ATTACHMENT B: AREA OF REVIEW AND CORRECTIVE ACTION PLAN
40 CFR 146.84(b)

CTV IV

1.0 Document Version History

Version	Revision Date	File Name	Description of Change
1	4/12/2023	Att B - CTV IV AoR _CA_v1	Original Submission

2.0 Facility Information

Facility name: CTV IV

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3.0 Computational Modeling Approach

The computational modeling workflow begins with the development of a three-dimensional representation of the subsurface geology. It leverages well data (bottom and surface hole location, wellbore trajectory, well logs, etc.) for rendering structural surfaces into a geo-cellular grid, which also includes seismic information to understand faults and flow barriers. Attributes of the grid include porosity, permeability and facies distributions of reservoir lithologies by subzone, as well as observed fluid contacts and saturations for each fluid phase. This geologic model is often referred to as a static model, as it reflects the reservoir at a single moment. Carbon TerraVault Holdings, LLC (CTV) licenses Schlumberger Petrel, industry-standard geo-cellular modeling software, for building and maintaining static models. The static model becomes dynamic in the computational modeler with the addition of:

- Fluid properties such as density and viscosity for each hydrocarbon and water phase
- Liquid and gas relative permeability
- Capillary pressure data
- Proposed injection well completions, injection rates and injection pressure over the life of the project
- Field pressure history
- Fluid geochemical analysis

Results from the computational model are used to establish the area of review (AoR), the 'region surrounding the geologic sequestration project where underground sources of drinking water (USDWs) may be endangered by the injection activity' (EPA 75 FR 77230). In the case of the CTV IV storage project, the AoR encompasses the maximum aerial extent of the critical pressure front that was calculated as being necessary to move brine from the injection zone to the USDW via an open conduit.

3.1 Model Background

Computational modeling was completed using Computer Modeling Group's (CMG) Equation of State Compositional Simulator (GEM). GEM is capable of modeling enhanced oil recovery (EOR), chemical EOR, geomechanics, unconventional reservoir, geochemical EOR and carbon capture and storage. GEM can model flow of three components (gas, oil and aqueous) and multi-phase fluids as well as predict phase equilibrium compositions, densities, and viscosities of each phase. This simulator incorporates all the physics associated with handling of relative permeability as a function of interfacial tension (IFT), velocity, composition, and hysteresis. Computational modeling for the CO_2 plume utilized the Peng-Robinson Equation of State and the solubility of CO_2 in water is modeled by Henry's Law. The Peng-Robinson Equation of State establishes the properties of CO_2 over the Pressures and temperatures of the model. Solubility of CO_2 in aqueous phase was modeled by Henry's Law as a function of pressure, temperature, and salinity.

The plume model defines the potential quantity of CO_2 stored and simulates lateral and vertical movement of the CO_2 to define the extent of the CO_2 plume and the pressure changes in the reservoir during and after injection which are used to define the AoR.

The simulator predicts the evolution of the CO_2 plume by:

1. Incorporating complex reservoir geometry and wells and utilizing a full field static geological three-dimensional characterization of the reservoir incorporating lithology, saturation, porosity, and permeability.
2. Forecasting the CO_2 plume movement and growth by inputting the operating parameters into simulation (injection pressure and rates).
3. Assessing the movement of CO_2 after injection ceases and allowing the plume to reach equilibrium, including pressure equilibrium and compositions in each phase.

CMG's GEM software has been used in numerous CO_2 sequestration peer reviewed papers, including:

1. Simulation of CO_2 EOR and Sequestration Processes with a Geochemical EOS Compositional Simulator (Nghiemw et al., 2004).
2. Model Predictions Via History Matching of CO_2 Plume Migration at the Sleipner Project, Norwegian North Sea (Zhang et al., 2014).
3. Geomechanical Risk Mitigation for CO_2 Sequestration in Saline Aquifers. (Tran et al., 2009).

3.2 Site Geology and Hydrology

[redacted]

[redacted]

[redacted]

3.3 Model Domain

A static geological model developed with Schlumberger's Petrel software, commonly used in the petroleum industry for exploration and production, is the computational modeling input. It allows the user to incorporate seismic and well data to build reservoir models and visualize reservoir simulation results. Model domain information is summarized in **Table 3.1**.

The geo-cellular grid is uniformly spaced throughout the [redacted] at 500 ft. x 500 ft. Local grid refinement scenario was investigated for both injection target zones, and the refined grid size is 100 feet x 100 feet around each injector within 52 acres. The results show minor impact to CO_2 plume and critical pressure front. These original designed grid dimensions allow for adequate resolution of plume development. A finer resolution grid (less than 100x100) would prevent the simulation from running efficiently and a coarser resolution grid (larger than 500x500) does not adequately simulate plume movement. The model grid is aligned north to south and reservoir properties were distributed in a northeast-southwest direction [redacted] parallel to the depositional trend of the injection zones. [redacted]

The open-hole logs have a half-foot resolution and a constant vertical cell height of 20 feet was utilized over the model domain to generate grid layers as shown in **Figure 3.4**. The 20-foot cell height provides the vertical resolution necessary to capture significant lithologic heterogeneity (sand versus shale) which helps to ensure accurate upscaling of log data and distribution of reservoir properties in the static model. **Figure 3.5** shows a comparison of open-hole log data and the associated upscaled logs for a well within the AoR.

3.4 Porosity and Permeability

Wireline log data was acquired with measurements that include but are not limited to spontaneous potential, natural gamma ray, borehole caliper, compressional sonic, resistivity as well as neutron porosity and bulk density.

Formation porosity is determined one of three ways: from bulk density using 2.65 g/cc matrix density as calibrated from core grain density and core porosity data, or from compressional sonic using 55.5 µsec/ft matrix slowness and the Wyllie time average equation or the Raymer-Hunt equation. See **Table 3.2** for explanation of which equations were used in each zone.

Volume of clay is determined by spontaneous potential and is calibrated to core data.
Log-derived permeability is determined by applying a core-based transform that utilizes capillary pressure porosity and permeability along with clay values from XRD or FTIR. Core data from two wells with 13 data points was used to develop a permeability transform (**Figure 3.6**). The transform from core data is illustrated in **Figure 3.7**.

Figure 3.8 shows porosity and permeability histograms for both the Upper Injection Zone and the Lower Injection Zone. Porosity is derived from open-hole well log analysis and permeability is a function 4of porosity and clay volume. **Figure 3.9** shows the distribution of permeability and porosity using Sequential Gaussian simulation (kriging) within the static model.

3.5 Constitutive Relationships and Other Rock Properties

As no site specific Upper and Lower Injection Zone relative permeability was available, data obtained from cores from the similar geologic age and setting [redacted] in the neighboring [redacted] were used for the computational simulation. Based on the representative samples, normalization, averaging and de-normalization of the relative permeability data was used to generate the gas-water relative permeability curve with endpoints scaling for the computational modeling.

Capillary pressure data is from sidewall core samples taken from the injection zones in well [redacted] The simulation and AoR will be updated once site specific data is obtained during the pre-operational testing phase. **Figure 3.10** and **3.11** show the relative permeability curve and capillary pressure curve used in the computational modeling.

3.6 Mineralization

Previous studies into reactive transport modeling and geochemical reaction in CCS have shown that the amount of CO_2 trapped by mineralization reactions is extremely small over a 100-year post injection time frame (IPCC, 2005) for sandstone reservoirs. For the sake of computational efficiency and the minor expected effect on the AoR, reactive transport was not included as a part of the compositional simulation modeling.

Potential geochemical reactions of the Injection zone, Confining zone and formation fluids with the injectate streams being considered were modeled using PHREEQC (ph-REdox-Equilibrium), the USGS geochemical modeling software. Details on the modeling procedure and results are provided in Appendix 3 (CTV IV Geochemical modeling). The modeling indicates as expected that as the formations are stable quartz dominated mineralogy, the effect of geochemical reactions with the injectate will be minor. Based on molar mass, there is a minimal net molar mass change: +0.6% to +1.3% in the Upper Injection Zone and +2.9% to +3% in the Lower Injection Zone. This is not expected to have a major impact on porosity or permeability in the injection zone or upper confining zone.

3.7 Boundary Conditions

The following Boundary conditions were applied to the model domain:

1. The overlying [redacted] which is continuous and present at an average thickness of 270' over the model domain has low permeability, has been shown to be a proven hydrocarbon seal over the model domain and was thus set as a no flow boundary.
2. [redacted] bounding conditions to the model are open, with large volume modifiers at the edge cells to model connection to the reservoir volume beyond the model domain based on regional mapping of the formations in the area.

3.8 Initial Conditions

Initial model conditions (start of CO_2 injection) of the Upper and Lower Injection zones are given in **Table 3.3**.

3.9 Operational Information

Details on the injection operation are presented in **Table 3.4**. Further details are provided in the Narrative document and in the Operational Procedures Appendix.

3.10 Fracture Pressure and Fracture Gradient

Calculated fracture gradient and target injection pressure values are given in **Table 3.5**. A fracture pressure gradient of 0.76 psi/ft is assumed for the injection zones. Within the project AoR there is no site specific fracture pressure or fracture gradient for the injection zones. However, several wells in [redacted] have formation integrity tests (FIT) performed at similar depth ranges to the project injection and confining zones. Tests from nine wells average 0.76 psi/ft from tests in the depth range of [redacted] TVD. CTV will conduct a step rate test in the injection zone as part of the pre-operational testing plan to confirm this fracture pressure gradient.

At this time, no fracture gradient information has been found for the upper confining zone. CTV will conduct a step rate test for the upper confining zone as part of the pre-operational testing.

CTV will ensure that the injection pressure is below 90% of the injection zone fracture pressure, calculated at the top of the perforations in the injection wells (**Table 3.5**). CTV expects to operate the wells with a planned down hole injection pressure well below the maximum allowable injection pressure calculated using the fracture gradient and safety factor.

4.0 Computational Modeling Results

4.1 Predictions of System Behavior

Figure 4.1 and **Figure 4.2** show the computational modeling results and development of the CO_2 plume at different time steps. The boundaries of the CO_2 plume have been defined with a 0.01 CO_2 global mole fraction cutoff.

As shown in **Figure 4.1**, the CO_2 extent is largely defined by [redacted] years post-injection for the upper injection zone and [redacted] years post injection for the lower injection zone. The majority of the CO_2 injectate remains as super-critical CO_2 (67% for Upper and 67% for Lower) at the end of the simulation with the remaining portion of the CO_2 dissolving in the formation brine over the simulated 100 years post injection. **Figure 4.3** shows the cumulative storage for each of the mechanisms.

4.2 Model Calibration and Validation

Model inputs were compared against publicly available reports and presentations by Lawrence Berkley National Laboratory (LBNL) and the West Coast Regional Carbon Sequestration Partnership (WESTCARB) investigating the CCS potential of the area (Foxall, et. al., 2017; Doughty and Oldenburg, 2011; Beyer et. al., 2013). The results of CTV's simulation compare favorably against the previous work by LBNL regarding storage capacity and CO_2 plume size.

4.2.1 CO_2 Injectate Effect on Plume and AoR Modeling Results

The compositional simulation model developed in CMG GEM software was run for the two simplified injectate compositions discussed in Section 7.2 in Attachment A, and their results were also compared against a 100% CO_2 injectate case. The cumulative volume, rate and injection duration for all 3 cases was kept the same.

The upper injection zone CO_2 plume for Injectate 1 and Injectate 2 is consistent with the plume outline for 100% CO_2 injectate (**Figure 4.4**), with negligible difference between the 3 cases. The CO_2 plume outline was defined by a 0.01 global CO_2 mole fraction for all 3 cases. The 100 year post end of injection plumes for the 3 cases are shown below in **Figure 4.4.** The wells that fall within the CO_2 plume are the same for all 3 cases. Similarly, the lower injection zone CO_2 plume for Injectate 1 and Injectate 2 is consistent with the plume outline for 100% CO_2 injectate (**Figure**

4.4), and the plume outline was defined by a 0.03 global CO_2 mole fraction for all 3 cases. The 100 year post end of injection plumes for the 3 cases are shown below in **Figure 4.4.** The wells that fall within the CO_2 plume are the same for all 3 cases.

Similarly, the AoR was delineated using critical pressure (see Section 4.3) for the 3 cases and was found to be consistent. **Figure 4.4** shows the upper injection zone and lower injection AoR boundary for the 3 cases. Additionally, the average pore volume pressure within the approximate AoR boundary was plotted for the 3 cases and was found to be very close with a maximum difference of ~6 psi seen between the cases for upper injection zone and ~2 psi for the lower injection zone, as shown in **Figure 4.5**. Multiple scenarios were also run to test the effect of mixing Injectate 1 and Injectates 2 in different ratios on the AoR boundary and plume shapes. As expected, since the resulting mixed injectates were still high purity CO_2 streams with impurity concentrations in-between those of Injectates 1 and 2, the AoR boundaries and plume shapes for these scenarios were within the envelope represented by the end point compositions.

In summary, there is minimal effect of the minor components on the CO_2 plume shape and the AoR boundary, for the proposed injectate compositions. As such, CTV's plume and AoR modeling for corrective action assessment is adequate for the expected injectate composition ranges. CTV will confirm that the properties of the injectate are consistent with the model inputs at pre-operational injectate sampling and will do so for any additional sources. In addition, the AoR will be reviewed as per Section 6 Reevaluation Schedule and Criteria.

4.2.2 Sensitivity Cases

In addition, scenarios listed in the **Table 4.1** were run to test the effect of varying major model inputs on the CO_2 plume and AoR extent. These scenarios and the comparison against previous work in the area provides us with confidence in the CO_2 plume extent and AoR, and that the corrective action well review and potential impact to the USDW has been appropriately evaluated.

4.3 AoR Delineation

The AoR delineation was based on the methods of Thornhill et al. (1982), which is referenced in the EPA AoR and Corrective Action Guidance (Critical pressure calculation and results details are also discussed in **Appendix 7**). Based on pressure data available in the Upper and Lower Injection Zone formations in the region (**Figure 4.7**), it appears that both formations are under-pressured. Graph and data table showing this are shown in **Figure 4.6**. This is likely due to historic withdrawal from regional gas field operations in the area and limited recharge.

For the purpose of calculating the critical pressure and delineating the AoR for the project area, the aquifers are considered to be under-pressured by 128 psi for the Upper injection zone and 37 psi for the lower injection zone. Also the following equations were used to calculate critical pressure across the model domain:

$$P_{i,f} = P_u + \rho_i g(Z_u - Z_i) \qquad \text{– Eq (1)}$$

$$\Delta P_{i,f} = P_u + \rho_i g(Z_u - Z_i) - P_i \qquad \text{– Eq (2)}$$

Where,

$\Delta P_{i,f}$	-	the admissible overpressure in an under-pressured aquifer before fluid in the injection zone would flow into the USDW through a hypothetical open conduit
P_u	-	the initial pressure in the USDW. Assumed to be hydrostatic.
P_i	-	the initial pressure in the injection zone. The upper injection zone is assumed to be 128psi below hydrostatic pressure across the model domain, and the lower injection zone is assumed to be 37psi below hydrostatic.
g	-	acceleration due to gravity, 9.81m/s^2
Z_u	-	Elevation of the base of the USDW
Z_i	-	Elevation of the injection zone
ρ_i	-	Density of the brine in injection zone

An average TDS of 13,889 ppm was used for the upper injection zone and 14,415 ppm was used for the Lower injection zones based on test data. An average TDS of 6,930 ppm was assumed for the USDW based on Salinity calculations in the project area. Injection zone and USDW depths were based on the model grid and USDW mapping in the project area. Density and density gradients were calculated as a function of temperature and salinity using standard methods (McCutcheon et. al. 1993). Using these, the critical pressure was calculated at each grid point in the Petrel model using **Equations 1 & 2**, and combined with the pressure outputs from the plume simulation to delineate an AoR boundary at different timesteps. The final AoR boundary was determined by combining the outermost extent of the threshold pressure for the Upper Injection zone (seen at [redacted] years of injection) and the Lower Injection zone (seen at [redacted] years of injection). **Figure 4.8** shows the AoR extent, CO_2 plume extent, injector locations and proposed monitoring well locations. Details on the monitoring wells are discussed in further detail in Attachment C (Testing and Monitoring Plan).

5.0 Corrective Action

5.1 Tabulation of Wells within the AoR

Wells within the AoR are associated with exploration of the upper and lower Injection Zones for natural gas accumulations. [redacted] As such, there are excellent records for wells drilled in the study area and no undocumented historical wells in the AoR are expected.

CTV accessed internal databases as well as California Geologic Energy Management Division (CalGEM) information to identify and confirm wells within the AoR (Sources: https://wellstar.conservation.ca.gov , https://maps.conservation.ca.gov/doggr/wellfinder).

Table 5.1 provides counts of wellbores that penetrate the upper confining zone within the AoR by status and type, for each wellbore with a unique API-12 identifier. Appendix 6 provides a complete list of all wellbores by API-12 within the AoR. As required by 40 CFR 146.84(c)(2), the well table in Appendix 6 describes each well's type, construction, date drilled, location, measured depth, true vertical depth, completion record relative to the upper and lower injection zones, record of plugging, requirement for corrective action, if necessary. CTV also identified well work to be completed during the pre-operational testing phase.

5.2 Protection of USDWs

For the project area, CTV assessed USDW protection by evaluating all wellbores that penetrate the confining [redacted] The corrective action assessment included the generation of detailed casing diagrams for each wellbore, review of all perforations, top of cement assessment for each casing string, and determination of cement plug depths. Non-endangerment of USDWs will be ensured during all stages of the project.

5.3 Wells Penetrating the Confining Zone

The depth of the confining zone in each of the wells penetrating [redacted] was determined by interpretation of open-hole well logs and utilizing the deviation survey. Six wells in the AoR penetrate [redacted] confining zone. These wells also penetrate the upper and lower storage reservoirs. These well are in the AoR and but outside the CO_2 plume. CTV will provide a strategy and/or corrective action plan on these wells during pre-operational testing. The implementation and results of the corrective action plan for the [six] wells located within the CO_2 plume will inform the corrective action assessment and planning of these wells

5.4 Upper and Lower Injection Zone Isolation

All six wells within the AoR penetrate the upper and lower injection zones, and none will be used for the project. If isolation of this formation is determined to be deficient in such a way that USDWs may be impacted, corrective action plans will be communicated and implemented prior to injection to ensure non-endangerment of USDWs.

5.5 Corrective Action Assessment of Wells in AoR

The six wells in the AoR and outside the CO_2 plume were drilled as gas exploration wells and determined to be dry holes (no hydrocarbon present), which resulted in abandonment of the open-hole section with a cement plug set across the surface casing and above the USDW. CTV will evaluate the condition of the abandoned wells inside the pressure boundary for brine migration during pre-operational testing. If migration is expected within any of these six wells in the pressure boundary, CTV will provide a strategy and/or corrective action plan on these wells. A map with these wells is shown in **Figure 5.1**, and the table of wells in Appendix 6 provides well information pursuant to 40 CFR §146.84(c)(2). There are no wells within the CO_2 plume.

5.6 Plan for Site Access

CTV has obtained surface access rights for the duration of the project.

5.7 Corrective Action Schedule

As there are no wells within the CO_2 plume boundary, no corrective action is deemed necessary prior to the start of injection at this time. CTV will provide a strategy and/or corrective action plan on these wells during pre-operational testing. CTV will ensure that CO_2 is confined to the injection zones within the AoR, protecting the overlying USDW and ensuring confinement.

Through time, if the plume development is not consistent with the predicted results, computational modeling will be updated to reassess the AoR. In this event, all wells in the updated AoR will be subject to the Corrective Action Plan and be remediated if necessary.

6.0 Reevaluation Schedule and Criteria

6.1 AoR Reevaluation Cycle

CTV will reevaluate the above described AoR at a minimum every five years during the injection and post-injection phases, as required by 40 CFR 146.84 (e).

Simulation study results are reviewed when operating data is acquired. Preparation of necessary operational data for the review includes injection rates and pressures, CO_2 injectate concentrations, and monitoring well information (storage reservoir and overlying dissipation intervals).

Dynamic operating and monitoring data that will be incorporated into future reevaluation will include:

1. Pressure data from monitoring wells that constrain and define plume development.
2. CO_2 content/saturation from monitoring wells. This data may be acquired with direct aqueous measurements and cased hole log results that will constrain and define plume development.
3. Injection pressures and volumes. The injection pressures and volumes in the computational model are maximum values. If the actual rates are lower than expected, the plume will develop at a slower rate than expected and be reflected in the pressure and CO_2 concentration data in 1 and 2 above.
4. A review of the full suite of water quality data collected from monitoring wells in addition to CO_2 content/saturation (to evaluate the potential for unexpected reactions between the injected fluid and the rock formation).
5. Review and submission of any geologic data acquired since the last modeling effort, including any additional site characterization performed for future injection wells.
6. Reevaluation modeling results will be compared with the most recent modeling (i.e., from the most recent AoR reevaluation). A report describing the comparison of the modeling results will be provided to the EPA with a discussion on whether the results are consistent.
7. Description of the specific actions that will be taken if there are discrepancies between monitoring data and prior modeling results (e.g., remodel the AoR, update all project plans, perform additional corrective action if needed, and submit the results to EPA).

Re-evaluation results will be compared to the original results to understand dynamic inputs affecting plume development and static inputs that would impact injectivity and storage space. Static inputs that may potentially be considered to understand discrepancies between initial and re-evaluation computational models could include permeability, sand continuity and porosity. Although the AoR has been fully delineated, all inputs to the static and dynamic model will be reviewed.

As needed, CTV will review all of the plans that are impacted by a potential AoR increase such as Corrective Action and Emergency and Remedial Response. For corrective action, all wells potentially impacted by a changing AoR will be addressed immediately.

6.2 Triggers for AoR Reevaluations Prior to the Next Scheduled Reevaluation

An ad-hoc re-evaluation prior to the next scheduled re-evaluation will be triggered if any of the following occur:

1. Changes in pressure or injection rate that are unexpected and outside three (3) standard deviations from the average will trigger a new evaluation of the AoR.
2. Difference between the computation modeling and observed plume development:
    a. Unexpected changes in fluid constituents or pressure outside the zones of injection that are not related to well integrity.
    b. Reservoir pressures increase versus injected volume is inconsistent with computational modeling results with a variance >±10% from the Base Case Simulation.
    c. Any other activity prompting a model recalibration.
3. Seismic monitoring anomalies within two miles of the injection well that are indicative of:
    a. The presence of faults near the confining zone that indicates propagation into the confining zone.
    b. Events reasonably associated with CO_2 injection that are greater than M3.5.
2. Exceeding 90% of the geologic formation fracture pressure in any injection or monitoring wells.
3. Detection of changes in shallow groundwater chemistry (e.g., a significant increase in the concentration of any analytical parameter that was not anticipated by the AoR delineation modeling).
4. Initiation of competing injection projects within the same injection formation within a 1- mile radius of the injection well (including when additional CTV injection wells come online);
5. A significant change in injection operations, as measured by wellhead monitoring;
6. Significant land-use changes that would impact site access; and
7. Any other activity prompting a model recalibration.

CTV will discuss any such events with the UIC Program Director as soon as possible to determine if an AoR re-evaluation is required. If an unscheduled re-evaluation is triggered, CTV will perform the steps described at the beginning of this section of the Plan within six months for the triggering event.

References

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

FIGURES

[redacted]

Figure 3.1. Cross section showing stratigraphy and lateral continuity of major formations across the AoR.

[redacted]

Figure 3.2. Location of wells with open-hole log data used to develop the static and computational models.

[redacted]

Figure 3.3. Plan view of the model boundary and geo-cellular grid used to define the CO_2 plume extent and associated AoR.

[redacted]

Figure 3.2. Static model grid layering of the Injection Zones. Stratigraphic units have an open boundary in all directions.

[redacted]

Figure 3.5. Well [redacted] upscaled logs versus open-hole logs.

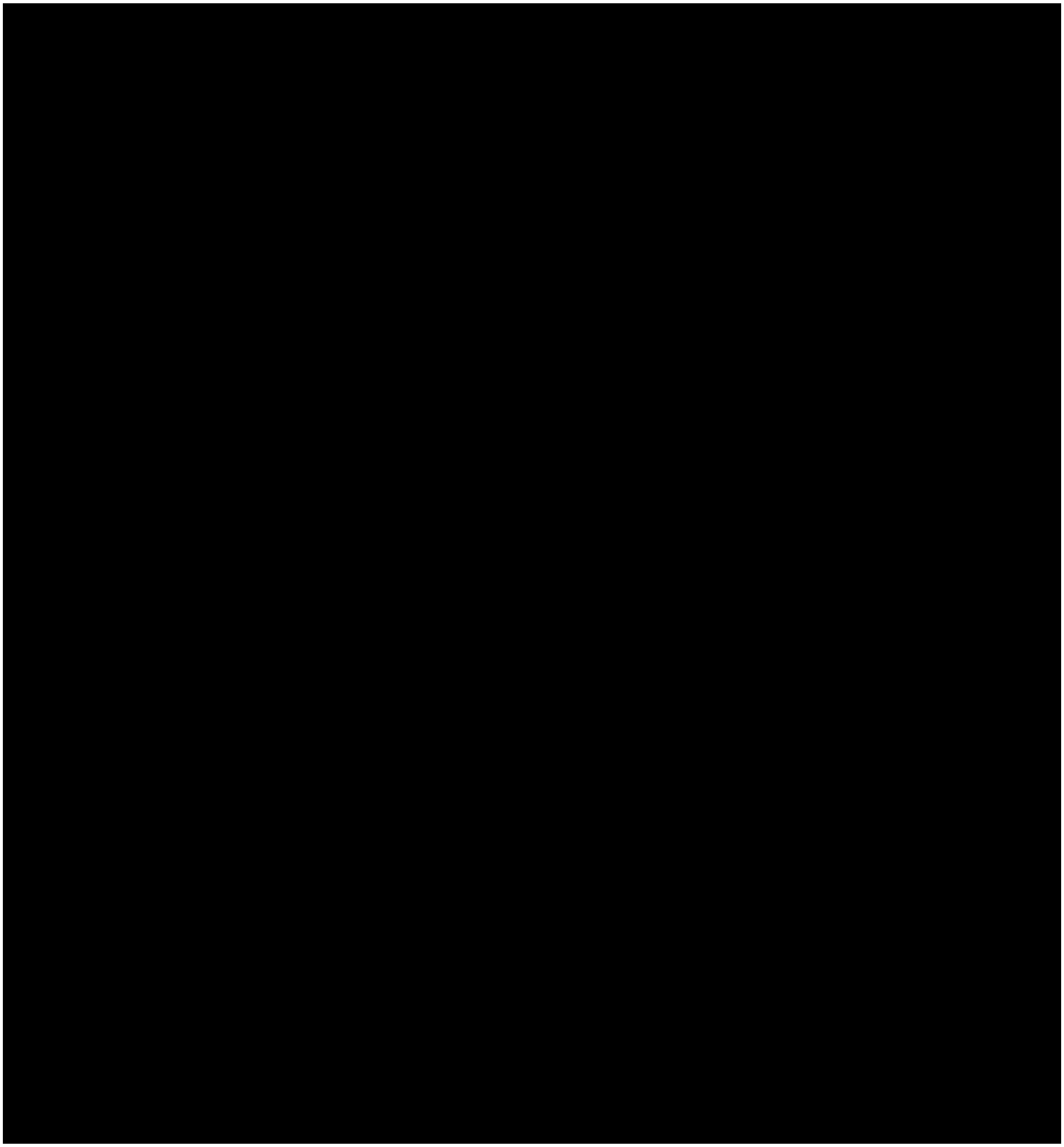


Figure 3.6: Location of wells with core data used for permeability transform.

[redacted]

Figure 3.7: Permeability transform for [redacted]

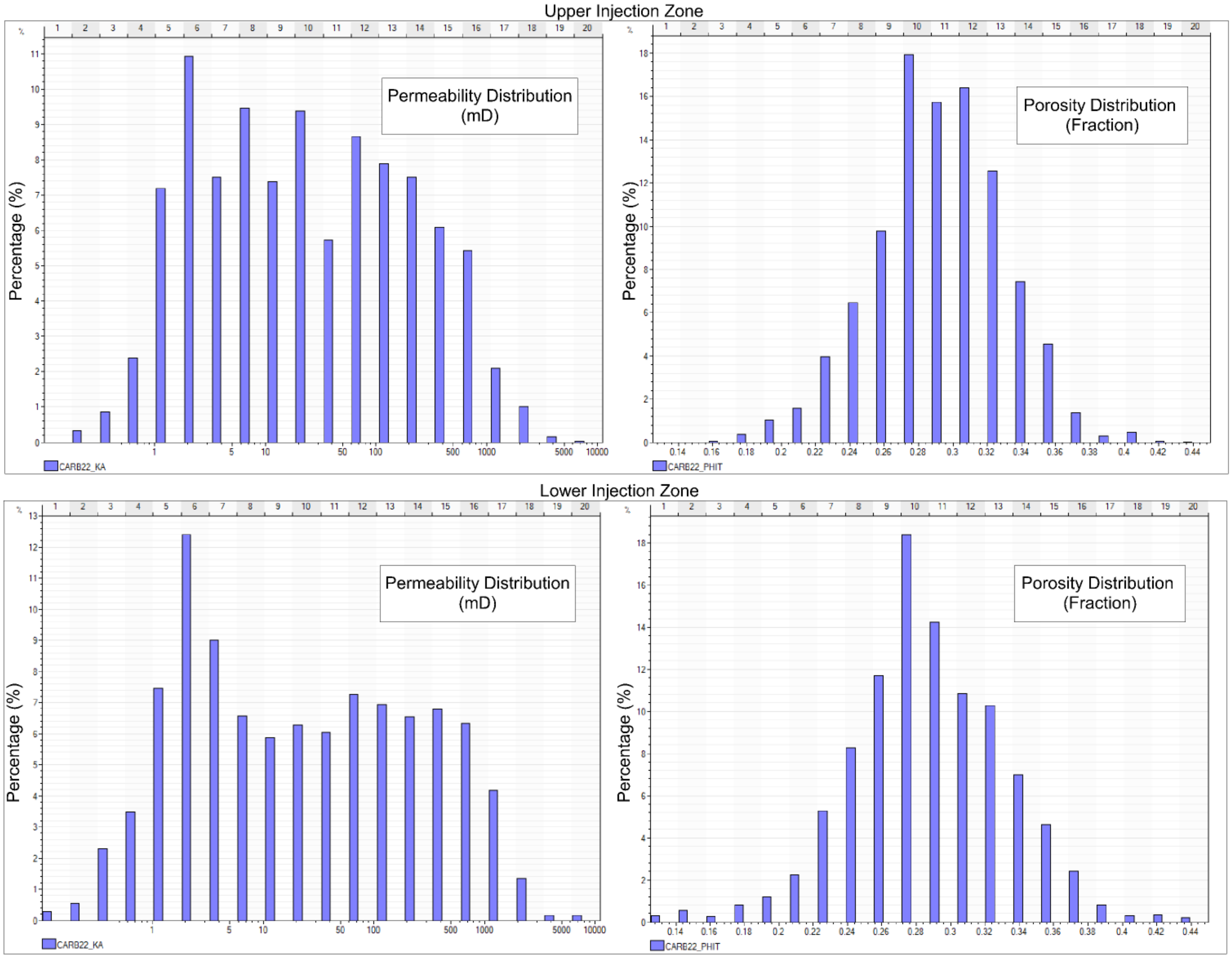


Figure 3.8. Upper and Lower Injection Zone porosity and permeability distribution used in the static model.

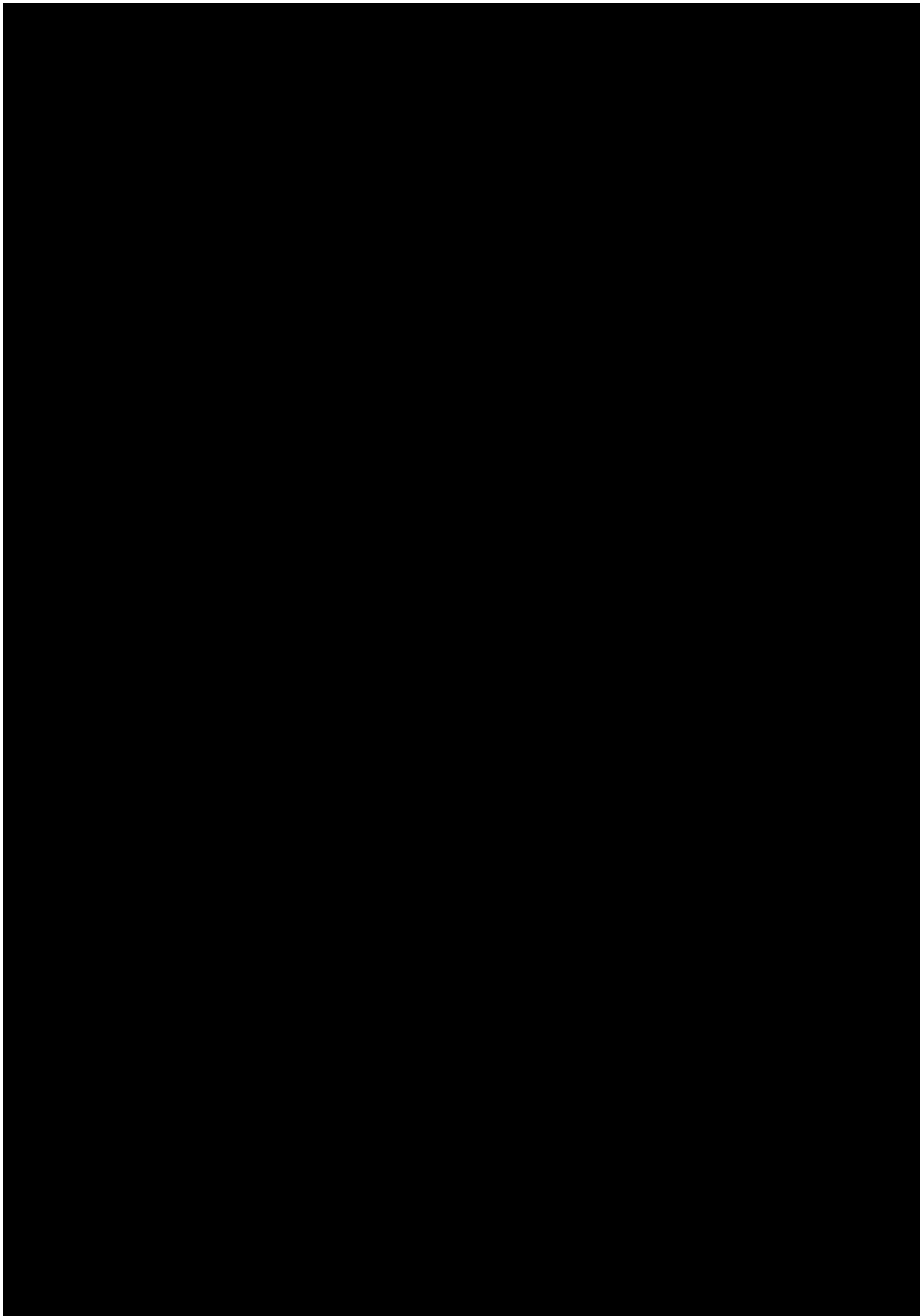


Figure 3.9. Sections through the static grid showing the distribution of porosity and permeability in the reservoir.

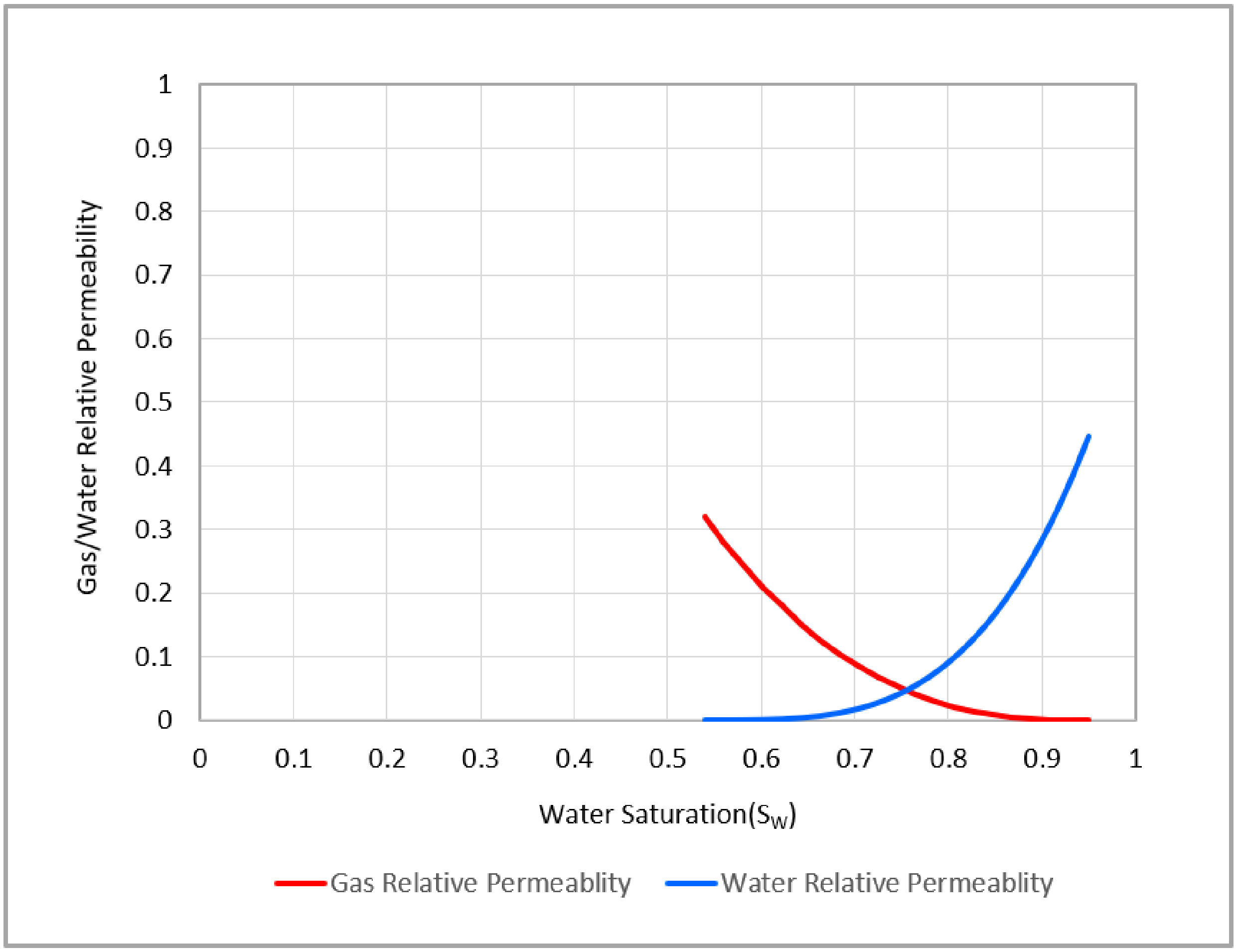


Figure 3.10. Relative permeability curves for Gas-Water system

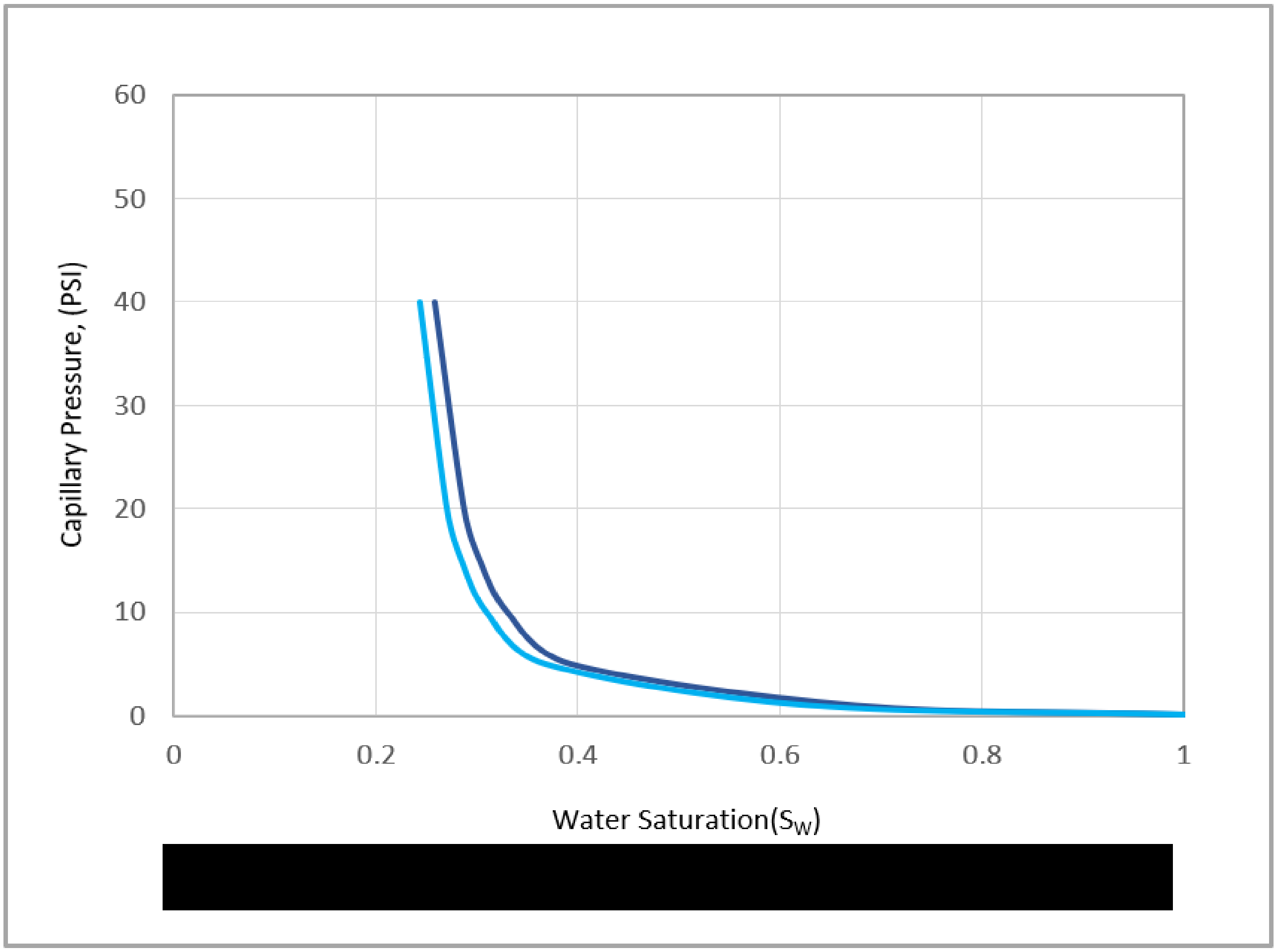


Figure 3.11. Capillary pressure curve

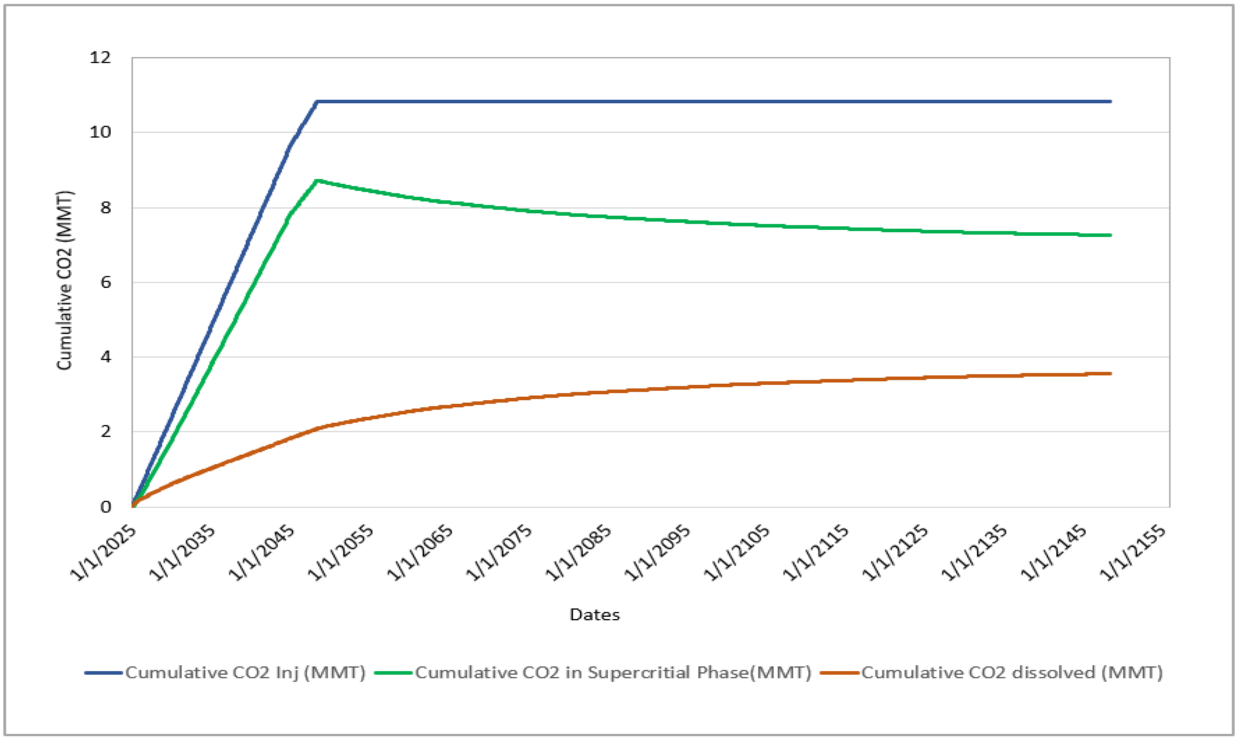
[redacted]

Figure 4.1. (A) Upper Injection Zone plume development through time: 1-year, 5-year, 10-year, 20-year, 23-year (end of injection), 77-year, and 100-year post injection. (B) Lower Injection Zone plume development through time: 1-year, 5-year, 10-year, 20-year, 25-year (end of injection), 75-year, and 100-year post injection.

[redacted]

Figure 4.2 Cross-sections showing plume development at various time steps through the project

(A) Upper Injection Zone



(B) Lower Injection Zone

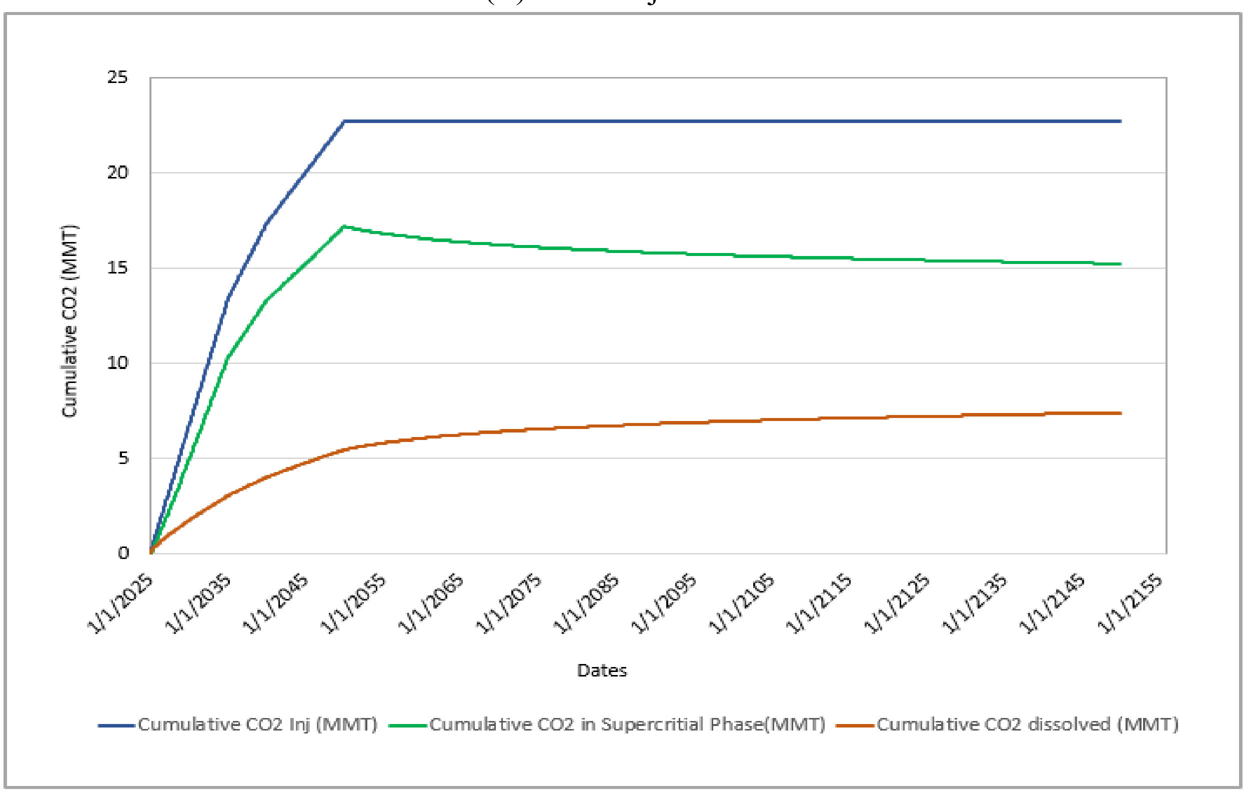


Figure 4.3 CO_2 storage mechanisms in the reservoir.

[redacted]

Figure 4.4. AoR boundaries and CO_2 plume outlines for Injectate 1 (Light Blue), Injectate 2 (Pink) and 100% CO2 Cases (Dark Blue). Larger Red outline is the model boundary. Minimal difference in AoR boundaries between the 3 cases with the boundaries overlying each other for the most part.

[redacted]

Figure 4.5. Average reservoir pressure within approximate AoR for Injectate 1, Injectate 2 and 100% CO_2 cases. 100% CO_2 case and Injectate 2 case pressure trends plot almost on top of each other.

[redacted]

Figure 4.6. Upper Injection Zone pressure profile and data and Lower Injection Zone pressure profile and data.

[redacted]

Figure 4.7. Map showing location of wells with pressure data for the Upper and Lower Injection Zones.

[redacted]

Figure 4.8. Map showing the location of injection and monitoring wells.

[redacted]

Figure 5.1. Wells penetrating the [redacted] confining layer and sequestration reservoirs in the AoR. No wells are identified for corrective action at this time.

TABLES

Table 3.1. Model domain information

Coordinate System	State Plane		
Horizontal Datum	North American Datum (NAD) 27		
Coordinate System Units	Feet		
Zone	Zone 2		
FIPSZONE	0402	**ADSZONE**	3301
Coordinate of X min	[redacted]	**Coordinate of X max**	[redacted]
Coordinate of Y min	[redacted]	**Coordinate of Y max**	[redacted]
Elevation of Bottom of Domain	[redacted]	**Elevation of Top of Domain**	[redacted]

Table 3.2: Sonic porosity equations by zone

Zones	Sonic Porosity Equation	Wyllie Compaction Factor
[redacted]	Wyllie	1.6
[redacted]	Raymer-Hunt	—
[redacted]	Wyllie	1.2

Table 3.3. Initial conditions

Parameter	Injection Zone	Value	Units	Corresponding Elevation (ft msl)	Data Source
Temperature	Lower	121°	Fahrenheit	[redacted]	Bottom hole temperature data from logs in area
	Upper	108°		[redacted]	
Formation Pressure	Lower	1,953	Pounds per square inch	[redacted]	37 psi below hydrostatic based on offset field production
	Upper	1,451		[redacted]	128 psi below hydrostatic based on offset field production
Salinity	Lower	14,415	Parts per million	[redacted]	Water analysis and log calculated salinity curves
	Upper	13,889		[redacted]	

Table 3.4. Operational details

[redacted]

Table 3.5. Injection pressure details

Injection Pressure Details	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Fracture gradient (psi/ft)	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Maximum allowable downhole injection pressure (90% of fracture pressure) (psi)	2,335	2,459	2,467	2,836	2,993	2,809	2,865	3,019
Elevation corresponding to maximum injection pressure (ft TVD)	3,414	3,595	3,607	4,146	4,376	4,106	4,188	4,414
Elevation at the top of the perforated interval (ft TVD)	3,414	3,595	3,607	4,146	4,376	4,106	4,188	4,414
Planned injection pressure (psi) / gradient (psi/ft) at top of perforations	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 4.1. Simulation sensitivity scenarios

Scenario	CO_2 plume and AoR impact
Porosity: 10% reduction from base case	Minimal Impact
Porosity: 10% increase from base case	Minimal Impact
Permeability: 10% reduction from base case	Minimal Impact
Permeability: 10% increase from base case	Minimal Impact
Upper Injection Zone Local Grid Refinement: the refined grid size to 100 feet x 100 feet around each injector within 52 acres	Minimal Impact
Lower Injection Zone Local Grid Refinement: the refined grid size to 100 feet x 100 feet around each injector within 52 acres	Minimal Impact

Table 5.1. Wellbores in the AoR by status

Status	Count
Active	0
Idle	0
Plugged and Abandoned	6
Total	**6**