EMERGENCY AND REMEDIAL RESPONSE PLAN
40 CFR 146.82(a)(19), 40 CFR 146.94(a)

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]

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

Introduction

This Emergency and Remedial Response Plan (ERRP) describes actions that Lambda will take to address the movement of injection or formation fluid in a manner that may endanger an underground source of drinking water (USDW) during the construction, operation, or post-injection site care periods.

If Lambda obtains evidence that the injected CO_2 stream and/or associated pressure front may cause an endangerment to the USDW, Lambda must perform the following actions:

1. Initiate a shutdown plan for the injection well;

2. Take all steps reasonably necessary to identify and characterize any release;

3. Notify the permitting agency (UIC Program Director) of the emergency event within 24 hours; and

4. Implement applicable portions of the approved ERRP.

Where the phrase "initiate shutdown plan" is used, the following protocol will be employed: Lambda will immediately cease injection. However, in some circumstances, Lambda will, in consultation with the UIC Program Director, determine whether gradual cessation of injection (using the parameters set forth in the Summary of Requirements of the Class VI permit) is appropriate.

Local Resources and Infrastructure

Resources in the vicinity of the Brown 4 Geologic Sequestration Project (GSP) that may be affected as a result of an emergency event at the project site include:

1. Adjacent oil and gas production resources not associated with the Brown 4 GSP.
2. Glacial Drift (USDW).
3. Chief Lake.

Infrastructure in the vicinity of the Brown 4 GSP that may be affected as a result of an emergency at the project site include:

1. Infrastructure owned and operated by Lambda that is associated with oil and gas operations.
2. Homes within Chief Lake subdivision and other local non-affiliated residential homes.

Resources and infrastructure addressed in this plan are shown in Figure 1.

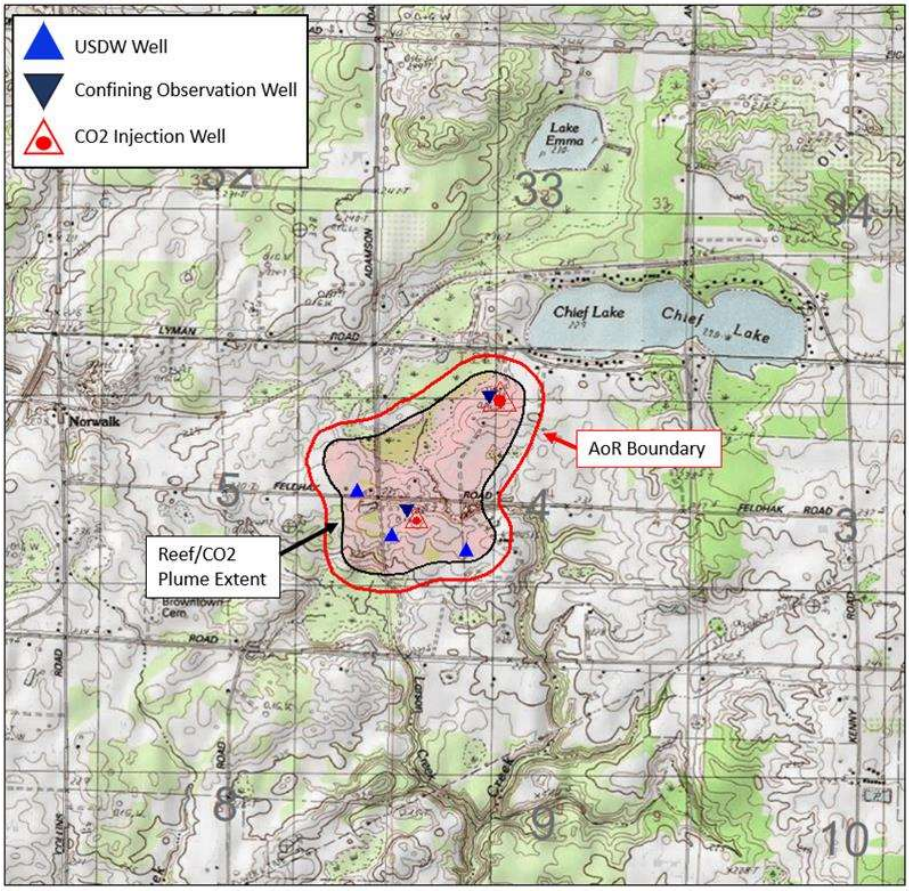

Figure 1. Map of site resources and infrastructure. USDW wells inside AoR are shown.

Potential Risk Scenarios

The following events related to the Brown 4 GSP could potentially result in an emergency response:

- Well integrity failure;
- Injection well monitoring equipment failure;
- Potential CO_2 leakage to a USDW or the surface;
- A natural disaster; or
- Induced or natural seismic event.

Response actions will depend on the severity of the event(s) triggering an emergency response. "Emergency events" are categorized as shown in Table 1.

Table 1. Degrees of risk for emergency events

Emergency Condition	Definition
Major Emergency	Event poses immediate substantial risk to human health, resources, or infrastructure. Emergency actions involving local authorities (evacuation or isolation of areas) should be initiated.
Serious Emergency	Event poses potential serious (or significant) near term risk to human health, resources, or infrastructure if conditions worsen or no response actions taken.
Minor Emergency	Event poses no immediate risk to human health, resources, or infrastructure.

Emergency Identification and Response Actions

Steps to identify and characterize the event will depend on the specific issue identified and the severity of the event. The potential risk scenarios identified are detailed below.

Well Integrity Failure

Integrity loss of the injection well and/or verification well may endanger USDWs. Integrity loss may have occurred if the following events occur:

- Automatic shutdown devices are activated;
    - Wellhead pressure exceeds the specified shutdown pressure specified in the permit.

    - Annulus pressure indicates a loss of external or internal well containment.

    - Pursuant to 40 CFR 146.91(c)(3), Lambda must notify the UIC Program Director within 24 hours of any triggering of a shut-off system.

- Mechanical integrity tests (MIT) results identify a loss of mechanical integrity.

Severity:

- Wellhead: Low risk of USDW endangerment. Any CO_2 containment loss would occur at the surface and not endanger the deeper USDW.

- Annulus: Low risk of USDW endangerment. Annulus pressure loss typically indicates a packer leak and pressure gains typically indicate a hole in the injection tubing.

- MIT failure (external): Low risk of USDW endangerment. MIT failures indicate a failure of mechanical isolation in the tubing, at the packer, or in the long casing string. Typically, these failures are fixed by replacing the injection tubing and packer.

Timing of event:

- Wellhead: Injection / Post-Injection

- Annulus: Injection / Post-Injection

- MIT Failure: Injection / Post-Injection

Avoidance measures:

- Wellhead: The wellheads Lambda will be utilizing either meet or exceed API Specifications 6A requirements and will be constructed from non-corrosive 316 stainless steel, despite the non-corrosive properties of the source CO_2 stream.

    - Additionally, Lambda will conduct annual testing of all parts of the wellheads by qualified third-party technicians to ensure integrity.

- Annulus: Lambda will have continuous monitoring set up on the long-string injection tubing annulus. Any change in normal operating pressure parameters will trigger an internal MIT test.

- MIT Failure: All casing strings will be constructed having cement circulated to the surface to mitigate vertical fluid flow.

Detection methods:

- Wellhead: Gauges on the wellhead will continuously monitor pressures.
- Annulus: Lambda will have pressure gauges on the injection tubing annulus to detect any pressure changes.
- MIT failure: This failure would be detected by the MIT.

Potential response actions:

- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).
- Determine the severity of the event, based on the information available, within 24 hours of notification.
- For a Major or Serious emergency:
    - Initiate shutdown plan.
    - Identify and, if necessary, implement appropriate remedial actions (in consultation with the UIC Program Director).
- For a Minor emergency:
    - Conduct assessment to determine whether there has been a loss of mechanical integrity.
    - If there has been a loss of mechanical integrity, initiate shutdown plan.
- MIT Failure: Shut in injection pumps, close injection valve at wellhead, kill well with kill weight fluid down path of CO_2 release (tubing, tubing annulus or production casing annulus), check pressure on surface, run relevant inspection logs (temperature, caliper, injection survey, etc.), mobilize workover rig to mechanically resolve leak:
    - If contamination is detected, identify and implement appropriate remedial actions (in consultation with the UIC Program Director).
- Leak in wellhead / injection tree:
    - Mitigation: Shut down injection pumps, isolate flow line valve, kill well with kill weight fluid, install backpressure valve in wellhead, repair injection tree, return injector to service.

- Leak in injection tubing:

    - Mitigation: Shut in injection pumps, close injection valve at wellhead, kill well with kill weight fluid, mobilize workover rig to pull tubing and replace, return injector to service.

- Failure of injection packer:

    - Mitigation: Shut in injection pumps, close injection valve at wellhead, kill well with kill weight fluid, mobilize workover rig to pull packer and replace, return injector to service.

- Leak via well fluid column during well work:

    - Mitigation: Close blowout preventers, kill well with kill weight fluid, monitor pressure on surface, confirm well is dead, continue well work.

- Objective formation release via wellbore to surface:

    - Mitigation: Shut in injection pumps, close injection valve at wellhead, kill well with kill weight fluid down path of CO_2 release (tubing, tubing annulus), check pressure on surface, run relevant inspection logs, mobilize workover rig to mechanically resolve leak.

Response personnel:

- Lambda has provided an "on call" list of qualified, experienced operations personnel to the after-hours operator for any abnormal operational conditions. The operator will contact the Lambda operations personnel, who will then be dispatched to the site.

Equipment:

- Workover rig: A mobile unit capable of performing any well intervention necessary for sequestration operations.

- Wireline truck: A mobile unit capable of running various electric logs to analyze downhole issues.

- Casing and Cement: Available on call and at short notice.

Injection Well Monitoring Equipment Failure

The failure of monitoring equipment for wellhead pressure, temperature, and/or annulus pressure may indicate a problem with the injection well that could endanger USDWs.

Severity:

- Lambda would classify the failure of monitoring equipment as a low risk due to the frequency with which a qualified, experienced Lambda operator would be visiting the site and visually inspecting the equipment and gauges. Additionally, remote viewing of operational parameters via Lambda SCADA system, would also indicate a failure in monitoring equipment.

Timing of event:

- Injection

Avoidance measures:

- A qualified, experienced Lambda operator would frequently visit the site to visually inspect the equipment and gauges. Additionally, remote viewing of operational parameters via Lambda SCADA system would also indicate a failure in monitoring equipment.

Detection methods:

- Any failure of wellhead monitoring equipment would be noticed by the qualified, experienced Lambda personnel or by other personnel monitoring the equipment remotely.

Potential Response actions:

- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).

- Determine the severity of the event, based on the information available, within 24 hours of notification.

- For a Major or Serious emergency:

    - Initiate shutdown plan.

    - Shut down injection pumps, isolate flow line valve, kill well with kill weight fluid, install backpressure valve in wellhead, repair injection tree, return injector to service.

    - Identify and, if necessary, implement appropriate remedial actions (in consultation with the UIC Program Director).

- For a Minor emergency:

    - Conduct an assessment to determine whether there has been a loss of mechanical integrity.

    - If there has been a loss of mechanical integrity, initiate shutdown plan.

Response personnel:

- Lambda has given an "on call" list of qualified, experienced operations personnel to the after-hours operator for any abnormal operational conditions. The operator will call out the Lambda operations personnel, who will then be dispatched to the site.

Equipment:

- Workover rig: A mobile unit capable of performing any well intervention necessary for sequestration operations.

- Wireline truck: A mobile unit capable of running various electric logs to analyze downhole issues.

- Casing and Cement: Available on call and at short notice.

Potential Brine or CO_2 Leakage to USDW or the Surface

Elevated concentrations of indicator parameters in groundwater samples or other evidence of fluid (brine) or CO_2 leakage into a USDW.

Severity: High

Timing of event: Injection

Avoidance measures:

- Lambda will set the maximum bottom hole injection pressure to a limit equivalent to the original reservoir pressure prior to depletion of hydrocarbons. This pressure will be below the fracture gradient of the injection and confining zones.

Detection methods:

- Continuous monitoring of bottom hole reservoir pressure in the injection wells would indicate if the project is behaving as predicted and modeled. Any abnormal discrepancies

in pressure data would trigger conducting an external MIT. Additionally, annual MIT will be performed on all wells within the injection zone.

Potential Response actions:

- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).

- Determine the severity of the event based on the information available within 24 hours of notification.

- For all emergencies (Major, Serious, or Minor):

    - Initiate shutdown plan.

    - Mitigation: Shut in injection pumps, close injection valve at wellhead, kill well with kill weight fluid down path of CO_2 release (tubing, tubing annulus or production casing annulus), check pressure on surface, run relevant inspection logs, and mobilize workover rig to mechanically resolve leak.

    - If the presence of indicator parameters is confirmed, develop (in consultation with the UIC Program Director) a case-specific work plan to:

        - Install additional groundwater monitoring points near the affected groundwater well(s) to delineate the extent of impact.

        - Remediate unacceptable impacts to the affected USDW.

    - Arrange for an alternate potable water supply if the USDW was being utilized and has been caused to exceed drinking water standards.

    - Proceed with efforts to remediate USDW to mitigate any unsafe conditions (e.g., install system to intercept/extract brine or CO_2 or "pump and treat" to aerate CO_2-laden water).

    - Continue groundwater remediation and monitoring on a frequent basis (frequency to be determined by Lambda and the UIC Program Director) until unacceptable adverse USDW impact has been fully addressed.

Response personnel:

- Lambda has given an "on call" list of qualified, experienced operations personnel to the after-hours operator for any abnormal operational conditions. The operator will notify the Lambda operations personnel, who will then be dispatched to the site.

Equipment:

- Workover rig: A mobile unit capable of performing any well intervention necessary for sequestration operations.

- Wireline truck: A mobile unit capable of running various electric logs to analyze downhole issues.

- Casing and Cement: Available on call and at short notice.

Natural Disaster

Well problems such as integrity loss, leakage, or malfunction may arise as a result of a natural disaster affecting the normal operation of the injection well. An earthquake may disturb surface and/or subsurface facilities, while weather-related disasters (e.g., tornado or lightning strike) may affect surface facilities.

Severity:

- The risk of a natural disaster in this location is minimal. Remote monitoring and long-standing emergency response plans for the oil and gas development of the region are well established to address any significant weather patterns for this region (e.g., lightning strikes, blizzards).

Timing of event:

- Pre-Injection, Injection, and/or Post-Injection

Avoidance measures: N/A

Detection methods: N/A

Potential Response actions:

If a natural disaster occurs that affects normal operation of the injection well, Lambda will perform the following:

- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).

- Determine the severity of the event, based on the information available, within 24 hours of notification.

- For a Major or Serious emergency:
    - Initiate shutdown plan.
    - If contamination or endangerment is detected, identify and implement appropriate remedial actions (in consultation with the UIC Program Director).
- For a Minor emergency:
    - Conduct an assessment to determine whether there has been a loss of mechanical integrity.
    - If there has been a loss of mechanical integrity, initiate shutdown plan.

Blizzard, Extreme Cold, Etc:

- Utilize US weather stations, State Police, and radio to maintain awareness of conditions.
- Notify appropriate supervisor as soon as possible of extreme weather conditions and actions proposed or initiated.
- Supervisors are to determine severity of storm and have facilities shut in as they deem necessary. In some cases, the immediate field personnel will be making this decision.

Windstorm, Tornado, Forest Fires, Etc:

- Ensure safety of personnel and/or institute evacuation procedures if time permits.
- If time permits, block in fuel sources and shut down facilities, secure equipment where possible.
- Notify appropriate supervisor as soon as possible and advise of them of the seriousness of the situation, actions taken, and current status.
- Request assistance from local authorities as needed.

Lightning Storms:

- Personnel must remain clear of tank batteries throughout the storm. It is not unusual for tank batteries to be ignited with catastrophic results.
    - If contamination or endangerment is detected, identify and implement appropriate remedial actions (in consultation with the UIC Program Director).

Response personnel:

- Lambda has provided an "on call" list of qualified, experienced operations personnel to the after-hours operator for any abnormal operational conditions. The operator will call out the Lambda operations personnel, who will then be dispatched to the site.

Equipment:

- Workover rig: A mobile unit capable of performing any well intervention necessary for sequestration operations

- Wireline truck: A mobile unit capable of running various electric logs to analyze downhole issues.

- Casing and Cement: Available on call and at short notice.

Induced or Natural Seismic Event

Based on the project operating conditions, it is highly unlikely that injection operations would ever induce a seismic event outside a 0.5-mile radius from the wellhead. Therefore, this portion of the response plan is developed for any seismic event with an epicenter within a 0.5-mile radius of the injection well.

To monitor the area for seismic activity, Lambda will subscribe to the USGS Earthquake Notification Service (ENS) and customize alert parameters as needed. Alerts will be distributed to all relevant parties via email and text message.

Based on the periodic analysis of the monitoring data, observed seismic activity levels, and local reports of felt events, the site will be assigned an operating state. The operating state is determined using threshold criteria corresponding to the site's potential risk and level of seismic activity. This state provides operating personnel with information about the potential risk of further seismic activity and guides them through a series of response actions.

Severity:

- Low risk. Historical injection of CO_2 into analogous reefs has not caused any known seismic events in this region of Michigan. A review of seismic events in Michigan can be found in the application narrative. The geologic features underlying the Brown 4 are not known to be seismically active. An extensive 2D seismic review covered in the application narrative does not identify any faults in the region of the Brown 4 GSP.

Timing of event:

- Injection / Post-Injection

Avoidance measures: N/A

Detection methods:

- Lambda will subscribe to the USGS Earthquake Notification Service (ENS) and customize alert parameters as needed to all relevant parties via email and text message.

Potential Response actions:

The seismic monitoring system structure is presented in Table 2. The table corresponds each level of operating state with the threshold conditions and operational response actions.

Table 2. Seismic monitoring system, for seismic events > M1.0 with an epicenter within a half mile radius of the injection well.

Operating State	Threshold Condition[1,2]	Response Action[3]
Green	Seismic events less than or equal to M1.5	1. Continue normal operation within permitted levels.
Yellow	Five (5) or more seismic events within a 30 day period having a magnitude greater than M1.5 but less than or equal to M2.0	1. Continue normal operation within permitted levels. 2. Within 24 hours of the incident, notify the UIC Program Director of the operating status of the well.
Orange	Seismic event greater than M1.5 and local observation or felt report	1. Continue normal operation within permitted levels. 2. Within 24 hours of the incident, notify the UIC Program Director, of the operating status of the well. 3. Review seismic and operational data. 4. Report findings to the UIC Program Director and issue corrective actions.
	Seismic event greater than M2.0 and no felt report	

[1] Specified magnitudes refer to magnitudes determined by USGS seismic monitoring stations or reported by the USGS National Earthquake Information Center using the national seismic network.

[2] "Felt report" and "local observation and report" refer to events confirmed by local reports of felt ground motion or reported on the USGS "Did You Feel It?" reporting system.

[3] Reporting findings to the UIC Program Director and issuing corrective action will occur within 25 business days (five weeks) of change in operating state.

Operating State	Threshold Condition[1,2]	Response Action[3]
Magenta	Seismic event greater than M2.0 and local observation or report	1. Initiate rate reduction plan. 2. Vent CO_2 from surface facilities. 3. Within 24 hours of the incident, notify the UIC Program Director, of the operating status of the well. 4. Limit access to wellhead to authorized personnel only. 5. Communicate with facility personnel and local authorities to initiate evacuation plans, as necessary. 6. Monitor well pressure, temperature, and annulus pressure to verify well status and determine the cause and extent of any failure; identify and implement appropriate remedial actions (in consultation with the UIC Program Director). 7. Determine if leaks to ground water or surface water occurred. 8. If USDW contamination is detected: a. Notify the UIC Program Director within 24 hours of the determination. 9. Review seismic and operational data. 10. Report findings to the UIC Program Director and issue corrective actions.
Red	Seismic event greater than M2.0, and local observation or report, and local report and confirmation of damage[4]	1. Initiate shutdown plan. 2. Vent CO_2 from surface facilities.

[4] Onset of damage is defined as cosmetic damage to structures, such as bricks dislodged from chimneys and parapet walls, broken windows, and fallen objects from walls, shelves, and cabinets.

Operating State	Threshold Condition[1,2]	Response Action[3]
	Seismic event >M3.5	3. Within 24 hours of the incident, notify the UIC Program Director of the operating status of the well. 4. Limit access to wellhead to authorized personnel only. 5. Communicate with facility personnel and local authorities to initiate evacuation plans, as necessary. 6. Monitor well pressure, temperature, and annulus pressure to verify well status and determine the cause and extent of any failure; identify and implement appropriate remedial actions (in consultation with the UIC Program Director). 7. Determine if leaks to ground water or surface water occurred. 8. If USDW contamination is detected: a. Notify the UIC Program Director within 24 hours of the determination. 9. Review seismic and operational data. 10. Report findings to the UIC Program Director and issue corrective actions.

Response personnel:

- Lambda has provided an "on call" list of qualified, experienced operations personnel to the after-hours operator for any abnormal operational conditions. The operator will contact the Lambda operations personnel, which will then be dispatched to the site.

Equipment:

- Workover rig: A mobile unit capable of performing any well intervention necessary for sequestration operations.
- Wireline truck: A mobile unit capable of running various electric logs to analyze downhole issues.
- Casing and Cement: Available on call and at short notice.

Response Personnel and Equipment

Site personnel, project personnel, and local authorities will be relied upon to implement this ERRP.

Site personnel to be notified (not listed in order of notification):

1. Operations Manager
2. Operations Engineer
3. Environmental Health and Safety Manager
4. Vice President of Operations
5. Operations Foreman
6. Project Manager

A site-specific emergency contact list will be developed and maintained throughout the life of the project. Lambda will provide the current site-specific emergency contact list to the UIC Program Director.

Table 3. Contact information for key local, state, and other authorities.

Agency	Phone Number
Local police	231-723-8393
State police	231-873-2171

Agency	Phone Number
State emergency management agency	517-373-8481
UIC Program Director	312-353-7648 or 312-353-3944
EPA National Response Center (24 hours)	800-424-8802
State geological survey	231-357-3948

Equipment needed in the event of an emergency and remedial response will vary depending on the triggering emergency event. Response actions such as cessation of injection, well shut-in, and evacuation generally will not require specialized equipment to implement. However, in cases where specialized equipment such as a drilling rig or logging equipment is required, Lambda shall be responsible for its procurement.

Emergency Communications Plan

Lambda will communicate to the public about any event that requires an emergency response to ensure that the public understands what happened and whether or not there are any environmental or safety implications. The amount of information, timing, and communication method(s) will be appropriate to the event's severity, whether any impacts to drinking water or other environmental resources occurred, any impacts to the surrounding community, and their awareness of the event.

Lambda will describe what happened, any impacts to the environment or other local resources, how the event was investigated, what responses were taken, and the status of the response. For responses that occur over the long-term (e.g., ongoing cleanups), Lambda will provide periodic updates on the progress of the response actions.

Lambda will also communicate with entities who may need to be informed about or take action in response to the event, including local water systems, CO_2 sources and pipeline operators, land owners, and Regional Response Teams (as part of the National Response Team).

Plan Review

This ERRP shall be reviewed:

- At least once every five years following its approval by the permitting agency.
- Within one year of an area of review (AOR) reevaluation.
- Within 45 days following any significant changes to the injection process or the injection facility, or an emergency event.
- As required by the permitting agency.

If the review indicates that no amendments to the ERRP are necessary, Lambda will provide the permitting agency with the documentation supporting the determination of "no amendment necessary."

If the review indicates that amendments to the ERRP are necessary, amendments shall be made and submitted to the permitting agency within 90 days following an event that initiates the ERRP review procedure.

Staff Training and Exercise Procedures

Lambda will integrate the ERRP into the site-specific standard operating procedures and training program. All Lambda staff and contractors operating at the CO_2 sequestration facilities or working in the AoR will receive annual training for site-specific issues and monthly training for safety and emergency procedures. The training plan will document that the above listed personnel have been trained and possess the required skills to perform their relevant emergency response activities described in the ERRP.