CCS on the Gulf Coast

Guest Speaker:

Tip Meckel, CCS Expert

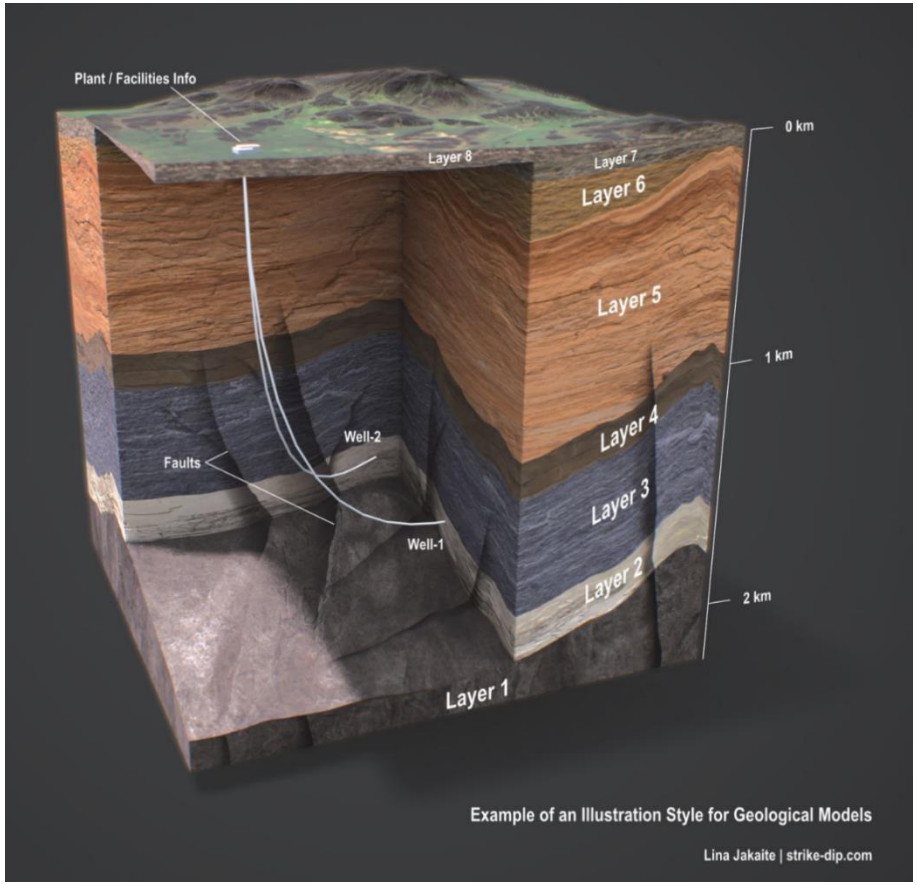
Senior Research Scientist at Texas Bureau of Economic Geology

Chamber of Commerce Luncheon

Community Development & Growth: Fostering a Thriving Local Economy

Winnie Area Chamber of Commerce

Linking Business with Community



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Bureau of Economic Geology

WHAT WE WILL DISCUSS

Section 1: Introduction to CCS, Tip's experience, and CCS Landscape on the Gulf Coast

- Sources of public information (EPA hearing, DOE projects, Conferences)

Section 2: How big is the underground CO_2 warehouse?

- Geology and CO_2 Pressure and Plumes
- Risks

Section 3: What happens during the development planning and execution?

- Permitting - timing, wells, pipelines, facilities
- Development – What could it look like? Rigs and traffic
- Operations - leasehold is bigger than the (sub)surface impact

Section 4: Status of Legislation in Texas and Louisiana

- Surface vs. Mineral Owners
- Primacy for Permitting; Long Term Liability; Eminent Domain

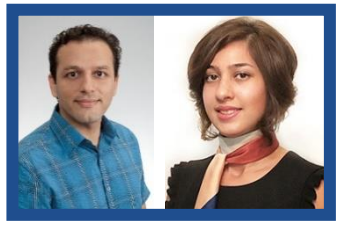
Q&A After Each Section

Engage directly with Tip Meckel to ask your pressing questions after each topic.

The Gulf Coast Carbon Center (GCCC)

- **Largest research group** devoted to the topic in the US; **globally recognized**.
- **Applied Research** – 1-3 year outlook
- **Enabling the private sector to develop an economically viable industry** to store CO_2 in the Gulf of Mexico, across the U.S., and globally
- **Educating all stakeholders** – industry, regulatory, policy, public, etc.

Fluid Flow Modeling



Seyyed Hosseini, Sahar Bakhshian

Surface/Deep Monitoring

Hailun Ni, Katherine Romanak, Susan Hovorka

Geologic Characterization

Carlos Uroza, Alex Bump, Timothy Meckel, Mariana Olariu

Seismic Interpretation

Michael DeAngelo, Dallas Dunlap, Ramón Treviño

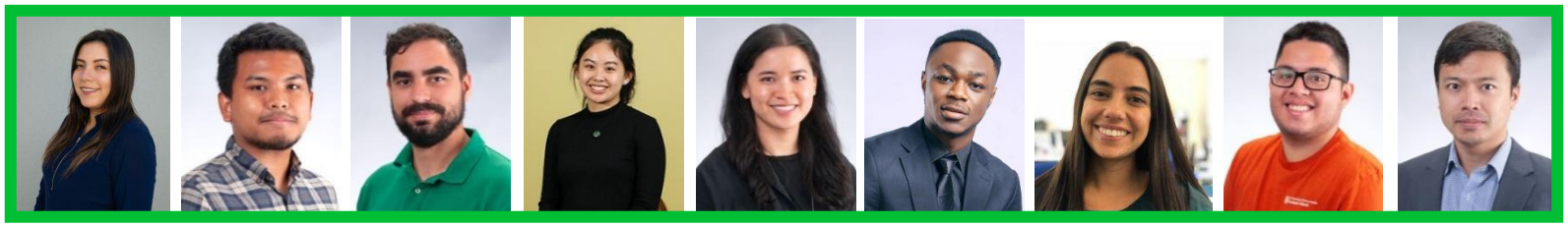
Energy Economist

Ramon Gil

Communications Coordinator

Dolores van der Kolk

Graduate Students



Edna Rodriquez Calzado, Ismail Halim Faruqi, Richard Colt Larson, Yushan Li, Angela Luciano, Chinemerem Okezie, Shadya Taleb Restrepo, Jose Eduardo Ubillus, Charlie (Yu-Chen) Zheng

Postdoctoral Fellows

Jianqiao 'Tim' Leng, Reza Ershadnia, Hongsheng Wang, Refaat Hashish

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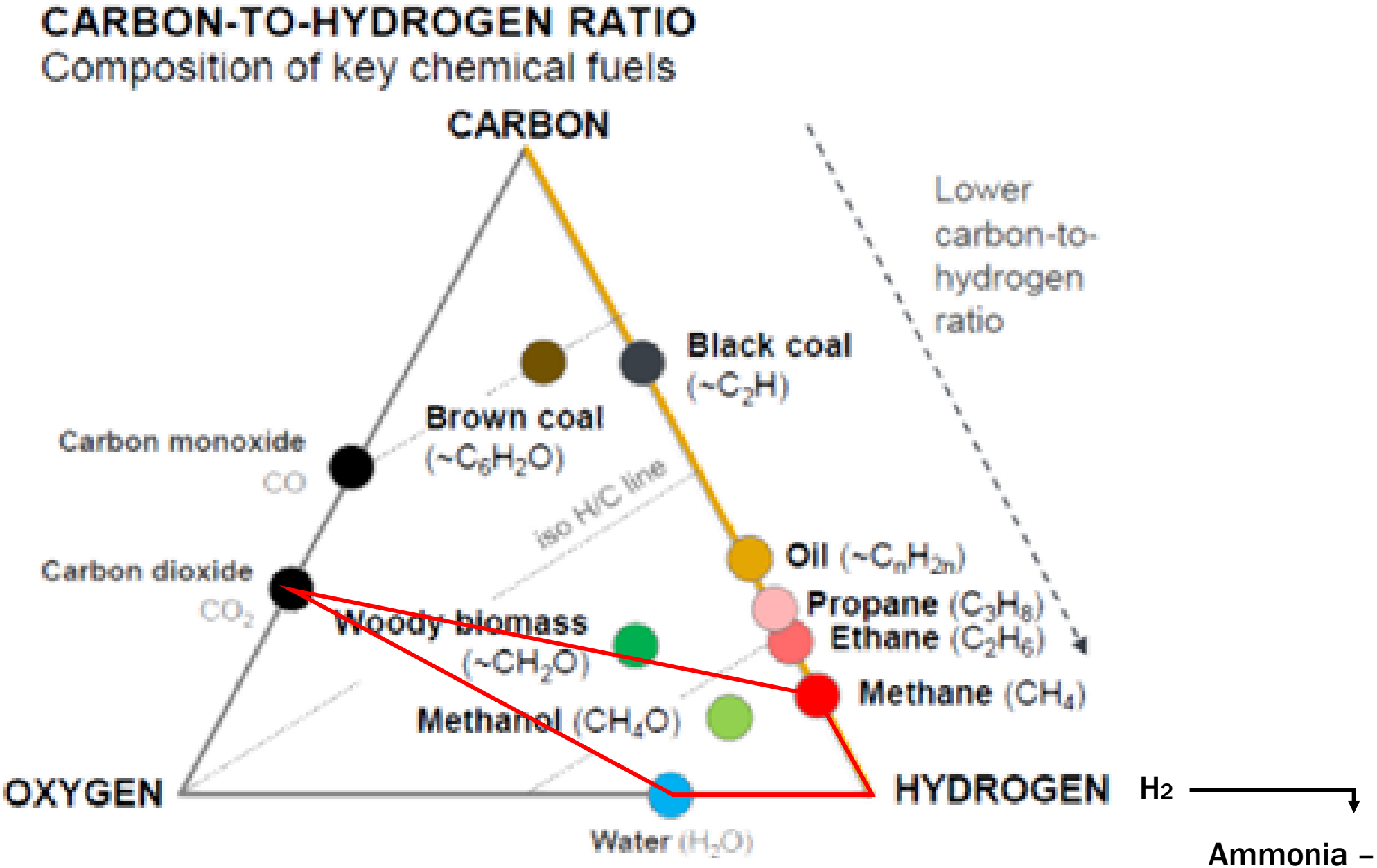
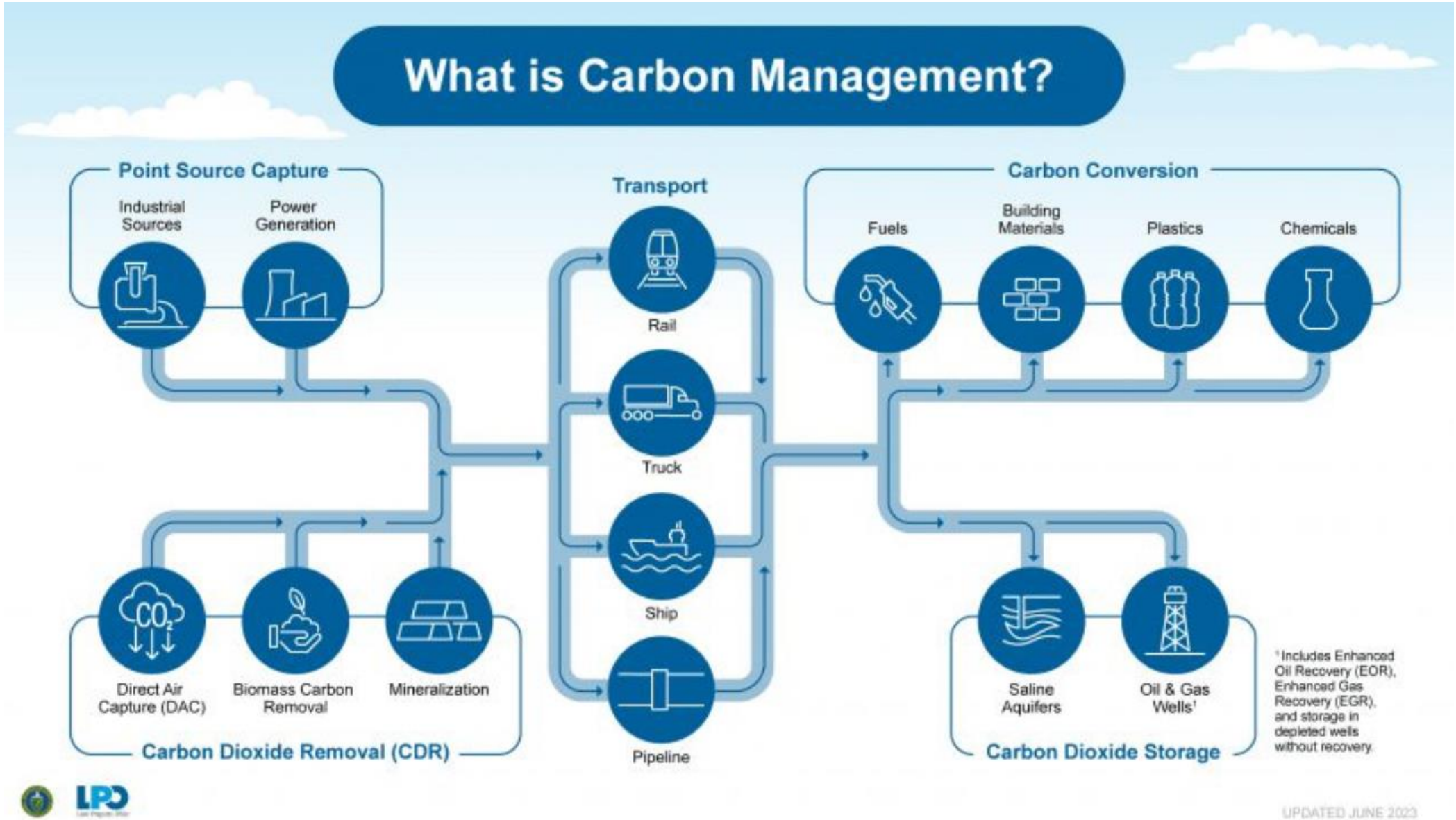
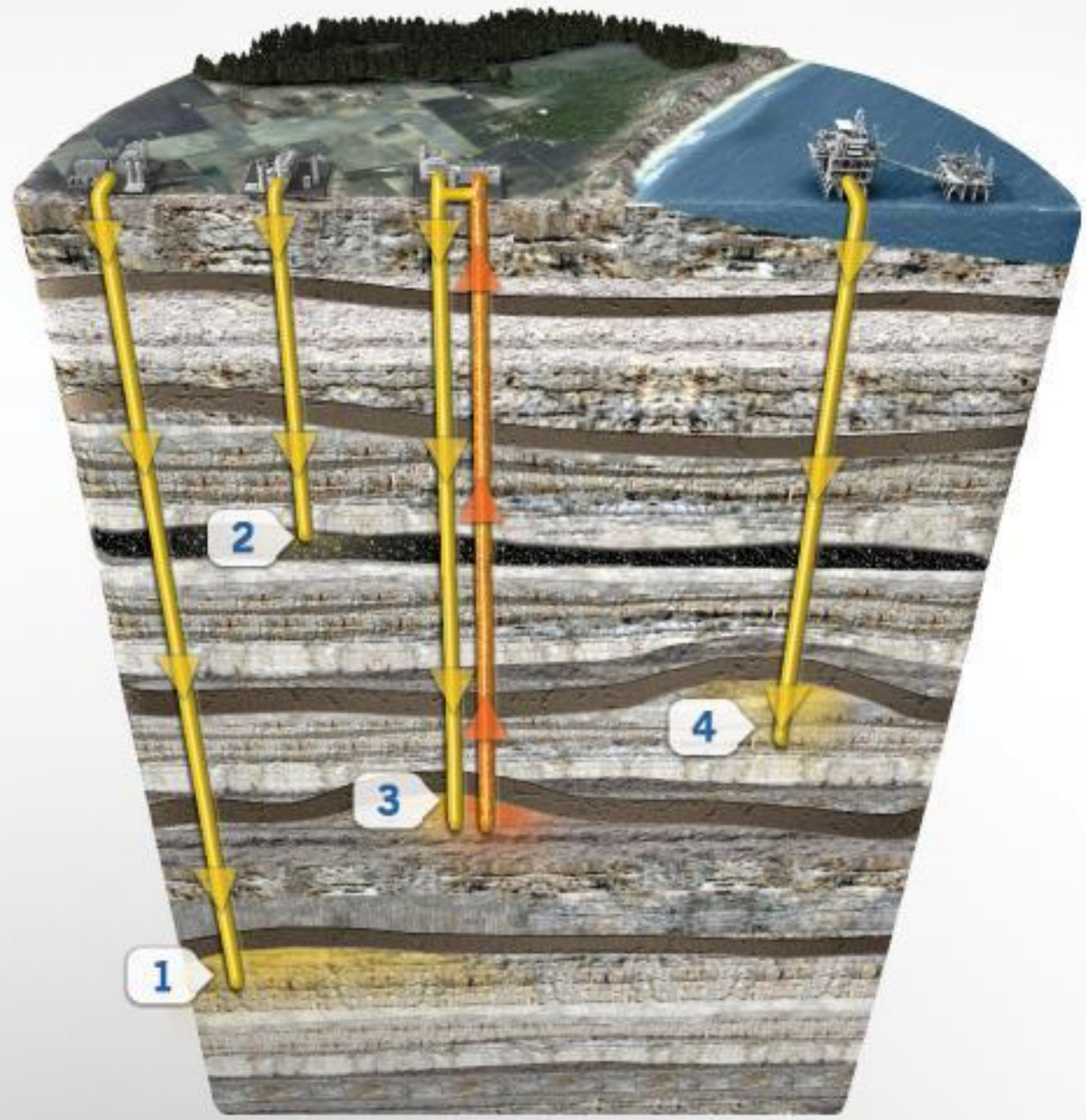

CARBON-TO-HYDROGEN RATIO
Composition of key chemical fuels
CARBON
Lower carbon-to-hydrogen ratio
Black coal (~C2H)
Brown coal (~C6H2O)
Carbon monoxide CO
Carbon dioxide CO2
iso H/C line
Oil (~CnH2n)
Propane (C3H8)
Ethane (C2H6)
Methane (CH4)
Woody biomass (~CH2O)
Methanol (CH4O)
OXYGEN
HYDROGEN
H2
Water (H2O)
Ammonia – NH3


What is Carbon Management?
Point Source Capture
Industrial Sources
Power Generation
Transport
Rail
Truck
Ship
Pipeline
Carbon Conversion
Fuels
Building Materials
Plastics
Chemicals
Direct Air Capture (DAC)
Biomass Carbon Removal
Mineralization
Carbon Dioxide Removal (CDR)
Saline Aquifers
Oil & Gas Wells[1]
Carbon Dioxide Storage
[1] Includes Enhanced Oil Recovery (EOR), Enhanced Gas Recovery (EGR), and storage in depleted wells without recovery.
UPDATED JUNE 2023

STORAGE OVERVIEW

SITE OPTIONS

1. Saline formations
2. Injection into deep unmineable coal seams or ECBM
3. Use of CO_2 in enhanced oil recovery
4. Depleted oil and gas reservoirs



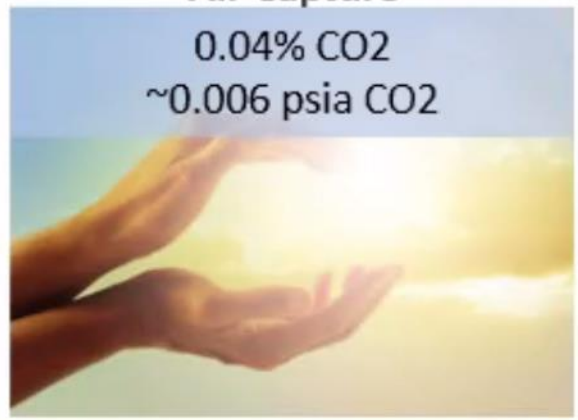
Provided by the Global CCS Institute

CO_2 Management Addresses Diverse Sources, and the CO_2 Concentration Affects Technical and Cost Challenges

Coal Power Plant

Gas Power Plant

Air Capture

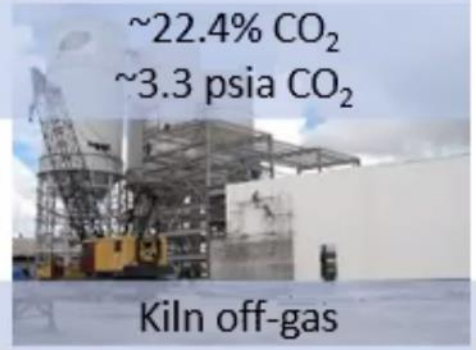


NG Processing Plant

Ammonia Plant

Ethanol Plant

Cement Plant

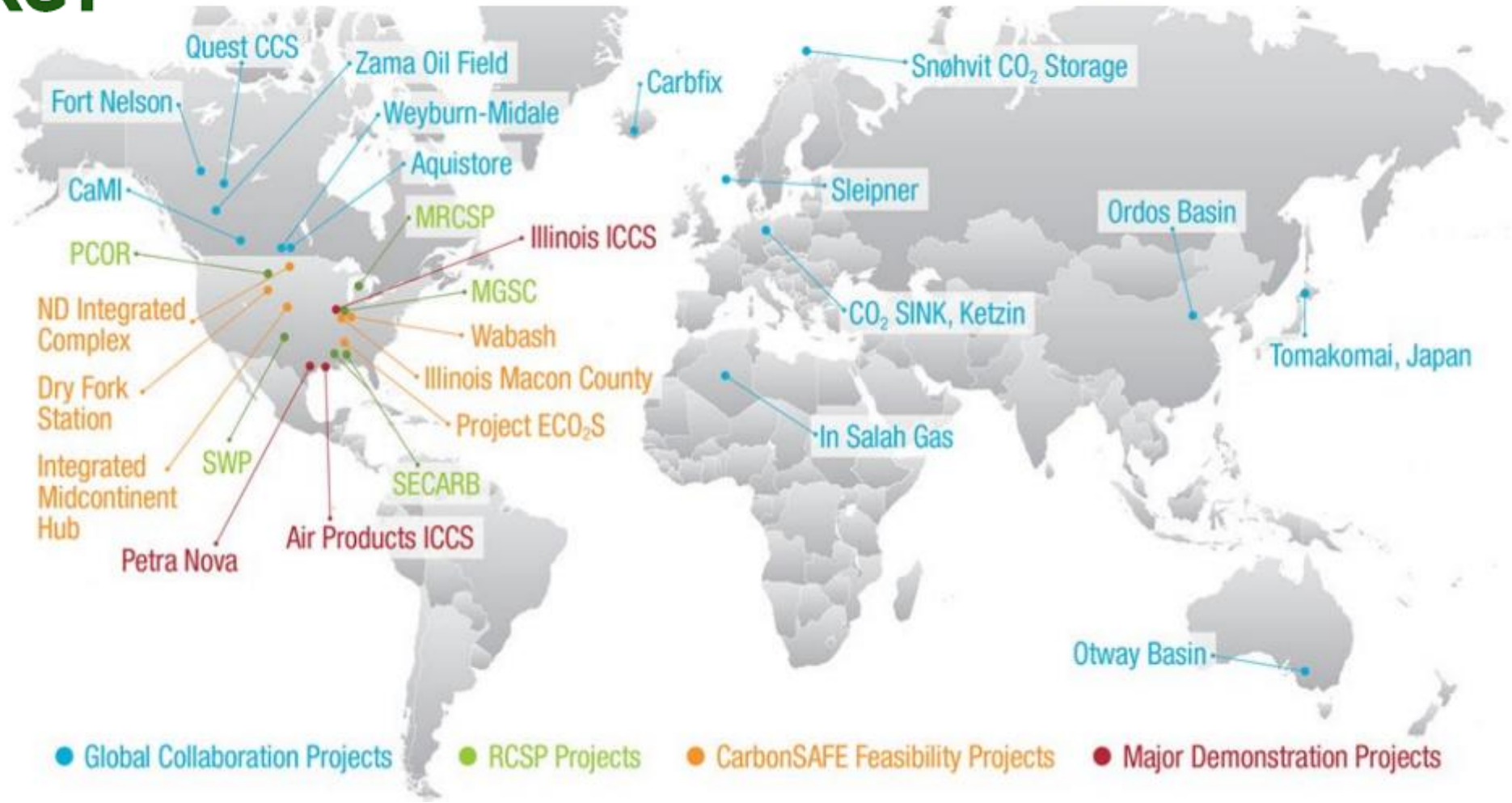


Cost of Capturing CO_2 from Industrial Sources, January 10, 2014, DOE/NETL-2013/1602

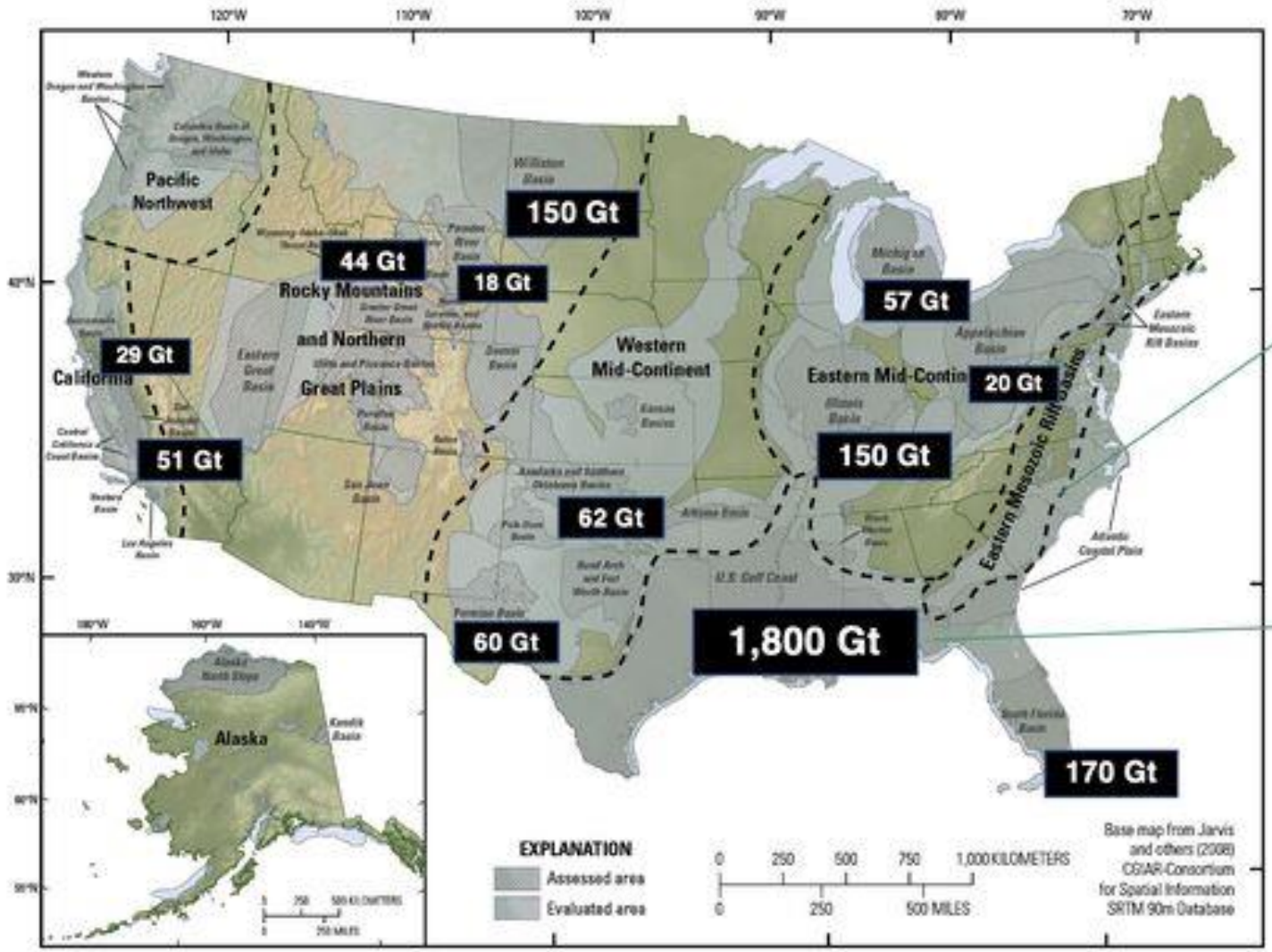
We have already ‘done’ a lot of CCS!

U.S. DEPARTMENT OF ENERGY

Exhibit 2-2. Map depicting locations of major U.S. DOE/NETL projects and global collaborations



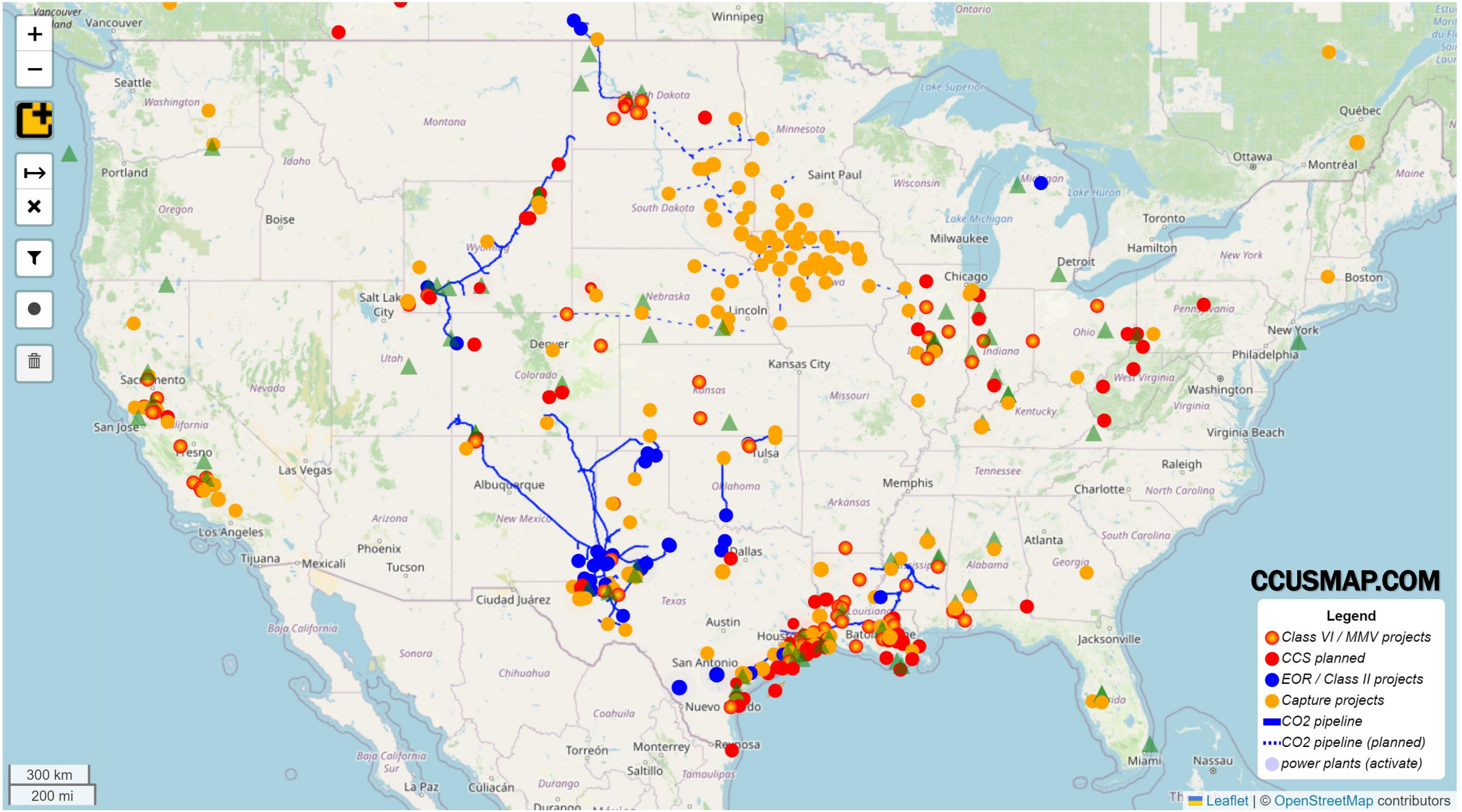
2,600 Gigatons of Storage in US Onshore

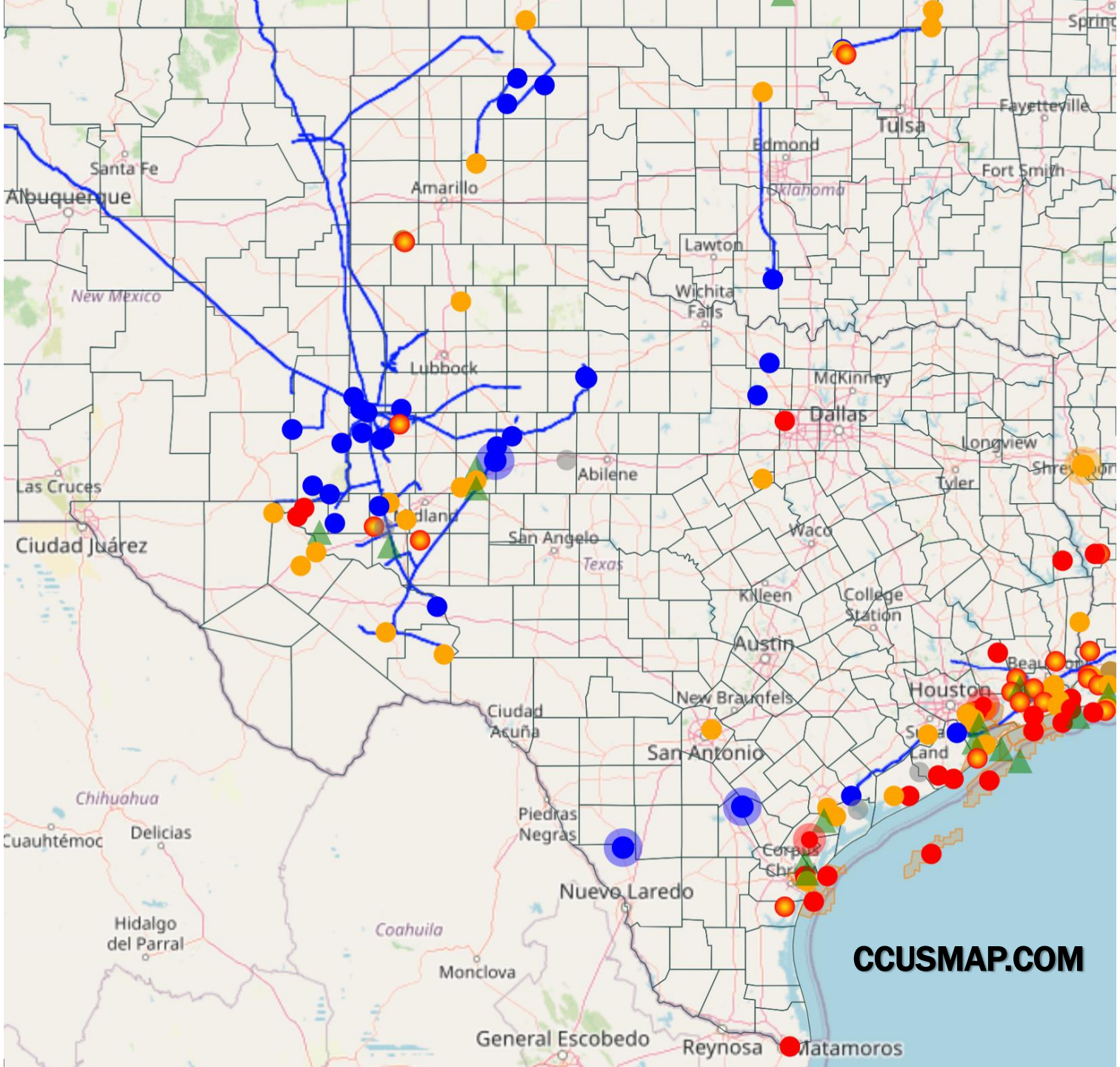


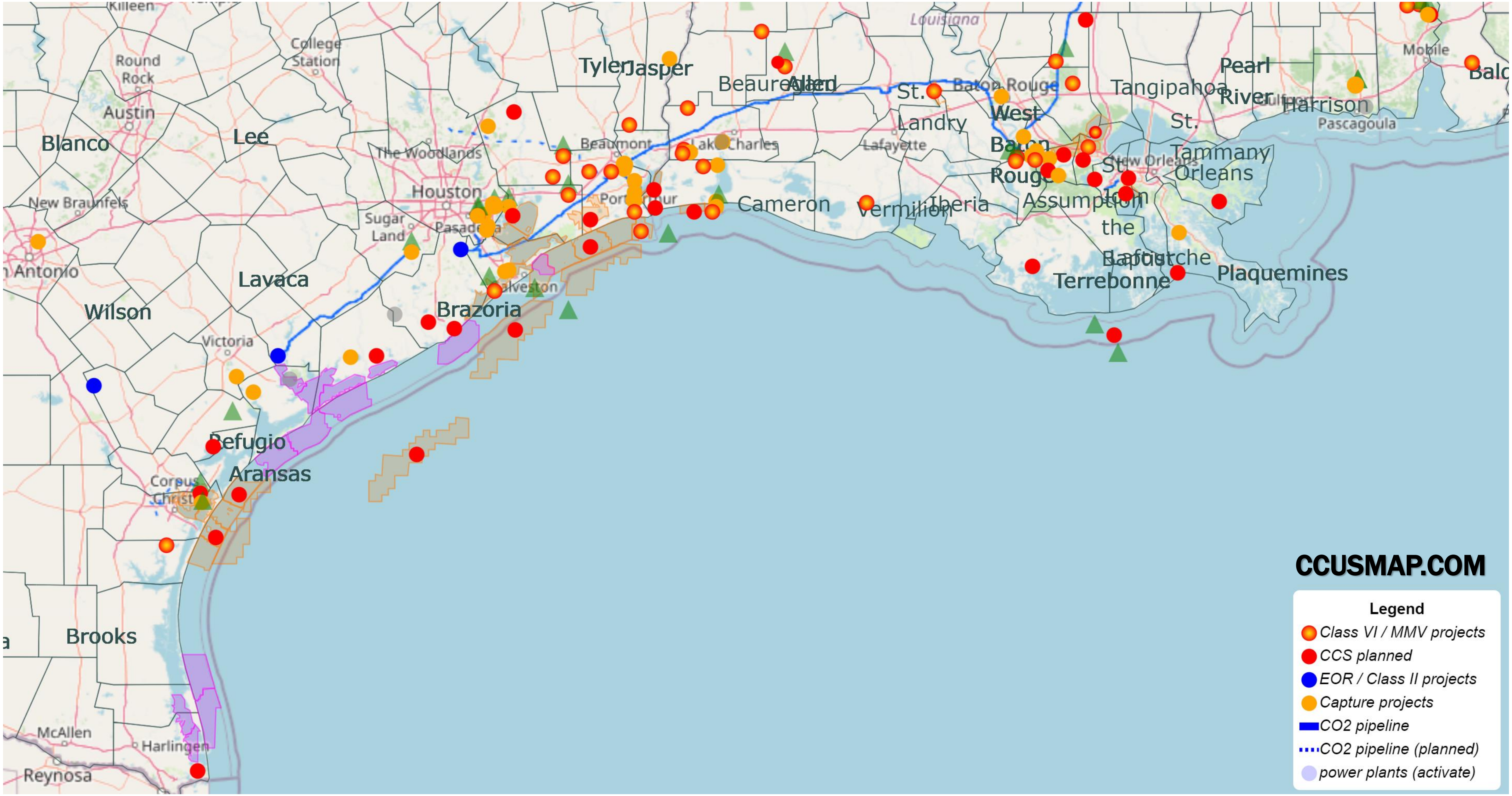
2,610 Gt of Storage Capacity in US Onshore, excluding Alaska

~70% of Storage in U.S. Gulf Coast

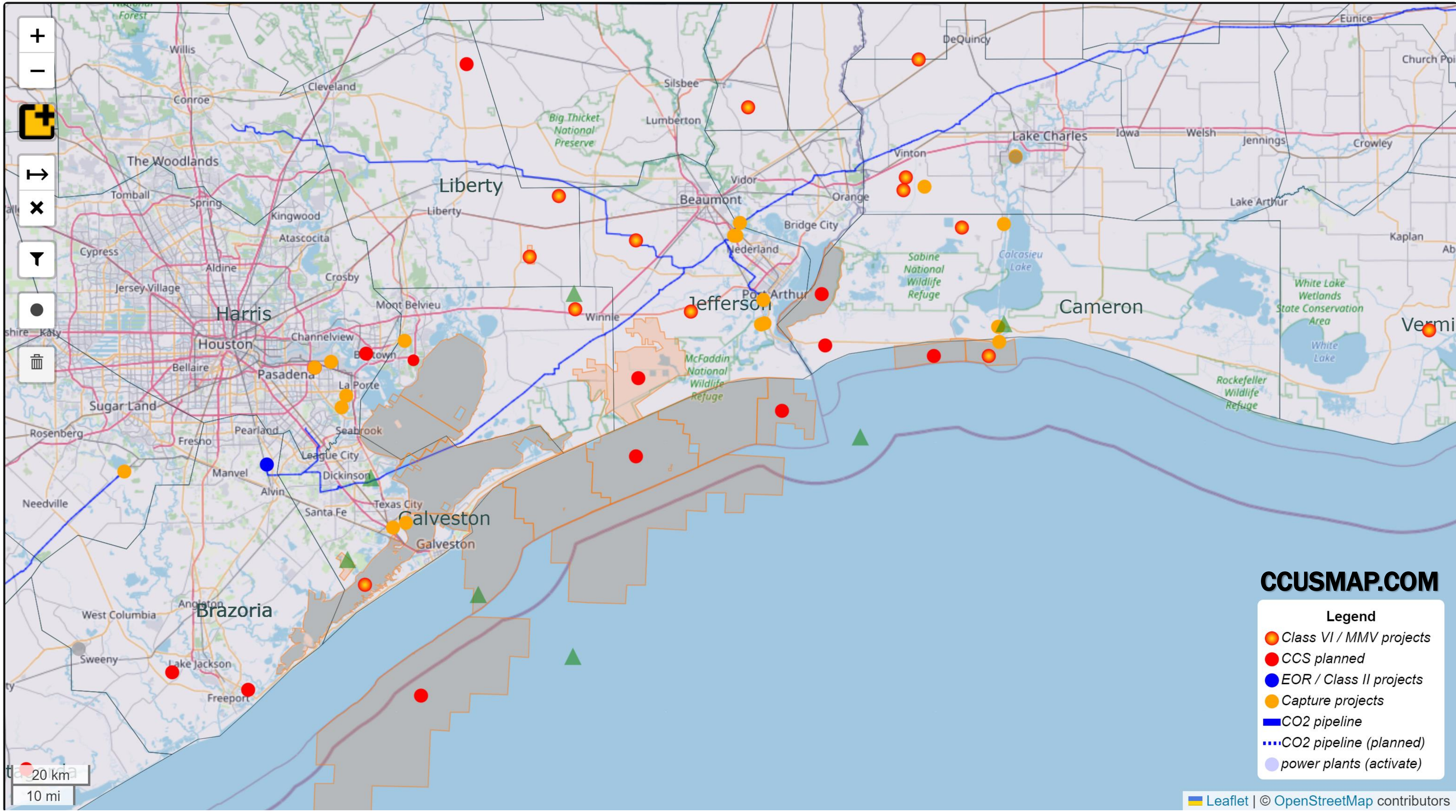
decarbonfuse

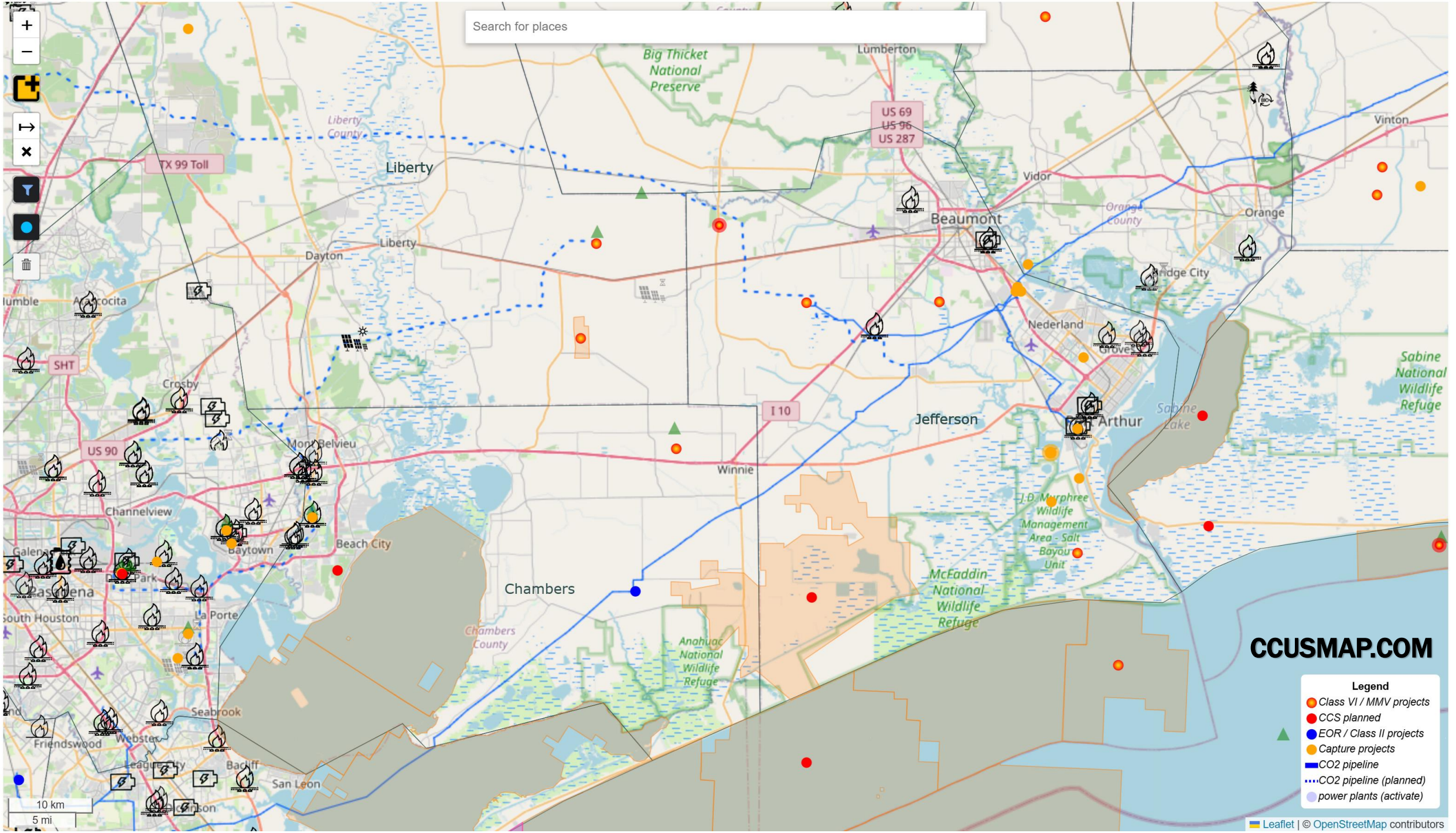

CCUSMAP.COM
Legend
Class VI / MMV projects
CCS planned
EOR / Class II projects
Capture projects
CO2 pipeline
CO2 pipeline (planned)
power plants (activate)
300 km
200 mi
Leaflet | © OpenStreetMap contributors
Winnipeg
Seattle
Portland
Boise
Salt Lake City
Denver
Lincoln
Kansas City
Saint Paul
Milwaukee
Chicago
Detroit
Toronto
Hamilton
Ottawa
Montréal
Québec
Boston
New York
Philadelphia
Washington
Virginia Beach
Raleigh
Charlotte
Atlanta
Jacksonville
Miami
Nassau
Memphis
Tulsa
Albuquerque
Las Vegas
Sacramento
San Jose
Fresno
Los Angeles
Phoenix
Tucson
Tijuana
Mexicali
Ciudad Juárez
Dallas
Austin
San Antonio
Houston
Nuevo Laredo
Monterrey
Torreón
Saltillo
Reynosa
La Paz
Culiacán
Durango
Montana
Idaho
Oregon
Washington
Wyoming
South Dakota
North Dakota
Minnesota
Wisconsin
Michigan
Lake Superior
Lake Huron
Lake Michigan
Ontario
Nebraska
Colorado
Utah
Nevada
Kansas
Missouri
Oklahoma
Arkansas
Texas
New Mexico
Arizona
Louisiana
Mississippi
Alabama
Georgia
South Carolina
North Carolina
Tennessee
Kentucky
West Virginia
Virginia
Ohio
Indiana
Pennsylvania
New York
Maine
Baja California
Baja California Sur
Sonora
Chihuahua
Coahuila
Tamaulipas
Durango


Albuquerque
Santa Fe
New Mexico
Amarillo
Lubbock
Abilene
Las Cruces
Ciudad Juárez
San Angelo
Texas
Midland
Lawton
Wichita Falls
Oklahoma
Edmond
Tulsa
Fayetteville
Fort Smith
McKinney
Dallas
Longview
Tyler
Waco
Killeen
College Station
Austin
Houston
New Braunfels
San Antonio
Ciudad Acuña
Piedras Negras
Nuevo Laredo
Chihuahua
Cuauhtémoc
Delicias
Hidalgo del Parral
Coahuila
Monclova
General Escobedo
Reynosa
Matamoros
CCUSMAP.COM



Killeen
Round Rock
Austin
Blanco
Lee
College Station
Tyler
Jasper
Beauregard
Allen
Louisiana
St. Landry
Baton Rouge
West Baton Rouge
Tangipahoa
Pearl River
Harrison
Mobile
Pascagoula
St. Tammany
Orleans
New Orleans
The Woodlands
Beaumont
Lake Charles
Lafayette
Houston
New Braunfels
Sugar Land
Pasadena
Port Arthur
Cameron
Vermilion
Iberia
Assumption
Lafourche
Terrebonne
Plaquemines
San Antonio
Lavaca
Wilson
Brazoria
Galveston
Victoria
Refugio
Aransas
Corpus Christi
Brooks
McAllen
Harlingen
Reynosa
CCUSMAP.COM
Legend
Class VI / MMV projects
CCS planned
EOR / Class II projects
Capture projects
CO2 pipeline
CO2 pipeline (planned)
power plants (activate)


CCUSMAP.COM
Legend
Class VI / MMV projects
CCS planned
EOR / Class II projects
Capture projects
CO2 pipeline
CO2 pipeline (planned)
power plants (activate)
Harris
Houston
Liberty
Jefferson
Cameron
Galveston
Brazoria
Beaumont
Port Arthur
Lake Charles
Orange
Pasadena
Sugar Land
The Woodlands
Big Thicket National Preserve
Sabine National Wildlife Refuge
McFaddin National Wildlife Refuge
Rockefeller Wildlife Refuge
White Lake Wetlands State Conservation Area
Calcasieu Lake
20 km
10 mi
Leaflet | © OpenStreetMap contributors


Search for places
Big Thicket National Preserve
Liberty County
Liberty
Dayton
TX 99 Toll
US 69
US 96
US 287
Lumberton
Vinton
Vidor
Beaumont
Orange County
Orange
Nederland
Port Arthur
Jefferson
Sabine National Wildlife Refuge
Sabine Lake
I 10
Winnie
Mont Belvieu
Crosby
SHT
US 90
Channelview
Baytown
Beach City
Chambers
Chambers County
Anahuac National Wildlife Refuge
J.D. Murphree Wildlife Management Area - Salt Bayou Unit
McFaddin National Wildlife Refuge
La Porte
Seabrook
Friendswood
Webster
Bacliff
San Leon
10 km
5 mi
CCUSMAP.COM
Legend
Class VI / MMV projects
CCS planned
EOR / Class II projects
Capture projects
CO2 pipeline
CO2 pipeline (planned)
power plants (activate)
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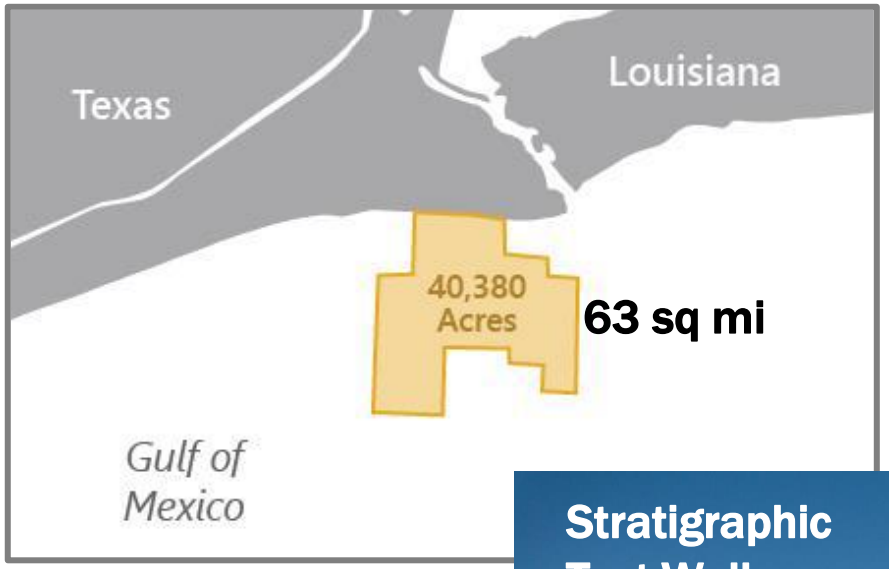
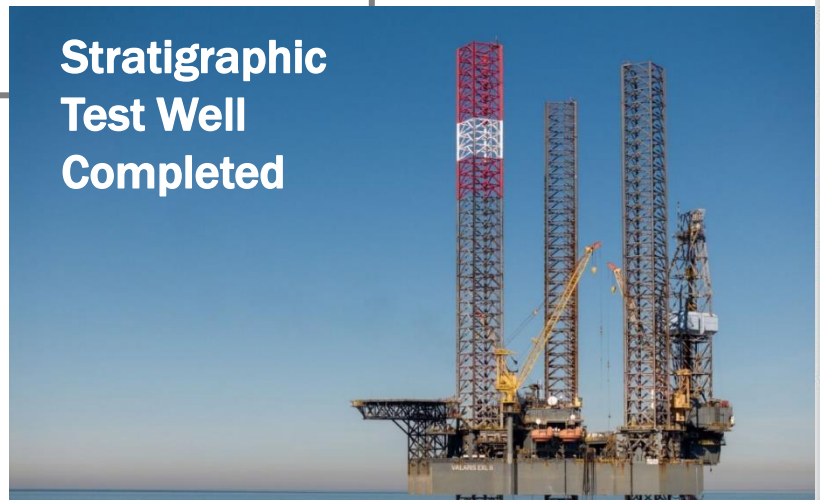
BAYOU BEND PROJECT

First Offshore CCS Project Developed in US

Chevron, Equinor, TotalEnergies



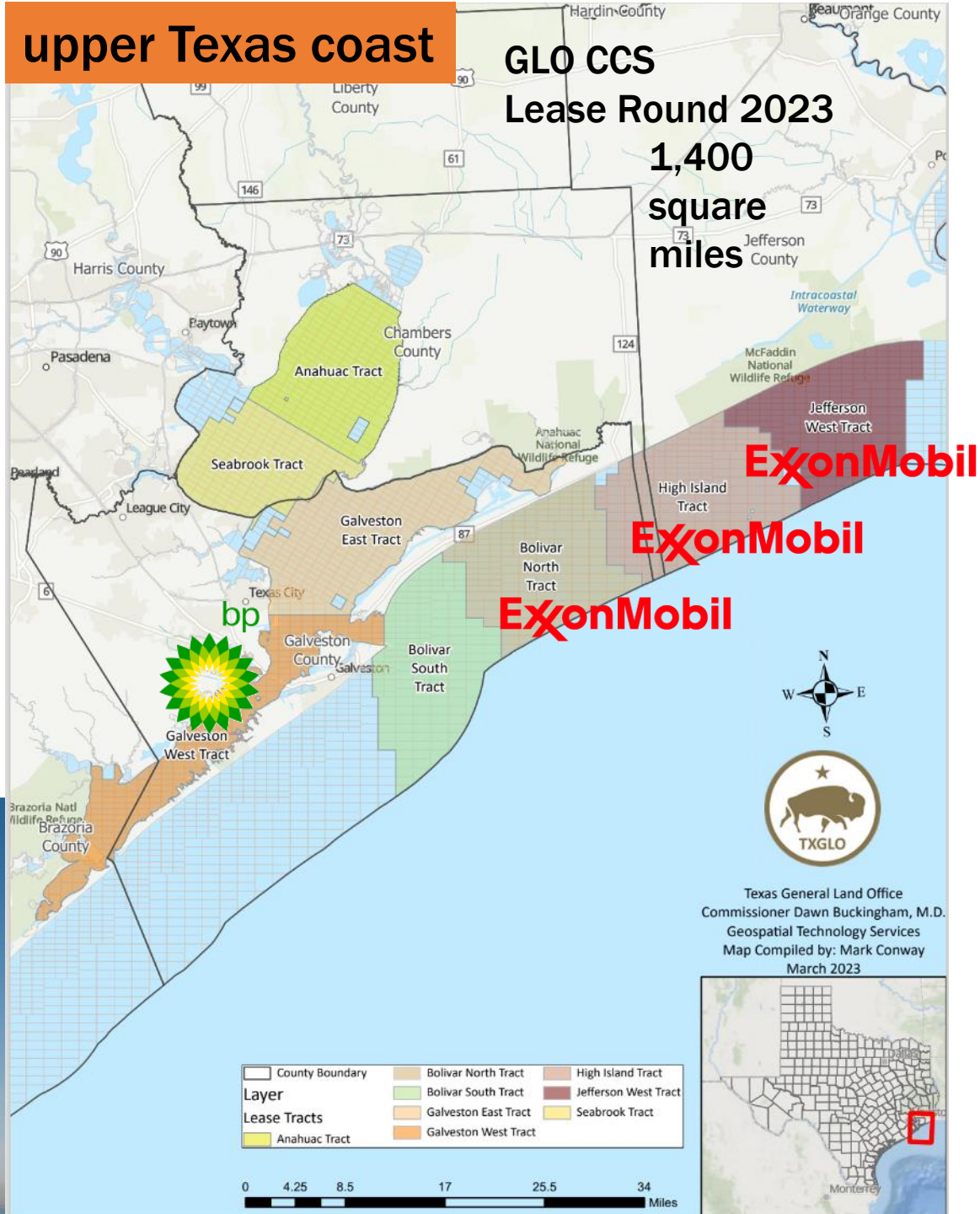
GLO LEASE 2022

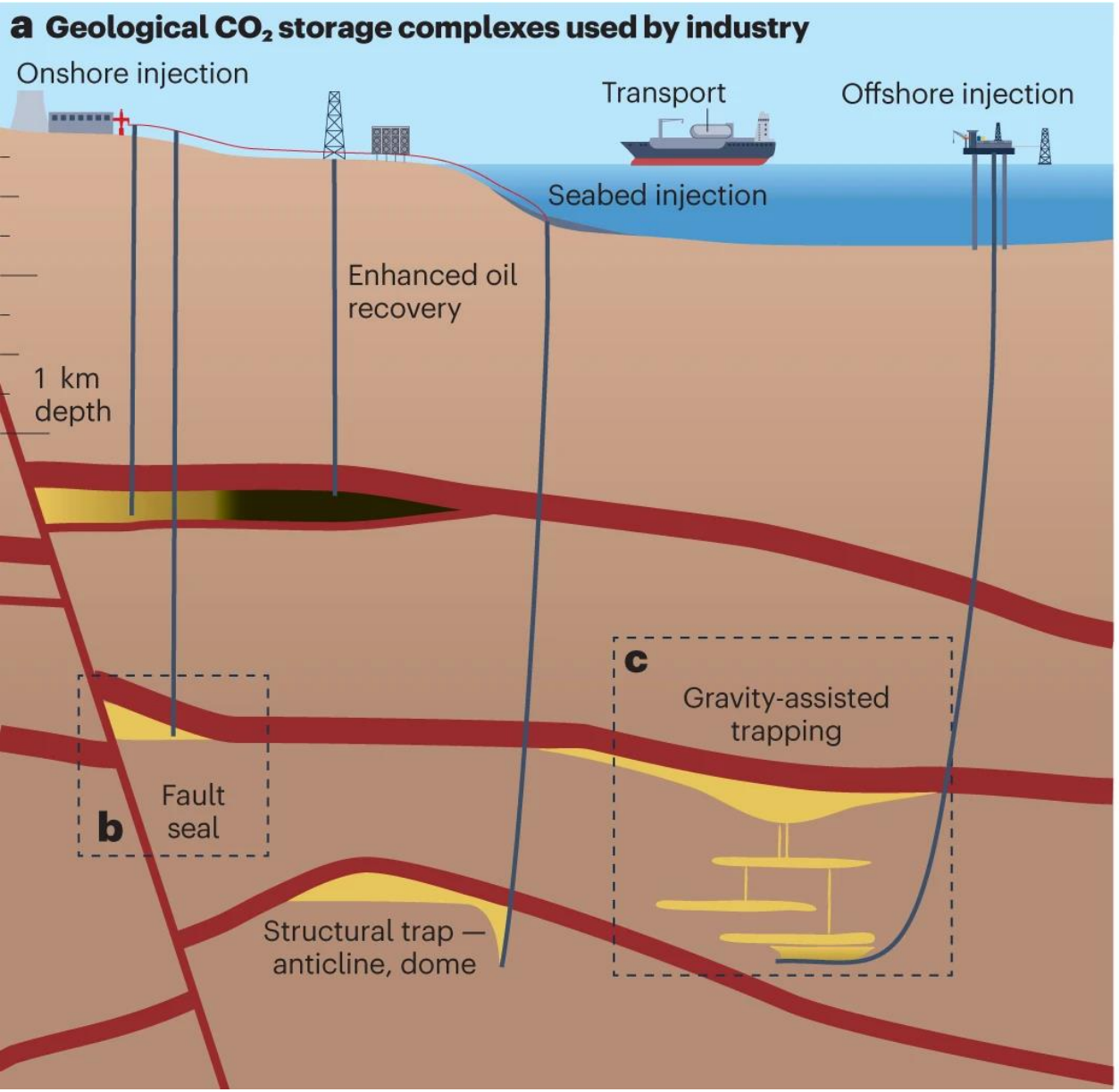


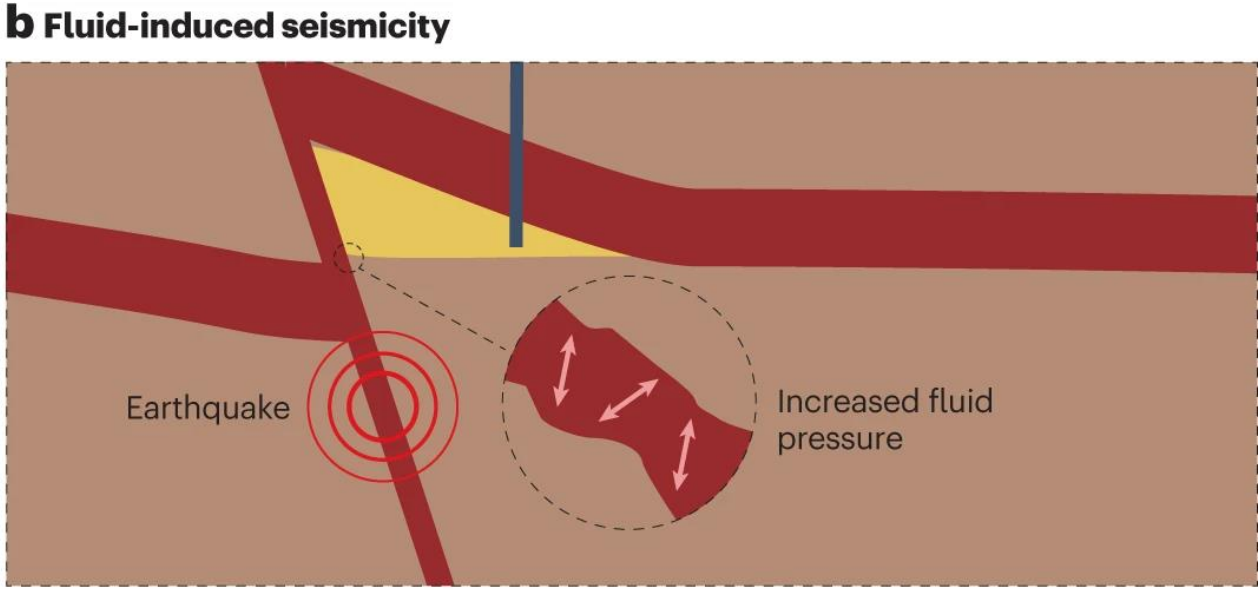
upper Texas coast

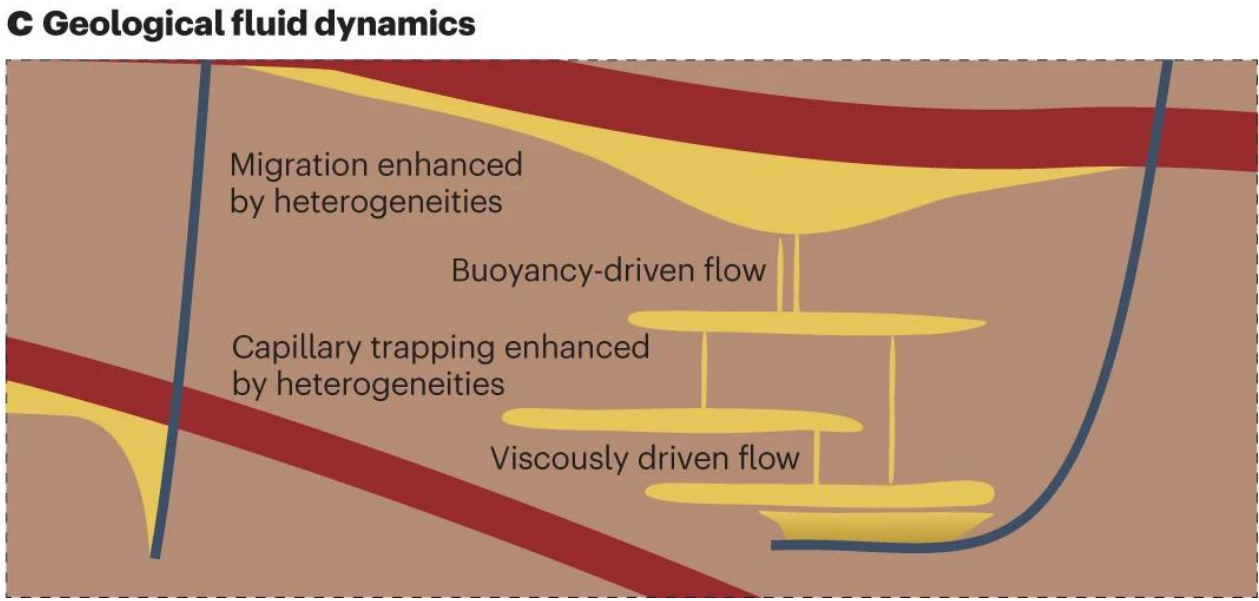
GLO CCS Lease Round 2023

1,400 square miles

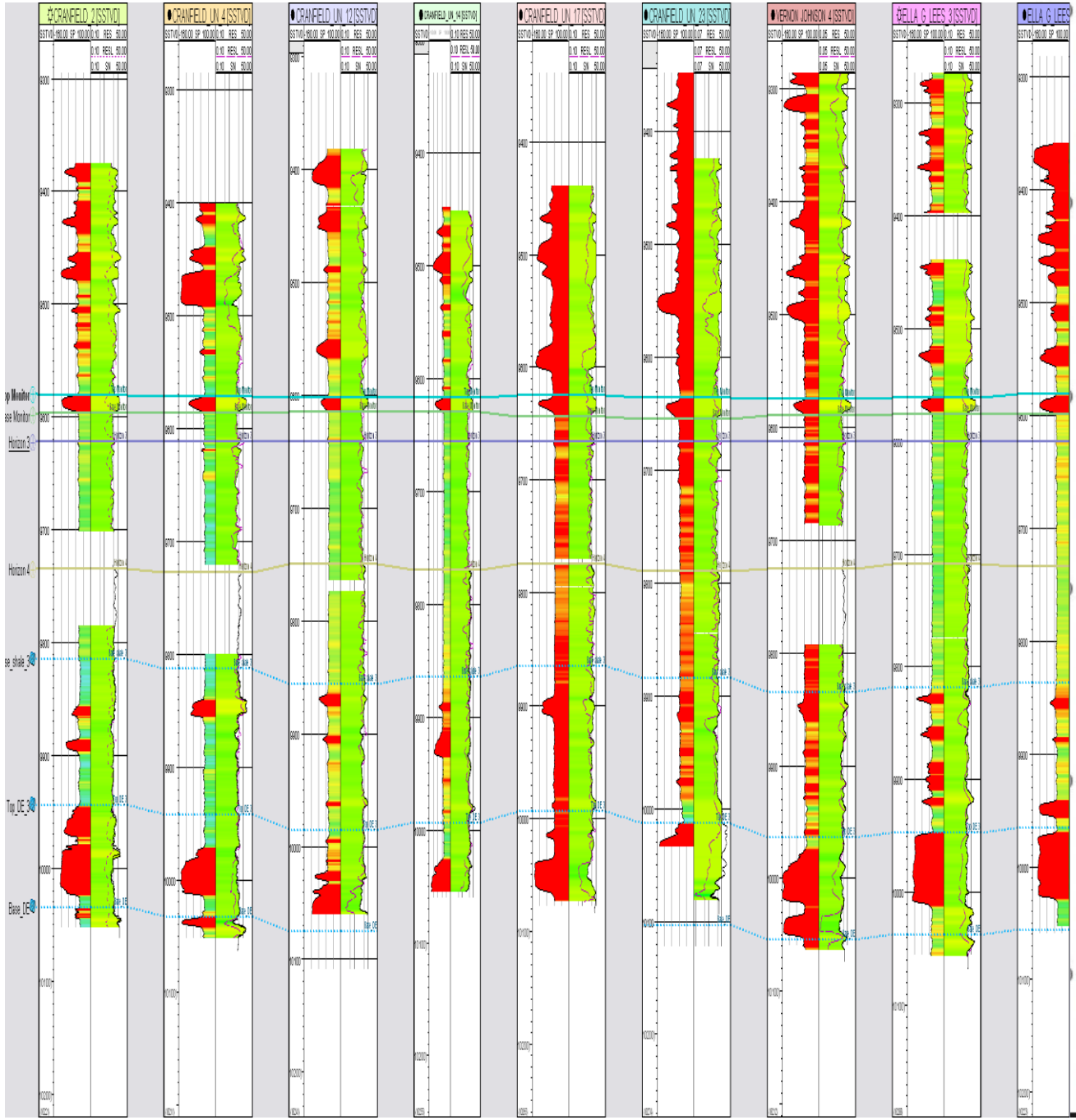


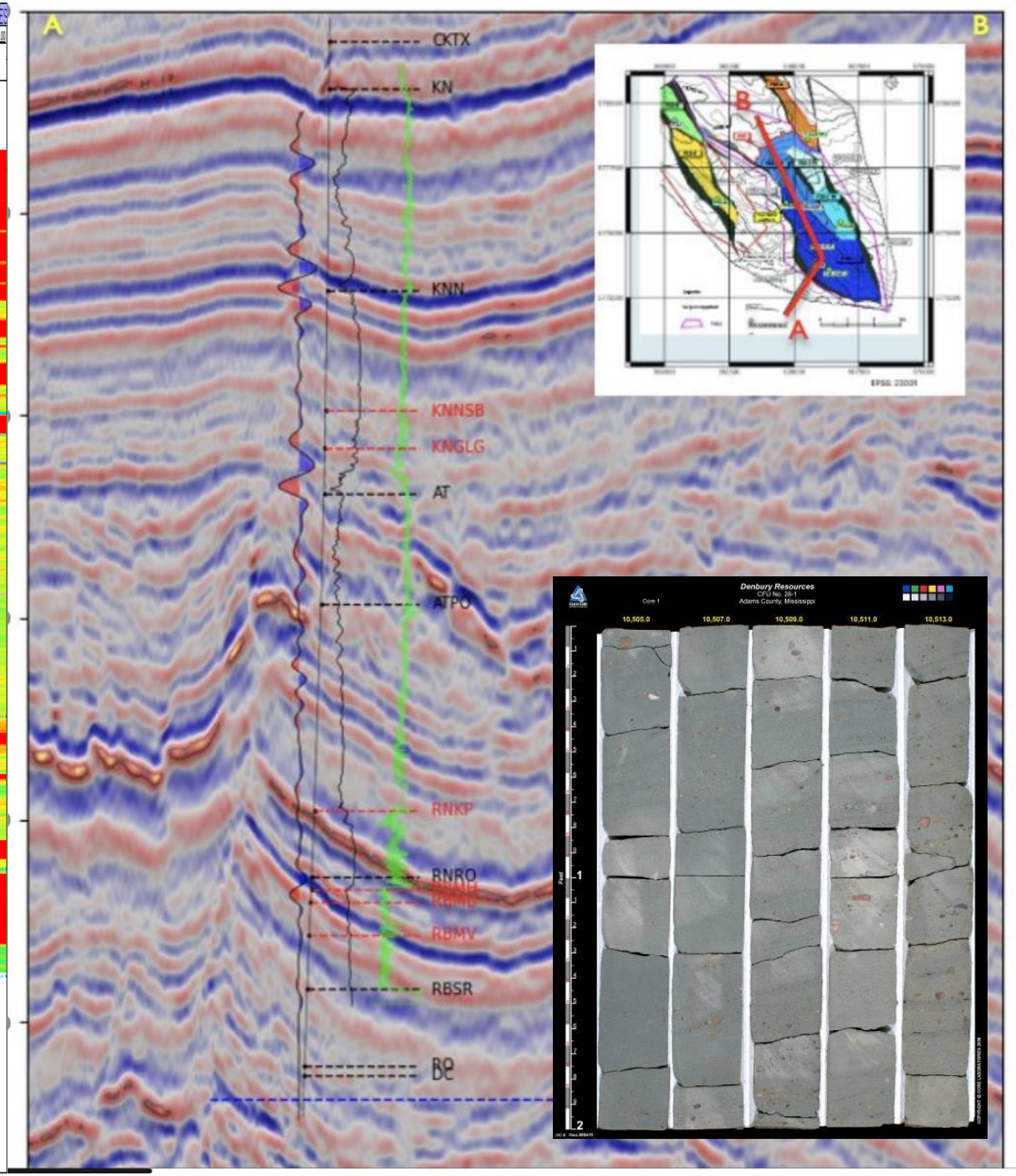






Krevor, S., de Coninck, H., Gasda, S.E. *et al.* Subsurface carbon dioxide and hydrogen storage for a sustainable energy future. *Nat Rev Earth Environ* **4**, 102–118 (2023). https://doi.org/10.1038/s43017-022-00376-8


CRANFIELD_2 [SSTVD]
CRANFIELD_UN_4 [SSTVD]
CRANFIELD_UN_12 [SSTVD]
CRANFIELD_UN_14 [SSTVD]
CRANFIELD_UN_17 [SSTVD]
CRANFIELD_UN_23 [SSTVD]
VERNON JOHNSON 4 [SSTVD]
ELLA_G_LEES_3 [SSTVD]
ELLA_G_LEES
Horizon 3
Horizon 4
Top_DE
Base_DE


A
B
CKTX
KN
KNN
KNNSB
KNGLG
AT
ATPO
RNKP
RNRO
RBMV
RBSR
BO
DE

B
A

Denbury Resources
CFU No. 29-1
Adams County, Mississippi
Core 1
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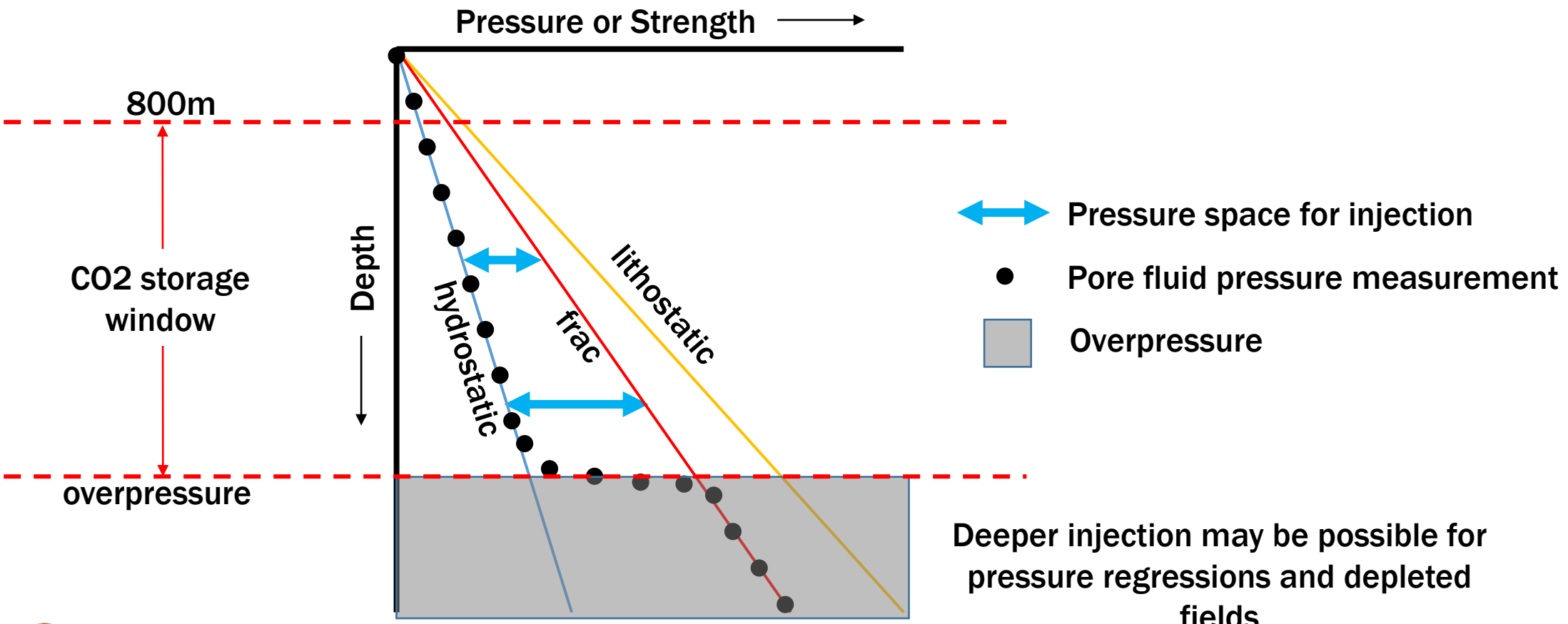
10,507.0
10,509.0
10,511.0
10,513.0

Injection Pressure



Deeper injection may be possible for pressure regressions and depleted fields

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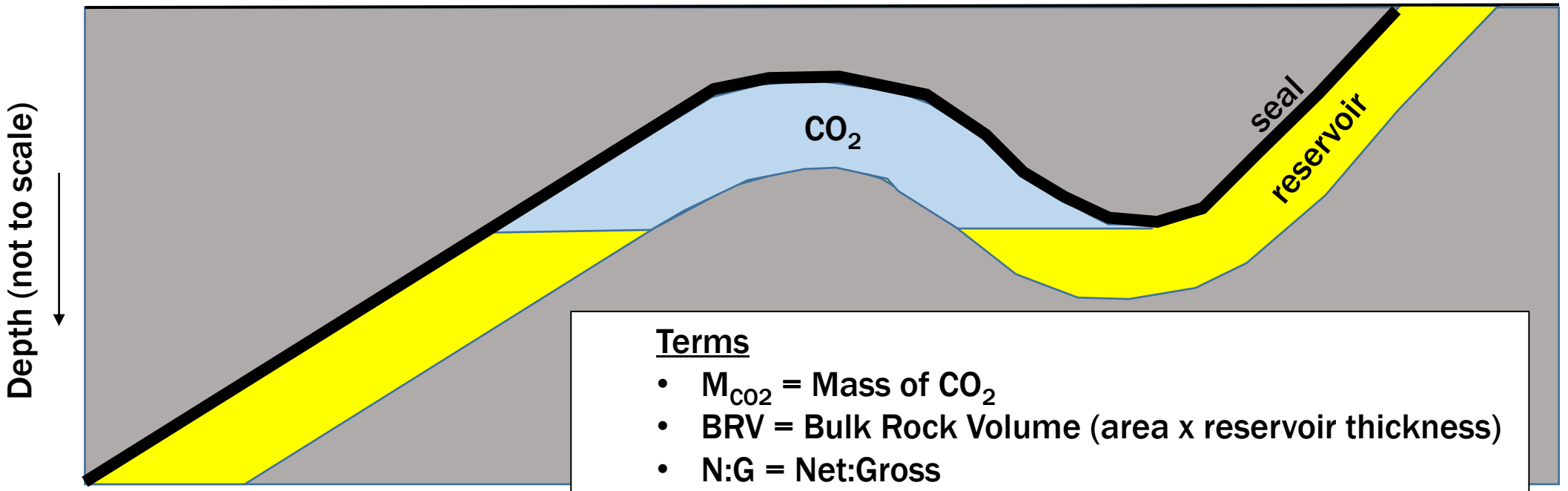
CO_2 Static Capacity (Saturated Pore Volume)

$$M_{CO2} = BRV * N:G * \varphi * \rho_{CO2\ res} * SE$$



Terms

- M_{CO2} = Mass of CO_2
- BRV = Bulk Rock Volume (area x reservoir thickness)
- N:G = Net:Gross
- φ = Porosity
- $\rho_{CO2\ res}$ = density of CO_2 at reservoir conditions
- SE = Storage Efficiency

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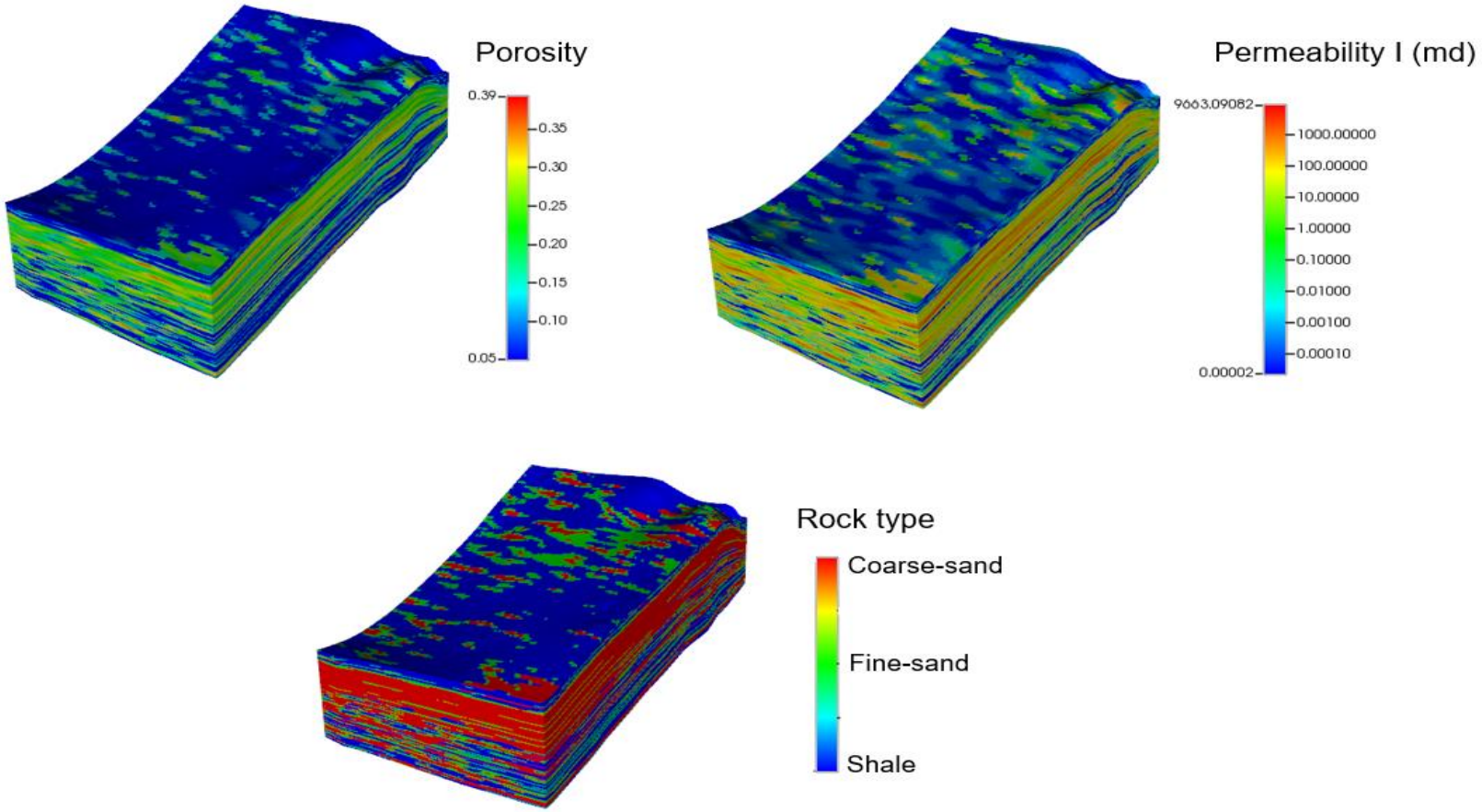
3D Reservoir Modelling



- 3D geologic model: 1,8884,610 grid blocks (upscaled version)
- Based on Southern LA Miocene
- CO_2 injection: 12 years, total injected CO_2~ 12 Mt, 100 years post-injection

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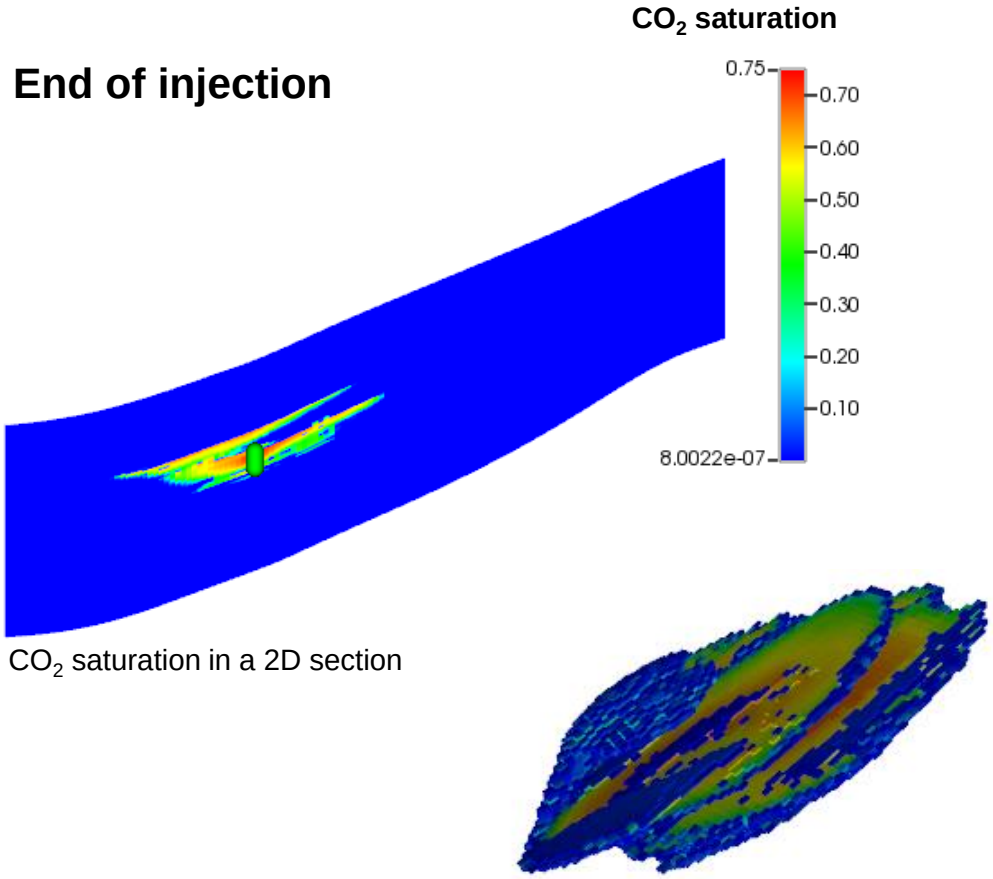
Modelled CO_2 Saturation

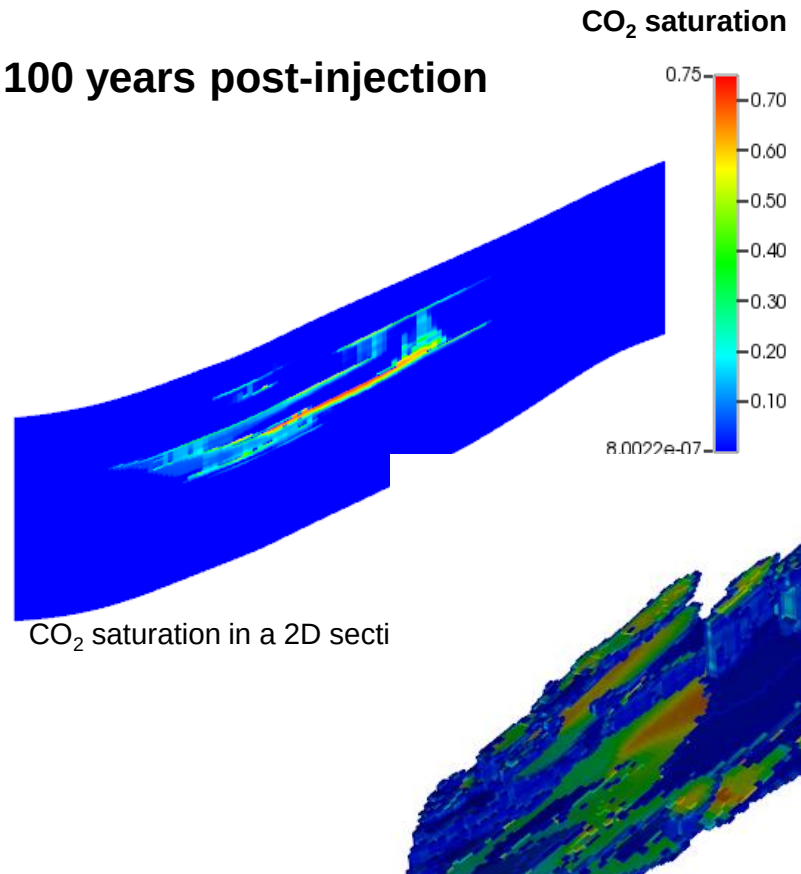
End of injection



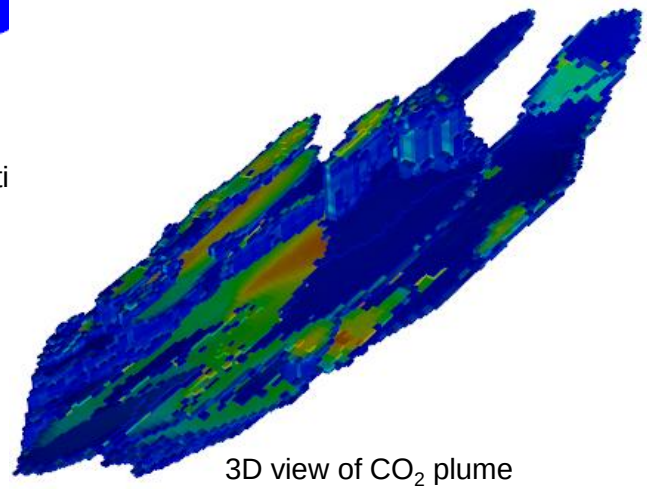
CO_2 saturation in a 2D section

3D view of CO_2 plume

100 years post-injection



CO_2 saturation in a 2D secti



3D view of CO_2 plume

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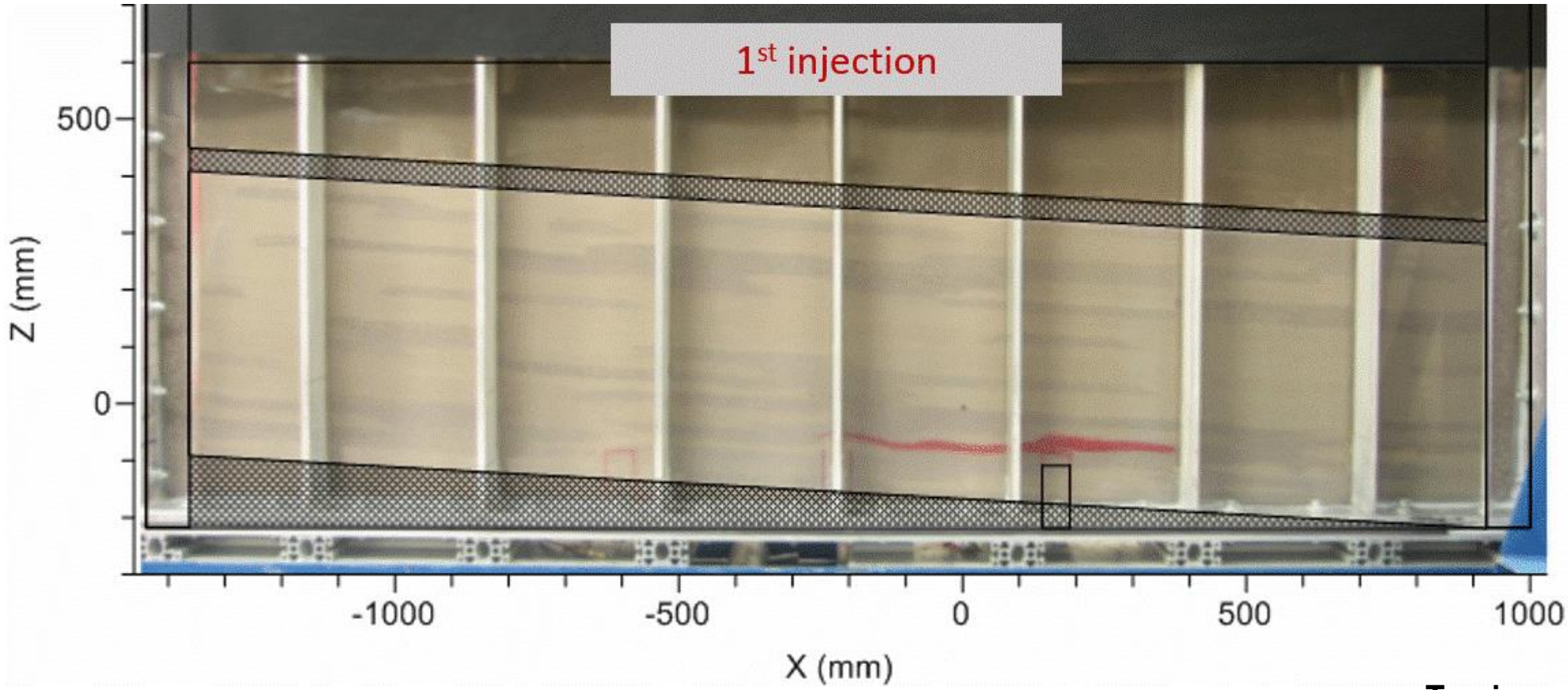
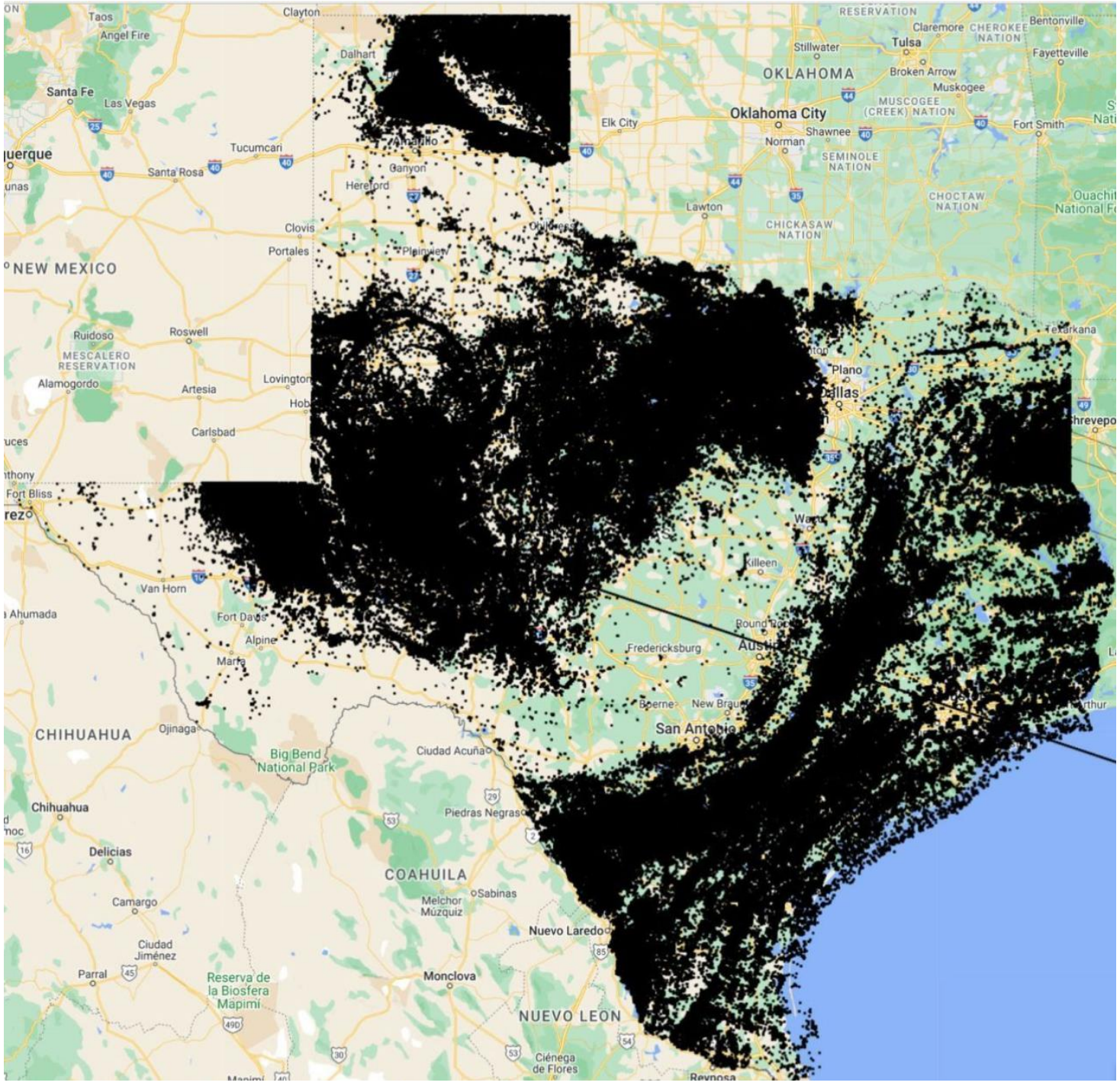
Injection into Heterogeneous Sand



Trevisan, 2016


Taos
Angel Fire
Clayton
Dalhart
Santa Fe
Las Vegas
Tucumcari
Santa Rosa
Amarillo
Canyon
Hereford
Clovis
Portales
Plainview
NEW MEXICO
Ruidoso
Roswell
MESCALERO RESERVATION
Alamogordo
Artesia
Carlsbad
Fort Bliss
Van Horn
Fort Davis
Alpine
Marfa
Ojinaga
CHIHUAHUA
Big Bend National Park
Ciudad Acuña
Chihuahua
Piedras Negras
Delicias
COAHUILA
Camargo
Sabinas
Melchor Múzquiz
Nuevo Laredo
Ciudad Jiménez
Parral
Reserva de la Biosfera Mapimí
Monclova
NUEVO LEON
Ciénega de Flores
Reynosa
OKLAHOMA
Oklahoma City
Elk City
Stillwater
Tulsa
Broken Arrow
Claremore
Bentonville
Fayetteville
Muskogee
Fort Smith
Norman
Shawnee
SEMINOLE NATION
MUSCOGEE (CREEK) NATION
CHEROKEE NATION
CHOCTAW NATION
CHICKASAW NATION
Lawton
Plano
Killeen
Fredericksburg
Austin
San Antonio
Boerne
New Braunfels


13 5/8"
13 3/8"
10 3/4"
7"

Integrity of old casing

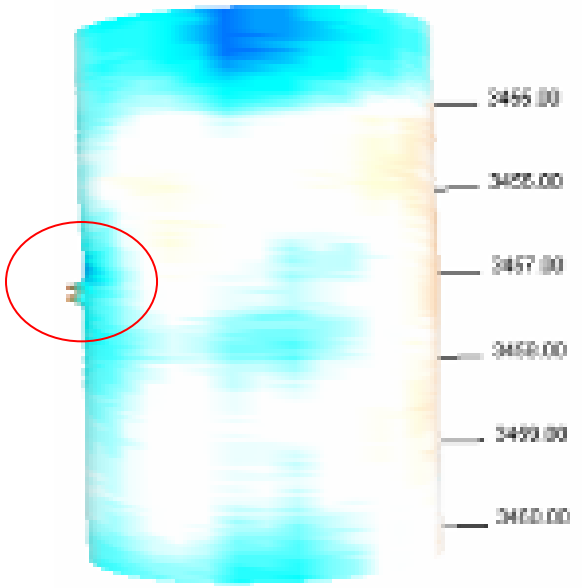
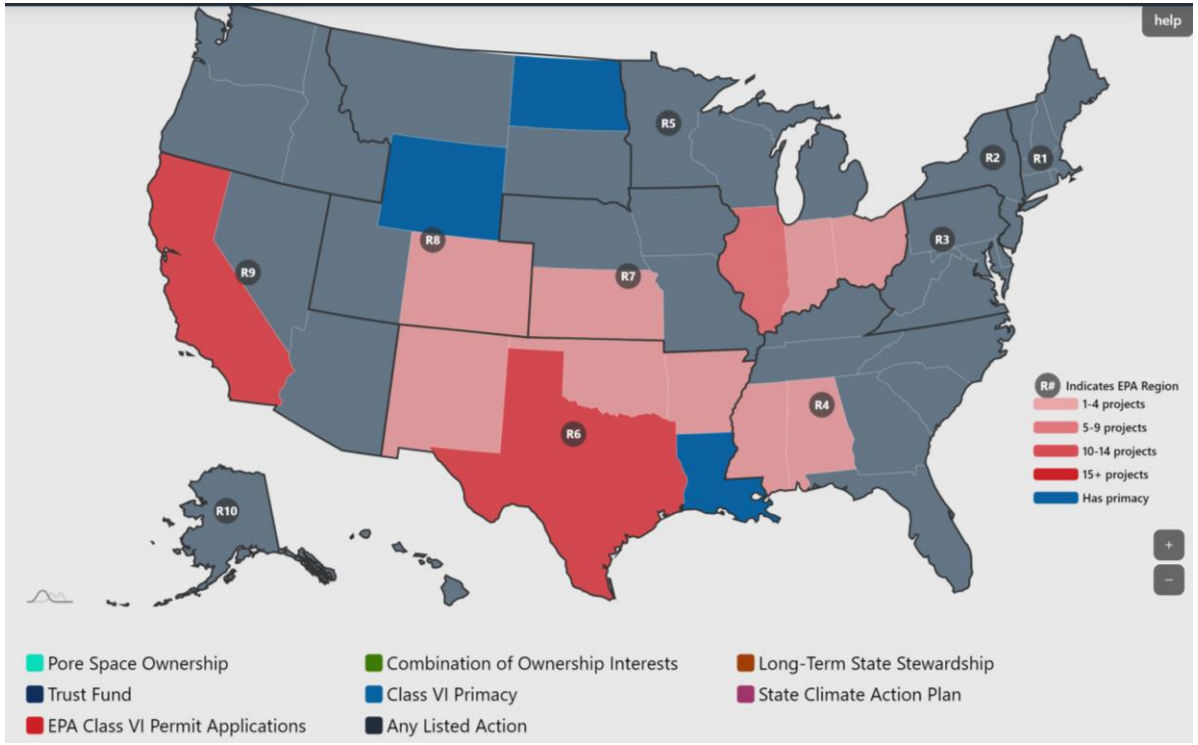


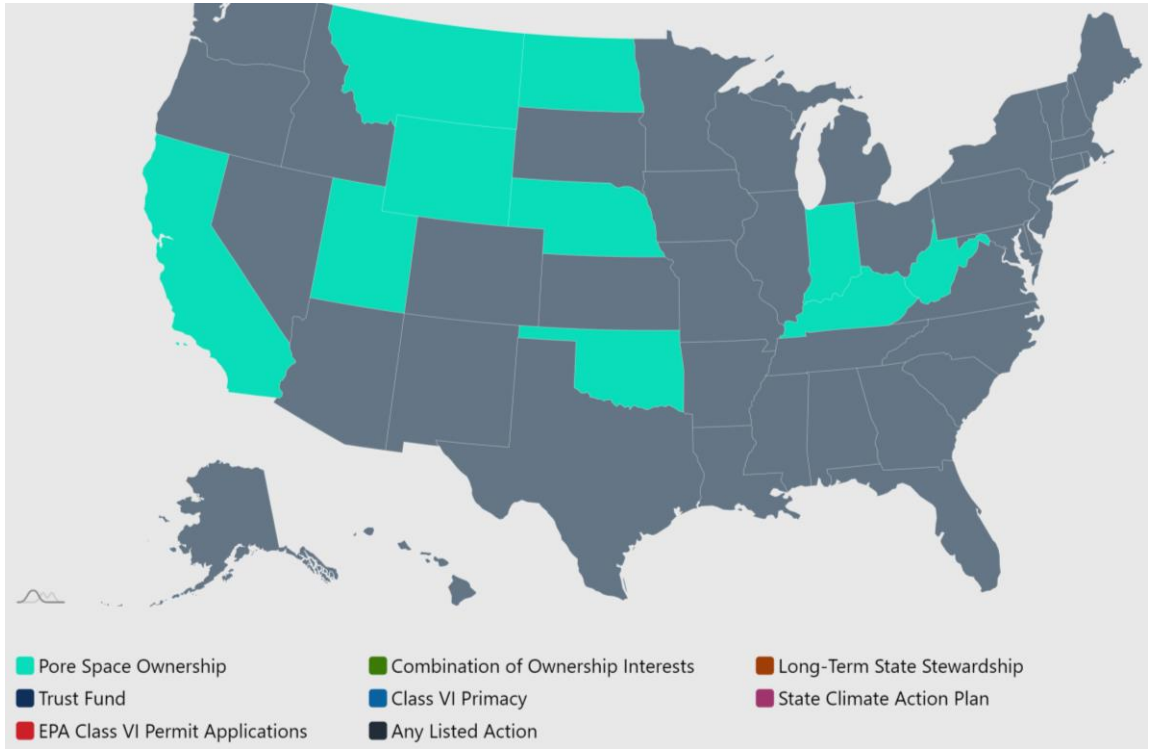
Exhibit 4. Satartia Pipeline Rupture Site

Source: Eller (2022)

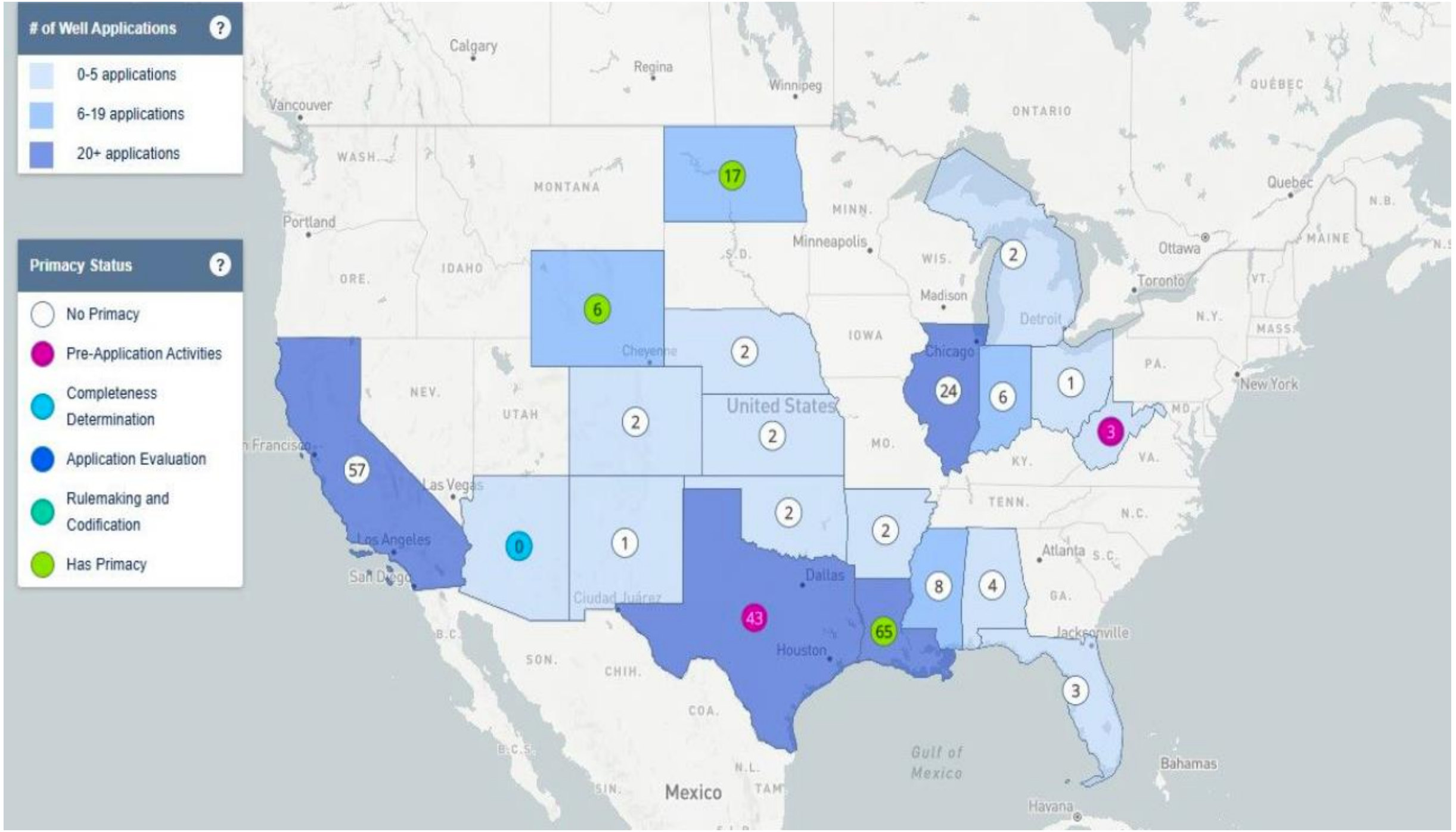
Injection Well Permitting

- EPA Class II – CO2 used for enhanced oil recovery (EOR).
- EPA Class VI – CO2 injected for storage/disposal.
- State Primacy





https://cdrlaw.org/ccus-tracker/


# of Well Applications
0-5 applications
6-19 applications
20+ applications
Primacy Status
No Primacy
Pre-Application Activities
Completeness Determination
Application Evaluation
Rulemaking and Codification
Has Primacy
Calgary
Regina
Winnipeg
Vancouver
Portland
Minneapolis
Toronto
Ottawa
Quebec
Madison
Detroit
Chicago
Cheyenne
New York
Atlanta
Dallas
Houston
Jacksonville
Las Vegas
Los Angeles
San Diego
Ciudad Juárez
Mexico
Gulf of Mexico
Bahamas
Havana
United States
WASH.
ORE.
IDAHO
MONTANA
NEV.
UTAH
S.D.
MINN.
WIS.
IOWA
MO.
ILL.
KY.
TENN.
MISS.
ALA.
GA.
S.C.
N.C.
VA.
W.VA.
PA.
N.Y.
MASS.
VT.
MAINE
N.B.
ONTARIO
QUÉBEC
B.C.
SON.
CHIH.
COA.
N.L.
TAM.
SIN.
B.C.S.
17
6
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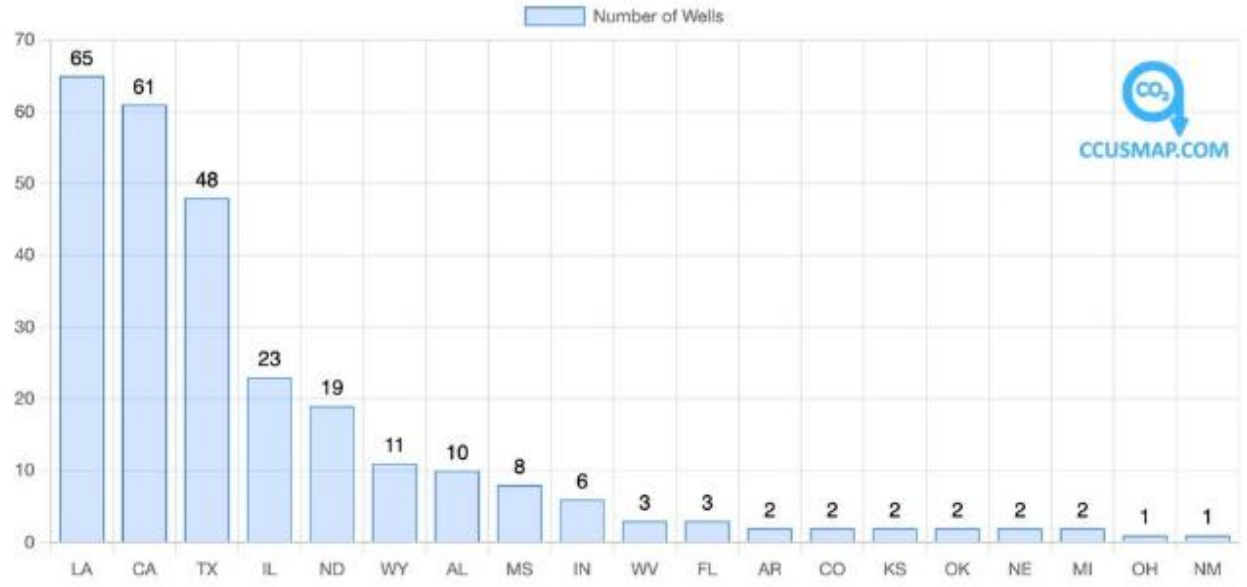
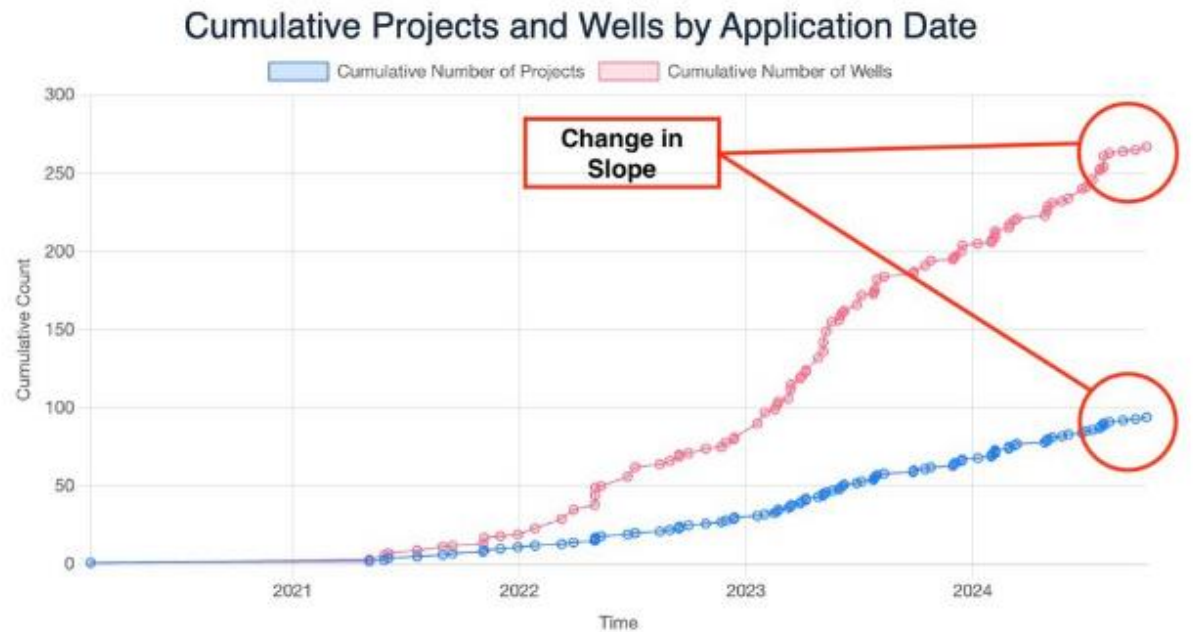
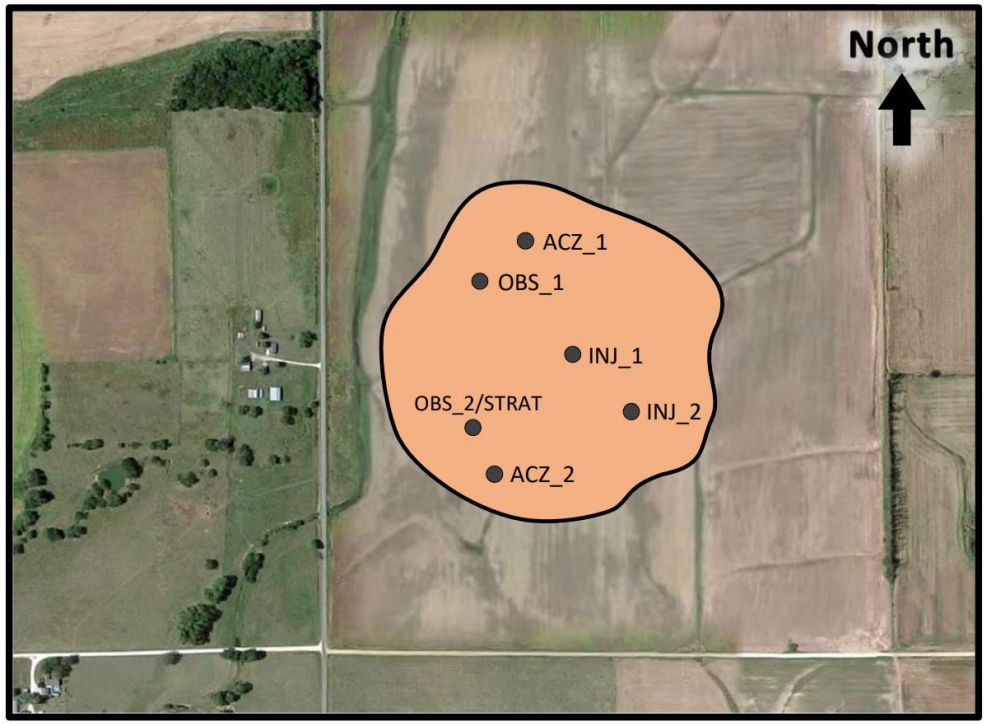
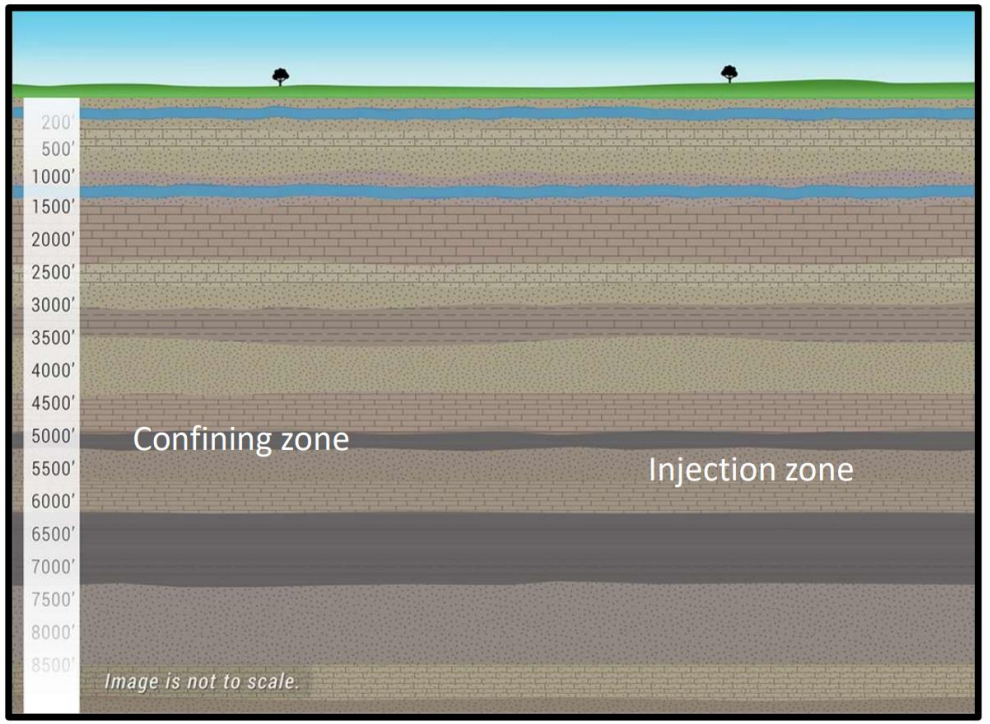


Name	# Wells	State
CarbonFrontier	9	CA
Carbon TerraVault IV	8	CA
River Parish Sequestration Project	7	LA
Orchard	7	TX
Carbon TerraVault VI	7	CA
Great Plains CO2 Sequestration Project	6	ND
Carbon TerraVault III	6	CA
Carbon TerraVault V	6	CA
Denbury Leo	6	MS
CENLA Hub Rapides One CCS	6	LA
CENLA Hub Vernon One CCS	6	LA
Heartland Greenway Carbon Storage	6	IL
Eastern Wyoming Sequestration Hub	6	WY
Diamond Vault	6	LA
Denbury Draco	6	LA
Bayou Bend East	6	TX
ConocoPhillips Texas Gulf Coast CCS Refugio	6	TX



Overview of the Workshop and the Permit Application

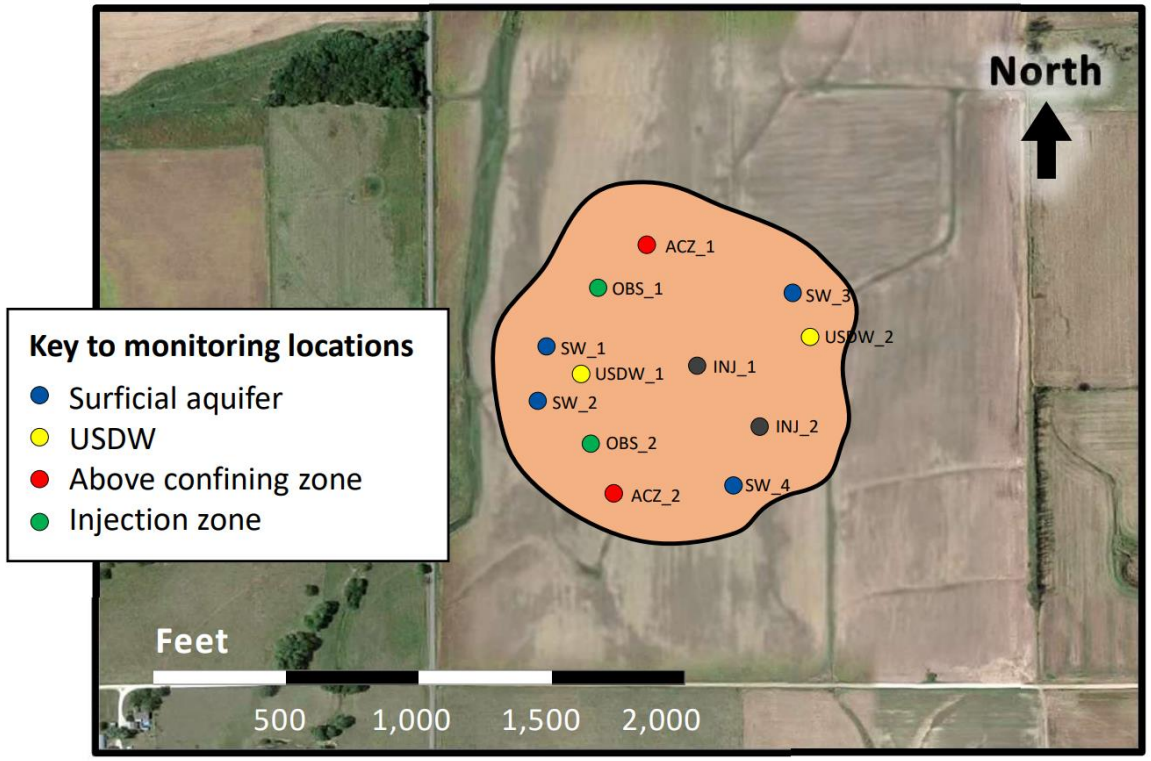




Project Information Tracking Module; 40 CFR 146.82(a); Site Characterization Guidance

EPA Class VI Program: https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide

Groundwater Monitoring Locations and Depths

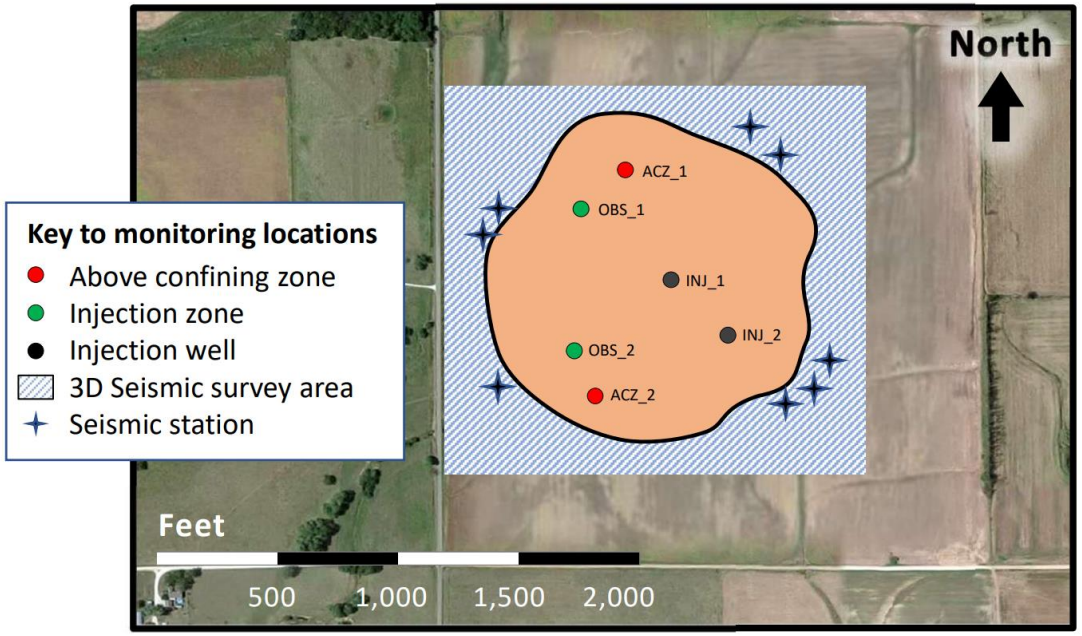


Proposed Ground Water Quality Monitoring Above the Confining Zone				
Target Formation	**Monitoring Activity**	**Monitoring Location(s)**	**Spatial Coverage**	**Frequency**
Surficial aquifer	Fluid sampling	Shallow monitoring wells: SW_1, SW_2, SW_#, SW_4	4 point locations, 1 sampling interval each. Approx. depths: SW_1 - 101 ft SW_2- 107 ft SW_3- 95 ft SW_4- 80 ft	Baseline; Year 1-2: Quarterly; Year 3-5: Semi-Annual
	DTS	INJ_1	1 point location, distributed measurement to 6325 KB/5631 MSL	Continuous
		INJ_2	1 point location, distributed measurement to 6325 KB/5631 MSL	Continuous
Lowermost USDW	Fluid sampling	USDW_2	1 point location, 1 interval: 3300 KB/2606 MSL	Baseline; Year 1-5: Annual
	Pressure/ temperature monitoring	USDW_2	1 point location, 1 interval: 3450 KB/2756 MSL	Continuous
	DTS	INJ_1	1 point location, distributed measurement to 6325 KB/5631 MSL	Continuous
		INJ_2	1 point location, distributed measurement to 6325 KB/5631 MSL	Continuous
First Permeable Formation Above the Confining Zone	Fluid sampling	ACZ_1	1 point location, 1 interval: 4918 - 5000 KB, 4224 - 4306 MSL	Baseline; Year 1-3: Annual Year 4-5: None
		ACZ_2	1 point location, 1 interval: 5000 KB/4918 MSL	Baseline; Year 1-5: Annual
	Pressure/ temperature monitoring	ACZ_1	1 point location, 1 interval: 4918 - 5000 KB, 4224 - 4306 MSL	Year 1-3: Continuous Year 4-5: None
		ACZ_2	1 point location, 1 interval: 5000 KB/4918 MSL	Continuous
	DTS	INJ_1	1 point location, distributed measurement to 6325 KB/5631 MSL	
		INJ_2	1 point location, distributed measurement to 6325 KB/5631 MSL	Continuous

Project Plan Module; 146.90(d); Testing and Monitoring Guidance Section 4

Plume and Pressure Front Tracking

- Use direct and indirect methods to track the CO_2 plume and pressure front
- Describe methods
  - Class VI Rule has flexibility
  - Appropriate tests will be site-specific
- Multiple, complimentary methods can fully illustrate CO_2 plume and pressure front behavior



Project Plan Module; 146.90(g); Testing and Monitoring Guidance Section 5

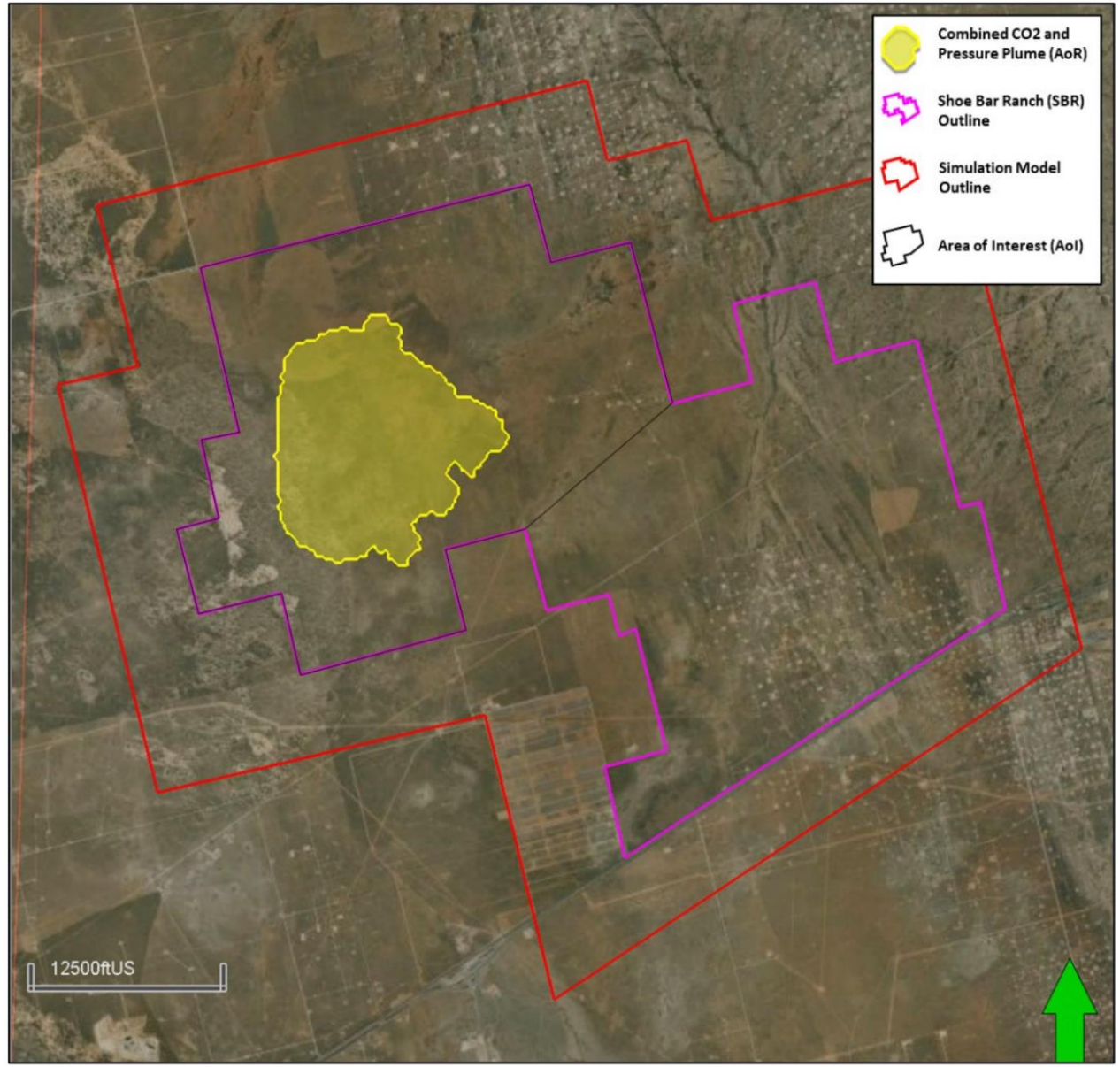


Figure 2—Definition of the outlines used in the Area of Review and Corrective Action Plan document.

Texas Prioritization System for Orphan Wells[156]

Table: Well Plugging Priority System

	FACTOR	Weight
1	**Well Completion**	
A	Unknown (no well records	15
B	No surface casing or set above base of deepest usable quality water	10
C	Additional casing string not adequately cemented to isolate usable quality water	5
D	Injection or Disposal Well	10
E	Well penetrates salt/corrosive water bearing formation or abnormally pressured formation	5
F	Well in H_2S Field	5
G	Age: Well drilled $\geq$ 25 years ago	5
	Total: (40 points max)	
2	**Wellbore Conditions**	
A	Well is pressured up at the surface (tubing or prod casing)	10
B	Bradenhead pressure exists *	5
	Auto 2H if UQW* not protected and fluid at BH is not UQW**	
C	Measured fluid level	
D	Fluid level at or above the base of deepest usable quality water.	50
E	Fluid level less than 250' below base of deepest usable quality water (NA if 2D applies)	15
F	MIT Failure	5
G	H-15 (MIT) never performed or test > 5 years old (NA if F applies)	3
H	Inadequate wellhead control/integrity	5
	Total: (75 points max)	
3	**Well location with respect to sensitive areas:**	
A	H_2S well with public area ROE** **Automatic Priority 2H**	
B	In Marine Environment	10
C	Within 100' or river, lake, creek, or domestic use fresh water well (NA if B applies)	5
D	Between 100' and 1/4 mile of river, lake, creek, or domestic use fresh water well (NA if C applies)	3
E	Located within agricultural area.	2
F	Well located in known sensitive wildlife area.	3
G	Well located within city or town site limits.	10
	Total (20 points max)	
4	**Unique environmental, Safety, or Economic Concern**	
A	Adjacent to active water flood or disposal well at or above completion interval.	5
B	Logistics (poor roads, encroaching public, etc.)	5
C	Well contains junk.	5
D	P-5 Delinquent > 5 years	5
E	Other (attach explanation)	1-20
	Total: (20 points max)	

Total Weight

Priority 1 = Leaking Well [based upon definition]
Priority 2H = Higher Risk well [based on definition and/or total weight of 75+]
Priority 2 = Total Weight of 50-75
Priority 3 = Total Weight of 25-49
Priority 4 = Total Weight < 25

*BH pressure is sustained.

**2H if public areas could be impacted based on 16 Texas Administrative Code §3.36 [Statewide Rule 36] definition.

Table 12. Plugging Funds

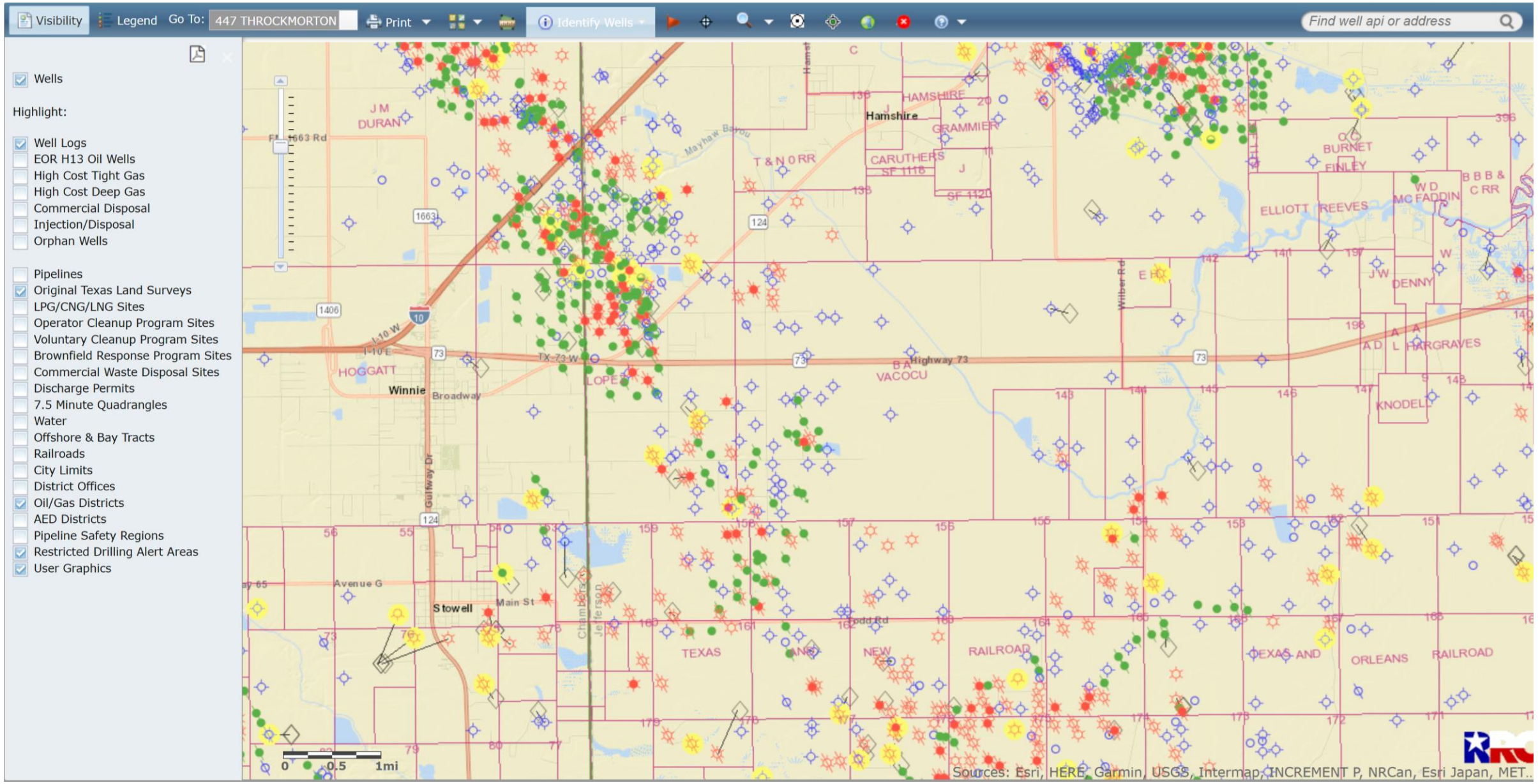
Table 12. Plugging Funds

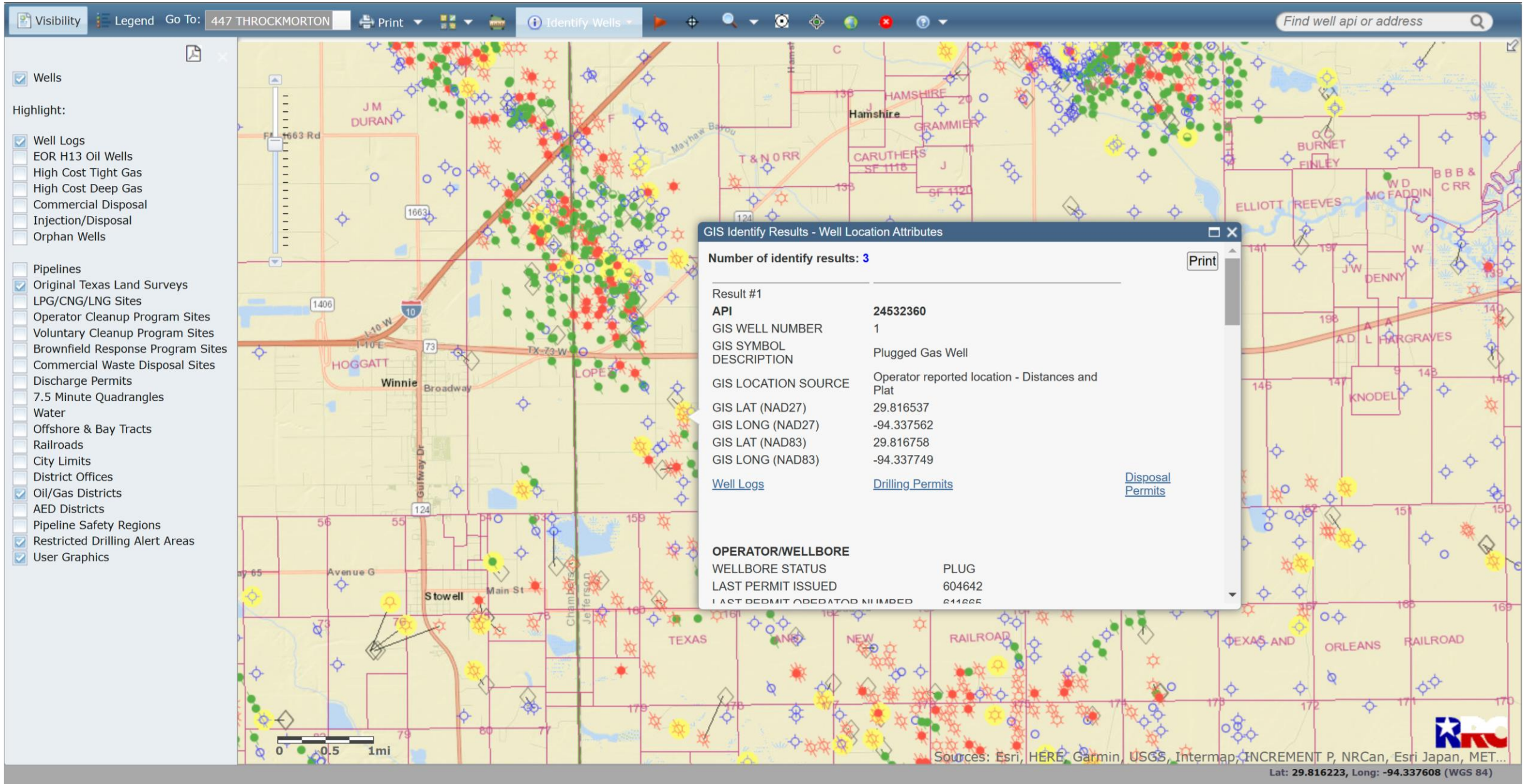
Blank fields indicate that no data was reported or available.
*An * indicates no plugging fund.*

State or Province	Year established	Last modified	Prioritization for plugging?	Emergency use for non-orphan wells?	Annual spending target?	Covers restoration?	Salvage recovered?
Texas	1984	2013	Y	Y	N	Y	Y

Railroad Commission map data:

https://rrc.texas.gov/resource-center/research/gis-viewer/




Visibility
Legend
Go To:
447 THROCKMORTON
Print
Identify Wells
Find well api or address
Wells
Highlight:
Well Logs
EOR H13 Oil Wells
High Cost Tight Gas
High Cost Deep Gas
Commercial Disposal
Injection/Disposal
Orphan Wells
Pipelines
Original Texas Land Surveys
LPG/CNG/LNG Sites
Operator Cleanup Program Sites
Voluntary Cleanup Program Sites
Brownfield Response Program Sites
Commercial Waste Disposal Sites
Discharge Permits
7.5 Minute Quadrangles
Water
Offshore & Bay Tracts
Railroads
City Limits
District Offices
Oil/Gas Districts
AED Districts
Pipeline Safety Regions
Restricted Drilling Alert Areas
User Graphics
GIS Identify Results - Well Location Attributes
Number of identify results: 3
Print
Result #1
API 24532360
GIS WELL NUMBER 1
GIS SYMBOL DESCRIPTION Plugged Gas Well
GIS LOCATION SOURCE Operator reported location - Distances and Plat
GIS LAT (NAD27) 29.816537
GIS LONG (NAD27) -94.337562
GIS LAT (NAD83) 29.816758
GIS LONG (NAD83) -94.337749
Well Logs
Drilling Permits
Disposal Permits
OPERATOR/WELLBORE
WELLBORE STATUS PLUG
LAST PERMIT ISSUED 604642
Winnie
Stowell
HOGGATT
HAMSHIRE
Hamshire
GRAMMIER
CARUTHERS
ELLIOTT
REEVES
BURNET
FINLEY
DENNY
HARGRAVES
KNODEL
TEXAS
RAILROAD
ORLEANS
Broadway
Main St
Avenue G
Gulfway Dr
Chambers
Jefferson
0 0.5 1mi
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, MET...
Lat: 29.816223, Long: -94.337608 (WGS 84)

Showing 3 of 3 Records (sort data by clicking on any column heading)

Visible Columns | **Load Size:** 10

	District	Field Number	Field Name	Oil Lease/Gas ID	Lease Name	API Number	Operator Name	Well Number	County Name	Copy to Public	County Number	Survey Name	Survey Section Number	Alternate Survey Name	Abstract Number	Block	File Type	O/G/D Code	Top Log Interval	Bottom Total Depth	Document Date	Image Size	Scan Date
Actions	03	38644625	HAMSHIRE W MARGINULIN A 8700	206593	CASSINI	24532360	NOBLE ENERGY INC	210902	JEFFERSON		245	LOPEZ L			37			G	9466	10404	08/29/2004	14.7 MB	02/12/2008
Actions	03	02818430	ANGELINA 10700	205437	CASSINI	24532360	NOBLE ENERGY INC		JEFFERSON		245	LOPEZ L			37			G	9466	10404	08/29/2004	14.7 MB	02/12/2008
Actions	03	86429589	STOWELL SULLIVAN -C-	210902	CASSINI	24532360	NOBLE ENERGY INC		JEFFERSON		245	LOPEZ L			37			G	9466	10404	08/29/2004	14.7 MB	02/12/2008

View Record

Download Well Log

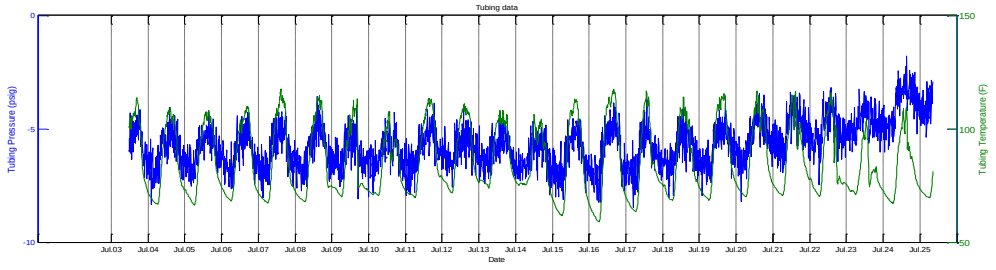
[close]

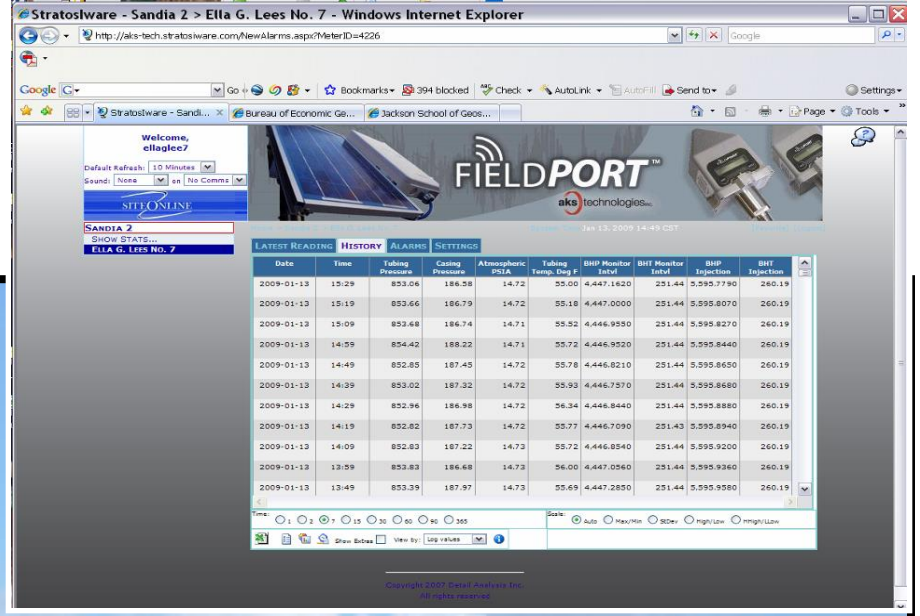
Prev 1 Next

Land Ownership Aspects

- CCS is very different than agricultural carbon programs; different agreements.
- The SURFACE OWNER is the owner of the subsurface pore space, and therefor CO_2 storage rights.
  - The Texas Supreme Court has held that reservoir, or pore space ownership rests in the surface owner as a matter of law Lightning Oil Company v. Anadarko E&P Onshore, LLC, 520 S.W.3d 39 (Tex. 2017)
- The MINERAL OWNER owns the minerals in the pore space.
  - Severed estates?
- CCS projects are large: include pressure and CO_2 extent.
  - Class VI wells are preceded by Class V Characterization wells.
  - All permitting is through either EPA or State Agency (RRC for TX expected) under the Safe Water Drinking Act.
    - Main objective is protection of Underground Sources of Drinking Water (10,000 TDS)
    - Area of Review is based on extent of pressure that can impact lowermost USDW.

What could this look like on my property?

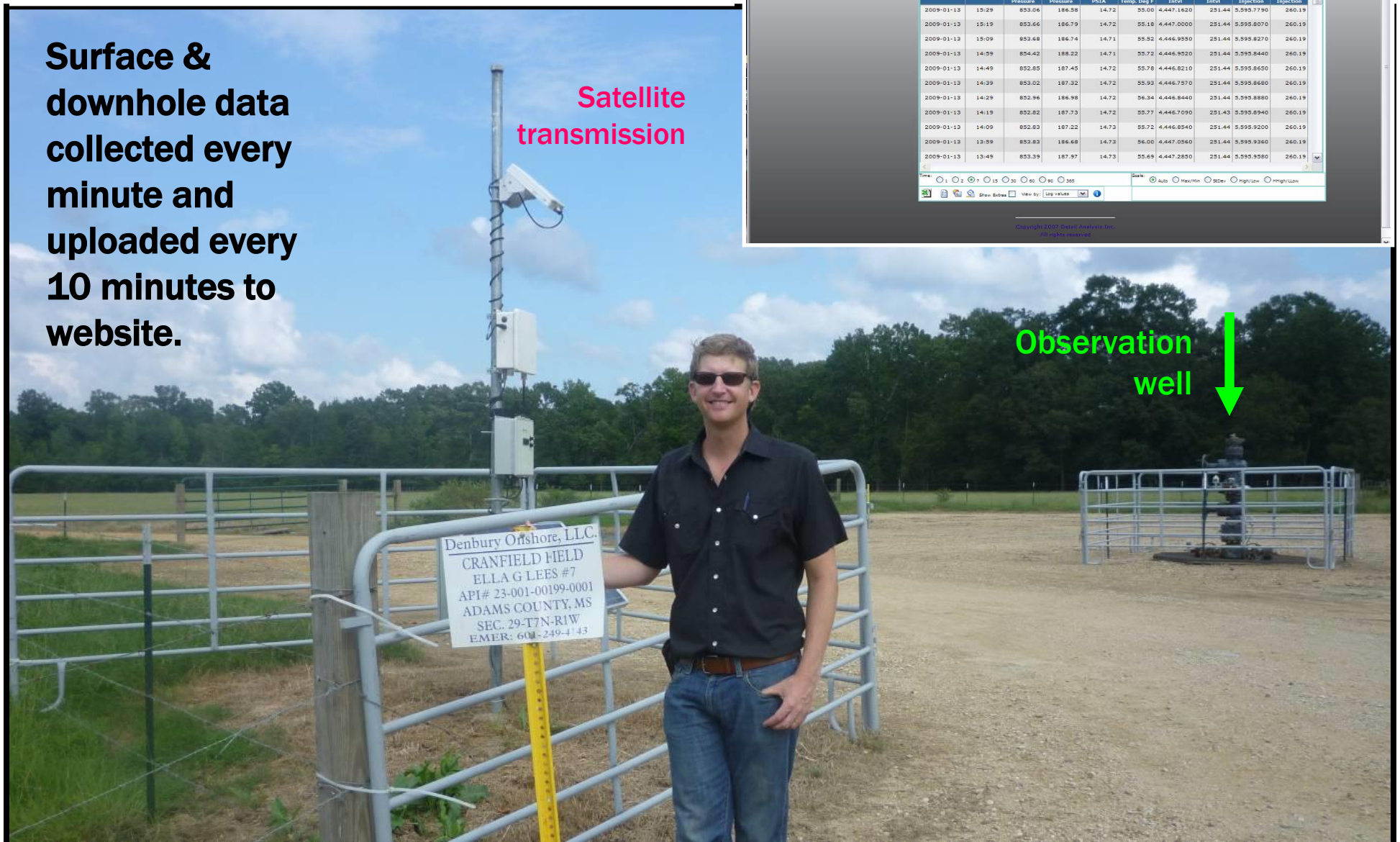




Surface & downhole data collected every minute and uploaded every 10 minutes to website.

Satellite transmission

Observation well



Wireline Well Logging

Texas

Texas is home to the energy capital of America, hundreds of large industrial emissions sources ripe for carbon-capture retrofitting, and easy access to numerous geologic formations capable of permanently storing large amounts of CO_2 safely. Moreover, Texas has the highest concentration of energy companies with institutional knowledge and experience relating to carbon capture, including with respect to projects that require capturing carbon, drilling injection wells, and deploying carbon-capture technology at scale. To capitalize on the state's head start and geographic advantages, the Texas Legislature has passed comprehensive carbon-capture legislation and taken several steps to obtain Class VI primacy from the EPA.

Issue	Description	Authority
Regulatory Authority	The Texas Railroad Commission has jurisdiction and authority to enforce laws relating to the injection and geologic storage of CO_2.	Tex. Admin. Code §5.201 *et seq.*; Texas Water Code §27.047; Tex. Health & Safety Code §382.506
CO_2 Ownership and Liability (Onshore)	Unless otherwise provided by contract or other legally binding document, or by other law, CO_2 stored in a geologic storage facility is considered the property of the storage operator. It is not considered the property of the owner of the surface or mineral estate.	Tex. Nat. Res. Code §121.002
Pore Space Ownership	Unclear due to conflicting case law.	
Class VI Primacy	Not granted. The EPA is the primary enforcement authority. The Texas Railroad Commission has been granted authority to seek Class VI primacy.	Tex. Water Code §27.048
Mineral Rights Primacy	A permit for injection and geologic storage may be issued only if it is shown that the injection and geologic storage of CO_2 will not endanger any oil, gas or other mineral formation.	Tex. Water Code §27.051
Storage Fund	The Anthropogenic Carbon Dioxide Storage Trust Fund is a special fund created to cover long-term monitoring and remediation of CO_2 injection and storage sites. The fund consists of application fees ($50,000/application), an annual fee ($50,000/yr), and an injection fee ($.025/ton of CO_2). The fund is statutorily capped at $5 mllion.	Tex. Nat. Res. Code §121.003; Tex. Admin. Code §5.205
EOR	Requirements and regulations relating to injection of CO_2 for the purpose of EOR are distinct from requirements and regulations relating to injection of CO_2 for other purposes.	Tex. Admin. Code §5.301
Permits	An operator may transfer its geologic storage facility permit to another party if specific requirements are met.	Tex. Admin. Code §5.202(c)
Offshore	The commissioner of the land office shall contract with the University of Texas Bureau of Economic Geology to identify potential locations for offshore CO_2 repositories. The School Land Board will make the final determination on suitable location, contract for creation of suitable infrastructure, issue fees, and set rules for monitoring and verification. The School Land Board will acquire title to CO_2 stored in CO_2 repositories on a determination by the board that permanent storage has been verified and that the storage location has met all applicable state and federal requirements for closure of CO_2 storage sites. On the day the permanent school fund acquires the right, title and interest in CO_2, the producer of the CO_2 is relieved of liability.	Tex. Health & Safety Code §382.503-506 Tex. Health & Safety Code §382.507

Notable Legislation: H.B. No. 1796 (2009); S.B. No. 1387 (2009); H.B. No. 1284 (2021)

Louisiana

Louisiana has a long history of carbon-capture operations for enhanced oil recovery operations. As a result, the state has developed one of the most extensive networks of pipeline infrastructure in the country to meet carbon transportation needs. Louisiana is also home to numerous coal and gas power plants, gas processing facilities, petroleum refineries, chemical plants, and other industrial facilities that may be prime candidates for carbon retrofit based on emissions and estimated capture cost. To capitalize on these conditions, the Louisiana Legislature passed the Louisiana Geologic Sequestration of Carbon Dioxide Act to govern future deployment of CCUS throughout the state.

Issue	Description	Authority
Regulatory Authority	The commissioner of conservation is granted jurisdiction and authority to enforce laws relating to the geologic storage of CO_2 and subsequent withdrawal of stored CO_2. Approval of a storage facility by the commissioner requires notice and public hearing.	LSA-R.S. 30:1102-1111
CO_2 Ownership and Liability	A certificate of completion may not be issued until at least 10 years after CO_2 injections end. Upon issuance of the certificate, the storage operator, all generators of any injected CO_2, all owners of CO_2 stored in the storage facility, and all owners otherwise having any interest in the storage facility, shall be released from any and all duties, obligations, or liability.	LSA-R.S. 30:1109(A)(1)
Pore Space Ownership	Ownership of the pore space is presumed to be vested in the surface estate owner(s).	Common Law
Class VI Primacy	Not granted. The EPA is the primary enforcement authority. Once primacy is granted, the state regulations that will govern Class VI wells can be found in Statewide Order No. 29-N-6.	
Storage Fund	The Carbon Dioxide Geologic Storage Fund has been established to fund operational and long-term inspecting, testing, and monitoring of CCUS sites as well as remediation, plugging and abandoning, repairs, and general administration. The fund shall consist of fees, penalties, and bond forfeitures collected in connection with permitting, private contributions, the contents of site-specific trust accounts (to be used only for each respective site) and fees levied by the commissioner on storage operators. The amount of such fees is determined according to a formula (F x 144 <M) that establishes the fee per ton of CO_2 over the course of at least 144 months, not to exceed $5 million.	LSA-R.S. 30:1110
EOR	Use of CO_2 for enhanced hydrocarbon recovery requires the creation of a unit by the commissioner of conservation for the purpose of secondary or tertiary recovery. A hearing is required before permission is granted.	LSA-R.S. 30:5(C).
Eminent Domain	Storage operators and owners that obtain a certificate of public convenience and necessity from the commissioner may exercise the power of eminent domain over property to acquire surface and subsurface rights and property interests necessary for the purpose of constructing, operating, or modifying a storage facility. A certificate of public convenience and necessity may be issued only after a public hearing.	LSA-R.S. 30:1108 LSA-R.S. 30:1107

Notable Legislation: H.B. 661 (2009); H.B. 1220 (2008)

Long-term Liability

State	Minimum Number of Years Before Transfer of Liability	Statute
Montana	50[11]	Mont. Code Ann. §82-11-183(3)(f)
Wyoming	20	Wyo. Stat. Ann. §35-11-319(b)
North Dakota	10	N.D. Cent. Code §38-22-17(4)
West Virginia	10	W. Va. Code §22-11B-12
Louisiana	10	La. Stat. Ann. §30:1109
California	100	Ca. Pub. Res. Code §71464
Utah	10	Utah Code §40-11-16

Texas provides for the state to assume liability for the period after well closure, but **only with regard to offshore storage sites**. The Texas School Land Board takes title and liability relating to the CO_2 in the storage facility once permanent storage is verified and applicable regulations are complied with. Tex. Health & Safety Code § 382.508 (2009);

TEXAS RESPONSIBILITY FOR LONG-TERM STORAGE OF CARBON DIOXIDE.

- Sec. 124.003. APPLICATION FOR TRANSFER OF TITLE AND CUSTODY TO THE STATE – Certificate of Closure. State has 60 days to respond or approve.
- APPROVAL Conditions:
  - Waiting period of at least 10 years after receiving certificate.
    - Commission may require less than a ten-year waiting period under Subsection (b)(1)
  - Operator in full compliance (Section 27.047(1) (I)
  - Stored carbon dioxide and geologic storage facility are stable and not expected to endanger USDW;
  - Fee - Section 124.005 – additional per-ton fee into Trust Fund for addressing Section 124.003(d)(8)
    - Amount that is commensurate with obligation reasonably expected to be incurred by the state.
- All responsibility and potential liability associated with stored CO2 and the geologic storage facility is transferred to the state.
- Release from regulatory requirements and liability.
- Release of any remaining performance bond or other financial security.
- State shall assume responsibility to monitor until federal government assumes responsibility.

TEXAS INTEGRATION OF PORE SPACE FOR DEVELOPMENT OF A GEOLOGIC STORAGE FACILITY

- Protect correlative rights, conserve natural resources, enforce compliance with state and federal law to facilitate and optimize energy resources, including pore space for sequestration.
- Pore space owner may integrate its interests
- Owners who do not agree to integrate – storage operator or pore space owner can file an application with Commission requesting an order for the integration
  - Hearing within 60 days
  - will not endanger or injure any oil, gas, or other mineral formation in any material respect (or has been addressed in arrangement)
  - 60% owner agreement or consent; fair and reasonable offer; equitably compensated for the appurtenant and reasonable use of the pore space and surface.
- Surface estate is owner of pore space; Existing relationships between surface and mineral estate unchanged.

Representative Drew Darby:
House Committee on Energy Resources
Vice-Chair of The Energy Council

State	Texas
Class II State Primacy	Texas's Class II well program obtained primacy in 1982 and is administered by the Texas Railroad Commission. 47 Fed. Reg. 17488 (1982)
Class VI State Primacy	Recently-passed HB 1284 gave the Texas Railroad Commission sole jurisdiction over carbon sequestration wells and required the Railroad Commission to seek primacy. Texas is preparing its application while actively consulting with the EPA. Tex. H.B. 1284 (2022)
Pore Space Ownership	The Texas Supreme Court has held that reservoir, or pore space ownership rests in the surface owner as a matter of law Lightning Oil Company v. Anadarko E&P Onshore, LLC, 520 S.W.3d 39 (Tex. 2017)
Pore Space Unitization	The RRC is tasked with regulating geologic storage of anthropogenic CO_2, to the extent that Texas has jurisdiction over such injection and storage. 16 Tex. Admin. Code § 5.101, et seq.
State Lands Available	No applicable law or regulations were located.
Ownership Of Injected CO_2	Texas provides for the state to assume liability for the period after well closure, but only with regard to offshore storage sites. The Texas School Land Board takes title and liability relating to the CO_2 in the storage facility once permanent storage is verified and applicable regulations are complied with. Tex. Health & Safety Code § 382.508 (2009);
Liability For Carbon Storage	On the date the Texas School Board acquires the right, title, and interest in stored CO_2, the producer of the carbon dioxide is relieved of liability for any act or omission regarding the carbon dioxide in the carbon dioxide repository. However, the producer remains liable for any act or omission regarding the generation of stored carbon dioxide performed before the carbon dioxide was stored. TEX. HEALTH & SAFETY CODE § 382.508 (2009)
Subsurface Trespass	Both surface and mineral owners or lessees may bring subsurface trespass claims. A subsurface trespass claim requires a demonstration of actual injury; simple drainage of oil and gas from fracturing does not constitute actionable injury. Regency Field Servs., LLC v. Swift Energy Operating, LLC, 622 S.W.3d 807, 820 (Tex. 2021); Coastal Oil & Gas Corp. v. Garza Energy Tr., 268 S.W.3d 1 (Tex. 2008); Lightning Oil Co. v. Anadarko E&P Onshore, LLC, 520 S.W.3d 39 (Tex. 2017).
Injected Volume Certification	The Texas Railroad Commission requires a semi-annual report containing the volume injected into a class II well. 16 Tex. Admin. Code § 5.207(a)(2) (2022).
Administrative Agency	The Texas Railroad Commission oversees **intrastate CO_2 pipeline siting**. 16 Tex. Admin. Code § 8.1 (2020).
Eminent Domain	Texas **authorizes the use of eminent domain powers for common carrier pipeline operators** to "enter on and condemn the land, rights-of-way, easements, and property of any person or corporation necessary for the construction, maintenance, or operation of the common carrier pipeline." TEX. NAT. RES. CODE ANN. § 111.002(6) (2019).
Stakeholder Engagement	Texas Pipeline Awareness performs education, outreach, and safety services regarding pipelines in general for the affected public and other stakeholders. 49 CFR 192.616; 49 CFR 195.440

Great Plains Institute State Legislative Tracker:

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LOUISIANA
CURRENT BILLS & STATUS (06/12/2024)

BILL NAME	STATUS
HB 73: Authorize parish tax levy	Original text, First reading 03/11
HB 169: Limits payment for non-economic damages	Signed 06/03 by the Governor. Becomes Act No. 415
HB 276: Compliance with local land use & zoning	Original text, first reading 03/11
HB 280: Prohibits structures above Lakes Maurepas	Original text, First reading 03/11
HB 389: Moratorium below lakes Maurepaus etc.	Original text, First reading 03/11
HB 492: Eminent domain provisions	Sent to the Governor for executive approval 06/04
HB 516: Additional Requirements for CCS projects	Sent to the Governor for executive approval 06/04
HB 696: Authorizes CCS unitization	Becomes HB 966; Sent to the Governor for executive approval 06/04
HB 729: Repeals expropriation/eminent domain	Original text, First reading 03/12

LA HB 492: Eminent domain provisions

- Property located in Louisiana may be **expropriated for the transportation** of carbon dioxide for underground injection in connection with such projects located in Louisiana or in other states or jurisdictions (provisions in R.S. 30:1107(A))
  - Including but not limited to **surface and subsurface rights**, **mineral rights**, and **other property interests** necessary or useful for the purpose of constructing, operating, or modifying a carbon dioxide storage facility
    - R.S. 30:1108(B)(2) must be applicable
- 'certificate of public convenience and necessity'
  - commissioner shall issue a certificate of public convenience and necessity or a certificate of completion of injection operations
- No forced 'common carrier' or 'public utility' status.

LA HB 492: Eminent domain provisions

- The exercise of eminent domain or expropriation powers under this Section shall **not allow for the expropriation of reservoir storage rights for geologic storage**.
  - Except if R.S. 30:1108(B)(2) is applicable: Caldwell Parish.
    - The exercise of the right of eminent domain granted in this Section **may prohibit** persons having the right to do so from **drilling through the storage facility** located in **Caldwell Parish** only when the following requirements are satisfied…
- The exercise of the right of **eminent domain** granted in this Chapter **shall not prevent** persons having the right to do so from **drilling through the storage facility** in such manner as shall comply with the rules of the commissioner issued for the purpose of protecting the storage facility against pollution or invasion and against the escape or migration of carbon dioxide.

LA HB 696: Authorizes CCS unitization

- The **Commissioner** upon the application of a proposed storage operator is authorized and empowered to enter an **order requiring the unit operation of a reservoir or portion thereof** for geologic storage.
  - The commissioner shall have the **right to unitize, pool, and consolidate all separately owned tracts and other property interests** within the portion of the proposed reservoir sought to be used for storage.
  - Proposed storage reservoir meets the requirements of R.S. 4 30:1104© - CoC
- At the time of the hearing, **at least three-fourths of the owners** of the total undivided interest in the storage unit *regardless of the number of individual owners* thereof and not based on three-fourths of the total number of individual owners in the storage unit.
  - Fair and equitable compensation to any owner with an interest (methodology)

State	Louisiana
Class II State Primacy	Louisiana's Class II well program obtained primacy in 1982 and is administered by the Louisiana Office of Conservation. 47 Fed. Reg. 17487 (1982)
Class VI State Primacy	Louisiana submitted its application for Class VI primacy in 2021. It remains under review by EPA as of December 2022. No applicable law or regulations were located.
Pore Space Ownership	Louisiana case law appears to follow the proposition that the surface owner also owns title to the subsurface (see, e.g., Boudreaux v. Jefferson Island Storage & Hub, 255 F.3d 271 (5th Cir. 2001); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955 (La. 1986); Gliptis v. Fifteen Oil Co., 204 La. 896, 904 (1944)), though the extent of this right may be unsettled. See Hall. Boudreaux v. Jefferson Island Storage & Hub, 255 F.3d 271 (5th Cir. 2001); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955 (La. 1986); Gliptis v. Fifteen Oil Co., 204 La. 896, 904 (1944); Keith B. Hall, Hydraulic Fracturing: If Fractures Cross Property Lines, Is There an Actionable Subsurface Trespass, 54 Nat. Resources J. 361 (2014).
Pore Space Unitization	No applicable law or regulations were located.
State Lands Available	No applicable law or regulations were located.
Ownership Of Injected CO_2	Upon the issuance of the certificate of completion of injection operations (by default within ten years after the cessation of storage injection operations), ownership to the remaining project, including the stored carbon dioxide, transfers to the state. La. Stat. Ann. § 30:1109
Liability For Carbon Storage	Upon the issuance of the certificate of completion of injection operations (by default within ten years after the cessation of storage injection operations), Louisiana law releases the storage operator, all generators of any injected carbon dioxide, all owners of carbon dioxide stored in the storage facility, and all owners otherwise having any interest in the storage facility from any and all duties or obligations under the Louisiana Geologic Sequestration of Carbon Dioxide Act and any and all liability associated with or related to that storage facility which arises after the issuance of the certificate of completion of injection operations. La. Rev. Stat. § 30:1109.
Subsurface Trespass	No statutes in Louisiana create a cause of action for subsurface trespass, but Louisiana case law on trespass generally recognizes the landowner's ownership of the subsurface and the Louisiana Supreme Court has considered subsurface trespass actions on several occations. For example, in Gliptis v. Fifteen Oil Co., the Court found that a defendant's drilling operations had constituted a subsurface trespass, stating that certain drilling deviations may result in subsurface trespass whether or not "the deviation is normal or whether it is brought about by intentional controlled directional drilling." But see, e.g., Boudreaux v. Jefferson Island Storage & Hub, 255 F.3d 271 (5th Cir. 2001) (dismissing alleged trespass due to inability to show damages, but seeming to acknowledge landowner's rights in pore space beneath the surface); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955 (La. 1986) (holding that the existence of a compulsory drilling unit altered the rules for subsurface trespass, but generally adhering to the proposition that a landowner owns the subsurface below his land) Gliptis v. Fifteen Oil Co., 204 La. 896, 904 (1944); Boudreaux v. Jefferson Island Storage & Hub, 255 F.3d 271 (5th Cir. 2001); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955 (La. 1986).
Injected Volume Certification	Class II well operators are required to file monthly reports on injected volumes with the Department of Natural Resources. Under the Louisiana Geologic Sequestration of Carbon Dioxide Act and as described in Louisiana's application for Class VI primacy, Class VI well reporting and monitoring duties will be allocated to the Office of Conservation, which will require operators to 1) submit monthly injected volume reports and 2) implement continuous recording devices to monitor injection volumes. Upon any conveyance of a Class VI well, each owner or operator must include a notation on the deed indicating the volume of fluid injected, the injection zone or zones into which it was injected, and the period over which injection occurred. La. Rev. Stat. § 30:1104; Class VI Primacy Application
Administrative Agency	The Commissioner of Conservation regulates the development and operation of storage facilities and pipelines transmitting carbon dioxide to storage facilities. Yet, the Office of Conservation website currently provides hat the Louisiana Public Service Commission oversees all aspects of pipeline siting generally. La. Rev. Stat. Ann. § 30:1104.
Eminent Domain	The Louisiana Geologic Sequestration of Carbon Dioxide Act sets forth eminent domain laws for operation and transportation of CO_2 to storage facilities. Storage operators seeking to exercise eminent domain and surface and subsurface rights must first obtain a permit and a certificate of public convenience from the Commissioner of Conservation. The operator must then (among other requirements) conduct an appraisal and offer the affected property owner(s) a specific amount not less than the value of the lowest appraisal received. Finally, the operator may initiate proceedings in the district court of the parish in which the property is situated. La. Rev. Stat. §§ 30:1108; 19:2.2; 19:2.1.
Stakeholder Engagement	The Pipeline Association of Louisiana performs education, outreach, and safety services regarding pipelines in general for the affected public and other stakeholders. 49 CFR 192.616; 49 CFR 195.440

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RESOURCES

- Gulf Coast Carbon Center: https://www.beg.utexas.edu/gccc/
- DOE-NETL CCS Newsletter: https://listserv.netl.doe.gov/scripts/wa.exe?SUBED1=SEQUESTRATION&A=1
- GCCSI: https://www.globalccsinstitute.com/
- CCUSMAP.COM
- EPA Class VI Program: https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide
- Railroad Commission map data: https://rrc.texas.gov/resource-center/research/gis-viewer/
- Great Plains Institute State Legislative Tracker: https://carboncaptureready.betterenergy.org/state-legislation/
- https://cdrlaw.org/ccus-tracker/