



# Factors Impacting CCS Project Development: Recent Project and Regulatory Experience

## Preview of Day 2

### USEA Saline Storage Cost Modelling Workshop

#### Presenter

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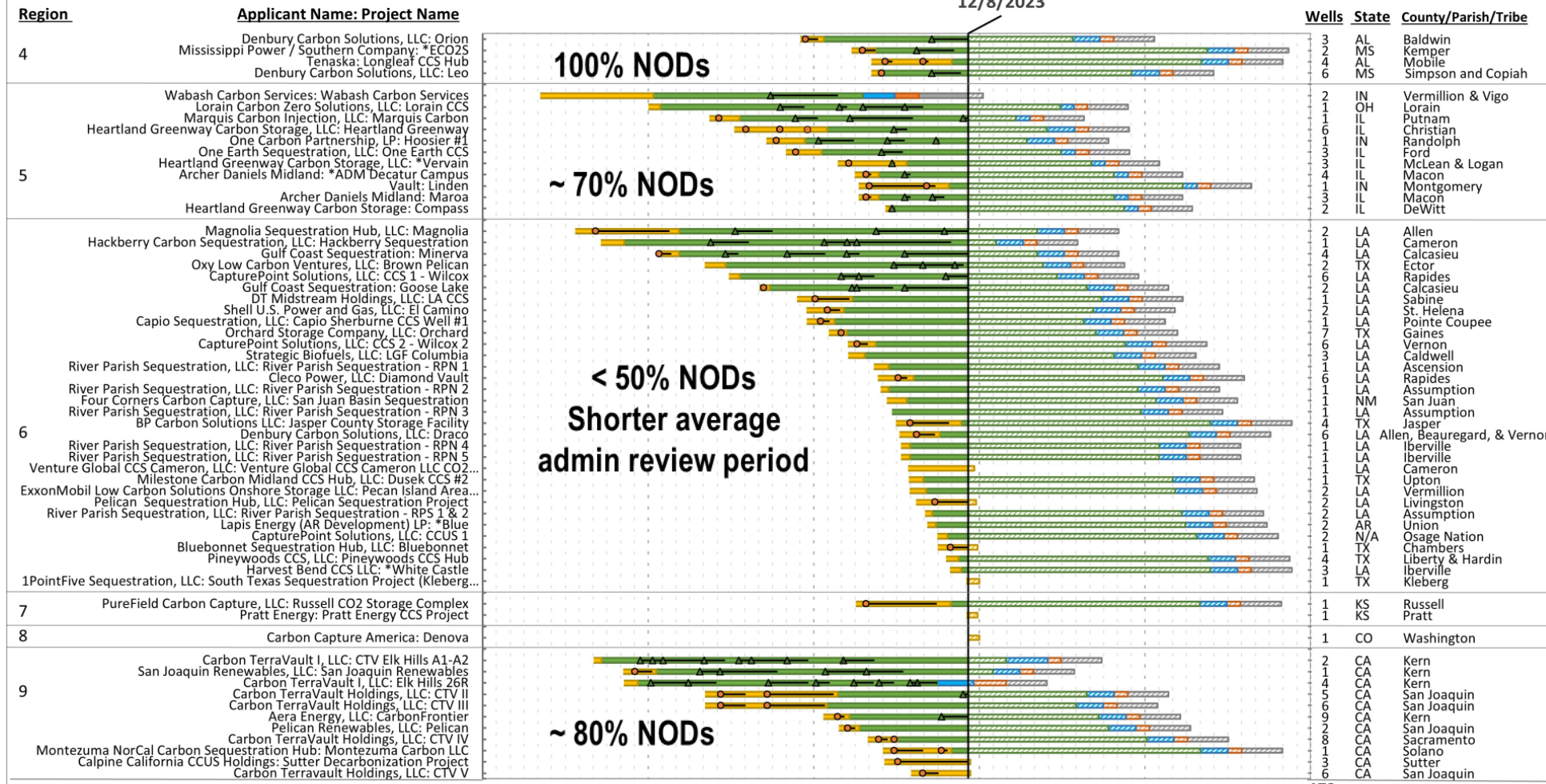
**December 12, 2023**

# Presentation Outline

- ❑ Recent Trends in Project Planning/Class VI Permitting
- ❑ Impacts of these Trends on Project Risks, Costs and Liabilities
- ❑ Agenda for Day 2
  - Topic 4: Instruments to Manage Project Risks/Liabilities and Financial Responsibility
  - Topic 5: Industry's View of Costing Project Risks and Liabilities

# Recent Trends in Class VI Permitting

## Class VI Permit Tracker



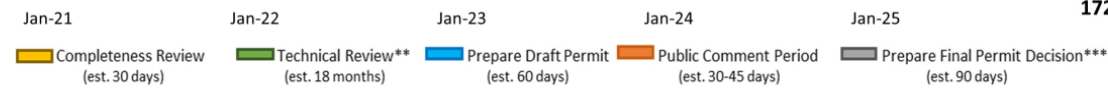
AL, MS

IN, OH, IL

LA, TX, NM, AR

CA

Total Projects = 61



Note: Hashed bars represent estimates of future review periods.  
 \*Completeness review restarted after substantial changes made to project.  
 \*\*Estimated Technical Review period depends on the complexity and quantity of RAIs needed to evaluate the application and receiving timely responses from the applicant.  
 \*\*\* Time to Prepare Final Permit Decision depends on the number and complexity of Public Comments received.



# Impacts on Project Risks, Costs and Liabilities

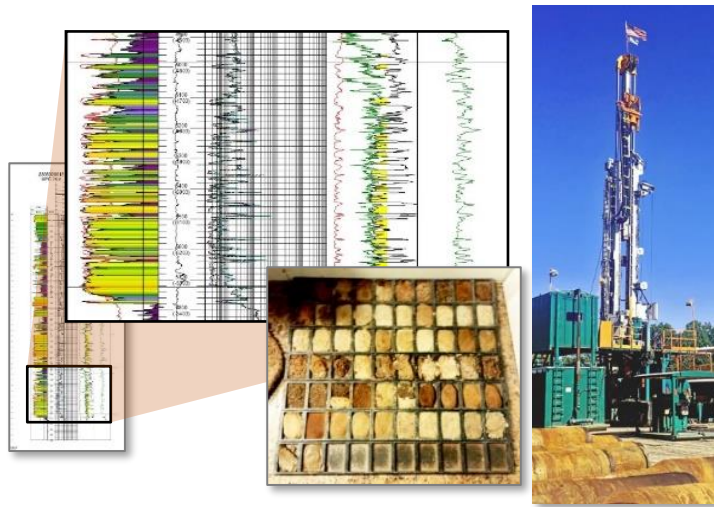
- **EPA's Notices of Deficiency (NODs) point to subjectivity in interpretation of Class VI regulations.**
  - ❑ NOD is sent when the permit application cannot be deemed administratively complete.
  - ❑ Regional EPA offices have been focusing on local factors in NOD determinations.
  - ❑ Examples include additional analysis on subsurface uncertainty, proof of financial assurance, and legacy well records
  - ❑ Blurry line between data for administrative completeness versus data for technical review.
- **Regulators are tending to regulate by Guidance, rather than Regulations; requiring additional information and justification, increasing costs**
- **Important to have periodic conversations with the regulators prior to submittal to minimize NOD requests after application submittal**
  - ❑ Regulators are emphasizing strong applications that can stand trial at public hearings.
  - ❑ Inadequate applications could significantly delay technical review.
- **Operators must consider EPA's requirement for location-specific data to build Class VI permits**
  - ❑ Project owners should weigh cost-to-benefit of drilling a test well to gather sites-specific data
  - ❑ Could later convert to a Class VI project well if built to Class VI standards.
- **These trends are adding to costs requiring demonstration of financial assurance**

# CCS Project Risks – Ideal Storage Site Attributes

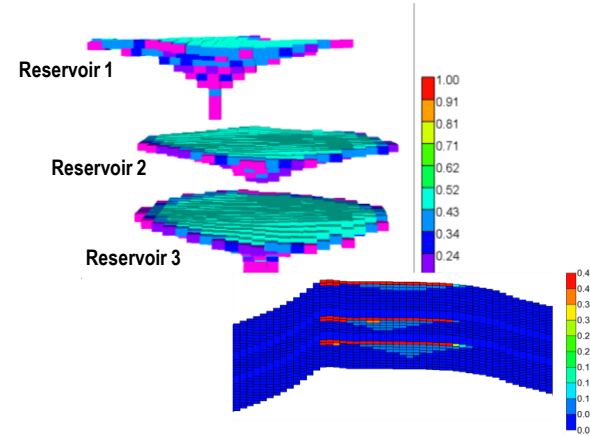
- 1 Optimum Depth** For efficient storage of dense phase CO<sub>2</sub>, the storage horizon would be between 3,000 ft (900 m) and 10,000 ft (3,000 m) of depth.
- 2 Adequate Storage Capacity** High potential volume of storage, as defined by areal extent, thickness, and porosity.
- 3 Reliable Reservoir Seal** A confining zone that includes thick, low permeability sealing layer(s) above the storage zone(s).
- 4 Protection of Potable Sources of Water** The storage horizon needs to be located below potential sources of potable water separated by secure reservoir seals.
- 5 High CO<sub>2</sub> injectivity** Sufficient permeability and thickness to inject relatively large amounts of CO<sub>2</sub> per well.
- 6 Limited CO<sub>2</sub> Plume** Geological characteristics that help manage the areal extent of the CO<sub>2</sub> plume.
- 7 Verifiable Storage Integrity** Understanding and monitoring the storage formation (CO<sub>2</sub> leakage pathways such as from legacy wells, faults, fractures, etc.).

# Pursuing a CCS Project – UNTIL CLOSURE

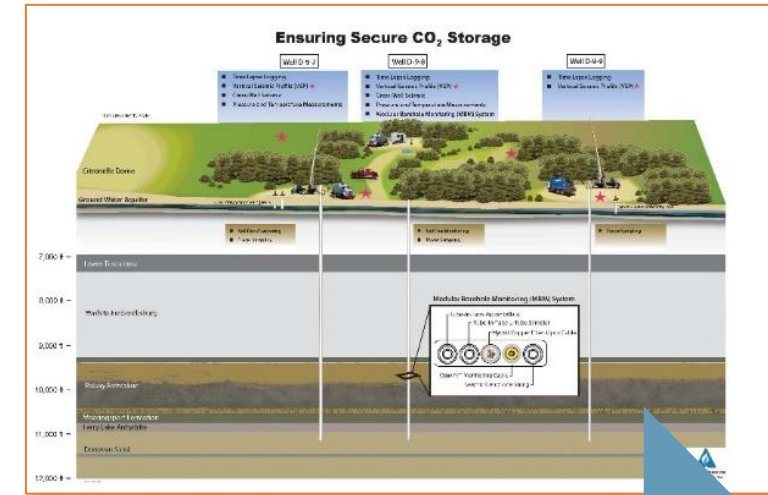
## Geologic Characterization



## CO<sub>2</sub> Plume Modeling and Project Optimization



## Field Storage Implementation



Screening

Feasibility

Project Design & Permit Application

Regulatory Review of Permit

Investment & Construction

Operations

- Geologic Evaluation and Screening
- Well Logs, Core Analysis, Sampling/ Testing

- Geologic Modeling
- Mapping
- Designing Well Plans
- Geophysical Analysis
- Geo-mechanical Analysis

- Drilling Characterization Well
- Core Analysis
- Seismic Monitoring and Analysis

- Drill and Construct Injection and Monitoring Wells
- Install Infrastructure
- Update Permits

- CO<sub>2</sub> Injection
- Geologic Monitoring of the Plume


Higher Subsurface Risk

Lower Subsurface Risk

# Storage Project Activities for Which Risk Mitigation Costs May Need to be Considered

<b>Data Acquisition, Planning, and Permitting</b>	<b>Electrical/Other</b>	<b>Well Costs (one time, except MITs)</b>
Regional Evaluation	Electrical Resistivity Tomography	New Class VI Injection Wells.
Site Characterization	Gravity Survey	New Deep Monitoring Wells
Data Preparation and Analysis	Micro-seismic (Initial)	New Stratigraphic Wells
Initial and Periodic Modeling	Micro-seismic (Annual O&M)	EOR Well Convert to Monitor Wells
Corrective Action Planning	<b>Atmospheric Surveys</b>	EOR Wells Converted to Injectors
FEED	Eddy Covariance - Initial	Well Testing
Class VI Permitting	Eddy Covariance - O&M	MITs (annual)
Leasing	CIR	<b>Plugging and Abandonment (one time)</b>
Public Outreach	Laser System and LIDAR - O&M	Existing EOR wells
Other Permitting	Surface Leak Detection -- Initial	CO2 Injection Wells
Subpart RR Requirements	Surface Leak Detection -- Annual	Stratigraphic Wells
<b>Aerial /Satellite Survey</b>	Cased Hole Logging (Annual)	Deep Monitoring Wells
Aerial Survey	Coring (initial)	Groundwater Monitoring Wells
Air Magnetic Survey	<b>Subsurface Monitoring</b>	Vadose Monitoring Wells
Sar and InSAR	Vadose Zone Monitoring (initial)	<b>Operations Monitoring</b>
<b>Geophysical Surveys (Seismic)</b>	Vadose Zone Monitoring (Annual)	Monitor Surface P, T, and Rates
Seismic Planning Q&A	Soil Flux Monitoring (initial)	Gas Composition Sampling
3-D Seismic	Soil Flux Monitoring (Annual)	Corrosion Monitoring
2-D Seismic	Groundwater Monitoring (initial)	Monitor Subsurface P, T, and Fluids
Crosswell	Groundwater Monitoring (Annual)	Tracers
Vertical Seismic Profile		<b>PISC and Closure (One Time)</b>
Tiltmeters		Site Closure Report

# Financial Assurance to Mitigate Risks

- **Financial Assurance demonstration required for:**
  - Corrective Action – Key is the extent of legacy wells requiring mitigation
  - Injection Well Plugging -- for all injection and monitoring wells associated with project
  - Post-Injection Site Care (PISC)
  - Site Closure
  - Emergency and Remedial Response
- **The first 4 are associated with site closure; Emergency and Remedial Response applies to the mitigation of events from traditional operations.**
- **Project activities must reduce overall risk profile, preferably in a stage gated process.**
  -  **Decreasing project risk**
  - Qualify:** Quick look of readily available data to assess a prospect
  - Design:** Closer look on additional site data; model implementation scenarios; assess permitting pathways
  - Permit:** Conduct analyses required to permit for project construction
  - Execute:** Construct and operate the site
- **Development options should be weighed relative to risks prior to developing Class VI permits.**
  - Each project has unique subsurface risks, surface considerations, and investor requirements
  - Understanding pros and cons of various development and permitting options is key to setting expectations with regard to risks, liabilities, and associated costs.



# Stakeholder Concerns with Risk Need to be Addressed



# Agenda for Day 2

## □ **Topic 4: Instruments to Manage Project Risks/Liabilities and Financial Responsibility**

- Fred Eames, Hunton, Andrews, Kurth
- Chiara Trabucchi, Industrial Economics, Inc.

## □ **Topic 5: Industry's View of Costing Project Risks and Liabilities**

- John Zuckerman, ZuCO2/Pelican
- Tracy Evans, CapturePoint
- Angie Contreras, Oxy
- David Lawson and Joseph Jephson, Carbon TerraVault