Plan revision number: 0
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POST-INJECTION SITE CARE AND SITE CLOSURE PLAN
40 CFR 146.93(a)

Bluebonnet Sequestration Project

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1.0 Facility Information

Facility name: Bluebonnet CO_2 Sequestration Project
Bluebonnet CCS 1 Well

Facility contact: [redacted], Project Manager
5 Greenway Plaza Houston, TX 77046
[redacted]

Well location: Winnie, Chambers County, Texas
[redacted] (North American Datum 1927)

This Post-Injection Site Care and Site Closure (PISC) plan describes the activities that the Bluebonnet Sequestration Hub, LLC will perform to meet the requirements of 40 CFR 146.93. The Bluebonnet Sequestration Hub, LLC will monitor ground water quality and track the position of the carbon dioxide plume and pressure front for 50 years post injection. The Bluebonnet Sequestration Hub, LLC 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, the Bluebonnet Sequestration Hub, LLC 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, the maximum pressure differential is [redacted] psi at the top of the perforations in the Bluebonnet CCS 1 when the 15-year period of injection ceases. The magnitude and area of elevated pressure gradually decreases over time after the end of injection.

Table PIS-1 shows the pressure differential versus time at the top of the [redacted] formation for the monitoring well locations in the Area of Review (AoR). The highest pressures are in the immediate vicinity of each injection well. The pressure is expected to decrease below the critical pressure of [redacted] psi in all areas of the site by the end of the PISC timeframe.

Additional information on the projected post-injection pressure declines and differentials is presented in the Narrative and the Area of Review and Corrective Action Plan documents of this permit.

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Table PIS-1—Pressure Differential to Pre-Injection Conditions at the Top of the [redacted] at Monitoring Well Locations

[redacted]

Figure PIS-1 shows the simulated pressure vs. time for the Bluebonnet CCS_1 and monitoring well locations.

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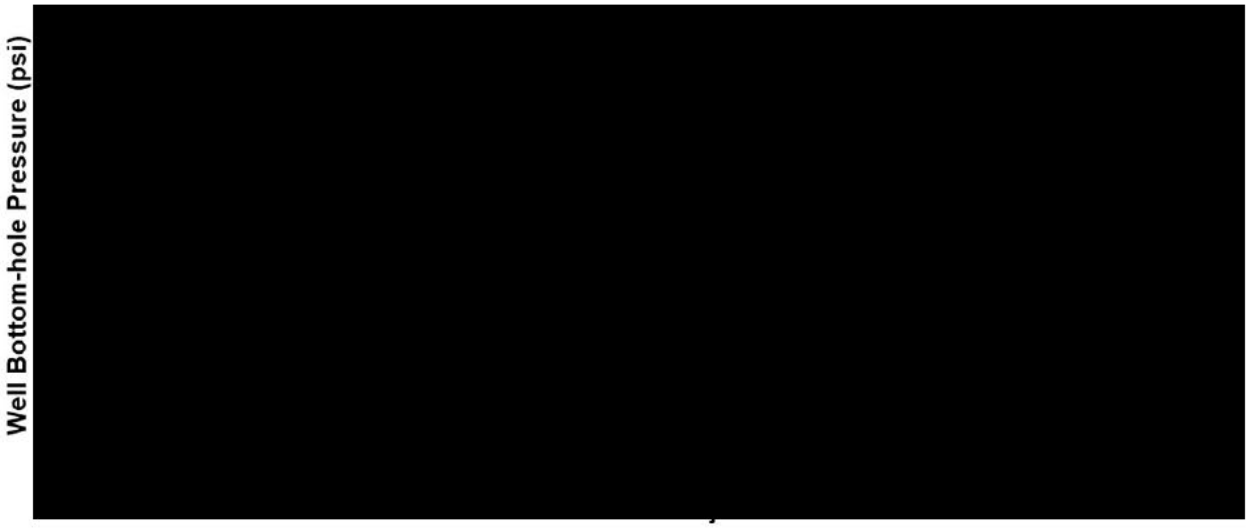

Figure PIS-1—Simulated pressure vs. time at the top perforation in the Bluebonnet CCS 1 injection well and at the top of the [redacted] in monitoring well locations

Figure PIS-2 and Figure PIS-3 show the simulated pressure differentials from the baseline at the top of the injection zone and in the cross-section through Bluebonnet CCS 1 at 15 years after the start of injection and 65 years after the start of injection, respectively. The pressure has dissipated below the critical pressure in all areas of the site at year 65, which is site closure.

Figure PIS-2— njection (end of injection)

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Figure PIS-3—Averaged aqueous pressure differentials from the baseline condition at 65 years after start of injection (50 years post-injection)

3.0 Predicted Position of the CO_2 Plume and Associated Pressure Front at Site Closure [40 CFR 146.93(a)(2)(ii)]

The reservoir simulation indicates that after injection ceases, the CO_2 plume remains within the [redacted], but continues to expand northward in the up-dip direction of the reservoir with time. To be conservative, the AoR is defined by the combination of the pressure front at end of injection and the plume shape and size in year 115 (100 years after injection ceases) represented by the red outline in Figure PIS-4. The colored area in Figure PIS-4 shows the CO_2 plume extent in year 65 (i.e., 50 years post-injection). The simulated plume in year 15 (proposed cessation of injection) is represented by the blue outline. In addition, a N–S cross-section through well Bluebonnet CCS 1 at both times is shown in Figure PIS-5. The differences between the vertical extents of the 65- and 115-year plumes are almost negligible. The calculated plume size difference after 65- and 115-year injection is about [redacted] $mile^2$ This continued migration of the plume is due to buoyancy of the mobile supercritical phase CO_2, which moves along the strata in the up-dip direction. Figure PIS- shows plume movement on a gas saturation basis. In addition, as previously shown in
Figure **PIS-2** and Figure PIS-3, all pressures have been reduced to levels below the level of endangerment to USDWs. Therefore, year 65 (50 years post-injection) is considered as the site closure date.

The maps are based on the final AoR delineation modeling results submitted pursuant to 40 CFR 146.84.

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Figure PIS-4—Areal extent of the CO_2 plume at site closure at year 65. The red outline represents the simulated CO_2 plume at year 115

Figure PIS-5—North–South cross-section through well Bluebonnet CCS 1 showing simulated gas saturation at year 65 and at year 115.

Figure PIS-6—Simulated areal extent of the CO_2 plume from injection start-up to shut-in, then to 115 years after injection (100 year after end of the injection).

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

Performing groundwater quality monitoring and plume and pressure front tracking as described in the following sections during the post-injection phase will meet the requirements of 40 CFR 146.93(a)(2)(iii). The results of all post-injection phase testing and monitoring will be submitted annually, within 60 days of the anniversary of the date that injection ceases, as described under Section 4.3 Schedule for Submitting Post-Injection Monitoring Results.

A quality assurance and surveillance plan (QASP) for all testing and monitoring activities during the injection and post injection phases is provided as a separate document of this permit.

After the injection ceases, the project will plug and abandon the injector wells according to the plugging procedure proposed in the Plugging Plan document of this permit.

During the post-injection period, the model predicts that after [redacted] years of the stop of injection the pressure variation from a year to the next one will be [redacted] as shown in Table PIS-2, while the CO2 plume will continue migrate in the north direction. The model shows a stabilized plume at year 65 (50 years post-injection).

Table PIS-2—Modeled Bottomhole Pressure Variation with Time at the In-Zone Monitoring Locations

Year	Differential Bottom Hole Pressure Changes (psi) [redacted]	Pressure Changes %
[redacted]		

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Description of the methods and techniques to be used while monitoring the site during the post injection period are show in Table PIS-3. Locations and frequency for each method or technique are also presented in Table PIS-3.

Table PIS-3—Monitoring Plan for Post-Injection Site Care

Description	Method	Location	Post Injection period
[redacted]			

Specifics of the methods, techniques, and analytics to be tested as part of the proposed monitoring plan are described in detailed in the Testing and Monitoring Plan as wells as in the QASP document.

4.3 Schedule for Submitting Post-Injection Monitoring Results [40 CFR 146.93(a)(2)(iv)]

During the PISC period, the monitoring reports will be prepared annually and submitted to the EPA Region 6 UIC Branch Office. These reports will summarize methods and results of ground water quality monitoring, CO_2 storage zone pressure tracking, and indirect geophysical monitoring for CO_2 plume tracking.

The PISC and Site Closure Plan will be reviewed every 5 years during the PISC period. Results of the plan review will be included in the PISC monitoring reports. The operational and monitoring results will be reviewed for adequacy in relation to the objectives of the PISC. The monitoring locations, methods, and schedule will be analyzed in relation to the size of the CO_2 storage zone, pressure front, and protection of USDWs. In case of changes to the PISC plan, a modified plan will be submitted to the EPA Region 6 UIC Branch Office at least 30 days before the planned initiation of the changes.

5.0 Non-Endangerment Demonstration Criteria

Prior to approval of the end of the post-injection phase, the Bluebonnet Sequestration Hub, LLC 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:

5.1 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.

5.2 Summary of Existing Monitoring Data

A summary of all previous monitoring data collected at the site, pursuant to the Testing and Monitoring Plan document 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)].

5.3 Summary of Computational Modeling History

The computational modeling results used for the AoR delineation will be compared to monitoring data collected during the operational and PISC periods. Monitoring data will also be compared with data collected during site characterization, as per 40 CFR 146.82(a)(6) and 146.87(d)(3). The data will be used to update the computational model and monitor the site, and will include both direct (e.g., measurements of pressure, temperature, groundwater quality) and indirect (e.g., 2D seismic, Pulse Neutron logging) geophysical methods.

Data generated during the PISC period will be used to 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 Bluebonnet Sequestration Hub, LLC will demonstrate this degree of accuracy by comparing the monitoring data obtained during the operational and PISC period with 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 represent the storage site accurately. The validation of the computational model with the large quantity of measured data will be a significant element to support the non-endangerment demonstration.

5.4 Evaluation of Reservoir Pressure

The Bluebonnet Sequestration Hub, LLC will demonstrate non-endangerment to USDWs by showing that during the PISC period, the pressure within the [redacted] will rapidly decrease to levels near its pre-injection static reservoir pressure. Because increased pressure is the primary driving force for fluid movement, which might endanger a USDW, the decay in the pressure differential provides strong justification that the injectant will no longer pose a risk to any USDWs.

The Bluebonnet Sequestration Hub, LLC 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 with the pressure predicted by the computational model, which was previously shown in Figure PIS-1,
Figure **PIS-2**, and Figure PIS-3. Agreement between the actual and predicted values will validate the accuracy of the model and further demonstrate non-endangerment.

5.5 Evaluation of Carbon Dioxide Plume

The Bluebonnet Sequestration Hub, LLC will use a combination of monitoring data, logs, geophysical surveys, and seismic methods to locate and track the movement of the CO_2 plume.

The data produced by these activities will be compared with the modeled predictions (previously shown in Figure PIS-) using statistical methods to validate the model's ability to represent the storage site accurately. Regarding the separate-phase carbon dioxide plume, the PISC monitoring data will show the stabilization of the CO_2 plume as the reservoir pressure returns to its near pre-injection state. The risk to USDWs will decrease when the extent of pure-phase CO_2 ceases to grow either laterally or vertically.

5.6 Evaluation of Emergencies or Other Events

In addition to the CO_2 plume, mobilized fluids may also pose an ongoing risk to USDWs, as the reservoir fluids include brines high in TDS and other drinking water contaminants. The geochemical data collected from above confining zone and USDW monitoring wells will be used to demonstrate that no mobilized fluids have moved above the confining formation, and therefore, would not pose a risk to USDWs after the PISC period. Of particular importance are any monitoring wells above the primary confining zone, within any USDWs, and in the vicinity of any known leakage pathways.

To demonstrate non-endangerment, the Bluebonnet Sequestration Hub, LLC will compare the operational and PISC period samples of the lowermost USDW with the pre-injection characterization of the aquifers . This evaluation will demonstrate that no mobilized formation fluids have moved through the confining formation. In addition, this validation of confining zone integrity will demonstrate that the injectant and/or mobilized fluids will not represent an endangerment to any USDWs.

Other than the project and monitoring wells, other potential conduits for fluid movement or leakage pathways within the AoR will be adequately plugged and abandoned. Based on this information, the potential for fluid movement through artificial penetrations of the confining formation does not present a risk of endangerment to any USDWs.

6.0 Site Closure Plan

The Bluebonnet Sequestration Hub, LLC will conduct site closure activities to meet the requirements of 40 CFR 146.93(e) as described below. The Bluebonnet Sequestration Hub, LLC 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, the Bluebonnet Sequestration Hub, LLC will plug the remaining 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.

In addition to the EPA, the Texas Railroad Commission, Chambers County, the City of Winnie, and any other agencies governing the project at the time of site closure will be notified prior to the scheduled site closure. Currently, there are no federally recognized Native American Tribes located within the AoR; however, if a federally recognized Native American Tribe becomes known within the AoR at the time of site closure, that tribe(s) will be notified of the site closure.

6.1 Plugging Monitoring Wells

Upon conclusion of the 50-year post-injection site care period, any remaining monitoring well will be plugged and capped below grade in accordance with the approved plugging and abandonment plans, which is included as Appendix A in the Injection Well Plugging Plan.

After the completion of the plugging activities, a plugging report will be submitted to the UIC Program Director describing the methods used and tests performed on the well during plugging. This report will be submitted to the UIC Program Director within 60 days of completing the plugging activities.

6.2 Planned Remedial and Site Restoration Activities

At the end of the PISC phase, Bluebonnet Sequestration Hub, LLC will ensure the site is reclaimed and returned to predevelopment condition to meet the requirements of 40 CFR 146.93(e).

Surface equipment decommissioning will occur in two phases: the first phase will occur after the active injection phase and the second phase will occur at the end of the PISC phase.

At the end of the active injection period, plume monitoring will continue, but there will be no further need for the pumping and control equipment. The process control building at the surface pumping facility will remain. This building serves as a hub for control and monitoring of the well network, so it will remain operational. The pumping system and above-ground pipe, valves, and fittings at the surface pumping facility will be demolished.

The injection wells will be plugged and capped below grade as per the Injection Well Plugging Plan document of this permit. The process control building at the pumping facility site will act as the collection node for data from the plume monitoring equipment. This building will contain the equipment required to receive real-time data from the monitoring wells and other monitoring stations and send the data via an internet connection to be analyzed offsite during the 50-year post-injection monitoring period.

Surface facilities will be removed at the end of the PISC phase. The site will be reclaimed and returned to predevelopment condition except any facilities still in operation to serve other active projects (e.g. electrical supply serving other power users and roadways used or needed by surface landowners). Buried pipelines are expected to be idled and abandoned in place.

The soil will be backfilled around the monitoring and geophysical wells to bring the area around the wells back to the pre-installation grade. Any remaining surface facilities associated with the monitoring wells will be reclaimed and the area will be returned to the predevelopment condition. Gravel wellpads will be removed and the land will be reclaimed for preconstruction uses.

6.3 Site Closure Report

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

- Plugging of all injection and monitoring wells,
- Details of site restoration activities,
- Location of the sealed injection well on a plat survey submitted to the local zoning authority,
- Notifications to state and local authorities,
- Records regarding the nature, composition, and volume of CO_2 injected,
- Pre-injection, injection, and post-injection monitoring records, and
- Certifications that all injection and storage activities have been completed.

Bluebonnet Sequestration Hub, LLC 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.

7.0 Quality Assurance and Surveillance Plan (QASP)

The Quality Assurance and Surveillance Plan is presented as a separate document.