Chapter 24 Proposed Rule Revisions

Wyoming Environmental Quality Council
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Background & Scope Which Informed Proposed Chapter 24 Rule

- State of Wyoming's Geologic Sequestration ("GS") approach, legal history and framework
  - Primary findings and recommendations of the Carbon Sequestration Working Group
  - Statutes passed which established requirements for bonding and financial assurance
  - Basis and charge to DEQ for rulemaking

- DEQ participation in two additional studies to help define approach towards estimating costs and risks and required financial assurance levels and mechanisms, particularly in the post-closure and long-term liability phases of a project.
  - Industrial Economics (IeC) Study
  - Interstate Oil and Gas Compact Commission (IOGCC) Report

- EPA UIC Class VI Rule and Wyoming's desire to seek primacy

Wyoming's Geologic Sequestration ("GS") Vision and Early Efforts

- In 2007, Wyoming's leadership recognized that without a financial assurance foundation to address liability issues, geologic carbon sequestration would likely fail to advance. Leadership identified the need to develop a financial assurance regime which offers assurances to both the public and private sector and which appropriately manages the risks inherent to geologic carbon sequestration activities in Wyoming.

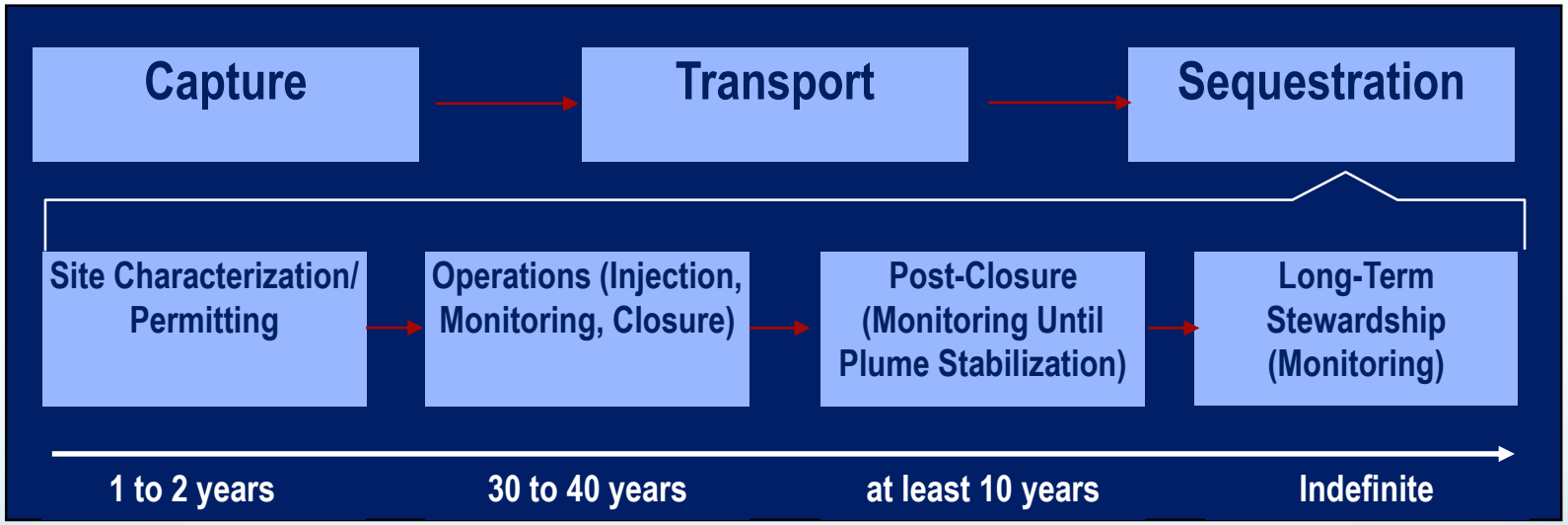
- In 2008, Wyoming passed the first of several laws pertaining to geologic sequestration. House Bill 90 authorized the state geologist, oil and gas supervisor and the director of the Department of Environmental Quality (DEQ) to convene a working group for the purpose of developing an appropriate bonding procedure and other financial assurance methods to assure adequate financial resources were provided to pay for mitigation or reclamation costs that the state may incur as a result of default by the permit holder, which bond or other financial assurance requirement shall be required during the operating life and throughout the post-closure care period. The working group was also asked to recommend the duration of the post-closure care period.

- The working group was comprised of approximately 10 members with experience and knowledge related to the work needed to develop the recommendation. Professions represented included legal, geological, oil & gas, environmental, engineering, and financial. The group also had representation from industry and the landowner community.

- In 2009, the legislature passed three additional laws regarding ownership of the pore space, ownership of the material injected into a geologic sequestration site and unitization of geologic sequestration sites.

Primary Findings and Recommendations of the Carbon Sequestration Working Group ("CSWG")

- Established the phases of a CCS project, the likely level of risk and the acceptable types of financial assurance for each phase all of which are incorporated into the proposed rule
  - e.g. self-bonding is acceptable in the operating phase, but not in the post-closure phase



Primary Findings and Recommendations of the Carbon Sequestration Working Group ("CSWG")

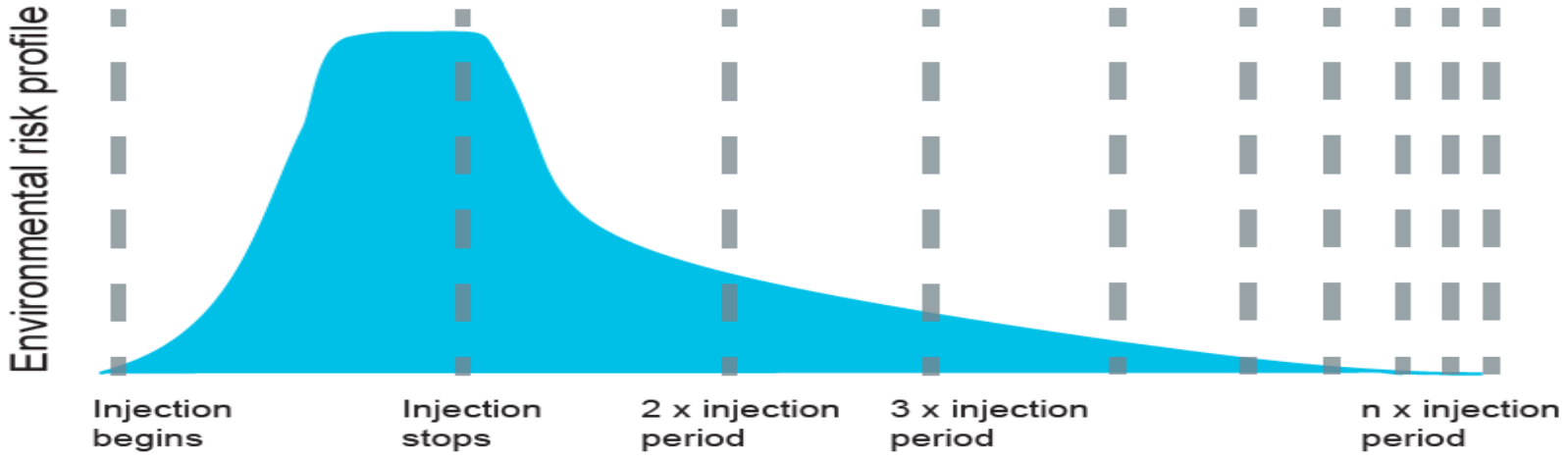


Figure 2: Hypothetical example of the variation of risk over time for geologic storage of CO_2. Source: Adapted from Sally Benson, Stanford University.

- Established the major risk events (basis for Appendix A of the rule and highlighted in Section 19(d)(i))
    - Contamination of underground water, including potable water
    - Trespass (mineral rights infringement),
    - Atmospheric releases of carbon dioxide, and
    - Property damage (including changes to surface topography and structures)

Primary Findings and Recommendations of the Carbon Sequestration Working Group Continued

- Recommended duration of a post-closure period and established closure criteria (incorporated into the rule)
  - Minimum 10 year period
  - Three consecutive years of acceptable plume migration levels and evidence of plume stabilization
- Creation of a Special Revenue Account to fund monitoring measurement and verification by DEQ after operator is released
  - Privately-funded, publicly-controlled account within Special Revenue Fund
  - Based on a per-ton injection fee and/or a closure fee
  - Used by DEQ to pay for MMV of sites following closure, release of financial assurance instruments, and termination of the permit
- Statutory Recommendations…

Wyoming Statutes Adopted in 2010

- Section 1: Creates a Special Revenue Account to be administered by the DEQ
  - Provide funding source for monitoring, measuring, and verifying sequestration sites following site closure certification and release of bonds
  - ***Requires rules to be developed that prescribe how fees will be set and collected***
  - Provides that sovereign immunity is preserved (no assumption of liability by the State)

- Section 2: Amends 35-11-313 establishes permitting requirements and authority to develop rules for bonding and financial assurance
  - Certificate of insurance for personal injury and property damage
  - Authority to develop procedures for the type and amount of bonds to assure that the operator complies with rules, performs all requirements and provides adequate financial resources to pay for mitigation and reclamation in the event of default
  - Periodic reporting requirements (allow for bond adjustments as needed)
  - Proof of compliance
  - Replacement, substitution, forfeiture and release procedures
    - Release not less than 10 years and 3 consecutive years of data supporting site stabilization
  - Affidavit recorded with county clerk showing that tract underlain with GS

- Section 3: Repeals 35-11-313 (g)

Additional Study Participation Also Helped Shape Proposed Chapter 24 Rule

- "Valuation of Potential Risks Arising from a Model, Commercial Scale CCS Project Site", Industrial Economics, 2012
  - Contributing Member

- "Guidance for States and Provinces on Operational and Post-Operational Liability", Interstate Oil and Gas Compact Commission Task Force on Carbon Geologic Storage, 2014
  - Observer Status

EPA UIC Class VI Rule and Guidance Document Also Incorporated into the Proposed Chapter 24 Rule

- States seeking primacy:
  - Must adopt all Class VI permit rules (primary basis for revised Section 19)
  - May include additional requirements, to be reviewed by EPA (e.g. Wyoming's creation of a minimum 10 year post-closure period and 3 years of consecutive site stabilization data)
- EPA guidance document and rule define project phases, acceptable financial assurance instruments and risks in great detail
- Neither EPA nor Wyoming statute address liability after post-closure

Key Takeaways From All of These Efforts

- GS projects are limited to-date. Financial assurance approach and rules are likely to evolve with time and experience.
- Wyoming should seek primacy, though expect limited flexibility from EPA and a 1-2 year process for approval.
- Class II to Class VI permit transition critical for EOR operations.
- Good site selection and the purity of the CO2 stream have significant bearing on the potential risks and damages estimates of a project.
- Risk-based probabilistic modeling is important in determining valuation estimates and required financial assurance levels.
- Post-injection site care, at a well-sited project, was modeled by Industrial Economics to cost less than $1/ton, providing a good barometer for Special Revenue Account targets.
- Long-term liability remains an unresolved issue. The CSWG envisioned a trust fund concept that was privately-funded but publicly controlled where funds were collected during the permitting and operating phases of the project. Traditional financial assurance instruments may not be available or appropriate at this phase of a project.

Section 19(d)(iii)(A) and (B) incorporates risk based probabilistic modeling concepts

19(d)(iii): The cost estimate shall be based upon a multi-disciplinary analytical framework such as Monte Carlo or other commonly accepted stochastic modeling tools

(A) Cost curves shall combine risk probabilities, event outcomes and damages assessment to calculate expected losses under a series of events

(B) The probability distributions for potential damages should be identified for 50 percent, 95 percent and 99 percent of all cases

What is probabilistic modeling or Monte Carlo analysis?

Monte Carlo simulation, or probability simulation, is a technique used to understand the impact of risk and uncertainty in financial, project management, cost, and other forecasting models.

- **Uncertainty in Forecasting Models**
  - When you develop a forecasting model – any model that plans ahead for the future – you make certain assumptions. These might be assumptions about the investment return on a portfolio, the cost of a construction project, or how long it will take to complete a certain task. **Because these are projections into the future, the best you can do is estimate the expected value.**
  - You can't know with certainty what the actual value will be, but based on historical data, or expertise in the field, or past experience, you can draw an estimate. While this **estimate is useful for developing a model, it contains some inherent uncertainty and risk, because it's an estimate of an unknown value**.

- **Estimating Ranges of Values**
  - **In some cases, it's possible to estimate a range of values**. In a construction project, you might estimate the time it will take to complete a particular job; based on some expert knowledge, you can also estimate the absolute maximum time it might take, in the worst possible case, and the absolute minimum time, in the best possible case.
  - **By using a range of possible values, instead of a single guess, you can create a more realistic picture of what might happen in the future.** When a model is based on ranges of estimates, the output of the model will also be a range.
  - **This is different from a normal forecasting model**, in which you start with some fixed estimates – say the time it will take to complete each of three parts of a project – and end up with another value – the total time for the project. **If the same model were based on ranges of estimates for each of the three parts of the project, the result would be a range of times it might take to complete the project**. When each part has a minimum and maximum estimate, we can use those values to estimate the total minimum and maximum time for the project.

What is Monte Carlo or probabilistic modeling? (Cont'd)

- **What Monte Carlo Simulation can Tell You**
  - **When you have a range of values as a result, you are beginning to understand the risk and uncertainty in the model.** The key feature of a Monte Carlo simulation is that it can tell you – based on how you create the ranges of estimates – how *likely* the resulting outcomes are.

- **How It Works**
  - In a Monte Carlo simulation, a random value is selected for each of the tasks, based on the range of estimates. The model is calculated based on this random value. The result of the model is recorded, and the process is repeated. **A typical Monte Carlo simulation calculates the model hundreds or thousands of times, each time using different randomly-selected values.**
  - **When the simulation is complete, we have a large number of results from the model, each based on random input values. These results are used to describe the likelihood, or probability, of reaching various results in the model.**

Source: "What is Monte Carlo Simulation", Riskamp.com

The IeC Probabilistic Model and Results for Sample Project in Jewett, TX

- Relevant Risk Events were selected (e.g. leakage during capture, transport, and storage)
- The Magnitude and Probability of Risk Events were characterized (Future Gen risk probabilities were utilized, proximate location to population centers has large impact on magnitude of human health damages)
- Potential Costs of Impacts were calculated based on cost curves (e.g. human health impacts)
- Over 100,000 model runs were completed using a probabilistic simulation
- Generation of a probability distribution curve in 50%, 95% and 99% of all scenarios

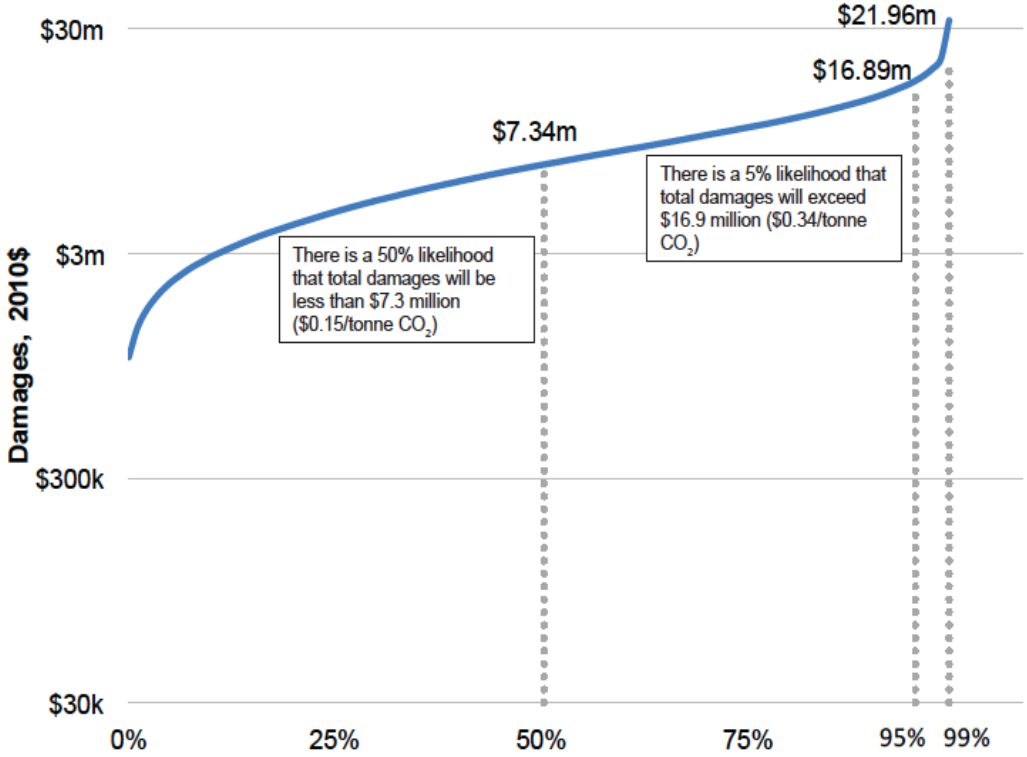


Figure 4: Estimated Jewett Project Damage Distribution for CO_2 capture, transport and storage. Source: Industrial Economics, Incorporated, "Valuation of Risks Arising from a Model, Commercial-scale CCS Project Site," Cambridge, MA, June 2012.

Source: Carbon Capture and Storage: An Approach to Understanding Potential Risks and Their Cost Implications, Global CCS Institute, October 2012

Wyoming Approval Process

- Wyoming Water and Waste Advisory Board Meetings—2015
  - Background Presentation and Review of Chapter 24 Rule: minor edits and suggestions provided
  - Review and Approval of Chapter 24 Rule Section 19 Financial Responsibility
    - Mirrors Fed Rule
    - Incorporates Class VI Language
  - 2016 Legislative Session: Passage of Senate File 28 outlining conversion from a Class II to a Class VI permit
    - Mirrors Fed Rule Language
    - Clarifies process for conversion and roles of the Director and Oil & Gas Conservation Commission to complete transition from Enhanced Oil Recovery to Permanent Sequestration facility
  - EQC Review and Approval
  - Primacy Application Underway