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8.0 INJECTION WELL PLUGGING PLAN
40 CFR 146.92 (b)

MARQUIS BIOCARBON PROJECT

Facility Information

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Well Name: MCI CCS 3

Well location: PUTNAM COUNTY, ILLINOIS
S2 T32N R2W
Latitude: 41.27026520 N, Longitude: 89.30939322 W

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8.0 Injection Well Plugging Plan

8.1 Plugging Plan for the MCI CCS 3 Injection Well

The MCI CCS 3 well plugging plan described in this section, details the methods and materials that will be used to plug and abandon the MCI CCS 3 injection well in accordance with 40 CFR 146.92. The well construction details for the MCI CCS 3 injection well are provided in the Injection Well Construction Plan (Permit Section 4) of this application; this includes the casing and cement used in the completion of the well. These details will be used to determine an appropriate approach to plugging the MCI CCS 3 well to prevent migration of fluids upwards through the abandoned well. The Post-Injection site Care and Closure (PISC) Plan (Permit Section 9) describes tests that will be performed prior to well abandonment to confirm the well has maintained mechanical integrity throughout the injection phase of the project.

The Class VI permit, in accordance with 40 CFR 146.92, requires that specific data be collected prior to plugging an injection well. The bottom-hole pressure must be determined and the mechanical integrity of the well casing must be confirmed prior to plugging and abandoning the well. The procedures that will be used to generate these data are described in the following sections.

8.2 Tests or Measures for Determining Bottom-Hole Reservoir Pressure

Bottom-hole pressure measurements will be conducted prior to plugging and abandonment of the MCI CCS 3 well as required by 40 CFR 146.92(a). These measurements will be used to determine several parameters required during the plugging and abandonment of the MCI CCS 3 well, including the pressure required to squeeze the cement from the well casing into the storage formation, the need for well control such as the weight of brine required to prevent the well from flowing, and the required blowout preventor (BOP) stack during the pre-abandoment workover activities. The bottom-hole reservoir pressure will also be used to confirm the blend of cement to be used to plug the well.

8.3 Planned External Mechanical Integrity Tests

External mechanical integrity tests (MITs) will be conducted prior to plugging the MCI CCS 3 well as required by 40 CFR 146.92(a). The mechanical integrity of the well must be demonstrated after the injection phase of the project has been completed and prior to plugging the well to ensure conduits between the injection zone and the underground sources of drinking water (USDWs) have not developed. The external mechanical integrity will be evaluated by acquiring a temperature measurement in the MCI CCS 3 well (Table 8-1).

Test Description	Location

Temperature measurement	MCI CCS 3
Oxygen-Activation Log (Contingency)	MCI CCS 3

Table 8-1: Planned Mechanical Integrity Tests.

Throughout the injection phase of the project, the external mechanical integrity of the MCI CCS 3 well will be confirmed through regular temperature measurements in accordance with the Testing and Monitoring plan (Permit Section 7). A final temperature measurement will be acquired over the entire MCI CCS 3 well after the tubing has been pulled and prior to the plugging and abandonment process (40 CFR 146.92 (b)(2)). The temperature data will be evaluated for anomalies and compared to previous temperature measurements acquired during the pre-operational and injection phases of the project for any indications that the storage formation fluids have migrated outside of the storage formation.

The post-injection temperature data are expected to display a similar temperature gradient above the confining zone as the previous measurements. If the temperature gradient deviates less than 10% between the post-injection data and previous data, the well will be considered to have maintained external mechanical integrity. A temperature gradient change greater than 10% would suggest an external mechanical integrity issue, and an oxygen-activation log will be acquired to corroborate the results of the temperature log. If a loss in external mechanical integrity is discovered, corrective action will be taken prior to proceeding to the plugging and abandonment. The response actions to such a situation are described in the Emergency and Remedial Response Plan (Permit Section 10).

8.4 Plugging Plan

A Notice of Intent to plug the well will be submitted to the EPA at least 60 days prior to the plugging operations (40 CFR 146.92 (c)). Section 8.5 details the pre-plugging procedures that will be completed prior to plugging the well, and Section 8.6 contains a detailed description of the plugging procedures.

After the the project has verified that there are no external well integrity issues, the well will be flushed with a buffer fluid to remove any fluids or particulates that may be present in the well (Section 8.6). The weight of the buffer fluid will be determined from the final reservoir pressure measurement and will be chemically compatible with the formation fluids and solids to reduce the potential of corrosion of the well materials. A minimum of three casing volumes will be circulated without exceeding the fracture pressure of the Mt. Simon Sandstone.

resistant cement). The injection zone will be plugged using CO_2-resistant cement with a

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once the MCI CCS 3 well has been drilled and formation depths have been established with greater certainty. Approximately 681 sacks of CO_2-resistant cement will be used to plug the injection interval; this includes a 10% excess volume to be squeezed through the perforations into the Mt. Simon Sandstone. It requires approximately 0.44 sack of cement to seal one foot of perforated casing (including the 10% excess), and this value may be used to estimate for amount of cement needed for different perforation scenarios.

The pressure used to squeeze the cement will be determined from the bottom-hole pressure data measured before beginning the plugging and abandonment process. The injection pressure of the cement will not exceed the fracture pressure of the Mt. Simon Sandstone. 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 decrease 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 the plug.

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After the the top cement plug has been set, the casing sections will be cut off approximately 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, the UIC Class VI permit number, and the date of plug and abandonment inscribed on it. Soil will be backfilled around the well to bring the area around the well back to pre-well installation grade. This area will then be planted with natural vegetation.

The methods and materials described in the preceding paragraph are based upon current understanding of the geology at the site and current well designs. If necessary, the plans will be updated to reflect latest well designs. The new designs, materials, and methods will be described in the Notice of Intent to Plug submitted at least 60 days prior to the plugging of the well (40 CFR 146.92 (c)).

After the completion of the plugging activities, a plugging report will be submitted to the UIC Director describing the methods and tests that were performed on the well during plugging. This report will be submitted to the UIC Director within 60 days of completing the plugging activities (40 CFR 146.92 (d)).

Description	Cemented Interval (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
Sensitive, Confidential, or Privileged Information				CO_2-Resistant	681 sacks
				Class A	36 sacks
				Class A	36 sacks

Table 8-2: Intervals to be plugged and materials/methods used (40 CFR 146.92 (b)(2 – 4)).

Plug Information	Plug #1	Plug #2	Plug #3
Diameter of boring in which plug will be placed (in.)	Sensitive, Confidential, or Privileged Information		
Depth to bottom of tubing or drill pipe (ft)			
Sacks of cement to be used (each plug)			
Slurry volume to be pumped (ft^3)			
Slurry weight (lb./gal)			
Slurry Yield (ft^3/sack)			
Calculated top of plug (ft)			
Bottom of plug (ft)			
Type of cement or other material			
Method of emplacement (e.g., balance method, retainer method, or two-plug method)			

Table 8-3: Information on proposed well plugs.

8.5 Detailed Pre-Plugging Procedure

1. Notify EPA 60 days in advance of plugging via letter of intent, and 48 hours prior to commencing field operations. Ensure proper notifications and permits are in place and given to all regulatory agencies for rig move.

2. Ensure all permits for Plug & Abandonment (P&A) procedure and work plan have been approved and work authorized by the EPA. With the injection well falling under the EPA Class VI Permit jurisdiction, State and Local agencies do not require notifications.

3. Ensure that advance 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. Provide on-site and at well location of all copies of permits prior to initiating operations. Monitor and ensure all permit conditions of approval have been met.

5. Confirm all necessary forms for Owner are on the rig, i.e., permits, safety meetings, trip sheets, etc.

8.6 Detailed Plugging and Abandonment Procedure (Post-Injection)

1. Conduct and document a safety meeting.

2. Conduct bottom hole pressures and MITs. See Sections 8.2 and 8.3.

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. Sensitive, Confidential, or Privileged Information set retainer to cement the perforated portion of the well, and prepare for cement plugging operations. Pump 681 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.

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[redacted]

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 exquipment.

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 CFR 146.92 (d)).