TESTING AND MONITORING PLAN
40 CFR 146.90

Brown 4 Geologic Sequestration Project

Facility Information

Facility name:	Brown 4 Geologic Sequestration Project Lambda-Brown 4-1 & Lambda-Brown 4-2
Facility contact:	Claimed as PBI [redacted] Claimed as PBI [redacted]
Well location:	Lambda-Brown 4-1: Brown, Manistee County, Michigan 44.3361397, -86.1393888, NAD 27 Lambda-Brown 4-2: Brown, Manistee County, Michigan 44.3418411, -86.1342111, NAD 27

This Testing and Monitoring Plan describes how Lambda will monitor the Brown 4 Geologic Sequestration Project (GSP) site pursuant to 40 CFR 146.90. The Brown 4 GSP will utilize two injection wells to achieve the proposed injection rate. The monitoring data will be used to demonstrate that the wells are operating as planned, that the CO_2 plume and pressure front are moving as predicted, and that there is no endangerment to USDWs. Additionally, the monitoring data will be used to validate and adjust the geological models used to predict the distribution of the CO_2 within the storage zone, to support potential AoR reevaluations, and assessing a non-endangerment demonstration.

Results of the testing and monitoring activities described below may trigger action according to the Emergency and Remedial Response Plan.

Overall Strategy and Approach for Testing and Monitoring

Lambda intends to implement a testing program that will detect CO_2 leaks from within the Brown 4 GSP. To assess and mitigate any potential risks to the reservoir containment integrity, Lambda intends to use a combination of the following technologies:

1. Utilize downhole gauges to monitor the pressure and temperature.
2. Sample monitoring wells for groundwater chemistry at consistent intervals.
3. Complete a baseline vegetation survey and repeat annually.
4. Install a corrosion loop built from wellbore materials and test on a quarterly basis.

Quality Assurance Procedures

A quality assurance and surveillance plan (QASP) for all testing and monitoring activities, required pursuant to 146.90(k), is provided in the Appendix to this Testing and Monitoring Plan.

Reporting Procedures

Lambda will report the results of all testing and monitoring activities to EPA in compliance with the requirements under 40 CFR 146.91.

CO_2 Stream Analysis [40 CFR 146.90(a)]

Lambda will analyze the CO_2 stream during the operation period to obtain data representative of its chemical and physical characteristics, as required in 40 CFR 146.90(a). Samples will be collected and analyzed quarterly, beginning three months after the date of authorization of injection.

Lambda plans to adapt existing oil and gas infrastructure to facilitate the storage of high purity CO_2 captured from various carbon intensive operations, including ethanol plants, cement plants and natural gas processing plants. Notification will be sent to the EPA prior to switching or adding CO_2 sources, allowing for the reassessment of sampling procedures can at that time.

Sampling Location and Frequency

Samples will be collected and analyzed from the offload point prior to injection and on a quarterly basis. Lambda will increase the frequency and collect additional samples if significant changes occur, such as:

1. Material changes in CO_2 composition
2. Changes in CO_2 source
3. Facility or injector downtime of greater than thirty days

Analytical Parameters

Lambda will analyze the CO_2 for the constituents identified in Table 1 using the methods listed. An equivalent method may be employed with the prior approval of the UIC Program Director.

Table 1. Summary of analytical parameters for CO_2 stream.

Parameter	Analytical Method(s)
Oxygen, Argon, and Hydrogen	ISBT 4.0 [GC/DID]
Nitrogen	ISBT 4.0 [GC/DID]
Carbon Monoxide	ISBT 5.0 [GC/DID]
Total Hydrocarbons	ISBT 10.0
Methane	ISBT 10.1 [GC]
CO_2 Purity	ISBT 2.0/SAM 2.0 – Caustic absorption Zahm-Nagel
Total Sulfur Content	ISBT 14.0
Ammonia	ISBT 6.0 [DT]
Oxides of Nitrogen	ISBT 7.0 [DT]
Hydrogen Sulfide and Sulfur Dioxide	ISBT 14.0 [GC]
Water Vapor	ISBT 3.0 [FTIR]

Sampling Methods

Stream sampling will occur for each required CO_2 analysis before being sent to the injector. A sampling station will be installed to facilitate collection of samples into a container. Sample containers will include a chain of custody form and will be labeled appropriately.

Laboratory for CO_2 Analysis

Samples will be sent to and analyzed by Airborne Labs International, Inc, a well-recognized, independent, commercial laboratory located in Somerset, New Jersey. The laboratory possesses the necessary equipment, experience, and certifications to complete the analysis. The detection limit and precision can be found in the QASP. The chain of custody documentation will be completed in full.

For each required CO_2 analysis, Lambda will report the time each sample was taken, a tabulation of all CO_2 stream analyses (including any quality assurance/quality control samples), an interpretation of the results, any identified changes, and explanations of any data gaps. If at any time this monitoring reveals a substantive change from the expected CO_2 stream, Lambda will investigate to determine the root cause of the CO_2 quality deviation.

Continuous Recording of Operational Parameters [40 CFR 146.88(e)(1), 146.89(b) and 146.90(b)]

Lambda will install and use continuous recording devices to monitor injection pressure, rate, and volume; the pressure on the annulus between the tubing and the production casing; the annulus fluid volume added; and the temperature of the CO_2 stream, as required at 40 CFR 146.88(e)(1), 146.89(b), and 146.90(b).

Monitoring Location and Frequency

Lambda will perform the activities identified in Table 2 to monitor operational parameters and verify internal mechanical integrity of the injection wells. All monitoring will take place at the locations and frequencies shown in the table.

Table 2. Sampling devices, locations, and frequencies for continuous monitoring.

Parameter	Device(s)	Location	Min. Sampling Frequency	Min. Recording Frequency
Injection pressure	Pressure Gauges	Surface & DH	10 seconds	5 minutes
Injection rate	Flow Meters	Surface (near WH)	10 seconds	5 minutes
Injection volume	Flow Meters	Surface (near WH)	10 seconds	5 minutes
Annular pressure	Pressure Gauges	Surface (on WH)	10 seconds	5 minutes
Annulus fluid volume	-	Surface (on WH)	As modified	As modified
CO_2 stream temperature	Temperature Gauge	Surface (near WH)	10 seconds	5 minutes

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.*

Monitoring Details

Injection pressure, temperature, and flow rate will be continuously monitored and recorded. Since all casing strings will be cemented to surface, constant pressure monitoring is the most direct method to detect CO_2 migration. Injection pressure will be measured and recorded using both surface and downhole pressure gauges. Injectate temperature will be measured with a temperature gauge at the surface. Injection rate will be measured with a Coriolis flowmeter. Injection rate and pressure limitations will be implemented to ensure adherence to the maximum proposed bottomhole injection pressure of 2,428 psig. All pressure and temperature gauges will be calibrated annually. The operating range and precision specifications are included in the QASP.

Corrosion Monitoring

To meet the requirements of 40 CFR 146.90(c), Lambda will monitor well materials during the operation period for loss of mass, thickness, cracking, pitting, and other signs of corrosion to ensure that the well components meet the minimum standards for material strength and performance. Lambda will monitor corrosion using a corrosion loop and collect samples according to the description below.

Monitoring Location and Frequency

Lambda will flow the CO_2 stream through a loop constructed with materials used in the well and inspect and test the materials on a quarterly basis.

Sample Description

The general construction materials for the pipeline, casing, tubing, wellhead, and packer are detailed in Table 3. Material selection will be verified post well and pipeline construction and prior to injection.

Table 3. List of equipment with material of construction.

Equipment	Material of Construction
Pipeline	Carbon Steel
Long String Casing (To set point minus 300 ft)	Carbon Steel
Long String Casing (Bottom 300 ft)	Chrome Alloy
Injection Tubing	Chrome Alloy
Wellhead	Chrome Alloy
Packer	Chrome Alloy

Monitoring Details

The proposed CO_2 stream is expected to be dry and extremely pure CO_2 ([redacted]), and therefore non-corrosive. However, Lambda will use corrosion resistant materials as an extra precaution. Samples of the materials utilized in constructing the pipeline, injection wells, and monitoring wells that come into direct contact with CO_2 injectate will undergo corrosion monitoring. Lambda will flow the CO_2 stream through a loop constructed with the materials used in the well and inspect and test the materials on a quarterly basis. Corrosion loops representing the materials listed in Table 3 will be weighed, measured, and photographed before installation and positioned upstream of the wellhead.

Sample Handling and Monitoring

The loops will be handled and assessed for corrosion in accordance with the American Society for Testing and Materials (ASTM) G1-03, Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens (ASTM 2011) and/or the NACE Standard RP0775 (NACE 2005), Preparation, Installation, Analysis and Interpretation of Corrosion Coupons in Oilfield Operations. Monitoring results will be documented and submitted to the EPA as per 40 CFR 146.91(a)(7). Lambda will continually update the corrosion monitoring plan as data is acquired.

Above-Confining-Zone Monitoring

Lambda will monitor groundwater quality and geochemical changes above the confining zone throughout the life of the project to meet the requirements of 40 CFR 146.90(d). Lambda will convert the existing Viol 1-4 and 3-4 wells into deep monitoring wells and drill two shallow monitoring wells in the USDW. These wells will monitor changes in the water quality and CO_2 concentration in strata above the confining zone.

Above-confining-zone water sampling analysis will provide assurance that CO_2 levels have not increased from the baseline data to ensure no alterations in the sealing ability of the reservoir cap and the integrity of well cement against vertical fluid flow.

Bass Island Formation Monitoring

The BILD is the first permeable layer above the confining zone and is laterally continuous across the AoR. This zone will be monitored continuously for pressure and temperature changes and also sampled quarterly for fluid changes. Leakage to the BILD would increase the reservoir pressure and change the composition of the formation water, resulting in increased CO_2 concentration. The BILD will be monitored between 3,010' – 3,025' MD in the deep monitoring wells, Viol 1-4 and Viol 3-4. A baseline water chemistry composition will be established during pre-operational testing. Subsequent results will be compared against these baseline results for significant changes or anomalies. The pH will also be monitored as a key indicator of CO_2 presence. If water samples show excessively higher CO_2 levels than baseline, all wells in the storage complex will be immediately shut in for surface and downhole investigative measurement to determine corrective action.

USDW (i.e. Glacial Drift) Monitoring

The local USDW is located in the Glacial Drift formation. This zone will be sampled quarterly for fluid changes. Leakage into the USDW would change the composition of the groundwater. The Glacial Drift will be monitored in two shallow monitoring wells to be drilled by Lambda. A baseline water chemistry composition will be established during pre-operational testing. Subsequent results will be compared against these baseline results for significant changes or anomalies. The pH will also be monitored as a key indicator of CO_2 presence. If water samples show excessively higher CO_2 levels than baseline, all wells in the storage complex will be immediately shut in for surface and downhole investigative measurement to determine corrective action.

Additional groundwater monitoring wells will be drilled to assess and monitor the USDW if the following occurs: BILD or Glacial Drift pressure or composition changes as a result of CO_2 injection.

Monitoring Location and Frequency

Table 4 shows the planned monitoring methods, locations, and frequencies for monitoring above the confining zone. Figure 1 shows the locations of the existing and proposed monitoring wells within the AoR.

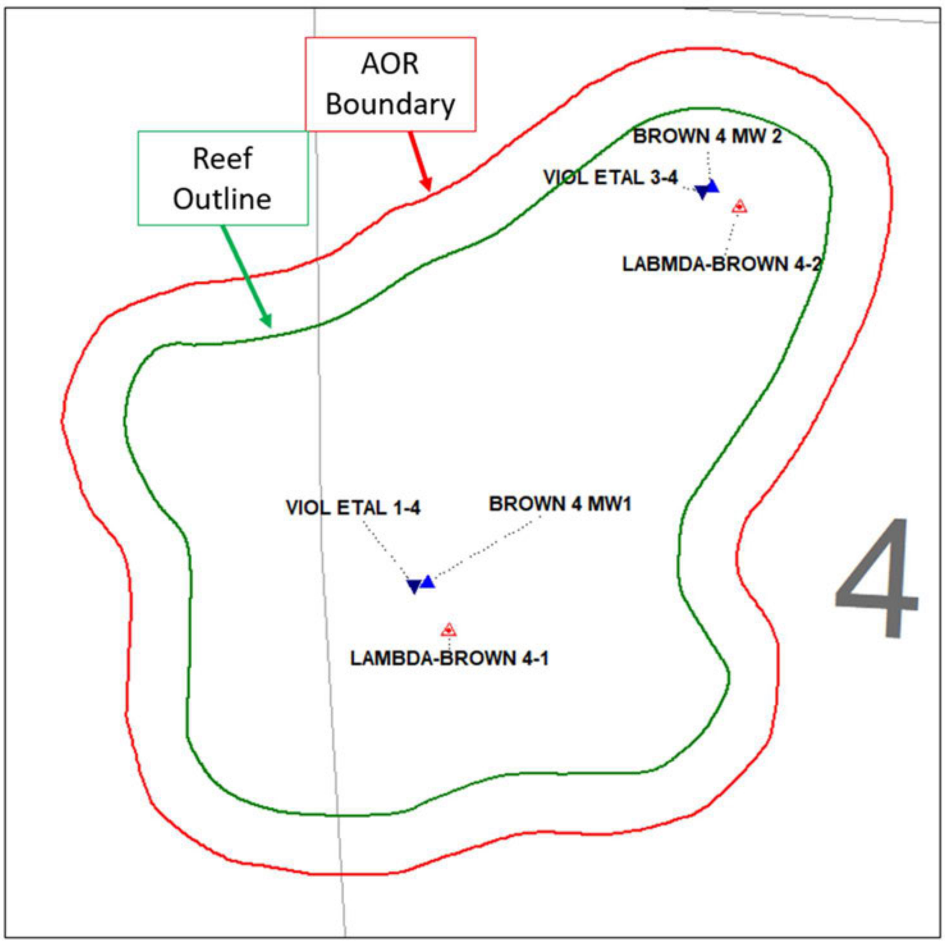

Figure 1: Map showing the location of the injection wells, Viol 1-4 and Viol 3-4 monitoring wells, and USDW monitoring wells.

Table 4. Monitoring of groundwater quality and geochemical changes above the confining zone.

Target Formation	Monitoring Activity	Monitoring Location(s)	Device	Spatial Coverage or Depth	Frequency
Glacial Drift (USDW)	Fluid Sampling	Shallow Water Monitoring Wells	Pump	Expected depth <250’ MD/TVD	Quarterly
BILD	Fluid Sampling	Viol 1-4 & Viol 3-4	Swab	3,010’ – 3,025’ MD/TVD	Quarterly
	External MIT	Viol 1-4 & Viol 3-4	Temperature Log or Noise Log	3,010’ – 3,025’ MD/TVD	Annual
	Pressure	Viol 1-4 & Viol 3-4	Pressure Gauge	3,010’ – 3,025’ MD/TVD	Continuous
	Temperature	Viol 1-4 & Viol 3-4	Temperature Sensor	3,010’ – 3,025’ MD/TVD	Continuous

Analytical Parameters

Table 5 identifies the parameters to be monitored and the analytical methods Lambda will use. Detection limits and precision are shown in the QASP.

Table 5. Summary of analytical and field parameters for groundwater samples.

Parameters	Analytical Methods
Glacial Drift (USDW)	
Cations: Metals	ICP EPA Method 6010
Anions: Chloride	Standard Method 4500E
Specific Conductivity (μS/cm)	ASTM Std Method 2510
pH (S.U.)	ASTM Std Method 4500
Temperature	Field Test
Dissolved Carbon Dioxide	EPA Method RSK 175
Water Density	ASTM Method D5057
Total Dissolved Solids (TDS) –	ASTM Method 2540
Bass Island Dolomite Formation	
Cations: Metals	ICP EPA Method 6010
Anions: Chloride	Standard Method 4500E

Parameters	Analytical Methods
Specific Conductivity (µS/cm)	ASTM Std Method 2510
pH (S.U.)	ASTM Std Method 4500
Temperature	Field Test
Dissolved Carbon Dioxide	EPA Method RSK 175
Water Density	ASTM Method D5057
Total Dissolved Solids (TDS) –	ASTM Method 2540

Sampling Methods

<u>Deep Viol 1-4 and Viol 3-4 wells:</u>

Sample collection procedures:

1. Hold on-site Job Safety Analysis/Safety Meetings with Lambda and service company personnel daily and before each change in operation.
2. Prior to moving in the equipment, check the area around the well head and take the necessary steps to provide a safe working area.
3. Move in and rig up the pulling unit.
4. Inspect the sand line and dress the rig for swabbing.
5. Make up the undersized cups and run in the hole to seat nipple through the swab valve.
6. Swab the fluid samples to the surface for collection and testing.
7. Secure the sand line and clean the site.
8. Rig down the pulling unit and return to operations.

<u>Shallow USDW monitor wells:</u>

Materials: A Peristaltic or bladder pump with inert/dedicated polyethylene or Teflon tubing.

If a pump cannot be used because the recovery rate is inadequate and the volume of the water removed is minimal (less than 5 feet of water), then a Teflon® bailer, equipped with a double check valve and bottom-emptying device with a control-flow check valve, will be used to obtain the samples. The polypropylene rope used with the bailer will be disposed of following the completion of sampling at each well. The sample collection procedures are as follows:

1. All equipment used will either be new or decontaminated before use.

2. A static water level will be obtained to determine the depth to the water before sampling begins in order to determine the amount of water within the casing.

3. Once the volume of stagnant water is calculated in the well, at least three times that amount will be removed prior to sample collection to ensure a representative sample of the aquifer is being recovered.

4. Samples will be collected in clean containers and stored in cool container. Samples will be kept from the sunlight and freezing during transport to the lab. The samples will either be mailed or dropped off as quickly as possible at the laboratory for analysis following chain of custody protocol.

Laboratory Chain of Custody Procedures

Samples will be sent to and analyzed by ALS Laboratory in Holland, MI. The detection limits and precisions can be found in the QASP. Chain of custody documentation will be completed in full.

External Mechanical Integrity Testing

Lambda will conduct external mechanical integrity tests (MIT) on each injection well at least once per year to demonstrate external mechanical integrity using an approved test method per 146.89(c). Annual MITs will ensure that cement continues to mitigate and prevent vertical flow out of the sequestration zone through well penetrations.

Testing Location and Frequency

MITs will be performed annually, up to 45 days before the anniversary date of authorization of injection each year.

Testing Details

Table 6 shows testing methods that may be utilized for MIT on injection and deep monitoring wells associated with this project. Lambda will utilize an approved MIT technique, such as noise logging or temperature logging. If Lambda elects to conduct an alternate MIT, notification including a description of the proposed testing method and procedure will be sent to the UIC Director for approval.

Table 6. MIT test methodology.

Test Description	Location
Noise Log	Along wellbore using wireline well log
Temperature Log	Along wellbore using wireline well log
Oxygen Activation Log	Along wellbore using wireline well log

Noise Log Procedure

The following procedures will be followed for the external MIT operations if a noise log is utilized:

1. Notify, in writing, the UIC Director at least thirty days prior to testing;
2. Mobilize and rig up the wireline service to the swab valve;
3. Conduct the operational safety meeting with all crews on site;
4. Open swab valve and pressurize lubricator;
5. Run in the hole with the noise log to injection zone;
6. Begin measurement stops (3-4 minutes each) at ten feet increments for the first fifty feet above the injection zone, then twenty feet increments to 100 feet above the injection zone, recording stops will be made at 100 feet intervals from 100 feet above the injection zone to the base of the USDW;
7. Pull up the logging tool into the lubricator;
8. Shut in the swab valve and bleed down the lubricator;
9. Rig down and demobilize the wireline service;
10. Any readings of ambient noise materially above the baseline injection log performed at initial injection will result in the injection being halted until further investigation has been performed.

Temperature Log Procedure

The following procedures will be followed for the external MIT operations if a temperature log is utilized:

1. Notify, in writing, the UIC Director at least thirty days prior to testing;
2. Mobilize and rig up the wireline service to the swab valve;
3. Conduct the operational safety meeting with all crews on site.
4. Perform temperature tool calibration;
    i. Run electronic diagnostics;
    ii. Allow the tool to stabilize at ambient temperatures and compare to thermometer and record;

iii. Insert the tool and thermometer into a bucket of ice water and allow tool to stabilize and record;
iv. Insert tool and thermometer into a bucket of warm water and allow tool to stabilize and record;

5. Rig up logging tool to well head with pressure control equipment;
6. Lower tool to thirty feet and allow tool to stabilize to wellbore temperature;
7. Begin logging down from the surface with GR/CCL/Temp logs to the injection string set point with a maximum logging rate of 25 feet per minute;
    i. Record on 5 inch per 100 foot scale;
    ii. Compare with previous log for comparison and evaluation (if not on initial survey);
8. Rig down and demobilize wireline equipment from site;
9. Assess the time-lapse temperature profiles against the baseline injection survey to identify temperature anomalies that may indicate a failure of well integrity.
    i. Evaluate the data to determine if additional passes are needed for interpretation.
    ii. If CO_2 migration is interpreted within the topmost section of the logging pass such that the top of the migration pathway cannot be identified, additional logging runs over a shallower interval will be required to find the top of migration.

Oxygen Activation Log Procedure

The following procedures will be followed for the external MIT operations if an oxygen activation log is utilized:

1. Move in and rig up an electrical logging unit with lubricator.
2. Conduct a baseline Gamma Ray (GR) log and Casing Collar Locator (CCL) log from the top of the injection zone to the surface prior to taking the stationary readings with the OA tool. Gamma Ray Log is necessary to evaluate the contribution of naturally occurring background radiation to the total gamma radiation count detected by the OA tool. There are different types of natural radiation emitted from various geologic formations or zones and the natural radiation may change over time.
3. The OA log shall be used only for casing diameters of greater than 1-11/16 inches and less than 13- 3/8 inches.
4. All stationary readings should be taken with the well injecting fluid at the normal rate with minimal rate and pressure fluctuations.

5. Prior to taking the stationary readings, the OA tool must be properly calibrated in a "no vertical flow behind the casing" section of the well to ensure accurate, repeatable tool response and for measuring background counts.

6. Take, at a minimum, a 15-minute stationary reading adjacent to the confining interval located immediately above the injection interval. This must be at least 10 feet above the injection interval so that turbulence does not affect the readings.

7. Take, at a minimum, a 15-minute stationary reading at a location approximately midway between the base of the lowermost USDW and the confining interval located immediately above the injection interval.

8. Take, at a minimum, a 15-minute stationary reading adjacent to the top of the confining zone.

9. Take, at a minimum, a 15-minute stationary reading at the base of the lowermost USDW. 10. If flow is indicated by the OA log at a location, move up hole or downhole as necessary at no more than 50-foot intervals and take stationary readings to determine the area of fluid migration.

Internal Mechanical Integrity Testing

Continuous Monitoring of Annular Pressure

Lambda will implement continuous monitoring of the annulus between the long string and tubing. Any deviations in pressure that do not correspond with alterations in operating conditions or seasonal temperature fluctuations will be promptly identified and investigated. Should a casing leak occur into a permeable zone, a decrease in pressure is typically expected. Conversely, in the event of a tubing or packer leak, the annulus pressure will likely increase. This testing will help complete a comprehensive leak detection/ground water monitoring strategy.

Pressure Fall-Off Testing

Lambda will perform pressure fall-off tests on each injector during the injection phase as described below to meet the requirements of 40 CFR 146.90(f). Lambda will refer to the EPA "UIC Pressure Falloff Testing Guideline" requirements for planning and conducting the testing as well as preparing and submitting the monitoring report.

Testing Location and Frequency

Due to the anticipated short injection period estimated at 4.5 years until fill-up, Lambda has opted to increase the frequency of required pressure fall-off tests. Annual fall-off tests will be performed by shutting in the injection wells for 24 hours. Pressure data will be gathered and analyzed, measured from downhole pressure and temperature gauges.

Testing Details

The DataCan Piezo Perm 0.75-inch bottom pressure tool will be implemented for the injector wells. The tool is intended for long term repetitive use, allowing for accurate repeatability of tests in the same location. The spec sheet for this tool is shown in Figure 2 below.

0.75"

Piezo Perm

Application

DataCan's Multi-Gauge Piezo Bottom Pressure Tool can be used on its own or at the bottom of a multi-gauge pressure system.

Benefits

The Multi-Gauge Piezo Bottom Pressure Tool is easy to install and produces high quality reservoir data in real time. It's fully welded construction, dual protection metal to metal seal design, and hermetically sealed electronics make it a very reliable product. This is the final gauge in a multi-gauge system. Alternatively, this gauge can be used on it's own as a single gauge in a single gauge system.

Features

- Fully Welded Construction
- Hermetically Sealed
- Corrosion Resistant - NACE MR0175
- Slim 0.75" Diameter

Multi-Gauge Piezo Bottom Pressure Tool - Stainless

Pressure	Temperature	Part No.		
		1/8" Wire	1/4" Wire	4mm Wire
750 psi	150°C	110822	108928	110828
1,500 psi		110823	108929	110829
3,000 psi		110824	108844	110830
6,000 psi		110825	108931	110831
10,000 psi		110826	108932	110832
15,000 psi		110827	108933	110833

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Multi-Gauge Piezo Bottom Pressure Tool - Inconel

Pressure	Temperature	Part No.		
		1/8" Wire	1/4" Wire	4mm Wire
750 psi	150°C	110834	110840	110846
1,500 psi		110835	110841	110847
3,000 psi		110836	110842	110848
6,000 psi		110837	110843	110849
10,000 psi		110838	110844	110850
15,000 psi		110839	110845	110851

Specifications

	Pressure	Temperature
Accuracy Up To	0.03% F.S.	0.5°C
Resolution	0.0003% F.S.	0.005°C
Drift	< 3 psi / year	< 0.1°C / year

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Figure 2: Downhole pressure and temperature tool specifications.

<u>CO_2 Plume and Pressure Front Tracking</u>

Due to the closed nature of the system, the Brown 4 GSP will not experience a "pressure front" or "CO_2 plume" beyond the extent of the reef, typical of saline aquifer sequestration zones. This is demonstrated by the computational modeling, which indicates rapid and equal dispersion of CO_2 within a few weeks, as discussed in the AoR section. The limited areal extent and high degree of connectivity within the reef yield a high degree of accuracy in determining connected volume via material balance methods gathered from bottomhole pressure data. The various methods described in earlier sections of this document will serve as effective testing and monitoring to ensure that the project is behaving as expected. Furthermore, Lambda does not deem it necessary to install monitoring wells for the reasons discussed below.

Computational modeling shows that CO_2 will quickly reach the vertical and lateral boundaries of the reef and continue to increase both CO_2 concentration and reservoir pressure relatively uniformly across the entire reef. The relationship for both of these can be observed in Figures 3 and 4.

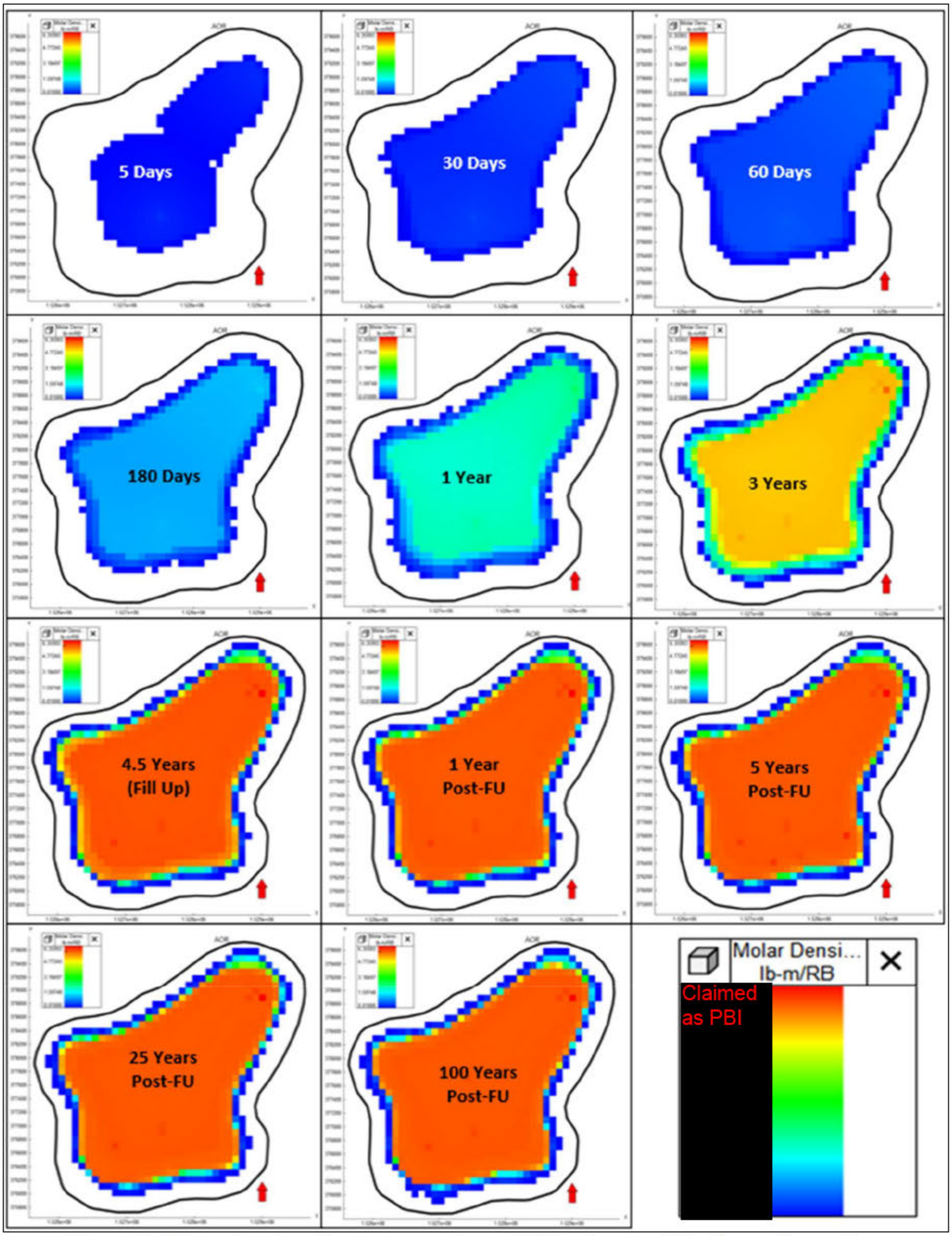

Figure 3: Maps showing the concentrations of CO_2 plume within the reef over time. Note: Outline depicts edge of simulation model. White cells have zero CO_2 concentration.

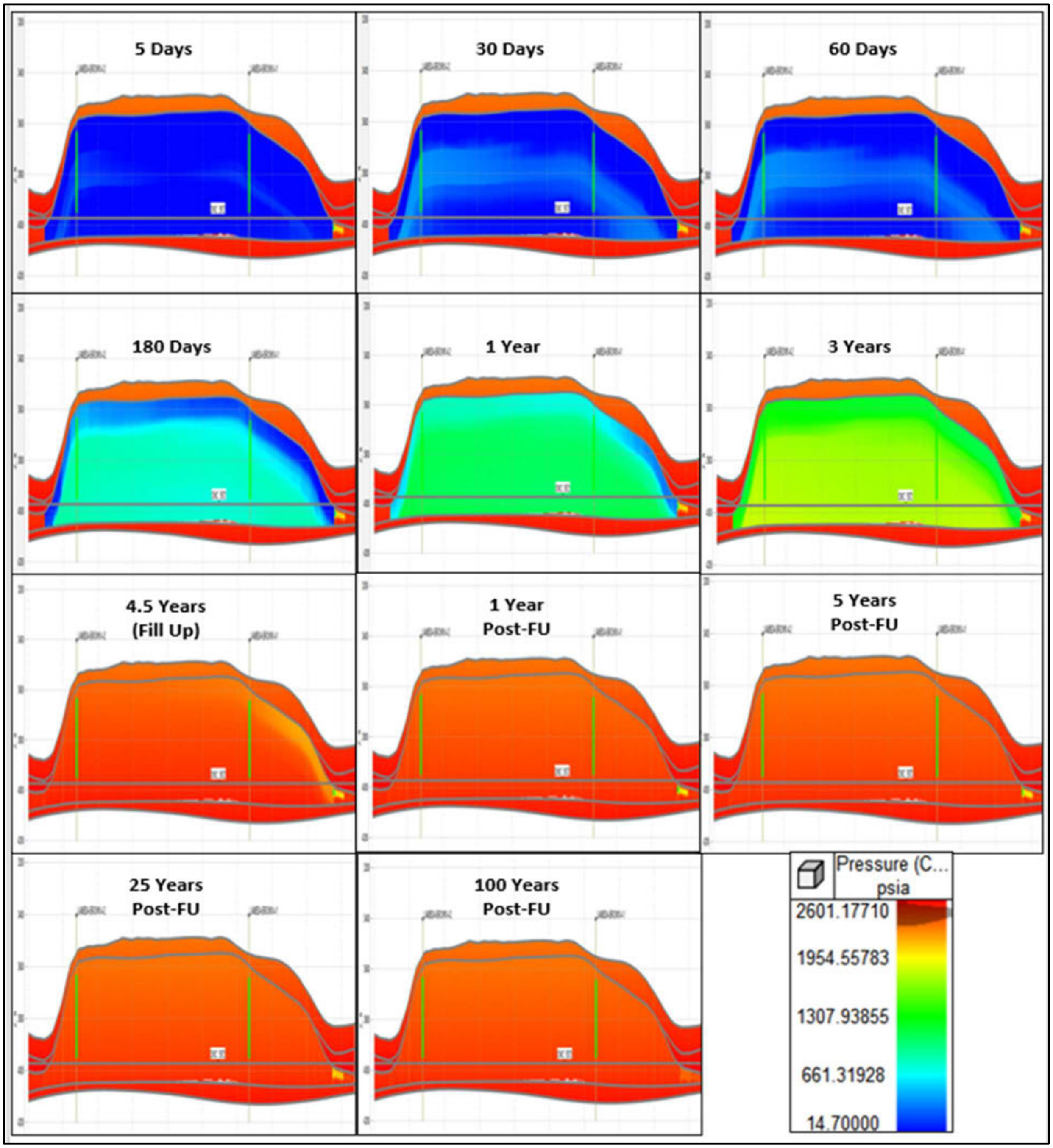

Figure 4: Cross sections showing the pressure front within the reef over time.

The injection zone is limited to the 170-acre extent of the Brown 4 reef. The reef is surrounded both vertically and laterally by salts, anhydrites, and tight carbonates that sealed the original hydrocarbon accumulation for several hundred million years. This absence of connectivity with any formations outside the reef boundary is corroborated by different pressure profiles of offset reefs (Figure 5). Additionally, the reservoir within the reef is extremely well connected, as evidenced by the pressure vs time plots of the two Brown 4 producers approximately 2,350 feet apart (Figure 6). As such, monitoring wells in any part of the reef would experience pressures and CO_2 concentrations nearly identical to those conditions seen at the injection wells. Lambda does not foresee needing any supplementary information beyond what will be obtained from the injection wells.

Claimed as PBI

[redacted]

Figure 5: Static pressure plots of adjacent reefs showing pressure isolation between different formations.

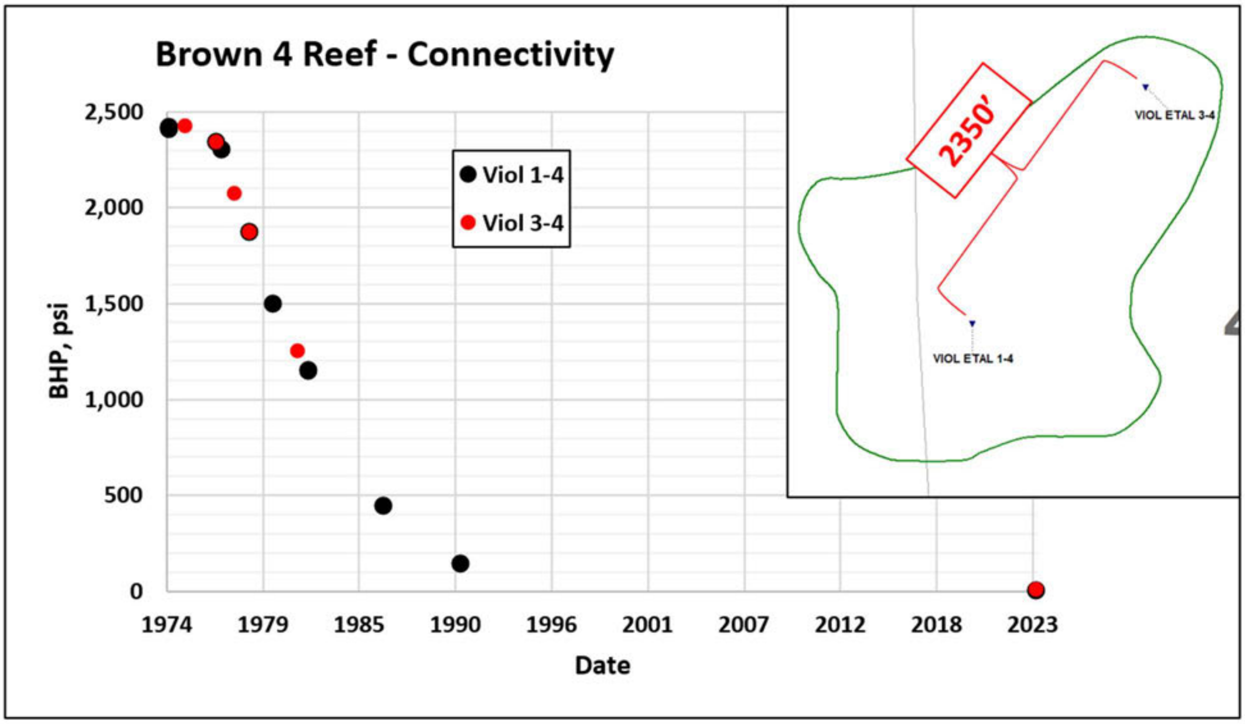

Figure 6: Bottomhole pressure versus time (hydraulic connectivity) showing consistent pressure trend and high connectivity between the wells within the Brown 4 reef.

Lambda maintains a high degree of confidence in the ability of the Brown 4 GSP to preserve integrity throughout the life of the project. Lambda does not deem it necessary to utilize reservoir monitoring wells for direct monitoring of the pressure front and CO_2 plume and instead will utilize data captured from the injection wells. Pressure and temperature will be monitored via downhole pressure and temperature gauges (described in detail in previous sections) in the injection wells. The data will be captured every ten seconds and recorded every five minutes. Storage complex capacity will be calculated using flowing material balance (injection volume and bottomhole pressure). A drop in pressure in either of the wells will trigger an automatic company review and timely verification of the history match in the simulation model. If pressure loss is unexplained by material balance, then all wells in the GSP will immediately be shut in for surface and downhole investigative measurement to determine corrective action. Additionally, annual pressure fall-off tests will validate flowing material balance calculations with static material balance calculations. Both of these analyses will be compared to computational modeling results to confirm CO_2 capacity. Lambda will utilize SCADA system alarms that will alert field and office personnel in the event of a sudden change in surface tubing pressure, downhole pressure, or annulus pressure.

Indirect plume and pressure-front monitoring

As noted above, the CO_2 plume will quickly reach the boundary of the reef within weeks of initial injection. Thus, Lambda does not deem it necessary to install monitoring wells within the sequestration zone as the pressure front and CO_2 concentrations will be nearly identical to those conditions seen at the injection wells. Lambda also believes that indirect monitoring methods such as seismic, resistivity, or gravity are not applicable to the Brown 4 GSP for the following reasons:

1. Seismic Monitoring

    - The Brown 4 reef is a highly depleted, gas reservoir, and as noted in Section 5.3.1 from the UIC Class VI Testing and Monitoring Guidance document, these methodologies “perform poorly for detecting CO_2 in depleted gas reservoirs.”

2. Electric Geophysical (i.e. Resistivity)

    - The Brown 4 reef has a very low, initial water saturation, and has not observed any influx from an aquifer throughout the production history. As such, the relative differential of the resistivity between the natural gas in formation and the injected CO_2 would be negligible and not provide a meaningful assessment of the CO_2 migration. This methodology is best utilized in saline aquifer sequestration zones, and is not pertinent in this project.

3. Gravity

    - The Brown 4 reef is a highly depleted, gas reservoir, and as noted in Section 5.3.3 from the UIC Class VI Testing and Monitoring Guidance document, this methodology would “pose a challenge for gravity monitoring because residual gas trapped within pores in the reservoir can decrease the density contrast with the injected CO_2.”

    - The limited arial extent of the Brown 4 GSP limits the ability to acquire data at the resolution needed to assess plume movement within the reservoir.