

## Evaluation of Proposed Testing and Monitoring Activities at the San Joaquin Renewables Class VI Project

In June 2022, EPA provided questions presented in *blue italicized text* to San Joaquin Renewables (SJRenew) about the testing and monitoring plan submitted as part of SJRenew's Class VI permit application (dated October 13, 2021) for the proposed SJRenew Class VI geologic sequestration (GS) facility. In response, SJRenew provided an updated testing and monitoring plan (Attachment C Testing and Monitoring Plan\_090722) and a document summarizing their responses (Response\_090822) to EPA on September 8, 2022. EPA's evaluation of how the testing and monitoring plan addresses its questions and requests for revisions and additional information are presented in *red italicized text*.

SJR says that it will report the results of all injection-phase testing (including supporting data) semi-annually or within 30 days of the completion of each mechanical integrity test/pressure fall-off test. SJR will submit all post-injection monitoring results to EPA in annual reports within 60 days following the anniversary of the date on which it ceases injection. These reporting schedules are consistent with the requirements of 40 CFR 146.91.

### *Questions/Requests for the Applicant:*

- *When SJR submits its updated Testing and Monitoring Plan, please clarify that CO<sub>2</sub> stream analysis, corrosion monitoring, plume and pressure front tracking results will be submitted in an electronic format.*

*The applicant updated Section 2.2 to state that the data will be submitted in electronic format. The response is adequate.*

## Carbon Dioxide Stream Analysis

To meet the requirements of 40 CFR 146.90(a), SJR plans to analyze the carbon dioxide (CO<sub>2</sub>) stream for the following parameters using the methods listed below:

- CO<sub>2</sub> purity (ASTM E1747);
- Total sulfur (ISBT 14.0);
- Hydrogen sulfide (ISBT 14.0);
- Nitrogen (ISBT 4.0);
- Total Hydrocarbons (ISBT 10.0); and
- Methane (ISBT 10.1).

These analytes are consistent with information in the permit application narrative, which states that 99.9 percent by mass of the stream will be CO<sub>2</sub>, methane, benzene, ethane, and nitrogen (narrative, pg. 30 and Table 2-10). Table 3-1 of the narrative presents the modeled composition of the injectate and includes a wider range of parameters, primarily hydrocarbons, many of which are predicted to be present in extremely low concentrations, i.e., in concentrations of 10<sup>-5</sup> or less. Table 3-1 also includes carbon monoxide and water, which EPA recommends be included in the analytes for completeness.

There are no EPA-approved analytical methods for CO<sub>2</sub> injection streams. The majority of the analytical methods SJR proposes to use are from the International Society of Beverage Technologists, and have

been employed for other CO<sub>2</sub> GS projects, so there is EPA precedent for their use in EPA Class VI permits. In the QASP, SJR mentions the use of ASTM methods for CO<sub>2</sub> stream analysis (including ASTM D1945, D3246, and D6228) in addition to the methods listed above.

#### **Questions/Requests for the Applicant:**

- *For completeness and consistency with the preliminary injectate information and other Class VI permits, EPA requests that injectate analysis also include water, ammonia, oxygen, carbon monoxide, and oxides of nitrogen.*

*The applicant added these analytes to Section 3 of the Testing and Monitoring Plan. The response is acceptable.*

- *Please clarify the discrepancy with the QASP, where SJR describes ASTM methods for CO<sub>2</sub> stream analysis or revise the Testing and Monitoring Plan to include these methods. (Including these methods in the Testing and Monitoring Plan would avoid the need for future approval prior to their use during project operations.)*

*The applicant added these methods to Section 3 of the Testing and Monitoring Plan. The response is acceptable.*

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

- *EPA will require that a baseline injectate sample be analyzed for the same parameters as in the Testing and Monitoring Plan prior to commencement of injection.*
- *If this sample or any updated information about injection formation fluids indicates that any injectate constituents may lead to geochemical reactions that could affect operations or change formation properties, additional analytical parameters for the injectate analysis may be requested.*

## Injection Well Testing

The subsections below describe: the planned corrosion monitoring; continuous recording of injection pressure, rate, and volume to evaluate internal mechanical integrity; and annual external MITs for the SJR-I1 injection well that will meet the requirements at 40 CFR 146.90(b), (c), and (e).

### Corrosion Monitoring

SJR proposes to conduct corrosion monitoring using the coupon method and by conducting casing inspection logs.

SJR will perform quarterly monitoring of corrosion coupons. SJR states that coupons made of materials that are representative of the long-string casing, injection tubing, and wellhead will be installed in a flow-through pipe arrangement directly upstream of the wellhead, but does not describe the coupons. SJR states that coupon corrosion will be evaluated based on ASTM method G1-03 including photography, dimensional measurement, and weighing.

SJR will also monitor for corrosion by performing semi-annual casing inspection logs using one or more of the following methods: ultrasonic imaging log, multi-finger caliper log, electromagnetic flux log, or downhole video. The logging procedures are not described; however, EPA recommends including

logging descriptions to provide for a complete plan and to facilitate their use, especially if they are ever to be used as a substitute for the use of coupons.

**Questions/Requests for the Applicant:**

- *Please describe the corrosion coupons in the Testing and Monitoring Plan, i.e., based on the materials for the injection well as described in the narrative.*

*The applicant provided an overview of the corrosion coupon monitoring process in Section 5 of the updated Testing and Monitoring plan, including references to ASTM G1-03 and NACE TM01-69 standards. The applicant did not provide information on the coupon types that will be used to monitor corrosion of the various well components, however.*

- *The QASP also mentions the possible use of corrosion coupons by National Association of Engineers (NACE) International TM-01-69. EPA recommends adding this to the Testing and Monitoring Plan for completeness and to facilitate their use during project operations.*

*The applicant added the reference to Section 5 of the updated Testing and Monitoring Plan. The response is acceptable.*

- *What level/rate (e.g., 0.3 mils/year) of observed corrosion of the coupons would indicate an integrity concern?*

*The applicant added the corrosion rate (>1 mils per year; ~ a thousand of an inch) to Section 5 of the updated Testing and Monitoring Plan, as recommended in EPA's Testing Monitoring Guidance (EPA, 2013). The response is acceptable.*

- *Please describe casing inspection logging procedures to facilitate their use if they are to be used as a substitute for the use of corrosion coupons.*

*The applicant added various casing inspection logging methods to Section 5 of the updated Testing and Monitoring Plan. The applicant states that one or more of the logging methods will be used in addition to the coupon method, if requested by the UIC Program Director. The response is acceptable.*

**Follow-up Question/Request for the Applicant:**

- *Please provide the specific coupon types that will be assigned and used for each well material. EPA recommends a tabular format, as shown in the Testing and Monitoring Plan template, which lists the individual well components (e.g., surface casing, intermediate casing, etc.) and the associated coupon material (e.g., N80 steel).*

## Continuous Monitoring to Evaluate Internal Mechanical Integrity

SJR describes continuous recording devices to monitor: injection pressure, rate, and volume; the pressure on the annulus between the tubing and the long string casing; and the temperature of the CO<sub>2</sub> stream, as required by 40 CFR 146.88(e)(1), 146.89(b), and 146.90(b). However, the Testing and Monitoring Plan does not describe methods to measure the annulus fluid volume added, which is also required at 146.90(b).

According to the permit application narrative, SJR plans to perform formation testing to determine the fracture pressure of the injection zone. It is presumed that, at that point, SJR will calculate an appropriate injection pressure, and SJR will need to install pressure gauges that will ensure the maximum allowable surface and downhole injection pressures are not exceeded. SJR will also need to indicate the annular pressure needed to signify a mechanical integrity issue based on the final construction of the well.

***Questions/Requests for the Applicant:***

- *Please clarify the location/depths of the downhole gauges described in the Testing and Monitoring Plan. These should also be depicted on the injection well schematics when they are submitted.*

*The applicant added these details to Section 4 and to the well schematics in Appendix B of the updated Testing and Monitoring Plan. The response is acceptable.*

- *Please add monitoring of the annulus fluid volume to match the activities required at 40 CFR 146.90(b).*

*The applicant added this monitoring to Table 1 in Section 4 of the updated Testing and Monitoring Plan. The response is acceptable.*

- *Please explicitly define the annular pressure deviation that would warrant a mechanical integrity investigation.*

*The applicant added the annular pressure deviation rate that would trigger additional mechanical integrity testing to Section 7.1 of the updated Testing and Monitoring Plan. The response is acceptable.*

- *Please describe the minimum measuring and recording frequencies (e.g., measuring every 10 seconds, recording every 2 minutes) for each continuous monitoring device described in the Testing and Monitoring Plan.*

*The applicant added this information as Table 1 in Section 4 in the updated Testing and Monitoring Plan. The response is acceptable.*

- *EPA recommends that information about continuous monitoring be provided in a table that describes each device, its location (i.e., surface vs. downhole), and the sampling and recording frequencies. See, e.g., the table in the Testing and Monitoring Plan template, which is available in the GSDT.*

*The applicant added this information as Table 1 of Section 4 in the updated Testing and Monitoring Plan. The response is acceptable.*

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

- The maximum pressure thresholds identified for continuous monitoring and the annulus pressure will need to be incorporated into the Testing and Monitoring Plan based on formation testing and the final permit conditions related to injection pressure.*
- The final injection well schematics will need to reflect all downhole gauges.*

### External MITs

To verify external mechanical integrity as required at 40 CFR 146.89(c) and 146.90, SJR plans to perform temperature and/or oxygen activation logs annually. SJR also plans to perform the same MITs prior to commencing injection.

SJR states that temperature logs (TL) and/or oxygen activation logs (OALs) will be conducted according to the specifications in EPA's Class VI Testing and Monitoring Guidance. That guidance does not provide specific procedures for MITs; however, the TL procedures are described in guidance from EPA Region 9. SJR outlines the basic procedure for conducting temperature logs, including descriptions of shut-in times and temperature logging times.

SJR states that it will conduct OALs only if necessary to resolve temperature logging results or if temperature logging results indicate potential failure. No OAL procedures are provided. If SJR plans to perform an OAL, it would need to provide a detailed description of the MIT testing procedures to EPA prior to performing the test.

SJR's financial responsibility demonstration includes costs for post-injection MITs in the Vedder Formation monitoring well, which is consistent with EPA guidance; however, this testing is not described in the Testing and Monitoring or PISC and Site Closure plans. EPA recommends that SJR include MITs of both of the deep monitoring wells in the Testing and Monitoring Plan.

### *Questions/Requests for the Applicant:*

- Please provide more extensive temperature logging procedures, e.g., in accordance with the document, "Appendix E – Temperature Logging Procedures – U.S.E.P.A. Region IX," which is available online at:*  
<https://archive.epa.gov/region9/water/archive/web/pdf/appendixetemplogreqs.pdf>.

*The applicant added the temperature logging procedures to Section 7 of the updated Testing and Monitoring Plan including references to EPA's temperature logging procedures provided as Appendix D. The response is acceptable.*

- EPA recommends that SJR describe OAL procedures in the Testing and Monitoring Plan to facilitate their use during project operations.*

*The applicant added the OAL procedures to Section 7 of the updated Testing and Monitoring Plan, which states that testing will be performed as described in EPA's MIT guidance documents, which were added as Appendix D to the Testing and Monitoring Plan. The response is acceptable.*

- *Please provide procedures and plans for performing MITs in the Vedder Formation and ACZ monitoring wells in the Testing and Monitoring Plan.*

*Section 7 of the updated Testing and Monitoring Plan states that MITs will be completed in the monitoring wells, which also details the procedures and plans for performing MITs. The response is acceptable.*

## Pressure Fall-Off Testing (PFOT)

SJR states that it will perform PFOTs every five years during the injection phase to meet the requirements of 40 CFR 146.90(f). SJR will also perform a PFOT after initial completion of the injection well. The Testing and Monitoring Plan provides a brief description of the test procedures and information to be submitted to EPA.

### *Questions/Requests for the Applicant:*

- *Please provide more detailed PFOT procedures, e.g., in accordance with the document, “EPA Region 9 UIC Pressure Falloff Requirements,” which is available online at: <https://archive.epa.gov/region9/water/archive/web/pdf/falloff-testing-guidlines.pdf>.*

*The applicant provided PFOT procedures in Section 8 of the updated Testing and Monitoring Plan and stated that they will be performed according to the EPA Region 9 UIC Pressure Falloff Requirements, which are in Appendix E of the updated plan. The response is acceptable.*

## Groundwater Quality Monitoring

To meet the requirements of 40 CFR 146.90(d), SJR plans to perform the following direct and indirect monitoring above the confining zone:

- Quarterly injection-phase water quality monitoring and continuous pressure monitoring in one above confining zone (ACZ) monitoring well that SJR plans to install immediately southeast of the injection well (per Figure 1). The well will be completed in the Olcese Formation, which is the formation immediately above the Freeman-Jewett confining zone and occurs from approximately 6,625 to 7,095 feet below ground surface. During the post-injection phase, SJR plans to perform annual water quality sampling and continuous pressure monitoring.
- Semi-annual water quality monitoring in eleven (11) publicly- and privately-owned wells that are currently monitored by the Southern San Joaquin Municipal Utility District (SSJMUD). The wells are screened within USDWs overlying the SJR project site. Six of the wells (Delano Well 14, McFarland Taylor Well, SSJMUD-23, SSJMUD-42, SSJMUD-53 and SSJMUD-14) are located within the delineated AoR; the others are just outside of the AoR. According to Figure 2, the wells are between 6 and 329 feet deep.

SJR says that it will seek to enter into a memorandum of understanding (MOU) with SSJMUD to (1) gain access to water quality data from each of the monitoring wells within the AoR, and (2) if needed, obtain access to the wells for periodic sampling. The permit application narrative states that the deepest USDW is over 1,000 feet, and would therefore not be monitored. However, monitoring in the shallow formation that likely serves as the drinking water source is appropriate.

If an MOU with SSJMUD is in place for the duration of the injection and post injection time frames, this should provide the necessary access to water quality data. However, any change in ownership of the USDW monitoring wells, particularly those within the AoR, could affect the applicant's ability to perform all of the monitoring. Any change in SJR's ability to access these wells could necessitate an update to the injection or post-injection monitoring plan.

SJR proposes to monitor water quality in the USDW and the ACZ wells for the same set of parameters using the same analytical methods. The table below identifies these parameters and provides EPA's evaluation notes and questions for SJR.

Parameter (Method)	Evaluation Notes/Questions
Carbon dioxide (ASTM D513 or similar)	Please clarify the year of the ASTM method. Revised as requested.
Dissolved metals (EPA 200.8/200.9/7010 or similar)	EPA Methods 200.7, 200.8 and 200.9 are likely more appropriate options. EPA Method 7010 does not appear to be an approved EPA wastewater analytical method. Please specify the following revision numbers: 200.7, Rev. 4.4; 200.8, Rev. 5.4; 200.9, Rev. 2.2. Revised as requested.
Total dissolved solids (ASTM D5907 or similar)	Please clarify the year of the ASTM method. Revised as requested.
Major anions (EPA 300.1 or similar)	Please list the specific anions (e.g., Br, Ca, F, NO <sub>3</sub> , SO <sub>4</sub> , and Cl). Revised as requested.
Major cations (EPA 6020A/6020C/700B or similar)	Please list the specific cations (e.g., Al, Ba, Mn, As, Cd, Cr, Cu, Pb, Se, Tl, Sb, Ca, Fe, K, Mg, Na, and Si). Revised as requested. Please provide additional information about EPA Method 6020C, which is not an EPA-approved wastewater analytical method. The method was removed from the T&M Plan, but is still referenced in the QASP. Please edit "EPA Method 700B" to be "EPA Method 7000B." The method was removed. Please clarify that EPA Method 6020A is the February 2007 version. Revised as requested; however, the QASP still references "EPA 6020A/6020C/700B or similar."
pH, temperature, specific conductivity (calibrated field meter)	Please provide documentation that meter calibration is using standards that are not out of date. Revised as requested.

The parameters appear to be generally appropriate for groundwater quality monitoring needs for GS projects, and are consistent with other Class VI monitoring programs, except as noted in the table above and the questions below. As the permit application narrative describes (on pg. 28), the Vedder and Freeman-Jewett formations are composed predominantly of silicate minerals like quartz, feldspar, and clays that are not expected to be highly reactive during CO<sub>2</sub> sequestration. The graywacke sandstones in the Vedder Formation indicate iron and/or magnesium presence with potential manganese when dissolution/oxidation occurs; thus, dissolved metals and cations of manganese are appropriate analytes. Note that, as additional information is gathered based on the reviews of other parts of the permit application or pre-operational data collection, recommendations or requirements for additional analytical parameters may be provided.



Many of the methods SJR proposes are used in other UIC permits (including Class VI permits), and are considered acceptable as part of the Testing and Monitoring Plan. Most of the methods are EPA-approved wastewater analytical methods or ASTM methods; while no information was provided about the ASTM methods, they are generally considered to be acceptable testing methods and approvable in EPA permits. For several analytes, SJR indicates they may use a “similar” method to the one listed; this could introduce some uncertainty about the method to be used, and EPA recommends that SJR explicitly describe all methods they may potentially use in the plan.

EPA recommends in Class VI guidance that monitoring well construction and planned plugging procedures be reviewed as part of the permit application evaluation to confirm that these wells will not provide conduits for fluid movement that could endanger USDWs. No monitoring well construction or plugging information was provided in the permit application materials. Verification of the depth and construction of the ACZ well will be needed prior to authorization of injection. EPA will also need to review schematics, including the pressure gauges, for the ACZ well.

SJR’s QASP describes similar analytes and methods to the Testing and Monitoring Plan. However, it also mentions analysis of dissolved oxygen (DO), which EPA recommends including in the Testing and Monitoring Plan.

SJR should note that the Central Valley Water Board indicated in its consultations with EPA on a prior Class VI project that any newly drilled monitoring wells must be approved by the Water Board and, while existing wells would not need to be approved, the Water Board expressed interest in any plans to use existing wells as monitoring wells.

#### ***Questions/Requests for the Applicant:***

- *Please update the discussion of water quality monitoring parameters to address the comments in the table above.*

*The applicant incorporated some of the information requested above into Sections 6.1 and 6.2 of the updated Testing and Monitoring Plan. However, there is still some missing or inconsistent information, as noted in the above table.*

- *In addition, please include the following groundwater quality parameters to support a robust monitoring program, as follows:*
  - *Dissolved O<sub>2</sub> and H<sub>2</sub>S. Dissolved O<sub>2</sub> is a primary indicator of water quality (and is mentioned in SJR’s QASP). H<sub>2</sub>S occurs in the subsurface and has the potential to be mobilized, and is listed as a toxic substance by the CDC.*

*The applicant revised Sections 6.1 and 6.2 of the updated Testing and Monitoring Plan to include dissolved oxygen and H<sub>2</sub>S as parameters for analysis. The response is acceptable.*

- *EPA also recommends SJR analyze groundwater for alkalinity (e.g., using SM 2320 B) and dissolved methane (e.g., via RSK-175/Gas Chromatography).*

*The applicant revised Sections 6.1 and 6.2 of the Testing and Monitoring Plan to include alkalinity and dissolved methane as parameters for analysis. The response is acceptable.*



- EPA requests that, where SJR mentions the use of analytical methods that are “similar” to the EPA methods listed, SJR should describe these methods in the plan; otherwise, SJR will need to gain EPA’s approval before using any of them.

*The word “similar” was removed from Section 6.1 but still remains in the QASP which is included as Appendix A.*

- What is SJR’s plan for conducting USDW monitoring if any of the wells that are owned by municipalities or private entities were to be closed?
  - EPA recommends that SJR include in the Testing and Monitoring and PISC and Site Closure Plans that, should any of the USDW wells be plugged by their owners, SJR will notify EPA and identify whether additional monitoring wells are needed and revise the plan if necessary.

*The applicant added the requested language to the updated Testing and Monitoring Plan and the updated PISC and Site Closure Plan. The response is acceptable.*

- The Testing and Monitoring Plan says that SJR plans to gain access to water-quality data obtained from each of the SSJMUD monitoring wells “within the AoR.” Please clarify in the plan if SJR also plans to gain water quality data from the wells outside the delineated AoR.

*The applicant responded that they will access the wells listed even those outside of the AoR in order to be conservative. Based on Figure 2, the wells for which SJRenew plans to collect data are inside and outside of the delineated AoR. This response is acceptable, assuming that the applicant will successfully secure the MOU with SSJMUD.*

- Please provide schematics of all the wells to be used for monitoring that depict the sampling equipment/gauges to be used and their depths.

*The applicant provided monitoring well schematics in Appendix B of the updated Testing and Monitoring Plan. However, no sampling equipment is depicted on the schematics, although it is described in Section 3.1.2 of the QASP.*

- Please also provide plugging and abandonment plans for the ACZ monitoring well.

*The applicant provided monitoring well plugging details in Section 8.1 of the updated PISC and Site Closure Plan. The response is acceptable.*

#### **Follow-up Question/Request for the Applicant:**

- Please add sampling equipment and pressure monitoring gauges to the monitoring well schematics, similar to the injection well schematic.

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

- Confirm the depth and diameter of the ACZ well after it is constructed for consistency with other permit attachments, e.g., the financial responsibility demonstration.
- Confirm the appropriateness of the water quality analytes based on formation water quality analyses during drilling of the injection and monitoring wells.

## CO<sub>2</sub> Plume and Pressure Front Tracking

SJR describes planned CO<sub>2</sub> plume and pressure front tracking that includes the use of direct and indirect methods for tracking the extent of the CO<sub>2</sub> plume and pressure front during the injection and post-injection phases, per the requirements of 40 CFR 146.90(g)(1),(2). Specifically, SJR proposes to track the plume and pressure front using the following methods:

- **Indirect monitoring of the CO<sub>2</sub> plume** using time-lapse three-dimensional surface seismic surveys within the AoR.
- **Direct pressure monitoring** within the injection zone via the injection well and a monitoring well completed in the injection zone.

## CO<sub>2</sub> Plume Monitoring

SJR proposes to monitor the CO<sub>2</sub> plume using time-lapse three-dimensional (3D) surface seismic surveys within the AoR. The 3D seismic surveys will be conducted prior to injection (baseline), and at Years 2, 5, and 10 during the injection phase. According to the PISC and Site Closure Plan, seismic surveys will be performed at the cessation of injection and in Year 15 of the post-injection phase.

SJR states that plume monitoring will cover the entire extent of the area anticipated to be subject to CO<sub>2</sub> migration. On Figure 1, it appears that the area covered by the seismic survey is a 6-square mile area that extends beyond the areas depicted where CO<sub>2</sub> plume saturation will be greater than 5%. SJR also states that surface-seismic results will provide an indication of whether supercritical-phase CO<sub>2</sub> is present in any given location and that it plans to compare the results of the seismic surveys to the predicted extent of the CO<sub>2</sub> plume; however, it does not explain how this correlation between seismic survey data and CO<sub>2</sub> plume saturation will be made.

In their financial responsibility demonstration, SJR describes fluid sampling in the Injection-Zone (IZ) monitoring well; however, this sampling is not described in the Testing and Monitoring Plan. EPA recommends in guidance that permittees perform fluid sampling in the injection zone with similar analytes as in the above confining zone monitoring to gather data to demonstrate that USDWs are not endangered and to support AoR reevaluations and the non-endangerment demonstration required at 40 CFR 146.93(b).

### *Questions/Requests for the Applicant:*

- *Please clarify in the Testing and Monitoring Plan that updating of the computational modeling is not a plume tracking method, but is a verification process.*

*The applicant provided the requested revision in Section 2 of the updated Testing and Monitoring Plan. The response is acceptable.*

- *EPA recommends that SJR perform fluid sampling in the IZ monitoring well (at least until the CO<sub>2</sub> plume reaches the well) with similar analytes as in the ACZ monitoring to demonstrate that USDWs are not endangered and to gather data to support AoR reevaluations and the non-endangerment demonstration.*

*The applicant responded that they do not anticipate collecting injection zone groundwater samples from the monitoring wells, asserting that 40 CFR 146.90(g) does not require direct*

plume monitoring in all circumstances. However, 146.90(g) requires the owner or operator to monitor the plume and pressure front using direct methods in the injection zone and indirect methods unless the Director determines such methods are not appropriate.

The applicant asserts that injection zone geochemical sampling may be required if indirect methods are not feasible, a condition that they assert does not apply to the project. However, SJRenew does not appear to plan to perform any direct monitoring to track the CO<sub>2</sub> plume, and the first seismic survey for indirect plume tracking will be conducted 2 years after injection commences. (The plume is not predicted to reach the injection zone monitoring well, which is located 2 miles to the east of the injector, per Figure 1a of the Testing and Monitoring Plan.) SJRenew indicated that they are prepared to discuss these monitoring requirements if requested by EPA.

- EPA recommends that SJR ensure that the second seismic survey (i.e., at 5 years of injection), be timed to allow collection of this data prior to the initial AoR revaluation.

The applicant revised the timing in Section 9 of the updated Testing and Monitoring Plan. The response is acceptable.

- Please explain how SJR plans to use the seismic and pressure data collected as part of plume and pressure front tracking to estimate CO<sub>2</sub> saturation and characterize any changes that might occur.

The applicant responded that they will use both seismic and pressure monitoring to comply with Class VI requirements for pressure front tracking, and reference that the EPA Testing and Monitoring Guidance does not require estimating CO<sub>2</sub> saturation from indirect plume and pressure front tracking. See above for additional comments on planned plume tracking.

- EPA recommends that SJR include monitoring for seismic events (e.g., via existing state- or USGS-operated seismic monitoring networks) to afford an opportunity to respond to any events that could affect the injection/monitoring wells.

The applicant added recommended seismic monitoring methods and event response details to Section 9 of the updated Testing and Monitoring Plan. The response is acceptable.

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

- Gather baseline seismic data via a 3D seismic survey.

#### **Follow-up Questions/Requests for the Applicant:**

- Please describe how SJRenew will directly monitor the CO<sub>2</sub> plume in the injection zone, as required at 146.90(g)(1) to support updates to the AoR modeling.
- Please describe what information will be collected about the position of the CO<sub>2</sub> plume during the first 2 years of injection operations.
- Please explain the appropriateness of the injection zone monitoring well location relative to the predicted maximum extent of the CO<sub>2</sub> plume (i.e., approximately 1 mile beyond this extent) and how it will generate data to validate predictions of plume movement and inform AoR reevaluations.

## Pressure Front Monitoring

SJR proposes to perform direct pressure monitoring within the injection zone via the Class VI injection well and in a monitoring well to be installed within the Vedder Formation (the IZ well). SJR states that the injection well will be fitted with downhole fiber optics for monitoring pressure within the injection zone, and the IZ monitoring well will be fitted with a downhole transducer for continuous pressure measurement. This monitoring well is depicted on Figure 1 in the Testing and Monitoring Plan, and is approximately two miles to the east of the injection well, and within the area where pressures are expected to increase, as shown in the AoR and Corrective Action Plan (i.e., on Figure 1-8a which shows the distribution of overpressures at the end of the 15-year injection period). However, it is unclear based on Figure 1 when the pressure front will reach the location of the IZ monitoring well. Pressure monitoring in the injection zone monitoring well will continue in the post-injection timeframe, according to the PISC and Site Closure Plan.

No pressure monitoring is planned to the west of AoR, where the Pond-Poso Creek Fault Complex forms the western structural boundary of the AoR. As described in EPA's geologic evaluation report, there is no definitive pressure data that would indicate that the fault complex is sealing to pressure. Depending on SJR's responses to questions in that report about the sealing nature of the fault, pressure monitoring to the west of the Pond-Poso Creek Fault Complex may be appropriate.

Verification of the depth and construction of the Vedder Formation monitoring well will be needed prior to authorization of injection.

### Questions/Requests for the Applicant:

- *When is the pressure front expected to intersect the location of the IZ monitoring well?*

*The applicant does not anticipate that the pressure front will intersect the IZ monitoring well as it is "predicted to be smaller than the carbon dioxide plume." However, the applicant notes that increased pressure will be detected in the IZ monitoring well, but does not state when this is anticipated to occur and what that pressure would be. This information is needed to afford a comparison of observed pressures with modeled predictions.*

- *EPA recommends adding a map to the Testing and Monitoring Plan that shows the IZ monitoring well along with the pressure contours shown on Figure 1-8a of the AoR and Corrective Action Plan to provide context for the location of the IZ monitoring well.*

*Figure 1b of the updated Testing and Monitoring Plan shows the pressure contours and the location of the injection zone monitoring well. The response is acceptable.*

- *On page 9, the Testing and Monitoring Plan states that the planned location of the IZ monitoring well is on Figure 2; however, the well is on Figure 1. Please clarify the reference.*

*The applicant clarified that the planned location of the injection zone monitoring well is on Figure 1b of the updated Testing and Monitoring Plan. The response is acceptable.*

- Please provide schematics of the IZ well that depict the sampling equipment/gauges to be used, and their depths.

*The monitoring well schematics in Appendix B of the updated Testing and Monitoring Plan do not show any gauges. See the follow up request under ground water monitoring.*

- Please provide a plugging and abandonment plan for the IZ monitoring well.

*The applicant provided injection zone monitoring well plugging and abandonment procedures in Section 8.1 of the updated PISC and Site Closure Plan. The response is acceptable.*

**Follow-up Question/Request for the Applicant:**

- Please provide an estimate, based on the modeling, as to when increased pressures are predicted to be initially observed at the IZ monitoring well, and what those pressures are anticipated to be.

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

- Confirm the depth and diameter of the IZ well after it is constructed for consistency with other permit attachments, e.g., the financial responsibility demonstration.
- Determine whether pressure monitoring west of the Pond-Poso Creek Fault Complex is needed.

## Air/Soil or Other Testing and Monitoring

No monitoring of CO<sub>2</sub> levels in air or soils is described in the Testing and Monitoring Plan.

**Questions/Requests for the Applicant:**

- The Emergency and Remedial Response Plan scenarios include elevated CO<sub>2</sub> in indoor air. How does SJR plan to monitor and detect this?

*The applicant responded that indoor air monitoring is not included in the application materials as it is not required by the Class VI Rule. The applicant states that the indoor air detection response was included in the ERRP for completeness and contingency should that scenario occur. The ERRP includes unexpected CO<sub>2</sub> accumulation as a potential risk scenario and includes this in their event evaluation (Table 4) and response procedures (Table 5). Because indoor air monitoring is not a UIC requirement, the response is acceptable.*

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

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

## Quality Assurance Procedures

EPA reviewed the QASP to verify that the testing activities, analytes, etc., included in the QASP are consistent with proposed injection and post-injection phase testing and monitoring. The QASP outlines QA procedures (e.g., for laboratories, field instruments/field sampling methods, analytical methods, and sample handling) for all of the activities described in the Testing and Monitoring Plan. The methods described are similar to those in the Testing and Monitoring Plan, except as described in EPA's evaluation notes above.

### **Questions/Requests for the Applicant:**

- *The Testing and Monitoring Plan refers to quality assurance and quality control procedures. EPA recommends that it specifically reference the QASP document.*

*The applicant referenced the QASP in Section 2.1 of the updated Testing and Monitoring Plan. Additionally, the QASP was included as Appendix A of the updated plan. The response is acceptable.*

- *Water quality sampling methods in the above confining zone well are described in the QASP. EPA requests that SJR indicate that any water quality sampling/analysis in the USDW or injection zone wells that is performed by SJR will be performed with the same QA protocols.*

*The applicant referenced the QASP regarding water quality sampling in Section 6 of the updated Testing and Monitoring Plan. The response is acceptable.*

### **Follow-up Questions/Requests for the Applicant:**

- *Please remove the word "similar" in regard to analytical methods for cations from Section 3.1.4 of the QASP as noted under ground water monitoring above.*
- *Please update the analytical method for major cations to be consistent with the Testing and Monitoring Plan (i.e., EPA Method 6020A, February 2007).*