Review of Project Plans for the CTV II Class VI Project

This evaluation report for the proposed CTV II Class VI Sequestration Project summarizes EPA's evaluation of several plans in the permit application submitted by Carbon TerraVault Holdings, LLC (CTV). Each plan evaluation is a self-contained report to facilitate separate requests for additional information. Questions and requests for CTV are provided below in *blue italics*.

Attachment A: Operational Procedures

This evaluation report for the proposed CTV II Class VI Sequestration Project summarizes EPA's evaluation of the operational procedures that CTV proposes during injection into the Winters Formation. CTV submitted information regarding operational procedures in their Class VI permit application narrative dated February 28, 2024 (Version 5).

Operational procedures for the five proposed injection wells are described in Tables 1 through 5 of Appendix 4 of the application narrative. Operating parameters and conditions for each well are summarized in Table 1 below:

Table 1. Operating Parameters and Conditions

Parameters/Conditions	Unit	Sonol Securities 1-A	Sonol Securities 3	Pool B-2	UI-INJ-1	UI-INJ-2
Maximum Injection Pressure						
Surface	psig	2,448	2,447	2,471	2,465	2,472
Downhole	psig	6,043	6,061	6,178	6,163	6,146
Average Injection Rate	mmscfpd	10	10	10	10	10
Average Injection Pressure						
Surface	psig	1,297	1,274	1,098	1,080	1,092
Downhole	psig	3,388	3,372	3,065	2,960	3,005
Maximum Injection Rate	mmscfpd	15	15	15	15	15
Injection Rate Range	mmscfpd tonnes/day	10 - 15 530 - 794	10 - 15 530 - 794	10 - 15 530 - 794	10 - 15 530 - 794	10 - 15 530 - 794
Average Injection Mass	million tons	4.5	4.5	4.5	4.5	4.5
Average Annulus Pressure						
Surface	psig	100	100	100	100	100
Downhole	psig	4,635	4,649	4,356	4,342	4,365
Annulus – Tubing pressure differential at Packer	psig	1,247	1,277	1,291	1,382	1,360

According to Table B-6 of the AoR and Corrective Action Plan, CTV proposes to operate each well for 24 years, from 2025-2048.

Injection Pressure

The maximum allowable injection pressure (MAIP) calculated for each well incorporates a safety factor of 90% of the formation fracture pressure, where local fracture pressure is estimated by an assumed fracture gradient of 0.7 psi/ft. CTV chose this fracture gradient for their Area of Review (AoR) modeling as a conservative estimation, since formation integrity tests conducted in nearby wells in shallower formations showed higher gradients ranging from 0.75 to 0.809 psi/ft. Step rate tests will be conducted in the injection and primary upper confining zones to confirm the fracture gradient per CTV's Pre-Operational Testing Plan (POTP).

CTV estimated surface and bottomhole injection pressures for a target average injection rate of 10 million standard cubic feet per day (mmscfpd) using results from their reservoir simulation as an input into PROSPER, a multiphase well nodal analysis software. In these estimations, CTV assumed a 100% CO_2 injectate, though CTV notes that operating conditions will be updated as the injection stream and impurities are ascertained during the pre-injection phase.

Injection pressures will be automated during operation to never exceed the MAIPs. CTV plans to start injection at a low pressure and increase pressure over the life of the project. This approach is consistent with the characterization of the injection site as a significantly underpressured depleted gas reservoir (based on the difference between the initial Winters Formation reservoir pressure of 5,040 psi and the pressure of 1,200 psi measured in the injection well Pool B-2 in 2022; Figure A-21). The underpressured reservoir will require increasing injection pressure over the life of the project to maintain the target injection rate.

Fracture gradient, MAIPs, and average bottomhole injection pressures are consistent between Appendix 4 and Table B-7 in the Area of Review and Corrective Action (AoR/CA) Plan.

Annulus Pressure

CTV proposes to maintain a minimum annular pressure of 100 psi measured at the surface during the injection phase in order to detect a loss of annular pressure via continuous surface monitoring as described in Attachment C: Testing and Monitoring (T&M) Plan. Downhole annular pressure will be held at a pressure differential between the tubing and tubing annulus of 100 psi over the injection pressure. Table 1 indicates this differential will be as great as over 1,200 psi at the packer. CTV asserts that the range of annular pressures described in Table 1 are suitable to the well design and will not impact the well integrity or induce formation fracture. The burst ratings of the injection wells' tubing and packer are >10,000 psi and 7,500 psi, respectively, so these components can withstand the anticipated pressure differential (Attachment G). The range of potential annular pressures is consistent with the proposed injection pressure, which was calculated based on a 90% safety factor of fracture pressure.

CTV intends to use 4% KCl completion fluid with corrosion inhibition and biocide as the annulus packer fluid. CTV states that this fluid is compatible with all well components and is not corrosive. CTV estimates the specific gravity of the packer fluid to be 1.024.

Questions/Request for CTV:

- *Please revise the annulus pressures in Table 1 to meet the requirements of 40 CFR 146.88(c) such that the annulus pressures would exceed the operating injection pressures anticipated for each injection well. Additionally, please describe the annulus* *pressure values, clarifying if they are average pressure values and their corresponding location (i.e. surface, bottomhole, above or below the packer).*

- *Please provide the proposed maximum annulus pressure for each injection well and explain how it is determined.*

Injection Rate and Volume

The maximum proposed injection rate corresponding to the MAIP is 15 mmscfpd for each well (Table 1). Average daily injection rates are targeted to be 10 mmscfpd. This equates to 530 tonnes per day or 967,250 tonnes per year.

CTV plans to implement a 10% safety threshold on injection rate to account for daily rate and pressure fluctuations on top of the 90% safety factor used to calculate the maximum allowable injection pressure. Automation and alarms will be configured to trigger when either injection rate or pressure vary to within 10% below the expected maximum allowable injection rate or 10% below the maximum allowable injection pressure (e.g., 13.5 mmscfpd rate and/or 5,439 psi injection pressure in injection well Sonol Securities 1-A). If alarms trigger, CTV states that they will take “appropriate steps” to resume appropriate operations. However, neither the Operations Plan nor Attachment F: Emergency and Remedial Response (ERR) Plan directly describe what these steps entail.

In the T&M Plan, CTV states that the volume of CO_2 injected into the Winters Formation will be calculated from the injection flow rate and CO_2 density using PVTP, a fluid thermodynamics package.

Automated Shutdown System

CTV states that downhole temperature and pressure and surface flow/mass movement, pressure, and temperature data will be monitored in real time. If an established operating threshold is reached or exceeded, the software will issue visual, audible, and digital alerts and/or begin with an unload procedure and initiate the shutdown process until it is understood why the thresholds were achieved and what corrective measures must be implemented.

CTV has not yet established the monitoring system that would trigger the automated shutdown system, and will share information about the monitoring system with EPA when it is established. Section 3.8 of Attachment G (Version 3.1 dated February 2, 2023) indicates that the shutdown system will involve an automated surface shut-off valve.

The ERR plan states that CTV will notify the UIC Program Director, pursuant to 40 CFR 146.91(c)(3), within 24 hours of any triggering of a surface or downhole shut-off system.

Questions/Requests for CTV:

- *Please provide information (e.g., manufacturer’s specifications/stress ratings) to support the assertion that maintaining a tubing annulus pressure differential of up to 1,200 psi will not compromise the tubing or packer.*

- *Please clarify in the Operations Plan or Emergency and Remedial Response Plan what "appropriate steps" CTV would take if alarms trigger (i.e., would this invoke responses under the "Injection well or monitoring equipment failure" scenario).*

Stimulation

CTV states in Section 5.1 of the narrative that it does not plan to perform any stimulation activities. 40 CFR §146.88(a) requires that all stimulation programs be approved by the Director as part of the permit application and incorporated into the permit. If the initial permit does not include a stimulation program and the operator identifies a need for well stimulation later in the life of the project, a major permit modification would be necessary. EPA suggests that CTV prepare and include a proposed well stimulation program in the permit application. A generic stimulation program may be used for the pre-construction phase of the project.

Questions/Requests for CTV:

- *To avoid the need for a permit modification if stimulation were to become necessary in the future, EPA requests that CTV prepare a draft stimulation plan. EPA can provide some additional guidance about the content of the plan, but anticipates that the plan should describe:*
  - *The stimulation fluids to be used, including any additives (e.g., corrosion inhibitors, clay inhibitors, biocides, complexing agents, or surfactants) or diverting agents; and*
  - *Step-by-step procedures that would be employed during stimulation.*

Attachment B: Corrective Action Plan

This corrective action plan evaluation report for the proposed CTV II Class VI Sequestration Project summarizes EPA’s evaluation of CTV’s findings related to wells/artificial penetrations within the Area of Review (AoR) and corrective action needed to address potential migration of injection fluids and impacts to USDWs. CTV submitted this information in Attachment B: AoR and Corrective Action (AoR/CA) Plan dated February 28, 2024 (Version 6).

Tabulation of Wells within the AoR

To identify wells within the AoR, CTV reviewed “internal databases” and California Geologic Energy Management Division (CalGEM) data. Table B-9 summarizes the number and type of wellbores found within the AoR and Appendix 7 provides a detailed list of information for the wells including their location, type, depth, construction methods, and plugging and abandonment (P&A) methods (if applicable). This list also provides a determination for corrective action.

A total of 29 wellbores were identified including 5 active producing wells (mainly associated with gas production), 15 idle producing wells, and 9 wells that were P&A. Figure 3.17 shows the locations of the wells within the AoR that penetrate the upper confining layer and the injection zone.

The depth of the confining zone in each of the wells was determined through open-hole well logs utilizing the deviation survey. CTV evaluated the following to assess the need for corrective action:

- Detailed casing diagrams for each wellbore.
- Perforations.
- Well architecture (casing depths, annular cement, etc.).
- Cement plug depths relative to key storage complex formation tops.

CTV indicates that all of the wells in the AoR have a surface or intermediate casing over the lowermost USDW, cement in the annulus of the intermediate casing above the surface casing shoe, and adequate annular cement within the upper confining zone. CTV asserts these conditions are protective of USDWs.

However, CTV identifies four wells that need corrective action, including BROOKS_10_1, POOL_B_1 RD1, Bomberger1, and Mobil Parcel X 1, based on the following conditions:

- Brooks 10-1 was sidetracked by setting a cement plug from 5,648 to 6,246 ft MD, and the well was suspended with drilling mud below the plug. CTV will re-abandon the well to ensure isolation of the injection zone. Brooks 10-1-RD1, a sidetrack of the Brooks 10-1 original hole, is being repurposed as a monitoring well.
- Pool B-1 RD1, an idle sidetrack of Pool B-1, will require corrective action. There is no cement across the confining layer in this wellbore.

- Bomberger 1 and Mobil Parcel X 1 are both abandoned dry holes outside of the Union Island gas field boundary. These wells were abandoned with casing set above the confining layer and openhole drilled through the injection zone. Abandonment plugs were set within the casing, but no cement was laid across the confining layer.

Abandonment schematics are provided for these wells in Appendix 9. Class G cement will be used for the plugs when abandoning the wells. CTV describes the approach for plugging each well.

- For Brooks 10-1-RD1, CTV plans to re-enter the section of the well beneath the previously installed plug from 5,700 to 6,500 ft MD, clean out the original openhole as deep as possible, and then fill the well with Class G cement plugs.
- For Pool B-1 RD1, CTV plans to re-abandon the portion of the well below the drillpipe fish by re-entering the wellbore and filling the well with Class G cement plugs.
- For the Bomberger 1 and Mobil Parcel X 1 wells, CTV plans to drill out abandonment plugs and re-enter the openhole portion of the abandoned wellbore, and fill the well with Class G Portland cement.

The corrective action P&A appears to be sufficient. The plugs for the proposed Mobil Parcel X 1 and Bomberger 1 wells are much thinner compared to the other wells and incorporate more mud into the abandonment.

Plan for Site Access

CTV obtained surface access rights for the duration of the project.

Corrective Action Schedule

CTV indicated that all corrective action will be completed prior to commencing CO_2 injection into the reservoir. No schedule or timeline was provided for the corrective action activities.

Questions/Requests for CTV:

- *Did CTV perform any physical surveys (e.g., aerial surveys) to supplement the database searches?*
- *Please provide evidence that the plugs planned for the Mobil Parcel X 1 and Bomberger 1 wells are of sufficient thickness to prevent fluid movement.*
- *Please clarify whether the wells in Appendix 7 that are designated as "abandon" in the "Pre-Operational Testing Requirement" column need any additional corrective action.*
- *What is the rationale for Plug 2 in the Bomberger 1 well?*
- *Please provide a schedule for corrective action activities.*

Attachment C: Testing and Monitoring Plan

This testing and monitoring evaluation report for the proposed CTV II Class VI Sequestration Project summarizes EPA's evaluation of the testing and monitoring that CTV proposes to conduct during injection operations into the Winters Formation. CTV submitted information regarding well testing and monitoring in their Class VI permit application in Attachment C: Testing and Monitoring (T&M) Plan dated February 2, 2023 (Version 2.1).

CTV notes that the results of all injection phase testing and monitoring activities will be reported to EPA semi-annually in compliance with the requirements under 40 CFR 146.91.

Carbon Dioxide Stream Analysis

To meet the requirements of 40 CFR 146.90(a), CTV plans to analyze the carbon dioxide (CO_2) stream quarterly for the constituents identified in Table 1 of the T&M Plan, which is replicated below:

Parameter	**Analytical Method(s)**
Oxygen, Argon, Hydrogen	ISBT 4.0 (GC/DID) GC/TCD
Nitrogen	ISBT 4.0 (GC/DID) GC/TCD
Carbon Monoxide	ISBT 5.0 (Colorimetric) ISBT 4.0 (GC/DID)
Total Hydrocarbons	ISBT 10.0 THA (FID)
Ammonia	ISBT 6.0 (DT)
Ethanol	ISBT 11.0 (GC/FID)
Oxides of Nitrogen	ISBT 7.0 Colorimetric
Methane, Ethane, Ethylene	ISBT 10.1 (FID)
Hydrogen Sulfide and Sulfur Dioxide	ISBT 14.0 (GC/SCD)
CO_2 purity	ISBT 2.0 Caustic absorption Zahm-Nagel ALI method SAM 4.1 subtraction method (GC/DID) GC/TCD
δ13C	Isotope ratio mass spectrometry

CTV will use analytical methods from the International Society of Beverage Technologists (ISBT) for injectate monitoring. These methods are accepted for CO_2 stream analysis in other Class VI projects. Table 4 in CTV's Quality Assurance Surveillance Plan (QASP) includes the testing methodology and is consistent with Table 1 in the T&M Plan. Sampling will be conducted at the transfer point from the source and at the discharge of the last compressor upstream of the injector starting three months after the start of injection and every three months thereafter.

Samples will be collected at sampling stations into containers and sent to Eurofins TestAmerica (Eurofins), a state-certified laboratory. Eurofins' chain of custody procedure is described in section 3.4 of the T&M Plan and in subsection B.3.e of the QASP; the procedure includes recording sample date, sample description, sample type, relinquished by and received by signature, sampler name, and location information. CTV describes that sample transport and handling will be strictly controlled by the service provider field technician, and upon delivery to the laboratory, samples will be given unique laboratory sample numbers and recorded in a logbook indicating the client, well number, date, and time of delivery. CO_2 stream samples will be contained in one-liter tedlar bags for a maximum of 72 hours according to Table 16 of the QASP.

CTV will increase the sampling frequency if there is a significant change in the chemical or physical characteristics of the CO_2 injectate, a change in the CO_2 injectate source, or if the facility or injection well experiences a downtime over more than 30 days. Note that any change in the injection fluid would require advance notice and written approval from EPA. Addition of a new injection fluid (source) not authorized by the permit would also require a permit modification.

CTV is currently evaluating several anthropogenic sources of CO_2 as the injectate for the project, and states that it will notify EPA prior to switching or adding CO_2 sources so that the sampling procedures can be reassessed. Section 7.2 of the application narrative dated February 28, 2024 (Version 5) describes two sets of potential CO_2 stream constituents based on engineering design studies and literature. The compositions of both potential injectate sources are described by mass percent in Table A-16. Simplified injectate compositions were devised for both sets of potential constituents (Table A-17). Ranges of viscosity, density, and compressibility values are described for both injectates in Table A-18. Note that while multiple CO_2 sources can be permitted for injection, EPA requires that every source be clearly identified and characterized for it to be included in the permit as an authorized injection fluid. EPA will also require that a sample of every authorized fluid/source be analyzed prior to initiation of its injection to ensure that its physical/chemical properties are consistent with the pre-permitting characterization. The information provided is acceptable at this point of the permit application review; however, CTV will need to update Table 1 of the T&M Plan and Table 4 of the QASP once the specific CO_2 sources are identified.

Questions/Requests for CTV:

- *Please add H_2O as a CO_2 stream analyte on Table 1 to provide information about the potential presence of free phase water.*
- *Tables A-16 and A-17 of the narrative indicate that sulfur trioxide (SO_3) may be a constituent of the CO_2 stream. Please update Table 1 of the Testing and Monitoring Plan*

to provide an appropriate analytical or alternative method for measuring SO_3 if it is determined to be a constituent of the final CO_2 stream.

Continuous Recording of Operational Parameters

CTV will utilize continuous recording devices in the five proposed injection wells to monitor injection pressure, rate, and volume; the pressure on the annulus between the tubing and the long string casing; the annulus fluid volume added; and the temperature of the CO_2 stream as required by 40 CFR 146.88(e)(1), 146.89(b), and 146.90(b).

Table 2 describes the recording devices, their locations, and minimum sampling and recording frequencies. The depths of the devices are consistent with the injection well construction diagrams in Appendix 5. The minimum sampling frequency for annulus fluid volume is 4 hours, and the minimum recording frequency is 24 hours. For all other parameters, minimum sampling frequency is 10 seconds and minimum recording frequency is 30 seconds. Table 6 of the QASP summarizes these measurement parameters for each type of field gauge and includes detection limits and ranges, typical measurement precision, and QC requirements. Instrument sensitivities are described in Tables 8 through 14 of the QASP.

CTV will continuously monitor and record injection pressure, temperature, and annulus pressure from the CTV Central Command Facility using method ANSI Z540-1-1994. Injection pressure will be measured with surface and downhole pressure gauges with a detection limit of 0.001 psi and range of 0 – 5,000 psi. Injectate temperature will be measured with surface and downhole temperature sensors with a detection limit of 0.001°F and range of 0 – 500 °F. The injection rate will be measured with a surface Coriolis flowmeter calibrated to be accurate to within 0.1%. Injection volume will be calculated from the injection flow rate and density of CO_2 (as calculated by the PVTP fluid thermodynamics package).

Annular pressure will be measured with a surface electronic pressure gauge with a detection limit of 0.001 psi and range of 0 – 5,000 psi. The annulus will be filled with a non-corrosive and incompressible aqueous packer fluid and be maintained with a 100-psi positive annular pressure at the surface. CTV notes that a SCADA alarm system will identify any decrease in pressure or annular fluid level. This is consistent with information in the Operations Plan and the monitoring approach appears to be sufficient to detect any triggers for responses specified in the ERR Plan. CTV states that they will identify and investigate pressure deviations that do not align with changes to operating conditions or temperature effects due to seasonal variation. CTV will notify EPA if 1) pressure decreases to 0 psig and cannot be explained by operational conditions, 2) pressure drops below 100 psi threshold and cannot be maintained or stabilized after three attempts, or 3) pressure increases above 1,000 psi and cannot be explained by operational conditions. Data from continuous monitoring of annular pressure will be provided in CTV's semi-annual report to demonstrate ongoing internal mechanical integrity.

Question for CTV:

- *Please describe the device CTV would use to measure annular fluid level in the T&M Plan.*

- *Please describe the steps CTV would take to identify and investigate any unexpected pressure deviations, or reference that CTV would implement the procedures under "Injection well or monitoring equipment failure" in the Emergency and Remedial Response Plan.*
- *Please indicate what threshold change would trigger the SCADA alarm system.*

Corrosion Monitoring

CTV will monitor corrosion of wellbore materials using corrosion coupons. Coupons will be installed in the pipeline that feeds CO_2 injectate to the injectors, between the compressor and wellhead (Table 1 of the QASP). Corrosion monitoring will be conducted starting three months after injection begins and quarterly thereafter. A baseline assessment prior to exposing the materials to corrosive conditions is not described.

CTV will monitor well material coupon samples for loss of mass, change in thickness, cracking, pitting, and other signs of corrosion. The coupons (in the custody of Eurofins according to Table 1 of the QASP) will be photographed, measured, visually inspected, and weighed to a resolution of 0.1 milligram. The samples will be handled and assessed by Eurofins in accordance with NACE TM0169/G31 and EPA 1110A SW846. According to CTV, a detected corrosion rate of greater than 0.3 mils/year will initiate consultation with the EPA. In addition, a casing inspection log may be run to assess the thickness and quality of the casing if the corrosion rate exceeds 0.3 mils/year. According to Table 5 of the QASP, CTV will use the analytical methods of NACE TM0169/ G31 and EPA 1110A SW846, the detection limit is 0.001 mg, and typical precisions are 10%.

Table 3 describes the material compositions of the proposed coupons. The materials described in the corrosion monitoring plan do not include all of the casing materials described in the construction diagrams for each injection well in Appendix 5, as shown in the table below.

Equipment	**Coupon Material (T&M, Table 3)**	**Construction Material (Appendix 5 tables)**
Pipeline	Carbon Steel	
Casing (Intermediate and Long-String)	N-80 Carbon Steel (Sonol Securities 1-A)	N-80
	N-80 Carbon Steel (Sonol Securities 3)	K-55 and N-80
	N-80 Carbon Steel (Pool B2)	N-80 and S-95
	L-80 CRA casing below packer (INJ-1)	N-80 and L-80 CRA
	L-80 CRA casing below packer (INJ-2)	N-80 and L-80 CRA
Tubing	Chrome alloy consistent with final well construction	L-80 CRA
Packer	Chrome alloy consistent with final well construction	CRA
Wellhead	Chrome alloy consistent with final well	Not listed

Equipment	Coupon Material (T&M, Table 3)	Construction Material (Appendix 5 tables)
	construction	

CTV states that construction materials will be reaffirmed post-construction and prior to injection as part of pre-operational testing, and corrosion coupons consistent with the final well construction materials will be used for corrosion monitoring. Additionally, CTV plans to continually update the corrosion monitoring plan as data is acquired.

Questions/Requests for CTV:

- *Please modify Table 3 to include coupons that reflect both the intermediate and long-string casing types listed in Attachment G/Appendix 5 and the table above.*
- *Please modify Table 3 to clarify that the injectors UI-INJ-1 and UI-INJ-2 will have both N-80 and L-80 CRA coupons.*
- *Please indicate in the plan that CTV will record the baseline condition of the coupons to support future evaluations.*

Above Confining Zone Monitoring

CTV will monitor groundwater quality and geochemical changes above the confining zone during the injection and post-injection phases through quarterly fluid sampling and continuous temperature and pressure monitoring to meet the requirements of 40 CFR 146.90(d). CTV will also acquire baseline water samples for analyses per the Pre-Operational Testing Plan. Monitoring above the confining zone will be concentrated in two intervals:

- Three monitoring wells will be completed in the undifferentiated non-marine sediments, the lowermost underground source of drinking water (USDW).
- Two monitoring wells will be completed in a continuous sand interval of the Mokelumne River Formation (CO_2 dissipation zone between the upper confining zone and USDW).

Figure 1 shows the above confining zone monitoring well locations around the AoR. The lowermost USDW monitoring wells are centrally located above the predicted CO_2 plume extent near the injection wells and potential conduits, in particular between the injection wells and Stockton Arch Fault to the east. The Mokelumne River Formation monitoring wells are located north and west of the injection wells in the predicted directions of plume expansion. The well locations are appropriate given the modeled expansion of the CO_2 plume in the Area of Review and Corrective Action (AoR/CA Plan). CTV states that surface access to the monitoring wells will be available for the life of the project and the post-injection monitoring timeframe.

CTV notes that additional groundwater monitoring wells will be drilled to assess and monitor the lowermost USDW if the Mokelumne River Formation monitoring wells indicate pressure increases or if the undifferentiated non-marine sediments experience pressure or composition changes due to CO_2 injection. Additional monitoring will include pressure, temperature, and fluid sampling.

Table 4 shows the planned monitoring activities, locations, depth intervals, and frequencies for ground water quality and geochemical monitoring above the confining zone. Fluid sampling will be conducted quarterly, and pressure and temperature will be continuously monitored. The spatial coverage reported for the lowermost USDW and Mokelumne River monitoring wells are consistent with the depths of the perforations of those wells as shown in the well schematics in Appendix 5.

Table 5 shows a summary of field parameters and analytical methods for fluid samples. Detection limit, ranges, typical precisions, and QC procedures are presented in Table 3 of the QASP. Table 5, Table 3 of the QASP, and Table 2 of the PISC/SC Plan are consistent with each other. All analytical methods chosen by CTV are EPA-approved, and both the lowermost USDW and Mokelumne River Formation will be tested for the same analytical and field parameters per Table 5. The analytes described in Table 5 are representative of the constituents of the equilibrium aqueous chemistry from Table 7 in Appendix 3: Geochemical Modeling. Section 6.5 describes the proposed sampling procedure. Fluid samples will be sent to Eurofins for analysis; the chain of custody procedure is the same as described for continuous monitoring of operational parameters above. Anticipated fluid sample containers, preservation techniques, and sample holding times for target cations, anions, dissolved CO_2, δ13C, and alkalinity samples are provided in Table 17 of the QASP.

Table 7 of the QASP describes actionable testing and monitoring outputs, where action will be taken if above-confining-zone pressure or water quality measurements deviate from the baseline analysis. However, Table 7 is qualitative and does not clarify values or ranges that would trigger action for any parameter.

Specific monitoring devices and instruments are not described; however, subsection B.4.b of the QASP states that service providers are expected to provide and utilize the equipment and instruments necessary to perform the required testing and analysis. CTV should provide this information in the updated Testing and Monitoring Plan submitted per 40 CFR 146.82(c).

Questions/Requests for CTV:

- *What threshold above or below baseline values for temperature, pressure, or water quality would trigger action? Please add this information to Testing and Monitoring Plan.*
- *EPA recommends that CTV document in the AoR reevaluation schedule (Section 4.1 of the AoR and Corrective Action Plan) that updates to the testing and monitoring plan may include additional USDW monitoring wells (e.g., if pressure increases are detected in the Mokelumne River Formation or USDW) or additional plume and pressure front monitoring.*

Internal Mechanical Integrity Testing

In addition to the continuous monitoring described above, CTV will conduct an initial annulus pressure test on all injection wells and monitoring wells that penetrate the confining zone and are configured with tubing and packer, then CTV will conduct a standard annular pressure test (SAPT) any time the packer is replaced or reset. Table 6 describes the internal mechanical integrity testing (MIT) specifications, and Table 6 of the QASP describes measurement parameters. CTV states that they will notify the Director prior to annular pressure testing to provide the opportunity to witness the testing.

The T&M Plan describes the SAPT procedure and how results will be interpreted. Wells with specified maximum tubing pressures will be tested to 100 psi above the maximum pressure, and wells without a specified maximum pressure will be tested to 1,000 psi. If the change in pressure following 1 hour of system isolation is found to be less than 3% of the test pressure, then the well has demonstrated mechanical integrity and CTV will provide EPA with an EPA-approved annular pressure test form and the raw pressure data (as original chart recordings or a digitized log of pressure and time). If the change in pressure exceeds 3% of the test pressure, then CTV will cease injection, shut in the well, and notify EPA within 24 hours.

External Mechanical Integrity Testing

CTV will conduct external MITs on each injection and monitoring well at least once per year using an approved testing method per 40 CFR 146.89(c). CTV states that they may perform a temperature decay log, distributed temperature log (DTS), oxygen activation (OA) log, and/or noise log (Table 7). At a minimum, CTV plans to perform a temperature decay log with wireline logging in the injection wells, which meets the requirement at 40 CFR 146.89(c). Sections 8.2 through 8.6 describe the procedures for temperature logging with wireline, active and passive temperature logging with DTS, noise logging, and OA logging. Table 9 of the QASP indicates the specifications of the logging tool.

Table 7 of the QASP states that temperature log results will be compared against a baseline to evaluate external mechanical integrity. The specific deviation that would trigger action is not provided, though Table 7 of the QASP describes a temperature detection limit of 0.01°F.

CTV states that they will utilize an EPA-approved method other than temperature decay logging for the monitoring wells. CTV may propose DTS for EPA Director approval for monitoring well MIT, and if CTV elects to conduct an alternate MIT, notification to the Director, including a description of the proposed testing method and procedure, will be sent to EPA for approval.

Question for CTV:

- *What deviations in the temperature log would indicate a mechanical integrity issue?*

Pressure Fall-Off Testing

CTV will perform pressure fall-off tests (FOTs) every five years during the injection phase to meet the requirements of 40 CFR 146.90(f). CTV includes procedures for the FOTs (Section 9.1) and states that they will refer to EPA Region 9 UIC Pressure Fall-off Requirements for planning and conducting the testing as well as preparing and submitting the monitoring report. Data interpretation will be performed by a trained engineering professional using proven industry standard methodologies. Though specific equipment is not described in the T&M Plan or QASP, the procedures are consistent with the EPA Region 9 UIC Pressure Fall-Off Testing Requirements.

Question/Request For CTV:

- *Please clarify in the T&M Plan that a pressure fall-off test will be conducted prior to injection operations.*

Carbon Dioxide Plume and Pressure Front Tracking

CTV will employ direct and indirect methods to track the extent of the CO_2 plume and the pressure front during the injection and post-injection phases to meet the requirements of 40 CFR 146.90(g). Four wells will actively monitor the Winters Formation injection zone as depicted in Figure 2 of the T&M Plan. CTV clarifies that one of these wells (Brooks 10-1 RD1) is intended only for pressure front monitoring. This well is located east of the injection wells on the border of the Stockton Arch Fault. The well schematic in Appendix 5 indicates that this well intersects the Stockton Arch Fault at a depth of 8,742 ft (above this depth, the wellbore is outside of the AoR; the perforations are thus in the footwall of the fault within the AoR). The other three monitoring wells are located south, west, and between the injection wells. Monitoring well locations are shown in Figures 3a and 3b for the two modeled injectate compositions.

The position of these wells within the AoR appears appropriate to detect any unplanned plume and pressure front movement to validate predictions from the AoR delineation modeling, and the perforations of each well per Appendix 5 are at the appropriate depths, consistent with the narrative. However, data coverage is missing to the north, where no injection zone monitoring wells are proposed by CTV. Figure B-30 of the AoR/CA Plan depicts three abandoned wells in the northern portion of the AoR; one of these wells (Mobil Parcel X 1) was identified as requiring corrective action. Depending on the status of this well, it could be converted for monitoring to address the lack of data coverage within the injection interval to the north.

CO_2 Plume Tracking

Plume monitoring activities during the injection phase are summarized in Table 8 of the T&M Plan, which also indicates that baseline data will be collected for each activity. Direct monitoring activities include quarterly fluid sampling and continuous pressure and temperature monitoring. Table 2 of the QASP indicates that downhole gauges, DTS, and direct sampling will be utilized for direct monitoring. CTV states that DTS will provide continuous temperature measurements from the packer to the surface. Fluid sampling analytes are presented in Table 9, and the analytical methods are consistent with above-confining-zone monitoring methods in Table 5. CTV expects to observe minor changes to pH, dissolved CO_2, and water density in fluid samples. Data collection, analysis, and QA procedures appear to be the same as that of above-confining-zone monitoring for fluid sampling, pressure monitoring, and temperature monitoring. Anticipated fluid sample containers, preservation techniques, and sample holding times for the fluid analytes are provided in Table 17 of the QASP. The one indirect plume tracking activity listed in Table 9 is pulsed neutron logging, which will be run once pre-injection as a baseline and every two years following the start of injection. CTV plans to use pulsed neutron logging to measure CO_2 saturation changes through time.

CTV states that, if the CO_2 plume development is not consistent with computation modeling results, CTV will assess whether additional monitoring of the plume is necessary. Determination for plume monitoring changes will be made in consultation with the UIC Program Director and would trigger an AoR reevaluation (as described in the AoR and Corrective Action Plan).

Tables 8 and 9 of the T&M Plan are also consistent with Tables 4 and 5 of the PISC/SC Plan.

Pressure Front Tracking

Table 10 presents the direct and indirect methods that CTV proposes to monitor the position of the pressure front, including the activities, locations, and frequencies CTV will employ. This is consistent with Table 6 of the PISC/SC Plan, which describes post-injection phase pressure front monitoring. Direct monitoring will include continuous pressure and temperature monitoring at the perforation depths in all four injection zone monitoring wells. The monitoring wells will have pressure gauges to measure the pressure increase, which CTV will compare with the computational model to validate computational modeling results and identify operational discrepancies.

CTV indicates that the CO_2 plume is not expected to encounter Brooks 10-1 RD1, which appears accurate based on the plume modeling in Figures 3a and 3b. As such, Brooks 10-1 RD1 will only be used for pressure front monitoring, so only pressure and temperature will be monitored in this well. CTV notes that fluid sampling will be initiated in Brooks 10-1 RD1 if temperature and pressure measurements indicate signs of leakage.

CTV also plans to use passive seismic monitoring through a network of surface and shallow borehole seismometers across the AoR for indirect pressure front tracking. Per the QASP, CTV will partner with a third-party for data processing (this partner is not identified in the T&M Plan or QASP). CTV will also monitor the Northern California Earthquake Data Center (NCEDC) network for seismic events. A baseline seismic study will be conducted across the AoR for at least 12 months during the pre-injection phase to understand naturally occurring seismicity and later distinguish induced seismicity. Data from NCEDC will be utilized in the baseline analysis. CTV describes that sensor locations will be determined in the field with high-sensitivity 3-

component geophones. Borehole seismometers will be deployed deeper than 1,500 ft to ensure a good quality signal and minimize noise. CTV states that the system will be capable of detecting seismic events greater than moment magnitude Mw 0.0. CTV plans to derive a velocity model from vertical seismic profiles, sonic well logs, and check shots. EPA recommends that, to the extent possible, CTV provide EPA with information about the sensors before they are installed and collect as much seismic data as possible from them during baseline analysis. CTV should provide information about the location and depth of the installed seismometers in the updated Testing and Monitoring Plan submitted per 40 CFR 146.82(c).

Seismic monitoring during the injection phase will be continuous. Waveform data will be transmitted near real-time via cellular modem or other wireless means and archived in a database. CTV will also continuously monitor data from NCEDC broadband seismometers and strong motion accelerometers. CTV will notify the EPA Director of seismic events as per Table 2 of the ERR Plan. Continuous seismic monitoring will continue throughout the duration of the post-injection phase per the PISC/SC Plan.

Questions/Request for CTV:

- *Please describe the pulsed neutron logging procedures for plume monitoring.*
- *Please include the sampling and recording frequencies for continuous pressure monitoring (i.e., to be consistent with Table 3 of the PISC/SC Plan).*
- *Please clarify or specify what threshold temperature and pressure changes would indicate signs of leakage that would warrant fluid sampling in Brooks 10-1 RD1.*
- *Can CTV provide any preliminary information about the location of the seismometers to demonstrate coverage throughout the AoR?*
- *Please explain how the combination of pulsed neutron logging, pressure/temperature monitoring, and seismic monitoring via geophones at the planned locations would provide a complete description of the plume and pressure front movement throughout the AoR that meets the goals of 40 CFR 146.90(g).Your response should address the lack of data coverage within the injection interval to the north, including consideration of an additional injection zone monitoring well (e.g., Mobil Parcel X1).*
- *On pages 13-14, where CTV proposes that, "if the plume development is not consistent with computation modeling results, CTV will assess whether additional monitoring of the plume is necessary," please add a statement that, if CTV detects evidence of USDW endangerment, it will implement the Emergency and Remedial Response Plan (Attachment F of the permit).*

Surface Air and/or Soil Gas Monitoring

No surface air and/or soil gas data were submitted with the permit application. However, we could request surface air and/or soil gas monitoring, per 40 CFR 146.90(h), as we continue with the permitting process (e.g., during further technical review, in response to public comments, or as noted below).

Considerations based on the results of Pre-Operational Testing/Modeling Updates:

- *If, based on the results of planned pre-operational testing, uncertainties about the geologic setting are identified, the need for surface air and/or soil gas monitoring will be reconsidered.*

Quality Assurance Procedures

CTV's QASP is provided as Appendix 11 in the permit application. All monitoring and testing activities proposed in the T&M and PISC/SC Plans are addressed in the QASP, and that information is represented consistently between documents. The QASP describes sampling methods; sample handling and custody; analytical methods; quality control; instrument/equipment testing, inspection, and maintenance; data management; and data review, verification, and validation procedures. CTV plans to rely on third-party service providers for data collection and interpretation, as such the QASP does not list specific instruments or equipment and associated procedures. CTV does plan to maintain data storage internally.

Questions/Requests for CTV:

- *Please include H_2O in Table 4 of the QASP.*
- *Please correct the following minor errors in the QASP:*
    - *Table 2 of the QASP states that fluid sampling in the lowermost USDW monitoring wells will be conducted in the Tulare Formation, rather than the undifferentiated non-marine sediments.*
    - *Section B.1.a of the QASP describes the Capay Shale as the confining layer and Domengine Formation as a pressure monitoring zone.*

Attachment E: Post-Injection Site Care/Site Closure Plan

This evaluation report for the proposed CTV II Class VI Sequestration Project summarizes EPA's evaluation of the post-injection site care and site closure (PISC/SC) procedures that CTV proposes in the post-injection phase. CTV submitted information regarding PISC/SC procedures in their Class VI permit application in a Post-Injection Site Care and Site Closure Plan dated February 2, 2023 (Version 2.1). CTV clarifies that they have obtained surface access rights for the duration of the project.

Note that, per version 5 of the application narrative dated February 28, 2024, CTV is not proposing an alternative PISC timeframe for the CTV II project. CTV plans to monitor groundwater quality and track the position of the carbon dioxide (CO_2) plume and pressure front for the default 50-year post-injection timeframe. CTV states that they will not cease post-injection monitoring until a demonstration of non-endangerment of underground sources of drinking water (USDWs) has been approved by the UIC Program Director pursuant to 40 CFR 146.93(b)(3). Following approval for site closure, CTV will plug all monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation.

Pre- and Post-Injection Pressure Differential

The Winters Formation had a measured formation pressure of 5,040 psi at field discovery in 1972. Natural gas and water production drew down formation pressure to its minimum of 1,200 psi, as measured in proposed Class VI injection well Pool B-2 in 2022. CTV explains that the largest pressure differential experienced by the Winters will be between its current pressure and that at its time of discovery.

The CTV II project was designed to reach a maximum average formation pressure of approximately 90% of the original formation pressure at discovery so as to not exceed the initial pressure. In section 2.1.2 of the Area of Review and Corrective Action (AoR/CA) Plan, CTV explains that at the cessation of injection, formation pressure for the Winters Formation injection zone is predicted to be 4,500 psi, or approximately 89% of 5,040 psi. This is the highest value predicted by the modeling for the entire duration of the project; thus, the maximum pre- and post-injection pressure differential predicted by the AoR modeling is approximately 3,300 psi at cessation of injection. For a 10-year period following cessation of injection, pressure is predicted to decrease by less than 10%, after which the pressure stabilizes at approximately 4,300 psi and remains constant. The formation pressure modeling results are depicted in Figure B-20a. Figure 1 compares cumulative injection volume and reservoir pressure between the modeled Injectate 1 and Injectate 2 (Tables A-16 through A-18 of the narrative). CTV notes that reservoir pressure with respect to time is nearly identical for both injectates, where pressure stabilizes approximately 15 years post-cessation of injection.

Predicted Position of the CO_2 Plume and Associated Pressure Front at Site Closure

The predicted positions of the 100-year CO_2 plumes for both of the modeled injectates and the pressure front at the end of the PISC timeframe are depicted in Figure 2. This figure is consistent with the AoR delineation modeling results presented in Figures B-15a and B-15b and the area CTV proposes to monitor.

Post-Injection Monitoring Plan

CTV will conduct post-injection monitoring to meet the requirements of 40 CFR 146.93(b)(1), and all monitoring data and results will be submitted to EPA in annual reports submitted within 90 days following the anniversary date on which injection ceases. The reports will contain information and data generated during the reporting period; i.e., well-based monitoring data, sample analysis, and the results from updated site models.

Planned post-injection monitoring in the PISC/SC Plan is consistent with Attachment C: Testing and Monitoring (T&M) Plan and Appendix 11: Quality Assurance and Surveillance Procedures (QASP).

Tables 1 through 3 describe above-confining zone monitoring, where CTV proposed fluid annual fluid sampling and continuous pressure and temperature monitoring throughout the post-injection phase:

- Table 1 presents above-confining zone monitoring methods, devices, locations, depths covered, and frequencies. Table 1 is consistent with Table 4 of the T&M Plan.
- Table 2 summarizes fluid sample parameters and analytical methods and is identical to Table 5 in the T&M Plan. All proposed analytical methods are appropriate for use in Class VI projects.
- Table 3 presents sampling and recording frequencies for continuous monitoring in the USDW monitoring wells. During the post-injection phase, the sampling and recording frequencies for continuous monitoring will be reduced relative to injection-phase monitoring from 5 hours to 12 hours. This is consistent with recommendations in EPA's UIC Class VI Well Plugging, Post-Injection Site Care, and Site Closure Guidance. It appears that Table 3 only applies to the pressure gauge and not the temperature monitoring devices. It is unclear whether Table 3 applies to the Mokelumne River Formation monitoring wells intended for pressure dissipation zone monitoring or to the Winters Formation monitoring wells for pressure front tracking.

The injection zone monitoring wells and CO_2 plume boundary, as predicted in the AoR delineation modeling, are depicted in map view in Figures 3a and 3b and cross-section in Figures 4a and 4b for the two modeled injectates. Time steps include years 1, 5, 10, 15, 23 (cessation of injection), 30, 50, and 100. Tables 4 through 6 describe injection zone monitoring, where CTV will use direct and indirect methods to track the CO_2 plume and pressure front:

- Table 4 presents the direct and indirect monitoring CO_2 plume tracking activities and includes locations, depths, and frequencies. The wells Sonol Securities 4, M-1, and Yamada Brothers 2 will have annual fluid sampling, continuous pressure and temperature monitoring, and pulsed neutron logging on a 5-year frequency. Table 4 is consistent with Table 8 in the T&M Plan except that the frequency of pulsed neutron logging will be reduced during post-injection from 2 years to 5 years.
- Table 5 summarizes fluid sample parameters and analytical methods and is identical to Table 9 in the T&M Plan. The frequency for injection zone fluid sampling is unchanged between the injection and post-injection phases.
- Table 6 describes the direct and indirect monitoring activities for pressure front tracking and includes locations, depths, and frequencies. The wells Sonol Securities 4, M-1, Yamada Brothers 2, and Brooks 10-1 RD1 will be continuously monitored for pressure and temperature. CTV will indirectly monitor the pressure front by monitoring seismicity with a seismic monitoring network with coverage across the entire AoR. Table 6 is consistent with Table 10 in the T&M Plan.

Questions/Requests for CTV:

- *Please add the sampling and recording frequency of temperature monitoring to Table 3.*
- *Do the sampling and recording frequencies described in Table 3 of the PISC/SC Plan apply to all of the USDW monitoring wells? Do these frequencies apply to continuous monitoring in the Mokelumne River Formation and Winters Formation as well? If so, please update Table 3 accordingly.*

Non-Endangerment Demonstration Criteria

CTV will provide a report demonstrating non-endangerment of USDWs to the Director prior to authorization of site closure per 40 CFR 143.93(b)(3). The report will include a summary of monitoring data from the injection and post-injection phases, computational modeling results of the CO_2 plume and pressure front, and evaluations of reservoir pressure, potential conduits, and seismic monitoring. CTV's description of the non-endangerment demonstration report is consistent with EPA's recommendations, appears adequate to support the demonstration of plume stability and negligible year over year pressure changes, and will support a common understanding with EPA about the criteria that will be used for the non-endangerment demonstration.

CTV will include in the summary of monitoring data a narrative that explains the monitoring activities, dates of all monitoring events, changes to the monitoring program over time, an explanation of all monitoring information collected at the site, an explanation of how the monitoring data from injection and PISC phases have varied from the baseline data collected during site characterization, and a summary of any emergencies that occurred. Included will be a description of how any issues have been resolved and that there is no endangerment to USDWs.

CTV will calibrate computational modeling results with monitoring data to demonstrate the lack of CO_2 leakage over the project timeframe, the accuracy of the original model to predict and represent the storage reservoir, and that the computational model adequately defined the AoR.

CTV will evaluate reservoir pressure to demonstrate that plume migration is minimal and reservoir pressure changes are less than 10 psi/year. CTV will support this demonstration with the calibrated computational model.

CTV will review and assess wells that either required or will require corrective action (including injection and monitoring wells) to demonstrate that natural or artificial conduits will not allow fluid migration from the storage reservoir.

CTV will use the seismic monitoring network to demonstrate plume stabilization, negligible pressure change, and seal integrity.

Site Closure Plan

CTV will provide notice of intent to close the site at least 120 days prior to site closure pursuant to 40 CFR 146.93(d). After approval to close the site, CTV will plug the injection and monitoring wells, restore the site, and submit a site closure plan to the EPA. Appendix 5 provides proposed abandonment schematics for all of the monitoring wells. The proposed activities appear to be adequate to protect USDWs, with plugs across the lowermost USDW and injection zone.

CTV plans to submit the site closure plan within 90 days following site closure pursuant to 40 CFR 146.93(f). The plan is stated to include verification of injection and monitoring well plugging, notifications to state and local authorities per 40 CFR 146.93 (f)(2), composition and volume of the injected CO_2, and post-injection monitoring records.

CTV will also record a notation to the property's deed that will indicate that the property was used for CO_2 sequestration, the period of injection and the volume of CO_2 injected, the formation that the fluid was injected, and the name of the local agency to which a plat of survey with injection well locations was submitted.

Question/Requests for CTV:

- *Please adjust the first sentence of section 7 to refer to 40 CFR 146.93(d).*
- *Please indicate that the monitoring wells will be plugged as described in the Proposed Abandonment Schematics in Appendix 5.*
- *Please clarify that CTV will retain the site closure report and records collected during the post-injection site care period for 10 years following site closure pursuant to 40 CFR 146.93(f) and 40 CFR 146.93(h).*

Attachment F: Proposed Emergency and Remedial Response Plan

EPA reviewed the proposed Emergency and Remedial Response Plan for CTV's proposed CTV-II Class VI geologic sequestration (GS) project (Attachment F, Version 2.1 submitted February 2, 2023). While the evaluation of certain response scenarios is pending other reviews, the plan appears to be complete. EPA has the following questions and recommendations for the applicant:

Potential Risk Scenarios

There is no description of responses to the "CO_2 leakage to USDW or land surface" scenario. However, this appears to be addressed in the "Potential Brine or CO_2 Leakage to a USDW" scenario. EPA recommends combining these in the list of Risk Scenarios.

Emergency Identification and Response Actions

EPA recommends some revisions to the descriptions and response actions for the scenarios identified in the Emergency and Remedial Response Plan. These are presented in the table below:

Event/Scenario	**EPA Comment/Recommendation**
1. Well Integrity Failure	a) A mechanical integrity failure can also occur in the post-injection phase; please update the "timing of the event" accordingly. b) There is a typo, "*Preform* a well log/MIT to detect CO_2 movement outside of the casing" under Major and Minor emergencies (pages 5 and 6). Please revise.
2. Injection Well Monitoring Equipment Failure	a) Please revise the title of this scenario to read "Injection Well <u>or</u> Monitoring Equipment Failure" to reflect the list of scenarios. b) Please edit the fifth item under Responses to a Major or Serious emergency to read: "Manually collect surface tubing pressure and annulus pressure <u>data</u> as needed to monitor the well until monitoring equipment is repaired."

Event/Scenario	EPA Comment/Recommendation
3. Potential Brine or CO_2 Leakage to USDW	a) Please describe how CO_2 leakage would be identified (e.g., via elevated concentrations of indicator parameters in groundwater samples or other evidence of fluid/brine or CO_2 leakage into a USDW), including specific triggers (e.g., pressure increase or pH changes). b) EPA recommends that the introduction to this scenario be broadened to encompass any evidence of CO_2 or fluid movement out of the injection zone (i.e., not necessarily to a USDW) to address events associated with unanticipated fluid movement pathways, any potential USDW endangerment/unacceptable changes in water quality, and CO_2 leakage to the surface. This would also better address the identified "potential risk scenarios." c) Under detection methods, please identify specific triggers (e.g., pressure gauge detection limits). d) Please refer to shutting the injection wells (plural) rather than "the injection well" throughout the responses since there are multiple wells at the site.
4. Natural Disaster	a) Please move the sentence "If a natural disaster occurs that affects normal operation of the injection well, CTV will perform the following" to immediately precede the listed response actions. b) Please refer to shutting the injection wells (plural) rather than "the injection well" throughout the responses since there are multiple wells at the site.

Event/Scenario	EPA Comment/Recommendation
5. Induced or Natural Seismic Event	a) Under timing, please edit the sentence to read, "An induced seismic event ~~will~~ would occur when the reservoir stresses are altered…" since this is a conditional statement. b) Please make the following revisions to the response activities in Table 2: • Refer to shutting the injection wells (plural) rather than "the injection well" throughout the table since there are multiple wells at the site. • Edit, "Report findings to the UIC Program Director and ~~issue~~ perform corrective actions" in item # 5 under the orange operating state, and # 11 in the magenta and red operating states. • Edit #1 in the magenta operating state to refer to the "gradual shutdown plan" (instead of a rate reduction plan) to be consistent with other text in the E&RR Plan. • Edit items #9 under the magenta and red operating states to read, "If USDW contamination is detected, endangerment ~~and~~ or CO_2 leaked" (so the response applies to either situation). • In #10 in the red operating state, delete the text as written, since it duplicates # 7. Replace it with: "Assess monitoring plans and where necessary intensify the monitoring plan to ensure containment." • On the magenta and red operating states, please add a step: "Perform a fall-off test to identify whether any changes to formation pressure or injectivity occurred" to address concerns about the effects of seismic events on the subsurface. c) How will California Geological Survey staff participate in response actions?

Attachment G: Well Construction and Plugging Plans

This well construction and plugging plan evaluation report for the proposed CTV II Class VI Sequestration Project summarizes EPA's evaluation of CTV's well construction design details and plugging and abandonment (P&A) procedures for the injection wells intended to be used for the sequestration of carbon dioxide (CO_2) into the Winters Formation at the project site. CTV submitted information regarding well construction with the well Construction and Plugging Plans (Attachments G1 through G5, V 3.1, February 2, 2023) as required in 40 CFR 146.86 and 146.92.

Injection Well Construction

CTV intends to convert three existing gas production wells (Sonol Securities 1-A, Sonol Securities 3, and Pool B-2) to Class VI injectors and drill two new injection wells (INJ-1 and INJ-2) at the project site. The locations of the wells are shown on Figure 1 of each Construction and Plugging (C&P) Plan provided as Attachments G1 through G5. Well schematics for each well are included in Appendix 5. The casing, tubing, and packer materials appear to be suitable for the purposes of CO_2 injection.

The well schematics show the depths of the temperature and pressure gauges and the wellhead surface equipment. Construction and materials used for well installation will adhere to various API specifications. General well details are provided below:

Sonol Securities 1-A

Sonol Securities 1-A was drilled in 1972 as a gas production well. CTV asserts that available drilling records did not reveal any issues during drilling and completion. Based on the well schematic, this well consists of the following components:

- Surface casing installed from the surface to 376 ft.
- Intermediate casing installed from the surface to 3,588 ft.
- Long string casing is installed in 2 sections, one from surface to 2,186 ft and the other from 2,186 to 9,540 ft. The deeper casing has a slightly different inside diameter, burst strength, and collapse strength.
- A liner installed from 9,352 to 9,995 ft.
- Class G Portland cement was used to cement the casings in place.

The casing details that are provided in Table 1 include all specifications listed in EPA's Well Construction Guidance.

The intermediate and surface casings are cemented from their base depth to the surface. Intermediate casing is set at 1,207 ft below the established lowermost USDW and is cemented to the surface, but the surface casing is very shallow and does not cover the lowermost USDW. The long string casing is only cemented from its base depth of 9,540 to approximately 4,213 ft, leaving a 625 ft section of the long string casing uncemented. The casing material is N-80 grade, with the exception of the surface casing which is H-40 grade. Tubing specifications are provided in Table 2. The tubing consists of L-80 corrosion resistant alloy (CRA). The packer specifications are provided in Table 3; however, the details differ from those provided on the well schematic. The packer is set at 9,200 ft, which is above the perforations that will be at a depth of 9,697 to 9,982 ft.

Sonol Securities 3

Sonol Securities 3 was also drilled in 1972 as a gas production well. CTV indicated that the well was constructed to API specifications. Drilling documentation noted casing damage and "junk" discovered in the hole. CTV states that this shouldn't affect usage but does not elaborate on this point. Based on the well schematic, this well consists of the following components:

- Surface casing is installed from surface to 1,007 ft.
- Intermediate casing consists of two sections:
    - The first section is installed from surface to 4,754 ft and consists of K-55 grade steel.
    - The second section is installed from 4,754 to 5,618 ft and consists of N-80 grade steel. The second section has higher burst, collapse, and tensile strength.
- Long string casing is installed in two sections, one from surface to 8,184 ft and the other from 8,184 to 9,927 ft. The deeper casing has a slightly different inside diameter and has higher burst, collapse, and tensile strength.
- Class G Portland and/or Poz D cement was used to cement the casings in place.
- No liner is installed in this well.
- Tubing is set at 9,570 ft with a packer system set at 9,540 ft.

The casing details that are provided in Table 1 differ from those indicated on the well schematic in Appendix 5. Namely, Table 1 does not describe both intervals of the intermediate or long-string casing, and the intermediate casing materials differ (i.e., K-55 and N-80 in Appendix 5 and N-80 in Attachment G). The details for each interval are condensed into one line for both casings.

The intermediate and surface casings are cemented from their base depth to the surface. Intermediate casing extends approximately 3,244 ft below the established lowermost USDW and is cemented to the surface, but the surface casing is shallow and does not cover the lowermost USDW. The long string casing is cemented in place from its base depth of 9,927 ft to approximately 4,213 ft, leaving a 1,405 ft section of the long string casing uncemented. The tubing consists of L-80 CRA. The tubing specifications are provided in Table 2. Packer specifications are provided in Table 3. The packer will be set at 9,562 ft above perforations that will be at a depth of 9,697 to 9,982 ft.

Pool B-2

Pool B-2 was drilled in 1976 as a gas production well. CTV indicated that the well was constructed to API specifications and is currently inactive. Based on the well schematic, this well consists of the following components:

- The surface casing was installed from 4 to 636 ft consisting of K-55 grade steel.
- The intermediate casing consists of two sections:
  - The first section is installed from 4 to 4,131 ft and consists of N-80 grade steel.
  - The second section is installed from 4,131 to 6,175 ft and consists of S-95 grade steel. The second section has higher burst, collapse, and tensile strength.
- The long string casing is also installed in two sections, one from the surface to 8,184 ft and the other from 8,184 to 9,927 ft. Both sections consist of N-80 grade steel. The deeper casing has a slightly different inside diameter and has higher burst, collapse, and tensile strength.
- Class G Portland cement was used to cement the casings in place.
- No liner is installed in this well.
- The tubing extends to 10,020 ft, with a packer system set at 9,990 ft.

The casing details that are provided in Table 1 differ from those indicated on the well schematic in Appendix 5. Namely, Table 1 does not describe both intervals of the intermediate or long-string casing and the intermediate casing materials differ (i.e., S-95 and N-80 in Appendix 5 and N-80 in Attachment G). The details for each interval are condensed into one line for both casings.

The intermediate and surface casings are cemented from their base depth to the surface. Intermediate casing is set at approximately 3,757 ft below the lowermost USDW and is cemented to the surface, but the surface casing is shallow and does not cover the lowermost USDW. The long string casing is cemented in place from its base depth of 10,460 ft to approximately 3,500 ft. This places the cement up within the intermediate casing, but leaves an open annulus from 3,500 ft to the surface. The tubing is L-80 CRA. The tubing specifications are provided in Table 2. The packer specifications are provided in Table 3. The packer will be set at 9,990 ft, which is above the perforations that will be at a depth of 10,033 to 10,387 ft. The packer depth on the schematic differs from the depth listed on Table 3.

INJ-1

INJ-1 will be a newly constructed injection well using components that are compatible with the injectate and formation fluids encountered. CTV states that the proposed well materials will have material strength is sufficient to withstand all loads encountered throughout the life of the well with an acceptable safety factor incorporated into the design. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- The conductor casing set from 14 to 54 ft.

- The surface casing will be installed from 14 to 600 ft and consist of K-55 grade steel.
- The intermediate casing will be installed from 14 to 4,100 ft and consist of N-80 grade steel.
- The long-string casing will consist of 2 sections:
    - The first section will be installed from 14 to 9,700 ft and consisting of N-80 grade steel.
    - The second section installed from 9,700 to 10,300 ft and consisting of L-80 CRA grade steel.
- No liner will be installed.
- The tubing will extend to 10,600 ft depth with a packer system set at 9,870 ft.

The casing details are provided in Table 1. Class G cement will be used to cement the casings in place from their base depth to the surface for each casing string. Intermediate casing will be set at approximately 1,703 ft below the lowermost USDW, but the surface casing is shallow and does not cover the lowermost USDW, as required per 40 CFR 146.86(b)(2). The tubing and packer specifications are provided in Table 2 and will consist of L-80 CRA materials. The packer will be set at 9,870 ft, which is above the perforations that will be at a depth of 9,905 to 10,173 ft.

INJ-2

INJ-2 injection well will be a newly constructed well using components that are compatible with the injectate and formation fluids encountered. CTV states that the proposed well materials will have sufficient strength to withstand all loads encountered throughout the life of the well with an acceptable safety factor incorporated into the design. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- A conductor set from 14 to 54 ft.
- Surface casing installed from 14 to 600 ft consisting of K-55 grade steel.
- Intermediate casing installed from 14 to 4,900 ft consisting of N-80 grade steel.
- Long-string casing will consist of 2 sections:
    - First section installed from 14 to 10,300 ft and consisting of N-80 grade steel.
    - Second section installed from 10,300 to 11,100 ft and consisting of L-80 CRA grade steel.
- No liner installed.
- Tubing to 10,600 ft with a packer system set at 10,430 ft.

The casing details that are provided in Table 1 include all specifications listed in EPA's Well Construction Guidance. Class G cement will be used to cement the casings in place from their base depth to the surface for each casing string. Intermediate casing will be set at approximately 2,466 ft below the lowermost USDW, but the surface casing is shallow and does not cover the lowermost USDW, as required per 40 CFR 146.86(b)(2). The tubing and packer specifications are provided in Table 2 and will consist of L-80 CRA materials. The packer will be set at 10,430 ft, which is above the perforations that will be at a depth of 10,465 to 10,845 ft.

Question/Request for CTV:

- *The packer setting depth provided in the corresponding table and well schematic of the 'Injection and Monitoring Well Schematics' document is not consistent for UI Inj 1 and UI Inj 2. Please clarify.*

Monitoring Well Construction

CTV plans to have nine total monitoring wells for the project consisting of four injection zone monitoring wells, two above confining zone monitoring wells, and three USDW monitoring wells. Five existing wells will be converted to monitoring wells. The remaining four will be newly drilled monitoring wells. Drilling plans for these wells were not provided; however, well construction schematics were included in Appendix 5. The locations of the proposed monitoring wells are shown in Figure 5.1 of the Narrative. CTV states that the proposed well materials will have sufficient strength to withstand all loads encountered throughout the life of the well with an acceptable safety factor incorporated into the design and will be compatible with the injectate and formation fluids encountered. The well schematics show the depths of the temperature and pressure gauges and the wellhead surface equipment, in addition to the casing, tubing, and packer depths and specifications. Cement specifications were not provided in the monitoring well specifications but the narrative states that the "cementing design, additives, and placement procedures will be sufficient to ensure isolation of the injection zone and protection of USDW using cementing materials that are compatible with injectate, formation fluids, and subsurface pressure and temperature conditions." General well details are provided below:

Brooks 10-1 RD1

Brooks 10-1 RD1 is an existing well located along the eastern edge of the AoR that will be converted to an injection zone monitoring well. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- A conductor set from 0 to 40 ft.
- Surface casing installed from 0 to 2,011 ft consisting of K-55 grade steel.
- Long-string casing installed from 0 to 9,783 ft consisting of N-80 grade steel.
- Tubing installed to 9,601 ft consisting of L-80 grade steel.
- A mechanical packer set at 8,030 ft consisting of low carbon, alloy steel.
- Perforations will be located from 9,578 to 9,654 ft.

M-1

M-1 will be a new well located along the west/northwestern edge of the AoR that will be converted to an injection zone monitoring well. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- A conductor set from 14 to 54 ft.
- Surface casing installed from 14 to 600 ft consisting of K-55 grade steel.
- Intermediate casing installed from 14 to 5,400 ft consisting of N-80 grade steel.
- Long-string casing installed from 14 to 10,378 ft consisting of N-80 grade steel.
- Tubing installed to 9,950 ft consisting of L-80 CRA grade steel.
- A permanent Sealbore packer set at 9,920 ft consisting of CRA material.
- Perforations will be located from 10,025 to 10,225 ft.

Sonal Securities 2

Sonal Securities 2 is an existing well located in the northern portion of the AoR that will be converted to an above confining zone monitoring well, with perforations set from 5,731 to 5,792 ft. The lower portion of the well will be plugged back from 9,215 to approximately 6,000 ft using two cement plugs separated with abandonment mud. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- Surface casing installed from 13 to 357 ft consisting of H-40 grade steel.
- Intermediate casing installed from 13 to 3,423 ft consisting of K-55 grade steel.
- Unidentified casing installed from 13 to 9,401 ft consisting of N-80 grade steel.
- Liner installed from 9,215 to 9,962 ft.
- Tubing installed to 5,720 ft consisting of L-80 grade steel.
- A mechanical packer set at 5,690 ft consisting of carbon alloy steel material.

Yamada Brothers 2

Yamada Brothers 2 is an existing well located along the southwest edge of the AoR that will be converted to an injection zone monitoring well. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- Surface casing installed from 16 to 630 ft consisting of K-55 grade steel.
- Intermediate casing installed from 16 to 5,800 ft consisting of N-80 grade steel.
- Long-string casing installed in two sections both consisting of N-80 grade steel and having slightly different strength specifications.
  - Upper section installed from 16 to 7,520 ft.
  - Lower section installed from 7,520 to 10,413 ft
- Tubing installed to 9,975 ft consisting of L-80 CRA grade steel.
- A permanent Sealbore packer set at 9,945 ft consisting of CRA material.
- Perforations will be located from 10,003 to 10,326 ft.

Phillips Yamada Brothers 1

Yamada Brothers 1 is an existing well located along the southwest edge of the AoR that will be converted to an above confining zone monitoring well, with perforations set from 6,265 to 6,317 ft. The lower portion of the existing well will be plugged back from 10,144 ft to approximately 6,317 ft using two cement plugs separated with abandonment mud. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- Surface casing installed from 16 to 595 ft consisting of K-55 grade steel.
- Intermediate casing installed from 16 to 6,004 ft consisting of N-80 grade steel.
- Long-string casing installed from 16 to 10,114 consisting of N-80 grade steel.
- Tubing installed to 6,260 ft consisting of N-80 CRA grade steel.
- A permanent Sealbore packer set at 6,230 ft consisting of CRA material.

Sonol Securities 4

The Sonol Securities 4 is an existing well located within the central portion of the AoR that will be converted to an injection zone monitoring well. Proposed well construction (provisional based on actual CO_2 composition) consists of the following:

- Surface casing installed from 17 to 613 ft consisting of K-55 grade steel.
- Intermediate casing installed from 17 to 5,440 ft consisting of K-55 grade steel.
- Long-string casing installed in three sections having slightly different strength specifications:
  - Upper section installed from 17 to 5,304 ft consisting of N-80 grade steel.
  - Middle section installed from 5,304 to 8,555 ft consisting of N-80 grade steel.
  - Lower section installed from 8,555 to 9,997 ft consisting of P-110 grade steel.
- Tubing installed to 9,601 ft consisting of L-80 grade steel.
- A permanent Sealbore packer set at 9,570 ft consisting of CRA material.
- Perforations will be located from 9,661 to 9,733 ft.

US-1

US-1 will be a newly installed USDW monitoring well. Proposed well construction consists of the following:

- Conductor casing installed from 12 to 52 ft consisting of H-40 grade steel.
- General casing installed from 12 to 2,270 ft consisting of J-55 grade steel.

- Tubing installed to 2,100 ft consisting of J-55 grade steel.
- A mechanical packer set at 2,070 ft consisting of low carbon alloy steel material.
- Perforations will be installed from 2,105 to 2,147 ft.

US-2

US-2 will be a newly installed USDW monitoring well. Proposed well construction consists of the following:

- Conductor casing installed from 12 to 52 ft consisting of H-40 grade steel.
- General casing installed from 12 to 2,300 ft consisting of J-55 grade steel.
- Tubing installed to 2,140 ft consisting of J-55 grade steel.
- A mechanical packer set at 2,110 ft consisting of low carbon alloy steel material.
- Perforations will be installed from 2,141 to 2,183 ft.

US-3

US-3 will be a newly installed USDW monitoring well. Proposed well construction consists of the following:

- Conductor casing installed from 12 to 52 ft consisting of H-40 grade steel.
- General casing installed from 12 to 2,280 ft consisting of J-55 grade steel.
- Tubing installed to 2,120 ft consisting of J-55 grade steel.
- A mechanical packer set at 2,090 ft consisting of low carbon alloy steel material.
- Perforations will be installed from 2,122 to 2,164 ft.

Corrosion of Well Construction Materials

Factors impacting the corrosivity of an environment containing CO_2 are complex and include pressure, temperature, and impurities (Cl^-, O_2, SO_2, NO_x, H_2S, etc.) that are frequently found to be present in sequestration injectate and/or formation fluids. Selection of appropriate well construction materials is therefore project-specific and depends, among other things, on the composition of formation fluids and the CO_2 stream.

Due to the acidic conditions generated by the mixing of CO_2 and water, alloys that may come into contact with water should be able to withstand pH values below 2.5. Examples of acceptable alloys may include Cr-25 steel and Hastelloy C-22. Some materials commonly used in less corrosive environments, such as Portland cement and Cr-13, are likely not appropriate for the corrosive conditions that occur where both water and CO_2 are present, either from aqueous formation fluids mixing with CO_2 or water present in the CO_2 stream itself. Also, monitoring wells located in the injection zone that contact the CO_2 plume will need to be adequately corrosion-resistant to tolerate the acidic conditions that can be generated by mixing of CO_2 streams and formation fluids in order to prevent endangerment of underground sources of drinking water.

Applicants proposing to use less corrosion resistant materials should demonstrate the adequacy of their planned materials including, but not limited to, through performing corrosion modeling over the timescale of their project. Any corrosion modeling used to validate well materials should take into account site specific chemistry, including the CO_2 stream and the formation fluids, and consider possible stress cases, in addition to normal operations, among other relevant factors.

Questions/Requests for CTV:

- *Please revise the planned construction of INJ-1 and INJ-2 to include surface casing that is cemented below the lowermost USDW, per 40 CFR 146.86(b)(2).*
- *Please describe how the construction of the existing wells meets the goals for Class VI well construction, particularly the requirement at 40 CFR 146.86(b)(2) that surface casing must extend through the base of the lowermost USDW and be cemented to the surface.*
- *Please provide evidence as to why the noted casing damage and "junk" discovered in the hole of Sonol Securities 3 will not be a concern for usage at the site.*
- *For wells Sonol Securities 1-A, Sonol Securities 3, and Pool B-2, please revise the casing material details on Table 1 so they are consistent with the well schematics in Appendix 5.*
- *For well Sonol Securities 1-A and Pool B-2, please revise the packer details (e.g., depth) on Table 3 so they are consistent with the well schematics in Appendix 5.*
- *Please confirm EPA's understanding of which monitoring wells are new and which are existing wells to be converted to monitoring wells.*
- *Please provide cement specifications for the monitoring wells.*
- *Please discuss an approach for corrosion modeling over the timescale of the CTV II project to demonstrate the adequacy of CTV's planned materials. The corrosion modeling should take into account site specific chemistry, including the CO_2 stream and the formation fluids, and consider possible stress cases, in addition to normal operations, among other relevant factors.*

Injection Well Plugging and Abandonment

The well plugging and abandonment (P&A) procedures are summarized in Section 6 of each well's C&P document. Prior to plugging each well, the pressure required to properly squeeze the cement into the perforations will be determined based on bottom hole pressure monitoring. The cement slurry will be overbalanced to ensure a proper seal of the perforations such that no reservoir fluids will enter the wellbore during P&A. Also prior to P&A, CTV will perform at least one external mechanical integrity test (MIT) such as a temperature log. The log data will be compared to pre-injection conditions to evaluate any potential integrity issues. Each well will be plugged using 4 cement plugs consisting of a blend equivalent to Class G cement.

Plug details including depth, volume, type, and emplacement method are summarized on Table 5 of each well's construction and plugging plan. Section 7.5 of each well's C&P plan provides detailed procedures for the P&A of the well. The plugging details match those presented on the proposed abandonment schematics. The plugs will target specific depths of the well as follows:

- Plug 1 - Bottomhole plug targeting the perforations and will extend 100 ft above the top of a landed liner, the uppermost perforations, the casing cementing point, the water shut-off holes, or the oil or gas zone, whichever is highest.
- Plug 2 – Plug across the base of the Capay Shale or top of the Mokelumne River Formation.
- Plug 3 – Base of the lowermost USDW; placement will be based on positioning of casing and the presence of cement behind the casing.
- Plug 4 – Surface plug consisting of at least 25 ft of cement.

Prior to emplacing cement plugs, a kill fluid will be pumped into the well to buffer and flush the wellbore and ensure reservoir fluid does not flow back into the well. The cement plugs will be emplaced into the wells using a coil tubing unit or cement retainer. Abandonment mud will be placed in between the cement plugs. CTV will notify EPA at least 60 days prior to implementing well plugging activities as required by 40 CFR 146.92(c).

Monitoring Well Plugging and Abandonment

Plugging schematics for the monitoring wells (including depth, volume, type, and emplacement method) are summarized on each well plugging schematic provided in Appendix 5. Class G cement will be used for each plug. The plugs will target specific depths of the well as follows:

- Plug 1 - Bottomhole plug targeting the perforations and will extend 100 ft above the top of a landed liner, the uppermost perforations, the casing cementing point, the water shut-off holes, or the oil or gas zone, whichever is highest.
- Plug 2 – Plug across the base of the Capay Shale or top of the Mokelumne River Formation.
- Plug 3 – Base of the lowermost USDW; placement will be based on positioning of casing and the presence of cement behind the casing.
- Plug 4 – Surface plug consisting of at least 25 ft of cement.

The USDW wells will be plugged with a two-plug system consisting of the following:

- Plug 1 - Bottomhole plug targeting the perforations and will extend approximately 100 ft above the top of the perforations.
- Plug 2 – Surface plug consisting of at least 25 ft of cement.

Questions/Requests for CTV:

- *What is the rationale for the placement of Plug 2 within the injection well plugging plan?*
- *Please clarify that the final MIT will be approved for Class VI wells, e.g., a temperature or noise log.*

Proposed Pre-Operational Testing Plan

This pre-operational testing evaluation report for the proposed CTV II Class VI Sequestration Project summarizes EPA's evaluation of the pre-operational well construction and mechanical integrity testing that has been completed for existing wells and/or will be performed for newly drilled wells prior to injection. EPA previously evaluated CTV's planned pre-operational formation testing program as part of the site characterization evaluation.

CTV plans to convert three existing gas wells into injection wells (Sonol Securities 1-A, Sonol Securities 3, and Pool B-2) and drill two new injection wells (UI-Inj-1 and UI-Inj-2).

Sonol Securities 1-A

Deviation checks were completed for Sonol Securities 1-A during drilling from a depth of 4,125 ft to 10,000 ft. Logging was also completed for Sonol Securities 1-A, including dual induction-laterolog, four-arm high resolution continuous dipmeter, and a compensated formation density log. A variable rate test was completed during drilling and completion in 1972.

Sonol Securities 3

Logging was completed for Sonol Securities 3 during drilling including dual induction-laterolog and a core log. No deviation checks are noted for Sonol Securities 3.

Pool B-2

Logging was completed for Well Pool B-2 during drilling including dual induction-laterolog, borehole compensated sonic, directional survey, and a core log. No deviation checks are noted for Pool B-2.

Prior to converting, CTV intends to perform a variety of testing as summarized on Table 4 of the construction and plugging plan for each well. These tests include a cement bond log, a casing inspection log, and a standard annulus pressure test (SAPT) for internal mechanical integrity. An external MIT will also be completed consisting of either an oxygen activation log or a noise log.

INJ-1 and INJ-2

For proposed new injection wells INJ-1 and INJ-2, CTV plans to perform a variety of logging and testing to fulfill the requirements of 40 CFR 146.87. Uncased logging of the borehole will be completed through wireline logging consisting of deviation checks, dual induction laterlog, gamma ray, and caliper logging. Cased wireline logging will be performed for each casing string (surface, intermediate, and long string) and consist of a cement bond log and casing inspection log. Mechanical integrity testing will consist of a standard annulus pressure test (internal MIT) and either an oxygen activation log, temperature log, or noise log for external MIT. Pre-operational logging and testing for the proposed injection wells are consistent with the tests summarized on Table 3 of their respective construction and plugging plans.

The specific testing procedures are described in Sections 7.0 through 9.0 of the T&M Plan. Injection well SAPT will be performed using a weighted brine with additives to pressurize the annulus to a surface pressure which exceeds the maximum injection pressure by at least 100 psi. The plans indicate that an SAPT will also be performed on the monitoring wells and tested at a specified tubing pressure will be tested to 1,000 psi. A change in pressure of less than ±3% will be used to demonstrate mechanical integrity.

Testing methods that CTV may use for external MIT are summarized in Table 7 of Attachment C and are consistent with the pre-operational testing referenced for injection wells in the well construction and plugging plans for each well. Monitoring wells will be tested using other approved methods under 40 CFR 146.89(c). Procedures for temperature logging are provided in Section 8.2 of the T&M Plan.

Questions/Requests for the Applicant:

- *Please confirm that deviation checks for the new injection wells will be completed every 120 ft as indicated in the pre-operational section of the construction and plugging plans.*
- *Aside from MIT, please describe any pre-operational testing that will be performed on the monitoring wells.*