UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

Sent via email only

April 25, 2022

Thomas J. Paskach
San Joaquin Renewables, LLC
1521 West F Avenue
Nevada, IA 50201

Re: Technical Review of Application
Underground Injection Control (UIC) Permit Application
Class VI Pre-Construction Permit Application No. R9UIC-CA6-FY22-2

Dear Mr. Paskach:

The United States Environmental Protection Agency, Region 9 (EPA) has conducted a technical evaluation of the site characterization, financial responsibility, and emergency and remedial response plan for the subject permit application. Based on this evaluation, we have identified additional information or clarification needed for continued evaluation of the permit application. These comments are included in the three Enclosures to this letter.

Please submit the information requested in the Enclosures by June 9, 2022. If you have any questions about this letter and the Enclosures, please contact Calvin Ho at (415) 972-3262, or call me at (415) 972-3971.

Sincerely,

DAVID ALBRIGHT

Digitally signed by DAVID ALBRIGHT
Date: 2022.04.25 13:03:19 -07'00'

David Albright
Manager, Groundwater Protection Section

Enclosures: Site Characterization
Financial Responsibility
Emergency and Remedial Response Plan

cc (via email): Chris Jones, CalGEM Inland District
Clay Rodgers, Central Valley Regional Water Quality Control Board
Janice Zinky, CA State Water Resources Control Board

Site Characterization Evaluation of the San Joaquin Renewables (SJR) Class VI Permit Application

This geologic site characterization evaluation report for the proposed San Joaquin Renewables (SJR) Class VI geologic sequestration (GS) project summarizes EPA's evaluation of the permit application narrative submitted as part of SJR's Class VI permit application (dated January 7, 2022). This review also identifies preliminary questions for the applicant. Where specific information is lacking based on the currently available information, this evaluation identifies testing objectives that EPA recommends be incorporated into the Pre-Operational Testing Plan.

Regional Geology and Geologic Structure

SJR is proposing to construct and operate a Class VI well to inject carbon dioxide (CO_2) generated by a biomass gasification process at a GS project located in the southern portion of the San Joaquin Basin Province near McFarland, in Kern County, CA. The southern portion of the San Joaquin Basin is described as an enclosed forearc basin with up to 30,000 feet of Cenozoic strata onlapping a west-dipping Mesozoic basement. Overlying strata thin to the east, and compressional forces from the San Andreas Fault have created a fold and thrust belt system to the west (pg. 7; Figures 2-2 to 2-5).

SJR plans to construct one (1) Class VI injection well (SJR-I1) to inject 1,200 tons of CO_2 per day into the Oligocene Vedder Formation sandstone (the injection zone) at a depth of approximately 7,780 ft below ground for a period of 15 years, for a total of 6.57 million tons of CO_2 (pgs. 6, 9, 29). The Vedder Formation is confined above by the Miocene Freeman-Jewett Formation shale and mudstone (the confining zone). Overlying the Freeman-Jewett are the Olcese Formation sandstone, the Round Mountain Silt, and Fruitvale Shale (Figures 2-10 and 2-23). The Vedder Formation is confined from below by a shale layer and impermeable granitic basement. The San Joaquin Basin hosts many oil and gas reservoirs, e.g., the Antelope-Stevens and Tumey-Temblor Petroleum Systems; however, none are within the defined area of review (AoR) for the project (pgs. 8, 23; Figures 2-10 to 2-13, 2-57).

The Vedder Formation is an east to west progradational shallow marine shelf filling the basin from the Sierra Nevada highlands to the east (pg. 7; Figures 2-7, 2-20). It is composed of several sand units, Vedder 1/Vedder 1a/Vedder 2/Vedder 3/Vedder 4/Cantleberry Sand, five of which are present within the AoR (the Cantleberry is not present). The sands are separated by shales and overlain locally by the Pyramid Hills sandstone and Freeman-Jewett shale and mudstone (pgs. 12-13; Figures 2-7, 2-10, 2-20). In the narrative, SJR states that injection will be into two of these intervals: the Pyramid Hill/Vedder 1/Vedder 2 and the Vedder 3 (pg. 31); in the AoR and Corrective Action Plan (AoR/CA) submitted with the permit application, it appears that SJR has not definitively determined whether the well will be perforated in both intervals. Regionally, the Vedder Formation gently dips about 4° to the west as part of a homocline structure in the forearc basin defined by the Sierran Uplift to the east and a fold and thrust belt system to the west (pgs. 7, 13; Figure 2-5). The injection reservoir laterally pinches out to the east, where Cenozoic strata onlap the granitic basement, and is truncated to the west by the Pond-Poso Creek Fault Complex (pgs. 7, 9; Figure 2-23). The application asserts that this normal fault complex is predicted to be sealing (see the discussion of "Faults and Fractures," below).

The approximate depths and relationships of each stratigraphic unit within the proposed AoR are based on seismic studies (pg. 12; Appendix D). Historical studies, e.g., Wagoner (2009) and Hewlett and Tye (2015), also characterize the stratigraphic relationships of the units (Figures 2-15, 2-16, 2-19, 2-20, 2-21).

Questions/Requests for the Applicant:

- *For context, please label the project AoR and well location on the seismic cross sections and maps of Appendix D, or provide a map of the seismic survey area in the application narrative.*
- *Please clarify the location of Cross Section 1 from Wagoner (2009) on Figure 2-14. The cross section line is obscured due to its low resolution and the well labels. Also, the legend shows Cross Section 1 as a blue line, while the figure caption says it is indicated in black.*
- *The application on pg. 31, states that there will be two injection zones: the Pyramid Hill/Vedder 1/Vedder 2 and Vedder 3. Please explain how the Pyramid Hill Formation is addressed in the geologic characterization and the modeling, which focuses on the Vedder Formation.*
- *Although it is understood that no oil and gas fields are in the AoR, are there any geochemical analyses for hydrocarbons from the oil and gas wells in the region, and if so, does the compositional data indicate any type of geochemical trend (e.g., up-section/upward movement)?*
- *The narrative states on pg. 6 that "the Vedder Formation porosity and permeability make it ideal for production." Please revise this text to clarify that the Vedder is an injection zone.*
- *EPA requests revisions of several figures to clarify their context for the narrative:*
    - *Please label the Vedder Formation on Figure 2-1.*
    - *Please label the Vedder Formation in the cross section on Figure 2-5 and the injection site in the map view in the figure.*
    - *Please correct the reference to the Birkholzer (2011) table (which is in Appendix C, not Appendix D) in the last paragraph of Section 2.1.2 on page 10.*
    - *Please draw the AoR on Figure 2-17.*
    - *Please provide index maps showing the cross section lines and locations of the wells used for Figures 2-23 to 2-27.*

Objectives for Pre-Operational Testing:

- *Determine, based on pre-operational testing, which of the Vedder Formation intervals will ultimately be selected as the injection zone(s).*

Faults and Fractures

Faults near the proposed injection site include the recent Pond Fault, Pond-Poso Creek Fault (Quaternary), and unnamed Quaternary faults near Rag Gulch in the Sierra Nevada Foothills (pg. 20; Figures 2-45 to 2-47). The Pond-Poso Creek Fault Complex, which consists of the Pond Deep, Pond West, and Pond East faults, marks the western structural boundary of the AoR. The Pond-Poso Creek Fault Complex runs NW-SE about 1 mile west of the injection site, dips west, has normal slip, and terminates below-ground (Appendix D, pg. 159 of the narrative PDF). Appendix D to the narrative presents a seismic interpretation of the geometry of the Pond-Poso Creek Fault Complex. Data for Appendix D is from 148 well logs and 5 seismic lines (pg. 11). Stratigraphic unit depths are shown in Appendix D, but are not clearly described in the narrative; nor is the depth of the Pond-Poso Creek Fault Complex clear within the narrative, particularly at the location of the proposed injection well.

Geophysical surveys were also conducted on 23 parallel lines one mile apart across the Pond-Poso Creek Fault Complex (and presented in Appendix E). Resultant cross sections display the stratigraphic offset between the hanging wall and footwall (pg. 16). Fault throw was estimated to range from 10 m at the fault system ends to about 395 m at Cross Section 13, where the Pyramid Hill/Vedder 1/Vedder 2 juxtapose with the Olcese (pg. 16; Appendix E Cross Section 13). Allan diagrams created from the cross sections show the juxtaposition of hanging/footwalls (pgs. 16-17; Figures 2-39 to 2-41).

These Allan diagrams serve as a basis for the applicant's assertion that the fault complex is non-transmissive via shale gouge, with possible assistance from clay smear, diagenesis, pore volume collapse, and/or grain contact dissolution (pgs. 14-16; Figure 2-36). The narrative claims that a calculated bulk shale gouge ratio of >15% in most areas and >50% in some areas demonstrates that the fault system is non-transmissive at project depth (pg. 17; Figure 2-42). Additional geochemical data, e.g., geochemical hydrocarbon analysis showing differing geochemistries across the fault, would provide further evidence of sealing across the fault.

It is unclear whether the Pond-Poso Creek Fault Complex is sealing with respect to pressure changes and what would happen if pressure were to increase to the west of the fault. If pressure changes were to occur outside of the fault boundary, this could result in a larger AoR to the west. Additional evidence of fault sealing is presented in sensitivity analyses described in the AoR/CA; EPA will provide additional evaluation and questions in the forthcoming AoR modeling report.

Questions/Requests for the Applicant:

- *Please indicate the depth of the Pond-Poso Fault system within the narrative, particularly at the location of the injection well and deep monitoring wells.*
- *Will the proposed injection well intersect any identified fault planes?*
- *Please discuss in the narrative the implications for the size of the AoR if elevated pressure were to occur to the west of the Pond-Poso Creek Fault Complex.*
- *Does any pressure data exist in wells on either side of the Pond-Poso Creek Fault Complex to demonstrate pressure containment across the fault complex?*
- *Is there any existing core data or geochemical analyses that can further confirm the sealing capacity of the Pond-Poso Creek Fault Complex, e.g., via differing geochemistries at similar depths across the fault?*

Objectives for Pre-Operational Testing:

- *Collect data to provide evidence of fault sealing (i.e., geochemical and pressure) within the Pond-Poso Creek Fault Complex.*

Depth, Areal Extent, and Thickness of the Injection and Confining Zones

At the injection site, the stratigraphic sequence from top to bottom consists of the alluvium and Etchegoin Formations (which contain the lowermost underground source of drinking water (USDW)), Round Mountain Silt, Fruitvale Shale, Olcese Formation, Freeman-Jewett Formation (confining zone), Vedder Formation (injection zone), and Walker Formation. All of these formations extend laterally throughout the AoR and onlap the granitic basement, wedging to the east (pg. 13; Figures 2-23 to 2-27). The cross sections from Figures 2-23 and 2-25 show lateral continuity of the Freeman-Jewett confining zone with no pinch outs along strike and a pinch out updip perpendicular to strike east of the AoR. The western end of the AoR is truncated by Pond-Poso Creek Fault Complex (see "Faults and Fractures" for additional evaluation).

The table below summarizes the depth and thickness of the formations of interest based on available data in the narrative. The data below are based on different sources (i.e., geophysical surveys, literature reviews, cross sections, etc.), but show general agreement. Some depth/thickness information for the Round Mountain Silt, Fruitvale Shale, Olcese, and Walker Formations was not provided. AoR modelling does not predict the plume to migrate above the primary confining zone, the Freeman-Jewett. Porosity and permeability data are also presented in the table below; additional discussion of these characteristics is provided under "Geomechanical and Petrophysical Characterization."

Unit	Average Depth within the AoR	Thickness Across the AoR	Porosity	Permeability (mD)
Lowermost USDW	2,100-2,900 ft bgs, 2,400 ft bgs at Facility (pg. 22).			
Round Mountain Silt/Fruitvale Shale	-5,600 to -6,600 ft msl (Figure 2-23)	900 ft (pg. 13)	33.8% (Appendix C, Table B-3) 20% (Table 2-4)	0.002 horizontal, 0.001 vertical (Appendix C, Table B-3) 0.037 horizontal, 0.00073 vertical (pg. 18; Table 2-4)
Olcese Formation	-6,600 to -6,900 ft msl (Figure 2-23)	430 ft Figure (2-23)	33.6% (Appendix C, Table B-3) 28% (Table 2-4)	170 horizontal, 34 vertical (Appendix C, Table B-3) 76.6 horizontal, 4.3 vertical (pg. 18; Table 2-4)
Freeman-Jewett Formation (Confining Zone)	-6,900 to -7,460 ft msl (Figure 2-23)	700 ft (pg. 13) Approx. 615 ft (Figure 2-23)	33.8% (Appendix C, Table B-3) 20% (Table 2-4)	0.002 horizontal, 0.001 vertical (pg. 18; Appendix C, Table B-3) 0.26 horizontal, 0.0036 vertical (pg. 18; Table 2-4)
Vedder Formation (Injection Zone)	7,870 ft bgs (pg. 3); -7,460 ft to -8,000 ft msl (Figure 2-23); -7,560 to -8,200 ft msl (Figures 2-29 and 2-34)	300-450 ft (Appendix D, Figure 9); Approx. 500 ft (Figure 2-23); Approx. 450 ft (Appendix D, Figure 8)		
Vedder Sand Units	Pyramid Hills (local): 7,775 ft Vedder 1: 7,789 ft Vedder 2: 8,040 ft Vedder 3: 8,167 ft Vedder 4: 8,344 ft (Figure 3-1)		26.4% (pg. 18; Appendix C, Table B-3) 26-34% (pg. 18; Table 2-4)	303 horizontal, 60.6 vertical (pg. 18; Appendix C, Table B-3) 192-613 horizontal, 62-154 vertical (pg. 18; Table 2-4)

Unit	Average Depth within the AoR	Thickness Across the AoR	Porosity	Permeability (mD)
Vedder Shale Units	Between Vedder 2 and 3 Between Vedder 3 and 4 Base of Vedder 4 (pg. 13)		32% (Appendix C, PDF pg. 151,) 15-27% (pg. 18; Table 2-4)	0.1 horizontal, 0.05 vertical (pg. 18; Appendix C, Table B-3) 0.11-0.91 horizontal, 0.0052-0.025 vertical (pg. 18; Table 2-4)
Walker Formation	-8,000 to -9,300 ft msl (Figure 2-23)	1,100 ft (Figure 2-23)	26% (pg. 18; Table 2-4)	36.37 horizontal, 1.41 vertical (Table 2-4)

Questions/Requests for the Applicant:

- *Please clarify the depths (particularly of the Vedder sub-units) or reference elevations in Appendix D, Figure 9. Please also label the extent/edges of the AoR within the figure.*
- *Are more precise values for the thicknesses of Round Mountain/Fruitvale and Freeman-Jewett Formations than the approximations from pg. 13 available?*
- *Are any other depths and thicknesses of the relevant stratigraphic units in addition to those tabulated above available within the AoR?*
- *Please reformat the depth marks on the Y-axes of Figures 2-23 and 2-24 so that the location of the depth markers match the numbers.*

Hydrologic and Hydrogeologic Information

Groundwater data was synthesized from the Kern County Water Authority (Figures 2-50 and 2-51), California Department of Water Resources (Figures 2-52 and 2-53; Table 2-6), and a combination of data from previous studies (Figures 2-53 to 2-56).

The GS project is located in the San Joaquin Valley groundwater basin and Kern County subbasin, in which 31 water supply wells in the AoR are used for drinking water or other uses (pg. 21; Table 2-6; Figure 2-52). The static water depth of these water supply wells ranges from 70 to 400 ft bgs (pg. 21). While the testing to determine the depths is old, the data demonstrate significant separation between the base of the lowermost USDW and the confining zone and local water supply wells.

The base of the lowermost USDW is approximately 2,400 ft bgs at the project location but ranges from 2,100 ft bgs to 2,900 ft bgs across the subbasin (pg. 22; Figure 2-54). According to cross sections in Figures 2-23, 2-24, 2-25 and 2-27, the base of the lowermost USDW within the AoR is contained within surface alluvial fan deposits or the Etchegoin Formation. However, on Figure 2-24, the base of the USDW is within the Vedder Formation where the Vedder shallows, about 8 miles outside the AoR. On Figure 2-26, the base of the lowermost USDW is shown within the Freeman-Jewett Formation; however, this cross section (D-D’) does not intersect the AoR. In all of the cross sections except Figure 2-24, there appears to be approximately 5,500 feet of separation between the injection zone and the base of the lowermost USDW, and the confining zone is present between these layers. Within the AoR, there are several thousand feet of separation between the USDW and the injection zone.

Figure 2-54 shows the depth of the USDW at several locations (although none are in the AoR); the depths range from 1,500 to 2,700 feet, and appear to be based on literature reviews, e.g., Gillespie et al. (2017), Kong (2016), and Metzger and Landon (2018). The depths are extrapolated to the AoR based on geostatistical kriging (pg. 22).

The Vedder Formation is described as a saline aquifer with an estimated TDS of about 25,000 mg/L (pg. 22, 24). These measurements indicate a relationship between water salinity and depth, which is quantified in Figure 2-55. Two groundwater samples from the Vedder Formation (taken in 1960 and 1968) from the Rio Bravo Oil Field (Table 2-7; Figures 2-54 and 2-56), have a TDS of 21,982 and 24,757 mg/L, based on United States Geological Survey (USGS) data. While these samples are old (and a baseline sample will be taken as part of the pre-operational testing), this appears to provide sufficient documentation that the Vedder Formation is not a USDW in the AoR. Portions of the Vedder Formation are an exempted aquifer within the Jasmin Oil Field (for the Cantleberry Sand) and in the Mount Poso Oil Field.

Questions/Requests for the Applicant:

- *When were the samples from Gillespie et al. (2017), Kong (2016), and Metzger and Landon (2018) taken, i.e., are they recent to the dates of the studies?*
- *Is any direct data on the depth of the lowermost USDW within the AoR available?*
- *How far is the SJR project's AoR from the exempted portions of the Vedder Formation in the Jasmin and Mount Poso Oil Fields?*

Objectives for Pre-Operational Testing:

- *Establish the depth of the lowermost USDW within the AoR.*
- *Sample all formations during drilling of the injection well and deep monitoring wells to confirm that no other formations are USDWs.*

Geochemistry/Geochemical Data

Freshwater aquifer geochemical data comes from the Southern San Joaquin Municipality Utility District Management Area Plan (pg. 23). The data indicates concerns with salinity, arsenic, nitrate, and trichloropropane levels in some water wells (pg. 23); however, since these shallow wells will not be affected by CO_2 injection, any maximum contamination level (MCL) exceedances are outside the purview of this UIC permit. Baseline chemistry for any shallow wells to be used as part of the Class VI Testing and Monitoring Plan will be established.

Historical geochemical data for the Vedder Formation comes from the USGS Produced Waters Database for the Rio Bravo Oil Field (shown in Figures 2-54 and 2-56), which is approximately 10 miles south of the AoR (pgs. 23-24). Two samples from the USGS database were used to create Table 2-7, which shows baseline geochemistry of the Vedder Formation and is reproduced below.

Analyte	Concentration (ppm) at Rio Bravo Field	
	4/6/1960	4/2/1968
Bicarbonate	961	671
Calcium	433	283
Chloride	13,788	12,340
Magnesium	68	42
pH (standard units)	7.25	7.6
Potassium	187	—
Sodium	8,799	8,211
Sulfate	354	—
Total Dissolved Solids (TDS)	24,757	21,982
Data Source	USGS 4001271	USGS 4000447

Both samples match the Vedder Formation TDS predicted by the salinity curve of Figure 2-55 and the isohaline map of Figure 2-56. The lower TDS value for sample 4000447 is explained by the lack of testing for potassium and sulfate. It is unclear how the TDS value was derived (i.e., measured vs. calculated); however, it should be noted that it appears that other parameters that are required to use the anion/cation balance to calculate TDS were not run, i.e., perchlorate, nitrate, and fluoride. Given the dates of the Vedder Formation samples (i.e., in 1960 and 1968), and the applicant's reliance on them for geochemical modeling, the geochemistry of the Vedder Formation will need to be confirmed during pre-operational testing, and the geochemical modeling revised as needed if newer testing provides significantly different results.

PHREEQC (pH-REdox-Equilibrium) geochemical modeling software was used to calculate the behavior of minerals and aqueous chemistry in the Vedder and Freeman-Jewett formations from the onset of CO_2 injection until chemical equilibrium conditions are reached (pgs. 23, 25). Four samples were used for geochemical modeling: Vedder at 4,308-4,333 ft depth, Vedder at 8,350-8,360 ft depth, Freeman-Jewett at 4,369-4,379 ft depth, and Freeman-Jewett at 4,801-4,805 ft depth. Table 2-2 summarizes the source wells from which core samples were collected and the laboratory tests that were performed. Figure 2-43 shows the locations of these wells; of the four samples used for the modeling, three are outside the AoR within 1-2 km to the east; the other is from the southwestern part of the AoR.

The application describes the sources of parameters for the PHREEQC modeling. Known thermodynamic parameters are from USGS and Lawrence Livermore National Laboratory (pg. 26) databases. Injectate chemistry, modeled using ASPEN process simulation software, is given in Table 2-10 (pg. 25; Appendix B). The geochemical inputs (in Table 2-7), geomechanical inputs (in Table 2-11), and mineralogy (from four samples shown in Table 2-12), are discussed elsewhere in this site characterization evaluation.

Modeling the Vedder Formation involved equilibrating the Vedder groundwater sample with the Vedder mineralogy samples and CO_2. Freeman-Jewett modeling involved using the Vedder modeling results at 4,308-4,333 ft depth and equilibrating that with Freeman-Jewett mineralogy and CO_2. Results of mineralogical changes are shown in Table 2-13 and equilibrium aqueous concentrations in Table 2-14 (pg. 28). The results indicate that mineral dissolution and precipitation will occur and affect the volume of the injection zone by an approximately 1% increase; however, the porosity of the injection and confining zones is not significantly affected by CO_2 injection activities. CO_2 injection is therefore not expected to cause chemical reactions that would affect the injection or containment of the CO_2 (pgs. 28-29). Trace concentrations of ferrous iron (Fe^{2+}) were detected in solution in samples with reducing conditions. See "CO_2 Stream Compatibility with Subsurface Fluids and Minerals" for more detail on specific chemical reactions.

Questions/Requests for the Applicant:

- *Have there been any significant changes in local geochemistry of the Vedder Formation since the 1960's, when the two Vedder Formation geochemical samples were taken? What evidence is there that they are still representative of the geochemistry of the Vedder Formation within the AoR? Did they come from wells that are still operating?*
- *Is any information available about fluoride, nitrate, or perchlorate concentrations in the Vedder Formation from past analyses?*
- *Is any TDS data for the Vedder Formation available from the wells that provided the four samples that were used for geochemical modeling?*
- *What are the implications for reactions with CO_2 of ferrous iron in solution?*
- *Please add references to the ASPEN modeling/Appendix B to Section 2.6.3 on pg. 25 and Section 3.1, if appropriate.*
- *Please indicate whether applicable cations in the Vedder Formation samples from the Rio Bravo Oil Field are dissolved or total.*

Objectives for Pre-Operational Testing:

- *Characterize the baseline geochemistry of the USDW and the Vedder Formation and in all wells to be monitored for all parameters described in the Testing and Monitoring Plan to: (1) confirm the inputs to the geochemical modeling, and (2) establish a baseline for monitoring.*

Geomechanical and Petrophysical Characterization

SJR performed geomechanical tests on archival core samples supplied by CalGEM (pg. 17), including triaxial compressive strength testing (TXC) and mercury-injection capillary pressure analyses (MICP). Table 2-2 identifies which tests were applied to cores, and the source wells. MICP porosity and permeability results are presented for each core in Table 2-3 and summarized in Table 2-4. Laboratory reports are provided in Appendix F, and a fracture gradient calculation is provided in Appendix G.

Geomechanics

Appendix F, Geomechanical Analysis, contains TXC laboratory test results for one sample from the Vedder Formation at 8,499 ft bgs and one sample from the Olcese Formation at 6,194 ft bgs (pg. 19). These results are reproduced below.

Geomechanical Properties	Vedder Sample 3 (Shell KCL-A 83-85)	Olcese Sample 5 (General Petroleum KCL 25#1)
Bulk Density (g/cc)	2.476	2.450
Confining Stress (psi)	2,850	2,050
Peak Strength (psi)	11,413	16,061
Compressive Wave Vp (ft/sec)	13,082	14,690
Shear Wave Vs (ft/sec)	5,667	6,319
Vp:Vs Ratio	2.31	2.32
Static Poisson's Ratio	0.129	0.338
Static Young's Modulus (psi)	8.61E+05	1.85E+06
Dynamic Young's Modulus (psi)	1.78E+06	3.72E+06

Below is a summary of the fracture gradient of the injection zone, as calculated in Appendix G.

Stress	Gradient (psi/ft)
Calculated Fracture Gradient	0.51
Assumed Tectonic Stress Gradient	0.15
Total Fracture Gradient	0.66

Two core samples from shale units failed during loading into the testing apparatus, therefore, there is no geomechanical TXC information for the confining zone (pg. 19).

Porosity and Permeability

The Vedder Formation sand units have porosities ranging from 26% to 34% and permeabilities from 192 to 613 mD horizontally, and 62 to 154 mD vertically (pg. 18; Table 2-4). Vedder shale units have porosities ranging from 15% to 27% and permeabilities from 0.11 to 0.91 mD horizontal, 0.0052 to 0.025 mD vertical (pg. 18; Table 2-4). The Freeman-Jewett (confining zone) shale and mudstone has an approximate porosity of 20% and permeabilities of 0.26 mD horizontal, 0.0036 mD vertical (pg. 18; Table 2-4). It appears that these results are consistent with the lithological characteristics of the formations and support the assertion that the Vedder Formation will serve as a sufficient injection zone and the Freeman-Jewett an effective confining zone. Data is also provided for the overlying Olcese sandstone and Round Mountain Silt/Fruitvale Shale units. See the table under "Depth, Areal Extent, and Thickness of the Injection and Confining Zones."

The results from archival core laboratory testing compare well with historical porosity and permeability values given in Appendix C, Table B-3 from Birkholzer et al. (2011) (pg. 19). Historical data shows the porosity of the entire Vedder Formation to be 26.4% and the permeability as 303 mD horizontal, 60.6 mD vertical (pg. 18; Appendix C, Table B-3). The Freeman-Jewett historical porosity is given as 33.8% and permeability as 0.002 mD horizontal, 0.001 mD vertical, showing a slight divergence between the historical data and laboratory results (pg. 18; Appendix C, Table B-3). However, this is not expected to affect the confining ability of the Freeman-Jewett Formation, which depends on consistently low permeability (pg. 19).

Table 2-11, which shows geomechanical and petrophysical parameters used for PHREEQC geochemical modeling, is reproduced below.

Formation	Rock Density (kg/L)	Modeled Porosity (%)	Modeled Porosity	Bulk Density (kg/L)
Freeman-Jewett	2.2	20	0.2	1.76
Vedder	2.65	34	0.34	1.749

Questions/Requests for the Applicant:

- *Is any data available on in situ stress within the AoR? Where are the principal stress directions?*
- *Where are the Shell KCL-A 83-85 and General Petroleum KCL 25#1 wells (the sources of the geomechanical data)? If they are not within the AoR, please explain how they are representative of the geomechanical properties of the injection and confining zones within the AoR and at the injection well location.*
- *Please provide evidence for the statement on page 19 that sample 5 from the Olcese Sand is representative of the Vedder Formation at the injection depth. Also, please explain how the sample at 8,499 feet in the Vedder Formation represents the injection zone depth at 7,780 ft.*
- *How will SJR identify any heterogeneities between the zones updip and zones proximal to the fault system that could affect CO_2 storage?*
- *The depth of Sample 3 in the Geomechanical Analysis is stated as 8,400 ft bgs on page 19 of the narrative, but is listed as 8,499 ft bgs in the Triaxial Compressive Strength table of the Appendix F Geomechanical Report. Please correct the discrepancy.*
- *What is the basis of the assumed tectonic stress from Appendix G?*
- *Why do several core samples from Table 2-3 (e.g., in 410720206) have no formation identified?*
- *Please explain why the permeability value for the KCL-25-1 Olcese sample at 6,131 feet bgs on Table 2-4 is considered to be an outlier and is excluded.*

Objectives for Pre-Operational Testing:

- *Gather site-specific measurements during drilling of the injection well and deep monitoring well of capillary pressure; information on fractures, stress, ductility, rock strength, elastic properties; and in situ fluid pressures within the confining zone to support an evaluation of confining zone integrity.*
- *Confirm/characterize the geomechanical and petrophysical properties (including porosity and permeability) of the Vedder and Freeman-Jewett Formations and other relevant formations based on analyses of core samples taken during drilling of the injection and monitoring wells to confirm the representativeness of the available data from nearby oil fields.*

Mineralogy of the Injection and Confining Zones

Baseline mineralogy of the injection and confining zones is based on studies by Nguyen and others (2014). The Vedder Formation consists of arkosic arenites and graywacke sandstones and is predominantly composed of quartz and feldspar minerals. The Freeman-Jewett Formation consists of siltstones and shales and has a high clay content, which varies from 5-30% and is primarily smectite (pg. 24), which is consistent with the depositional environment (pg. 10; Figure 2-20).

Table 2-9 shows the results of core sample analyses, which are described in detail in Appendix F. The samples analyzed include the four samples used in the PHREEQC geochemical modeling (including three from 1-2 km to the east of the AoR and one from the southwestern part of the AoR). The laboratory tests conducted include X-Ray diffraction (XRD), scanning electron microscopy (SEM), and micro-computed tomography (Micro-CT). This information is summarized in Table 2-2, and XRD results, thin section images, SEM images, and Micro-CT images are provided in Appendix F. The application asserts that these tests confirm the findings of Nguyen and others (2014).

The Freeman-Jewett Formation consists of shale and siltstones and is predominantly smectite clay, quartz, and plagioclase feldspars. About half of the Freeman-Jewett consists of clay minerals (pg. 25; Table 2-9).

Table 2-12, reproduced in part below, shows the mineralogical parameters used from the four samples for PHREEQC geochemical modeling.

Mineral	Molar Mass (g/mol)	Freeman-Jewett 4,801-4,805 ft		Freeman-Jewett 4,369-4,379		Vedder 4,308-4,333 ft		Vedder 8,350-8,360 ft	
		Relative Abundance (%)	moles/L	Relative Abundance (%)	moles/L	Relative Abundance (%)	moles/L	Relative Abundance (%)	moles/L
Albite (for plagioclase)	262.223	21	7.05	23	7.72	31	6.08	29	5.69
Smectite-low-Fe-Mg	549.07	51	8.17	32	5.13	2	0.19	27	2.53
K-Feldspar (orthoclase)	278.33	2	0.63	5	1.58	18.5	3.42	6	1.11
Calcite	100.09	0	0	6	5.28	0.5	0.26	0	0
Dolomite	184.4	0	0	5	2.39	3	0.84	0	0
Illite	389.34	4	0.90	6	1.36	0.5	0.07	2	0.26
Kaolinite	258.16	0.5	0.17	0	0	2	0.40	1	0.20
Gypsum	172.17	0.5	0.26	0	0	0	0	0	0
Pyrite	119.98	1	0.73	2	1.47	0.5	0.21	0	0
Fluorapatite	486.82	0	0	7	1.27	0	0	0	0
Quartz (+ opal)	60.08	20	29.29	14	20.51	41	35.10	34	29.11

The application asserts that quartz, feldspars, and clays in the injection and confining zones are not expected to be highly reactive with the injectate due to their relative stability and low reactivity. However, mineral dissolution and precipitation, especially for carbonate minerals, is still expected to occur in small amounts (pg. 28). Additionally, trace concentrations of ferrous iron (Fe^{2+}) were detected in solution at equilibrium. Table 2-13 shows a summary of mineralogical changes based on equilibrium modeling, and Table 2-14 shows the final equilibrium aqueous chemistry. See "CO_2 Stream Compatibility with Subsurface Fluids and Minerals" for more discussion on predicted changes in mineralogy and aqueous concentrations resulting from CO_2 injection.

Questions/Requests for the Applicant:

- *Page 24 of the narrative lists minerals formed as a result of reactions that have occurred due to dissolution in groundwater. Please identify what groundwater parameters may be in solution after leaching, erosion, or other reactions that occur from the minerals formed, i.e., pyrite reacts with oxygen to produce the ferrous iron in solution.*

- *Please make the following clarifications in Section 2.6.2:*
    - *Reference Table 2-9, rather than Table 2-8.*
    - *Based on the XRD analyses and Clay Subtotal of Table 2-9, clay content for the Vedder Formation ranges from 4.5% to 30%, not 10% to 30% as stated in the second paragraph.*
    - *Add a reference to the XRD data in Appendix F.*
- *Section 2.6.4.3 refers to Table 2-9 as the mineralogical input for PHREEQC and Table 2-12 as the calculated values for mineralogy, while the title of Table 2-12 is, "Mineralogy Input for PHREEQC." Please clarify the following:*
    - *Do the "calculated values" described in the text refer to values that are calculated as results of modeling, or values that were derived from the conversion to mol/L?*
    - *Table 2-12 shows the mol/L converted data, rather than "calculated values."*
    - *Which table is the source of the values that were used in the PHREEQC equilibrium modeling?*

Objectives for Pre-Operational Testing:

- *Perform a mineralogic analysis of the injection zone and confining zone solids that represents the project site during drilling of the injection well and the injection zone monitoring well.*

Seismic History and Seismic Risk

Seismic data for the Southern San Joaquin Basin Province was compiled from USGS and California Geological Survey (CGS) databases (pg. 20; Table 2-5).

- The USGS database indicates that nine M 2.5 - M 3.09 earthquake events occurred between 1970 and 2021 within a 25 km x 18 km box centered on McFarland. All of the events originated in the granite basement at depths of 4.76 km to 28.58 km and none were associated with Quaternary or recent faults. 152 seismic events were recorded from 1970 to 2021 within a 65 km x 75 km box centered around the nearby town of Shafter (pgs. 20, 21; Figures 2-48 and 2-49).
- CGS's database catalogues events greater than M 5.0. There are two periods of seismicity with earthquakes greater than M 5.0 for a total of five earthquake events: 2 earthquakes in 1905 and 3 earthquakes in 1952. All events occurred far from the SJR property, south and east of Bakersfield (pg. 20; Figures 2-48 and 2-49).

Figure 2-46 and Figure 2-47 show some creep that was previously associated with groundwater withdrawal (Smith, 1983). This is associated with the Pond-Poso Creek Fault, but there have been no earthquakes associated with this feature (Figure 2-46).

Of all known historical earthquakes of significant magnitude near McFarland, the application asserts that none are associated with the faults in the McFarland area or within the AoR (pg. 21). Further, none originated above the granitic basement, and none are associated with recent/Quaternary faults (pg. 21). Given overall concerns about seismicity in California and the presence of the fault system to the west, a baseline microseismicity study may support further characterization of the AoR.

The applicant asserts that fault reactivation due to CO_2 injection activities is unlikely. The AoR/CA details modeled overpressuring of the Pond-Poso Creek Fault Complex due to injection on the order of 3 bars. According to Renaldi et al. (2015), a typical fault reactivation pressure is 20 bars (AoR/CA, pg. 16).

The evaluation of seismic risk also reflects other elements of the comprehensive permit application review (described elsewhere in this report), including porosity and permeability of the injection and confining zones; regional structural features; information on faults in the vicinity of the project site; formation pressure; and the geomechanical properties of the injection and confining zones.

Seismic risk and risk mitigation will also be considered in the review of the following aspects of the permit application:

- Predictions of plume and pressure front behavior over time, including pressure build-up over time, and pressure dissipation following cessation of injection.
- The ability of the injection well to maintain mechanical integrity under stress.
- Wells within the project area and the status of well corrective action.
- Planned injection pressures.
- Emergency and remedial response planning.

Based on the information provided, it appears that the risk of an induced seismic event associated with the injection project is low, if injection pressure and volume limits are met.

Questions/Requests for the Applicant:

- *Please explain how the project will be monitored such that, in the unlikely event of an induced seismic event, risks will be quickly addressed and mitigated.*
- *Please revise Section 2.3 to remove duplicate information that appears on pages 20 and 21, including:*
    - *"CGS maintains a database of earthquakes … none in the McFarland vicinity."*
    - *Information on the 9 seismic events from USGS.*
- *Please add a legend to Figure 2-48 to explain the magnitude represented by differently sized circles.*
- *Please show the AoR and injection site on Figures 2-45 to 2-49 (the SJR Property is already labeled on Figure 2-48).*

Objectives for Pre-Operational Testing:

- *Establish pressure in the injection zone.*
- *Establish baseline seismicity.*

Surface Air and/or Soil Gas Monitoring Data

No soil gas or surface air data were submitted with the permit application. At this point, we do not believe this will be necessary; however, if the results of future reviews necessitate surface air and/or soil gas monitoring, we would request baseline data.

Facies Changes in the Injection or Confining Zones

Based on seismic profile interpretations from Appendix D, the Vedder Formation is a progradational shallow marine shelf deposit with sand layers separated by various shale layers: Vedder 1/1A/2/3/4/Cantleberry Sand (pg. 13). The Cantleberry Sand layer is limited in lateral extent and is not present in the AoR (Figures 2-28 and 2-33). Shale layers exist between layers 2/3 and 3/4, and the Vedder 4 has a basal shale (pgs. 6, 13; Table 2-4; Appendix D). Section 3.3 of the narrative (the injection well description) indicates that the well will have a dual completion of two intervals within the Vedder Formation: Pyramid Hill/Vedder 1/Vedder 2 and Vedder 3 (pg. 31; Figure 3-1). The interpretation from Appendix D is consistent with the wireline log interpretation of the depositional environment from Hewlett and Tye (2015; pgs. 9-10; Figures 2-17 to 2-21) and wireline logs from Wagoner (2009; pg. 9; Figures 2-15 and 2-16), which are in turn consistent with the proposed depositional setting of a progradational shallow marine shelf (pg. 13; Figure 2-7). The plume migration modeling described in the AoR/CA takes the heterogeneity of the Vedder Formation injection zone into account, where some internal layers may assist in CO_2 confinement (AoR/CA: pgs. 17-18).

The Freeman-Jewett confining zone is interpreted as a transgressive-systems tract (Jewett Shale) transitioning to a highstand-systems tract (Freeman Silt) that forms an overlying seal above the Vedder Formation (pg. 10, Figure 2-20). From this depositional interpretation, the Freeman-Jewett is expected to form a thick and continuous overlying seal (shown in well log-derived cross sections in Figures 2-23 to 2-27). According to MICP data from core samples (identified in Table 2-3), there are no appreciable heterogeneities in the Freeman-Jewett with regards to permeability that might adversely affect the containment of CO_2. The Freeman Jewett formation horizontal permeability is calculated to be 0.26 mD, and vertical permeability is 0.0036 mD through the core sample MICP analyses in Appendix F (pg. 18; Table 2-4). See “Confining Zone Integrity” for more details on the efficacy of the confining zone.

Questions/Requests for the Applicant:

- *What does the facies succession look like within the Vedder Formation? Are there any depositional features within the Vedder Formation that may affect containment or fluid flow?*
- *Are there any potential fluid flow pathways associated with facies changes within the Freeman-Jewett or Vedder Formation? What evidence supports this finding?*
- *Please provide additional detail about the thicknesses of the various layers of the Vedder Formation, including how they may vary within the AoR.*
- *On page 13, the Vedder 4 is listed twice in the sentence listing the different Vedder Formation layers. Please revise the sentence.*

Objectives for Pre-Operational Testing:

- *Confirm the thickness of the Vedder Formation sands at the location of the injection and monitoring wells (e.g., via cores and well logging data) to provide additional information on their suitability for injection, including facies changes that could facilitate preferential flow.*

Structure of the Injection and Confining Zones

Based on the wireline logs, cross sections, and interpreted 2D seismic images provided in Appendix D, the Vedder Formation appears to be a laterally continuous and thick reservoir unit suited for injection activities. It is covered by the Freeman-Jewett shale and mudstone, a laterally continuous and thick confining layer (schematically shown in Figures 2-23 to 2-27). The primary structural features within the AoR are the homocline and the Pond-Poso Creek Fault System.

The injection zone is contained wholly within the regional homocline structure, gently dipping about 4° west (pg. 7; Figure 2-5). See "Regional Geology and Geologic Structure" for more details on the structure of the injection and confining zones, "Facies Changes in the Injection or Confining Zones" for details on internal structure due to facies changes, and "CO_2 Stream Compatibility with Subsurface Fluids and Minerals" for details on updip fluid migration.

The Pond-Poso Creek Fault Complex serves as the western boundary of the delineated AoR (pg. 20; Appendix D; AoR/CA: Figure 1-22). The CO_2 plume is not expected to migrate far enough downdip to encounter the Pond-Poso Creek Fault (AoR/CA: Figure 1-6a). However, the pressure front will reach and be arrested by the Pond-Poso Fault. See "Faults and Fractures" and the AoR modeling evaluation for more discussion on the effects of the fault system on pressure front migration.

CO_2 Stream Compatibility with Subsurface Fluids and Minerals

Appendix B presents the results of injectate chemistry modeling using the UNIQUAC equation of state and UNIFAC method within ASPEN Plus process modelling software (Appendix B: pg. 2). The injectate will be in liquid phase at the surface, and become supercritical at about 2,400 ft below surface (pg. 4; Appendix B). The modeled composition of the injectate is: 98.7% CO_2, with less than 1% methane/benzene/ethane/nitrogen (pg. 29). The specific modeled composition of the injectate is given in Table 3-1. The injectate composition used for PHREEQC geochemical modeling is given in Table 2-10, which is reproduced below.

Gas	Mass Fraction	Mass %
Carbon dioxide	0.9866	98.7%
Methane	0.0047	0.5%
Benzene	0.0036	0.4%
Ethane	0.0024	0.2%
Nitrogen	0.0014	0.1%
Total		99.9%

PHREEQC geochemical modeling results are presented in Tables 2-13 and 2-14, and are described in the narrative on pages 28 and 29. The modeling predicts the following reactions to occur between the fluids and minerals of the injection zone and the injectate:

- Dissolution of calcite (when present), then precipitation of dolomite;
- Illite dissolution (which will contribute magnesium to dolomite precipitation);
- Dolomite, kaolinite, quartz, k-feldspar precipitation (shown in all models due to their stability); and
- Gypsum dissolution when initially present (due to mineral instability).

The following equilibrium aqueous chemistry results are expected to occur:

- CO_2 will dissolve into solution, which is included in the Total Inorganic Carbon (TIC);
- Ferrous iron (Fe^{2+}) is in solution in samples with a reducing environment (negative pE);
- pH ranges from 6.5 to 7.5; and
- Low calcium concentrations due to precipitation of minerals like dolomite.

According to the applicant, the changes in mineralogy and aqueous chemistry due to CO_2 injection will not affect the injection or containment of CO_2 in the Vedder Formation (pg. 29). The volume of minerals in the confining zone is expected to increase by only about 1%, and the porosity of the Vedder and Freeman-Jewett Formations is not expected to be sustainably impacted (pg. 28). These expectations are based on the mineralogy of the Vedder and Freeman-Jewett Formations, which consists primarily of stable silicates such as quartz, feldspars, and clays. The precipitation of carbonates is predicted to assist in the sequestration of CO_2 through the incorporation of the carbon into mineral phases (pg. 29).

For the AoR delineation, the TOUGH2 equation-of-state (EOS) module ECO2N (Pruess, 2005) is used to simulate non-isothermal multiphase flow of fluid mixtures of water, CO_2, and sodium chloride (NaCl) in geologic media (AoR/CA: pgs. 1-2).

Questions/Requests for the Applicant:

- *Page 29 states that the aqueous chemistry results are presented in Table 2-13; however, this information is in Table 2-14. Please clarify the discrepancy.*

Objectives for Pre-Operational Testing:

- *Confirm the composition of the CO_2 injectate as part of baseline sampling and provide verification that it will not react with the formation matrix.*
- *Generate fluid chemistry and mineralogic data, pressure, temperature, and pH conditions at depth via core sampling and formation testing in the injection and monitoring wells to confirm the inputs to the geochemical modeling.*

Injection Zone Storage Capacity

SJR plans on generating and injecting 1,200 tons per day of CO_2 per year into one injection well (SJR-I1) for a period of 15 years (pg. 3) for a total of 6.57 million tons of CO_2 (pg. 29). This total volume is based on SJR's energy and material balance analyses. Due to the nature of the depositional environment and lack of structural traps, the full capacity of the injection zone likely exceeds the total volume of CO_2 to be injected at the project. The applicant claims that, according to the stratigraphic sections in Figures 2-1 and 2-10, Pyramid Hill and Vedder Formations are the thickest, most widespread potential CO_2 injection formations in the San Joaquin Basin Province (pg. 6). Based on the TOUGH2 AoR delineation modeling, the CO_2 plume will expand laterally outwards updip until its arrest by physical forces. The gas plume is expected to migrate up-dip to the east, until the cessation of injection activity. Then, the CO_2 plume is gradually arrested due to injection pressure subsidizing, capillary pressure gradients reducing, and the buoyancy forces weakening over time. Finally, modeling predicts that the gas phase may become discontinuous and trapped within the pore space or dissolved into the brine, and the advance of the gas pockets will be stopped (AoR/CA, pg. 13). Sensitivity Case M (described on page 21 of the AoR/CA) states that "there are no hydrogeological features (such as sealing faults or water divides) that would impose [no-flow] boundary conditions." Therefore, the plume will migration updip and gradually decline until it rests at the boundaries modeled by TOUGH2 (AoR/CA: Figure 1-6a/b).

Confining Zone Integrity

According to Section 3 of the permit application narrative, predicted pressure distributions throughout the AoR will remain below the fracture pressure of the Vedder Formation. The fracture gradient given for the Vedder Formation in Appendix G is 0.66 psi/ft, giving a fracture pressure of 5,132 psi (35,384,000 Pa, or 353.8 bar) at the planned injection depth of 7,775 ft bgs. The maximum predicted pressure from TOUGH2 modeling is 480,000 Pa (69.6 psi, or 4.8 bar) (pg. 30). The initial static pressure of the injection zone is 259.5 bar (AoR/CA: pg. 16). Adding the predicted pressure to the initial static pressure gives a final maximum predicted pressure at the cessation of injection operations of about 265 bar. This is approximately 75% of the fracture pressure for the Vedder Formation, which is below the 90% threshold in the Class VI Rule.

Variations in parameters that affect the maximum injection pressure are explored in the sensitivity cases of the AoR/CA (pgs. 16-21; Table 1-3). Additional evaluation of the sensitivity analyses will be provided in the AoR modeling evaluation report. The narrative (pg. 30) identifies testing SJR plans to confirm the fracture pressure and calibrate calculated results (these are listed under the objectives for pre-operational testing, below).

The Pond-Poso Creek Fault Complex does not appear to compromise the integrity of the confining zone. See "Faults and Fractures" for more details on the Pond-Poso Fault.

Questions/Requests for the Applicant:

- *Please discuss in the narrative whether the maximum predicted pressure falls below the capillary entry pressure for the confining zone.*
- *Is a figure available for capillary pressure versus wetting phase saturation for MICP core data?*

Objectives for Pre-Operational Testing:

- *Determine the maximum allowable injection pressure, based on the results of fall-off testing and injectivity testing.*
- *Confirm the fracture pressure of the injection zone via one or more of the following methods:*
    - *Triaxial stress test for rock mechanics for a static measurement from the rock core.*
    - *Dipole full wave sonic log, to provide a dynamic result that can be calibrated back to the static triaxial test.*

- *Step test rate test or leak-off test to determine fracture pressure after the well has been perforated.*

San Joaquin Renewables Class VI Project
Review of Financial Responsibility Demonstration

This financial responsibility demonstration evaluation report for the proposed San Joaquin Renewables (SJR) Class VI geologic sequestration (GS) project summarizes EPA's evaluation of the financial responsibility information that SJR submitted to the GSDT on November 3, 2021. Pursuant to 40 CFR 146.85, Class VI permit applicants must demonstrate financial responsibility for performing corrective action on deficient wells in the area of review (AoR), plugging the injection well, post-injection site care (PISC) and site closure, and emergency and remedial response (E&RR). To make this demonstration, the applicants must estimate the cost of each of these activities and provide qualifying financial instruments.

PART 1: Cost Estimate Evaluation

The SJR project consists of one injection well, which is projected to inject a total of 6,570,000 tons of CO_2 into the Vedder Formation over a period of 15 years. According to the permit application, the AoR for the project is 73 square miles and there is an underground source of drinking water (USDW) within the AoR of the project.

To evaluate SJR's financial responsibility demonstration, EPA compared the cost estimates provided by the applicant in their Class VI permit application to those generated by EPA's Cost Estimation Tool for Class VI Financial Responsibility Demonstrations (the Cost Tool). EPA developed the Cost Tool to provide an "acceptable range of costs" (including a high-end, middle range, and low-end cost estimate) for Class VI financial responsibility activities based on information submitted with a permit application.

For this evaluation, EPA determined the Cost Tool inputs based on information in SJR's permit application. These inputs include the size of the AoR, the presence/absence of USDWs in the AoR, the amount of CO_2 to be injected, the duration of the PISC period, the depths and diameters of the injection and monitoring wells in the AoR, and the characteristics of any deficient wells in the AoR requiring corrective action. Exhibit 1 presents the Cost Tool inputs EPA used.

Exhibit 1. Cost Tool Inputs.

Project Information

Variable Name	Value
Project Name (Corporate entity)	San Joaquin Renewables
Project Address/Location	McFarland, CA

Project Data

Variable Name	Value	Units (Click in Cell for Dropdown List)
Size of Area of Review (AoR)	73	Square Miles
Are There Underground Sources of Drinking Water (USDWs) in the AoR?	Yes	
Mass of CO_2 to be Injected	6,570,000	Tons
Duration of Post-Injection Site Care	15	Years
Depth of Injection Well	8,700	Feet
Diameter of Injection Well	7.00	inches

Information on Monitoring Wells *Note: Cost to clean out monitoring wells is based on a regression equation that is only valid for well depths greater than 2,000 ft. Model is run for all monitoring wells (where the shallow wells are conservatively assumed to be 2,001 ft deep).*

13 ←Number of Monitoring Wells

Enter the names, depths (feet), and diameters (inches) of monitoring wells in the table below.

Well Name	Delano # 14	Delano # 23	Delano # 30	McFarland Tayl	SSJMUD # 8	SSJMUD # 14	SSJMUD # 23	SSJMUD # 42	SSJMUD # 53	SSJMUD # 59	SSJMUD # 62	ACZ well	Vedder well
Well Depth (feet)	2,001	2,001	2,001	2,001	2,001	2,001	2,001	2,001	2,001	2,001	2,001	7,095	6,672
Well Diameter (inches)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	7.00	7.00

Information on Deficient Wells in the AoR Requiring Corrective Action

6 ←Number of Deficient Wells in the AoR that will be Remediated

Enter in the names, depths (feet), and diameters (inches) of deficient wells in the aor requiring corrective action in the table below.

Well Name	API402930522	API402930605	API402930607	API402930608	API402970053	API402980729	[Well Name]	[Well Name]	[Well Name]	[Well Name]	[Well Name]		
Well Depth (feet)	7,250	7,214	6,850	6,530	9,103	8,290							
Well Diameter (inches)	7.625	7.625	7.625	11.000	10.750	8.750							

As noted below, the specific activities that the Cost Tool assumes will be employed may differ from those in the approved project plans that describe specific activities that SJR will perform. However, because the goal of the financial responsibility requirements is to ensure that sufficient resources are available to cover the costs of EPA engaging a third party to complete the activities (i.e., if SJR were to become financially insolvent), the activities do not need to be identical. Where they differ, the ranges of estimates generated by the Cost Tool can be considered appropriate for evaluation purposes. The particular activities that SJR must perform are specified in the approved project plans that will be attached to the permit.

Comparison of Financial Responsibility Cost Estimates

Exhibit 2 compares the financial responsibility cost estimates provided by SJR (Column A) to the estimates EPA generated using the Cost Tool (Column B).

Exhibit 2. Comparison of Cost Estimates Provided by SJR and Generated by EPA

Financial Responsibility Categories	A. SJR Submission (2021$)	B. EPA Cost Tool Estimate (2021$)
Corrective Action	$1,329,000	$299,720 to $1,286,200
Injection Well Plugging	$234,600	$129,800 to $311,520
PISC and Site Closure	$3,489,200	$26,533,480 to $51,206,100
E&RR	$25,338,750	$13,027,200 to $89,996,240
Total Amount Needed to Show Financial Responsibility	$30,391,550	$39,989,020 to $142,798,880

Notes:

(1) Numbers may not appear to add due to rounding.
(2) The PISC and Site Closure estimate shown combines separate cost estimates for post-injection site care and site closure, which are discussed below.
(3) EPA assumes that SJR's cost estimates are in 2021$.

The following subsections discuss the assumptions that may contribute to differences between these cost estimates.

Performing Corrective Action on Deficient Wells in AoR

SJR estimates the cost of corrective action on deficient wells in the AoR to be $1,329,000; this is slightly above the high-end of the range of estimates generated by the Cost Tool (which are between $299,720 and $1,286,200, with a middle-range estimate of $553,420).

EPA generated the cost estimates based on information about six wells in the AoR that SJR plans to re-abandon, including depths listed on Table 2-1 of the AoR CA and the diameter of all but one of the wells on well schematics in Appendix C to the AoR corrective action. The diameter at total depth of API 402970053 is unknown; so, EPA conservatively assumed the diameter of the intermediate casing (10.75 inches) for the Cost Tool input. SJR plans to implement corrective action on a phased basis, by plugging one well prior to injection and plugging the remaining five wells within three years of commencing injection activities.

SJR sources the corrective action cost estimate from Driltek, which appears to be a drilling/service company. The cost estimate appears to be acceptable. However, if, based on the AoR modeling review a larger AoR is determined to be needed and there are any additional deficient wells in the AoR, the cost estimate would need to account for corrective action on these wells.

Plugging the Injection Well

SJR estimates the cost of plugging their Class VI injection well to be $234,600; this is slightly above the middle-range estimate of $193,520 generated by EPA's Cost Tool (which generated costs ranging from $129,800 to $311,520). EPA generated the cost estimates based on the depth and diameter of the injection well as described in the permit application narrative. SJR's cost estimate is sourced from a drilling/service company.

Post-Injection Site Care and Site Closure

EPA estimates the costs of all PISC and site closure activities to range from $26,533,480 to $51,206,100, with a middle-range estimate of $38,950,620. This is higher than the sum of SJR's estimate for these activities (which is $3,489,200). The Class VI Rule, at 40 CFR 146.85(a)(2)(iii), requires permit applicants to show adequate financial coverage for PISC and site closure activities combined; the assumptions underlying the PISC and site closure cost estimates are discussed separately below.

Post-Injection Site Care

SJR's cost estimate for post-injection site care activities is $3,066,000. This is significantly lower than the estimate EPA generated using the Cost Tool, which ranges from $25,505,700 to $48,330,440, with a middle-range estimate of $37,443,760.

The post-injection monitoring activities that SJR plans to perform are similar to those assumed by the Cost Tool estimates. In their PISC and Site Closure Plan, SJR plans to continue the injection-phase monitoring, which includes:

- Water quality monitoring in one above confining zone (ACZ) monitoring well in the Olcese Formation, which occurs from approximately 6,625 to 7,095 feet.
- Shallow water quality monitoring using existing public and privately-owned wells.
- Pressure front tracking in one monitoring well in the Vedder Formation, which is approximately 6,672 feet deep.

SJR also plans to perform two post-injection 3D seismic surveys, including one following cessation of injection and one at the end of the post-injection site care timeframe.

EPA's Cost Tool and SJR estimate the post-injection monitoring costs based on similar activities:

- SJR's cost estimate assumes geochemical monitoring in the USDW, ACZ, and injection zone monitoring wells; pressure monitoring in the ACZ and injection zone monitoring wells; O&M of the ACZ well; mechanical integrity testing of the injection zone monitoring well; 3D seismic surveys; and reporting and project management.
- EPA's Cost Tool estimates include the cost for fluid analysis and O&M in all monitoring wells, seismic surveys, and report preparation.

There are significant differences between the cost estimate provided by SJR and the estimate generated by the Cost Tool. These may be due to differences in the following assumptions:

- Seismic survey extent. SJR's cost estimate assumed that 3D seismic surveys will be performed over an area of 6 square miles (consistent with their PISC and Site Closure Plan). However, the Cost Tool estimate for this activity is based on the size of the AoR, which is significantly larger (73 square miles, according to the Permit application narrative, pg. 3). This difference accounts for approximately $16.4 million to $32.9 million of the cost tool estimate.
- Operating and maintenance (O&M) cost estimates. SJR only estimates this activity for the ACZ monitoring well; while the Cost Tool estimate is based on the number and depth of all monitoring wells associated with the project. Post-injection monitoring well O&M for the 11

USDW wells accounts for about $4 million to $5 million of the total Cost Tool-generated estimate. Since 11 of the 13 wells are not owned by SJR, the applicant would probably not be likely to incur these O&M costs.[1] However, SJR's cost estimate should account for O&M of the Vedder Formation monitoring well. Further, because there is currently no precise information about the depth of the ACZ or the Vedder formation wells, EPA assumed the depths of these wells to be the deepest reported depth of these formations; this may overestimate the actual depths of the monitoring wells, and therefore the O&M costs, although not significantly.

- Number of shallow fluid sampling events. SJR only assumes fluid sampling in one USDW well annually, for a total of 15 sampling events over the PISC timeframe; however, the PISC and Site Closure Plan describes monitoring in 11 shallow wells. Thus, SJR appears to be undercounting the number of fluid samples. This difference in the number of fluid sampling events accounts for about $10,000 to $40,000 of the Cost Tool estimate.

Note that, due to the specific calculations performed by the Cost Tool, the differences described above are not necessarily additive. However, based on an assumed 6 square-mile AoR (the extent of the seismic surveys) and sampling in only 3 monitoring wells (consistent with SJR's cost estimate), the Cost Tool-generated estimate for PISC activities would range between $5,373,720 and $10,032,360, with a middle-range estimate of $7,737,260, which is still higher than SJR's estimate. Also note that SJR's proposed 15-year alternative PISC timeframe is subject to EPA's approval.

Site Closure

SJR estimates the cost of site closure to be $423,200; this is below the Cost Tool estimate of $1,027,780 to $2,875,660, with a middle-range estimate of $1,506,860.

The difference in the estimates is primarily because SJR's cost estimate does not include the cost to plug any of the USDW monitoring wells (which are not owned by the applicant, and their closure would not be related to activities at the injection project). If the shallow wells are not included in the Cost Tool inputs, the Cost Tool-generated site closure cost estimate would range from $295,000 to $709,180, with a mid-range estimate of $440,140, which is similar to SJR's estimate.

EPA also notes the following uncertainties in the Cost Tool inputs related to the ACZ and Vedder Formation monitoring wells. While these do not affect the evaluation, they will need to be ascertained to finalize the cost evaluation.

- Because there is currently no specific information about the depth of the ACZ or the Vedder Formation monitoring wells, EPA assumed the depths of these wells to be the deepest reported depth of these formations. This likely overestimates the actual depth of the monitoring wells, and therefore the plugging costs.
- No information was provided about the diameters of the monitoring wells. Therefore, EPA assumed that the diameter of each of these wells would be 7 inches, which is commensurate with deep monitoring wells in other Class VI projects and the depth of the injection well.

The depth and diameter of the wells will need to be ascertained to confirm the cost estimate. If their depths or diameters change based on additional project activities, the post-injection site care cost estimate may need to be revised accordingly.

[1] While these O&M costs would need to be incurred if, e.g., the owners ceased to operate the wells, any change in the number of monitoring wells would necessitate a change to the PISC and Site Closure Plan and a revised financial responsibility cost estimate.

***Emergency and Remedial Response*[2]**

SJR's emergency and remedial response cost estimate is $30,391,550, which is slightly above the middle-range estimate of $27,462,140 (EPA's estimate ranges from $13,027,200 to $89,996,240).

SJR's E&RR Plan provides a list of emergency scenarios that could occur during the injection and post-injection phases of the project. These scenarios include an injection well failure, unexpected CO_2 or formation fluid migration, unexpected CO_2 accumulation in indoor air, and groundwater or surface water contamination.

The Cost Tool develops E&RR cost estimates for projects where a USDW is present based on scenarios that include activities to remediate mechanical integrity failures and USDW contamination. Activities to address USDW contamination include ceasing injection, creating a hydraulic barrier to contain fluid movement upward and/or laterally, installing chemical sealant to stop the CO_2 leak, and treating contaminated water.

SJR's estimate is based on the cost of performing groundwater remediation. While it does not include estimates for repairing damaged wells, the groundwater remediation component of the Cost Tool estimate accounts for the majority of the Cost Tool's estimate for emergency and remedial response (with well repair accounting for less than $150,000 of the total). Therefore, the two estimates appear to be similar.

Questions/Requests for the Applicant:

- *What dollar year do the cost estimates represent?*
- *EPA recommends that the cost estimate be revised to include:*
    - *Annual fluid sampling in all 11 USDW monitoring wells.*
    - *O&M costs for the Vedder Formation well.*
- *Please add or fix the table numbers for injection well plugging, site closure, and emergency and remedial response in the cost estimation spreadsheet.*

Considerations Based on the Results of Pre-Operational Testing/Modeling Updates:

- *Confirm assumptions about the number, depth, and diameters of the monitoring wells based on final plans/as-built specifications.*
- *Confirm the appropriateness of the area over which 3D seismic surveys will be performed (additional discussion will be provided in EPA's testing and monitoring evaluation), and revise the post-injection site care cost estimate if needed.*
- *Changes to various Cost Tool inputs (e.g., the size of the AoR based on final modeling, the total volume of CO_2 to be injected, and corrective action needs at the time the permit is issued) may affect the estimates generated by the Cost Tool.*

PART 2: Financial Instrument Demonstration

SJR submitted an October 5, 2021 Letter of Intent from New Energy Risk to provide insurance to meet SJR's financial responsibility requirements. The letter does not indicate what aspects of the project the New Energy Risk intends to cover or provide any specific information about the instrument language or guarantee insurance coverage. Rather, the letter describes the strength of New Energy Risk and their

[2] Although only a small fraction of GS sites are expected to require E&RR, all sites need to be financially capable of facing an emergency (40 CFR 146.84(a)(2)(iv)). As such, the Cost Tool will overestimate the actual E&RR costs incurred by most sites, but not overestimate the funds required for financial responsibility for E&RR.

ability to address financial responsibility needs for carbon storage projects. SJR and New Energy Risk intend to work with EPA to develop the specific instrument language.

It is anticipated that SJR will provide this additional information and draft insurance policy language as the time for issuance of the Class VI permit nears. EPA recommends that SJR consult the *UIC Program Class VI Financial Responsibility Guidance* as it develops the instruments, including:

- The required and recommended specifications for insurance (in Section 5.E), and
- The recommended financial instrument language for a certificate of insurance in Appendix B.

Question/Request for the Applicant:

- *Does SJR plan for insurance to cover all activities, i.e., corrective action, well plugging, post-injection site care and site closure, and emergency and remedial response?*

Appendix A
EPA Cost Estimation Inputs

Parameter	EPA Input	Source/Notes
Size of Area of Review (AoR)	73 sq. miles	Permit application narrative, pg. 3
Are there USDWs in the AoR?	Yes	USDWs are described in Section 2.4.2 of the permit application narrative
Mass of CO_2 to be Injected	6,570,000 tons	Permit application narrative, pg. 29
Duration of Post-Injection Site Care	15 years	PISC and Site Closure Plan
Depth of Injection Well	8,700 feet	Figure 3-1 of the permit application narrative
Diameter of Injection Well	7.0 inches	Figure 3-1 of the permit application narrative
Monitoring Well Plugging		
ACZ (Olcese) well depth	7,095 feet	T&M Plan, pg. 6: One ACZ well screened in the Olcese Formation, which occurs from approximately 6,625 to 7,095 ft
ACZ well diameter	7.0 inches	No construction details about the monitoring well is provided in the application; EPA estimates 7 inches, consistent with other application reviews
Vedder Formation well depth	6,672 feet	PISC and Site Closure Plan, pg. 4
Vedder Formation well diameter	7.0 inches	No construction details about the monitoring wells is provided in the application; EPA estimates 7 inches, consistent with other application reviews
Delano Well 14 depth	2,001 feet	Per Figure 2 of the T&M Plan, depth is 197 feet; however 2,001 feet is the minimum depth for Cost Tool calculations
Delano Well 14 diameter	4.0 inches	Not provided; EPA estimate
Delano Well 23 depth	2,001 feet	Depth is 214 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
Delano Well 23 diameter	4.0 inches	Not provided; EPA estimate
Delano Well 30 depth	2,001 feet	Depth is 100 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
Delano Well 30 diameter	4.0 inches	Not provided; EPA estimate
McFarland Taylor Ave. depth	2,001 feet	Depth is 42 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
McFarland Taylor Ave. diameter	4.0 inches	Not provided; EPA estimate
SSJMUD Well 14 depth	2,001 feet	Depth is 136 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
SSJMUD Well 14 diameter	4.0 inches	Not provided; EPA estimate
SSJMUD Well 23 depth	2,001 feet	Depth is 278 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
SSJMUD Well 23 diameter	4.0 inches	Not provided; EPA estimate
SSJMUD Well 42 depth	2,001 feet	Depth is 123 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
SSJMUD Well 42 diameter	4.0 inches	Not provided; EPA estimate
SSJMUD Well 53 depth	2,001 feet	Depth is 131 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
SSJMUD Well 53 diameter	4.0 inches	Not provided; EPA estimate
SSJMUD Well 59 depth	2,001 feet	Depth is 112 ft in Depth is Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
SSJMUD Well 59 diameter	4.0 inches	Not provided; EPA estimate
SSJMUD Well 62 depth	2,001 feet	Depth is 83 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
SSJMUD Well 62 diameter	4.0 inches	Not provided; EPA estimate
SSJMUD Well 8 depth	2,001 feet	Depth is 329 ft in Figure 2 of the T&M Plan; 2,001 feet used in Cost Tool
SSJMUD Well 8 diameter	4.0 inches	Not provided; EPA estimate
Wells Needing Corrective Action		
API# 402930522 depth	7,250 feet	AoR CA, Table 2-1
API# 402930522 diameter	7.625 inches	AoR CA, Appendix C
API# 402930605 depth	7,214 feet	AoR CA, Table 2-1
API# 402930605 diameter	7.625 inches	AoR CA, Appendix C
API# 402930607 depth	6,850 feet	AoR CA, Table 2-1
API# 402930607 diameter	7.625 inches	AoR CA, Appendix C
API# 402930608 depth	6,530 feet	AoR CA, Table 2-1
API# 402930608 diameter	11 inches	AoR CA, Appendix C
API# 402970053 depth	9,103 feet	AoR CA, Table 2-1
API# 402970053 diameter	10.75 inches	Unknown; but the intermediate casing is 10.75 inches, per AoR CA, Appendix C
API# 402980729 depth	8,290 feet	AoR CA, Table 2-1
API# 402980729 diameter	8.75 inches	AoR CA, Appendix C

[1] All Cost Tool inputs for EPA's evaluation are based on the permit application and are preliminary; the final cost estimates will reflect the UIC permit conditions and the approved project plans.

Appendix B
SJR Cost Estimates

Table 1. Financial Responsibility Cost Summary

Activity	Estimated Cost	Reference
Corrective Action on wells in AoR	$ 1,329,000	Table 2
Plugging Injection Wells	$ 234,600	Table 3
Post-Injection Site Care	$ 3,066,000	Table 4
Site Closure	$ 423,200	Table 5
Emergency and Remedial Response	$ 25,338,750	Table 6
Total	**$ 30,391,550**	

Table 2A. Costs, Plugging Deficient Wells

Well API	Well	Cost	Reference
04-029-30608	Chevron 32-15	$ 148,000.00	A
04-029-30522	Curry 1	$ 170,000.00	A
04-029-30607	Del Fortuna 1	$ 189,000.00	A
04-029-80729	Ingram 13-73	$ 188,000.00	A
04-029-30605	KCL 87-25	$ 229,000.00	A
04-029-70053	Tenneco 11x-31	$ 237,000.00	A
Total		**$ 1,161,000**	

Table 2B. Costs, Corrective Action Total

Activity	Unit		Unit Cost	Total	Reference
Revise TOUGH Model	400	hrs	$ 200	$ 80,000	-
Review CalGEM Well Database	40	hrs	$ 200	$ 8,000	-
Plug Deficient Wells	6	wells	see Table 2A	$ 1,161,000	A
Project Management	400	hrs	$ 200	$ 80,000	-
			Total	**$ 1,329,000**	

Notes

A: Abandonment costs from Driltek

Table 2B. Costs, Injection Well Plugging					
Activity	**Unit**		**Unit Cost**	**Total**	**Reference**
Injection Well Plugging	1	well	$ 204,000	$ 204,000	A
Documentation, project management	1	each	$ 30,600	$ 30,600	B
			Total	**$ 234,600**	
Notes					
A: Abandonment costs from Driltek					
B: 15% of project costs					

EPA note: Injection well plugging costs are labeled as Table 2B in SJR's submission, but this is assumed to be Table 3, as referenced in SJR's Table 1.

Table 4. Post Injection Site Care Costs						
Activity	**Unit**		**Events, 15 years**	**Unit Cost**	**Total (15 years)**	**Reference**
USDW geochemical monitoring	1	well	15	$ 2,000	$ 30,000	C
Above Confining zone geochemical, pressure monitoring	1	well	15	$ 5,000	$ 75,000	C
Injection zone geochemical, pressure monitoring	1	well	15	$ 5,000	$ 75,000	C
Monitoring well O&M, Above confining zone	1	well	3	$ 27,000	$ 81,000	A
Mechanical Integrity Test, Injection zone	1	well	3	$ 35,000	$ 105,000	A
3D Seismic Surveys	1	survey	2	$ 600,000	$ 1,200,000	B
Reporting	250	hour/yr	15	$ 200	$ 750,000	-
Project Management	250	hour/yr	15	$ 200	$ 750,000	-
				Total, 15 years	**$ 3,066,000**	
A: Patrick Engineering, 2013; assumes $2,000 base cost + $4.25/ft						
B: U.S. EPA, 2008 Table 3 (inflation adjusted); assumes $100,000 per square mile and survey of 6 square miles						
C: Assumes 1 geochemical monitoring event per year per well and continuous pressure monitoring with automated gage						

Table 2B. Costs, Site Closure					
Activity	**Unit**		**Unit Cost**	**Total**	**Reference**
Non-endangerment report	1	each	$ 40,000	$ 40,000	-
Injection zone monitoring well plugging	1	well	$ 174,000	$ 174,000	A
Above-confining zone monitoring well plugging	1	well	$ 154,000	$ 154,000	A
Plugging documentation, project management	1	each	$ 55,200	$ 55,200	B
			Total	**$ 423,200**	
Notes					
A: Abandonment costs from Driltek					
B: 15% of project costs					

EPA note: Site closure costs are labeled as Table 2B in SJR's submission, but this is assumed to be Table 5, as referenced in SJR's Table 1.

Groundwater Contamination Causal Investigation					
Activity	**Unit**		**Unit Cost**	**Total**	**Reference**
Planning/permitting	1	each	$ 1,072,500	$ 1,072,500	B
Monitoring wells, depth 1,000 ft	5	well	$ 350,000	$ 1,750,000	A
Monitoring wells, depth 5,000 ft	3	well	$ 1,750,000	$ 5,250,000	A
Abandoned well investigation	5	wells	$ 25,000	$ 125,000	-
Former Injection Well Investigation	1	well	$ 25,000	$ 25,000	-
Reporting/Project Management	1	each	$ 2,145,000	$ 2,145,000	C
Total				**$**	**10,367,500**

Groundwater Contamination Remediation					
Activity	**Unit**		**Unit Cost**	**Total**	**Reference**
Planning/permitting	1	each	$ 1,548,750	$ 1,548,750	B
Pumping well, depth 1,000 ft	4	well	$ 350,000	$ 1,400,000	A
Pumping well, depth 5,000 ft	4	well	$ 1,750,000	$ 7,000,000	A
Groundwater extraction	1	year	$ 300,000	$ 300,000	
Above-ground CO_2 removal (aeration)	1	unit	$ 150,000	$ 150,000	
Alternative water supply	1	community/yr	$ 1,250,000	$ 1,250,000	D
Former injection well repair	1	well	$ 225,000	$ 225,000	E
Reporting/Project Management	1	each	$ 3,097,500	$ 3,097,500	
Total				**$**	**14,971,250**
Total, Causal Investigation and Remediation				**$**	**25,338,750**

Notes

A: Assumes $350/ft for permitting, installation, field oversight, logging drilling, and waste

B: 15% of project costs

C: 15% of project costs for reporting, 15% of project costs for project management

D: Assumes $25/month per capita and 50,000 people

E: 15% of installation costs

Evaluation of the Proposed Emergency and Remedial Response Plan for the San Joaquin Renewables Class VI Project

EPA reviewed the proposed Emergency and Remedial Response Plan for the San Joaquin Renewables (SJR) Class VI project, dated October 22, 2021. EPA has the following questions and recommendations in blue for the applicant.

Some of the suggestions below reflect the information in an updated template for the Emergency and Remedial Response Plan that is available in the "Project Plan Submissions" module of the GSDT.

Area Resources

In Table 1, please clarify the difference between the columns labeled "AoR 5-year" and "AoR 15/20-year," and their significance for emergency response planning.

Emergency Identification and Response Actions

For a holistic documentation of the response, EPA recommends that, for each scenario, the following be identified: severity of the impact (i.e., high, medium, low); likelihood of the event; timing of the event (i.e., project phase); avoidance measures in place to reduce the likelihood of the event (e.g., maintenance or monitoring); detection methods that reflect planned testing and monitoring; response personnel; and equipment.

Please elaborate on the degrees of risk for various emergency events (e.g., major emergency, serious emergency, or minor emergency) and define these degrees of risk.

EPA recommends that the Emergency and Remedial Response Plan also address induced or natural seismic events. In guidance, EPA recommends a "stoplight" approach, in which the response varies (i.e., from documenting the event to gradually shutting down injection operations and investigating the event to immediately shutting in the well and performing necessary corrective and/or remedial actions) based on the magnitude or location of the event and whether it was felt.

EPA also recommends that natural disasters be addressed in the plan. While the responses to such events would be similar to other events (particularly those related to well failures), they should be described for a complete approach, as these events could affect the normal operation of the injection well or surface facilities.

EPA also recommends some additions/revisions to the descriptions of response actions on Table 2, which are summarized in the table below:

Event/Scenario	EPA Comment/Recommendation
All	Add a step to notify the UIC Program Director within 24 hours. Revise as follows: "Conduct causal investigation <u>and determine the severity of the event</u>."
Injection well failure	EPA recommends tying injection well failures to the types of monitoring that would detect losses of mechanical integrity, such as activation of automatic shutdown devices or detection of a failure through a mechanical integrity test. Please note in the plan that, per 40 CFR 146.91(c)(3), SJR must notify the UIC Program Director within 24 hours of any triggering of a shut-off system (i.e., down-hole or at the surface). This scenario should also address failures of monitoring wells and failure of injection well monitoring equipment (e.g., wellhead pressure, temperature, and/or annulus pressure). Please distinguish response actions for a major or serious emergency (e.g., initiating shutdown and responding if contamination is detected) versus a minor emergency (e.g., conducting an assessment to determine if there was a loss of mechanical integrity, and if so initiating the shutdown plan). Also include the response action: "Identify and implement appropriate remedial actions (in coordination with the UIC Program Director) if contamination is detected."
Groundwater or surface water contamination	EPA recommends that SJR expand on the response associated with evaluation of potential alternative remedial technologies. Activities may include: develop (in consultation with the UIC Program Director) a plan to install monitoring wells to delineate the extent of the impact; remediate the affected USDW; arrange for an alternate drinking water supply if maximum contaminant levels (MCLs) are exceeded; and continue remediation and monitoring until unacceptable impacts have been fully addressed.
Unexpected carbon dioxide migration	Please include steps to determine if groundwater contamination occurred and to take appropriate remedial steps (similar to those described under the groundwater surface water contamination scenario).

Response Personnel and Equipment

- EPA recommends the emergency contacts also include local/state police, CalGEM, and EPA's National Response Center (800-424-8802).
- Are any of the listed contacts on-call 24 hours/day? If so, please note this in the plan.
- Please fill in the contact information for the Onsite Plant Operations Manager and Onsite Plant Safety Officer in the next update.

Staff Training and Exercise Procedures

- Will the Emergency and Remedial Response Plan be incorporated into the overall Health and Safety Plan described on page 2?

Communication Plan

EPA recommends that, in Section 5.2, SJR also describe plans to communicate with entities who may need to be informed about or take action in response to an emergency event, including local water systems, CO_2 source(s) and pipeline operators, landowners, and Regional Response Teams (as part of the National Response Team).

Plan Updates

EPA recommends that Section 6 also indicate that the Emergency and Remedial Response Plan will be updated: within 1 year of an AoR reevaluation (or that SJR will provide documentation supporting a determination that no amendment is necessary); following any significant changes to the injection process or the injection facility, or an emergency event; or as required by EPA.