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Plan revision date: August 2021

**INJECTION WELL PLUGGING PLAN
40 CFR 146.92(b)**

**Lorain Carbon Zero Solutions, LLC
Class VI Permit Application**

Facility Information

Facility name: Lorain County Landfill
Well No. CCS #1

Facility contact: Gary McCuistion/Division VP Business Development
Lorain County Landfill
43502 Oberlin-Elyria Road
Oberlin, Ohio 44074
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Well location: Oberlin, Ohio

Well No. CCS #1 Location (US STP NAD27 Ohio North)		
Location	Easting (X)	Northing (Y)
Surface	2087845	595505.8
Heel	2088075	595833.5
Toe	2090333	599058.5

Lorain Carbon Zero Solutions, LLC will conduct injection well plugging and abandonment according to the procedures below.

When the project is complete or the CCS #1 injection well has reached end of life, the well will be plugged and abandoned as per the requirements in 40 CFR 146.92. The plugging plan and materials used will be designed to prevent upward fluid movement in the wellbore, to protect against possible corrosion from the carbon dioxide/water injectate, and to protect the USDW. Any modifications or revisions to this plugging plan based on acquiring new information from the logging and testing of the well during well construction will be completed at that time. As such, the final plugging plan may differ from what is written below. The final plugging plan will be submitted to the UIC Program Director.

When final injection of carbon dioxide ceases, the wellbore will be flushed and filled with a kill weight brine fluid. Three injection tubing volumes of brine will be injected at pressure below the fracture pressure. A bottomhole pressure measurement will be made and the well will be logged and tested to ensure mechanical integrity prior to conducting the plugging operations. Once the injection tubing and packer are removed, the balanced-plug method will be used to plug the well. If the injection tubing cannot be removed, it will be cut off using a tubing cutter and the injection packer will be left in the well. Plugging the wellbore below the packer will be conducted by

using a cement retainer to squeeze cement below the packer in the wellbore and formation below it.

Once the wellbore is plugged, all casing strings will be cut at least 3 feet below ground level (surface). A work plate containing the required permit information will be welded to the top of the final casing string at ground level height.

Planned Tests or Measures to Determine Bottom-Hole Reservoir Pressure

Lorain Carbon Zero Solutions, LLC will run a bottomhole pressure gauge to the top of formation to record bottomhole pressure and calculate the kill fluid density.

Planned External Mechanical Integrity Test(s)

Lorain Carbon Zero Solutions, LLC will conduct at least one of the tests listed in Table 1 to verify external mechanical integrity prior to plugging the injection well as required by 40 CFR 146.92(a).

Table 1. Planned MITs.

Test Description	Location
Temperature Log	Along wellbore from total depth to surface using wireline or DTS.
Noise Log	Wireline well log
Oxygen Activation Log	Wireline well log

Information on Plugs

Lorain Carbon Zero Solutions, LLC will use the materials and methods noted in Table 2 to plug the injection well. The volume and depth of the plug or plugs will depend on the final geology and downhole conditions of the well as assessed during construction. The cement(s) formulated for plugging will be compatible with the carbon dioxide stream. The cement formulation and required certification documents will be submitted to the agency with the well plugging plan. The owner or operator will report the wet density and will retain duplicate samples of the cement used for each plug.

Table 2. Plugging details.

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)			

Plug Information	Plug #1	Plug #2	Plug #3
Slurry volume to be pumped (ft ³)	Sensitive, Confidential, or Privileged Information		
Slurry weight (lb./gal)			
Calculated top of plug (ft)			
Bottom of plug (ft)			
Type of cement or other material	CO ₂ resistant (EverCrete or equivalent)	CO ₂ resistant (EverCrete or equivalent)	Class A
Method of emplacement (e.g., balance method, retainer method, or two-plug method)	Balance Method	Balance Method	Balance Method

Narrative Description of Plugging Procedures

Notifications, Permits, and Inspections

In compliance with 40 CFR 146.92(c), Lorain Carbon Zero Solutions, LLC will notify the regulatory agency at least 60 days before plugging the well and provide updated Injection Well Plugging Plan, if applicable.

Plugging Procedures

1. Move in and rig up (MIRU) onto Well CCS #1. A well pad walkthrough will be done with the rig supervisor before the rig moves in. All CO₂ pipelines near the well will be identified, marked, and discussed with the rig supervisor at that time.
2. Conduct a safety meeting with all personnel on site.
3. Using electric wireline, run a downhole pressure gauge to the top of the open-hole section (currently planned for 5000 ft MD (4845 ft TVD)) and record bottomhole pressure to determine kill fluid density.
4. Open all valves on the wellhead tree to check pressures.
5. Test the rig pump and flow line to 2500 psig. Fill the injection tubing (capacity: 38 bbls) with the kill fluid (density of kill fluid 10 ppg [maximum density or may be less, TBD] brine). Pump two more volumes of the injection tubing capacity (total volume: 76 bbls).
6. Pressure up the casing-tubing annulus to 1000 psig and monitor pressure loss for 30 minutes (like an annual MIT). Bleed off the pressure after the test.
7. Monitor the tubing and casing pressure for at least 1 hour. If both the casing and tubing are dead, nipple up the blowout preventors (BOP).
8. If the casing and tubing are not dead, rig up a slickline unit and set a plug in the profile nipple below the injection packer. Circulate the tubing and annulus with kill weight fluid until the well is dead. After the well is dead, nipple up the BOP and conduct a function test on the BOP. **Sensitive, Confidential, or Privileged Information**

Sensitive, Confidential, or Privileged Information

9. Pick up on the tubing string and unlatch the seal assembly from the seal bore in the injection packer.
10. Rig up slickline and retrieve the plug from the profile nipple.
11. Pull out the injection tubing and lay it down.
12. Run in the well with packer retrieval tool on workstring and pull the injection packer out of the well. If unable to retrieve packer, cut tubing 5-10 ft above the packer and remove from the well.
13. Conduct MIT operations including: temperature log, noise log, and oxygen activation log.
14. Rig up cementing operations. **Sensitive, Confidential, or Privileged Information**
15. After waiting over night for the cement to set up, run in with the workstring and tag the top of the cement. If is below the 4700 ft, pump some more CO₂ resistant cement to bring up to 4700 ft.
16. Pump the second CO₂ resistance cement plug from 4700 feet to 4400 feet. Wait overnight before tagging. The CO₂ resistant cement plugs will be 16 ppg density, 1.3 ft³/sack yield. Total sacks: 118.
17. Wait overnight and tag the top of cement. If the plug is below 4400 feet, pump more CO₂ resistant cement to bring up to 4400 feet.
18. Pump Class A cement **Sensitive, Confidential, or Privileged Information**
19. After waiting overnight for cement to gain compressive strength for the final plug, nipple down BOP.
20. Cut all casing strings below the plow line (minimum 3 feet below ground level).
21. Rig down all equipment and move out. Clean the well cellar.
22. Weld a plate onto the lowest casing string at 3 feet. The plate will include well name.
23. All procedures described above are subject to change during the plugging process or if any changes are made during installation of the well. These procedures will be revised after the well is installed if needed. The Plugging report will be certified accurate by Lorain Carbon Zero Solutions, LLC and the plugging contractor and will be submitted to regulatory agencies within 60 days after plugging is completed.