ATTACHMENT E: POST-INJECTION SITE CARE AND SITE CLOSURE PLAN

Facility Information

Facility name: Marquis Biocarbon Project
MCI CCS 3

Facility address: 10000 Marquis Dr
Hennepin, IL 61327

Well location: S2 T32N R2W
41.27026520°N, 89.30939322°W

The Post-Injection Site Care (PISC) and Site Closure period of this permit is 12 years after cessation of injection and system operation. The PISC and Site Closure plan describes the activities that Marquis will perform to meet the requirements of 40 C.F.R. § 146.93 and Section P of this permit. Marquis will monitor groundwater quality and track the position of the carbon dioxide plume and pressure front for the duration of the 12-year PISC period. Marquis may not cease post-injection monitoring until a demonstration of non-endangerment of USDWs has been approved by the Director pursuant to 40 C.F.R. § 146.93(b)(3). Following approval for site closure, Marquis will plug all monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation.

Post-Injection Monitoring Plan

Marquis will perform groundwater monitoring, USDW monitoring, injection formation pressure and temperature monitoring, and 2D/3D seismic monitoring as described in the following sections during the post-injection phase. The results of all post-injection phase testing and monitoring will be submitted to the Director annually on or before February 15.

For the PISC plan, the following definitions apply for the frequencies given for the different testing protocols described.

1) Continuous: Data is continuously sampled and recorded.
2) Quarterly: Sampling will take place within 5 days before the following dates each year: March 31st, June 30th, September 30th, December 31st.
3) Semi-annual: Sampling will take place within 5 days before June 30th and December 31st.
4) Annual: Sampling will take place within 45 days before January 1st of each year.

5) Year: Sampling will take place every 5 years within 45 days before January 1st during injection and PISC periods (i.e., 5, 10, 15, etc. years after commencement of injection until site closure).

Monitoring Above the Confining Zone

Table 1 presents the monitoring methods, locations, and frequencies for monitoring above the confining zone. Table 2 identifies the parameters to be monitored, and the analytical methods Marquis will employ.

Table 1: Monitoring of groundwater quality and geochemical changes above the confining zone.

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
Shallow Groundwater	Groundwater geochemistry and stable isotopes	GW-1, 2, 3, 4 existing wells and GW-5 existing or new well within AoR	Within 300 feet below ground surface	Q2/year after injection ceases
Gunter Sandstone	Groundwater geochemistry and stable isotopes	MCI ACZ-1	~2,118 ft	Q2/year after injection ceases
Galesville Sandstone	Groundwater geochemistry and stable isotopes	MCI ACZ-1	~2,635 ft, MD	Q2/year after injection ceases
Galesville to Gunter Sandstones	PNC Logging	MCI ACZ-1	2,100 – 2,700 ft MD	Q2/year after injection ceases

Table 2: Summary of analytical and field parameters for groundwater samples.

Parameters	Analytical Methods	Alternate Analytical Method (Note 1)
Cations: Na, Ca, Mg, Ba, Sr, Fe, and K	ASTM D1976	EPA Method 6020
Cations: Sr	ASTM D1976	EPA Method 6010
Anions: Cl, Br, SO_4	ASTM D4327	EPA Method 300
pH	ASTM D1293	Standard Method (SM) 4500H
Alkalinity	ASTM D3875	SM 2320B
Total Dissolved Solids (TDS)	ASTM D5907	SM 2540C
Density	ASTM D4052	SM 2710F
Dissolved Inorganic Carbon	ASTM D513-11	SM 5310C
Conductivity/Resistivity	ASTM D1125	SM 2510B
Stable Isotopes of C, O, and H	CRDS Laser H Isotope Ratio Mass Spectrometry (IRMS) for C	(Note 1)
Carbon-14	Accelerator Mass Spectrometry (AMS)	(Note 1)

Note:
1. If another alternative analytical method(s) is considered, prior approval will be obtained from the UIC Director.

Table 3: Sampling and recording frequencies for continuous monitoring.

Parameter	Device(s)	Location	Min. Sampling Frequency	Min. Recording Frequency
Pressure	Pressure Gauge	Gunter Sandstone Galesville Sandstone	Every 1 min.	Every 1 min.
Temperature	Temperature Gauge	Gunter Sandstone Galesville Sandstone	Every 1 min.	Every 1 min.

Note:
- 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.

Table 4: Post-injection phase plume monitoring.

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
DIRECT PLUME MONITORING				
Mt. Simon Sandstone	Fluid sampling	MCI MW 2	3,225 ft MD (Note 1)	Annual
Galesville	Isotope analysis	MCI MW 2 MCI ACZ 1	2,635 ft MD	Semi-Annual
INDIRECT PLUME MONITORING				
Galesville, Eau Claire Shale, and Mt. Simon Formations	Time-lapse 3D Surface Seismic Data	Over project AoR	Surface	Every 5 years and as required
Galesville, Eau Claire Shale, and Mt. Simon Formations	Pulsed Neutron Logging	MCI MW 2 well	2,118 – TD	Continuous

Notes:

1. The upper Mt. Simon at 3,225 ft is the estimated location of the first perforation of the topmost injection zone.
2. Frequency of sampling may be adjusted after post drilling model updates to attempt to detect fluid mixing front as it passes the well.

Table 5: Summary of laboratory analytical and field parameters for the Gunter Sandstone (lowermost USDW), Galesville Sandstone, and Mt. Simon Sandstone groundwater samples.

Parameters	Analytical Methods (Note 1)	Detection Limit/Range	Typical Precisions	QC Requirements
Cations: Na, Ca, Mg, Ba, Sr, Fe, K	ASTM D1976	<1 to 8 mg/L (analyte, dilution, and matrix dependent)	±10%	Daily calibration; blanks, duplicates, and matrix spikes at 10% or greater frequency
Anions: Cl, Br, SO_4	ASTM D4327	0.03 to 0.13 mg/L (analyte, dilution, and matrix dependent)	±15%	Daily calibration; blanks and duplicates at 10% or greater frequency
Dissolved Inorganic Carbon	EPA 9060	0.2 mg/L	±20%	Duplicate measurement; standards at 10% or greater frequency
Total Dissolved Solids	ASTM D5907	12 mg/L	±10%	Balance calibration, duplicate analysis
Alkalinity	ASTM D3875	1 mg/L	±10%	Daily calibration; blanks, duplicates, and matrix spikes at 10% or greater frequency
pH	ASTM D1293	1 to 13 pH units	0/2 pH unit	
Density	ASTM D4052	0.01 g/mL	±10%	
Conductivity/Resistivity	ASTM D1125	0 to 100	±1%	
Stable C, H, O Isotopes	CRDS Laser H IRMS for C	200 to 500‰ 50 ppm of DIC	±4‰ ±0.2‰	Duplicates, working standards at 10%
Radiocarbon	AMS	0 to 200 pMC	±0.5 pMC%	
pH (field)	EPA 150.1	2 to 12 pH units	±0.2 pH unit	User calibration per manufacturer recommendation
Specific conductance (field)	APHA 2510	0 to 200 mS/cm	±1% of reading	
Temperature (field)	Thermocouple	-5 to 50°C	±0.2°C	Factory calibration

Note:
1. An equivalent method may be utilized with the prior approval of the UIC Program Director.

Table 6: Post-injection phase pressure-front monitoring.

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
DIRECT PRESSURE-FRONT MONITORING				
Upper Mt. Simon Sandstone	Pressure monitoring	MCI MW 2	~3,225 ft, MD Exact TBD	Continuous
Top Mt. Simon Sandstone	Pressure monitoring	MCI CCS 3 well	~3,100 ft, MD	Continuous
INDIRECT PRESSURE-FRONT MONITORING				
Eau Claire and Mt. Simon Formations, and Precambrian Basement	Microseismic Monitoring	5 Surface Stations	AoR	Continuous

Schedule for Submitting Post-Injection Monitoring Results

All post-injection site care monitoring data and monitoring results (i.e., resulting from the groundwater monitoring and plume and pressure front tracking described above) will be submitted to the Director in annual reports. These reports will be submitted each year by February 15.

Site Closure Plan

Marquis will conduct site closure activities to meet the requirements of 40 C.F.R. § 146.93(e) as described below. Marquis will submit a final Site Closure Plan and notify the Director at least 120 days prior of its intent to close the site per 40 C.F.R. § 146.93(d). Once the Director has approved closure of the site, Marquis will plug the monitoring wells and submit a site closure report. The activities, as described below, represent the planned activities based on information provided to EPA. The actual site closure plan may employ different methods and procedures. A final Site Closure Plan will be submitted to the Director for approval with the notification of the intent to close the site.

Plugging Monitoring Wells (MCI MW 1, MCI MW 2, and MCI ACZ 1)

Each well (MCI MW 1, MCI MW 2, and MCI ACZ 1) will be flushed with a kill weight brine fluid. A minimum of three tubing volumes will be injected without exceeding fracture pressure. A final external mechanical integrity test (MIT) will be conducted to ensure mechanical integrity. Detailed plugging procedures are provided below. All casing in each well will be cemented to surface and will not be retrievable at abandonment. After injection ceases and after the appropriate post-injection monitoring period is finished, the completion equipment will be removed from the well.

The perforated zone of each well will be plugged using a retainer method and the upper portions of the well will be cemented with a balance method. In addition, the portion of the casing within the storage formation in the deep MCI MW 1 and MCI MW 2 well and the upper portion of MCI MW 2 will be plugged using CO_2-resistant cement. All the wells will have the casing cut off 5 ft below grade and a steel cap will be welded to the top of the deep casing string. The cap will have the well identification (ID) number and the date of plugging and abandonment inscribed on it.

Table 7: Intervals to be plugged and methods used when plugging the MCI MW 1 well.

Zone of Interest	Cemented Depth (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
Perforated Interval	Various between 3,165−4,050	Mt. Simon Sandstone	Retainer	CO_2-Resistant	132 sacks
5-1/2-in. Casing Column	~200-300	Pennsylvanian	Balance	Class A	12 sacks
5-1/2-in. Casing Column	~0-100	Pleistocene Drift	Balance	Class A	12 sacks

Table 8: Intervals to be plugged and methods used when plugging the MCI MW 2 well.

Zone of Interest	Cemented Depth (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
Perforated Interval	Various between 3,165−4,050	Mt. Simon Sandstone	Retainer	CO_2-Resistant	132 sacks
5-1/2-in. Casing Column	~200-300	Pennsylvanian	Balance	CO_2-Resistant	13 sacks
5-1/2-in. Casing Column	~0-100	Pleistocene Drift	Balance	CO_2-Resistant	13 sacks

Table 9: Intervals to be plugged and methods used when plugging the MCI ACZ 1 well.

Zone of Interest	Cemented Depth (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
Galesville Perforated Interval	2,409-2,579	Galesville Sandstone	Retainer	Class A	37 sacks
Deepest USDW Interval	1,321-1,466	Deepest USDW	Retainer	Class A	33 sacks
5-1/2-in. Casing Column	~200-300	Pennsylvanian	Balance	Class A	12 sacks
5-1/2-in. Casing Column	~0-100	Pleistocene Drift	Balance	Class A	12 sacks

Table 10: Materials used for plugging the MCI MW 1 well.

Plug Information	Plug #1	Plug #2	Plug #3
Diameter of boring in which plug will be placed (in.)	4.892	4.892	4.892
Depth to bottom of tubing or drill pipe (ft, MD)	~3,065	~300	~100
Sacks of cement to be used (each plug)	132	12	12
Slurry volume to be pumped (ft^3)	142	13.1	13.1
Slurry weight (lb./gal)	15.2	15.9	15.9
Slurry Yield (ft^3/sack)	1.07	1.18	1.18
Calculated top of plug (ft, MD)	~3,065	~200	~0
Bottom of plug (ft, MD)	~4,050	~300	~100
Type of cement or other material	CO_2-Resistant	Class A	Class A
Method of emplacement (e.g., balance method, retainer method, or two-plug method)	Retainer	Balance	Balance

Table 11: Materials used for plugging the MCI MW 2 well.

Plug Information	Plug #1	Plug #2	Plug #3
Diameter of boring in which plug will be placed (in.)	4.892	4.892	4.892
Depth to bottom of tubing or drill pipe (ft, MD)	~3,065	~300	~100
Sacks of cement to be used (each plug)	132	13	13
Slurry volume to be pumped (ft^3)	142	13.9	13.9
Slurry weight (lb./gal)	15.2	15.2	15.2
Slurry Yield (ft^3/sack)	1.07	1.07	1.07
Calculated top of plug (ft, MD)	~3,065	~200	~0
Bottom of plug (ft, MD)	~4,050	~300	~100
Type of cement or other material	CO_2-Resistant	CO_2-Resistant	CO_2-Resistant
Method of emplacement (e.g., balance method, retainer method, or two-plug method)	Retainer	Balance	Balance

Table 12: Materials used for plugging the MCI ACZ 1 well.

Plug Information	Plug #1	Plug #2	Plug #3	Plug #4
Diameter of boring in which plug will be placed (in.)	6.276	6.276	6.276	6.276
Depth to bottom of tubing or drill pipe (ft, MD)	~2,309	~1,221	~300	~100
Sacks of cement to be used (each plug)	54	50	18	18
Slurry volume to be pumped (ft^3)	58	53	21.5	21.5
Slurry weight (lb./gal)	15.2	15.2	15.9	15.9
Slurry Yield (ft^3/sack)	1.07	1.07	1.18	1.18
Calculated top of plug (ft, MD)	~2,309	~1,221	~200	~0
Bottom of plug (ft, MD)	~2,579	~1,466	~300	~100
Type of cement or other material	CO_2-Resistant	CO_2-Resistant	Class A	Class A
Method of emplacement (e.g., balance method, retainer method, or two-plug method)	Retainer	Retainer	Balance	Balance

Volume Calculations

Volumes will be calculated for specific abandonment wellbore environments based on desired plug diameter and length required. Volume calculations are the same for plug and abandonment during construction and post-injection.

1) Choose the following:
    a) Length of the cement plug desired.
    b) Desired setting depth of base of plug.
    c) Amount of spacer to be pumped ahead of the slurry.
2) Determine the following:
    a) Number of sacks of cement required.
    b) Volume of spacer to be pumped behind the slurry to balance the plug.
    c) Plug length before the pipe is withdrawn.
    d) Length of mud freefall in drill pipe.
    e) Displacement volume required to spot the plug.
3) Field cementing and wellsite supervisor will both review calculations prior to spotting any plug.

Plugging and Abandonment Procedure

A detailed procedure follows:

1) Notify EPA 60 days in advance of plugging via letter of intent and 48 hours prior to commencing operations. Ensure proper notifications have been given to all regulatory agencies for rig move.

2) Make sure Marquis has written permission from U.S. EPA to proceed with planned ultimate P&A procedure.

3) Ensure in advance that a pre-site inspection has been performed and the rig company has visited the site and is capable of transporting rig, tanks, and ancillary equipment to perform P&A operations. Notify all key third parties of expected work scope, and ensure third party contracts for work are in place prior to move in.

4) Have copies of the injection well permit prior to initiating operations and maintain on location at all times. Check to see if conditions of approval have been met.

5) Make sure all necessary safety forms are on the rig, i.e., NPDES, safety meetings, trip sheets, etc.

Plugging Procedures for Injection Well

1) Conduct and document a safety meeting.

2) Conduct bottom hole pressures and MITs.
3) Move-in (MI) rig and ancillary equipment onto MCI CCS 3 well site and rig up (RU). Nipple up and test BOPs, pressure test equipment and ensure proper operation.
4) Check wellhead tubing and casing pressures.
5) Record bottom-hole pressure from downhole gauge (if final pressure has not already been determined) and calculate kill fluid density.
6) Fill tubing with kill weight brine as determined by the final pressure measurement. Inject two tubing volumes of kill weight brine. Monitor tubing and casing pressure for 1 hour. Release from packer with tubing string and circulate one hole volume with kill weight brine.
    a) If the well is not dead or the pressure cannot be bled off of tubing, RU slickline and set plug in lower profile nipple below packer. Pick on tubing to remove tubing seals from packer and circulate tubing and annulus with kill weight fluid.
7) Release packer and pull out of hole with tubing laying it down. NOTE: Ensure that the well is over-balanced so there is no backflow due to formation pressure and there are at least two well control barriers in place at all times.
8) Trip into hole with work string with 9-5/8 inch cement retainer to a depth of 3,225 ft and set retainer to cement the perforated portion of the well, and prepare for cement plugging operations. Pump 661 sacks of CO_2-resistant cement (slurry weight of 15.2 pounds per gallon [lb/gal] through the retainer while maintaining bottom-hole pressure below fracture pressure). If it appears that the injection pressure will exceed the fracture pressure and the total amount of cement has not been pumped into the injection zone, cement pumping will cease. After allowing the pressure to reduce to an acceptable level, cement pumping will be attempted again. A rapid increase in pressure on the tubing would indicate that the perforations have been sealed with cement, and no additional cement will be added to the zone or plug.
9) Trip tubing string out of well and remove stinger from end of tubing.
10) Trip tubing string to a depth of 2,750 ft and prepare to set second cement plug. Pump 35 sacks of Class A cement with 50% POZ (slurry weight of 14.7 lb/gal) using a balance method to cement between a depth of 2,650 and 2,750 ft.
11) Trip tubing string to a depth of 350 ft and prepare to set third cement plug. Pump approximately 35 sacks of Class A cement to fill the casing from a depth of 350 to 250 ft.
12) Cut the casing string off at 5 ft below grade and weld a steel plate, (with well ID, permit number, and date of abandonment on it) to the casing strings.
13) Backfill the excavation.
14) Rig down and move off service rig and any remaining equipment.

The procedures described above are subject to modification during execution as necessary to ensure a plugging operation that protects worker safety and is effective to protect USDWs. Any significant modifications due to unforeseen circumstances will be described in the Plugging Report. The Plugging Report will be submitted to the EPA within 60 days after plugging is completed (40 C.F.R. § 146.92 (d)).

Plugging Procedures for the Monitoring Well(s)

1) Conduct and document a safety meeting.
2) Move-in (MI) rig and ancillary equipment onto well site and rig up (RU). Nipple up and test blow out preventors (BOPs), pressure test equipment and ensure proper operation.
3) Check wellhead tubing and casing pressures.
4) Record bottom-hole pressure from downhole gauge (if final pressure has not already been determined) and calculate kill fluid density.
5) Fill tubing with kill weight brine as determined by the final pressure measurement. Inject two tubing volumes of kill weight brine. Monitor tubing and casing pressure for 1 hour.
6) If the well is not dead or the pressure cannot be bled off the tubing, rig up slickline and set plug in lower profile nipple below packer. Disconnect the tubing and circulate tubing and annulus with kill weight fluid until well is dead.
7) Release packer and pull out of hole with tubing laying it down. NOTE: Ensure that the well is over-balanced so there is no backflow due to formation pressure and there are always at least two well control barriers in place.
8) Trip into hole with work string with 5-1/2-inch cement retainer to approximately 100 ft above the top perforation, set retainer to cement the perforated portion of the well, and prepare for cement plugging operations. Pump the specified number of sacks of cement through the retainer while maintaining bottom-hole pressure below fracture pressure. If it appears that the injection pressure will exceed the fracture pressure and the total amount of cement has not been pumped into the injection zone, cement pumping will cease. After allowing the pressure to reduce to an acceptable level, cement pumping will be attempted again. A rapid increase in pressure on the tubing would indicate that the perforations have been sealed with cement, and no additional cement will be added to the zone or plug.
9) If a second perforated zone is present in the well, repeat Step 8 for upper perforated zone.
10) Trip tubing string out of well and remove stinger from end of tubing.
11) Trip tubing string to a depth of approximately 300 ft and prepare to set second cement plug. Pump 12 sacks of Class A cement (slurry weight of 15.9 pounds per gallon [lb/gal]) using a balance method to cement between a depth of 200 and 300 ft.
12) Trip tubing string to a depth of 100 ft and prepare to set third cement plug. Pump approximately 12 sacks of Class A cement to fill the casing from a depth of 100 ft to near surface.
13) Cut the casing string off at 5 ft below grade and weld a steel plate, (with well ID, permit number, and date of abandonment on it) to the casing strings.
14) Backfill the excavation.
15) Rig down and move off service rig and any remaining equipment.

Planned Remedial/Site Restoration Activities

1) The free liquid fraction of the plugging fluid waste, which may consist of produced water and/or crude oil, shall be removed from the pit and disposed of in accordance with federal regulations (e.g., injection or in above ground tanks or containers pending disposal) prior to restoration. The remaining plugging fluid wastes shall be disposed of by on-site burial.
2) All plugging pits shall be filled and leveled in a manner that allows the site to be returned to original use with no subsidence or leakage of fluids, and where applicable, with sufficient compaction to support farm machinery.
3) All drilling and production equipment, machinery, and equipment debris shall be removed from the site.
4) Casing shall be cut off at least three feet below the surface of the ground, and a steel plate welded on the casing.
5) Any drilling rat holes shall be filled with cement to no lower than four feet and no higher than three feet below ground level.
6) The well site and all excavations, holes, and pits shall be filled, and the surface leveled.

Site Closure Report

A site closure report will be prepared and submitted to the Director within 90 days following site closure per 40 C.F.R. § 146.93(f) and Section P(6) of this permit. The report will document the following:

1) Plugging of the verification and geophysical wells (and the injection well if it has not previously been plugged),
2) Location of sealed injection well on a plat of survey that has been submitted to the local zoning authority,
3) Notifications to state and local authorities as required at 40 C.F.R. § 146.93(f)(2),
4) Records regarding the nature, composition, and volume of the injected carbon dioxide,
5) Post-injection monitoring records, and
6) Any other information required by the Director.

Marquis will record a notation to applicable property deeds per 40 C.F.R. § 146.93(g) documenting the following:

1) That the property was used for carbon dioxide sequestration,
2) The name of the local agency to which a plat of survey with injection well location was submitted,
3) The volume of fluid injected,
4) The formation into which the fluid was injected, and
5) The period over which the injection occurred.

The site closure report will be submitted to the Director and maintained by the owner or operator for a period of 10 years following site closure per 40 C.F.R. § 146.93(h). 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 Director.