Construction Details
40 CFR 146.86

Capio Sherburne Sequestration, LLC
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SCS ENGINEERS

Capio Sherburne CCS Well No. 1 | January, 2023

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Facility Information

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Well Name: Capio Sherburne CCS Well No. 1

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Well location: Sherburne Wildlife Management Area (WMA)
Pointe Coupee Parish, Louisiana
30.521385, -91.718429

Introduction

The construction details for the injection well are described herein. Capio Sherburne Sequestration, LLC ("Capio") proposes constructing one new injection well for the permanent sequestration of supercritical carbon dioxide ($scCO_2$). Capio will ensure that the injection well is constructed and completed to prevent the movement of fluids into or between USDWs or other unauthorized zones. Also, the well's construction will allow the use of appropriate testing devices and workover tools and continuous monitoring of the annulus space between the injection tubing and the long string casing.

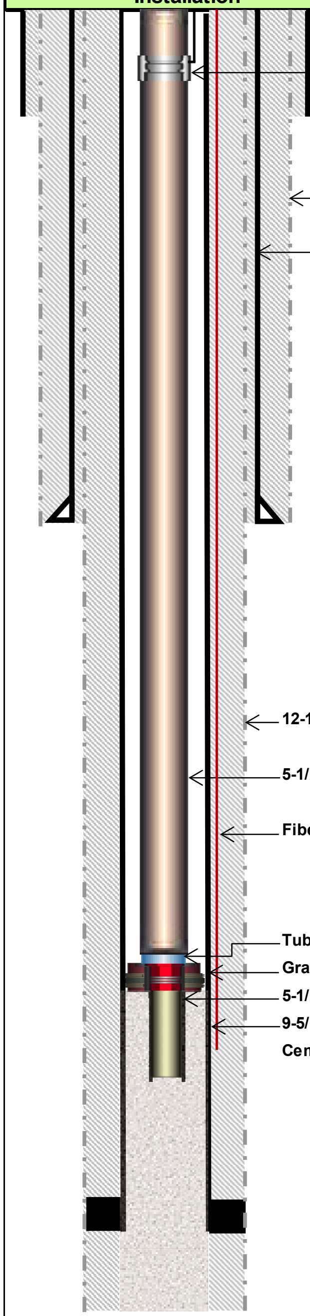
After the construction of the drilling pad, a conductor casing will be driven to the specified depth. A vertical well will be drilled and completed with a surface casing and long string-cased hole to a total depth of approximately 6,465 ft. The surface and long string casings will be cemented. The long string casing will be completed with CO_2-resistant cement from total depth through the confining zone. A conceptual well construction diagram is provided in **Figure 5-1**. Actual depths will depend on site-specific characterization data obtained when drilling the injection well.

Figure 5-1. Construction Diagram of Injection Well

Capio Sherburne CCS Well No. 1

Pointe Coupee Parish, Louisiana

Location: Lat.: 30.521385°, Long.: -91.718429°
Ground Level Elevation: 25'



Installation	Present Condition	OD	ID
		24"	
	5-1/2" Sub Surface Safety Valve at 100' (with SS Surface Control Line)		
	24" Conductor at 150'		
	17-1/2" Hole Drilled to 3000'		
	13-3/8", 68#, J-55 Casing @ 3000' (Cemented to Surface)	13.375"	12.515"
	12-1/4" Hole Drilled from 3000' to ~6225'		
	5-1/2", 17.0#, N-80, SMAX-TSR Tubing (Corrosion Resistant)	5.500"	4.892"
	Fiber Optic Sensor Line Strapped on 9-5/8" Casing to ~6206' (Top of ECP)		
	Tubing Seal Assembly (Stabbed into Seal Bore Packer)		
	Gravel Pack Liner Seal Bore Packer Top @ 6119' (Corrosion Resistant)		
	5-1/2" Gravel Pack Liner (Corrosion Resistant)		
	9-5/8", 43.5#, L-80, LT&C @ 6225' (Corrosion Resistant Pipe from 3200' to 6225') Cemented to surface (Corrosion Resistant Cement 3200' to 6206')	9.625"	8.755"

Formation	MD (ft)
Base of USDW	2700
Top Base Middle Miocene (2ndry conf. unit)	3165
Base Middle Miocene (2ndry conf. unit)	3630
Top Lower Mioocene Confining Int. (upper conf. unit)	5750
Base Lower Miocene Confining Int. (upper conf. unit)	6110
Top Sand 10	6110
Base Sand 10 (injection interval)	6210
Top Sand 11 (injection interval)	6250
Base Sand 11 (injection interval)	6440
Total Depth	6465

Prepared By: Irani Engineering	Date: 11/01/2022
Updated By: SCS Engineers	Date: 11/04/2022

Formation lithology and relative depths are described in Section 1 – Site Characterization. Based on the Class V characterization well, the bottom hole temperature at approximately 6,500 ft is 133 degrees Fahrenheit. The following subsections include information on construction procedures, casing cementing specifications, tubing and packer program, annulus fluid, and wellhead. Anticipated injection pressure, annulus pressure, and injection rate are in Section 7 – Well Operation.

Injection Well Construction Details

Pre-construction Activities

Prior to the beginning of drilling operations, Capio will work with the Louisiana Department of Wildlife and Fisheries to select a site and a drilling window that has the least impact on the normal operations of the Sherburne Wildlife Management Area. This includes planning around recreational activities such as hunting as well as being aware of mating seasons for certain protected species that may live in the WMA.

Construction Procedures

During drilling and completion operations, all activities are conducted in compliance with the Louisiana Office of Conservation and per 40 CFR 146.86. Drilling fluids will be maintained during all drilling stages to; control bottom hole pressures, support the wellbore and maintain stability, prevent formation influx and seal permeable formations, circulate cuttings away from the drilling bit to the surface, mitigate drilling damage to the targeted reservoir, and to cool the drilling bit and work string. Maintaining proper drilling fluids is important to prevent the movement of fluids into or between USDWs. Mud samples will be analyzed throughout drilling to ensure downhole pressure control. Well control will be maintained at all times through the use and frequent testing of blowout preventers. Care will be taken to prevent or minimize the discharge or spillage of construction-related fluids and debris. All personnel will be trained in proper emergency response, and a response plan will be maintained onsite. All drilling and completion activities will be annotated on daily drilling reports.

The following general construction procedures will be used in construction and completion of the injection well. Section 6 - Pre-Operational Logging and Testing contains information on deviation surveys, formation samples, logs, and tests to be conducted during drilling and before the operation of the injection well.

Prepare the location. Survey the well pad; provide notification of subsurface work to local underground utility location authority; conduct earthwork grading to level the location and construction well pad mats; drive conductor casing; excavate and board cellar; lay down containment where rig substructure will be placed.

Mobilize in and rig up. Set rig substructure and rig appurtenances; raise derrick and install remaining equipment; mix spud fluids; make ready to drill surface hole.

Drill and complete surface hole. Commence drilling a surface hole from surface to casing set depth; conduct deviation (1 degree or less) surveys; conduct logging; run casing with centralizers; cement casing with approximately 25% excess; wait on cement; run cement bond log.

Drill and complete production hole. Drill out float shoe; drill to core point; conduct straight hole surveys; run core barrels and bit to core confining interval; drill to core point; conduct straight hole surveys; run core barrels and bit to core injection interval; drill to total depth; condition hole; conduct logging; run casing with centralizers and strapped fiber optic monitoring system; cement casing with approximately 25% excess; wait on cement; pressure test casing; run cement bond log.

Run tubing and packer. Run tubing with packer; set packer; displace annular fluids with treated fresh water; set the liner hanger packer; pack off tubing in the surface head; top off annulus with treated fresh water; pressure test annulus.

Rig down and demobilize. Rig down; off-rent equipment; demobilize; restore location.

Pre-operational testing. Set wellhead and Christmas tree; pressure test of wellhead; conduct reservoir testing; test fiber optic monitoring system.

Proposed pilot hole depths and diameters are referenced in **Table 5-1**.

Table 5-1. Open Hole Diameters and Intervals

Name	Depth Interval (feet)	Open Hole Diameter (inches)	Comment
Conductor	150	N/A	Driven to bedrock
Surface	3,000	17½	Drilled to the primary seal
Intermediate	N/A	N/A	N/A
Long-string	6,225	12¼	Drilled to tubing seal assembly (stabbed into seal bore packer)

The operational injection schedule is presented in **Table 5-2**.

Table 5-2. Injection Schedule

Years	Injection Interval (Miocene Sand Identifier)	Volume (metric tons per year)
0-2	Bottom third Sand 11	750,000
2-4	Middle third Sand 11	1,000,000
4-6	Top third Sand 11	1,000,000
6-8	Bottom half Sand 10	1,000,000

Casing and Cementing

As specified in 40 CFR 146.86(b), casing and cement or other materials used in the construction of the injection well will have sufficient structural strength and be designed for the life of the geologic sequestration project. All well materials, including casing, cement, tubing, and packer will be compatible with fluids with which the materials may be expected to come into contact and will meet or exceed standards developed for such materials by the American Petroleum Institute

(API), ASTM International, or comparable standards. The casing and cementing program is designed to prevent movement of fluids into or between USDWs as summarized in **Table 5-3**.

Table 5-3. Casing Program

Casing[1]	Depth Interval (feet)	Outside Diameter (inches)	Inside/Drift Diameter (inches)	Weight (lbs/ft)	Grade (API)	Design Coupling	Burst Strength (psi)	Collapse Strength (psi)
Conductor	0 - 150	24	UNK	N/A	N/A	N/A	N/A	N/A
Surface	0 - 3,000	13⅜	12.259	68	J-55	STC	3,450	1,950
Intermediate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Long-string	0 - 3,200	9⅝	8.599	43.5	L-80	LTC	6,330	3,810
Long-string	3,200 - 6,206	9⅝	8.599	43.5	L-80, 25Cr[2]	LTC	6,330	3,810

(1) Conceptual casing program may be revised based on products available at the time of completion
(2) Super duplex 25 chrome stainless steel, corrosion resistant alloy

Casing centralizers will be used on the surface and long string casings to ensure sufficient cement bond to the borehole and casing. Float shoes will be run on the lowermost joint of the surface and long string casing strings. Surface casing will extend through the base of the USDW and will be cemented to the surface. One long string casing, using a sufficient number of centralizers to ensure proper cement bond, will extend into the injection zone and will be completed with conduits which allow for flow into the appropriate sand zone.

Cementing will occur in stages so that CO_2 resistant latex is uniformly placed from total depth through the confining zone. If cement returns are not observed at the surface remedial cementing techniques will be used to ensure sufficient bond. Cement and cement additives will be compatible with the carbon dioxide stream and formation fluids from total depth through the confining zone and of sufficient quality and quantity to maintain integrity over the design life of the geologic sequestration project. The integrity and location of the cement will be verified using cement bond logs and/or casing inspection logs capable of evaluating cement quality radially and identifying the location of channels to ensure that USDWs are not endangered. The conceptual cementing program is summarized in **Table 5-4**.

Table 5-4. Cementing Program

Casing	Casing Depth Interval (feet)	Borehole Diameter (inches)	Casing Outside Diameter (inches)	Cement Interval (feet)	Cement[1][2]
Conductor	0 - 150	24	24	N/A[3]	N/A[3]
Surface	0 - 3,000	17½	13⅜	0 - 3,000	1130 sacks Light cement (Class A, 12.80#, 1.85 cf/sk, 9.77 gal water/sk) premixed 1 #/sk pheno seal medium (lost circulation additive), 3% NaCl, followed with 470 sacks Standard cement (Class A , 15.6#, 1.18 cf/sk, 5.25 gal water/sk); If necessary, perform 80 sacks top job cement premixed 3% CaCl2 (top job will be performed if cement level drops in the annulus)
Intermediate	N/A	N/A	N/A	N/A	N/A
Long-string	0 - 3,200	12¼	9⅝	0 - 3,200	900 Sks Light Cement premixed with 3% KCl, 0.4% Halad-322, 0.25 PPS Pheno Seal, 0.1% FWCA, 0.2% HR-7(12.8 Lb/Gal, 1.48 CuFt/Sk, 7.63 Gal/Sk) followed with 1080 sacks Class A cement premixed with 1.5 gallons/sack Latex plus liquid dispersant, and liquid defoamer(1.1 ft^3/sk yield, 16.3 ppg); 60 sacks Class A with 3% CaCl2 top job if cement column drops
Long-string	3,200 - 6,206	12¼	9⅝	3,200 - 6,206	Lead: Halliburton's NeoCem™ 103 Cement Blend (CO_2 resistant); cement weight: 12.8 lb/gal; yield: 1.49 ft^3/sack; quantity: 483 sacks. Tail: Halliburton's CorrosaCem Cement Blend with 0.1% HR-5(PB), 2% latex and 0.08% Stabilizer 434D (CO_2 resistant); cement weight: 14.5 lb/gal; yield: 1.18 ft^3/sack; quantity: 609 sacks.

(1) Conceptual cement program may be revised based on similar products available at completion

(2) Cement calculations are estimates and include 25% excess

(3) Conductor casing driven, will not require cement

Tubing and Packer

Supercritical carbon dioxide will be injected into the well through tubing and packer that are comprised of corrosion resistant materials. The CO_2 stream will originate from two Capio-controlled facilities.

- Grön Fuels Renewable Diesel facility will generate up to 1.6 million metric tons annually
- Cyclus Steam & Power facility will generate up to 3.25 million metric tons annually

The cumulative CO_2 stream will be transported from the facilities to the injection well in a supercritical state. The anticipated CO_2 stream composition is characterized in **Table 5-5**.

Table 5-5. Chemical Composition of CO_2 Stream

Component	Pipeline Overall Fluid Value	Capio CryoCap™ FG Value	Units
CO_2	GT 96	GT 99	% vol.
CH_4, N_2, H_2, Ar	LT 4	LT 0.5	% vol.
H_2	LT 22	LT 1	ppmv
H_2O	LT 35	LT 35	ppmv
O_2	LT 10	LT 10	ppmv
H_2S	LT 10	LT 10	ppmv
SOx	LT 10	LT 10	ppmv
NOx	LT 10	LT 10	ppmv
CO	LT 100	LT 100	ppmv
NH_3	LT 30	LT 30	ppmv
VOC	LT 30	LT 50	ppmv
Mercury	LT 50	LT 100	ppbv
Total Metals	LT 10	LT 10	ppmw

GT = Greater than, LT = Less than

Tubing and packer materials used in the construction of the injection well will be compatible with fluids with which the materials may be expected to come into contact. These materials and/or coatings will meet or exceed standards developed by the API, ASTM International, or comparable standards.

A packer will be placed at the terminus of the injection tubing and isolate the annulus from the injection zone for continuous monitoring for tubing and packer leaks, as described in Section 8 – Testing and Monitoring. The packer will be installed inside the long string casing less than 100 feet above the perforated injection interval.

The tubing will stab into a seal bore packer, AS-1X mechanical packer (or equivalent). The packer will be manufactured or plated with corrosion resistant materials and will be rated with a minimum

7,000 psi differential, which exceeds the anticipated differential during installation, workovers, and injection.

Specifications for the conceptual design tubing and packer are provided in **Tables 5-6** and **5-7** below.

Table 5-6. Tubing Specifications[(1)]

Name	Depth Interval (feet)	Outside Diameter (inches)	Inside/Drift Diameter (inches)	Weight (lbs/ft)	Grade (API)	Design Coupling	Burst Strength (psi)	Collapse Strength (psi)
Injection tubing	5,950	5½	4.767	17	N-80, 25Cr	LTC	7,740	6,390

(1) Conceptual tubing program may be revised based on similar products available at the time of completion

Table 5-7. Packer Specifications[(1)]

Packer Type and Material	Packer Setting Depth (feet)	Length (inches)	Packer Main Body Outer Diameter (inches)	Packer Inner Diameter (inches)
Stainless steel, 7K, AS-1X	6,119	98	8.375	4.5

(1) Conceptual packer program may be revised based on similar products available at the time of completion

Annulus Fluid

The annular space above the packer between the long string casing and injection tubing will be filled with fluid to provide structural support for the injection tubing and continuous monitoring of internal mechanical integrity. If required, fluid pressure measured at the surface within the annulus will be maintained to exceed the maximum injection pressure within the injection tube at the elevation of the injection zone. This pressure differential (surface) will not exceed a value that is more than 200 psi greater than the injection pressure at the surface. Assuming packer placement at a measured depth of 6,119 ft, the volume of the annular space will be approximately 11,585 gal.

The annulus fluid will be freshwater with a corrosion inhibitor, biocide, and an oxygen scavenger. Depending on final selection of tubing, long string and packer materials, the annulus may include a dilute salt solution such as potassium chloride (KCl), sodium chloride (NaCl), calcium chloride (CaCl2), or similar solutions. The fluid will be mixed onsite using freshwater or it will be acquired pre-mixed. The fluid will also be filtered to ensure that solids do not interfere with the packer or other components of the annulus monitoring system.

Wellhead

The wellhead and Christmas tree will be composed of materials compatible with the injection fluid to minimize corrosion. In general, all components that come into contact with the CO2 injection fluid will be made of a corrosion-resistant alloy such as stainless steel. Because the CO2 injection fluid will be very dry, use of stainless-steel components for the flow-wetted components is a conservative measure to minimize corrosion and increase the life expectancy of this equipment. Materials that will not have contact with the injection fluid will be manufactured of carbon steel. All materials will comply with the API Specification 6A – Specification for Wellhead and Christmas Tree Equipment.