-31 (with capillary pressure data used in the modeling) appears to be the same as in the initial application. While documenting the actual values would improve the completeness of the application, the response is acceptable pending pre-operational data collection. ***Follow-up question: What are the values from the Citizen_Green_1 well?***
	15	*Why does CTV consider capillary pressure data for the Winters Formation to be an appropriate value for the Mokelumne River Formation within the AoR?*	Attachment A Section 2.4.3	See response to EPA question #14. Section 2.4.3 has been updated.	See #14.
	16	*Which of the "wells with relative perm or capillary pressure data" on Figure 2.1-7 provided the capillary pressure data used?*	Attachment A Section 2.4.3	Sonol_Securities_5 provided the capillary pressure data. Figures A-7 and A-30 (former figures 2.1-7 and 2.4-1) have been updated to display the well location.	Sonol_Securities_5 is just outside the AoR to the east. The response is acceptable pending pre-operational data collection.
Geomechanical and Petrophysical	17	*The narrative states that the brittleness factor for the Ohlendorf_Unit_1_1 well is shown on Figure 2.5-1; however, this is not included on the figure. Please revise the figure.*	N/A	Figure A-33 (former figure 2.5-1) has been updated.	The figure was updated as described; no further questions.

Information [40 CFR 146.82(a)(3)(iv)]	18	*Please clarify where the 0.91 psi/ft overburden stress gradient was referenced, or state how it was determined.*	Attachment A Section 2.5.2	The overburden gradient was calculated by integrating density logs from seven wells (Table A-9). The method for calculating the overburden gradient was to integrate the density logs using methodology laid out in Fjaer et al (2008): $$\sigma_v = \int_0^D \rho(z) g \, dz$$ where ρ is the density of the sediments, g is the acceleration due to gravity, D is the depth of interest, z is the vertical depth interval, and σ_v is the vertical stress. Reference: Fjaer, E., Holt, RM., Raaen, AM., & Horsrud, P. (2008). *Petroleum Related Rock Mechanics* (2nd ed.). Elsevier Science. Section 2.5.2 has been updated.	The response is added to Section 2.5.2 of the application. ***Follow-up request: Please provide documentation of the overburden gradient calculation.***

Seismic History [40 CFR 146.82(a)(3)(iv)]	19	*Please provide an evaluation, based on site-specific data and in consideration of proposed operating data (e.g., injection pressure), of the potential for induced seismicity along the normal fault within the AoR.*	Attachment A Section 2.5.3	The stability of the faults within and bounding the CTV III project AoR were analyzed using Mohr coulomb criteria. Four faults were studied: The Stockton Arch Fault on the eastern boundary of the project, the West Tracy Fault on the southern boundary of the project, the Midland Fault on the western boundary of the project, and the normal fault within the CO_2 plume. The input parameters for the Mohr Circle are shown in Table A-10 and can be referenced in Sections 2.3.1 and 2.5.2. The reference depth for all calculations was set to 6,900 feet TVD. The maximum horizontal stress gradient was determined using data from Lund-Snee and Zoback (2020). The maximum horizontal stress direction is 37.4º as stated in section 2.5.2. Fault strike and dip was averaged over each fault's contact with the project area in the vicinity of the AoR. The coefficient of friction was assumed to be 0.6 and the faults were prescribed a cohesive strength of 0 psi. Based on Mohr circle analysis, all of the faults are currently far from failure and will continue to be stable even after CO_2 injection has ceased (Figure A-37). Analysis by Mohr circle shows that the required pore pressure increase to reactivate any of the faults is over 1,800 psi above present day conditions (Figure A-38). This equates to a reservoir pressure of over 4,700 psi (equivalent to 0.68 psi/ft at the reference depth of 6900' TVD), far above the expected final pressure gradients after CO_2 injection has ceased. Pressures gradients in the CTV III project area along the three bounding faults (West Tracy, Midland, and Stockton Arch) are only expected to increase to approximately 0.47 psi/ft (Table A-11). This pressure gradient is very similar to the discovery pressure of the Mokelumne River Formation in Rio Vista gas field, where the Mokelumne gas reservoir is trapped against the Midland fault (Section 2.3.1). In deeper reservoirs in direct contact with both the Midland and Stockton Arch faults in gas fields in the project vicinity, discovery pressures approached 0.49-0.53 psi/ft (Section 2.3.1). The fact that these faults held natural gas reservoirs with these pressure gradients for long periods of	A fault stability analysis for the normal fault and the three bounding faults was added to the application, which improves the presentation of fault stability. However, the application only references the model predicted pressure increase along the three bounding faults. ***Follow-up question/request:*** ***What is the model-predicted pressure increase along the normal fault, and does the fault stability analysis hold true at this pressure?*** ***There was a magnitude 3.0 earthquake in/near Discovery Bay that occurred in February 2024. Please update the seismic history section of the application with the most updated information.***

				geologic time helps to reinforce the Mohr circle explanation of these faults being stable at higher reservoir pressures. New Section 2.5.3 Fault Reactivation was added to discuss fault stability.	
	20	*Please discuss further how the anticipated pressure increases due to CO_2 injection compare to existing/historical reservoir pressures and why CTV asserts that there are no concerns for fault reactivation.*	N/A	See response to EPA question #19.	See #19.
	21	*What pre-operational testing will be conducted to confirm CTV's assumptions regarding seismic hazards and induced seismicity?*	Attachment I	Attachment I (Pre-Operational Testing Plan) lists seismicity monitoring and geomechanical testing that will be performed.	The testing includes establishing pressure in the injection zone via pressure gauge measurement and establishing baseline seismicity. Response is acceptable; see #10.
Hydrologic and Hydrogeologic Information [40 CFR 146.82(a)(3)(vi), 146.82(a)(5)]	22	**Additional characterization of the lowermost USDW within the Markley Formation to satisfy the requirements of 146.82(a)(5) is required.**	Attachment A Section 2.7.2	New Figure A-46 displays a plan-view map of the base of the lowermost USDW across the model boundary.	Figure A-46 is a map showing the depth to the base of lowermost USDW in the project vicinity. It is at a large scale and does not provide any additional site-specific data; however, an objective of pre-operational testing (fluid sampling of the USDW) will provide the requested information. The response is acceptable at this point in the permit review.
	23	*Is any site-specific information available about the TDS content of the Markley Formation that contains the USDW?*	N/A	All available TDS data was already included in Section 2.7.2. No additional TDS data are available.	Acknowledged.
	24	*Where are the wells on which the geophysical logs used for the Markley Formation salinity calculations are based?*	Attachment A Section 2.7.2	Salinity calculations were performed on 41 wells in order to create a regional USDW surface. See new Table A-13 for well list and a map at Figure A-45.	The map is included in the application as described; two of the wells are within the AoR. The response is acceptable.
	25	*On page 46, the reference to Figure 2.2-3 in the statement about TDS range of 3,000 to 10,000 mg/L is incorrect (this figure is a summary map of the seismic data used to build the structural model). Please correct the figure reference.*	Attachment A Section 2.7.3	The figure reference has been updated to reference figure A-12.	The application was updated as described; no further questions.
	26	*Please provide Table 2.7-1 in the text of the narrative or as an attachment.*	Attachment A Tables	Table A-14 (former Table 2.7-1) has been added to the Table section of Attachment A.	The application was updated as described; no further questions.
Confining Zone and Injection Zone Geochemistry [40 CFR 146.82(a)(6)]	27	*How did CTV determine that the Capay Shale and H&T Shale will only provide formation fluid samples if stimulated?*	Attachment A Section 2.8.3	The statements pertaining to stimulation were removed. The intent was not to propose stimulation in the confining zones, rather it was to show the difficulty of collecting a water sample in these formations.	Acknowledged.
	28	*Which wells are the sources of the TDS values cited for the Mokelumne River Formation?*	Attachment A Section 2.8.2	Water samples are sourced from the Midland_Fee_Water_Injection_1 well (Figure A-54) located in the Rio Vista Gas Field, and the Piacentine_2-27 well (Figure A-55) located in the King Island/PGE Gas Field. Section 2.8.2 and Figure A-36 was updated to include both well locations.	The response provides the requested information and is acceptable. As noted elsewhere, pre-operational testing (fluid sampling of the USDW) will provide site-specific data needed to characterize the USDW in the AoR.

Site Suitability [40 CFR 146.83]	29	No concerns about potential facies changes that could affect the project were noted as part of this evaluation. **However, as noted elsewhere, these assertions are based on data collected outside the AoR; data collected during pre-operational testing should be evaluated to confirm these assertions and reduce uncertainties in the characterization of facies changes and allow final approval of the AoR.**	Attachment I	Attachment I (Pre-Operational Testing Plan) includes pre-operational tests that will be performed to confirm assumptions, and model revision will be performed if needed based on newly collected data.	See #10
	30	CTV asserts based on formation thicknesses (as shown in maps in the application) that the confining zones are adequately sealing across the 100 ft offset over the upper confining zone and the 170 ft offset across the lower confining zone. These assertions about regional structural features appear to be supported by available regional data. **However, additional characterization of the faults that form the AoR boundaries and the normal fault is needed to confirm these assertions**. CTV should provide additional evidence of fault sealing, i.e., data to clarify the juxtaposition of units, potential for leakage along faults, catalysis, diagenetic sealing, shale gouge ratio, and/or pressure compartmentalization per EPA's Class VI Site Characterization Guidance.	Attachment A Section 2.3.1	Fault seal analysis using Allan diagrams, SGR and SSF calculations were completed for Project area faults. As discussed in response to EPA question #4, the normal fault Allan Diagram (Figure A-19) shows an upper confining zone Capay Shale overlap of 98-feet to 198-feet along the length of the fault. This overlap with the combination of the SGR and SSF calculation results (>90% and <1, respectively) demonstrate that the normal fault is sealing (Yielding et al, 2010). As discussed in response to EPA question #6, the Stockton Fault Allan diagram (Figure A-21) shows a partial juxtaposition of the Mokelumne Formation (injection zone) on the footwall side of the fault against the H&T Shale on the hanging wall side of the fault. The Allan diagram combined with the SGR and SSF calculation results (31-67% and <1, respectively) demonstrate that the fault is sealing (Yielding et al, 2010). The West Tracy Fault Allan diagram (Figure A-22) shows that the Mokelumne Formation (injection zone) on the footwall side of the fault is fully juxtaposed against the H&T Shale on the hanging wall side of the fault. The Allan diagram combined with the SGR and SSF calculation results (18% and 1, respectively) demonstrate that the fault is sealing (Yielding et al, 2010). The Midland Fault Allan diagram (Figure A-20) shows that the Mokelumne Formation (injection zone) on the hanging wall side of the fault is partially juxtaposed against the H&T Shale on the footwall side of the fault. The Allan diagram combined with the SGR and SSF calculations (100% and <1, respectively) demonstrate that the fault is sealing (Yielding et al, 2010).	See # 5. The intent of this highlighted statement is to indicate that site-specific data collection is necessary as part of the pre-operational testing program prior to authorization of injection.

				Section 2.3.1 has been updated to reflect these fault seal analyses. Reference: Yielding, G., Bretan, P., Freeman, B. 2010. Fault Seal Calibration: A Brief Review. Geological Society, London, Special Publications. 347. 243-255. 10.1144/SP347.14	
	31	**Given the limited amount of geochemical and mineralogic data on the injection and confining zones from within the AoR, geochemical modeling inputs will need to be updated with site-specific data collected within the AoR during pre-operational testing to reduce uncertainty about the geologic characterization of the site and ultimately approve the AoR delineation before CTV is authorized to inject CO_2.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised to include geochemical data collection and updated geochemical modeling.	See #10.
	32	While the upper confining zone is relatively thin (i.e., 100 feet in some areas), pre-operational testing, particularly formation characterization as the injection and monitoring wells are drilled, should confirm uniformity in the thickness and a lack of any transecting faults or fractures to clear potential concerns for confinement. Notably, the transecting normal fault within the extent of the CO_2 plume must be demonstrated to not interfere with containment of the injectate. **Additionally, step-rate testing to determine fracture pressure will be needed to ensure that operating pressures are appropriate to confining zone geomechanical properties.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised to include Step Rate Tests and geomechanical properties data collection.	See #10, particularly related to geomechanical characterization.
	33	*Please provide information and calculations regarding how CTV determined the storage capacity of the injection zone, and how site-specific properties of the injection zone and operational conditions were factored into this evaluation.*	Attachment A Section 2.10	As discussed in **Attachment B: Area of Review and Corrective Action Plan**, a dynamic model was generated for each target injection zone with data from the static model (structure, porosity, absolute permeability, net to gross ratio, facies), special core analysis (relative permeability and capillary pressure), pressure, volume, temperature (PVT) analysis (fluid PVT), geochemical analysis (water salinity). Injector locations are based on geologic interpretation, petrophysical properties, and economic optimization. Injection rates were analyzed with flexibility to handle offset well failure during the project period. Injectors were also designed with a maximum allowable injection pressure limit. To assure storage site safety during the injection period, reservoir pressure was also controlled by critical pressure. Dynamic model results predicted a storage volume of 70.6 MMT at 28 years, using six CO2 injection wells.	The requested discussion was provided; no further questions at this point in the review. The inputs to the dynamic model will need to be confirmed or updated following pre-operational testing.

	34	*Please characterize the Nortonville Shale and Domengine Sandstone as secondary confining zones to satisfy the requirements of 40 CFR 146.83(b).*	Attachment A Section 2.2.2	According to EPA Class VI regulation and guidance, formal definition of secondary confining zones is needed only when the primary confining zone is determined to be potentially insufficient for containment (e.g., see the Class VI Site Characterization Guidance Section 3.6). In this case the Upper Confining Zone exhibits sufficient thickness, low permeability, extent and integrity and no Secondary Confining Zone is needed. The presence of overlying low-permeability zones (e.g., Nortonville shale) provides redundant containment and this is noted in Attachment A. However, CTV does not agree that definition of the Nortonville shale or other zones as Secondary Confinement Zones under the Class VI regulations is necessary to demonstrate site suitability. Section 2.2.2 has been updated to remove any mention of a secondary confining zone.	The response is acceptable pending confirmation of the physical and geomechanical properties of the primary confining zone.

Site Geomodel	35	**As data are collected from within the AoR during pre-operational testing, the inputs at the finer grids should be revised as necessary to reflect any heterogeneities identified.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	See #10.
	36	• Table 3.4 contains injection pressure details, including the estimated maximum allowable injection pressures at 90% of the assumed fracture pressure and elevations in each well corresponding to the maximum injection pressure. **The fracture pressure used in the model is assumed, and CTV will be required to perform a step rate test to confirm these values as part of the pre-operational testing.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	See #10..
	37	*Figure 3.4 in the AoR/CA Plan appears to be mislabeled as Figure 3.2. Please correct this discrepancy.*	Attachment B Figures	The incorrect Former figure number (Figure 3.2) has been updated to Figure B-4.	The plan was updated as requested; no further questions.
	38	*The reference to Figure 3.9 in the AoR/CA Plan on pg. 11 appears to refer to Figure 3.8 a second time. Please correct this typographical error.*	Attachment B, Section 1.4	The incorrect Former figure reference (Figure 3.8) has been updated to Figure B-9.	The plan was updated as requested; no further questions.
	39	*Please provide the data source used to estimate the fracture pressure value used in the geomodel.*	Attachment A Section 2.5.2	New Table A-8. Wells with Data for Fracture Gradient Determination has been added.	The table was added as requested. The wells are in the King Island and Union Island Fields. The response is acceptable pending site-specific data collection.
	40	*Please further elaborate on the data sources listed in Table 3.2, and please provide the data that were used to determine formation initial conditions.*	Attachment B, Section 1.8	Refer to the response in Comment Matrix – CTV lll Computational Modeling, EPA question #16. Refer to Figure B-13 for temperature data and Figures B-14 and B-15 for pressure data.	The information was provided as requested.
Summarized Objectives for Pre-Operational Testing	41	**• Identify site-specific mineral composition and petrophysical characteristics of the injection and confining zones at the location of each injection well.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	See #10.
	42	**• Clarify formation ductility, principal stresses, pore pressure, fracture gradient, and other petrophysical parameters to confirm assumptions used in geomechanical modeling.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	See #10.
	43	**• Determine static fluid levels (per 40 CFR 146.87(c)).**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	See #10.
	44	**• Characterize the hydrogeologic characteristics of the injection zones using a pump test or injectivity test (per 146.87(e)).**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	See #10.
	45	**• Characterize formation fluid geochemistry and identify potential geochemical reactions and interactions between the injection and confining zone mineralogies and formation brines with the CO_2 injectate to confirm the assumptions and results of the initial geochemical modeling to predict changes in formation water chemistry, mineral precipitation, and dissolution reactions.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	See #10.
	46	**• Identify potential fractures within the carbonates of the Capay and H&T Shale confining zones and evaluate their effect on confinement.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised to include SEM analyses. Note carbonate content is relatively low in these formations.	See #10.

	47	**Determine precise injection zone storage capacity based on site-specific injection zone characteristics and operational data.**	Attachment I	Attachment I (Pre-Operational Testing Plan) has been revised as requested.	Attachment I states that CTV will reevaluate CO_2 storage capacity based on site-specific injection zone characterization. *As noted above (#10), testing within multiple wells is recommended to provide a sufficient number of data points to improve the model's predictive accuracy.*
	48	**Confirm pressure isolation within the Mokelumne River Formation injection zone and other stratigraphic intervals across the major faults surrounding the AoR.**	Attachment A Section 2.3.1	Refer to the fault seal analysis responses to EPA question #4, #6, and #30.	The pre-operational testing plan describes geomechanical testing, including of principal stresses, pore pressure, and other petrophysical parameters.
	49	**Confirm that the unnamed normal fault transecting the upper and lower confining zones within the boundary of the CO_2 plume will not interfere with containment (per 40 CFR 146.82(a)(3)(ii); see Section 3.5.2 of EPA's Class VI Site Characterization Guidance).**	N/A	The Domengine will be monitored during active injection using monitoring well D1. Refer to Attachment C: Testing and Monitoring Plan monitoring details. Refer to the fault seal analysis responses to EPA question #4, #6, and #30.	See #48.
	50	*Please update Attachment G to include the following:* • *Detailed procedures for all planned testing.* • *Core sampling in each of the injection wells to provide a distribution of site-specific data, which will aid in accuracy.* • *Triaxial load testing to determine compressive strength and ductility in the upper confining zone.*	Attachment I	Coring program and triaxial load testing are listed in Attachment I - Preoperational Testing Plan.	CTV included triaxial load testing in the attachment as requested; however, as noted above, *EPA recommends that CTV perform core testing in all injection wells.* The plan does not describe step by step procedures for the testing; it is noted that the test procedures will need to be provided before CTV may perform them (providing them with the permit application may expedite approval of the testing). ***Follow up request: Please describe step by step procedures for the triaxial load testing.***