CLASS VI PERMIT APPLICATION NARRATIVE
40 CFR 146.82(a)

Bluebonnet Sequestration Hub

1.0 Project Background and Contact Information

Facility name: Bluebonnet Sequestration Hub
Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6 and Bluebonnet CCS 7 Wells.

Facility contacts: [redacted], Project Manager
5 Greenway Plaza Houston, TX 77046
[redacted]

Well location: Chambers County, Texas

Well Name	Latitude (NAD27)	Longitude (NAD27)
Bluebonnet CCS 1	[redacted]	[redacted]
Bluebonnet CCS 2	[redacted]	[redacted]
Bluebonnet CCS 3	[redacted]	[redacted]
Bluebonnet CCS 5	[redacted]	[redacted]
Bluebonnet CCS 6	[redacted]	[redacted]
Bluebonnet CCS 7	[redacted]	[redacted]

The advancement of carbon capture and sequestration (CCS) technology is critically important in addressing CO_2 emissions and global climate change concerns. The Bluebonnet Sequestration Hub is designed to demonstrate utility-scale integration of transport and permanent storage of captured CO_2 into a deep geologic formation.

The Bluebonnet Hub will display that the geologic sequestration process can be deployed safely, ensuring retainment of the injected CO_2 within the intended storage reservoir and protection of the underground sources of drinking water (USDW). By using safe and proven pipeline technology, the CO_2 will be transported to a storage site located in Chambers County, Texas, where it will be injected into the Lower Miocene, Frio, and Hackberry formations utilizing six newly built dedicated CO_2 injector wells, Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6 and Bluebonnet CCS 7. A total of [redacted] million metric tons (MMT) is estimated to be stored during the 20-year injection period.

The Bluebonnet Hub is strategically located near a concentration of industrial power-generating plants, refineries, and chemical production, natural-gas processing, and natural-gas liquefaction facilities along the Gulf Coast, from the Beaumont/Port Arthur area to the east and to the Houston area in the west.

The project will get custody of the CO_2 captured by these emitters through offtake agreements and transport the captured CO_2 via a third-party pipeline to the site, where the CO_2 will be stored. Bluebonnet Sequestration Hub, LLC, (through its affiliates) has leased approximately [redacted] acres across Chambers, Liberty, and Jefferson Counties, as part of the project development. These agreements include rights to sequester CO_2 in the pore space, surface use, and land access necessary to facilitate this proposed carbon sequestration project.

GSDT Submission - Project Background and Contact Information
GSDT Module: Project Information Tracking ***Tab(s):*** General Information tab; Facility Information and Owner/Operator Information tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒Required project and facility details ***[40 CFR 146.82(a)(1)]***

2.0 Site Characterization

The Bluebonnet Sequestration Hub is located approximately [redacted] miles east of Houston on the Lower Coastal Gulf Plain, where the topographic elevation ranges from 25 – 40 ft above mean sea level, with site access available via roads.

The surface geology of the proposed site is characterized by the clay, silt, and sand-rich deposits of the Beaumont Formation. The site contains several freshwater bodies such as lakes/ponds, canals, ditches, and a slow-moving bayou. The site is partially classified as farmed palustrine wetland among minor other wetland types.

No previously recorded National Register of Historic Places (NRHP) districts or properties, sites designated as State Antiquities Landmarks, Recorded Texas Historic Landmarks, or historical markers are within the project Area of Review (AoR). The Texas Archeological Sites Atlas (TASA) revealed no previously recorded archaeological sites within 0.5 mile of the proposed project area.

No schools, hospitals, or nursing homes are known within the AoR. There is a local small-craft airport, a major interstate (I-10), [redacted] residential houses or small farms, and [redacted] within the boundaries of the AoR.

No Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), aka Superfund, or Resource Conservation and Recovery Act (RCRA) sites were identified. No springs, no mines or mineral deposits, and no quarries were identified in the AoR.

Oxy Low Carbon Ventures, LLC, the parent company of Bluebonnet Sequestration Hub, LLC, drilled and completed Encanto 01 as a stratigraphic test well in 2022-2023, and acquired an extensive set of site-based data to complete the site characterization and AoR delineation. The project also drilled a shallow water well to refine the base of USDW with multiple fluid samples above and below the USDW. The different datasets across multiple disciplines acquired in these two wells have been integrated and are presented in this permit.

Claimed as PBI

[redacted]

Figure NAR-1: Bluebonnet Hub location with respect to potential remediation sites, existing legacy wells, water bodies, spring, mines, quarries, surface infrastructure, and State, Tribal and Territory boundaries as well as roads.

The Bluebonnet Sequestration Hub accommodates a stacked storage complex, located in a structural province called the Houston Embayment, into which the Houston Delta deposited thick Tertiary siliciclastic sediments. In this embayment, the formation dip is relatively flat and steepens with depth at varying rates ranging between [redacted]. The present-day structure is oriented towards the Southeast, i.e., in the direction of the Texas Gulf coastline. Tertiary sediments were deposited by fluvial-deltaic processes associated with the Houston Delta. This resulted in a series of gulfward-thickening formations, comprised of stacked porous sandstones overlain by confining low-permeability strata.

Within the Bluebonnet Sequestration Project site, areal sand trends of the [redacted] were mapped, providing largescale storage capacity, which are capped [redacted]

2.1 Regional Geology, Local Structural Geology, Injection & Confining Zone Summary [40 CFR 146.82(a)(3)(vi)], [40 CFR 146.82(a)(3)(iii)]

The Bluebonnet Sequestration Hub is located on the Texas Gulf Coast, approximately 20 miles inland, within a structural province called the Houston Embayment, into which the Oligocene-aged Houston Delta, and the Lower Miocene-aged Newton fluvial system and Calcasieu delta systems deposited Tertiary siliciclastic sediments. These sediments were transported to the coastal margin by rivers and subsequently deposited in deltas or reworked by marine processes.

Three examples of these fluvial-deltaic siliciclastic sedimentary systems are the [redacted] which are the three proposed injection zones for permanent CO_2 storage. The deposition of these gulfward-prograding depocenters was interrupted repeatedly by marine transgressions during the Oligocene, where the continental platform was submerged over a widespread period. These flooding events reflect increases in sea level and associated shale deposition, one of which is the prominent regional marine shale, the [redacted], which represents one of the five proposed confining units, capping the proposed [redacted] capping the [redacted] however are mostly composed of nonmarine coastal plain mudrocks, because at that time the system had evolved into a terrestrial environment.

At the time of deposition, the Bluebonnet Sequestration Hub was located on the landward updip stable shelf of the Gulf Coast basin, where contemporaneous growth faults developed parallel to the shelf margin and syndepositional movement resulted in sediment thickening on the downthrown side of the faults. Various faulting styles within the Bluebonnet 3D seismic region were evaluated extensively to ensure that the AoR selected for the Bluebonnet Sequestration Hub has no faulting that would impact the integrity of the storage complex.

The proposed storage complex includes, from top to bottom (shown in Figure NAR-2):

- [redacted]

- [redacted]

Only modeling purposes in CMG the study was divided into two storage complex the [redacted] Complex and the [redacted] Complex. [redacted] Complex includes the formations from the [redacted]. The [redacted] Complex includes the formations from the [redacted].

The [redacted] is laterally continuous in a north-south dip direction and is better developed in the northern updip part of the proposed AoR and thins toward the south and downdip. The [redacted]s also continuous in an east-west strike direction within and beyond the AoR, where minor thickness changes occur as well. The sandstones within the [redacted] were likely deposited in a proximal delta front and are characterized by high porosity and permeability, both critical parameters for input in the storage capacity and injectivity estimations.

[redacted] are composed of a series of fluvial/deltaic and marginal-marine to nonmarine sands. Based on whole core data, the internal architecture of the [redacted] These sands exhibit high porosity and permeability as well. The structure of the injection zone is a gently southeast-dipping monocline inside the proposed AoR. The [redacted] is laterally continuous in a north-south dip direction, beyond the limits of the AoR. [redacted] log signatures are correlative and very similar among the offset wells, which indicates preferred connectivity of reservoir properties in a dip direction. [redacted] is also laterally continuous in an east-west strike direction, beyond the limits of the AoR; however, small scale well-to-well lateral facies changes are expected, affecting the injectivity within the multiple stacked flow units of the [redacted] due to sedimentary distribution patterns, which are oriented perpendicular to the coastline.

The [redacted] is characterized by a fluvial-deltaic system that received sediment from the north. Multiple stacking of sedimentary deposits is observed including meander belts, storm washover deposits and crevasse splays in a mixed load system. These [redacted] are fine- to medium grained, very unconsolidated and contain sediment structures ranging from massive to low- and high-angled cross stratification as well as soft-sediment deformation. The porethroats are large and well interconnected, resulting in high porosity and permeability measurements. Different depositional environments exist within the individual subzones, which are perforated and injected into separately at different times.

The [redacted] are laterally continuous in north-south dip and east-west strike directions, with typical shale thickening towards the south and downdip. These marine transgressive shales reflect flooding events when the Gulf Coast was submerged under water due to rises of sea level and thus are excellent stratigraphic markers. Sequence stratigraphic analysis confirms the continuity of these confining zones. These compact shales are of marine origin and contain varying amounts of silt and bioturbation, depending on water depth. Overall, they are characterized by low permeabilities. [redacted] Depending on the individual rock fabric, mineralogy, porosity, permeability, and capillary pressure measurements, these shales offer good to excellent seal potential to contain the injected CO_2 within the injection zones.

[redacted]

[redacted]

Figure NAR-2: Proposed storage complex at Bluebonnet Sequestration Hub, identifying formations and elements of the storage complex. [redacted] zones as containment. After BEG 2017.

Claimed as PBI [redacted]

Figure NAR-3: Regional structural dip cross section through the Area of Interest (AOI), highlighting the proposed storage complex; scale 1:8,000. Claimed as PBI [redacted] **Major faults are highlighted in black. The base of Underground Sources of Drinking Water (USDW), below which TDS>10,000 mg/L is shown in dashed blue.**

2.2 Faults and Fracture Analysis and Structural Styles [40 CFR 146.82(a)(3)(ii)]

The AoR was chosen due to the lack of seismic-scale faulting within the Claimed as PBI [redacted] (Figure NAR-4). The structural styles interpreted from 3D seismic data include regional growth faulting, salt doming, transtensional faulting, and growth fault reactivation. All of these identified structural styles fit within the larger regional context and are common along the Texas Gulf Coast. Fault interpretation was manually performed with additional context provided by seismic attribute enhancements. Large-scale movement of the regional faults ceased prior to the end of Frio deposition and strain resulting from subsequent loading is concentrated more discreetly along select zones of weakness.

Claimed as PBI [redacted]

Figure NAR-4: Example map view of fault likelihood extraction on confining zone surfaces with 3D seismic cross section for reference. There is no evidence for faulting within the AoR at the Claimed as PBI [redacted] Claimed as PBI [redacted].

Fault seal analysis was performed on all faults included in the geomodel. Two techniques were performed, shale gouge ratio and CO_2 column height modeling (Figure NAR-5). The results from the independent techniques are complementary and demonstrate that the fault offset is sufficiently large for the modeled faults to seal in all the examined confining and injection zones.

[redacted]

Figure NAR-5: [redacted].

2.3 Petrophysical Information [40 CFR 146.82(a)(3)(iii)]

In the geomodel for the [redacted] complex, the net effective porosity in the main injection zones, [redacted] with a net sand thickness from [redacted] and an average permeability that ranges from [redacted] The confining zones' net effective porosity ranges from [redacted] the gross thickness from [redacted], and an average permeability from [redacted]. The average reservoir properties are calculated with the volume of shale cutoff [redacted]

In the [redacted]complex, the average of the effective porosity is 20[redacted]th an average gross thickness of 1,0[redacted] an average permeability of 3.8 [redacted]the [redacted] the average effective porosity is [redacted], with a gross thickness of [redacted] and an average permeability from [redacted]Figure NAR-6).

Claimed as PBI

[redacted]

Figure NAR- 6 : Geomodel net effective porosity, permeability, net sand and thickness over the injection's zones (Average reservoir properties used <= Claimed as PBI [redacted] hale as a cutoff) for Claimed as P [redacted] alculated in the petrophysical analysis, permeability and gross thickness.

2.4 Seal Capacity Analysis in Confining Zones Summary [40 CFR 146.82(a)(3)(iii)]

The Bluebonnet Hub project team performed the seal capacity analysis for the confining zones utilizing data from MICP (Mercury Injection Capillary Pressure). The project also performed additional tests to obtain the threshold entry pressure (TEP). The integration of MICP seal capacity analysis and TEP results obtained so far are explained in Appendix A.

The seal capacity of a particular formation or zone will vary based on the pore system. Claimed as PBI [redacted] are composed of layers that are highly effective as confining zones, intercalated with some slightly transmissive layers that, all together, provide the seal capacity of the zone. Table NAR-1 shows the results of the seal capacity analysis for each of the confining zones in terms of displacement pressure and reservoir height. Details of the seal capacity analysis for each confining zone are presented in the Appendix A of the AoR and Corrective Action Plan of this application.

Table NAR-1: Displacement pressure and reservoir height.

Claimed as PBI [redacted]

2.5 Geochemical Modeling [40 CFR 146.82(a)(6)]

The Bluebonnet Hub project team conducted a geochemical equilibrium modeling to identify primary chemical reactions (solid and aqueous phase) to be included into the reactive-transport simulations and provide an initial assessment of the CO_2 compatibility with rocks and fluids present in the confining and reservoir zones. Claimed as PBI [redacted] geochemical interactions were modeled separately as two independent systems and include: Claimed as PBI [redacted] The modeling included brines speciation, geochemical baseline prior injection, and CO_2 interaction with reservoir brine and minerals.

Fluid-rock interactions were found to be largely similar for the Claimed as PBI [redacted] models. Claimed as PBI [redacted].

Reactive-transport simulations were conducted to evaluate geochemical impacts on reservoir storage capacity, possible injectivity modification, and long-term trapping mechanisms. Porosity slightly increased with a maximum of Claimed as PBI [redacted] from the start of injection up to about 100 years after injection. Results at long timescales (100s of years) post-injection show injection zones Claimed as PBI [redacted] Maximum porosity reduction from mineral precipitation was about Claimed as PBI [redacted] the region where the CO_2 plume contacted the reservoir.

Porosity remained unchanged for the Claimed as PBI [redacted] Claimed as PBI [redacted]. Claimed as PBI [redacted] and no significant changes are observed in the current models that would comprise their integrity.

The main trapping mechanisms during injection periods are the super-critical phase as mobile and trapped CO_2. Post-injection, super-critical mobile CO_2 steadily decreases, reaching close to zero at long timescales. Mineral CO_2 storage is negative during injection periods due to calcite dissolution and release of HCO_3^-. Trapping of CO_2 predominantly occurs in a residual phase for several hundred years post-injection, during which time CO_2 is slowly trapped as carbonate precipitation. Mineralization (calcite) of injected CO_2 eventually becomes the dominant and permanent CO_2 trapping mechanism.

2.6 Geomechanics Study [40 CFR 146.82(a)(3)(iv)]

In the case of CO_2 injection into the reservoir, pore pressure and horizontal principal stress magnitudes increase while decreasing the magnitude of the effective principal stresses. The stress model was constrained by core measurements and calibrated to pressures and interpretations of minimal principal horizontal stress from wellbore pressure tests. Pore pressure increases required to cause failure on a hypothetical, optimally oriented fault and matrix are summarized in Table NAR-2. The Mohr Coulomb failure analysis was conducted at a particular depth and is representative of the entire formation.

Table NAR-2: Summary of pore pressure increase (psi) required to cause failure in a hypothetical, optimally oriented fault and matrix in formations identified as confining and injection zones.

Claimed as PBI [redacted]

The maximum expected increase in well bottomhole pressures for Claimed as PBI [redacted].

2.7 Hydrogeology and Underground Source of Drinking Water [40 CFR 146.82(a)(3)(vi), 146.82(a)(5)]

Groundwater production for drinking and municipal use in Chambers, Liberty, and Jefferson Counties, Texas, is primarily sourced from the Chicot Aquifer, the shallowest of three primary aquifers that make up the overall Gulf Coast Aquifer. The primary recharge mechanism for fresh groundwater is precipitation and infiltration that has not been consumed as runoff or stream flow. Aquifers under the Chicot Aquifer in the project area are generally considered too saline for drinking water and few water supply wells in the area penetrate the deeper Evangeline and Jasper Aquifers. Figure NAR-7 shows the geologic and hydrogeologic units of the Gulf Coast Aquifer system.

The USDW is defined by the Environmental Protection Agency (EPA) as an aquifer or part of an aquifer that contains fewer than 10,000 ppm total dissolved solids (TDS). Publicly available studies suggest base USDW depth ranges from Claimed as PBI [redacted] (lower Chicot Aquifer) across Chambers and Jefferson Counties. Within the Bluebonnet Sequestration project site, USDW depth ranges between Claimed as PBI [redacted]. Multiple fluid samples were acquired in a shallow water well above and below the USDW to reduce the uncertainty in salinity variations with depth and to assess salinity-depth relationships. The salinity-depth relationships were Claimed as PBI [redacted] Fluid samples and well logs were used to support base USDW interpretation.

Figure NAR-8 shows a cross-section for the base of the USDW in Bluebonnet Hub AoR.

Claimed as PBI

Figure NAR-7: Geologic and hydrogeologic units of the Gulf Coast Aquifer system, modified from Young et al. (2016).

Claimed as PBI

Figure NAR-8: Base of USDW shown in blue following the LDNR-IMD deep resistivity method. Site-specific RDT fluid samples acquired from Bluebonnet USDW 01 (offsetting Encanto 01) showed TDS values >10,000 mg/L in the Claimed as PBI **and are compared to the interpreted base Moderately Saline Zone (10,000 mg/l TDS) after Young et al. (2016).**

2.8 Seismic History [40 CFR 146.82(a)(3)(v)]

Regional earthquakes were identified using the USGS online database, cross-checked against the Bureau of Economic Geology's TEXNET database to determine the location of events (Figure NAR-9). No recorded events of any magnitude from 1900 to present were identified within 50 miles of the Bluebonnet site. A single earthquake was identified within a 75-mile radius of the Bluebonnet project: a magnitude 3.8 event occurring 1 km WNW of Sulphur, Louisiana, in 1983 at a depth of 5.9 km. The USGS Long-Term Seismic Hazard Map indicates that this area is at relatively low risk for natural earthquake activity. Plans for Bluebonnet include placement of a dense network of seismometers that will offer reliable location of seismic events with magnitude as small as 0.0 on the Richter scale (also shown in Figure NAR-9).

Claimed as PBI [redacted]

Figure NAR-9: Seismometer stations (green and white circles) and historic seismic activity (yellow star).

2.9 Geocellular and Dynamic Model Construction – Claimed as PBI Injection Zones

The static geomodel was created using Schlumberger Petrel (v2021) and is based on the interpretation of a diverse collection of geological, geophysical, and petrophysical data acquired throughout public data, literature, and in-house 3D seismic data.

The methodology applied to the static geomodel was to model the large-scale features, followed by modeling progressively smaller and more uncertain features. The first step applied to the Bluebonnet geomodel was to establish a conceptual structural and depositional model as well as its characteristic stratigraphic layering. The structural and stratigraphic architecture provided a first-order constraint on the spatial continuity, porosity, permeability, net sand, and other attributes within each layer. Next, petrophysical values were distributed for each zone using a cell-based methodology.

The project used [redacted] with quality logs and reservoir top data, in conjunction with 3D seismic data, to construct reservoir top surfaces. [redacted] of these wells also had the appropriate digital logs to be petrophysically analyzed and used in building the petrophysical property models. [redacted] of these wells have basic logs and have been used to pick the formation tops.

The model includes several major geological zones, from top to bottom: [redacted] The model covers an area of about [redacted] The bottom confining zone is the [redacted] The grid cell area is consistent throughout the geomodel area at [redacted] The grid thickness varies somewhat but averages about [redacted] The final geomodel is represented by a [redacted]rid in a Cartesian system for a total of [redacted] active grid cells.

The total porosity of the injection zone is based on neutron and density porosity logs from [redacted] within and around the Geomodel Domain (see Figure NAR-10). An interconnected (effective) porosity for wells with porosity logs was calculated from total porosity corrected for the shale volume. The remaining wells did not have neutron and/or density porosity logs but were required for porosity calculations in the petrophysical interpretation. A linear correlation between volume of shale and effective porosity from wells with porosity logs developed by the GCCC (Frio Pilot in CO_2 Sequestration in Brine – Bearing Sandstones, Hovorka et al. 2003) was used and corroborated with local data. The results of this method compared largely with the [redacted] subset, so the linear correlation was applied to the remaining wells.

T[redacted],

[redacted]

Figure NAR-10: Map representing [redacted]ells within and surrounding the Bluebonnet Hub AoR used for petrophysical interpretation of porosity, permeability, and net reservoir thickness of the [redacted] Injection Zone, and Confining Zones. A total of [redacted] wells are within the geomodel. Pie charts outlined in blue represent [redacted] with neutron and density well-logs. The stratigraphic well Encanto 01 is identified with a black star.

2.10 Geocellular and Dynamic Model Construction – [redacted] Injection Zone

The [redacted] static geomodel was built with collaborative interpretation of a diverse collection of geological, geophysical, and petrophysical data acquired from public databases, published literature, in-house studies, and in-house 3D seismic data. The geological subzones were created from horizons based on a combination of well log correlations in combination with the 3D seismic horizon interpretation. The internal layer subdivisions of the zones were based on the interpretation of digital well logs to determine the thickness of each subzone.

The model includes several major geological zones: [redacted] each with additional vertical layers to capture reservoir heterogeneity. The model extent covers approximately [redacted]. The top and bottom confining zones are the Lower Miocene Shale (LMIO_Shale_CZ) and Anahuac Shale (Anahuac_CZ), respectively.

Model horizons were first interpreted from available well log datasets, including depth-registered image logs and digital log data. These horizons were then combined with interpreted 3D seismic data to provide more accurate control of horizon construction where log data may be sparse. The methodology applied to the static geomodel was to model the large-scale features, followed by modeling progressively smaller and more uncertain features. The first step applied to the Bluebonnet geomodel was to establish a conceptual structural and depositional model as well as its characteristic stratigraphic layering.

Lithofacies logs were upscaled and propagated into the 3D grid using a Sequential Indicator Simulation (SIS) algorithm, conditioned by probability trend maps from depositional trends and seismic attributes. Porosity logs were upscaled and distributed using a Sequential Gaussian Simulation (SGS) algorithm, constrained by lithofacies and co-kriging with depositional trends. Permeability was modeled similarly, with co-kriging using the porosity model. Claimed as PBI [redacted]

2.11 Site Storage Capacity and CO_2 Retention

The dynamic simulation model provides an advanced method for determining the storage capacity. Details of the construction and physics of the base case dynamic model are described in detail in the Area of Review and Corrective Action Plan. The base case model includes CO_2 dissolved in the aqueous phase or as free or trapped supercritical CO_2 but does not model trapping due to mineralization. Figure NAR-11, Figure NAR-12 and Figure NAR-13 show the change in storage capacity and CO_2 plume area with time from the dynamic simulation, forecasted for Claimed as PBI [redacted] after injection.

Claimed as PBI [redacted]

Claimed as PBI

[redacted]

Figure NAR-11: CO_2 plume area and storage capacity from dynamic simulation, from start of injection to 100 years post injection in Claimed as [redacted] Injection Zone.

Claimed as PBI

[redacted]

Figure NAR-12: CO_2 plume area and storage capacity from dynamic simulation, from start of injection to 100 years post injection in the Claimed as PBI [redacted] Injection Zone.

[redacted]

Figure NAR-13: CO_2 plume area and storage capacity from dynamic simulation, from start of injection to 100 years post injection in the [redacted] Injection Zone.

More detailed geological description and site characterization is included in the AoR and Corrective Action Plan attachment of this application.

3.0 AoR and Corrective Action [40 CFR §146.82(a)(13)]

3.1 Definition of CO_2 Plume and Pressure Front – [redacted]jection Zones

As described in Section 2.9 above, the static geocellular models was constructed using Schlumberger's Petrel (v2021) 3D geostatistical modeling software, which is a comprehensive, integrated subsurface platform containing data interpretation tools for well correlation, mapping, and structural and property modeling.

The dynamic simulation model was created using the GEM (v2023.30) reservoir simulator with the Greenhouse Gas (GHG) module, from Computer Modeling Group Ltd. (CMG). GEM is a commercially available, compositional, and finite-difference simulator that is commonly used to model hydrocarbon production, enhanced oil recovery, and other thermodynamic and fluid flow reservoir processes. The GHG module accounts for the thermodynamic interactions between three phases: an H_2O-rich phase (liquid), CO_2-rich phase (gas), and a solid phase, which may include several minerals. Physical properties (e.g., density, viscosity, enthalpy) of the H_2O and CO_2 phases and CO_2 solubility in H_2O are calculated from a correlation suitable for a wide range of typical storage reservoir conditions.

Claimed as PBI [redacted]

Claimed as PBI [redacted]

Table NAR-3: Stage injection, injection, and production rate for all the wells.

Claimed as PBI [redacted]

The CO_2 plume extent was simulated assuming Claimed as PBI [redacted] of injection as described in the previous section. The project simulated Claimed as PBI [redacted] post-injection as well as Claimed as PBI [redacted] post-injection. The plume tends to stabilize before the end of the Claimed as PBI [redacted] post-injection period; however, the project defined the Claimed as PBI [redacted] plume outline to delineate the maximum extend of the CO_2 plume in the AoR as a conservative approach. The project used a cutoff of [redacted] [redacted] [redacted] Claimed as PBI [redacted]

[redacted] Figure NAR-14 and Figure NAR-15 show the pore-volume-weighted CO_2 saturation map distribution for the [redacted] Injection Zones, respectively.

[redacted]

Figure NAR-14: Pore-volume-weighted CO_2 saturation map distribution after [redacted] MT CO_2 injection in the [redacted] Injection Zone.

Claimed as PBI [redacted]

Figure NAR-15: Pore-volume-weighted CO_2 saturation map distribution after Claimed as PBI [redacted] MT CO_2 injection in the Claimed as PBI [redacted] zone.

The Bluebonnet Hub project team evaluated different approaches to estimate the critical pressure threshold as describe in the AoR and Corrective Action Plan attachment. Claimed as PBI [redacted]

Figure NAR-16 and Figure NAR-17 shows the critical pressure delineation for Claimed as PBI [redacted] Injection Zones.

Claimed as PBI [redacted]

Figure NAR-16: View of highest pore-pressure increases after Claimed as PBI MT of total CO_2 injection in Claimed as [redacted] Values displayed are pore-volume-weighted averages across the injection interval. The orange polygon is the pressure front for the Claimed as PBI.

Claimed as PBI [redacted]

Figure NAR-17: View of highest pore-pressure increases after Claimed as PBI of total CO_2 injection in Claimed as PBI [redacted] Values displayed are pore-volume-weighted averages across the injection interval. The purple polygon is the pressure front for Claimed as PBI [redacted] Zone.

3.2 Definition of the CO_2 Plume and Pressure Front – Claimed as PBI Injection Zones

As described in Section 2.10 above, the static geocellular models were constructed using Schlumberger's Petrel (v2023.7.0) 3D geostatistical modeling software.

The dynamic simulation model was created using the GEM (2024.10) reservoir simulator with the Greenhouse Gas (GHG) module, from Computer Modeling Group Ltd. (CMG). GEM is a commercially available, compositional, and finite-difference simulator that is commonly used to model hydrocarbon production, enhanced oil recovery, and other thermodynamic and fluid flow reservoir processes. The GHG module accounts for the thermodynamic interactions between three phases: an H_2O-rich phase (liquid), CO_2-rich phase (gas), and a solid phase, which may include several minerals. Physical properties (e.g., density, viscosity, enthalpy) of the H_2O and CO_2 phases and CO_2 solubility in H_2O are calculated from a correlation suitable for a wide range of typical storage reservoir conditions.

[redacted]

Table NAR-4: Stage injection, injection, and production rate for all the wells.

[redacted]

The CO_2 plume extent was simulated assuming [redacted] of injection as described in the previous section. The project simulated [redacted] as well as [redacted] The plume tends to stabilize before the end of the [redacted]ost-injection period; however, the project defined the [redacted] outline to delineate the maximum extend of the CO_2 plume in the AoR as a conservative approach. The project used a cutoff of [redacted] [redacted] as supported by the fluid substitution analysis. Figure NAR-18 show the CO_2 saturation map distribution for the [redacted] Injection Zone at [redacted] of Post-Injection.

[redacted]

Figure NAR-18: CO_2 saturation map distribution after [redacted] CO_2 injection in the [redacted] Injection Zone.

The calculated critical pressure differential for the Bluebonnet Hub is [redacted] Injection Zone. Figure NAR-19 shows the critical pressure delineation for the [redacted] Injection Zone.

Claimed as PBI

Figure NAR-19: View of highest pore-pressure increases in the Claimed as PBI Injection zone at Claimed as PBI of the injection period. The red polygon is the critical pressure for the Claimed as PBI Injection Zone.

3.3 Delineation of Bluebonnet Hub AoR

For the Claimed as PBI Confining Zone, Claimed as PBI as well as the base of USDW, Claimed as PBI as the confining zones are utilized for both storage complexes and also to capture the largest footprint to assess and mitigate any potential USDW contamination.

[redacted]

Figure NAR- 20: Combined AoR [redacted]

3.2 Corrective Action Plan

The proposed AoR represents approximately [redacted] of extension (combination of pressure front at [redacted] of injection and CO_2 plume [redacted]) and includes [redacted] legacy oil and gas wells and [redacted] according to the records obtained. The area is dedicated mostly to farming and recreational activities. Oil and gas development is present in areas outside of the AoR; however, exploration activities in the proposed AoR have not proved to be economical, as all the legacy wells were classified as dry holes.

The [redacted] wells inside the AoR targeted the Chicot aquifer. These wells are dedicated to domestic use, stock, rig supply, and groundwater monitoring activities. The measured depths range from [redacted] None of these forty wells penetrated the confining or injection zone; thus, none require any corrective action. The deepest well number 668850 correspond to the Bluebonnet USDW 1 well built by the project in 2024 in order to characterize the surface aquifers and will be used as part of the monitoring program proposed in this application.

All but one of the [redacted] oil and gas wells identified in the proposed AoR were drilled through the [redacted].

A detailed analysis was performed to evaluate the risk and timing of the plume and/or pressure front reaching each of the wells inside the AoR, relative to the project schedule, to propose corrective actions and a timeline for these procedures.

From the individual well analysis, [redacted] of the [redacted] wells were identified as requiring remedial actions to isolate the injection zone properly from the USDW zones. These wells are listed in the AoR and Corrective Action attachment, along with the main mechanism of failure and proposed schedule. The project plans to complement this evaluation with a [redacted] in the proposed area before starting construction operation and injection, to adjust the corrective action schedule and program.

At a fixed frequency specified in the Area of Review and Corrective Action Plan or more frequently when monitoring and operational conditions warrant, Bluebonnet Sequestration Hub, LLC, will reevaluate the AoR and perform any required corrective action in the manner specified in 40 CFR §146.84. As part of this reevaluation process, Bluebonnet Hub must also update the Area of Review and Corrective Action Plan or demonstrate to Environmental Protection Agency (EPA) Underground Injection Control (UIC) Program Director that no update is needed.

Following each Area of Review and Corrective Action Plan reevaluation or demonstration showing that no new evaluation is needed, the Bluebonnet Hub shall submit the resultant information in an electronic format to the UIC program Director for review and approval of the results. Once approved by the UIC Program Director, the revised Area of Review and Corrective Action Plan will become an enforceable condition of this permit.

AoR and Corrective Action GSDT Submissions
GSDT Module: AoR and Corrective Action ***Tab(s):*** All applicable tabs Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Tabulation of all wells within AoR that penetrate confining zone ***[40 CFR 146.82(a)(4)]*** ☒ AoR and Corrective Action Plan ***[40 CFR 146.82(a)(13) and 146.84(b)]*** ☒ Computational modeling details ***[40 CFR 146.84(c)]***

4.0 Financial Responsibility [40 CFR §146.82(a)(14)]

Bluebonnet Sequestration Hub, LLC, shall maintain financial responsibility and resources to meet the requirements of 40 CFR 146.85 and the conditions of this permit. Financial responsibility shall be maintained through all phases of the project. The approved financial assurance mechanisms are found in the Financial Assurance Plan document of this permit. The financial instrument(s) must be sufficient to cover the cost of:

- Corrective action (meeting the requirements of 40 CFR 146.84).
- Injection well plugging (meeting the requirements of 40 CFR 146.92).
- Post-injection site care and site closure (meeting the requirements of 40 CFR 146.93).
- Emergency and remedial response (meeting the requirements of 40 CFR 146.94).

During the active life of the geologic sequestration project, Bluebonnet Sequestration Hub, LLC, must adjust the cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument(s) and provide this adjustment to the UIC Program Director in an electronic format. Bluebonnet Sequestration Hub, LLC, must also provide to the Director written updates of adjustments to the cost estimate in an electronic format within 60 days of any amendments to the project plans that address the cost items covered in the financial assurance plan.

Bluebonnet Sequestration Hub, LLC, shall provide notification to meet the requirements of 40 CFR §146.85 and the conditions of this permit.

- Whenever the current cost estimate increases to an amount greater than the face amount of a financial instrument currently in use, Bluebonnet Sequestration Hub, LLC, within 60 days after the increase, must either cause the face amount to be increased to an amount at least equal to the current cost estimate and submit evidence of such an increase to the Director, or obtain other financial responsibility instruments to cover the increase. Whenever the current cost estimate decreases, the face amount of the financial assurance instrument may be reduced to the amount of the current cost estimate only after Bluebonnet Sequestration Hub, LLC, has received written approval from the Director.

- Bluebonnet Sequestration Hub, LLC, must notify the Director by certified mail and in an electronic format of adverse financial conditions, such as bankruptcy, that may affect the ability to carry out injection well plugging, post-injection site care and site closure, and any applicable ongoing actions under the Corrective Action and/or Emergency and Remedial Response.

    - If Bluebonnet Sequestration Hub, LLC, or a third-party provider of a financial responsibility instrument is going through a bankruptcy, Bluebonnet Sequestration Hub, LLC, must notify the Director by certified mail and in an electronic format of the commencement of voluntary or involuntary proceedings under Title 11 (Bankruptcy), U.S. Code, which names Bluebonnet Sequestration Hub, LLC, as the debtor within 10 days after commencement of the proceeding.

- A guarantor of a corporate guarantee must make such a notification, if he or she is named as debtor, as required under the terms of the guarantee.
- A permittee who fulfills the requirements of financial assurance by obtaining a trust fund, surety bond, letter of credit, escrow account, or insurance policy will be deemed to be without the required financial assurance in the event of bankruptcy of the trustee (or issuing institution) or suspension/revocation of the authority of the trustee institution to act as trustee of the institution issuing the trust fund, surety bond, letter of credit, escrow account, or insurance policy.

Bluebonnet Sequestration Hub, LLC, must establish other financial assurance or liability coverage, acceptable to the Director, within 60 days of a change to the Area of Review and Corrective Action Plan.

Financial Responsibility GSDT Submissions
GSDT Module: Financial Responsibility Demonstration ***Tab(s):*** Cost Estimate tab and all applicable financial instrument tabs Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Demonstration of financial responsibility ***[40 CFR 146.82(a)(14) and 146.85]***

5.0 CO_2 Injector Well Design and Construction [40 CFR §146.82(a)(11) and (12)]

The Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6, and Bluebonnet CCS 7 injector wells were designed with the highest standards and best practices for drilling and well construction. The operational parameters and material selection are intended to ensure mechanical integrity in the system and to optimize operations during the life of the project.

5.1 Well Design and Construction: Bluebonnet CCS 1

The Bluebonnet CCS 1 well design includes three main sections, conductor casing, surface casing, and long string casing, to cover the USDW, provide integrity while drilling the injection zone, acquire formation data, isolate the target formation, and provide mechanical support to run the upper completion.

[redacted]

Figure NAR 21: Bluebonnet CCS 1 well schematic – original completion.

5.1.1 Conductor Bluebonnet CCS 1

The [redacted] in. wellbore for the conductor casing will be drilled via auger to a depth of approximately [redacted] The wellbore will be cased with [redacted] line pipe and cemented with a mixture of concrete to the surface. This section will provide support for the surface section operations only and will be preset before the start of drilling operations and during the construction of the cellar and mousehole installation. Due to the shallow depth of this section, no logging or testing is planned.

5.1.2 Surface Section Bluebonnet CCS 1

The [redacted] vertical wellbore will be drilled to [redacted] to cover the base of the USDW, estimated at [redacted] and to provide mechanical integrity on the surface shoe to continue drilling to the next section. A deviation survey will be taken a minimum of every 100 ft while drilling. This section will be drilled with freshwater mud. Once the final depth is reached, the well will be circulated and conditioned to run openhole electric logs according to the Pre-Operation Formation Testing Plan. Then, [redacted]. casing will be run and cemented to the surface via circulation with [redacted] If there are no cement returns to the surface, the project will inform the UIC Program Director and Texas regulators, determine the top of cement with a temperature log or equivalent, and complete the annular cement program with a top job procedure after approval by the UIC Program Director. After the tail cement reaches at least [redacted] compressive strength, the rig will install Section A of the wellhead and blowout preventor (BOP) equipment. The rig will then test the BOP and casing and pick up the drilling assembly. After drilling out the shoe track, an additional 10 to 15 ft of new formation will be drilled to execute a formation integrity test (FIT).

5.1.3 Long String Section Bluebonnet CCS 1

Bluebonnet CCS 1 will be drilled [redacted], with the kickoff point planned at [redacted]. The detailed trajectory is provided in Table CON-5.

A [redacted] [redacted] will be drilled from [redacted] while taking deviation surveys every 100 ft and collecting cutting samples to describe the formation characteristics. The well will be drilled with [redacted]. Once TD is reached, the well will be circulated and conditioned to run openhole electric logs and acquire side wall cores (SWC) and water samples according to the Pre-Operational Formation Testing Plan. Then, the long string of 9 5/8 in. casing will be deployed with the [redacted]. The casing will be cemented to the surface via circulation with a combination of CO_2-resistant and conventional cement slurries. Based on simulations, a stage tool will be used to perform a two-stage cementing job to establish good cement from the bottom to the surface. The depth of the stage tool or cementing stage tool will be adjusted based on actual conditions of the well after it is drilled.

After the cementing is complete, Section B of the wellhead will be installed and the [redacted] The team will then install the rest of the wellhead to prepare for completion operations.

5.1.4 Completion Bluebonnet CCS 1

During completion operations, the rig crew will test the casing to [redacted] condition the long string with a bit and scraper, and run cement bond and casing inspection logs to evaluate cement bonding and casing conditions.

The [redacted] tubing and packer completion will be run to approximately [redacted] in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid and the packer will be set. Once the packer is set, an annular pressure test will be performed to [redacted] the surface to validate the mechanical seal and integrity in the annular space between the tubing and casing. The pulse neutron log will be run through tubing to set a baseline for future surveys.

The crew will proceed to perforate the injection zone through tubing and initiate the well testing. The well will be tested for injectivity with step rate test, injectivity test, and falloff test procedures before starting CO_2 injection.

5.2 Well Design and Construction: Bluebonnet CCS 2

The Bluebonnet CCS 2 well design includes three main sections, conductor casing, surface casing, and long string casing, to cover the USDW, provide integrity while drilling the injection zone, acquire formation data, isolate the target formation, and provide mechanical support to run the upper completion.

[redacted]

Figure NAR-22: Bluebonnet CCS 2 well schematic – original completion.

5.2.1 Conductor Bluebonnet CCS 2

The [redacted] wellbore for the conductor casing will be drilled via auger to a depth of approximately [redacted] The wellbore will be cased with a [redacted] line pipe and cemented with a mixture of concrete to the surface. This section will provide support for the surface section operations only and will be preset before the start of drilling operations and during the construction of the cellar and mousehole installation. Due to the shallow depth of this section, no logging or testing is planned.

5.2.2 Surface Section Bluebonnet CCS 2

The [redacted] vertical wellbore will be drilled to [redacted] ft to cover the base of the USDW, estimated at [redacted] and to provide mechanical integrity on the surface shoe to continue drilling to the next section. A deviation survey will be taken a minimum of every 100 ft while drilling. This section will be drilled with freshwater mud. Once the final depth is reached, the well will be circulated and conditioned to run openhole electric logs according to the Pre-Operation Formation Testing Plan. Then, [redacted] casing will be run and cemented to the surface via circulation with conventional Portland cement plus additives slurry. If there are no cement returns to the surface, the project will inform the UIC Program Director and Texas regulators, determine the top of cement with a temperature log or equivalent, and complete the annular cement program with a top job procedure after approval by the UIC Program Director. After the tail cement reaches at least [redacted] compressive strength, the rig will install Section A of the wellhead and BOP equipment. The rig will then test the BOP and casing and pick up the drilling assembly. After drilling out the shoe track, an additional 10 to 15 ft of new formation will be drilled to execute an FIT.

5.2.3 Long String Section Bluebonnet CCS 2

Bluebonnet CCS 2 will be drilled directionally in a [redacted]. The detailed trajectory is provided in Table CON-17.

A [redacted] while taking deviation surveys every 100 ft and collecting cutting samples to describe the formation characteristics. The well will be drilled with [redacted] mud. Once TD is reached, the well will be circulated and conditioned to run openhole electric logs and acquire SWC and water samples according to the Pre-Operational Formation Testing Plan. Then, the long string of [redacted] casing will be deployed with the [redacted] [redacted]. The casing will be cemented to the surface via circulation with a combination of CO_2-resistant and conventional cement slurries. Based on simulations, a stage tool will be used to perform a two-stage cementing job to establish good cement from the bottom to the surface. The depth of the stage tool or cementing stage tool will be adjusted based on actual conditions of the well after drilled.

After the cementing is complete, Section B of the wellhead will be installed and [redacted] The team will install the rest of the wellhead to prepare for completions operations.

5.2.4 Completion Bluebonnet CCS 2

During completion operations, the rig crew will test the casing to [redacted] condition the long string with a bit and scraper, and run cement bond and casing inspection logs to evaluate cement bonding and casing conditions.

The [redacted] tubing and packer completion will be run to approximately [redacted], in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid and the packer will be set. Once the packer is set, an annular pressure test will be performed to [redacted]si on the surface to validate the mechanical seal and integrity in the annular space between the tubing and casing. The pulse neutron log will be run through tubing to set a baseline for future surveys.

The crew will proceed to perforate the injection zone through tubing and initiate the well testing. The well will be tested for injectivity with step rate test, injectivity test, and falloff test procedures before starting CO_2 injection.

5.3 Well Design and Construction: Bluebonnet CCS 3

The Bluebonnet CCS 3 well design includes three main sections, conductor casing, surface casing, and long string casing, to cover the USDW, provide integrity while drilling the injection zone, acquire formation data, isolate the target formation, and provide mechanical support to run the upper completion.

Claimed as PBI

[redacted]

Figure NAR-23: Bluebonnet CCS 3 well schematic – original completion.

5.3.1 Conductor Bluebonnet CCS 3

The [redacted] wellbore for the conductor casing will be drilled via auger to a depth of approximately [redacted] The wellbore will be cased with a [redacted] line pipe and cemented with a mixture of concrete to the surface. This section will provide support for the surface section operations only and will be preset before the start of drilling operations and during the construction of the cellar and mousehole installation. Due to the shallow depth of this section, no logging or testing is planned.

5.3.2 Surface Section Bluebonnet CCS 3

The [redacted] vertical wellbore will be drilled to [redacted] to cover the base of the USDW, estimated at [redacted] and to provide mechanical integrity on the surface shoe to continue drilling to the next section. A deviation survey will be taken a minimum of every 100 ft while drilling. This section will be drilled with freshwater mud. Once the final depth is reached, the well will be circulated and conditioned to run openhole electric logs according to the Pre-Operation Formation Testing Plan. Then, [redacted] casing will be run and cemented to the surface via circulation with conventional Portland cement plus additives slurry. If there are no cement returns to the surface, the project will inform the UIC Program Director and Texas regulators, determine the top of cement with a temperature log or equivalent, and complete the annular cement program with a top job procedure after approval by the UIC Program Director. After the tail cement reaches at least [redacted] compressive strength, the rig will install Section A of the wellhead and BOP equipment. The rig will then test the BOP and casing and pick up the drilling assembly. After drilling out the shoe track, an additional 10 to 15 ft of new formation will be drilled to execute an FIT.

5.3.3 Long String Section Bluebonnet CCS 3

Bluebonnet CCS 3 will be drilled [redacted] The detailed trajectory is provided in Table CON-28.

A [redacted] [redacted] will be drilled from [redacted] while taking deviation surveys every 100 ft and collecting cutting samples to describe the formation characteristics. The well will be drilled with synthetic-based mud. Once TD is reached, the well will be circulated and conditioned to run openhole electric logs and SWC and water samples according to the Pre-Operational Formation Testing Plan. Then, the long string of [redacted] casing will be deployed with the [redacted] The casing will be cemented to the surface via circulation with a combination of CO_2-resistant and conventional cement slurries. Based on simulations, a stage tool will be used to perform a two-stage cementing job to establish good cement from the bottom to the surface. The depth of the stage tool or cementing stage tool will be adjusted based on actual conditions of the well after drilled.

After the cementing is complete, Section B of the wellhead will be installed, and the [redacted]. The team will install the rest of the wellhead to prepare for completions operations.

5.3.4 Completion Bluebonnet CCS 3

During completion operations, the rig crew will test the casing to [redacted] condition the long string with a bit and scraper, and run cement bond and casing inspection logs to evaluate cement bonding and casing conditions.

The [redacted] tubing and packer completion will be run to approximately [redacted], in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid and the packer will be set. Once the packer is set, an annular pressure test will be performed to [redacted] on the surface to validate the mechanical seal and integrity in the annular space between the tubing and casing. The pulse neutron log will be run through tubing to set a baseline for future surveys.

The crew will proceed to perforate the injection zone through tubing and initiate the well testing. The well will be tested for injectivity with step rate test, injectivity test, and falloff test procedures before starting CO_2 injection.

5.4 Well Design and Construction: Bluebonnet CCS 5

The Bluebonnet CCS 5 well design includes three main sections, conductor casing, surface casing, and long string casing, to cover the USDW, provide integrity while drilling the injection zone, acquire formation data, isolate the target formation, and provide mechanical support to run the upper completion.

[redacted]

Figure NAR-24: Bluebonnet CCS 5 well schematic – original completion.

5.4.1 Conductor Bluebonnet CCS 5

The [redacted] wellbore for the conductor casing will be drilled via auger to a depth of approximately [redacted] The wellbore will be cased with a [redacted]. line pipe and cemented with a mixture of concrete to the surface. This section will provide support for the surface section operations only and will be preset before the start of drilling operations and during the construction of the cellar and mousehole installation. Due to the shallow depth of this section, no logging or testing is planned.

5.4.2 Surface Section Bluebonnet CCS 5

The [redacted] vertical wellbore will be drilled to [redacted]t to cover the base of the USDW, estimated at [redacted] and to provide mechanical integrity on the surface shoe to continue drilling to the next section. A deviation survey will be taken a minimum of every 100 ft while drilling. This section will be drilled with freshwater mud. Once the final depth is reached, the well will be circulated and conditioned to run openhole electric logs according to the Pre-Operation Formation Testing Plan. Then, [redacted] in. casing will be run and cemented to the surface via circulation with conventional Portland cement plus additives slurry. If there are no cement returns to the surface, the project will inform the UIC Program Director and Texas regulators, determine the top of cement with a temperature log or equivalent, and complete the annular cement program with a top job procedure after approval by the UIC Program Director. After the tail cement reaches at least 500 psi compressive strength, the rig will install Section A of the wellhead and BOP equipment. The rig will then test the BOP and casing and pick up the drilling assembly. After drilling out the shoe track, an additional 10 to 15 ft of new formation will be drilled to execute an FIT.

5.4.3 Long String Section Bluebonnet CCS 5

A [redacted]. vertical wellbore will be drilled from [redacted]o total depth (TD) while taking deviation surveys every 100 ft and collecting cutting samples to describe the formation characteristics. The well will be drilled with synthetic-based mud. Once TD is reached, the well will be circulated and conditioned to run openhole electric logs and SWC and water samples according to the Pre-Operational Formation Testing Plan. Then, the long string of [redacted]. casing will be deployed with the [redacted] The casing will be cemented to the surface via circulation with a combination of CO_2-resistant and conventional cement slurries. Based on simulations, a stage tool will be used to perform a two-stage cementing job to establish good cement from the bottom to the surface. The depth of the stage tool or cementing stage tool will be adjusted based on actual conditions of the well after drilled.

After the cementing is complete, Section B of the wellhead will be installed, and [redacted] The team will install the rest of the wellhead to prepare for completions operations.

5.4.4 Completion Bluebonnet CCS 5

During completion operations, the rig crew will test the casing to [redacted] condition the long string with a bit and scraper, and run cement bond and casing inspection logs to evaluate cement bonding and casing conditions.

The [redacted]. tubing and packer completion will be run to approximately [redacted] in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid and the packer will be set. Once the packer is set, an annular pressure test will be performed to [redacted] on the surface to validate the mechanical seal and integrity in the annular space between the tubing and casing. The pulse neutron log will be run through tubing to set a baseline for future surveys.

The crew will proceed to perforate the injection zone through tubing and initiate the well testing. The well will be tested for injectivity with step rate test, injectivity test, and falloff test procedures before starting CO_2 injection.

5.5 Well Design and Construction: Bluebonnet CCS 6

The Bluebonnet CCS 6 well design includes three main sections, conductor casing, surface casing, and long string casing, to cover the USDW, provide integrity while drilling the injection zone, acquire formation data, isolate the target formation, and provide mechanical support to run the upper completion.

[redacted]

Figure NAR-25: Bluebonnet CCS 6 well schematic – original completion.

5.5.1 Conductor Bluebonnet CCS 6

The [redacted] wellbore for the conductor casing will be drilled via auger to a depth of approximately [redacted] The wellbore will be cased with a [redacted]. line pipe and cemented with a mixture of concrete to the surface. This section will provide support for the surface section operations only and will be preset before the start of drilling operations and during the construction of the cellar and mousehole installation. Due to the shallow depth of this section, no logging or testing is planned.

5.5.2 Surface Section Bluebonnet CCS 6

The [redacted] vertical wellbore will be drilled to [redacted] ft to cover the base of the USDW, estimated at [redacted]nd to provide mechanical integrity on the surface shoe to continue drilling to the next section. A deviation survey will be taken a minimum of every 100 ft while drilling. This section will be drilled with freshwater mud. Once the final depth is reached, the well will be circulated and conditioned to run openhole electric logs according to the Pre-Operation Formation Testing Plan. Then, [redacted] casing will be run and cemented to the surface via circulation with conventional Portland cement plus additives slurry. If there are no cement returns to the surface, the project will inform the UIC Program Director and Texas regulators, determine the top of cement with a temperature log or equivalent, and complete the annular cement program with a top job procedure after approval by the UIC Program Director. After the tail cement reaches at least 500 psi compressive strength, the rig will install Section A of the wellhead and BOP equipment. The rig will then test the BOP and casing and pick up the drilling assembly. After drilling out the shoe track, an additional 10 to 15 ft of new formation will be drilled to execute an FIT.

5.5.3 Long String Section Bluebonnet CCS 6

A [redacted]ertical wellbore will be drilled from [redacted] to total depth (TD) while taking deviation surveys every 100 ft and collecting cutting samples to describe the formation characteristics. The well will be drilled with synthetic-based mud. Once TD is reached, the well will be circulated and conditioned to run openhole electric logs and SWC and water samples according to the Pre-Operational Formation Testing Plan. Then, the long string of [redacted] in. casing will be deployed with the [redacted] The casing will be cemented to the surface via circulation with a combination of CO_2-resistant and conventional cement slurries. Based on simulations, a stage tool will be used to perform a two-stage cementing job to establish good cement from the bottom to the surface. The depth of the stage tool or cementing stage tool will be adjusted based on actual conditions of the well after drilled.

After the cementing is complete, Section B of the wellhead will be installed, and the [redacted] The team will install the rest of the wellhead to prepare for completions operations.

5.5.4 Completion Bluebonnet CCS 6

During completion operations, the rig crew will test the casing to [redacted], condition the long string with a bit and scraper, and run cement bond and casing inspection logs to evaluate cement bonding and casing conditions.

The [redacted] tubing and packer completion will be run to approximately [redacted] in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid and the packer will be set. Once the packer is set, an annular pressure test will be performed to [redacted]n the surface to validate the mechanical seal and integrity in the annular space between the tubing and casing. The pulse neutron log will be run through tubing to set a baseline for future surveys.

The crew will proceed to perforate the injection zone through tubing and initiate the well testing. The well will be tested for injectivity with step rate test, injectivity test, and falloff test procedures before starting CO_2 injection.

5.6 Well Design and Construction: Bluebonnet CCS 7

The Bluebonnet CCS 7 well design includes three main sections, conductor casing, surface casing, and long string casing, to cover the USDW, provide integrity while drilling the injection zone, acquire formation data, isolate the target formation, and provide mechanical support to run the upper completion.

Claimed as PBI

[redacted]

Figure NAR-26: Bluebonnet CCS 7 well schematic – original completion.

5.6.1 Conductor Bluebonnet CCS 7

The [redacted] in. wellbore for the conductor casing will be drilled via auger to a depth of approximately [redacted] The wellbore will be cased with a [redacted] line pipe and cemented with a mixture of concrete to the surface. This section will provide support for the surface section operations only and will be preset before the start of drilling operations and during the construction of the cellar and mousehole installation. Due to the shallow depth of this section, no logging or testing is planned.

5.6.2 Surface Section Bluebonnet CCS 7

The [redacted]n. vertical wellbore will be drilled to [redacted] ft to cover the base of the USDW, estimated at [redacted]VD, and to provide mechanical integrity on the surface shoe to continue drilling to the next section. A deviation survey will be taken a minimum of every 100 ft while drilling. This section will be drilled with freshwater mud. Once the final depth is reached, the well will be circulated and conditioned to run openhole electric logs according to the Pre-Operation Formation Testing Plan. Then, [redacted]. casing will be run and cemented to the surface via circulation with conventional Portland cement plus additives slurry. If there are no cement returns to the surface, the project will inform the UIC Program Director and Texas regulators, determine the top of cement with a temperature log or equivalent, and complete the annular cement program with a top job procedure after approval by the UIC Program Director. After the tail cement reaches at least 500 psi compressive strength, the rig will install Section A of the wellhead and BOP equipment. The rig will then test the BOP and casing and pick up the drilling assembly. After drilling out the shoe track, an additional 10 to 15 ft of new formation will be drilled to execute an FIT.

5.6.3 Long String Section Bluebonnet CCS 7

A [redacted] vertical wellbore will be drilled from [redacted] to total depth (TD) while taking deviation surveys every 100 ft and collecting cutting samples to describe the formation characteristics. The well will be drilled with synthetic-based mud. Once TD is reached, the well will be circulated and conditioned to run openhole electric logs and SWC and water samples according to the Pre-Operational Formation Testing Plan. Then, the long string of [redacted] casing will be deployed with the [redacted] The casing will be cemented to the surface via circulation with a combination of CO_2-resistant and conventional cement slurries. Based on simulations, a stage tool will be used to perform a two-stage cementing job to establish good cement from the bottom to the surface. The depth of the stage tool or cementing stage tool will be adjusted based on actual conditions of the well after drilled.

After the cementing is complete, Section B of the wellhead will be installed, and the [redacted]. The team will install the rest of the wellhead to prepare for completions operations.

5.6.4 Completion Bluebonnet CCS 7

During completion operations, the rig crew will test the casing to [redacted], condition the long string with a bit and scraper, and run cement bond and casing inspection logs to evaluate cement bonding and casing conditions.

The [redacted] tubing and packer completion will be run to approximately [redacted] in conjunction with the electric cable and pressure and temperature gauges. The fluid in the well will be displaced with packer fluid and the packer will be set. Once the packer is set, an annular pressure test will be performed to [redacted] on the surface to validate the mechanical seal and integrity in the annular space between the tubing and casing. The pulse neutron log will be run through tubing to set a baseline for future surveys.

The crew will proceed to perforate the injection zone through tubing and initiate the well testing. The well will be tested for injectivity with step rate test, injectivity test, and falloff test procedures before starting CO_2 injection.

6.0 Pre-Operational Logging and Testing [40 CFR §146.82(a)(8)]

Bluebonnet Sequestration Hub, LLC, will construct six new CO_2 injection wells, (Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6, and Bluebonnet CCS 7), targeting injection in the Lower Miocene, Frio, and Hackberry sands.

[redacted].

Oxy Low Carbon Ventures, LLC, the parent company of Bluebonnet Sequestration Hub, LLC, drilled the stratigraphic well Encanto 01 in 2022 and acquired advanced geophysical logs as well as [redacted] core and [redacted] The project also performed step rate tests and falloff tests in the prospect reservoirs and leak-off tests on the proposed confining zones. The results and a summary of the data acquisition program for Encanto 01 are shown in Appendix A of the Area of Review and Corrective Action Plan. In May 2024, Encanto 01 was reentered to collect additional water samples from the Frio reservoir. Stratigraphic well Encanto 01 was temporarily abandoned and will be recompleted as an in-zone monitoring well for the project.

The project plans to construct [redacted] These wells will be completed with pressure and temperature sensors downhole and pressure and temperature sensors on the surface and will be used as part of the monitoring network to track the CO_2 plume and pressure front.

The project defines the above-confining zone as the first permeable zone above the [redacted]. This first permeable formation is the base of the USDW as characterized by stratigraphic well Encanto 01 and mapped laterally though the storage complex.

In May 2024, the project drilled Bluebonnet USDW 1, targeting the shallow aquifers from the surface to [redacted]. The main objective of this well was to validate the base of the USDW and determine the water composition of the different flow units as part of the site characterization and baseline for injection operations. The detailed data acquired during Bluebonnet USDW 1 construction is provided in Appendix B of the Area of Review and Corrective Action Plan. Bluebonnet USDW 1 will be used as a monitoring well for the shallow aquifer to monitor changes in water composition during the injection and post-injection phases of the project.

The project plans to construct [redacted] above-confining-zone/USDW monitoring wells [redacted]. These wells will be used to track changes in pressure and in water composition of the base of the USDW in the Hub.

The project also plans [redacted] targeting the sands of the [redacted]

The Pre-Operational Formation Testing Plan for Bluebonnet Hub aims to obtain the chemical and physical characteristics of the injection and confining zone(s). This program includes a combination of logging, sidewall coring, formation hydrogeologic testing, and other activities performed during the drilling and construction of the CO_2 injection well, monitoring wells, water production wells, and water disposal wells.

The pre-operational testing program will determine or verify the depth, thickness, mineralogy, lithology, porosity, permeability, and geomechanical information of the injection zone, overlying confining zone, and other relevant geologic formations. In addition, formation fluid characteristics are to be obtained from the injection zone to establish baseline data against which future measurements may be compared after the start of injection operations.

Specific details on the proposed pre-operational logging and testing program are found in Pre-Operational Testing Plan of this permit.

Pre-Operational Logging and Testing GSDT Submissions
GSDT Module: Pre-Operational Testing ***Tab(s):*** Welcome tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Proposed pre-operational testing program ***[40 CFR 146.82(a)(8) and 146.87]***

7.0 Proposed Stimulation Program [40 CFR §146.82(a)(9)]

Bluebonnet Sequestration Hub, LLC, may stimulate the injection zone in the CO_2 injector wells Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6 and Bluebonnet CCS 7 to enhance or regain injection capabilities.

Stimulation and cleanouts to enhance or regain the injection potential of the [redacted] sandstones in the CO_2 injector wells may include, but are not limited to, coil tubing cleanouts, stick pipe cleanouts, matrix acid stimulation, and water flushes.

The need for stimulation and cleanouts will be determined once the characterization data from the Bluebonnet Sequestration Hub is completed, and the wells are available and have been evaluated (i.e., results of geophysical logs, core analyses, and hydrogeologic testing, operating conditions).

8.0 Well Operation [40 CFR §146.88]

The CO_2 wells are designed to maximize the rate of injection and to reduce the surface pressure and friction alongside the tubing, while maintaining the bottomhole pressure below 90% of the frac gradient. The selected design provides enough clearance to deploy the pressure and temperature gauges on tubing and to ensure continuous surveillance of external integrity and conformance through the external fiber optic cable. The design allows for other logs to be periodically run, (e.g., pulse neutron).

8.1 Operational Procedures [40 CFR 146.82(a)(10)]

The operational procedures detailed below describe how Bluebonnet Sequestration Hub, LLC, will initiate injection and conduct startup-specific monitoring of the Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6 and Bluebonnet CCS 7.

The multi-stage (step rate) startup procedure and period only apply to the initial start of injection operations until the well reaches the full injection rate. Monitoring frequencies and methodologies after the initial startup will follow the Testing and Monitoring Plan document of this permit.

During the startup period, Bluebonnet Sequestration Hub, LLC, will submit a daily report summarizing and interpreting the operational data. At the request of the EPA, Bluebonnet Sequestration Hub, LLC, may be required to schedule a daily conference call to discuss this information. The injection rates will be successively higher, controlled with variable frequency drive pumps. The elapsed time and pressure values will be read and recorded for each rate and time step. The injection rate will be measured and recorded using a Claimed as PBI

Additional operational parameters are detailed in the Summary of Operating Conditions document of this permit.

Table NAR-5 through Table NAR-10 show the operating parameters proposed for the CO_2 injector wells.

Table NAR-5: Bluebonnet CCS 1 Operating Conditions.

Claimed as PBI

[redacted]

1. MD: measured depth.
2. TVD: true vertical depth.
3. Maximum rate is limited by tubing size, not by reservoir.

Table NAR-6: Bluebonnet CCS 2 Operating Conditions.

Claimed as PBI

[redacted]

1. MD: measured depth.
2. TVD: true vertical depth.
3. Maximum rate is limited by tubing size, not by reservoir.

Table NAR-7: Bluebonnet CCS 3 Operating Conditions.

Claimed as PBI

[redacted]

1. MD: measured depth.
2. TVD: true vertical depth.
3. Maximum rate is limited by tubing size, not by reservoir.

Table NAR-8: Bluebonnet CCS 5 Operating Conditions.

Claimed as PBI

[redacted]

1. MD: measured depth.
2. Maximum rate is limited by tubing size, not by reservoir.

Table NAR-9: Bluebonnet CCS 6 Operating Conditions

Claimed as PBI

[redacted]

1. MD: measured depth.
2. Maximum rate is limited by tubing size, not by reservoir.

Table NAR-10: Bluebonnet CCS 7 Operating Conditions

Claimed as PBI

[redacted]

1. MD: measured depth.
2. Maximum rate is limited by tubing size, not by reservoir.

Automatic alarms and automatic shutoff systems will be installed and maintained. Successful function of the alarm system and shutoff system will be demonstrated prior to injection and once annually thereafter.

At all times, pressure will be maintained on the well that will prevent the return of the injection fluid to the surface. The wellbore must be filled with a high specific gravity fluid during workovers to maintain a positive (downward) gradient and/or a plug shall be installed that can resist the pressure differential. A BOP must be installed and kept in proper operational condition whenever the wellhead is removed for work on the well.

Bluebonnet Sequestration Hub, LLC, shall cease injection should it appear that the well is lacking mechanical integrity or that the injected CO_2 stream and/or associated pressure front may cause an endangerment to a USDW.

8.2 Proposed Carbon Dioxide Stream [40 CFR 146.82(a)(7)(iii) and (iv)]

The proposed carbon dioxide stream composition is shown below in Table NAR-11. No injectant other than that identified in this permit shall be injected into the well except fluids used for stimulation, rework, and well tests as approved by the UIC Program Director.

Table NAR-11: CO_2 stream composition.

Claimed as PBI

[redacted]

8.3 Reporting and Record Keeping

Electronic reports, submittals, notifications, and records made and maintained by Bluebonnet Sequestration Hub, LLC, under this permit must be in an electronic format approved by EPA. Bluebonnet Sequestration Hub, LLC, will electronically submit all required reports to the UIC Program Director.

Bluebonnet Sequestration Hub, LLC, shall submit semiannual reports containing:

- Any changes to the physical, chemical, and other relevant characteristics of the CO_2 stream from the proposed operating data.
- Monthly average, maximum, and minimum values for injection pressure, flow rate and daily volume, temperature, and annular pressure.
- A description of any event that exceeds operating parameters for the annulus or injection pressure specified in the permit.
- A description of any event that triggers the required shutoff systems and the responses taken.
- The monthly volume and/or mass of the CO_2 stream injected over the reporting period and volume and/or mass injected cumulatively over the life of the project.
- Monthly annulus fluid volume added or produced.
- Results of the continuous monitoring required including:
    - A tabulation of the:
      (1) daily maximum injection pressure
      (2) daily minimum annulus pressure
      (3) daily minimum value of the difference between simultaneous measurements of annulus and injection pressure
      (4) daily volume
      (5) daily maximum flow rate
      (6) average annulus tank fluid level
    - Graph(s) of the continuous monitoring required or of daily average values of these parameters. The injection pressure, injection volume and flow rate, annulus fluid level, annulus pressure, and temperature shall be submitted on one or more graphs, using contrasting symbols or colors, or in another manner approved by the Director.
- Results of any additional monitoring identified in the Testing and Monitoring Plan.

Any permit noncompliance shall be reported to the Director within 24 hours as described below:

- Bluebonnet Sequestration Hub, LLC, shall report to the Director any permit noncompliance that may endanger human health or the environment, and/or any events that require implementation of actions in the Emergency and Remedial Response Plan document of this permit. Any information shall be provided orally within 24 hours from the time Bluebonnet Sequestration Hub, LLC, becomes aware of the circumstances. Such verbal reports shall include, but not be limited to, the following information:
  - Any evidence that the injected CO_2 stream or associated pressure front may have caused an endangerment to a USDW or any monitoring or other information, which indicates that any contaminant may have caused endangerment to a USDW.
  - Any noncompliance with a permit condition or malfunction of the injection system, which may have caused fluid migration into or between USDWs.
  - Any triggering of the shutoff system.
  - Any failure to maintain mechanical integrity.
  - Pursuant to compliance with the requirement at 40 CFR 146.90 (h) for surface air/soil gas monitoring or other monitoring technologies, if required by the Director, any release of CO_2 to the atmosphere or biosphere.
  - Actions taken to implement appropriate protocols outlined in the Emergency and Remedial Response Plan document of this permit.
- A written submission shall be provided to the Director in electronic format within five days of the time Bluebonnet Sequestration Hub, LLC, becomes aware of the circumstances. The submission shall contain a description of the noncompliance and its cause; the period of noncompliance (including the exact dates and times); and if the noncompliance has not been corrected, then the anticipated time it is expected to continue, as well as actions taken to implement appropriate protocols outlined in the Emergency and Remedial Response Plan document of this permit. This submission should also include the steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

Within 30 days, Bluebonnet Sequestration Hub, LLC, will report to the Director the results of periodic tests of mechanical integrity; any well workover, including stimulation; any other test of the injection well conducted by the Project, if required by the Director; and any test of any monitoring well required by this permit.

The following items require advance notification from Bluebonnet Sequestration Hub, LLC, to the Director:

- **Well Tests –** Bluebonnet Sequestration Hub, LLC, shall give at least 30 days advance written notice to the Director in an electronic format of any planned workover, stimulation, or other well test.
- **Planned Changes –** Bluebonnet Sequestration Hub, LLC, shall give written notice to the Director in an electronic format, as soon as possible, of any planned physical alterations or additions to the permitted injection facility other than minor repair/replacement or

maintenance activities. An analysis of any new injection fluid shall be submitted to the Director for review and written approval at least 30 days prior to injection. This approval may result in a permit modification.

- **Anticipated Noncompliance –** Bluebonnet Sequestration Hub, LLC, shall give at least 14 days advance written notice to the Director in an electronic format of any planned changes in the permitted facility or activity that may result in noncompliance with the permit requirements.

The following paragraphs include other reporting requirements:

- **Compliance Schedules –** Reports of compliance or noncompliance with or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted in an electronic format by Bluebonnet Sequestration Hub, LLC, no later than 30 days following each scheduled date.
- **Transfer of Permits –** This permit is not transferable to any person except after notice is sent to the Director in an electronic format at least 30 days prior to the transfer and requirements of 40 CFR 144.38 (a) have been met. Pursuant to the requirements at 40 CFR 144.38 (a), the Director will require modification or revocation and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary under the SDWA.
- **Other Noncompliance –** Bluebonnet Sequestration Hub, LLC, shall report in an electronic format all other instances of noncompliance not otherwise reported in the next monitoring report. The reports shall contain the information previously listed in Section N (3)(b) of this permit.
- **Other Information –** When Bluebonnet Sequestration Hub, LLC, becomes aware of a failure to submit any relevant facts in the permit application or incorrect information has been submitted in a permit application or in any report to the Director, the Bluebonnet Sequestration Hub, LLC, shall submit such facts or corrected information in an electronic format, within 10 days, in accordance with 40 CFR 144.51 (l)(8).
- **Report on Permit Review –** Within 30 days of receipt of this permit, Bluebonnet Sequestration Hub, LLC Project Manager, shall certify to the UIC Program Director in an electronic format that he or she has read and is personally familiar with all terms and conditions of this permit.

The following guidelines are provided for record keeping:

- Bluebonnet Sequestration Hub, LLC, shall retain records and all monitoring information, including all calibration and maintenance records and original chart recordings for continuous monitoring instrumentation and copies of all reports required by this permit (including records from pre-injection, active injection, and post-injection phases) for a period of at least 10 years from collection.

- Bluebonnet Sequestration Hub, LLC, shall maintain records of all data required to complete the permit application form for this permit and any supplemental information (e.g., modeling inputs for AoR delineations and reevaluations and plan modifications) submitted under 40 CFR 144.27, 144.31, 144.39, and 144.41 for a period of at least 10 years after site closure.
- Bluebonnet Sequestration Hub, LLC, shall retain records concerning the nature and composition of all injected fluids until 10 years after site closure.
- The retention periods may be extended at any time at a request of the Director. Bluebonnet Sequestration Hub, LLC, shall continue to retain records after the specified retention period of this permit or any requested extension thereof expires, unless Bluebonnet Sequestration Hub, LLC, delivers the records to the Director or obtains written approval from the Director to discard the records.
- Records of monitoring information shall include:
  - The date, exact place, and time of sampling or measurements.
  - The name(s) of the individual(s) who performed the sampling or measurements.
  - A precise description of both the sampling methodology and handling of samples.
  - The date(s) analyses were performed.
  - The name(s) of the individual(s) who performed the analyses.
  - The analytical techniques or methods used.
  - The results of such analyses.

9.0 Testing and Monitoring [40 CFR §146.82(a)(15)]

The Testing and Monitoring Plan document of this permit describes how Bluebonnet Sequestration Hub, LLC, will monitor the Bluebonnet Sequestration Hub pursuant to 40 CFR 146.90. In addition to demonstrating that the well is operating as planned, the carbon dioxide plume and pressure front are moving as predicted, and that there is no endangerment to USDWs, the monitoring data will be used to validate and adjust the geomodel used to predict the distribution of the CO_2 within the storage zone to support AoR reevaluations and a non-endangerment demonstration.

Bluebonnet Hub Testing and Monitoring Plan was tailored based on a qualitative risk assessment of the site that was also used to inform the Emergency and Remedial Response Plan for the Bluebonnet Hub.

Several components are integrated into the master monitoring plan for the Bluebonnet Hub, which are classified in the following categories:

1. Operational testing and monitoring during injection.
2. Mechanical integrity testing.
3. Groundwater quality and geochemical monitoring.
4. CO_2 plume and pressure-front tracking.

5. Near-surface and surface monitoring.
6. Induced seismicity.

The methodology and frequency of testing and monitoring methods are expected to change throughout the project. Pre-injection monitoring and testing will focus on establishing baselines and ensuring that the site is ready to receive injected CO_2. Injection phase monitoring will be focused on collecting data that will be used to calibrate models and ensure the containment of CO_2. Post-injection phase monitoring and testing is designed to demonstrate CO_2 plume stabilization and ensure containment.

The proposed testing and monitoring plan will collect sufficient geospatial and monitoring data to validate the numerical simulation model, inform operational decisions on the quantity and rate of CO_2 injected, and trigger corrective or preventive maintenance actions, amongst others, to operate the site as designed, efficiently and safely. The monitoring results will allow the project to reevaluate the AoR and show that there is no endangerment to the USDW.

Bluebonnet Sequestration Hub, LLC, plans to drill six CO_2 injector wells: Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6 and Bluebonnet CCS 7, as part of the field development plan for the Bluebonnet Hub. The monitoring program proposed is designed based on the modeled CO_2 plume extension and propagation of the pressure front for the three wells injecting simultaneously according to the AoR delineation process.

Each CO_2 injector will be equipped with flow rate meters, pressure and temperature transducers at the surface, and downhole pressure and temperature gauges to monitor real time variations in operating conditions that could indicate changes in reservoir behaviors or potential loss of mechanical integrity. Claimed as PBI [redacted].

Claimed as PBI [redacted] These wells will be equipped with pressure and temperature transducers on the surface as well as pressure and temperature gauges downhole to monitor in real time the variation of pressure and temperature in the reservoir. These wells will allow the use of Claimed as PBI [redacted] to identify early breakthrough of CO_2 and will be equipped with Claimed as PBI [redacted] except for Encanto 01, enabling the project to Claimed as PBI [redacted] if required.

The Testing and Monitoring Plan includes Claimed as PBI [redacted] monitoring wells Claimed as PBI [redacted] to track geochemical changes in the aquifers as well as pressure variations. Bluebonnet USWD 1 was drilled in 2024 as part of the efforts to characterize the USDW.

The project team plans to Claimed as PBI [redacted]

[redacted] as part of the monitoring system, and they will be equipped with pressure and temperature sensors on the surface as well as downhole gauges and sensors according [redacted].

[redacted]

In addition to utilizing a well-based network to monitor pressure, temperature, CO_2 plume migration, and geochemistry changes in aquifers, the Bluebonnet Hub will also employ surface and near-surface methods to monitor CO_2 containment. Details for all the monitoring techniques proposed for Bluebonnet Hub are described in the Testing and Monitoring Plan of this permit.

9.1 Mechanical Integrity

Bluebonnet Sequestration Hub, LLC, will conduct tests to verify the internal and external mechanical integrity of the CO_2 injector wells before and during the injection period pursuant to 40 CFR §146.89(c), 40 CFR §146.90(e), 40 CFR §146.87(a)(2)(ii), and 40 CFR §146.87 (a)(3)(ii)]. Other than during periods of well workover or maintenance approved by the UIC Program Director, in which the sealed tubing-casing annulus will be disassembled for maintenance or corrective procedures, the injection wells must have and maintain mechanical integrity consistent with 40 CFR 146.89.

The purpose of internal mechanical integrity testing is to confirm the absence of significant leakage withing the injection tubing, casing, or packer [40 CFR§146.89 (a)(1)]. Continuous monitoring of injection pressure, injection rate, injected volume, and annulus pressure will be used to ensure internal mechanical integrity.

The purpose of external mechanical integrity testing is to confirm the absence of significant leakage outside of the casing [40 CFR §146.89(a)(2)]. [redacted]

Additional details regarding demonstration of mechanical integrity are described in the Testing and Monitoring Plan, the Well Construction Details Plan, the Pre-Operational Formation Testing Plan, and the Plugging Plan.

Bluebonnet Sequestration Hub, LLC, will observe the following reporting guidelines:

- Bluebonnet Sequestration Hub, LLC, shall notify the Director in an electronic format of his or her intent to demonstrate mechanical integrity at least 30 days prior to such demonstration. However, at the discretion of the Director, a shorter time may be allowed.
- Bluebonnet Sequestration Hub, LLC, shall report in an electronic format the results of a mechanical integrity demonstration. Reports of mechanical integrity demonstrations

that contain logs must include an interpretation of the results by a knowledgeable log analyst.

- Bluebonnet Sequestration Hub, LLC, shall calibrate all gauges used in mechanical integrity demonstrations and other required monitoring to an accuracy of not less than 0.5 percent of full scale, within one year prior to each required test. The date of the most recent calibration shall be noted on or near the gauge or meter. A copy of the calibration certificate shall be submitted to the UIC Program Director in an electronic format with the report of the test. Pressure gauge resolution shall be no greater than 5 psi. Certain mechanical integrity and other testing may require greater accuracy and shall be identified in the procedure submitted to the UIC Program Director prior to the test.

Bluebonnet Sequestration Hub, LLC, must adhere to the following guidelines regarding failure to maintain mechanical integrity:

- If Bluebonnet Sequestration Hub, LLC, or Director finds that the well fails to demonstrate mechanical integrity during a test; is unable to maintain mechanical integrity during operation; or that a loss of mechanical integrity as defined by 40 CFR 146.89 (a)(1) or (2) is suspected during operation (such as a significant unexpected change in the annulus or injection pressure), the project must:

    - Immediately cease injection.
    - Take all steps reasonably necessary to determine whether there may have been a release of the injected CO_2 stream or formation fluids into any unauthorized zone. If there is evidence of USDW endangerment, Bluebonnet Sequestration Hub, LLC, shall implement the Emergency and Remedial Response Plan document of this permit.
    - Follow the reporting requirements as directed in the Emergency and Remedial Response Plan.
    - Restore and demonstrate mechanical integrity to the satisfaction of the Director and receive written approval from the Program Director prior to resuming injection.
    - Notify the Program Director in an electronic format when injection is expected to resume.

- If a shutdown (e.g., downhole or at the surface) is triggered, Bluebonnet Sequestration Hub, LLC, must immediately investigate and identify, as expeditiously as possible, the cause of the shutdown. If, upon such investigation, the well appears to be lacking mechanical integrity or if monitoring required indicates that the well may be lacking mechanical integrity, Bluebonnet Sequestration Hub, LLC, must take the actions as described in the Emergency and Remedial Response Plan.

- If the well loses mechanical integrity prior to the next scheduled test date, then the well must either be plugged or repaired and retested within 30 days of losing mechanical integrity. Bluebonnet Sequestration Hub, LLC, shall not resume injection until the mechanical integrity is demonstrated and the Program Director gives written approval to recommence injection in cases where the well has lost mechanical integrity.

Bluebonnet Sequestration Hub, LLC, shall demonstrate mechanical integrity at any time upon written notice from the UIC Program Director.

Testing and Monitoring GSDT Submissions
GSDT Module: Project Plan Submissions ***Tab(s):*** Testing and Monitoring tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Testing and Monitoring Plan ***[40 CFR 146.82(a)(15) and 146.90]***

10.0 Injection Well Plugging [40 CFR §146.82(a)(16)]

Upon the end of life, Bluebonnet CCS 1, Bluebonnet CCS 2, Bluebonnet CCS 3, Bluebonnet CCS 5, Bluebonnet CCS 6, and Bluebonnet CCS 7 will be plugged and abandoned (P&A) consistent with the requirements of Environmental Protection Agency (EPA) document 40 CFR Subpart H – Criteria and Standards Applicable to Class VI Wells. The plugging procedure and materials will be designed to prevent any unwanted fluid movement, resist the corrosive aspects of CO_2 with water mixtures, and protect any underground sources of drinking water (USDWs).

Detailed plugging procedures and diagrams are presented in the Plugging Plan that is submitted as part of this application.

Injection Well Plugging GSDT Submissions
GSDT Module: Project Plan Submissions ***Tab(s):*** Injection Well Plugging tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Injection Well Plugging Plan ***[40 CFR 146.82(a)(16) and 146.92(b)]***

11.0 Post-Injection Site Care (PISC) and Site Closure [40 CFR §146.82(a)(17)]

The Post-Injection Site Care and Site Closure (PISC) plan describes the activities that Bluebonnet Sequestration Hub, LLC, will perform to meet the requirements of 40 CFR 146.93. Bluebonnet Sequestration Hub, LLC, will monitor groundwater quality and track the position of the CO_2 plume and pressure front for 50 years. Bluebonnet Sequestration Hub, LLC, may not cease post-injection monitoring until a demonstration of non-endangerment of USDWs has been approved by the UIC Program Director pursuant to 40 CFR 146.93(b)(3). Following approval for site closure, Bluebonnet Sequestration Hub, LLC, will plug all remaining monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation.

PISC and Site Closure GSDT Submissions
GSDT Module: Project Plan Submissions ***Tab(s):*** PISC and Site Closure tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ PISC and Site Closure Plan ***[40 CFR 146.82(a)(17) and 146.93(a)]***
GSDT Module: Alternative PISC Timeframe Demonstration ***Tab(s):*** All tabs (only if an alternative PISC timeframe is requested) Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☐ Alternative PISC timeframe demonstration ***[40 CFR 146.82(a)(18) and 146.93(c)]***

12.0 Emergency and Remedial Response [40 CFR §146.82(a)(19)]

The Emergency and Remedial Response Plan (ERRP) document of this permit describes actions that Bluebonnet Sequestration Hub, LLC, shall take to address movement of the injection fluid 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 Bluebonnet Sequestration Hub, LLC, obtains evidence that the injected CO_2 stream and/or associated pressure front may cause an endangerment to a USDW, Bluebonnet Sequestration Hub, LLC, will initiate shutdown plan for the injection well, take all steps reasonably necessary to identify and characterize any release, notify the permitting agency (UIC Program Director) of the emergency event within 24 hours, and implement applicable portions of the approved ERRP.

Emergency and Remedial Response GSDT Submissions
GSDT Module: Project Plan Submissions ***Tab(s):*** Emergency and Remedial Response tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Emergency and Remedial Response Plan ***[40 CFR 146.82(a)(19) and 146.94(a)]***

13.0 Injection Depth Waiver and Aquifer Exemption Expansion

Injection depth waivers are not requested in this permit application.

Injection Depth Waiver and Aquifer Exemption Expansion GSDT Submissions
GSDT Module: Injection Depth Waivers and Aquifer Exemption Expansions ***Tab(s):*** All applicable tabs Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☐ Injection Depth Waiver supplemental report ***[40 CFR 146.82(d) and 146.95(a)]***

☐ Aquifer exemption expansion request and data ***[40 CFR 146.4(d) and 144.7(d)]***

14.0 References

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