ExxonMobil

Underground Injection Control – Class VI Permit Application for Hummingbird Carbon Storage Project Injection Wells No. 01, No. 02, No. 03, No. 04, and No. 05

SECTION 4 – WELL CONSTRUCTION PLAN AND OPERATING CONDITIONS

Hummingbird Carbon Storage Project
Allen Parish, Louisiana
ExxonMobil Low Carbon Solutions Onshore Storage, LLC
March 2025

SECTION 4 – WELL CONSTRUCTION PLAN AND OPERATING CONDITIONS

TABLE OF CONTENTS

Figures

[redacted]

4.1 Well Construction Plan and Operating Conditions

ExxonMobil Low Carbon Solutions Onshore Storage, LLC (ExxonMobil) is undertaking the Hummingbird Carbon Storage (CS) Project (Hummingbird Project) in Allen Parish, Louisiana, to sequester CO_2 using five injection wells, Hummingbird INJ No. 01, No. 02, No. 03, No. 04, and No. 05. This section contains information on the well construction and operating conditions in compliance with the requirements of the Louisiana Administrative Code, Title 43 (LAC43): XVII **§3607** and **§3617.A**.

This section provides a narrative with associated schematics and data summary tables that describe how ExxonMobil will construct the injection wells to meet the goals of LAC43: XVII **§3617.A**—specifically, to do the following:

1. Prevent the movement of fluids into or between underground sources of drinking water (USDWs) or into unauthorized zones (LAC43: XVII **§3617.A.1.a**).
2. Permit the use of appropriate testing devices and workover tools (LAC43: XVII **§3617.A.1.b**).

[redacted]

The engineering design is based on the collection of as much site-specific data as possible. This level of effort was undertaken to facilitate the permit-writing process, between conducting the pre-construction activities required by LAC43: XVII **§3607.C** and the pre-operational phase activities required by LAC43: XVII **§3619.A**.

4.2 Objectives

ExxonMobil developed the engineering design, pre-operational testing plan, and operating strategy for the injection wells to meet the following objectives:

- The injection well construction design, material specifications, and construction will be compatible with the composition of the CO_2 stream over the duration of the Hummingbird Project, to reduce the potential for endangerment of USDWs (LAC43: XVII **§3607.C.2.j** and **k**).

- The injection wells will undergo logging and testing prior to operation, to assess injection well and formation performance, and to update the operating strategy as necessary before the injection of CO_2 (LAC43: XVII **§3607.C.2.g** and **§3617.B**).

- The injection well operating strategy provides continuous injection and annulus monitoring systems for each injection well, to control injection pressure and trigger automatic shutoff devices, consistent with safe operating procedures (LAC43: XVII **§3607.C.2.f**, **h**, and **i**; **§3621**].

[redacted]

ExxonMobil assessed the corrosion-resistance properties of various metal alloys under the operating conditions expected on the proposed injection wells. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

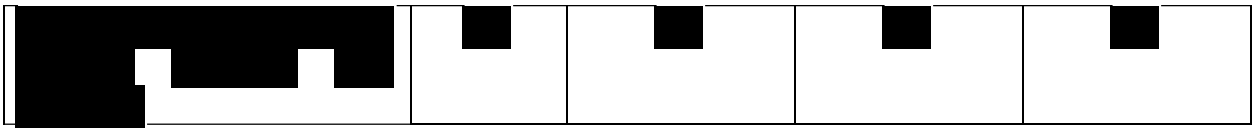
[redacted]

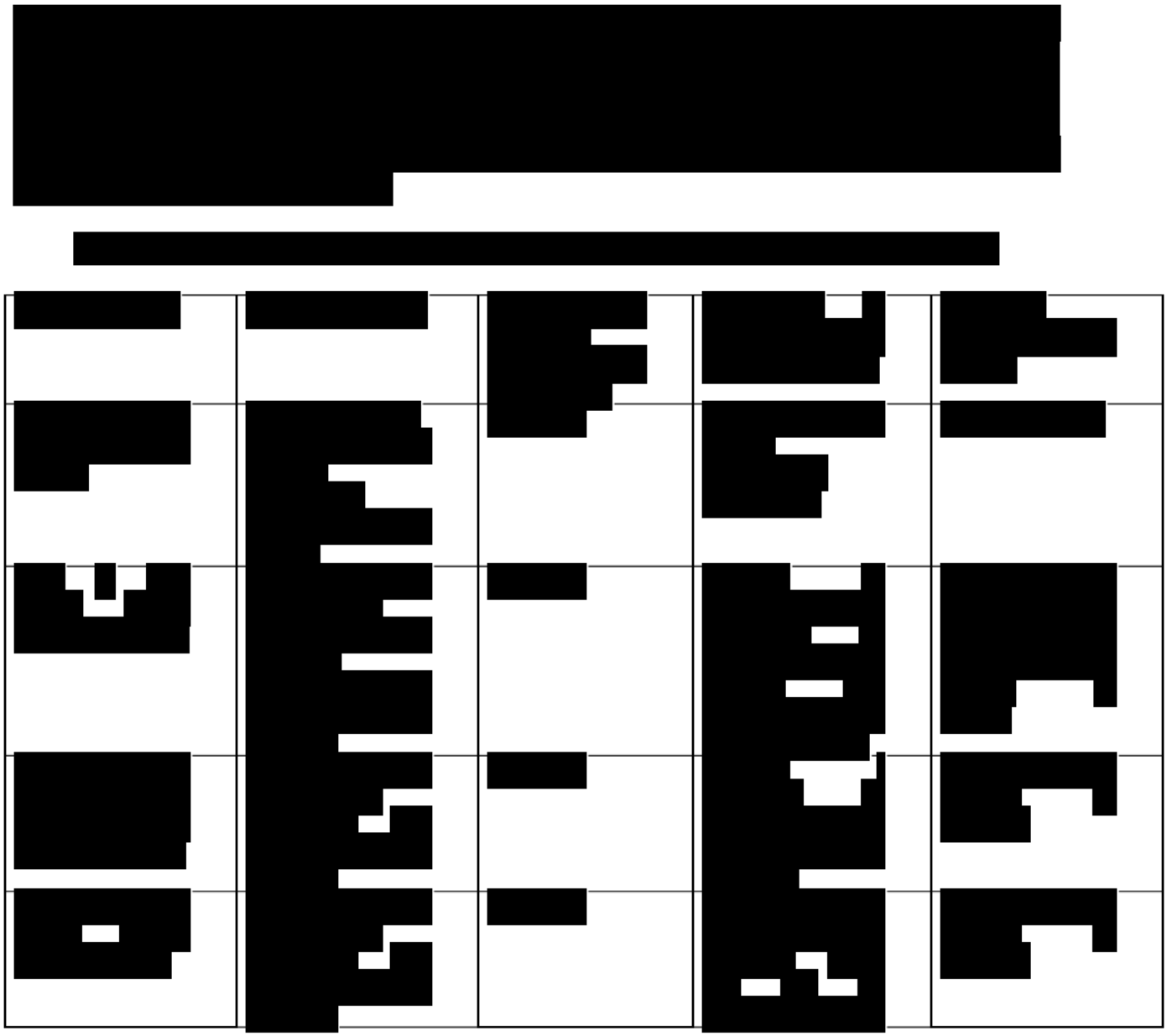
[redacted]

[redacted]

[redacted]

[redacted]





4.4 Well Design and Construction

The engineering design parameters for the five proposed injection wells are based on the planned injection rates, injection volumes, fluid properties, and chemical properties of the injectate fluid. Injection well design [redacted] The casing and cement were designed to have sufficient strength and material properties to withstand the pressure, temperature, and corrosive forces to which they will be exposed (LAC43: XVII **§3617.A.2.a**).

Well design schematics are included in *Appendices D.1-1* to *D.1-10* (LAC43: XVII **§3607.C.2.j**).

4.4.1 Surface Conductor Pipe Design

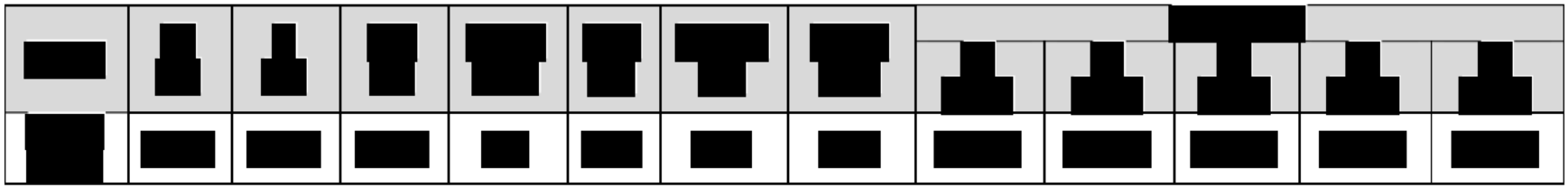
The unconsolidated nature of the sediments in the upper subsurface soil requires the installation of a conductor pipe to establish and maintain borehole integrity. [redacted]

4.4.2 Surface Casing Design

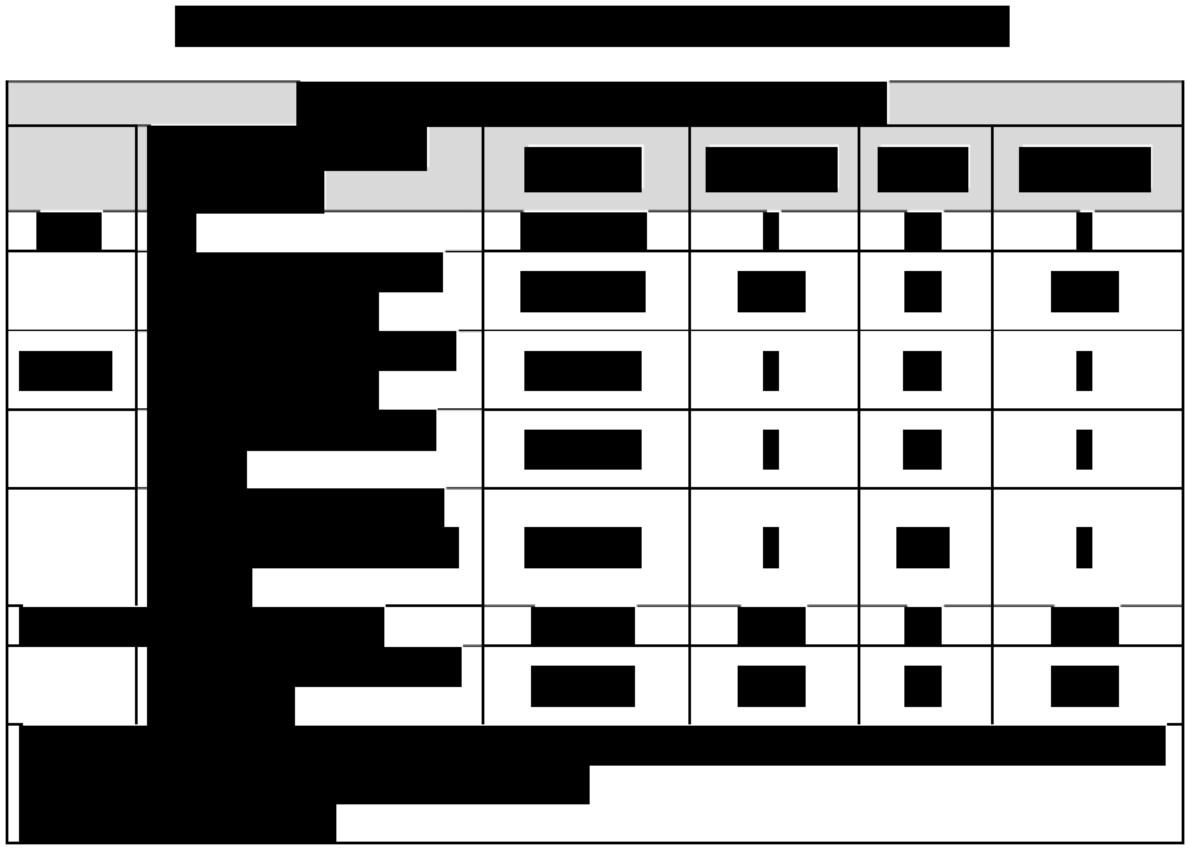
The [redacted] Actual surface casing setting depths will be determined based off the openhole logs of the injection wells themselves. [redacted]

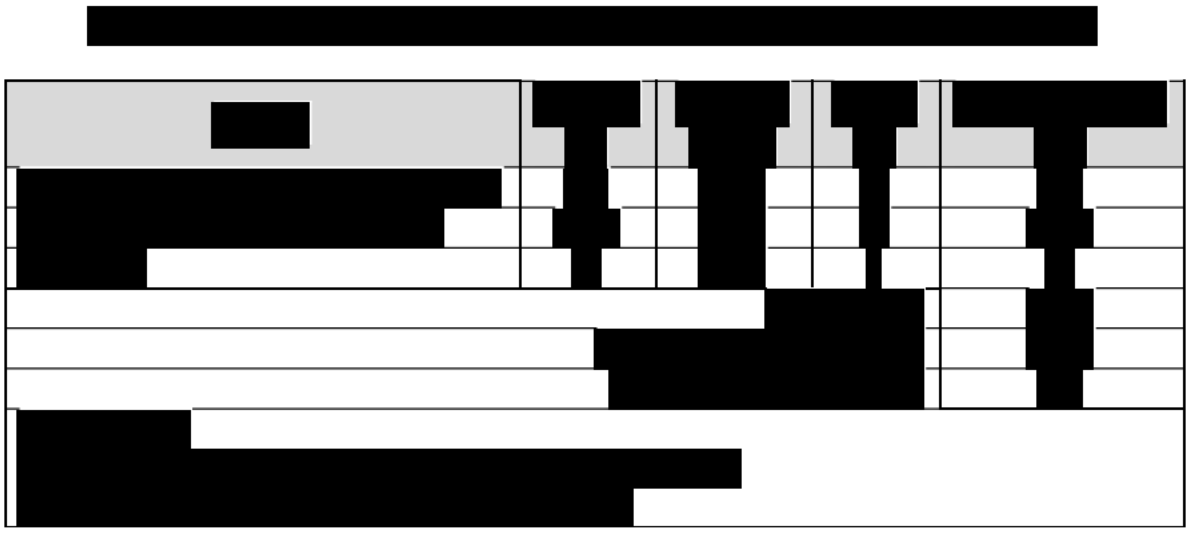
A summary of the surface casing design parameters is presented in Tables 4-4 through 4-11.

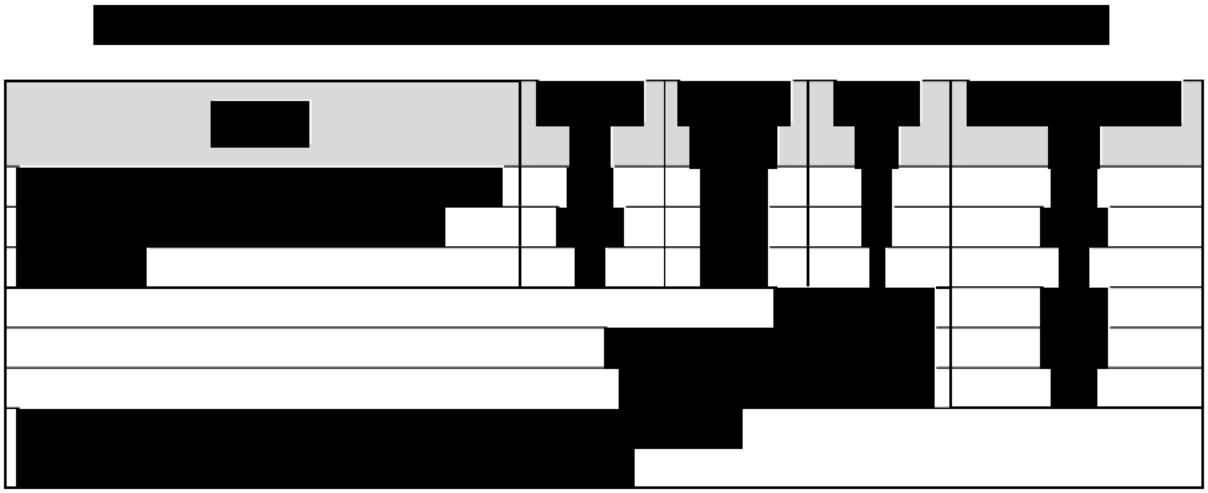
[redacted]

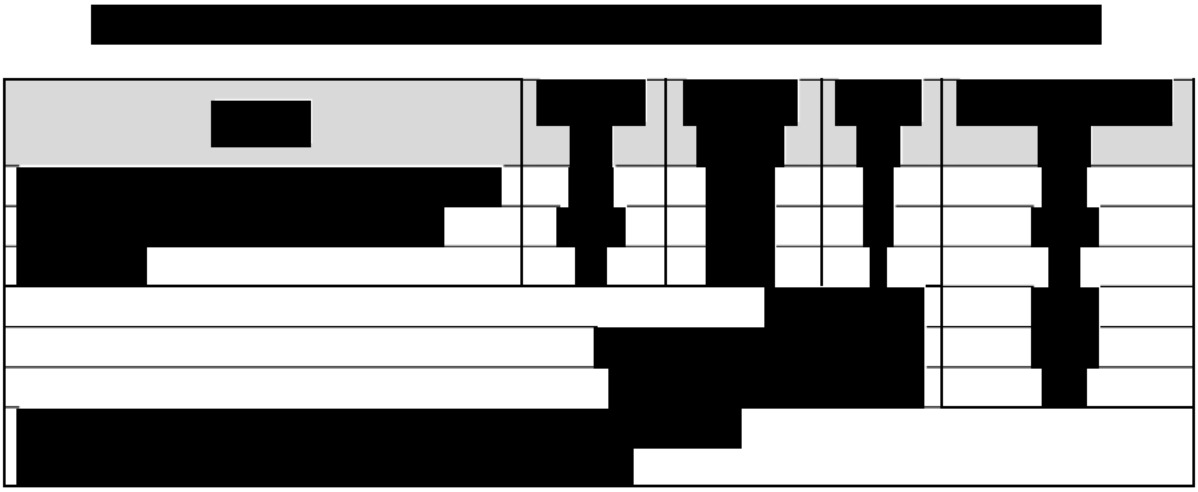


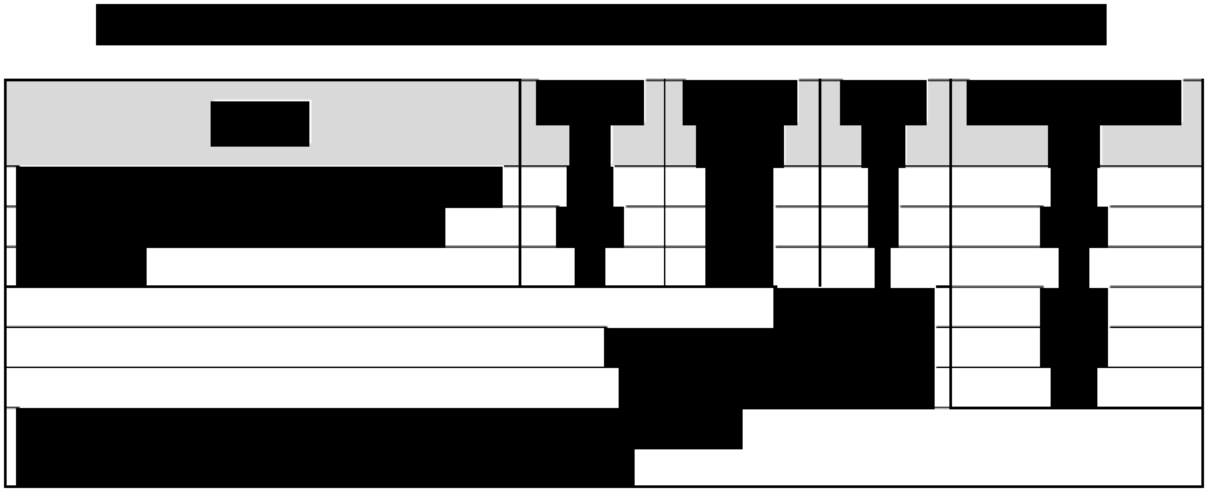
*OD – outer diameter
ID – inner diameter
lb/ft – pounds per foot
psi – pounds per square inch
kips – thousand pounds

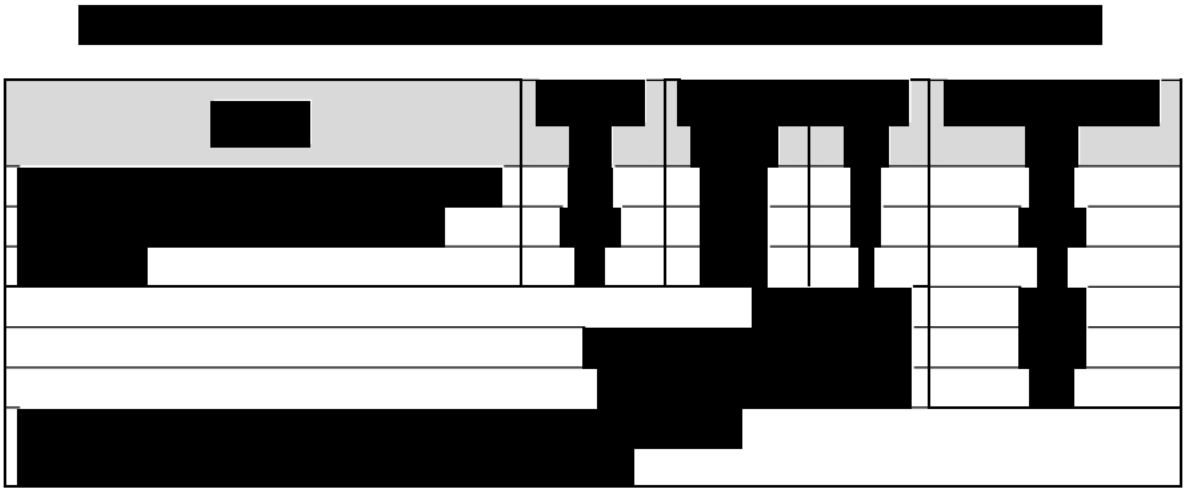


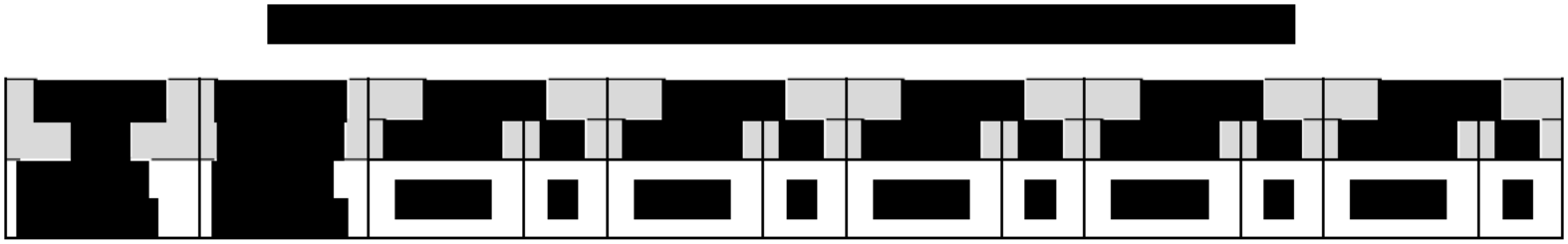






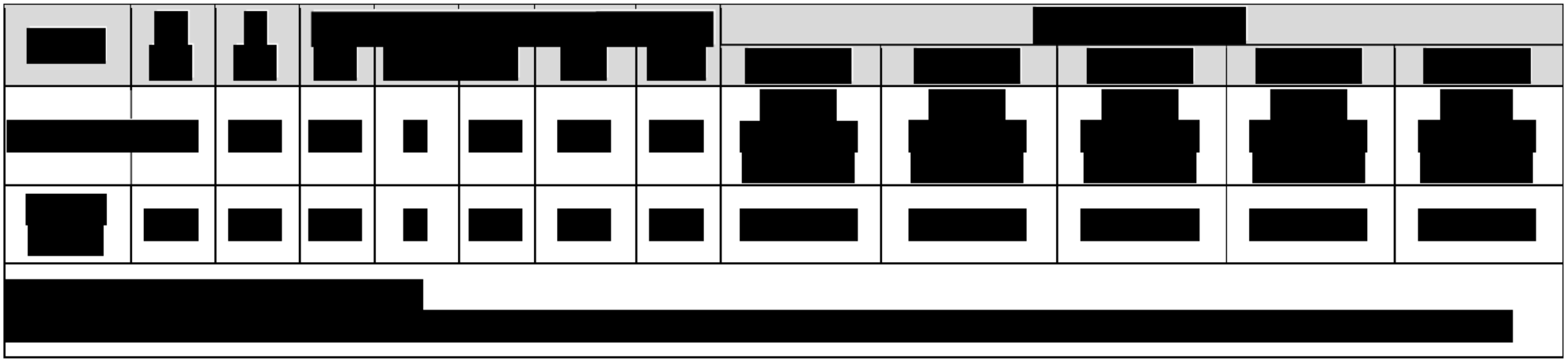






The engineering and design parameters for the production casing are summarized in Tables 4-12 and 4-13. These depths will be updated based on the final logging of the injection wells.

[redacted]



[redacted]

Tables 4-14 to 4-18 provide the production casing cement-volume calculations for each injection well.

[redacted]

[redacted]

[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
			[redacted]	[redacted]
			[redacted]	[redacted]
			[redacted]	[redacted]
[redacted]				

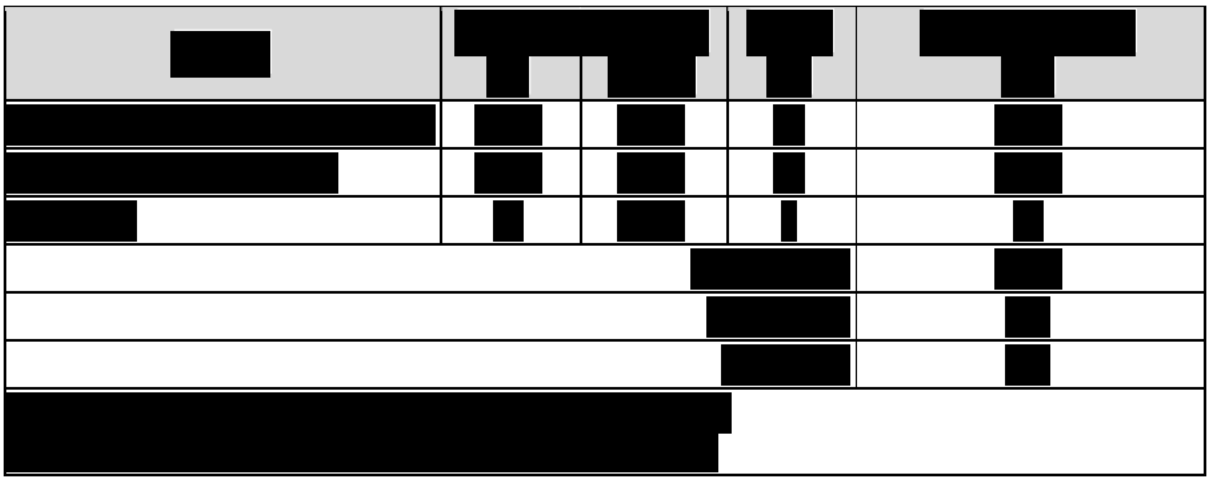
[redacted]

[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
			[redacted]	[redacted]
			[redacted]	[redacted]
			[redacted]	[redacted]
[redacted]				

[redacted]

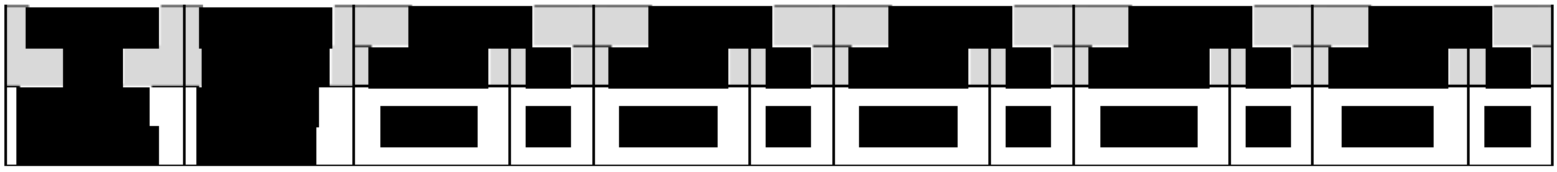
[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
			[redacted]	[redacted]
			[redacted]	[redacted]
			[redacted]	[redacted]
[redacted]				

[redacted]



Centralizer placement for [redacted] to promote a continuous, uniform column of cement throughout the production casing (LAC43: XVII **§3617.A.2.c**). The proposed placement of centralizers through the production casing is shown in Table 4-19.

[redacted]



4.5 Completion Design and Equipment

The engineering design parameters for the five proposed injection wells are based on the planned injection rates, injection volumes, fluid properties, and chemical properties of the injectate fluid. Injection well design is a cased and perforated natural completion. The tubing, packer, instrumentation, and wellhead equipment were selected to have sufficient strength and material properties to withstand the pressure, temperature, and corrosive forces to which they will be exposed (LAC43: XVII **§3617.A.4.a**).

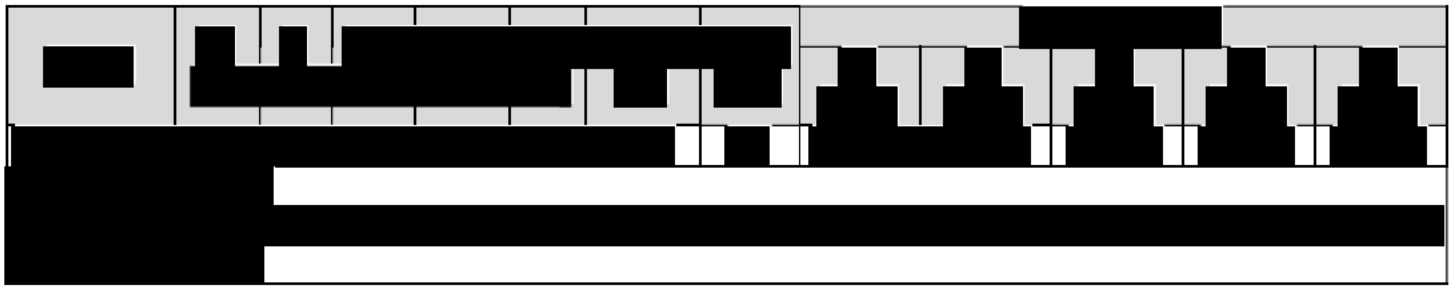
Completion schematics are included in *Appendices D.1-1* to *D.1-10*.

4.5.1 Injection Tubing Design

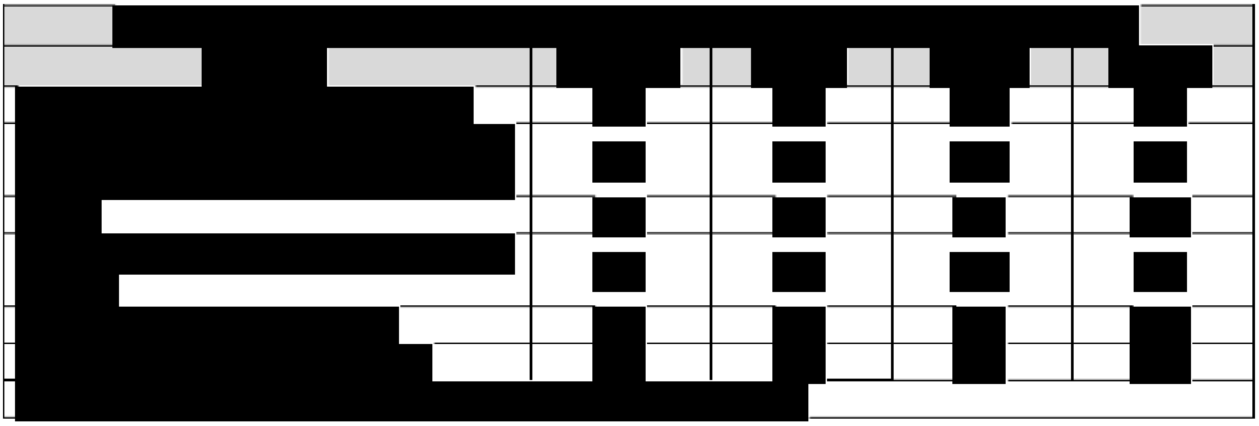
The production tubing will be [redacted] installed with an injection packer. [redacted] or its equivalent in all sections where the CO_2 will contact the tubulars. A tubing design analysis was conducted that considered calculated

pipe-friction losses, exit velocities, and compression requirements. Tables 4-20 and 4-21 provide the tubing design parameters and evaluation (LAC43: XVII **§3617.A.4.a**)

[redacted]



[redacted]



4.5.2 Safety and Continuous Monitoring Device Design

The following safety and continuous monitoring devices were designed for installation in the injection wells (LAC43: XVII **§3625.A.2**).

[redacted]

4.5.2.2 Downhole Pressure and Temperature Gauge Design

[redacted]

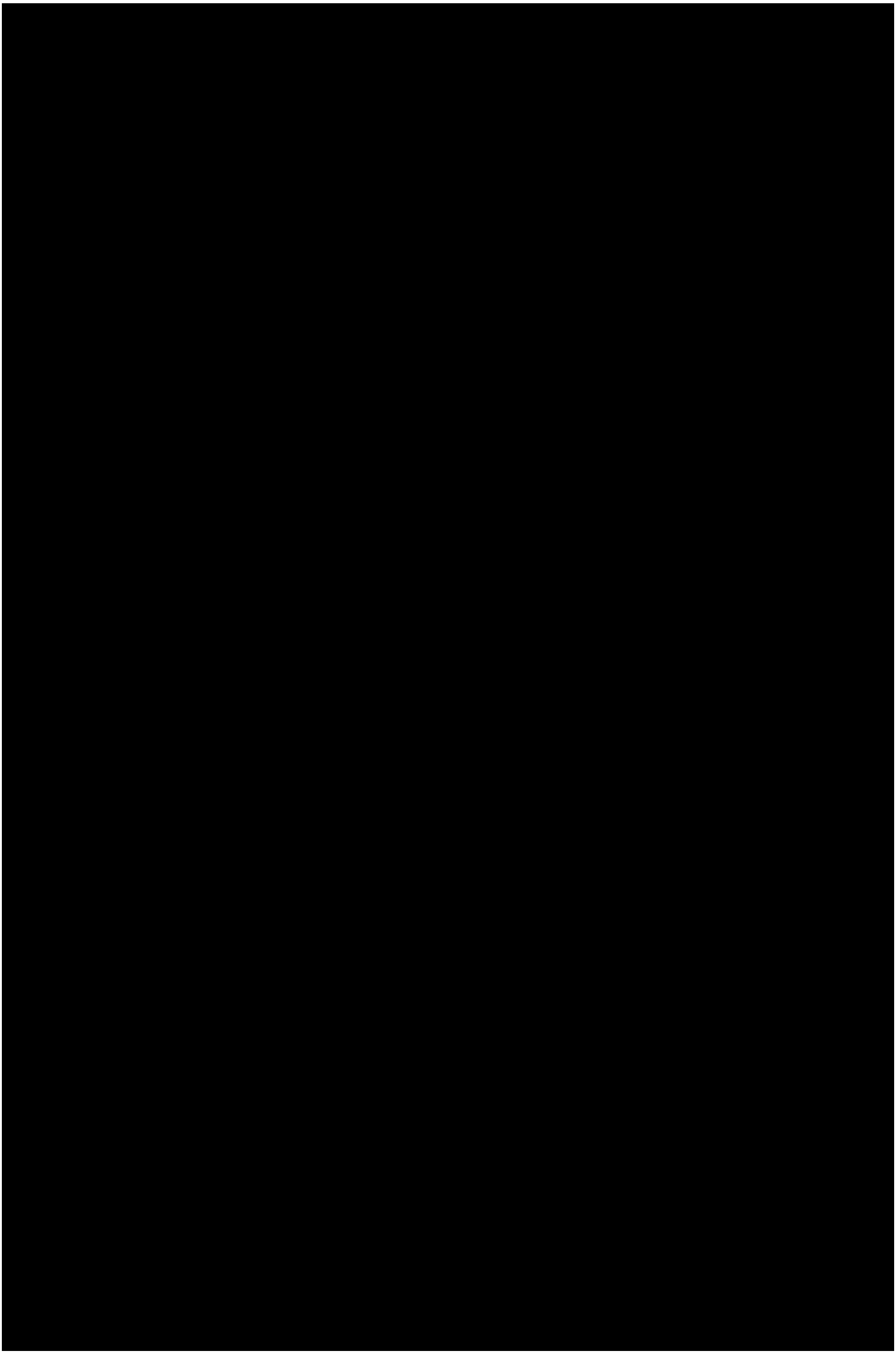
4.5.3 Injection Packer Design

[redacted]

4.5.4 Wellhead and Tree Equipment Design

[redacted]

[redacted]



4.6 Well Drilling and Completion Design

4.6.1 Drilling and Completion Procedure for the Injection Wells

The proposed design summary and procedure for the Hummingbird Project injection wells is described below. The tables presented here and in *Appendix D* provide the well design and completion details for each injection well. The final completion depths and specifications listed in those tables and the *Appendix D* schematics may be modified based on actual formation depths and/or conditions encountered during drilling.

A detailed drilling and completion prognosis for each injection well is included in *Appendix D*.

4.7 Pre-Operational Testing Plan

The planned pre-operational sampling and testing program for the cores, well logs, and injection testing will be executed during the construction of the proposed injection wells. Pursuant to LAC43: XVII **§3617.B.6**, ExxonMobil will provide at least a 72-hour notice to the Office of Conservation before performing any wireline logs, well tests, or reservoir tests.

4.7.1 Injection and Confining Zone Core Sampling

Pre-operational coring activities will further verify the physical characteristics of the injection and confining zones.

4.7.2 Pre-Operation Logging Program

The following geophysical logs are planned for each proposed injection well. The openhole logging plan is detailed in Table 4-22, and the cased-hole logging plan in Table 4-23.

Table 4- 22 – Openhole Logging Plan for the Injection Wells

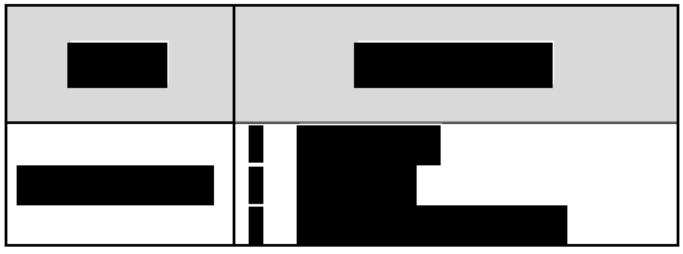


Table 4- 23 – Cased-Hole Logging Plan for the Injection Wells

4.7.3 Injection Zone Characterization

ExxonMobil will collect characterization data for the permitted injection zone of the injection wells, including formation fluid temperature, pH, specific conductivity, and formation pressure (LAC43: XVII **§3617.B.3**).

4.7.4 Fluid Characteristics and Downhole Conditions

During the construction of the injection wells,

[redacted]

[redacted]

[redacted]

4.7.5 Injection and Confining Zone Formation Testing

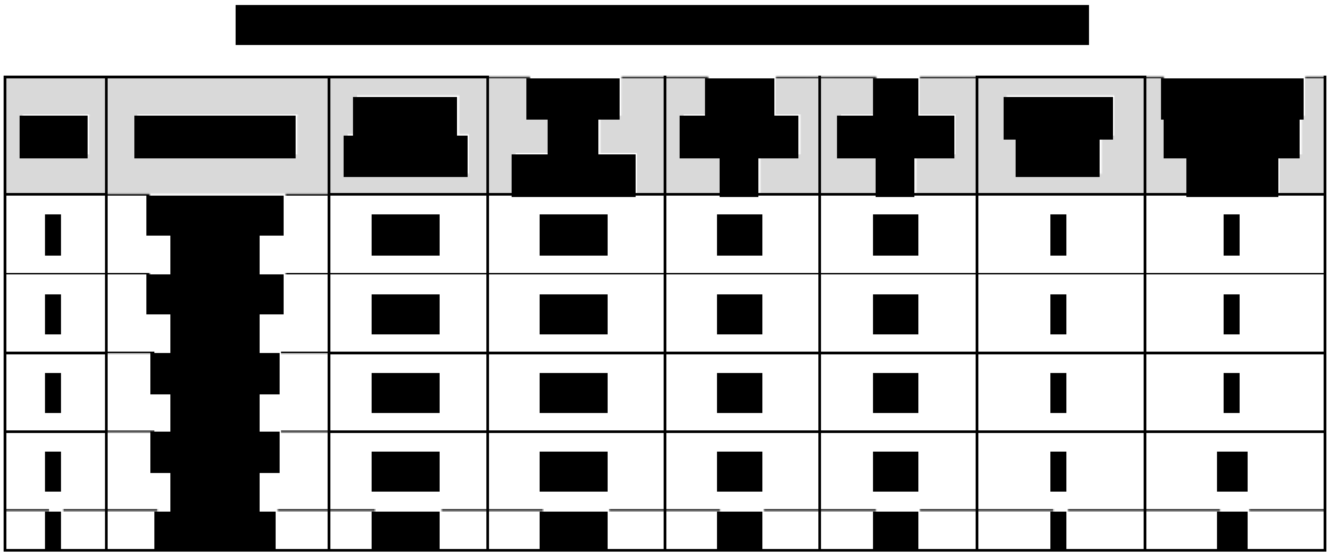
[redacted] These tests are intended to confirm reservoir and operational parameters used in the permitting process and provide needed data on the geologic and hydrogeologic properties of subsurface formations. [redacted]

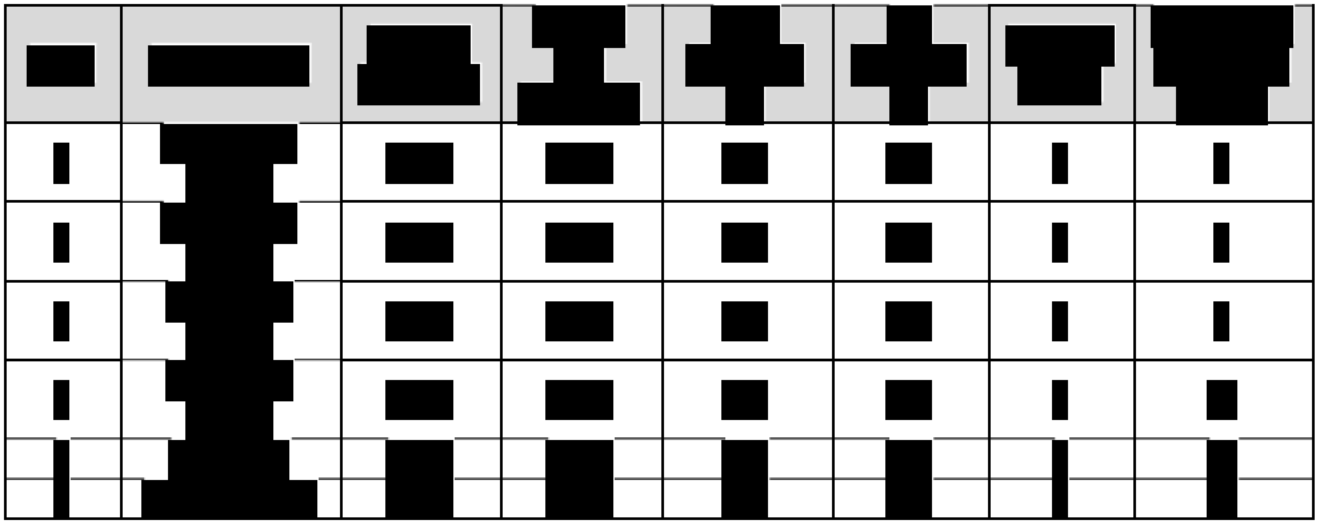
[redacted]

4.8 Injection Well Operating Strategy

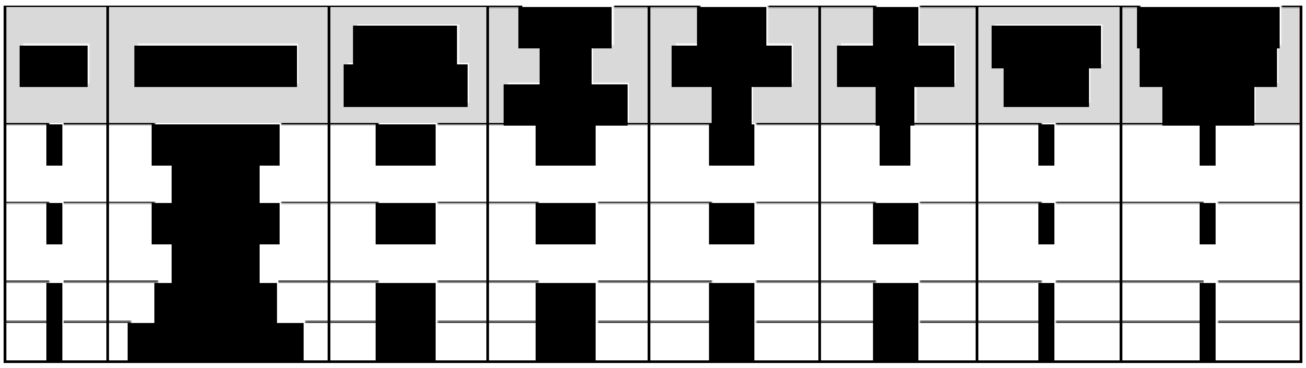
4.8.1 Overview of Injection Well Perforation and Completion Strategy

Upon permit approval, injection will start based on the stages and injection schedules referenced in Tables 4-25 through 4-29.





[redacted]

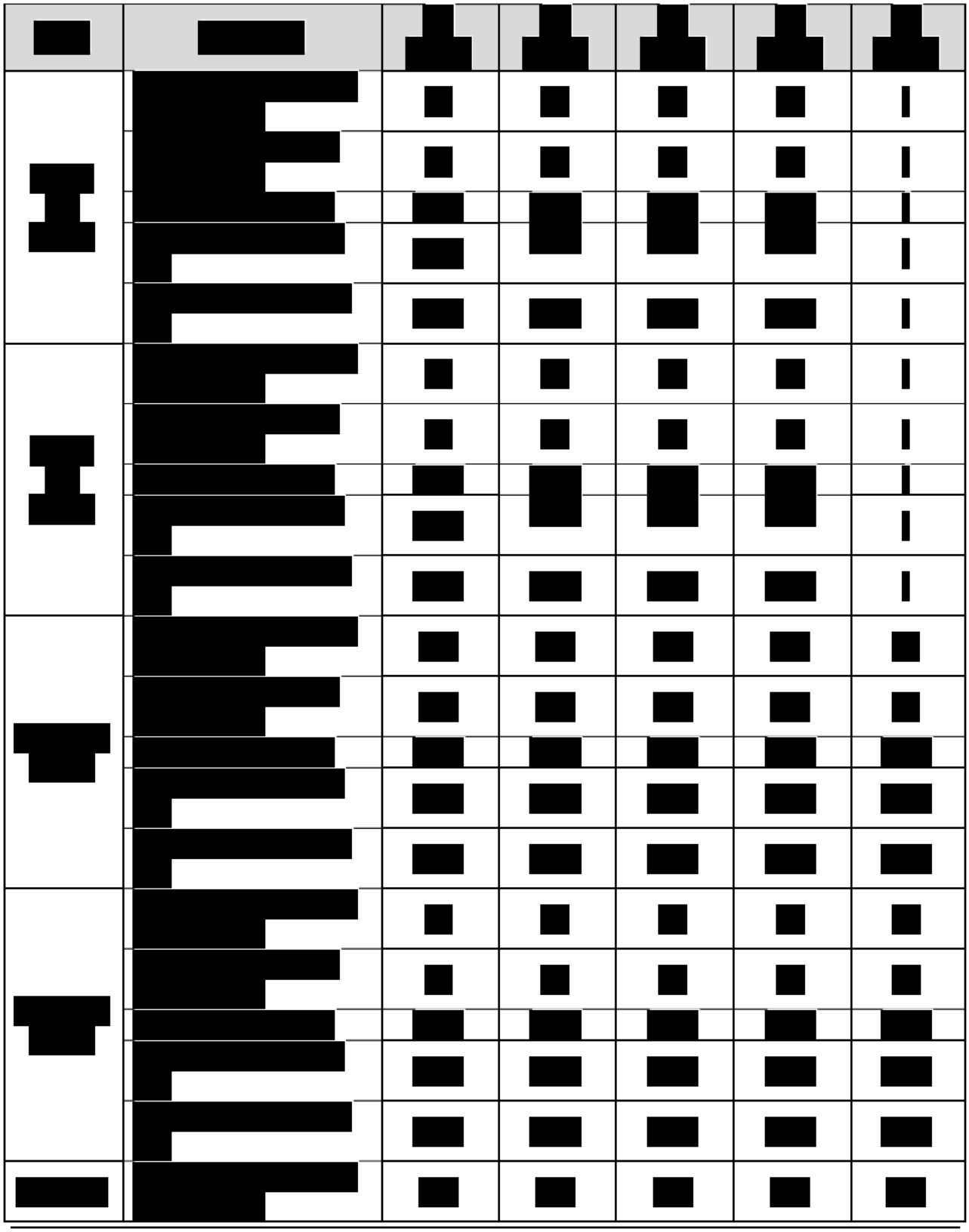


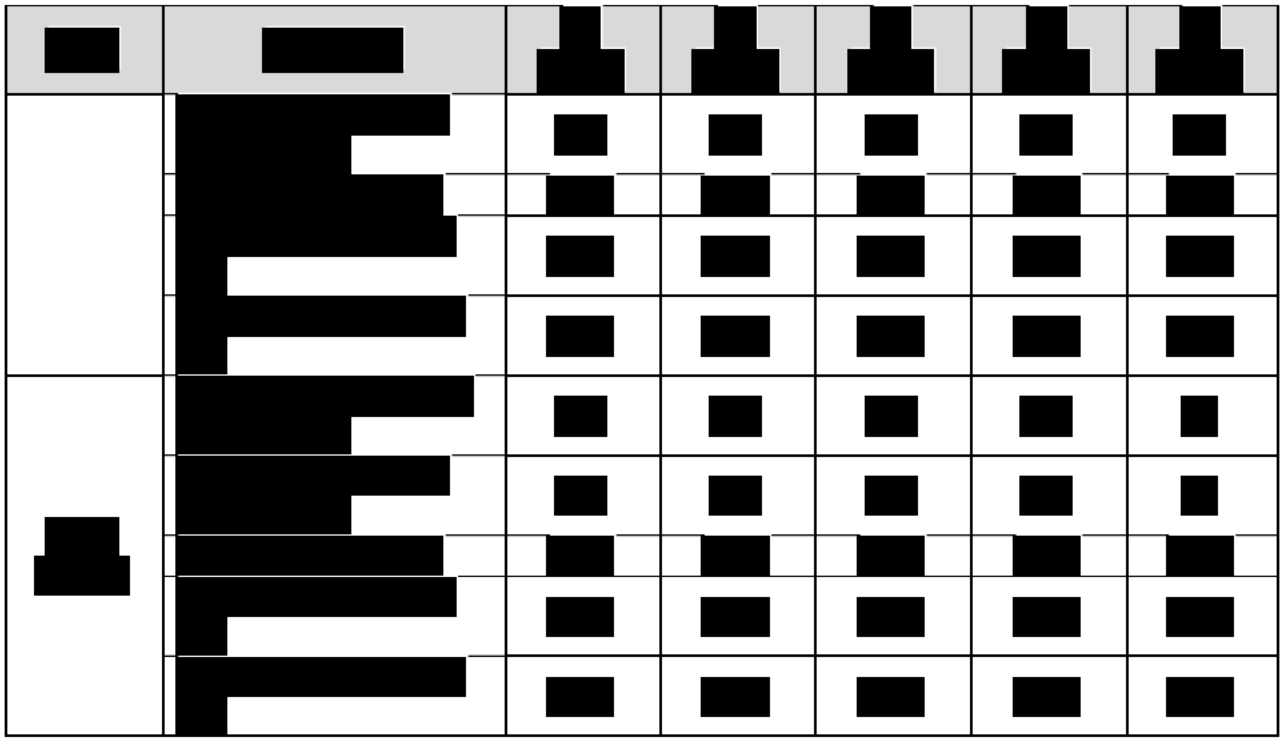
[redacted]

4.8.2 Injection Rate and Pressure

Table 4-30 provides the proposed operations for the injection wells, including injection rate and pressure by well. Both the maximum and average injection rates are predicted to result in reservoir pressure rises that are below 90% of the critical fracture pressure, shown in Table 4-30. Both the injection rates and pressures are within the operating window of the injection wells.

Table [redacted]





*BHP – bottomhole pressure

4.8.3 Annulus Pressure

The annulus pressure will be adjusted to exceed the wellhead injection pressure, [redacted] (LAC43: XVII **§3621.A.3** and **4**).

4.8.4 Well Stimulation Procedures

ExxonMobil is not proposing a stimulation program for the proposed injection wells. In accordance with LAC43: XVII **§3629.A.2**, if a stimulation program is proposed, ExxonMobil will provide an advance notice of the proposed stimulation procedures to the Commissioner of Conservation (Commissioner). Pursuant to LAC43: XVII **§3621.A.9**, ExxonMobil will seek well work authorization by filing a Form UIC-17, detailing plans of any proposed stimulation work.

4.8.5 Operational Reporting Plan

During the operational phase of the Hummingbird Project, ExxonMobil will, within 24 hours, report to the Commissioner any confirmed endangerment to USDWs, pursuant to the requirements in LAC43: XVII **§3621.A.7.b.iii**, **§3629.A.1.c**, and **§3623.A.2.c**—including the following:

- Evidence that the CO_2 plume or pressure front may endanger one or more USDWs
- The noncompliance situation as it relates to a permit condition
- Apparent malfunction of the injection system

- Triggering of a shutoff system or a loss of mechanical integrity
- A release of CO_2 to the atmosphere or biosphere

ExxonMobil will cease injection and take all steps reasonably necessary to determine whether there may have been a release of CO_2 to an unauthorized zone, in the event that there is a loss of mechanical integrity (LAC43: XVII **§3621.A.7.b.ii**).

Appendix D – Well Construction Schematics and Procedures:

- Appendix D1: Well Design and Completion Schematics for Injection Wells
- Appendix D2: Drilling and Completion Prognosis for Injection Wells

Appendix D – Well Construction Plan and Operating Conditions

- See Section 0 – Application Narrative for PE Stamp Cover Page