POST-INJECTION SITE CARE AND SITE CLOSURE PLAN

40 CFR 146.93(a)

SUTTER DECARBONIZATION PROJECT

1.0 Facility Information

Facility name: Sutter Energy Center
[redacted]

Facility contact: [redacted]

Well location: Robbins, Sutter County, CA
[redacted]

This Post-Injection Site Care (PISC) and Site Closure plan describes the activities that [redacted] will perform to meet the requirements of 40 CFR 146.93. [redacted] will monitor ground water quality and track the position of the carbon dioxide plume and pressure front for the duration of the PISC period years. [redacted] may not cease post-injection monitoring until a demonstration of non-endangerment of USDWs has been approved by the UIC Program Director pursuant to 40 CFR 146.93(b)(3). Following approval for site closure, [redacted] will plug all monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation.

2.0 Pre- and Post-Injection Pressure Differential [40 CFR 146.93(a)(2)(i)]

Based on the modeling of the pressure front as part of the AoR delineation, pressure at all three injection wells is expected to decrease to or near pre-injection levels by the end of the [redacted]-year post injection period as shown in **Figure 1**. The maximum pressure differential at any of the three wells is [redacted] psi. **Figure 2** shows the pressure differential with time at the proposed monitoring well locations. The plume area with time is presented in **Figure 3**, with the plume area being calculated by determining the area of the vertically integrated mass of each plume and then summing the area of the three plumes. This was done to represent the total area affected by CO_2 because the plumes do not coalesce during the operational or PISC period. Additional information on the projected post-injection pressure declines and differentials is presented in the permit application and the AoR and Corrective Action Plan.

[redacted]

Time, yrs

Figure 1. Simulated pressure differential with time at injection wells

[redacted]

Figure 2. Simulated pressure differential with time at monitoring wells

[redacted]

Figure 3. Simulated plume area vs. time

2.1 Predicted position of the CO2 plume and associated pressure front at site closure [40 CFR 146.93(a)(2)(ii)]

Figure 4 shows the predicted extent of the plume at the end of the PISC timeframe and the proposed AoR. This map is based on the final AoR delineation modeling results submitted pursuant to 40 CFR 146.84.

[redacted]

Figure 4. Map of the predicted extent of the CO_2 plume and AoR at site closure.

3.0 Post-Injection Monitoring Plan [40 CFR 146.93(b)(1)]

Performing ground water monitoring, LUSDW monitoring, injection formation pressure and temperature monitoring, and 2D/3D seismic monitoring as described in the following sections during the post-injection phase will meet the requirements of 40 CFR 146.93(b)(1). The results of all post-injection phase testing and monitoring will be submitted annually, within 60 days following the anniversary date of the date which injection ceases or with the prior approval of the Director, as described under "Schedule for Submitting Post-Injection Monitoring Results," below. Pursuant to 40 CFR 146.93((b)(2), however, the [redacted] could propose a shorter post-injection site care monitoring period after injection ceases if merited based on review of the plume relaxation during the post injection period monitoring. Such a proposal would be made based on a demonstration to EPA that a shorter time period would be protective of USDWs.

A quality assurance and surveillance plan (QASP) for all testing and monitoring activities during the injection and post injection phases is provided in the Appendix to the Testing and Monitoring Plan.

Post-injection monitoring will include groundwater monitoring and storage zone pressure monitoring. Pressure monitoring in the Starkey Storage Complex will monitor for pressure stabilization as this is the best method to confirm confinement in the reservoir.

3.1 Monitoring above the Confining Zone

Table 1 presents the monitoring methods, locations, and frequencies for monitoring above the confining zone. Table 2 identifies the parameters to be monitored and the analytical methods [redacted] will employ.

Table 1. Monitoring of ground water quality and geochemical changes above the confining zone.

Target Formation	**Monitoring Activity**	**Monitoring Location(s)**	**Spatial Coverage**	**Frequency**
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]

Table 2. Summary of analytical and field parameters for ground water samples.

[redacted]

[redacted]

Table 3. Sampling and recording frequencies for continuous monitoring.

[redacted]

Notes:

- Sampling frequency refers to how often the monitoring device obtains data from the well for a particular parameter. For example, a recording device might sample a pressure transducer monitoring injection pressure once every two seconds and save this value in memory.
- Recording frequency refers to how often the sampled information gets recorded to digital format (such as a computer hard drive). For example, the data from the injection pressure transducer might be recorded to a hard drive once every minute.

3.2 Carbon dioxide plume and pressure front tracking [40 CFR 146.93(a)(2)(iii)]

[redacted] will employ direct and indirect methods to track the extent of the carbon dioxide plume and the presence or absence of elevated pressure.

Table 4 presents the direct and indirect methods that [redacted] will use to monitor the CO_2 plume, including the activities, locations, and frequencies [redacted] will employ. The parameters to be analyzed as part of fluid sampling in the Starkey Storage Complex (and associated analytical methods) are presented in Table 5.

Table 6 presents the direct and indirect methods that [redacted] will use to monitor the pressure front, including the activities, locations, and frequencies [redacted] will employ. Fluid sampling will be performed as described in B.2 of the QASP; sample handling and custody will be performed as described in B.3 of the QASP; and quality control will be ensured using the methods described in B.5 of the QASP.

Table 4. Post-injection phase plume monitoring.

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
DIRECT PLUME MONITORING				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
INDIRECT PLUME MONITORING				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]

Table 5. Summary of analytical and field parameters for fluid sampling in the injection zone.

[redacted]

Table 6. Post-injection phase pressure-front monitoring.

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
DIRECT PRESSURE-FRONT MONITORING				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]

3.3 Schedule for submitting post-injection monitoring results [40 CFR 146.93(a)(2)(iv)]

All post-injection site care monitoring data and monitoring results collected using the methods described above will be submitted to EPA in reports submitted annually, within 60 days following the anniversary date of the date on which injection ceases or alternatively with the prior approval of the Director. The reports will contain information and data generated during the reporting period; i.e., well-based monitoring data, sample analysis, and the results from updated site models.

3.4 Non-Endangerment demonstration criteria

Prior to approval of the end of the post-injection phase, [redacted] will submit a demonstration of non-endangerment of USDWs to the UIC Program Director, per 40 CFR 146.93(b)(2) and (3).
The owner or operator will issue a report to the UIC Program Director. This report will make a demonstration of USDW non-endangerment based on the evaluation of the site monitoring data used in conjunction with the project's computational model. The report will detail how the non-endangerment demonstration evaluation uses site-specific conditions to confirm and demonstrate non-endangerment. The report will include all relevant monitoring data and interpretations upon which the non-endangerment demonstration is based, model documentation and all supporting data, and any other information necessary for the UIC Program Director to review the analysis. The report will include the following sections:

3.4.1 Introduction and overview

A summary of relevant background information will be provided, including the operational history of the injection project, the date of the non-endangerment demonstration relative to the post-injection period outlined in this PISC and Site Closure Plan, and a general overview of how monitoring and modeling results will be used together to support a demonstration of USDW non-endangerment.

3.4.2 Summary of existing monitoring data

A summary of all previous monitoring data collected at the site, pursuant to the Testing and Monitoring Plan of this permit and this PISC and Site Closure Plan, including data collected during the injection and post-injection phases of the project, will be submitted to help demonstrate non-endangerment.

Data submittals will be in a format acceptable to the UIC Program Director [40 CFR 146.91(e)], and will include a narrative explanation of monitoring activities, including the dates of all monitoring events, changes to the monitoring program over time, and an explanation of all monitoring infrastructure that has existed at the site. Data will be compared with baseline data collected during site characterization [40 CFR 146.82(a)(6) and 146.87(d)(3)].

3.4.3 Summary of computational modeling history

The results of computational modeling used for AoR delineation will be compared to monitoring data collected during the operational and the PISC period. The data will include the results of time-lapse temperature and pressure monitoring, groundwater quality analysis, and geophysical surveys (i.e., logging and 2D/3D surface seismic surveys) used to update the computational model and to monitor the site. Data generated during the PISC period will be used to help show that the computational model accurately represents the storage site and can be used as a proxy to determine the plume's properties and size. The operator will demonstrate this degree of accuracy by comparing the monitoring data obtained during the PISC period against the model's predicted properties (i.e., plume location, rate of movement, and pressure decay). Statistical methods will be employed to correlate the data and confirm the model's ability to accurately represent the storage site. The validation of the computational model with the large volume of available data will be a significant element to support the non-endangerment demonstration. The validation of the complete model over the areas, and at the points, where direct data collection has taken place will help to ensure confidence in the model for those areas where surface infrastructure preclude geophysical data collection and where direct observation wells cannot be placed.

3.4.4 Evaluation of reservoir pressure

[redacted] will support the demonstration of non-endangerment to USDWs by showing that, during the PISC period, the pressure in the Starkey Storage Complex has decreased towards pre-injection static reservoir pressure values. The increased pressure during injection is the main driving force for fluid movement that may endanger a USDW. Therefore, the decay in pressure differentials will provide justification that the injectate does not pose a risk to any USDWs.
During the PISC period the operator will collect formation pressure data that will be used to evaluate pressure decline and resulting non-endangerment to USDWs. The operator will monitor the downhole reservoir pressure at various locations and intervals using a combination of surface and downhole pressure gauges. The measured pressure at a specific depth interval will be compared against the pressure predicted by the numerical simulation. Agreement between the predicted values will help validate the accuracy of the model and demonstration of non-endangerment.

3.4.5 Evaluation of carbon dioxide plume

The plume area is expected to increase in areal extent over time, while decreasing notably in CO_2 saturation density. The expansion is a largely expected function of the local geological dip. During the PISC period, the CO_2 saturation density will be monitored to understand the evolution of the plume front. [redacted] will use a combination of time-lapse pulsed neutron logs and time lapse 2D/3D seismic methods to locate and track the extent of the CO2 plume. Pulsed neutron logging will be used to monitor the distribution and saturation of CO2 adjacent to the injection well and IZM monitoring wells. A good correlation between pulsed neutron data sets and modeled plume thicknesses will help provide strong evidence in validating the model's ability to represent the storage system.
The time-lapse 2D/3D surface seismic data will be acquired at longer time intervals and track the development of the CO2 plume over a larger spatial extent. The data will be compared against the model

using statistical methods to validate the model's ability to accurately represent the storage site. Both the pulsed neutron logs and seismic data will be used to verify the computational model's ability to predict the CO2 behavior in the PISC phase of the project and support a demonstration of non-endangerment of USDWs at the end of the project.

3.4.6 Evaluation of emergencies or other events

During the injection operations and post-injection phases of the project, measurement of water quality parameters from the monitoring wells will be used to demonstrate that the storage formation fluids have not migrated above the confining formations. Assuming there is no such detectable movement of injection zone fluids, they are not anticipated to pose a risk to USDWs. To demonstrate non-endangerment, the project will compare the results of the fluid sampling from the Lowermost USDW from the injection and PISC phases to the pre-injection baseline samples. This comparison will demonstrate whether significant changes in the fluid properties of the overlying formations have occurred and whether mobilized storage formation fluids have moved through the confining layer.
Passive seismic monitoring system will be designed and deployed to detect events over M1.0 within the AoR. This monitoring will continue in the post injection project phase. However, the monitoring capabilities from the injection wells will be eliminated once these wells are plugged and abandoned. Artificial penetrations include wells associated with the project. The injection wells will be plugged and abandoned with the permit P&A plan. The ACZ and IZM monitoring wells will be plugged and abandoned in accordance with the procedures outlined below. A total of [redacted] oil and gas wells penetrate the primary confining zone (Capay Shale) of the Starkey Storage Complex, and [redacted] of those have been identified as potential leakage risks. If corrective action is required for legacy wells that exist in the AoR that were not identified at the time of writing, the Sutter Decarbonization Project shall secure agreements to access, enter, and implement corrective action as needed.

4.0 Site Closure Plan

[redacted] will conduct site closure activities to meet the requirements of 40 CFR 146.93(e) as described below. [redacted] will submit a final Site Closure Plan and notify the permitting agency at least 120 days prior of its intent to close the site. Once the permitting agency has approved closure of the site, [redacted] will plug the monitoring wells and submit a site closure report to EPA. The activities, as described below, represent the planned activities based on information provided to EPA. The actual site closure plan may employ different methods and procedures. A final Site Closure Plan will be submitted to the UIC Program Director for approval with the notification of the intent to close the site.

4.1 Plugging monitoring wells

All monitoring wells will be plugged and capped upon site closure in a manner similar to described in the Plugging and Abandonment section of the permit. All deep monitoring wells will be plugged to prevent migration of the CO_2 or formation fluids to the USDWs. Each well will be plugged and abandoned using best practices to ensure no fluid movement between the injection zone and the USDWs.
The internal and external integrity of the wells will be confirmed by conducting either a temperature log, noise log, or oxygen activation log before the wells are plugged. Additionally, a pressure fall-off test will be performed above the perforated intervals, where present, to confirm well integrity. The logging and testing results will be reviewed and approved by the appropriate regulatory agencies before plugging the wells.
The wells with perforations will be plugged using CO_2 resistant cement. The plugging procedure and materials will be designed to prevent any unwanted fluid movement, to resist the corrosive aspects of

carbon dioxide/water mixtures, and the protect any USDWs. An initial bottom hole pressure measurement will be recorded, and the well will be flushed with kill weight brine fluid. The casing will be cemented to the surface and the injection tubing and packer will be removed. Next a retainer squeeze of the perforations followed by the balanced-plug placement method will be used to plug the well. The operator will report the wet density and retain duplicate samples of the cement used for each plug. All casing string will be cut off at least 3 feet from below the surface and a blanking plate with required permit information will be welded to the top of the cutoff casing to complete the plugging process.

4.2 Site restoration/remedial activities

Surface areas of the storage site will be reclaimed and returned to pre-development condition after the active injection phase. The land will be reclaimed for pre-development uses and all plugging pits, equipment, gravel pads, access roads, and surface facilities will be removed.
At the end of the post-injection site care phase, all surface facilities will be removed. This includes all remaining buildings, access roads and parking areas, sidewalks, underground electric and telecommunication facilities, and fencing.

4.3 Site closure report

A site closure report will be prepared and submitted within 90 days following site closure, documenting the following:

- Plugging of the verification and geophysical wells (and the injection well if it has not previously been plugged),
- Location of sealed injection well on a plat of survey that has been submitted to the local zoning authority,
- Notifications to state and local authorities as required at 40 CFR 146.93(f)(2),
- Records regarding the nature, composition, and volume of the injected CO_2, and
- Post-injection monitoring records.

[redacted] will record a notation to the property's deed on which the injection well was located that will indicate the following:

- That the property was used for carbon dioxide sequestration,
- The name of the local agency to which a plat of survey with injection well location was submitted,
- The volume of fluid injected,
- The formation into which the fluid was injected, and
- The period over which the injection occurred.

The site closure report will be submitted to the permitting agency and maintained by the owner or operator for a period of 10 years following site closure. Additionally, the owner or operator will maintain the records collected during the post-injection period for a period of 10 years after which these records will be delivered to the UIC Program Director.