POST-INJECTION SITE CARE AND SITE CLOSURE PLAN
40 CFR 146.93(a) [LAC 43:XVII:3633]

Venture Global CCS Cameron, LLC CO_2 Sequestration Project

Facility Information

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Well Location: West Cameron Block 5 CS004 Well 001, Cameron Parish, Louisiana
[redacted]

This Post-Injection Site Care (PISC) and Site Closure Plan describes the activities that Venture Global CCS Cameron, LLC (Venture Global) will perform to meet the requirements of 40 CFR 146.93 [LAC 43:XVII:3633]. Venture Global will monitor ground water quality and track the position of the carbon dioxide (CO_2) plume and pressure front for at least fifty (50) years after cessation of injection, for the duration of an alternative timeframe approved by the Director pursuant to 40 CFR 146.93(c) [LAC 43:XVII:3633.A.3], or until a demonstration can be made that the geologic sequestration project no longer poses an endangerment to Underground Sources of Drinking Water (USDWs) pursuant to 40 CFR 146.93(b) [LAC 43:XVII:3633.A.2]. Following approval for site closure, Venture Global will plug all monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation.

The Post-Injection Site Care and Closure Plan is designed to integrate the continuous flow of new information and data about the project and its performance with ongoing monitoring. The Post-Injection Site Care and Closure Plan is an essential part of the risk management approach where the monitoring results will be used by Venture Global to verify, test, and iterate the risk assessment on an ongoing basis.

1 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 Area of Review (AoR) delineation, the pressure at the CO_2 injection well is expected to decrease to within [redacted] psi of pre-injection levels after ten (10) years of cessation of injection, as described below. Additional information on the projected post-injection pressure declines and differentials is presented in Module 2 Area of Review and Corrective Action Plan (AoR and Corrective Action Plan).

To meet the requirements of 40 CFR 146.93(a)(2)(i) [LAC 43:XVII:3633.A.1.b.i], Figure 1 shows the estimated maximum pressure differential between pre-injection and post-injection pressures in

the injection zone from start of injection, as determined by the plume model described in the AoR and Corrective Action Plan. As discussed in the AoR and Corrective Action Plan, Venture Global will inject sequentially into intervals starting with the deepest completion to shallower intervals of CS004 Well 001 over the life of the project, resulting in separate pressure profiles for each interval. The highest-pressure differential will occur in Year [redacted], which is part of Completion Stage [redacted], and is anticipated to reach [redacted] psi. [redacted]

[redacted]

Figure 1 provides a graphical and tabular representation of the differential pressure over the life of the CO_2 injection well. The pink line shows when injection stops in the field.

2 Predicted Position of the CO_2 Plume and Associated Pressure Front at Site Closure (40 CFR 146.93(a)(2)(ii)) [LAC 43:XVII:3633.A.1.b.ii]

Figure 2 shows the predicted extent of the plume and pressure front at the end of the PISC timeframe, representing the maximum extent of the plume and pressure front. This map is based on the final AoR delineation modeling results submitted pursuant to 40 CFR 146.84 [LAC 43:XVII:3615.B].

[redacted]

Due to the stratified nature of the injection interval and the various geologic horizons, the plume's shape and size changes from layer to layer. The CO_2 plume AoR was delineated from the maximum extent of all differing plumes in the model. [redacted]

3 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(b)(1) [LAC 43:XVII:3633.A.2]. The results of all post-injection phase testing and monitoring will be submitted annually, within sixty (60) days following the date on which injection ceases, as described under "Schedule for Submitting Post-Injection Monitoring Results," below.

As required by 40 CFR 146.93(b) [LAC 43:XVII:3633.A.2], Venture Global will continue to monitor the site after CO_2 injection ceases to ensure the project poses no endangerment to the

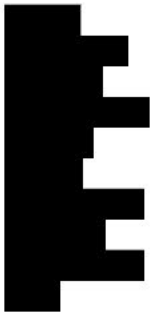
USDWs, as modelled. Upon cessation of injection, an amended PISC Plan will be submitted to the Director, if warranted, per the updated model.

See Module 11 Quality Assurance and Surveillance Plan (QASP) section for all testing and monitoring activities during the injection and post injection phases described in Module 3 Testing and Monitoring Plan.

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 Venture Global will employ. Table 3 shows the frequency that sampling and recording of continuous monitoring data will occur.

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

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency Year 1	Frequency Year 2-3	Frequency Year 4-9	Frequency Year 10	Frequency Every subsequent 5 years after Year 10 to Year 50
First mappable sand identified above the Upper Confining Interval (UCI)	Fluid chemistry sampling	CS004 Monitor Well 001		Semi-Annual	Annual	Annual	Annual	Annual
First mappable sand identified above the UCI	Downhole pressure/ temperature gauge	CS004 Monitor Well 001		Continuous	Continuous	None	None	None

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency Year 1	Frequency Year 2-3	Frequency Year 4-9	Frequency Year 10	Frequency Every subsequent 5 years after Year 10 to Year 50
First mappable sand identified above the UCI	Distributed Temperature Sensing (DTS)	CS004 Monitor Well 001	[redacted]	Continuous	Continuous	None	None	None

[redacted]

[redacted]

(1) 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.

(2) Recording frequency refers to how often the sampled information gets recorded to digital format (such as a computer hard drive). Following the same example above, the data from the injection pressure transducer might be recorded to a hard drive once every minute.

(3) This value can be an average of the sampled readings over the previous 5-minute recording interval, or the maximum (or minimum, as appropriate) value identified over that recording interval.

(4) DTS sampling frequency is once every 10 seconds and recorded on an hourly basis.

Figure 3 shows the location of the monitoring wells. The USDW confinement monitoring wells (light blue in Figure 3) have wellhead jackets that are normally accessible year-round for fluid sampling by boat.

3.2 Carbon Dioxide Plume and Pressure Front Tracking (40 CFR 146.93(a)(2)(iii)) [LAC 43:XVII:3633.A.1.b.iii]

Venture Global will employ direct and indirect methods to track the extent of the CO_2 plume and the presence or absence of elevated pressure.

Table 4 presents the direct and indirect methods that Venture Global will use to monitor the CO_2 plume and pressure front migration, including the activities, locations, and frequencies Venture

Global will employ. CS004 Monitor Well 002 is the in-zone monitoring well to be drilled vertically from the surface location of the CO_2 injection well, CS004 Well 001. The parameters to be analyzed as part of fluid sampling in the Middle & Lower Miocene sandstones (and associated analytical methods) are presented in Table 2.

Fluid sampling will be performed as described in Section B.2 of the QASP; sample handling and custody will be performed as described in Section B.3; and quality control will be ensured using the methods described in Section B.5. Quality assurance procedures for seismic monitoring methods are presented in Section B.9.

Table 4: Post-injection phase plume and pressure front monitoring.

Target Formation	Monitor-ing Activity	Monitoring Location(s)	Spatial Coverage	Frequency Year 1	Frequency Year 5	Frequency Year 10	Frequency Every subsequent 5 years after Year 10 to Year 50
DIRECT PLUME AND PRESSURE FRONT MONITORING							
Middle & Lower Miocene Sandstones	DTS	CS004 Monitor Well 002	[redacted]	Continuous	Continuous	None	None
Middle & Lower Miocene Sandstones	DTS	CS004 Monitor Well 002	[redacted]	Continuous	Continuous	None	None
Middle & Lower Miocene Sandstones	DTS	CS004 Monitor Well 002	[redacted]	Continuous	Continuous	None	None
Middle & Lower Miocene Sandstones	DTS	CS004 Monitor Well 002	[redacted]	Continuous	Continuous	None	None
Middle & Lower Miocene Sandstones	DTS	CS004 Monitor Well 002	[redacted]	Continuous	Continuous	None	None
Middle & Lower Miocene Sandstones	DTS	CS004 Monitor Well 002	[redacted]	Continuous	Continuous	None	None
Middle & Lower Miocene Sandstones	DTS	CS004 Monitor Well 002	[redacted]	Continuous	Continuous	None	None
INDIRECT PLUME AND PRESSURE FRONT MONITORING							

Target Formation	Monitor-ing Activity	Monitoring Location(s)	Spatial Coverage	Frequency Year 1	Frequency Year 5	Frequency Year 10	Frequency Every subsequent 5 years after Year 10 to Year 50
Middle & Lower Miocene Sandstones	Vertical Seismic Profiling (VSP)	AoR through time	Injection well laterally through AoR	Once (Year 1)	Once (Year 5)	Once (Year 10)	Every 10 years

Figure 3 shows the location of the planned deep monitoring well, CS004 Monitor Well 002. As part of contingency plan, an additional deep monitoring well, CS004 Monitor Well 003, will be considered and, if deemed necessary, will be drilled. It is anticipated that this well will be directionally drilled (bottomhole coordinates to be determined) from the same surface location as CS004 Monitor Well 001.

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 the Director in reports submitted on an annual basis, within sixty (60) days following the date on which CO_2 injection ceases. The reports will contain information and data generated during the reporting period (i.e., well-based monitoring data, sample analysis, and the results from updated site models).

4 Non-Endangerment Demonstration Criteria

Prior to approval of the end of the post-injection phase, Venture Global will submit a demonstration of non-endangerment of USDWs to the Director, per 40 CFR 146.93(b)(2) and (3) [LAC 43:XVII:3633.A.2.b and c], in the form a report.

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 Director to review the analysis. The report will include the following sections:

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.

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 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 Director per 40 CFR 146.91(e) [LAC 43:XVII.3629.A.3], 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 pursuant to 40 CFR 146.82(a)(6) [LAC 43:XVII:3607.C.2.e] and 40 CFR 146.87(d)(3) [LAC 43:XVII:3617.B.4.c].

4.3 Summary of Computational Modeling History

The AoR outline developed from computational modeling will be compared to data collected during the injection and post-injection periods. The data will include time-lapse temperature and pressure, ground water analysis, passive seismic, and geophysical surveys (VSP), which will be 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. Venture Global 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). Where there is a major difference between predicted plume and pressure front and actual data during the injection and post-injection periods, the computational model will be updated with available data and the updated model will be subsequently used to forecast plume and pressure front for future monitoring.

4.4 Evaluation of Reservoir Pressure

A pressure measurement will be taken from each completion stage of the monitoring well, CS004 Monitor Well 002, before plugging and compared with the computational model. If deemed necessary in the future, a second deep monitoring well, CS004 Monitor Well 03, could be drilled to the [redacted] of the injection well and additional pressure measurements could be obtained to further validate the model. The DTS/DAS Fiber Optic cable cemented to the outside of the casing can derive an indirect measurement of the pressure. The measured pressure for each completion stage and/or calculated pressure from indirect measurements will be compared to pressure predicted from the computational model to assess the accuracy of the computational model.

4.5 Evaluation of Carbon Dioxide Plume

Venture Global will use time-lapse VSP as the first method to monitor the CO_2 plume extent to meet the operation monitoring requirements specified in 40 CFR 146.90(g)(2) [LAC 43:XVII:3625.A.7.b]. The VSP surveys will identify density changes within the various injection intervals between survey efforts. This information provides confidence that deploying the method in a time-lapse format will generate a four-dimensional (4D) image of the plume's extent and development with time, after injection has ceased. As noted in Module 3 Testing and Monitoring Plan, employing VSP in the injection well with a permanently installed fiber optic sensor will create an image that is centered on the injection location with higher resolution compared to a traditional wireline-deployed geophone array. This proposed method eliminates the need for

additional penetrations within the injection formations for geophone monitoring purposes. This process has been used to quantify CO_2 plume movement with positive results from several similar operations worldwide (Shell Canada Limited, 2017[1]; Bacci et al., 2017[2]).

Venture Global, using petrophysical data (special core analysis data and well logs) from the proposed CS004 Well 001, will generate a modeled differential in compressional velocity and density to assess the likelihood to produce detectable changes in the reservoir where the connate fluid is replaced by CO_2. This information provides confidence that deploying the method in a time-lapse format will generate a 4D image of the plume extent and development into the future. This method eliminates the need for additional penetrations within the injection formations for geophone placement monitoring purposes.

A fiber optic cable with distributed acoustic sensing (DAS) will be incorporated in the cemented annulus behind the long string casing of the CS004 Monitor Well 001. A long sensor array will effectively be produced from the surface to the injection zone depth and will enable real-time or periodic monitoring using pressure and temperature gauges and the periodic VSP. The DAS fiber optic cable, designed with sensors [redacted] will be used to generate a VSP profile at the highest possible resolution. Three-dimensional (3D) models of the CO_2 plume will be created using a walk-away seismic source, in this offshore case, a seismic recording vessel. The data are captured by monitoring the well and repositioning the surface acoustic source. The data produced by these activities will be compared against the model using statistical methods to validate the model's ability to accurately represent the storage site. Venture Global will evaluate these proposed activities to ensure compliance with both the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA).

Geologic formation monitoring using time-lapse seismic has been used extensively in tertiary oil and gas recovery. The methodology has undergone thorough testing in saline aquifers with the presence of CO_2. The time-lapse effect is primarily driven by the change in acoustic impedance resulting from compressional changes in velocity between high CO_2 concentrations and formation gases/fluids. As formation fluids are displaced by CO_2, the change in acoustic impedance during plume growth can be analyzed. With proper seismic processing, both the pressure front and the plume saturation are detectable with VSP.

The work steps involved in a time-lapse VSP survey primarily include:

- Rock physics model
- Petro-elastic model
- Fluid Substitution Feasibility study

[1] Shell Canada Limited, 2017, "Shell Quest Carbon Capture and Storage Project, Measurement, Monitoring and Verification Plan," FEBRUARY 2017 VERSION, Calgary, Alberta, Revised: May 5, 2017.

[2] V. O. Bacci, S. O'Brien, J. Frank, M. Anderson, "Using a Walk-away DAS Time-lapse VSP for CO2 Plume Monitoring at the Quest CCS Project," RECORDER, Canadian Society of Exploration Geophysics, April 2017, Vol. 42 No. 03.

- Baseline survey (data acquisition)
- Repeat/time-lapse survey (data acquisition)
- Interpretation

A detailed account of the procedures and definitions can be found in Module 3 Testing and Monitoring Plan.

4.6 Evaluation of Emergencies or Other Events

There is no USDW within the AoR. The closest well to the edge of the AoR, [redacted], is a shallow monitoring well drilled to [redacted] that was plugged and abandoned. This well is about [redacted] from the AoR. The closest active freshwater well is [redacted], a domestic well drilled to [redacted] in depth which is approximately [redacted] away from the AoR. Venture Global will assess any possibility of fluid from the injection interval moving vertically above the top confining shale zone. To assess potential for mobilized fluid, Venture Global will take water samples below and above the confining zone pre-injection in the CS004 Well 001 and CS004 in-zone Monitor Well 002, and subsequently, post start of injection, in the CS004 Groundwater Monitor Well 001 (Figure 3). Comparison of the salinity and geochemical data from these water samples pre- and post-injection will be used to assess any movement of fluid above the confining zone.

[redacted]

[redacted] legacy wells drilled previously to explore for oil and gas exist within the AoR. Assessment of the quality of well construction and plugging of these wells and corrective actions plans for these wells are discussed in the AoR and Corrective Action Plan.

Quality of zonal isolation in new well construction and plugging of new and legacy wells will be assessed using well logs (casing and cement inspection logs) and pressure testing. A detailed account of the procedures can be found in the Testing and Monitoring Plan and AoR and Corrective Active Plan.

5 Site Closure Plan

Venture Global will conduct site closure activities to meet the requirements of 40 CFR 146.93 [LAC 43:XVII:3633] as described below. Venture Global will notify the Director at least 120 days prior of its intent to close the site and submit a final Site Closure Plan. Once the Director has approved closure of the site, Venture Global will plug the monitoring wells in a manner which will not allow movement of injection or formation fluids that endangers a USDW and will submit a site closure report to the Director within ninety (90) days of site closure. The activities, as described below, represent the planned activities based on information provided to the Director. 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.

5.1 Plugging Monitoring Wells

After the Director has authorized site closure, the owner or operator must plug all monitoring wells in a manner which will not allow movement of injection or formation fluids that endangers groundwater or a USDW.

5.1.1 In Zone CS004 Monitor Well 002 Plugging Procedure

[redacted]

5.1.2 Above Zone CS004 Monitor Well 001 Plugging Procedure

[redacted]

[redacted]

[redacted]

Venture Global will conduct at least one of the tests listed in Table 5 to verify external mechanical integrity as specified in 40 CFR 146.89 [LAC 43:XVII.3627] prior to plugging the injection well as required by 40 CFR 146.92(a) [LAC 43:XVII:3631.A.2]. Equipment details and specific testing procedures are included in Module 3 Testing and Monitoring Plan.

Table 5: Planned Mechanical Integrity Tests (MITs)

Test Description	Location
Pressure Test	Casing, tubing, downhole devices such as packers/retainers/mechanical plugs/cement plugs
Tag Test	Cement plugs, 15 kips pipe weight

6 Mechanical Integrity Testing – Annulus Pressure Test and Tag Test

Demonstration of mechanical integrity of cement plugs used for isolation during plugging operations will be accomplished by successfully performing a 15 kips tag test on the cement plug with no plug movement recorded at surface, or a pressure test on the plug [> 1,000 psi, 30 minutes, < 5% decline].

7 External Mechanical Integrity Testing – Temperature Log

Once the injection well and monitoring wells are plugged and capped below the mud line, as described above and in this Post-Injection Site Care and Site Closure Plan and Module 4 Injection Well Plugging Plan, all surface equipment will be decommissioned and removed from the site. Any produced fluids, plugging waste and decommissioning waste shall be disposed of in accordance with state and federal regulations. The caisson and wellhead platform shall then be removed from the well site location.

7.1 Site Closure Report

A site closure report will be prepared and submitted within ninety (90) days following site closure, which must thereafter be retained at a location designated by the Director for ten (10) years. The report must include the following documentation:

- Appropriate plugging of the verification and geophysical wells (and the injection well if it has not previously been plugged), as per 40 CFR 146.92 [LAC 43:XVII:3631];
- Location of sealed injection well on a plat of survey that has been submitted to the local zoning authority, designated by the Director;
- Notifications to state and local authorities, as required by 40 CFR 146.93(f)(2) [LAC 43:XVII:3633.A.6.];
- Records regarding the nature, composition, and volume of the injected CO_2; and
- Post-injection monitoring records

Venture Global 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 Louisiana state agency, local authority and address of the Environmental Protection Agency Regional Office 6, 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 Director and maintained by the owner or operator for a period of ten (10) years following site closure. Additionally, the owner or operator will maintain the records collected during the post-injection period for a period of ten (10) years after which these records will be delivered to the Director. Thereafter, the records shall be retained at a location designated by the Director as per 40 CFR 146.93 [LAC 43:XVII:3633].