CO2 Modeling & Carbon Storage Consulting: Company Work Plan

Carbon Modeling Team

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Executive Summary

I provide end-to-end CO2 storage modeling and decision support for CCS developers, operators, and technology companies. My work is focused on answering the questions that drive real project decisions: injectivity and pressure management, plume migration and containment, trapping and permanence accounting, operational optimization, and MRV-ready model packages.

My approach is practical and transparent: I document assumptions, quantify uncertainty where it matters, and deliver reproducible model packages that your technical team can run, review, and audit.

Core Capabilities

Injectivity and Pressure Management

I can evaluate whether target injection rates are feasible under pressure and fracture constraints, and I can recommend operating strategies that manage pressure buildup.

What I deliver

- Pressure vs time (and spatial pressure footprints)
- Injectivity curves and constraint exceedance summaries
- Recommendations for injection rate ramps, shut-in logic, and guardrails

Plume Migration and Containment

I can predict the evolution of the free-phase CO2 plume and pressure perturbation over operational (years) to post-injection (decades) time scales.

What I deliver

- Plume footprint maps/volumes through time
- Sensitivity to heterogeneity, anisotropy, salinity, and thermal effects
- Containment narratives tied to specific model assumptions

Trapping and Permanence Accounting

I can quantify CO2 partitioning into mobile/free-phase, residually trapped, dissolved, and (when applicable) mineralized fractions, and track how those fractions evolve over time.

What I deliver

- Mass partitioning curves and mass-balance reporting
- KPIs aligned with engineering and permanence reporting needs
- Uncertainty ranges tied to key parameters (e.g., relative permeability, residual saturations)

Wells, Schedules, and Operational Controls

I can model coupled well behavior and operational controls, including multi-well scenarios, water-alternating-gas (WAG), and brine extraction to manage pressure.

What I deliver

- Schedule design and comparative scenario runs
- Constraint management (fracture pressure limits, minimum pressure, BHP limits)
- Well-by-well and field-level KPIs (rates, cumulative mass, constraint utilization)

Reactive Transport and Mineralization

I can include reactive transport and geochemistry when project goals require mineralization potential and time-scale estimates, supporting defensible permanence claims.

What I deliver

- Geochemistry setup (database selection, reactions, kinetics, minerals)
- CO2 partitioning including mineralized mass
- Mineral formation diagnostics and consistent mass-balance checks

MRV-Ready Modeling Packages

I can produce auditable, repeatable modeling deliverables suitable for internal governance and regulatory-facing workflows.

What I deliver

- Versioned model package: inputs, parameters, run scripts, and run logs
- Standard QA/QC checks (mass balance, timestep/solver stability, boundary-condition audits)
- Standard plots and summary tables for each scenario

Risk and Uncertainty Framing

I can translate modeling into decision risk bounds by running sensitivity and uncertainty analyses that are right-sized to the business decision.

What I deliver

- Sensitivity studies to identify "what changes the answer"
- Probabilistic envelopes (e.g., P10/P50/P90) when warranted
- Clear interpretation of risk drivers and monitoring implications

Engagement Packages (How Companies Typically Buy This Work)

Package A — Rapid Screening (2–4 Weeks)

Goal: fast go/no-go on injectivity, pressure constraints, and first-order plume behavior.

Deliverables

- Screening model(s) sized to available data
- Injectivity and pressure constraint assessment
- Short technical memo with assumptions and prioritized sensitivities

Package B — Site Concept Model (6–12 Weeks)

Goal: a defensible site-scale model for engineering decisions and scenario evaluation.

Deliverables

- Site stratigraphy/heterogeneity representation with documented rationale
- Well configuration(s) and injection schedule(s)
- Pressure constraint evaluation and plume/trapping diagnostics
- Reproducible run package with standardized plots

Package C — Operations Optimization (4–8 Weeks)

Goal: optimize operating strategy under constraints.

Deliverables

- Comparative schedule design (including WAG and brine extraction where relevant)
- KPIs tied to objectives (injected mass, plume footprint, constraint utilization)
- Operational recommendations and contingency scenarios

Package D — Reactive Transport & Mineralization (6–12 Weeks)

Goal: quantify mineralization potential and time scales; support permanence claims.

Deliverables

- Chemistry and kinetic model setup with documented assumptions
- CO2 mass partitioning including mineralized fraction
- Sensitivity/uncertainty bounds focused on reaction kinetics and surface area

Package E — MRV-Ready Model Library (Ongoing)

Goal: keep the model auditable and up-to-date as new data and decisions arrive.

Deliverables

- Scenario library with versioned inputs/outputs and change logs
- Standard QA/QC and reporting artifacts per update
- "Decision snapshots" that show what changed and why

Delivery Workflow (How I Execute Projects)

1) Data Intake and Assumptions Register

I start with a structured data checklist and produce an assumptions register that is explicit about what is known, what is inferred, and what is uncertain.

2) Model Build and Verification

I build the model to the appropriate fidelity for the decision at hand and verify the fundamentals (initial conditions, boundary conditions, conservation, and solver robustness).

3) Calibration and Reasonableness Checks

When calibration targets exist (pressure, flow, temperature, chemistry), I use them. When they don't, I document reasonableness checks and parameter ranges.

4) Sensitivity and Uncertainty

I run targeted sensitivities first. If decision risk requires it, I expand to probabilistic runs and report results as risk bounds.

5) Decision-Ready Reporting

I deliver outputs that directly answer project questions, with concise interpretation, traceable assumptions, and reproducible artifacts.

Quality, Reproducibility, and Governance

Reproducible Model Packages

Each delivery includes a runnable package with pinned software versions (where possible), run scripts, and a clear directory structure.

QA/QC Standards

I apply consistent checks across scenarios: - Mass-balance and conservation checks - Nonphysical state checks (e.g., saturations, pressures) - Boundary-condition and unit sanity checks - Solver performance and timestep stability review

Transparent Documentation

I keep documentation lightweight but complete: assumptions register, parameter tables, and a change log that shows what changed between versions.

Inputs I Typically Request

Minimum Inputs (Screening)

- Basic stratigraphy and depth intervals
- Representative porosity/permeability ranges (and anisotropy assumptions)
- Temperature and pressure gradients; salinity
- Planned wells, injection rates, and operational constraints
- Fracture gradient / maximum allowable pressure criteria

Additional Inputs (Site-Scale and MRV)

- Geologic framework model and property grids
- Well completions/perforations and operating limits
- Monitoring data (pressure, flow, tracer/chemistry, seismic) when available
- Regulatory reporting requirements and internal QA expectations

Next Steps

1. I can start with a 30–60 minute technical scoping call to align on objectives, constraints, and available data.
2. I will provide a short data checklist and a fixed-scope proposal for a pilot (typically Rapid Screening or Site Concept Model).
3. Once scope is agreed, I deliver the first decision-ready results early, then iterate with weekly touchpoints.