STRATEGIC BIOFUELS

POST INJECTION SITE CARE AND SITE CLOSURE PLAN

LAC 43:XVII §3633 & LCFS Subsection 5.2(b)(2)

STRATEGIC BIOFUELS
LOUISIANA GREEN FUELS
PORT OF COLUMBIA FACILITY

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1.0 FACILITY INFORMATION

Facility Name: Louisiana Green Fuels, Port of Columbia Facility
Three Class VI Injection Wells

Facility Contact: Bob Meredith, COO
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Well Locations: Port of Columbia,
Caldwell Parish, Louisiana

Name: Latitude / Longitude

Well 1 (W-N1): 32.18812141510 / -92.10986101060
Well 2 (W-N2): 32.18686691570 / -92.05915551900
Well 3 (W-S2): 32.1639375970 / -92.08754320370

This Post-Injection Site Care (PISC) and Site Closure plan describes the activities that Louisiana Green Fuels will perform to meet the requirements of Louisiana Statewide Order No. 29-N-6 [LAC 43:XVII §3633] and under the California Air Resources Board (CARB) Low-Carbon Fuel Standard (LCFS) (Subsection 5.2(b)(2)). To achieve this, Louisiana Green Fuels plans to implement a PISC over a 100-year timeframe, which is greater than the 50-year timeframe set forth by the state of Louisiana, to demonstrate conformance and containment of the sequestered carbon dioxide. Data will be gathered to track the position of the sequestered carbon dioxide plume and its declining pressure front, and to demonstrate that any and all Underground Source of Drinking Waters (USDWs) are not endangered, using an adaptive, sustainable, risk-based monitoring approach.

Prior to authorization for site closure, Louisiana Green Fuels will demonstrate that no additional monitoring is needed to ensure that the geologic sequestration project does not pose an endangerment to USDWs as per LAC 43:XVII §3633 (A)(2), §3633 (A)(1)(c), and CARB LCFS.

Following approval for site closure, Louisiana Green Fuels will plug any remaining project wells, complete the restoration of the site, and submit a Site Closure Report and associated documentation.

Any amendments to the PISC and Site Closure plan, if required at time of cessation of injection, will be approved by the commissioner [LAC 43:XVII §3633 (A)(1)(c)].

2.0 PRESSURE DIFFERENTIALS

Based on the modeling of the pressure front as part of the Area of Review delineation, the pressure at each injection well is expected to decrease to values approaching pre-injection levels as described below. Additional information on the projected post-injection pressure declines and differentials is presented in "*AoR and Corrective Action Plan*" submitted in Section 5.0 of Module B. The following provides a comparison of the pressure differentials between the pre-injection and predicted post-injection periods for the Injection Zones [LAC 43:XVII §3633 (A)(1)(b)(i)].

2.1 UPPER TUSCALOOSA (UPPER INTERVAL) INJECTION ZONE

The initial pressure in the Upper Tuscaloosa (Upper Interval) Primary Injection Zone is 2,169 psia at the top of perforations in the Injection Well No. 1 (W-N1), located on the plant site. The pressure increases to a maximum value of 3,081 psi at the end of the modeled 20-year injection period, for an increase of about 42% over the original pressure. This amounts to a maximum differential pressure increase of 913 psi in the Upper Tuscaloosa (Upper Interval) Injection Zone at the end of injection (over the baseline pressure at the beginning of injection). Once injection of carbon dioxide ceases, the pressure rapidly declines asymptotically back towards the original pressure.

Table 1 Pressure with time at Injection Well No. 1 (W-N1)– Upper Tuscaloosa (Upper Interval) Injection Zone

EVENT	Pressure (psia)	Incremental Pressure (psi)	Percent Above Initial
Starting Pressure (psia)	2,168.74	0	0
Pressure at End of Injection (psia)	3,081.37	912.63	42%
Pressure at the end of PC 1 (psia)	2,753.63	584.89	27%
Pressure at the end of PC 5 (psia)	2,609.37	440.63	20%
Pressure at the end of PC 10 (psia)	2,509.31	340.57	16%
Pressure at the end of PC 20 (psia)	2,399.74	231	11%
Pressure at the end of PC 50 (psia)	2,260.24	91.5	4%
Pressure at the end of PC 100 (psia)	2,185.94	17.2	1%

The incremental pressure drops by one-half within the first 5 years of post-closure and is 11 percent above the original starting pressure at 20 years post-closure. The pressure profile with time for the Upper Tuscaloosa / Paluxy Primary Injection Zone – Upper Interval in Injection Well No. 1 (W-N1) is shown in Figure 1**.**

2.2 UPPER TUSCALOOSA (LOWER INTERVAL) / PALUXY INJECTION ZONE

The initial pressure in the Upper Tuscaloosa (Lower Interval) / Paluxy Primary Injection Zone is 2,291 psia at the top of the Upper Tuscaloosa Lower Interval perforations in Injection Well No. 1 (W-N1) located on the plant site. The pressure increases to a maximum value of 3,170 psi at the end of the modeled 20-year injection period, for an increase of about 38% over the original pressure. This amounts to a maximum differential pressure increase of 879 psi in the Upper Tuscaloosa (Lower Interval) / Paluxy Primary Injection Zone at the end of injection (over the baseline pressure at the beginning of injection). Once injection of carbon dioxide ceases, the pressure rapidly declines asymptotically back towards the original pressure.

Table 2 Pressure with time at Injection Well No. 1 (W-N1)– Upper Tuscaloosa (Lower Interval) / Paluxy Injection Zone

EVENT	Pressure (psia)	Incremental Pressure (psi)	Percent Above Initial
Starting Pressure (psia)	2,291.23	0	0
Pressure at End of Injection (psia)	3,170.42	879.19	38%
Pressure at the end of PC 1 (psia)	2,901.37	610.14	27%
Pressure at the end of PC 5 (psia)	2,724.60	433.37	19%
Pressure at the end of PC 10 (psia)	2,595.72	304.49	13%
Pressure at the end of PC 20 (psia)	2,452.81	161.58	7%
Pressure at the end of PC 50 (psia)	2,312.53	21.3	1%
Pressure at the end of PC 100 (psia)	2,246.77	-44.46	-2%

The incremental pressure drops by one-half within the first 5 years of post-closure and is 7 percent above the original starting pressure at 20 years post-closure. The pressure profile with time for the Upper Tuscaloosa (Lower Interval) / Paluxy Primary Injection Zone in Injection Well No. 1 (W-N1) is shown in Figure 2**.**

3.0 PREDICTED POSITION OF PLUME AND PRESSURE AT CLOSURE

Due to pressure decay at the cessation of injection, the risk of movement of fluids out of the storage complex is greatly diminished after the final shutting in of the injection wells. This is shown by the rapid recovery in formation pressure with time as presented in Section 1.0.

Because of the density contrast between the free-phase sequestered carbon dioxide and the formation brine, the carbon dioxide will tend to migrate towards the top of each porous layer in the storage reservoir and will tend to drift in an updip direction. The following mechanisms will act to arrest this movement and immobilize the injected carbon dioxide within the storage complex:

- Dissolution of carbon dioxide into unsaturated or partially saturated formation brine.
- Trapping by capillary forces at the deep/receding edge of the plume as brine invades the pore space previously occupied by carbon dioxide (hysteresis).
- In-situ mineralization of the carbon dioxide dissolved in the formation water (expected to be an important mechanism over an extended timescale; ignored in the current model).

Based on the dynamic modeling, which conservatively considers only the dissolution of carbon dioxide into formation brine, it is determined that the plume will remain within the storage complex, and well away from any potential leak paths in the Injection Zones. Within the AoR, the only vertical pathways out of the Injection Zones would be through the Injection Wells themselves, or through a converted monitoring well. However, these wells will be thoroughly plugged and abandoned either at time of cessation of Injection Operations, at that point in time the plume reaching the monitoring wells, or the end of the PISC 100-year period. All plugging and abandonment procedures will meet LAC 43:XVII §3631 standards. The maximum sequestered carbon dioxide plume extents at the end of the 100-year post-closure period are as shown in Figure 3 [LAC 43:XVII §3633 (A)(1)(b)(ii)].

4.0 POST-INJECTION MONITORING PLAN

A key focus of the post-injection monitoring plan will be to verify that the sequestered carbon dioxide plume extent develops in accordance to model predictions [LAC 43:XVII §3633 (A)(1)(b)(iii)]. These models will have been calibrated to the collected monitoring data and updated regularly (at least every 5 years) during the active injection phase of the project. Conformance of collected data with the updated model(s) during active operations is expected to provide a good guide to future plume and pressure behaviors. Matching observed data with model response will increase the confidence in the model and enable it to be used to support a longer-term prediction of plume and pressure, hence the demonstration of expected containment of the injected carbon dioxide and non-endangerment of USDWs. To further verify the expected performance of the storage site, additional monitoring activities post-injection include:

- Well testing;
- Carbon dioxide plume and pressure front expansion tracking;
- In and above zone monitoring as close as possible to the above confining zone (focusing on in-well gauges).

An overview of these PISC monitoring activities is provided in Sections 4.1 and 4.2.

Depending on the outcome of the data evaluation, additional monitoring activities may be triggered and implemented so as to verify that there is no endangerment to USDWs (*e.g.*, the collection of fluid samples for laboratory analyses).

As with the Testing and Monitoring Plan (**Module E**), adherence to QA/QC procedures is paramount for post-injection monitoring to ensure that representative, defensible, and reliable data are collected. Please refer to the quality assurance and surveillance plan (QASP) provided in Appendix 1 to "*E.1 -Testing and Monitoring Plan*" submitted in **Module E**.

Louisiana Green Fuels plans to implement a PISC over a 100-year timeframe, consistent with CARB LCFS Subsection 5.2(b)(2), to demonstrate conformance and containment of the sequestered carbon dioxide. Louisiana Green Fuels plans to use two In-Zone monitoring wells:

- New drill well "M-1" – new 7,000 foot In-Zone monitor well drilled adjacent to and just south of Artificial Penetration No. 69 – Bradford Brown Trust Shipp 1 (SN137738), located approximately 10,152 feet north and up dip of the facility.

- Artificial Penetration No. 76 – Bass Keahey 1 (SN165305), located approximately 13,730 feet northeast and up dip of the facility.

These wells are located updip of the injection wells and will provide direct detection of carbon dioxide. Additionally, on-site Injection Well No. 1 (W-N1) will be monitored during the PISC period.

The Annona Sand will continue to be monitored in Artificial Penetration No. 129 – Magnolia Petroleum – Reynolds No. 1 (ACZ-3; SN57466), located approximately 5,948 feet southeast of on-site Injection Well No. 1 (W-N1) at the facility. The Annona Sand is an intraformational porous and permeable marine sandstone deposited at the base of the Selma Chalk approximately 700 feet above the top of the Primary Injection Zone, which is the top of the Upper Tuscaloosa Formation. The Annona Sand represents the first porous and permeable reservoir located above the Primary Upper Confining Zone, the Austin Chalk / Eagleford Equivalent (approximately 450 feet above the top of that important primary confining layer). At the Top Austin Chalk / Eagleford Equivalent structural datum, the Reynolds No. 1 (SN57466) ACZ-3 Monitor Well is approximately 260 feet high to Injection Well No. 3 (W-S2), approximately 30 feet low to Injection Well No. 1 (W-N1), and approximately 120 feet low to Injection Well No. 2 (W-N2). The Reynolds No. 1 (SN57466) ACZMI Well is also approximately 100 feet high to Artificial Penetration No. 137 – Whitetail Operators – Louisiana Green Fuels Test Well (SN975841), and like that important monitoring well, the Reynolds No. 1 (SN57466) ACZ-3 Monitor Well is strategically located between all three Injection Wells, and thus in an optimal location to continue post-closure site monitoring. The Reynolds No. 1 (SN57466) Annona Sand ACZ-3 Monitor Well will be engineered for continuous monitoring and set up for fluid sampling on a repeat basis.

4.1 PISC TIME FRAME WELL TESTING

Testing will be conducted in Injection Well No. 1 (W-N1) and the two In-Zone monitoring wells to ensure that there is no endangerment to the environment or USDWs. Additional testing will be conducted in the off-site Reynolds No. 1 (SN57466) Annona Sand ACZ-3 Monitor Well.

Louisiana Green Fuels will periodically conduct a differential temperature survey and a reservoir saturation tool in each of the five PISC wells. These tools will ensure that there is no out-of-zone movement and will also monitor for the arrival of the sequestered carbon dioxide plume in either of the two updip monitor wells. The testing will be conducted as scheduled in Table 3 (attached at end of this report) and prior to well plugging at the end of the PISC period.

4.2 CARBON DIOXIDE PLUME AND PRESSURE FRONT TRACKING

Performing direct and indirect plume and pressure front monitoring as described in the following sections during the post-injection phase will meet the requirements of LAC 43:XVII §3627 (A)(7). The results of all post-injection phase testing and monitoring will be submitted annually, within 60 days of the anniversary date on which injection ceases, as described under "*Schedule for Submitting Post-Injection Monitoring Results*," below. All wells are either located on Louisiana Green Fuels property or accessible from other property via post-injection lease agreements until site closure has been approved by the Commissioner.

Post-injection pressure monitoring will evaluate the pressure differential between the pre-injection and predicted post-injection pressures within the Upper Tuscaloosa / Paluxy Primary Injection Zone. Predicted post-injection pressures will be projected forward from the final Area of Review reassessment at the time of project closure and will then be compared to measured/observed pressure readings during the PISC time period. Pressure measurements will be continuously monitored in the following In-Zone wells:

- Injection Well No. 1 (W-N1) (located on-site at the facility)
- New drill well "M-1" – new 7,000 foot In-Zone monitor well drilled adjacent to and just south of AP No. 69 - Bradford Brown Trust Shipp 1 (SN137738) well (updip, within the AoR)

- AP No. 76 - Bass Keahey 1 (SN165305) well (updip, within the AoR)

It is expected that when, or if, the sequestered carbon dioxide plume arrives at one or both updip monitoring wells – the new drill well "M-1" – new 7,000 foot In-Zone monitor well drilled adjacent to and just south of Bradford Brown Trust Shipp 1 (SN137738) well, or the Bass Keahey 1 (SN165305) well – the carbon dioxide will rise in response to buoyancy in the intersected well(s), which will result in changes to recorded surface and downhole pressures.

Direct monitoring will also consist of periodic fluid sampling in the two updip monitor wells. This sampling may also detect an approaching carbon dioxide plume.

Indirect monitoring of the carbon dioxide plume will build upon the proposed conducting of periodic walk-away vertical seismic profiles (VSPs) as a method for tracking plume growth employed during injection operations. The walk-away VSP acquisitions will be conducted in the two updip monitor wells and will aid in monitoring the advancing carbon dioxide plume.

Louisiana Green Fuels will employ direct and indirect methods to track the extent of the advancing carbon dioxide plume and the presence or absence of elevated pressure in accordance with LAC 43:XVII §3627 (A)(7). Table 4 presents the direct and indirect methods that Louisiana Green Fuels will use to monitor the advancing carbon dioxide plume, including the activities, locations, and frequencies which will be employed.

Table 4 Post-Injection phase plume monitoring

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
DIRECT PLUME MONITORING				
Upper Tuscaloosa / Paluxy	Geochemical Fluid Sampling	Northern In-Zone Monitoring Wells	Updip of injection operations	Scheduled/Adaptive if CO_2 detected
Upper Tuscaloosa / Paluxy	Saturation Log (Pulsed-Neutron Log)	Injection Well N-W1; Northern-In Zone Monitoring Wells	Plume area and area updip of injection operations	Scheduled/Adaptive if CO_2 detected

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
INDIRECT PLUME MONITORING				
Upper Tuscaloosa / Paluxy	Walk-away VSP method designed for plume tracking, also to detect any CO_2 above interval	Northern In-Zone Monitoring Wells; Reynolds No. 1 (SN57466) Annona Sand ACZ-3 Monitor Well	Azimuthal coverage of the advancing plume	Scheduled/Adaptive if CO_2 detected

Monitoring of the carbon dioxide plume will be accomplished by acquiring saturation logs in the northern monitoring wells as scheduled in Table 3 (attached at end of report) and through walk-away VSP acquisition during the 100-year PISC timeframe.

Table 5 presents the direct and indirect methods that Louisiana Green Fuels will employ to monitor the pressure front, including the activities, locations, and frequencies for the Port of Columbia project. Pressure monitoring results will be compared to modeling and simulation forecast predictions of expected pressure decay in each utilized Injection Zone. If there are significant deviations, the modeling will be updated to match the observed pressure data post-injection.

Table 5 Post-Injection phase direct pressure-front monitoring

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
Upper Tuscaloosa / Paluxy	In-Zone Pressure and Temperature Monitoring	Injection Well (W-N1); Northern In-Zone Monitoring Wells	Plume area and up dip of injection operations	Scheduled/Adaptive if CO_2 detected

4.3 MONITORING ABOVE THE CONFINING ZONE

In addition to the In-Zone monitoring conducted in the Injection Well No. 1 (W-N1), the new drill well "M-1" – the new 7,000 foot In-Zone monitor well drilled adjacent to and just south of the Bradford Brown Trust Shipp 1 (SN137738) well – and the Bass Keahey 1 (SN165305) well, the post-injection monitoring plan includes continuation of monitoring of the Annona Sand in the Reynolds No. 1 (SN57466) ACZ-3 Monitor Well. Louisiana Green Fuels, Port of Columbia Facility will utilize the Annona Sand ACZ-3 Monitor Well to monitor the pressure and temperature of the Annona Sand, approximately 450 feet above the Primary Upper Confining Zone, the Austin

Chalk / Eagleford Equivalent. This will allow for the early detection of any out-of-zone movement of either carbon dioxide or intraformational fluids out of the sequestration complex and above the Primary Upper Confining Zone, the Austin Chalk / Eagleford Equivalent (LCFS Protocol Subsection C.4.1(a)(10)). The ACZ-3 Monitor Well will be engineered for continuous monitoring and will be set up for fluid sampling on a repetitive basis. These wells will also be used in the post-injection monitoring period to collect discrete fluid samples at a frequency shown in Table 3. This monitoring of the ACZ-3 Monitor Well will ensure that any vertical pressure changes above the Primary Upper Confining Zone, the Austin Chalk / Eagleford Equivalent, remains monitored, as well as to confirm there is no unexpected pressure, injectate, or fluid breach out of the Sequestration Complex. Table 6 below presents the monitoring methods, locations, and frequencies for monitoring above the Primary and Secondary Upper Confining Zones. Table 7 provides the listing of analytical parameters to be tested.

Table 6 ACZMI Monitoring above the Primary and Secondary Upper Confining Zones

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
Annona Sand	Downhole pressure monitoring	Reynolds Annona Sand ACZ-3 Well	Over area of review	Real time daily read out
Annona Sand	Pulsed Neutron Logging	Reynolds Annona Sand ACZ-3 Well	Over area of review	Table 4
	Pulsed Neutron Logging	Reynolds Annona Sand ACZ-3 Well	Over Area of Review	Table 3
Annona Sand	Fluid Sampling	Reynolds Annona Sand ACZ-3 Well	Area of highest pressure buildup	Table 3

Table 7 Summary of analytical and field parameters for Annona Sand Fluid Samples (Annona Sand ACZ-3 Monitor Wells)

Parameters	Analytical Methods
Dissolved CO_2 gas by headspace	Gas Chromatography (GC)
Dissolved CH_4 gas by headspace	Gas Chromatography (GC)
Hydrocarbons	Gas Chromatography (GC)
Dissolved inorganic carbon	Combustion
Bicarbonate	Titration

Parameters	Analytical Methods
δD CH_{24}	Gas chromatography combustion isotope ratio mass spectrometry (GC/C/IRMS)
δC^{13} CO_2	Gas chromatography combustion isotope ratio mass spectrometry (GC/C/IRMS)
δC^{13} CH_4	Gas chromatography combustion isotope ratio mass spectrometry (GC/C/IRMS)
C^{14} CO_2	Accelerated mass spectrometry (AMS).
C^{14} Methane	Accelerated mass spectrometry (AMS).
Isotopic composition of selected major or minor constituents (*e.g.*, Sr $^{87/86,}$ S)	Multicollector-Inductively Coupled Plasma Mass Spectrometer (MC-ICPMS)
Cations: Al, As, B, Ba, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Pb, Sb, Se, Si, Ti, Zn,	ICP-MS or ICP-OES, ASTM D5673, EPA 200.8 Ion Chromatography, EPA Method 200.8, ASTM 6919
Anions: Br, Cl, F, NO_3, SO_4,	Ion Chromatography, EPA Method 300.8, ASTM 4327
Total Dissolved Solids	EPA 160.1, ASTMN D5907-10
Alkalinity	EPA 310.1
pH (field)	EPA Method 150.1
Specific Conductance (field)	EPA 120.1, ASTM 1125
Temperature (field)	Thermocouple
Hardness	ASTM D1126
Turbidity	EPA 180.1
Specific Gravity	Modified ASTM 4052
Density	Modified ASTM 4052

4.4 USDW MONITORING – PUBLIC WATER SUPPLY WELLS

Public drinking water supply in the area is supplied by the East Columbia Water District. The Louisiana Department of Health routinely monitors for contaminants in the drinking water supply in accordance with Federal and State laws. The Louisiana Green Fuels Port of Columbia Facility will coordinate its monitoring of the public drinking water supply with the East Columbia Water District (ECWD), located in Riverton, Louisiana (approximately 1 mile south of the Facility location). The Louisiana Green Fuels Port of Columbia Facility will secure split samples from two municipal drinking water supply wells when they are routinely sampled by the East Columbia Water District. These samples will be used for geochemical testing and monitored for any indicated long-term changes in the measured parameters.

Table 8 shows the planned monitoring methods, locations, and frequencies for ground water quality and geochemical monitoring of the MRVA.

Table 8: Monitoring of groundwater quality and geochemical parameters in Public Water Supply Wells

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
MRVA	Geochemical sampling	Municipal Wells in Riverton area	Over area of review	Quarterly first year, annual thereafter

For Post-Closure sampling, the frequency of sampling will continue to be performed on a quarterly basis for the first year after closure. Then from second year on, the samples will be collected and tested on an annual basis, within 45 days of the prior sample anniversary, for a determined post-site care closure timeframe.

4.4.1 Analytical Procedures

Table 9 identifies the parameters to be monitored and the analytical methods the Louisiana Green Fuels, Port of Columbia Facility will use for samples from Public Water Supply wells.

Table 9: Summary of analytical and field parameters for ground water samples – Public Water Supply Wells

Parameters	Analytical Methods
MRVA	
Total Dissolved Solids	EPA 160.1, ASTMN D5907-10
Alkalinity	EPA 310.1
pH (field)	EPA Method 150.1
Specific Conductance (field)	EPA 120.1, ASTM 1125
Temperature (field)	Thermocouple
Hardness	ASTM D1126
Turbidity	EPA 180.1
Specific Gravity	Modified ASTM 4052
Density	Modified ASTM 4052

Sample containers will be new and of an appropriate material and size for the analyte. Sufficient volumes will be collected to complete all the specified analyses in Table 9. The appropriate preservation of each sample container will be completed upon sample collection.

4.4.2 Sampling Methods

The sampling system used to sample and quantify the freshwater constituents will consist of split samples obtained from the East Columbia Water District following their standard sampling methodology. Samples will be filtered and preserved using standard techniques and protocols for freshwater sampling. All sample containers will be labeled with durable labels and indelible markings. A unique sample identification number and sampling date will be recorded on the sample containers. The sample container will be sealed and sent to an authorized third-party laboratory.

4.5 SCHEDULE FOR SUBMITTING POST-INJECTION MONITORING RESULTS

All post-injection site care monitoring data and monitoring results collected using the methods described above will be submitted to the regulatory governing entity (LDENR IMD) in reports submitted annually, within 60 days following the anniversary date on which injection operations cease. The reports will contain information and data generated during the reporting period, *e.g.* well-based monitoring data, sample analysis, and the results from updated site models.

At any time during the life of the injection project, if a change to the post-injection site care plan is deemed necessary, a request will be submitted to the Commissioner at least 30 days prior to making the change [LAC 43:XVII §3633 (A)(1)(d)].

5.0 ALTERNATIVE PISC TIMEFRAME

Louisiana Green Fuels is requesting a 100-year post-injection time frame consistent with LCFS Subsection 5.2(b)(2). This timeframe exceeds the 50-year period required under LAC 43:XVII Chapter 36.

6.0 USDW NON-ENDANGERMENT DEMONSTRATION CRITERIA

Prior to approval of the end of the post-injection phase, Louisiana Green Fuels will submit a demonstration of the non-endangerment of USDWs to the Commissioner, per LAC 43:XVII §3633 (A)(2).

A report will be issued to the Commissioner demonstrating USDW non-endangerment based on the evaluation of the post-injection site monitoring data used in conjunction with the project's computational model.

6.1 INTRODUCTION AND OVERVIEW

A summary of relevant background information will be provided, including the operational history of the sequestration 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.

6.2 SUMMARY OF EXISTING MONITORING DATA

A summary of all previous monitoring data collected at the site, pursuant to the "*E.1-Testing and Monitoring Plan*" (Submitted in **Module E** – Project Plan Submissions) 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 Commissioner, 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 pre-injection data collected during site characterization (consideration will also be given to potential factors that might lead to changes compared to pre-injection data and are not related to the proposed carbon dioxide injection project).

6.3 SUMMARY OF COMPUTATIONAL MODELING HISTORY

The computational model predictions submitted in **Module B** are intended to present a most-likely case estimate of pressure build-up and plume extent over the active sequestration phase and the post-closure phase of the project. The data used in the model is derived from regional data and from wells in proximity to the project site and from the Louisiana Green Fuels Stratigraphic Test Well (SN975841). Once information is obtained from site injection and repurposed monitoring wells, the computational model will be updated prior to startup of active injection. Subsequent model iterations will be adjusted to history match based on site-specific data obtained during the life of the project.

6.4 EVALUATION OF RESERVOIR PRESSURE

The current model assumes an initial reservoir pressure for the Primary Injection Zone based upon site-specific pore pressures already measured in the Louisiana Green Fuels Stratigraphic Test Well (SN975841). Initial static pressures will be confirmed in each injection well and in each re-entered monitoring well for the Louisiana Green Fuels site. The original static pressures will be collected in all proposed Injection Zone reservoirs or injection zones comprised of commingled reservoirs. The pre-injection pressures will be used as a comparison during injection and post-closure operations.

Continuous reservoir pressures will be collected during facility operations in each injection well. The measured incremental pressure buildups will be evaluated against the initial static pressures in the injection zone and compared to the computational modeling results. The monitored reservoir pressure data will be used to update and re-evaluate the model on at least a 5-year frequency to provide an operational model and a new projected modeled pressure for a future time-series and post-closure period.

6.5 EVALUATION OF CARBON DIOXIDE PLUME

The location and rate of movement of the carbon dioxide plume will be indirectly monitored using geophysical methods (repeat walk-away VSP acquisitions). The surveys will be conducted from the new In-Zone Monitor Well (M-1) to be drilled adjacent to the Bradford Brown Trust Shipp 1 (SN137738), the Bass Keahey 1 (SN165305) In-Zone Monitor Well, and the Magnolia Reynolds

No. 1 (SN57466) ACZ-3 Monitor Well. The anticipated schedule of each survey is specified in Table 3 but may become adaptive if the scheduled surveys show departure from anticipated results. Additional surveys may be triggered in response to anomalous monitoring data (*e.g.*, anomalous pressures, larger than anticipated plume dimensions, samples from ACZMI or IZ monitor wells). Note that both the new In-Zone Monitor Well (M-1) to be drilled adjacent to the Bradford Brown Trust Shipp 1 (SN137738) and the Bass Keahey 1 (SN165305) monitor wells will provide direct In-Zone monitoring of the advancing carbon dioxide plumes assuming the carbon dioxide has not reached one or both wells during the active injection period.

The scheduled surveys are sufficient to demonstrate the rate of buoyant plume movement throughout the PISC period (or document plume stabilization). The surveys will also confirm isolation and permanent retention of the plume within the sequestration complex. Gathered monitoring data will be used to adjust the dynamic model and reduce predictive uncertainty. The adjusted model will be used to update predictions of the repositioning of the pressure front due to declining pressure and prediction of carbon dioxide plume extent. The models will be used to characterize and demonstrate non-endangerment to all USDWs, demonstrate that pressure has declined in each injection zone such that there is insufficient driving force to displace fluids out of the sequestration complex, and that the sequestered carbon dioxide plume has either stopped moving or slowed to a rate at which it will not reach any potential leak pathway out of the sequestration complex.

6.6 EVALUATION OF EMERGENCIES OR OTHER EVENTS

Louisiana Green Fuels has developed a plan to evaluate emergencies related to the Port of Columbia facility site as detailed in "*E.4 – Emergency and Remedial Response Plan*" submitted in **Module E**. This plan accounts for potential emergencies and events at three phases of the project: 1) during the construction of the injection wells, 2) during the operation of the injection wells, 3) during the site closure and post closure monitoring of the site.

The plan includes, but is not limited to, adaptive (triggered) sampling analysis of USDWs and other groundwater systems within the Area of Review.

6.7 NEAREST POTENTIAL CONDUITS

Each of the 12 artificial (active/abandoned) penetrations (that penetrate the entire Upper Confining Zone, the Austin Chalk Equivalent / Upper Eagleford) located within either the modeled pressure front at the end of active operations or within the sequestered carbon dioxide plume area have been evaluated as to the adequacy of construction and plugging and to determine the potential or risk that the penetration could convey fluid from an injection zone into the overlying USDWs (non-endangerment) and the potential of the penetration to convey sequestered carbon dioxide out of the storage complex.

The artificial penetrations of the Primary Upper Confining Zone and the Primary Injection Zone within the delineated Area of Review have been evaluated per the protocol outlined in the "*Area of Review and Corrective Action Plan*" in Section 7.0, submitted in **Module B.** Additionally, Louisiana Green Fuels has identified additional possible geological mechanisms (*i.e.*, shale creep, clay swelling) that would further impede potential fluid movement out of the sequestration complex under the predicted pressure increases and plume extents the injection zones. Based on this evaluation, it has been demonstrated that all of the artificial penetrations in the Area of Review over the PISC timeframe will not act as conduits, and therefore, do not pose a threat for migration of the authorized zones.

The model during the PISC timeframe will be regularly updated and adjusted to match the acquired monitoring data (minimum every 5 years). The artificial penetration risk assessment and required corrective measures will likewise be updated in line with each adjustment to the modeled pressure and plume predictions.

7.0 SITE CLOSURE PLAN

Louisiana Green Fuels will conduct site closure activities to meet the requirements of LAC 43:XVII §3633 (A)(4) and CARB LCFS Section 5, as described below. Louisiana Green Fuels will submit a final Site Closure Plan and notify the Commissioner at least 120 days prior to the intent to close the site. Once the Commissioner has approved closure of the site, Louisiana Green Fuels will plug all the remaining wells and submit a site closure report. The activities, as described below, represent the planned activities based on information provided to LDNR and CARB. The

actual site closure plan may employ different methods and procedures. A final Site Closure Plan will be submitted to the Commissioner within 90 days of closure [LAC 43:XVII §3633 (A)(6)].

7.1 PLUGGING PISC MONITORING WELLS

Prior to the plugging and abandonment of the PISC monitoring wells, a final bottomhole pressure will be obtained using either the downhole pressure monitoring device(s), or if the downhole pressure device is not available (damaged), then a slickline or wireline pressure gauge will be run in the hole to measure the final bottomhole pressure.

For Injection Well No. 1 (W-N1), an examination of internal and external well integrity using appropriate tools will be carried out prior to well plugging. Cased hole logging will evaluate the cement quality using a cement bond log and include an examination of casing integrity using an electromagnetic casing thickness log with multi-finger caliper. External mechanical integrity will be demonstrated using either a radioactive tracer log or a temperature log. The casing will then be pressure tested to confirm the absence of any significant leaks.

Plugging and Abandonment of Injection Well No. 1 (W-N1) is contained in "*E.2 – Injection Plugging Plan*" submitted in **Module E** to meet closure requirements for Class VI Injection Wells under LAC 43:XVIII §3631.

The following plugging procedures are set forth for the two In-Zone monitoring wells:

- The new In-Zone Monitor Well to be drilled adjacent to the Artificial Penetration No. 69 – Bradford Brown Trust Shipp 1 (SN137738).
- Artificial Penetration No. 76 – Bass Keahey 1 (SN165305)

7.1.1 Plugging Procedures – In-Zone Monitoring Wells

The two monitor wells will generally be plugged as follows:

1. Notify the Commissioner at least 120 days before plugging each well and provide updated plugging plan.
2. Final bottom hole reservoir pressure will be obtained in each well prior to well plugging.

3. Differential temperature survey and reservoir saturation survey will be run and compared with the baseline and subsequent logs obtained during injection and post-injection periods to demonstrate external mechanical integrity. A remedial operations plan will be prepared if any out-of-zone movement is indicated.
4. Well will be flushed or circulated with brine to displace all well fluids. Normally the well is flushed/circulated by pumping 2 or more well volumes. Pump pressures will be at a pressure below 80% of fracture pressure.
5. Pull out / remove tubing, packer, and any downhole equipment from the well.
6. Run and set a permanent cement retainer above the perforations and squeeze acid resistant cement into the perforations, placing a minimum of 10 feet of acid-resistant cement on top of the retainer. An alternate option is to section mill the casing out at the top of the Upper Tuscaloosa / Paluxy Primary Injection Zone and place an acid-resistant cement "cap" at the base Upper Eagleford / top Upper Tuscaloosa interface.
7. Run in hole to tag and verify the top of the plug.
8. Displace the wellbore with fluid of a minimum density of 9.5 ppg mud.
9. Pull up hole to the top of the base Upper Eagleford / top Upper Tuscaloosa interface and rig up cementing equipment. Pump a 200-foot standard cement (Class A or G) plug mixed at a minimum density of 15.6 pounds per gallon (lb./gal.).
10. After allowing enough time for the cement to harden, locate the top of the cement plug and pressure test the cement plug to 1,500 psi to verify its competency.
11. Pull up to the base of the lowermost USDW and rig up cementing equipment. Pump a 200-foot standard cement (Class A or G) plug mixed at a minimum density of 15.6 pounds per gallon (lb./gal) at the base of the lowermost USDW.
12. After allowing enough time for the cement to harden, locate the top of the cement plug and pressure test the cement plug to 1,500 psi to verify its competency.
13. Remove wellhead, cut the casing three feet below the ground surface, place a 25 to 50-foot cement plug, and weld steel plate on top.
14. In accordance with the requirements of LAC 43:XVII §3633 (A)(6), within 90 days of plugging and closure, a plugging report will be submitted to the Commissioner. This report will be certified as accurate by the owner or operator, and by the person who has performed the plugging operations. The owner / operator will retain the well plugging

report for 10 years following the site closure.

7.1.2 Plugging Procedures – Above-Confining-Zone Monitoring Wells

The following plugging procedures are set forth for the Above-Confining-Zone (ACZMI) monitoring well, Artificial Penetration No. 129 – Magnolia Reynolds No. 1 (SN57466) (ACZ-3).

The Reynolds No. 1 (SN57466) (ACZ-3) Monitor Well shall generally be plugged as follows:

1. Notify the Commissioner at least 120 days before plugging each well and provide updated plugging plan.
2. Final bottom hole reservoir pressure will be obtained in each well prior to well plugging.
3. Differential temperature survey and reservoir saturation survey will be run and compared with the baseline and subsequent logs obtained during injection and post-injection periods to demonstrate external mechanical integrity. A remedial operations plan will be prepared if any out-of-zone movement is indicated.
4. Well will be flushed or circulated with brine to displace all well fluids. Normally the well is flushed/circulated by pumping 2 or more well volumes. Pump pressures will be at a pressure below 80% of fracture pressure.
5. Pull out / remove tubing, packer, and any downhole equipment from the well.
6. Run and set a permanent cement retainer above the perforations and squeeze acid resistant cement into the perforations, placing a minimum of 10 feet of acid resistant cement on top of the retainer. For the Magnolia Reynolds No. 1 (SN57466) Annona Sand ACZ-3 Well, an alternate option is to section mill the casing out at the top of the Annona Sand monitoring reservoir and place an acid resistant cement “cap” at the base Midway Shale / top Selma Chalk interface.
7. Run in hole to tag and verify the top of the plug.
8. Displace the wellbore with fluid of a minimum density of 9.5 ppg mud.
9. For the Magnolia Reynolds No. 1 (SN57466) Annona Sand ACZ-3 Well, pull up hole to the top of the base Midway Shale / top Selma Chalk interface and rig up cementing equipment. Pump a 200-foot standard cement (Class A or G) plug mixed at a minimum density of 15.6 pounds per gallon (lb./gal.).
10. After allowing enough time for the cement to harden, locate the top of the cement plug and

pressure test the cement plug to 1,500 psi to verify its competency.

11. Pull up to the base of the lowermost USDW and rig up cementing equipment. Pump a 200-foot standard cement (Class A or G) plug mixed at a minimum density of 15.6 pounds per gallon (lb./gal) at the base of the lowermost USDW.
12. After allowing enough time for the cement to harden, locate the top of the cement plug and pressure test the cement plug to 1,500 psi to verify its competency.
13. Remove wellhead, cut the casing three feet below the ground surface, place a 25 to 50-foot cement plug, and weld steel plate on top.
14. In accordance with the requirements of LAC 43:XVII §3633 (A)(6), within 90 days of plugging and closure, a plugging report will be submitted to the Commissioner. This report will be certified as accurate by the owner or operator, and by the person who has performed the plugging operations. The owner / operator will retain the well plugging report for 10 years following the site closure.

7.1.3 Site Restoration

After the plugging of the monitoring wells, the wellheads and all surface equipment will be decommissioned and removed from the sites. The wellsite pads will be cleaned, and the access roads will be left in place.

7.2 SITE CLOSURE REPORT

A site closure report will be prepared and submitted within 90 days [LAC 43:XVII §3633 (A)(6)] following site closure, documenting the following:

- Plugging of the monitoring / geophysical wells (and any injection well if it has not previously been plugged) [LAC 43:XVII §3633 (A)(6)(a)],
- Locations of the plugged monitoring / geophysical and injection wells on a survey plat that has been submitted to the local zoning authority [LAC 43:XVII §3633 (A)(6)(a)],
- Notifications to state and local authorities as required at LAC 43:XVII §3633 (A)(6)(b),

- Records regarding the nature, composition, and volume of the injected carbon dioxide [LAC 43:XVII §3633 (A)(6)(c)], and
- Post-injection monitoring records.

Louisiana Green Fuels will record a notation to the property's deed per LAC 43:XVII §3633 (A)(7) on which each injection and/or monitoring 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 survey plat with the injection / monitoring well location was submitted;
- The volume of fluid injected;
- The formation(s) 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 approved by the Commissioner. 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 Commissioner [LAC 43:XVII §3633 (A)(8)].

Oversized Table 3

Figures