

# Supporting Communities and Industry for Mid-Atlantic Offshore Carbon Storage Hub Development

(DE-FE0032407)

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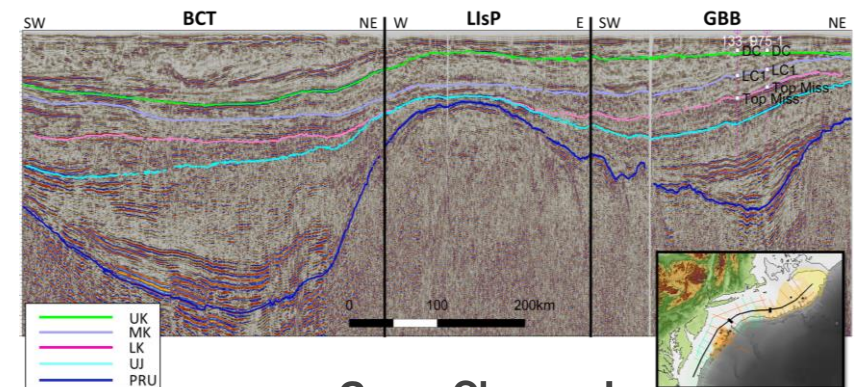
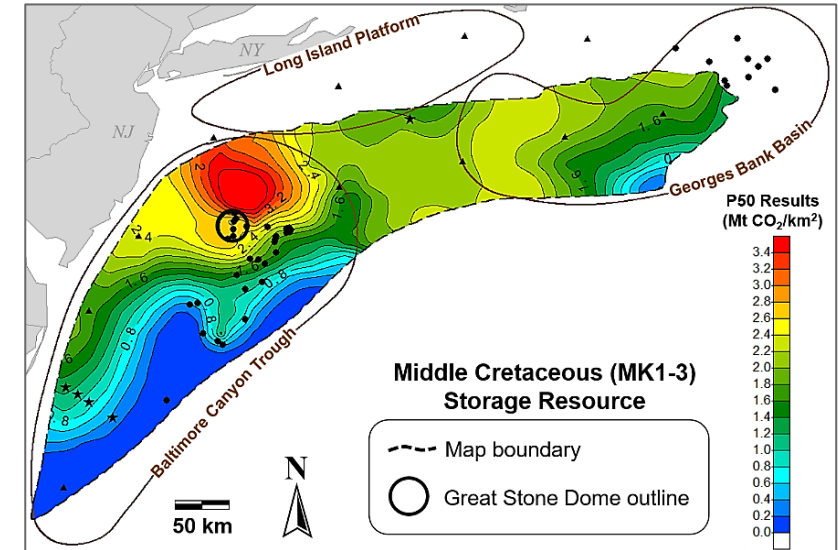
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# Background: CCS Potential Along Mid-Atlantic Outer Continental Shelf

- Very large storage resource in Mid-Atlantic Outer Continental Shelf: **150-1136 Gt**.
- **Opportunities:** large storage capacity, shallow water along OCS, large area, favorable porosity/permeability, limited development in subsurface, provides decarbonization options for eastern US communities, sustains jobs.
- **Challenges:** limits on offshore exploration, lack of infrastructure, environmental/stakeholder issues, source-sink routing.
- **Development Plan:** obtain community feedback, establish workforce/Justice 40 plans, minimize environmental impacts, exploration planning, transport feasibility for CO<sub>2</sub> sources, offshore drilling, well field, monitoring, logistics, cost-benefit risks.



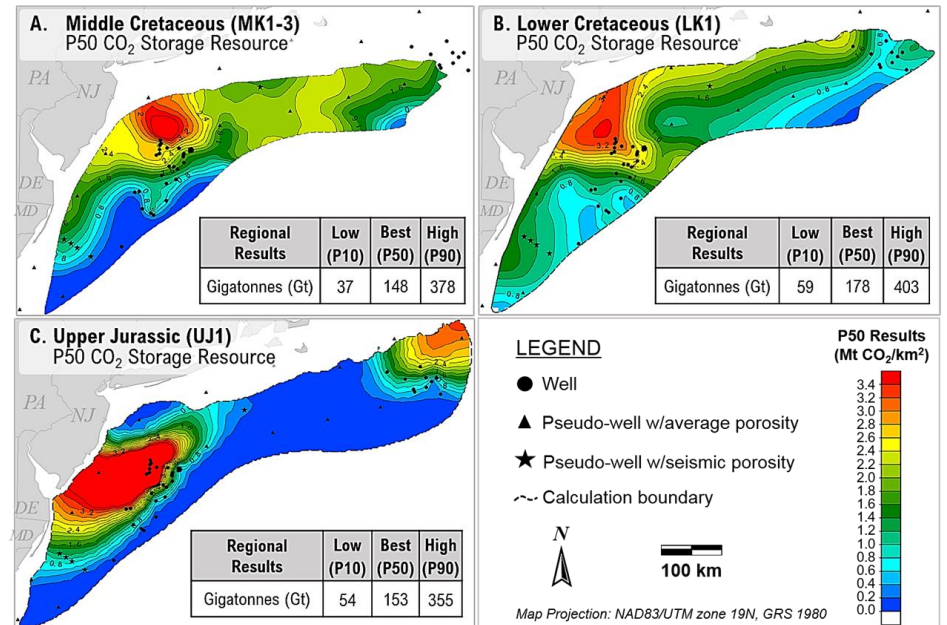
Game Changer!

# Background: Foundation for CCS Along Mid-Atlantic Outer Continental Shelf



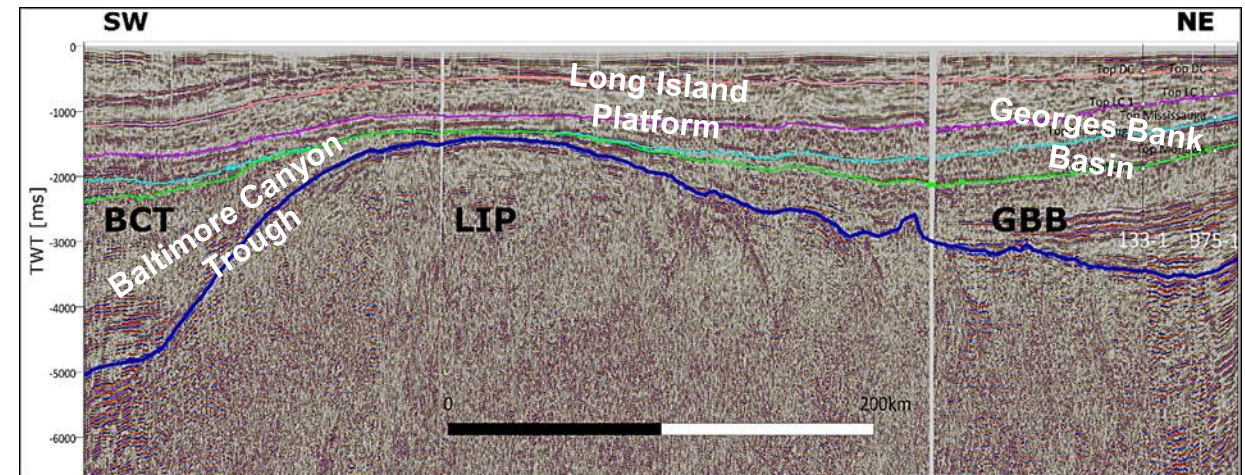
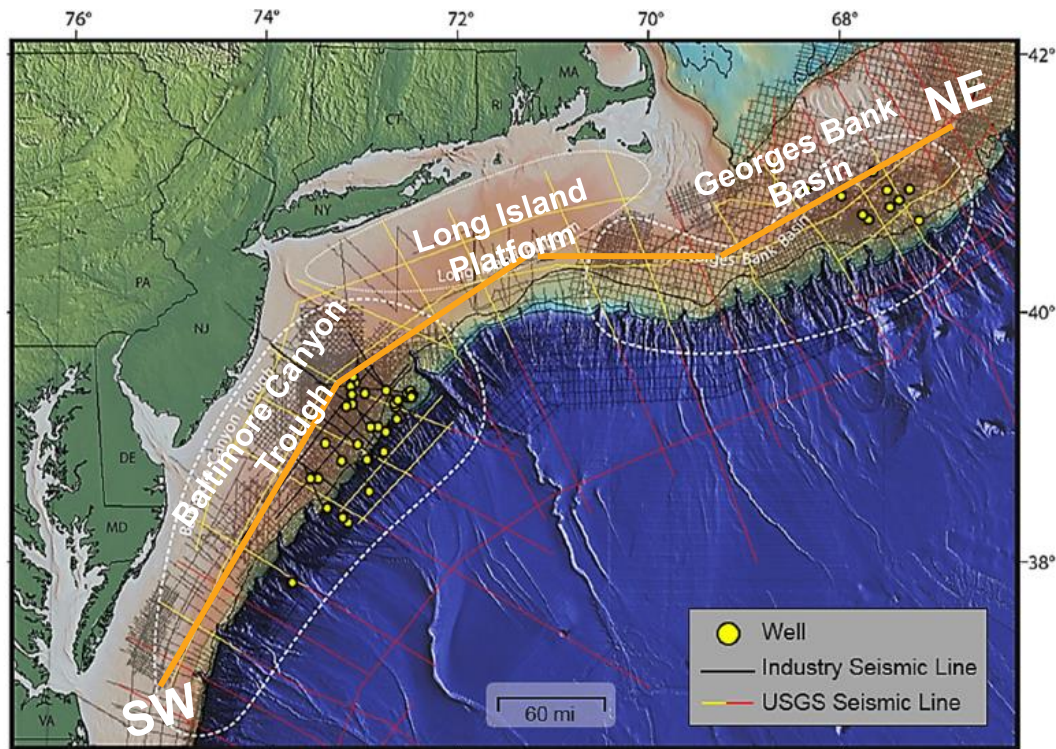
## MID-ATLANTIC U.S. OFFSHORE CARBON STORAGE RESOURCE ASSESSMENT PROJECT

- Past work completed 2015-2019 under the *Mid-Atlantic U.S. Offshore Carbon Storage Resource Assessment* (FE002385) and *Midwestern Regional Carbon Storage Initiative*.
- State geological surveys of Delaware, Maryland, and Pennsylvania; United States Geological Survey; Lamont-Doherty Earth Observatory at Columbia University; and Rutgers University. Harvard Uni., Texas BEG, and Virginia DMME serve as technical advisors.



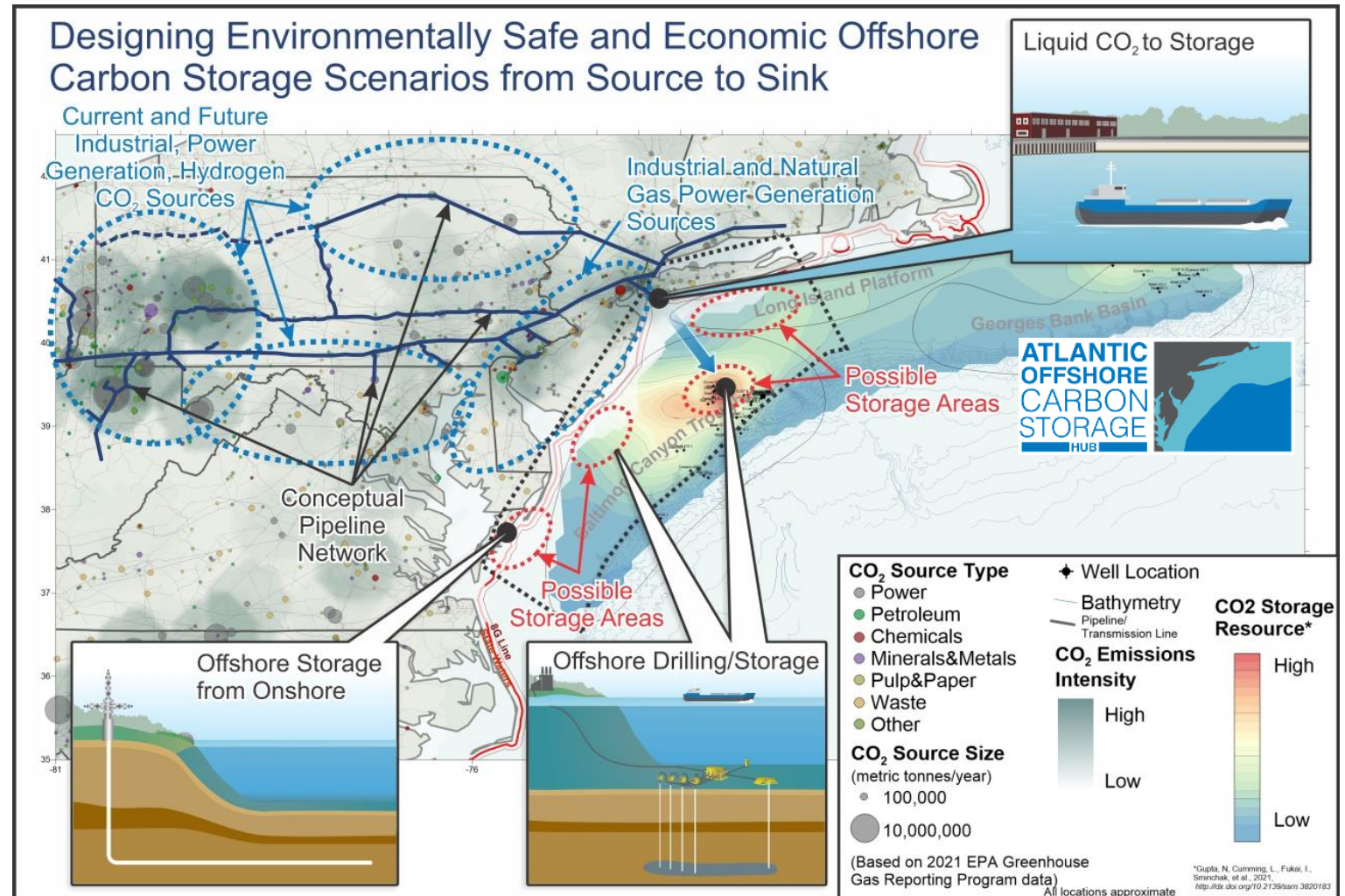
# Background

- Multiple Jurassic-Cretaceous age (66-200 MYA) sandstone rock layers 150-200 meters thick at depths of 1500-5000 meters subsea, porosity 20-30%.
- Additional storage layers possible nearshore, basalt rift basins also present.



# Background

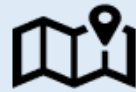
- There is a need to assess infrastructure scenarios and their feasibility.
- Policy, regulatory, safety, environmental justice, and community factors must be evaluated.
- This project will evaluate the viability of a large-scale storage hub along Atlantic offshore regions.



# Background: Supporting Communities and Industry for Mid-Atlantic Offshore Carbon Storage Hub Development



## Advancing Technology, Minimizing Risk, Supporting Growth



- **Storage Hub:** Mid-Atlantic Offshore
- **Scenario 1:** Offshore Drilling and Storage
- **Scenario 2:** Onshore Drilling to Nearshore Storage
- **Tier 1 Sources:** East Coast Cement Plants, Power Plants, and Refineries, **41 MT/yr**
- **Tier 2 Sources:** Stranded Eastern Appalachian Basin Industrial and Power Plants, Hydrogen and DAC Hub sources, **100+ MT/yr**

### Low Risks

- No seismicity
- Few well penetrations
- Experienced project team

### Support

- East Coast Universities
- Additional NGOs
- Carbon Emitters
- Offshore and Coastal Engineering and Environmental Firms
- Data Brokers



### Community Benefits

- K-12 STEM Engagement
- Community Investments and Improvements
- Education and Training
- Jobs

# Project Overview: Supporting Communities and Industry for Mid-Atlantic Offshore Carbon Storage Hub Development

**Funding:** (\$2.5M DOE, \$0.785M Cost Share)

**Performance Dates:** 2 years

**Project Team:**

***Battelle*** (Lead)

***Aker Solutions*** (offshore infrastructure)

***CarbonVert*** (CCS development)

***Columbia Lamont-Doherty Earth Observatory***

***Holcim*** (cement industry)

***Maryland Geological Survey*** (geology)

***Rutgers*** (geology, infrastructure, outreach)

***TGS*** (data sharing and analysis)

***TRC*** (pipeline, source-sink)



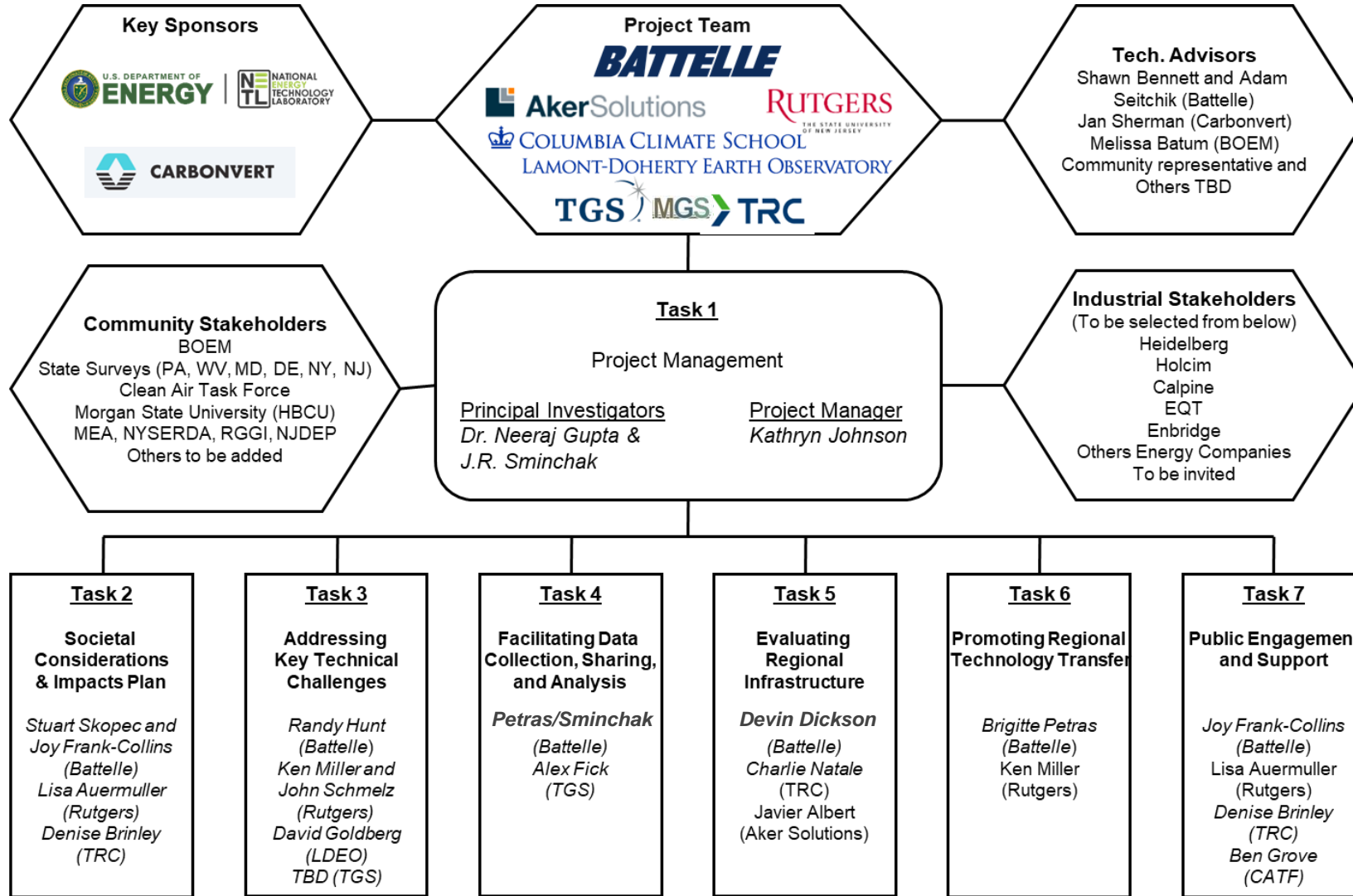


# Project Overview: Objectives



- **Facilitating Data Collection, Sharing, and Analysis**
  - Build on prior data collection and analysis (already shared with EDX and Bureau of Offshore Energy and Minerals BOEM) with additional work with industry and BOEM to establish a pathway for build-out of CCS.
- **Evaluating Regional Infrastructure**
  - Evaluate transport, source-sink matching, environmental factors along the coast, and offshore infrastructure scenarios (transport, injection systems, interaction with growing wind energy) along with policy/regulatory gaps.
- **Promoting Regional Technology Transfer**
  - Conduct workshops, outreach to key policy and regulatory stakeholders, especially State and local entities and Non-Governmental Organizations (NGOs), including BOEM/BSEE, NYSERDA, NJDEP, USGS, local communities.
- **Public Engagement and Support**
  - Conduct work on societal considerations, community benefits, evaluating concerns and mitigation strategies.
- **Linking sources and sinks**
  - connect new & existing CO<sub>2</sub> sources along the Appalachian/East Coast corridor with offshore storage resources, enabling decarbonization.
- **Community Benefits**
  - Collect community input for facility siting & construction, maximize local & DAC job creation and clean energy access.

# Technical Approach: Project Org Chart

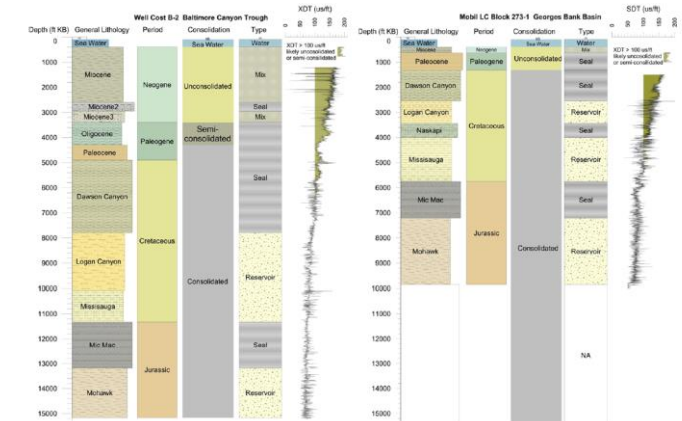
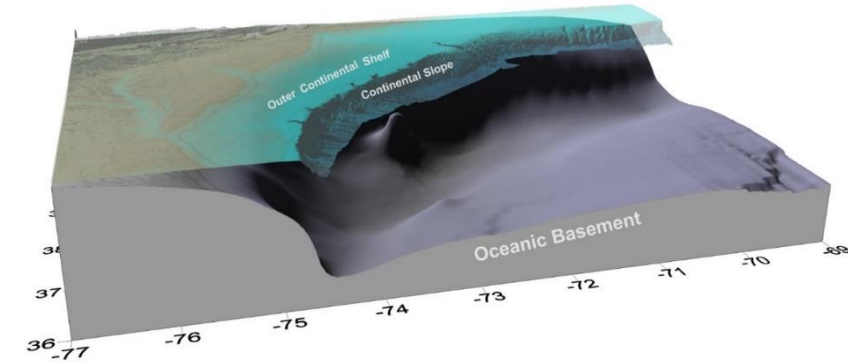


**ATLANTIC OFFSHORE CARBON STORAGE HUB**

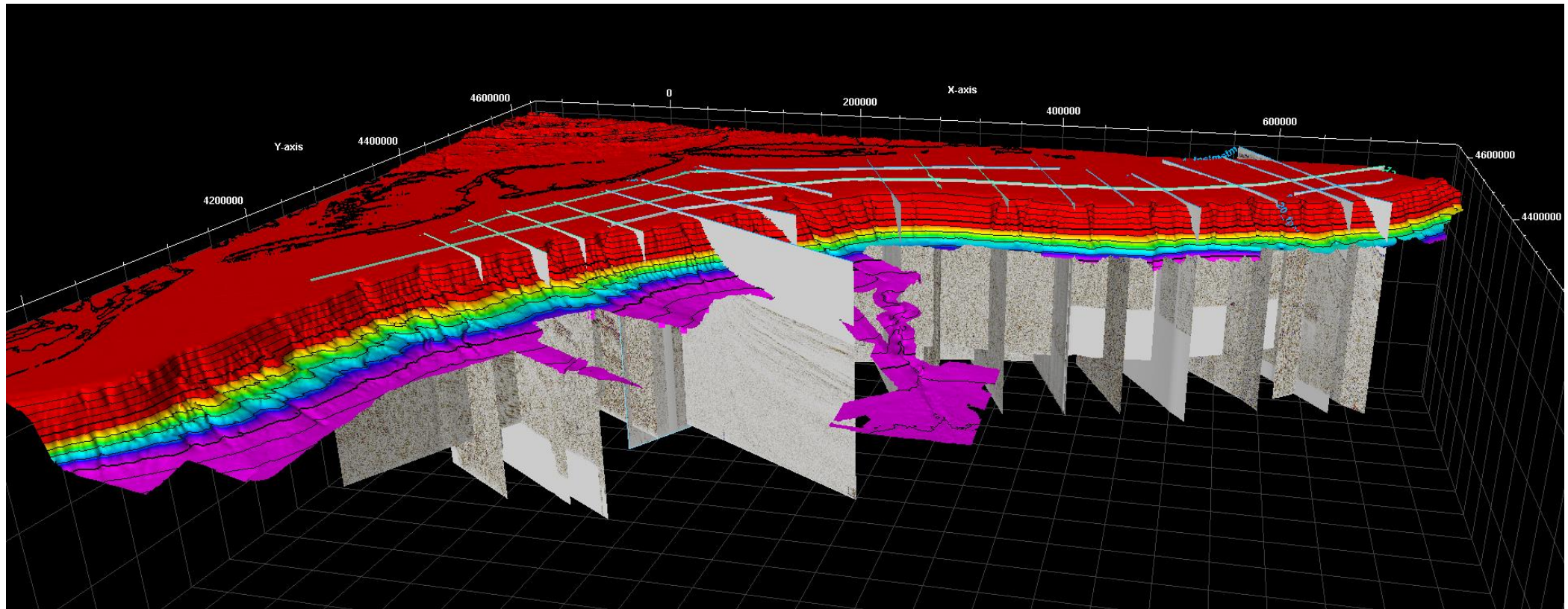


# Project Benefit to DOE Program Goals

- **Supports** DOE FECM programmatic goals to develop carbon storage hubs, address community benefits, develop skilled workforce, and support carbon capture implementation.
- **Includes** community benefits, decarbonization options for east coast industrial corridors, workforce development for CCS.
- **Provides** a realistic CO<sub>2</sub> storage hub development plan for this area that minimizes environmental impacts, benefits communities, and addresses concerns of stakeholders
- **Progresses** CO<sub>2</sub> storage from SRMS prospective storage volume to contingent storage resource.
- **Benefits** communities in areas with skilled workforce development needs, underserved communities, investments in energy transition.

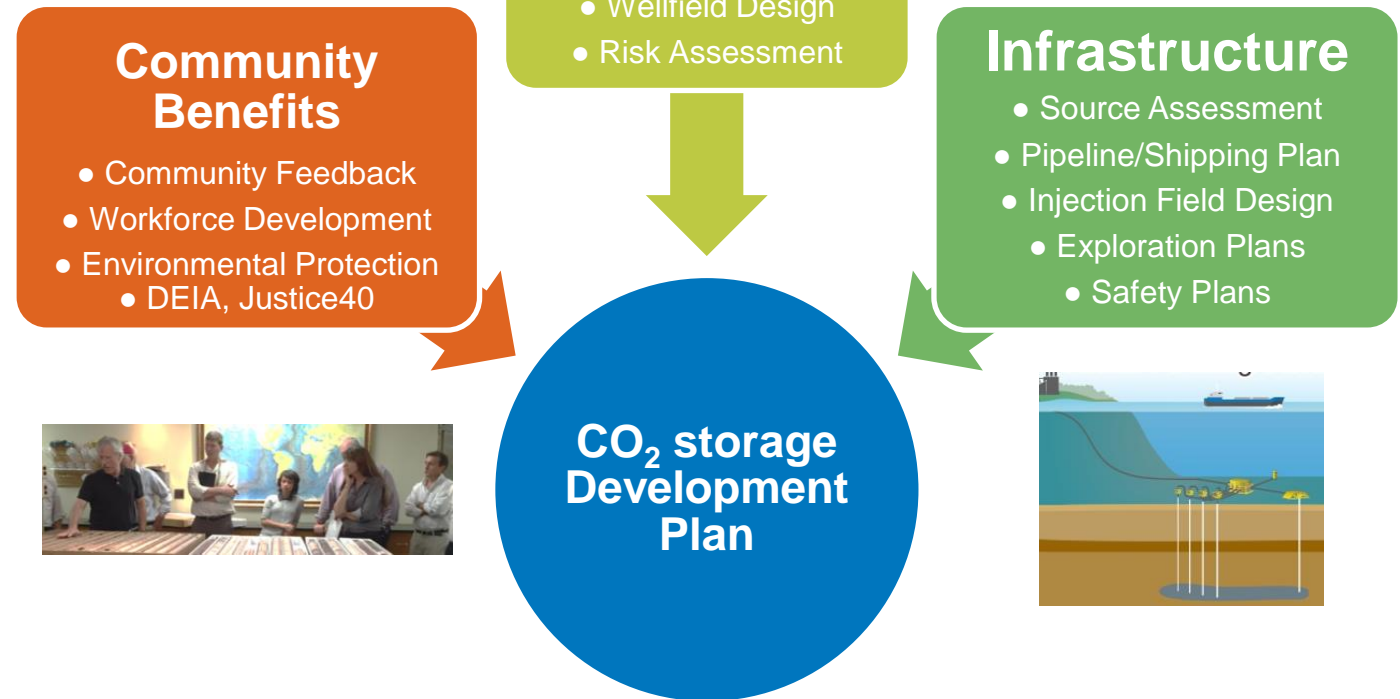
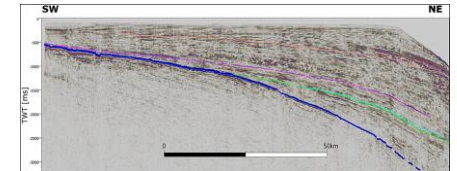
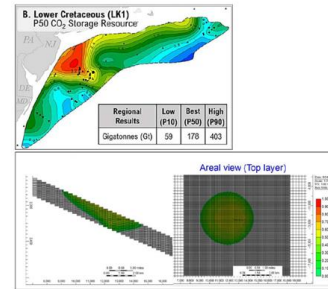


# TECHNICAL APPROACH/PROJECT SCOPE



# Project Execution Plan & Timeline

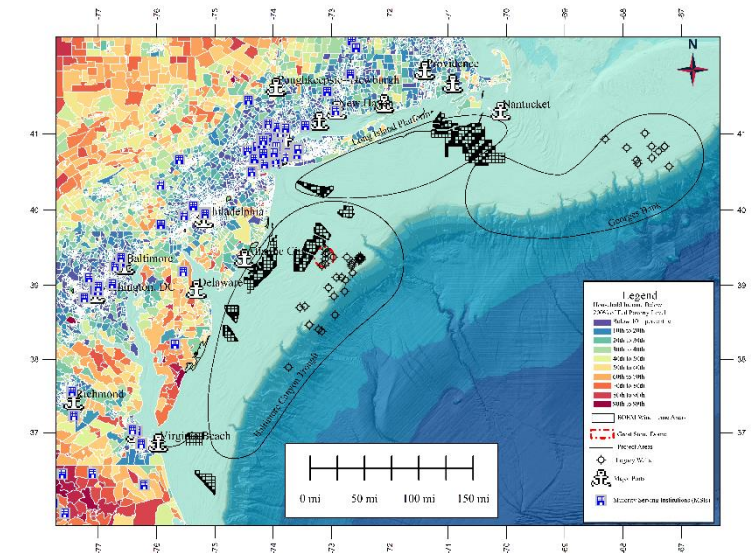
- The project plan is aimed at defining the main components necessary to develop CO<sub>2</sub> storage along Atlantic offshore region.
- Options for bringing these components together to be outlined in a CO<sub>2</sub> storage development plan.
- **Many options may be necessary for this area:** shipping CO<sub>2</sub>, subsea well completions, additional monitoring options, low-impact exploration.



# Task 2: Community Benefits Plan (CBP)

- CBP will integrate quality jobs; DEIA; and Justice40 initiatives along with community & labor engagement throughout the project development and plan for future phases.
- CBP will emphasize local community relations along with regional benefits related to advancement of offshore CCS technologies. Plans will be updated throughout the project based on community and stakeholder feedback.

FOA Objectives	Project Strategy	Project Tactics
Community Benefits Planning	<ul style="list-style-type: none"> <li>• Developing roadmap of community benefits and concerns</li> <li>• Creating a Justice40 Plan, DEIA Plan, and jobs-economic analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Implementing a DEIA plan by hosting engagements and sharing results with the local community</li> <li>• Implementing a Justice40 Plan as a preliminary assessment based on mapping and potential project benefits and disbenefits</li> <li>• Applying and maintaining a community and labor engagement plan, with outreach to HBCUs, disadvantaged communities, and unions.</li> </ul>



# Task 2: Initial Assistance & Validation (A&V) Meeting

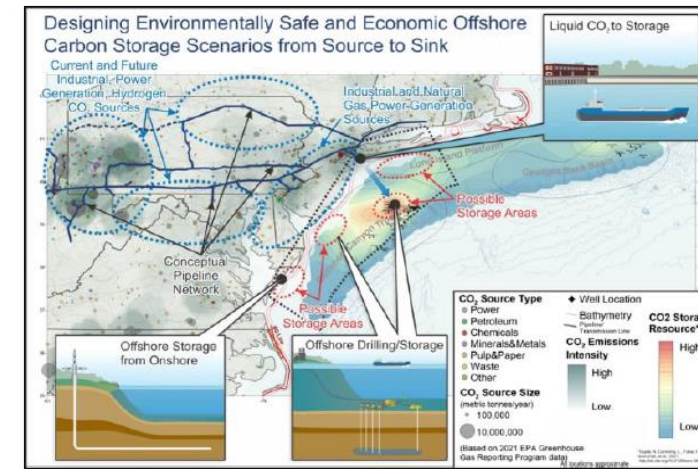
- DOE held an initial A&V meeting on May 23<sup>rd</sup>, 2024, where Battelle presented and discussed the proposed project CBP.
- The initial A&V report includes feedback from DOE and outlines 12 action items to be completed throughout the course of the project, grouped within Community & Labor Engagement, Investing in Job Quality & a Skilled Workforce, DEIA, and Justice40.

## INITIAL ASSISTANCE AND VALIDATION MEETING REPORT

### Supporting Communities and Industry for Mid-Atlantic Offshore Carbon Storage Hub Development

Recipient: Battelle Memorial Institute

Project Number: DE-FE0032407

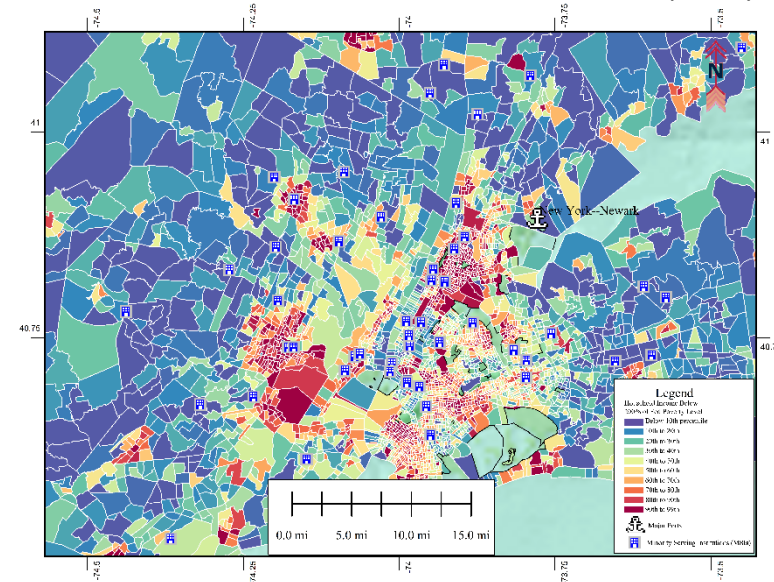


# Task 2: Community Mapping

Low-income communities in NYC/NJ area (%ile)

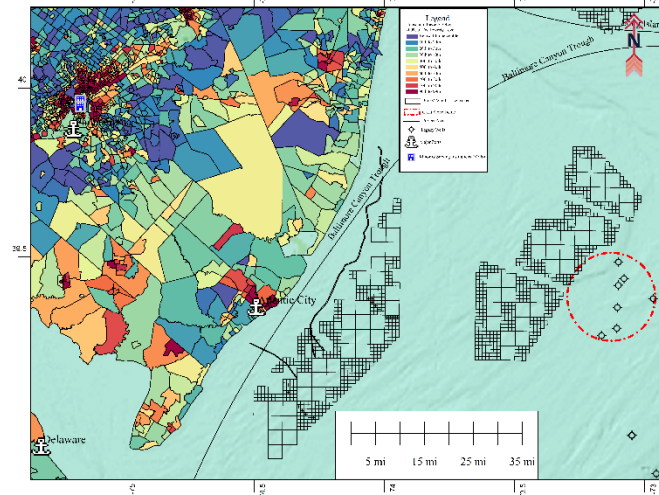


- Regional community mapping covered East Coast from Massachusetts to northern North Carolina, with more focused mapping centered on the regions around Newark, NJ, Atlantic City, NJ, Baltimore, MD, and Dover, DE.

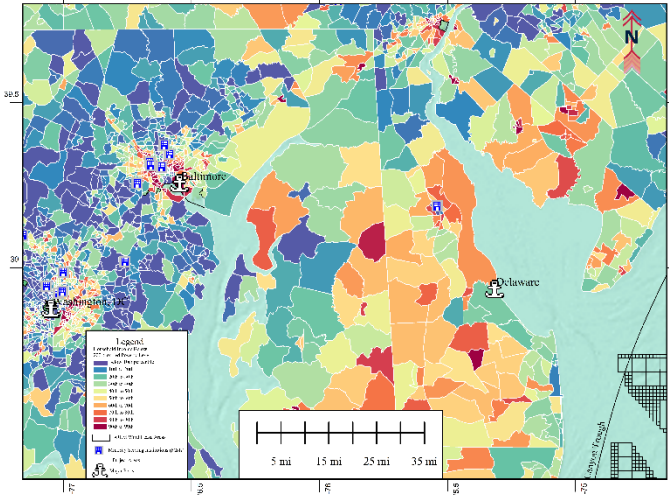


- Mapped metrics by census tract such as:
  - Percentile low-income
  - Percentile transportation burden
  - Percentile uninsured
  - Percentile without internet
  - Flood Risk

Low-income communities in Atlantic City, NJ area (percentile)



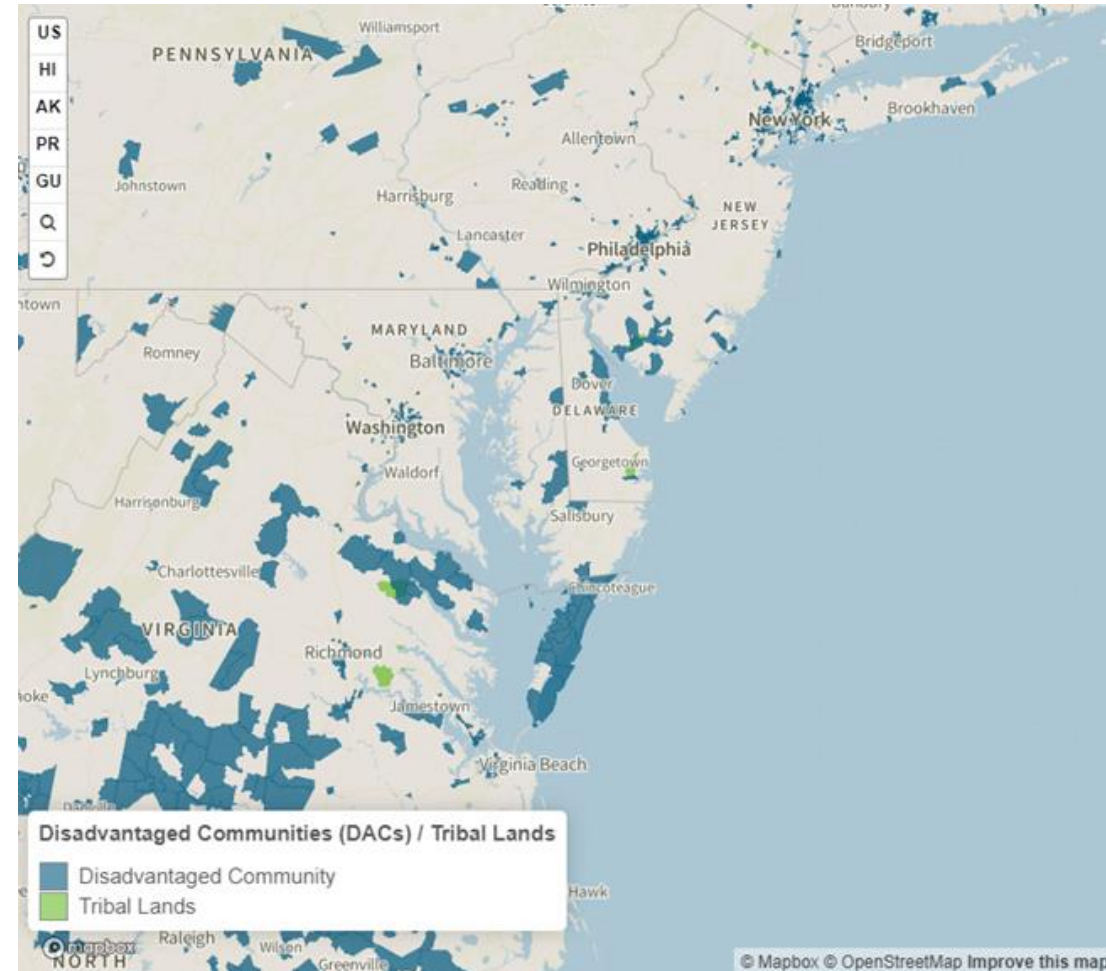
Low-income communities in Dover, DE/Baltimore, MD area (percentile)





# Task 2: Types of Communities to Engage

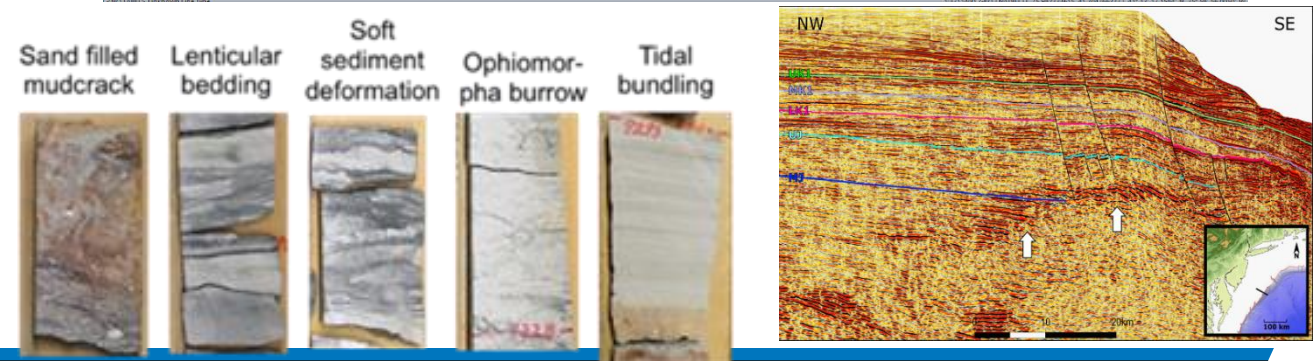
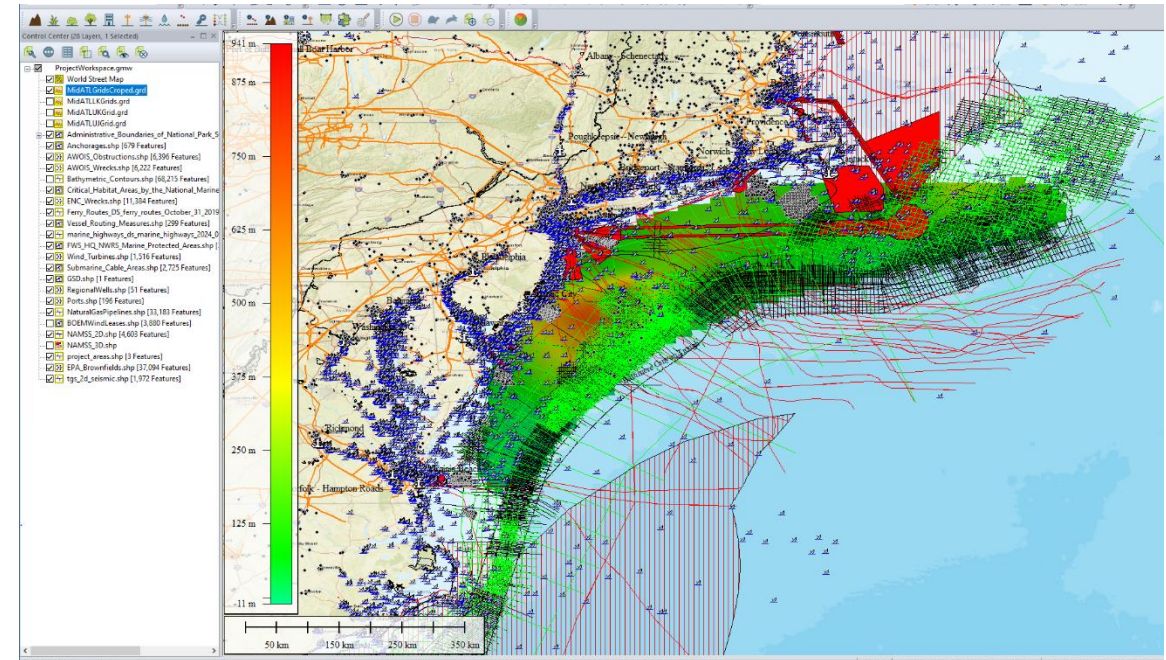
- Job creation in future project phases would largely impact port cities in areas such as Newark, NJ, Atlantic City, NJ, Dover, DE, and Baltimore, MD.
- Environmental impacts and community feelings towards a hub-scale project will be assessed – effect on existing industries such as tourism, shipping, and wind energy will also be evaluated.
- Based on project mapping efforts, communities in the study area have elevated flood risk and fall well above national averages in EJ indexes – traffic proximity, PM2.5, elevated cancer risk due to air toxics.
- Planned engagement with community leaders, job placement centers, K-12 schools, and HBCUs.



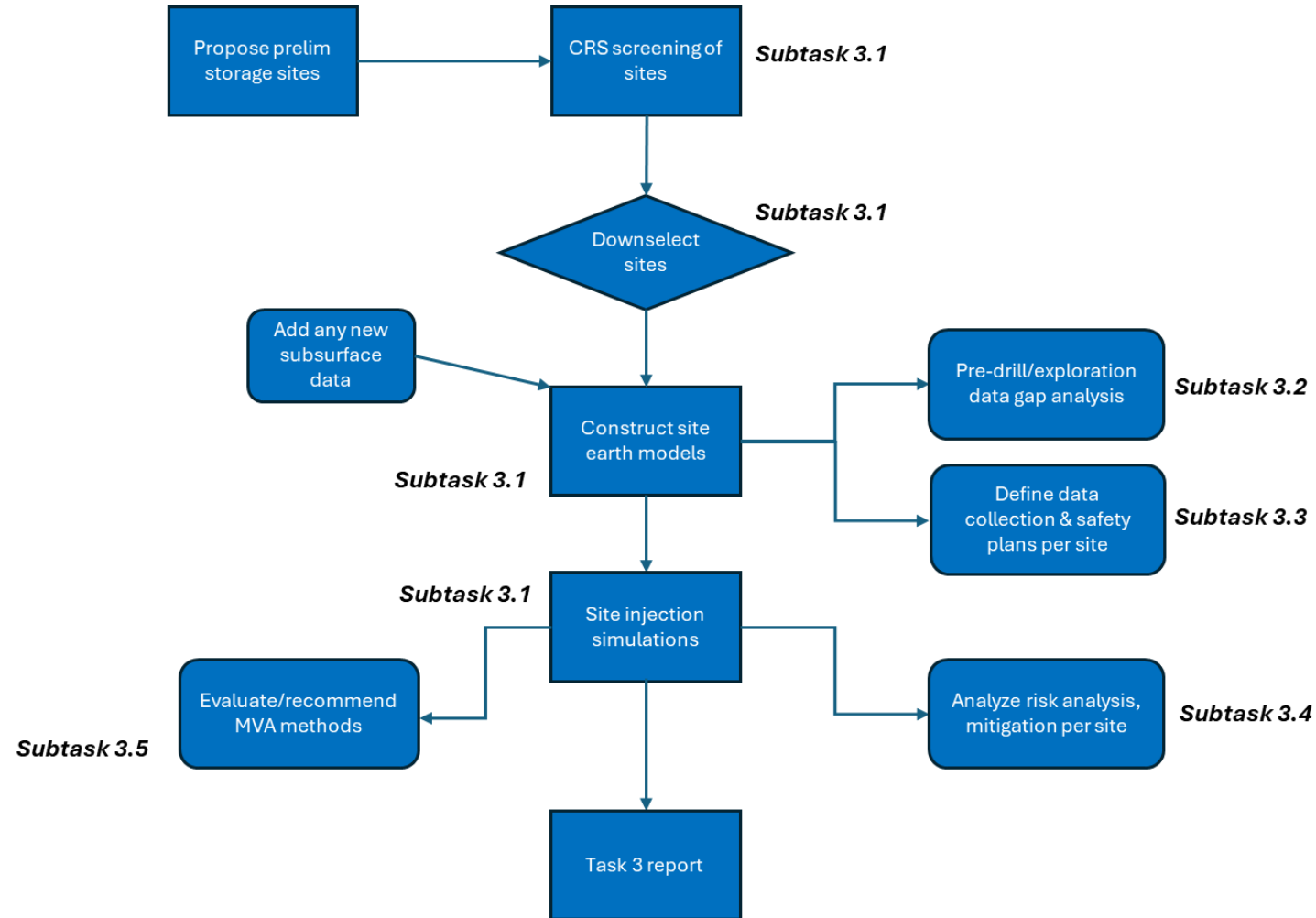
Location of disadvantaged communities and tribal lands within the proposed study area. Source: Energy Justice Dashboard.

# Task 3: Addressing Key Technical & Non-Technical Challenges

- Utilizing Characterization Data for CO<sub>2</sub> Saline Storage Scenarios
- Developing Pre-drilling Data Collection/Exploration Plans
- Defining the Site Characterization and Safety Plan
- Reviewing Site-Specific Risk and Planning Risk Mitigation
- Evaluating Monitoring, Verification, and Accounting (MVA) Methods

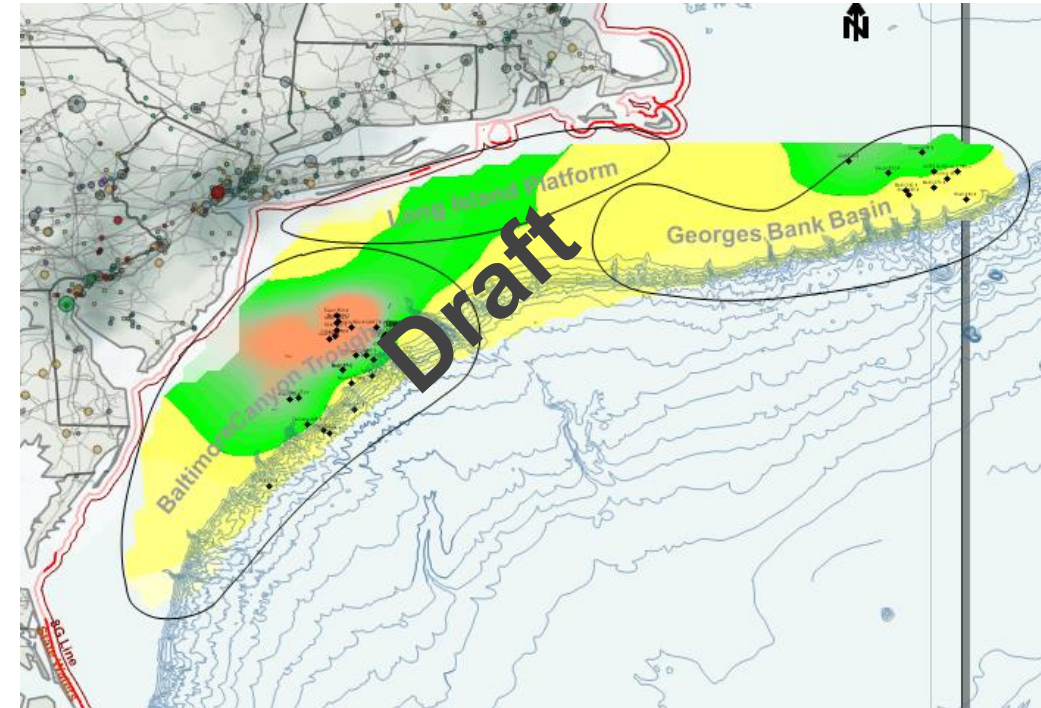


# Task 3: Technical Challenges – Draft Flow Chart



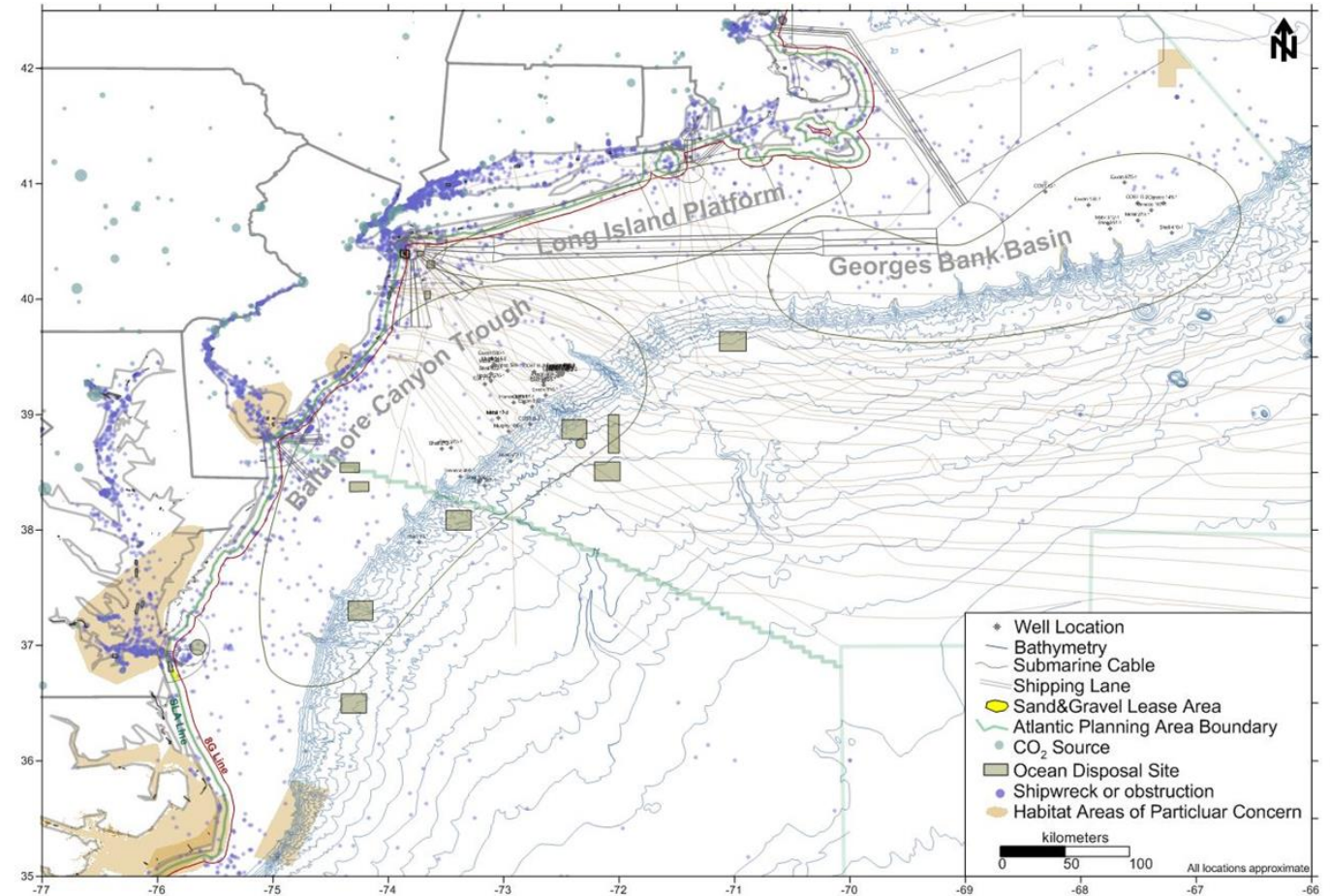
# Site(s) Selection: Common Risk Segment analysis Examples

Risk category	Common risk segment
<i>Subsurface</i>	Caprock
	Storage volumes
	Burial depth
<i>Marine/seabed Features</i>	Critical Habitat Areas/HAPCs
	Seafloor obstructions
<i>Economics</i>	Capture/transport costs
	Development costs
<i>Community</i>	Population Centers
	Jobs/Workforce Development
	Decarbonization Policy/Regulations



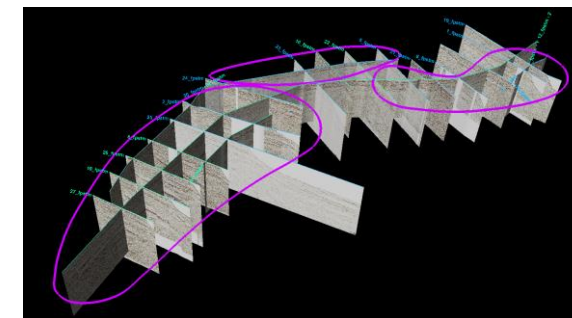
# Example of Previous Environmental Impact Risk Maps

- Submarine cables, shipping lanes, shipwrecks or obstructions, HAPCs, and ocean disposal sites were mapped to identify environments and infrastructure that could be impacted



# Task 4 - Facilitating Data Collection, Sharing, and Analysis

- Inventorying Available Data and Analyses
  - Compilation of Global Offshore CCS Projects to identify lessons learned and analogs
- Facilitating Data Sharing and Analysis
  - Coordination with Bureau of Ocean Energy Management (BOEM)
- Planning and Executing Additional Data Analyses



## Sample Inventory

- ~2,300 core samples
- ~5,000 thin-sections
- ~97,000 drill cuttings

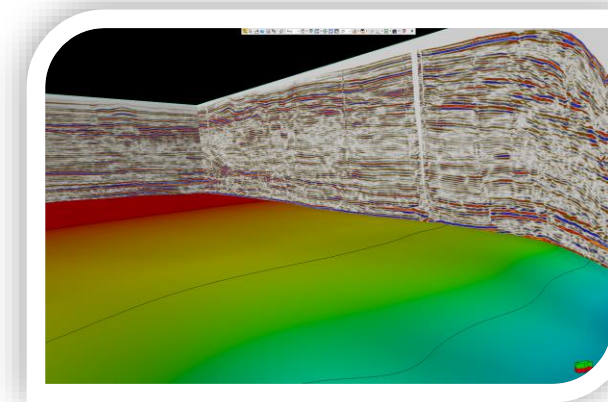


## Data Compilation

- 2,500 logs in well database
- Over 1,000,000 ft. of log data digitized
- 5,973 porosity and 5,729 permeability core data points\* from 184 reports

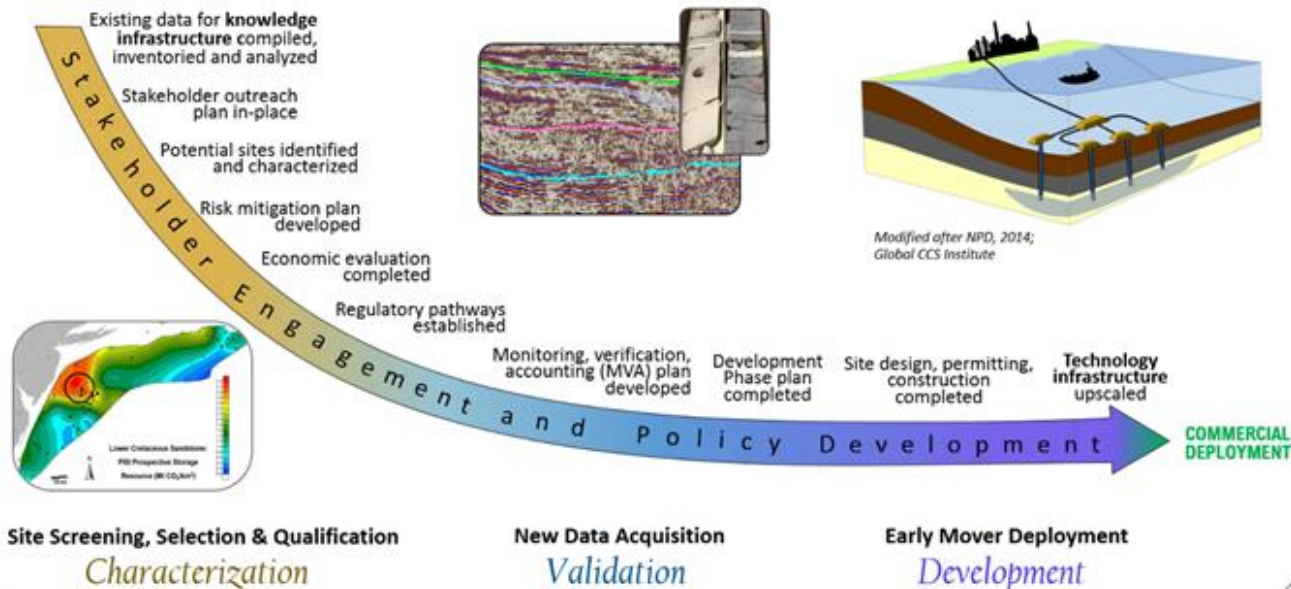


1: sandstone 2: mudstone



# Task 5 – Evaluating Regional Infrastructure

- Offshore CO<sub>2</sub> Transport and Delivery Options and Scenarios
- Assessing Site Readiness

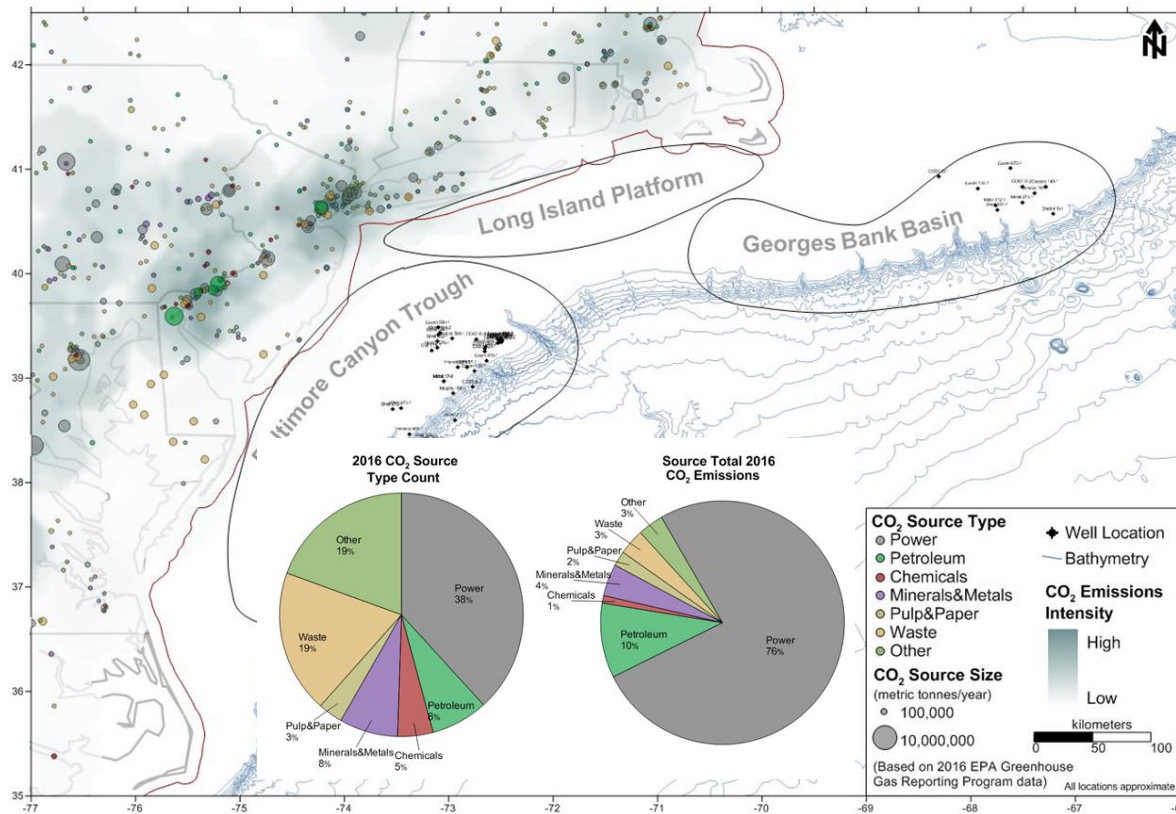


- Flow assurance analyses, transportation and injection equipment sizing
- Onshore and offshore pipeline system solutions and tie-back options
- Specifications for any additional boosting stations, metering, dehydration, and safety
- Definition of offshore injection system for shallow water structures, subsea fields & hybrid systems
- Verification, recommendations and design for topside facilities and shallow water structures
- Definition of subsea system including system architecture, injection tree recommendation and tie-in philosophy
- Control system definition and evaluation of different topologies
- Recommendations for location of electric/hydraulic power sources
- Umbilical services and functionalities

# Task 5- Evaluating Regional Infrastructure



- Review Existing Infrastructure of the Mid-Atlantic Offshore Study Area



Facility Name	State	Industry Type	CO2 Emissions (tons per year)
Brandon Shores LLC	MD	Power Plant	5,050,722
Morgantown	MD	Power Plant	4,407,257
Delaware City Refinery	DE	Refinery	4,167,327
Phillips 66 Bayway Refinery	NJ	Refinery	2,674,615
Linden Generating Station	NJ	Power Plant	2,511,175
Linden Cogeneration Facility	NJ	Power Plant	2,372,291
Chalk Point	MD	Power Plant	2,313,107
Red Oak Power LLC	NJ	Power Plant	2,319,626
Bergen	NJ	Power Plant	2,043,945
Lehigh Hanson Cement Co.	MD	Cement	1,843,978
West Deptford Energy Station	NJ	Power Plant	1,796,680
Paulsboro Refining Company LLC	NJ	Refinery	1,702,138
Hay Road	DE	Power Plant	1,705,239
Woodbridge Energy Center	NJ	Power Plant	1,607,512
Newark Energy Center, LLC	NJ	Power Plant	1,585,402
H A Wagner LLC	MD	Power Plant	1,178,284
Carneys Point	NJ	Power Plant	1,095,215
AES Warrior Run	MD	Power Plant	1,082,359
<b>Cumulative Emissions</b>			<b>41,456,870</b>



# Task 6 - Promoting Regional Technology Transfer



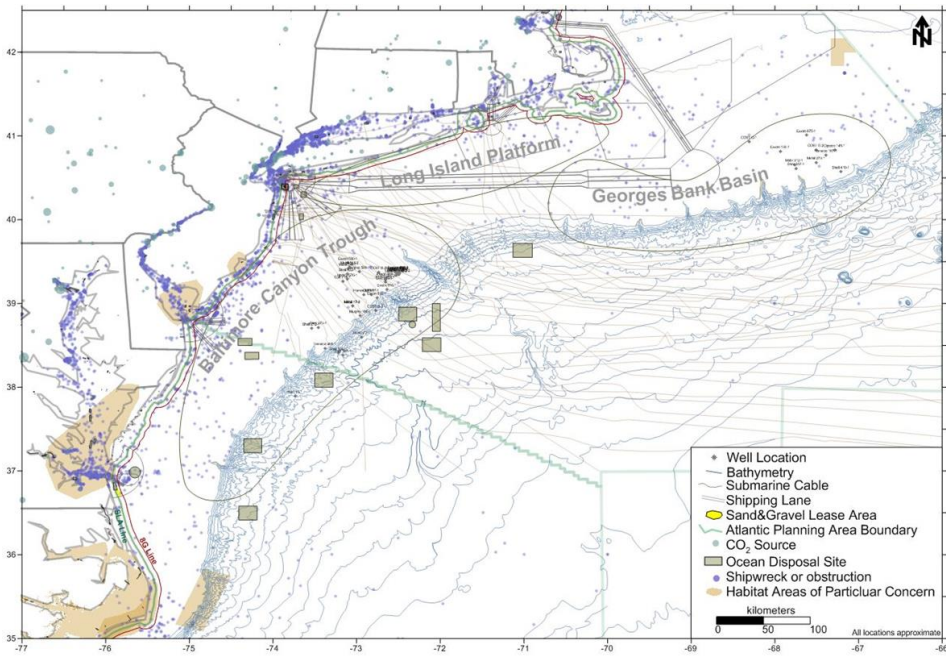
- Engaging Existing Partnerships
- Building Industry and Regional Technical Partnerships

<b>DOE Goals</b>	<b>Mid-Atlantic Offshore Carbon Storage Hub Goals</b>
<b>Support Industry's ability to predict CO<sub>2</sub> storage capacity</b>	<ul style="list-style-type: none"><li>• Define geologic characteristics of candidate storage sites</li><li>• Use seismic data to better define continuity of reservoirs</li><li>• Catalog hydrogeologic properties of offshore storage sites</li><li>• Determine appropriate efficiency parameters for offshore lithologies</li><li>• Calculate Prospective CO<sub>2</sub> Storage Resource</li></ul>
<b>Support Communities</b>	<ul style="list-style-type: none"><li>• Collect community feedback on CO<sub>2</sub> storage concerns</li><li>• Define options to minimize impact to environment, marine features</li><li>• Support workforce development for decarbonization of vital industry</li></ul>

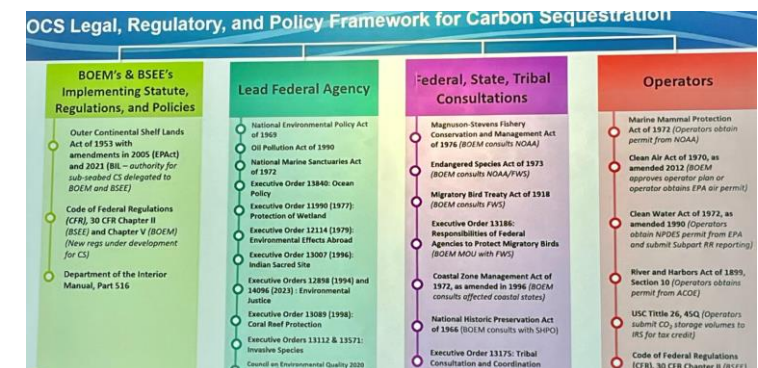
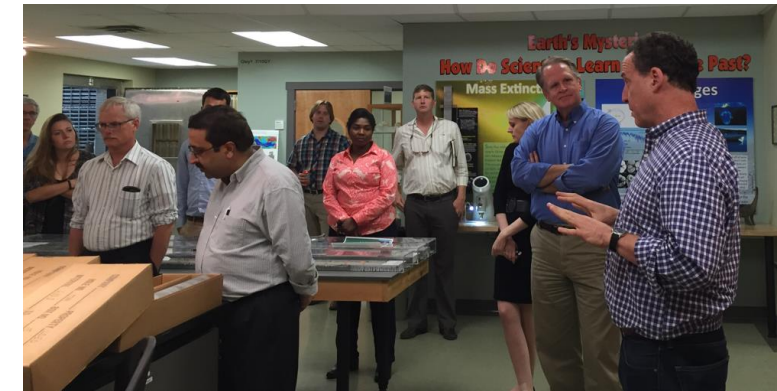
# Task 7 - Public Engagement and Support



- Creating an Advisory Committee or Stakeholder Pools
- Performing Outreach, Education, and Knowledge Sharing



Feature	Description	Source	Impact
Submerged Lands Act Boundary	Limit of state's land offshore and federally managed OCS	BOEM	State coastal water limits
8G line	Line projected 3 nautical miles seaward from SLA boundary	BOEM	Nearshore limit for federal resource management
Continental Shelf Boundary	200 nm exclusive economic zone boundary/limit of U.S. territory from coastline	BOEM	Offshore limit of federal resource management, boundary of OCS and slope
Endangered Species Act	Areas protected for threatened or endangered marine species and ecosystems	USFWS-NOAA NMFS	Endangered Species Act covers all areas out to CSB
Critical Habitat Areas/Habitat Areas of Particular Concern	Especially vulnerable habitat areas for marine species	BOEM/NOAA	No areas designated for Mid-Atlantic study area, some areas present inward of the 8G line
Marine Protected Areas	Areas with limited human activity to protect natural or cultural resources	NOAA	Most MPAs nearshore or in southern extent of region
Marine Sanctuary/Marine National Monuments	Federally protected underwater park areas with special marine features	NOAA	No marine sanctuaries designated in OCS study areas, Northeast Canyons and Seamounts near slope of GBB
Artificial Reefs	Man-made structures to support marine life	Mid Atl. Fishery Mgmt Council	Over 100 reef sites along Mid-Atlantic, but mostly nearshore. Limited extent.
Fishing Vessel Density	Density of fishing vessel traffic in 2011 for the US Atlantic from vessels with AIS transponders in 100 meter grid cells	NOAA Coastal Services Center	Some areas of high vessel density in offshore fishing grounds
Shipping Lanes	Delineated shipping routes marked for commercial traffic	NOAA Office of Coast Survey	Shipping routes concentrated along major ports, bays,
Submarine cables	Submarine communication cables in and around U.S. navigable waters	NOAA Office for Coastal Management	Submarine cables present in certain areas but have relatively minor footprint
Sand and Gravel Lease Borrow Areas	Areas with agreements in place for sand and gravel dredging	BOEM	Limited S&G borrow areas present nearshore
Shipwrecks/Obstructions	Designated shipwrecks and obstructions on seafloor within U.S. waters	NOAA, U.S. National Park Service	Several hundred wrecks present in study areas, but have limited extent
Ocean Disposal Sites	Current, historical, or discontinued sites for dumping dredging material, waste, or other materials	US EPA/MPRSA	There are about 15 disposal sites in mid-Atlantic OCS, which may be impediments to drill sites and pipelines



BOEM, 2024

# Summary



- Technical approach is designed to evaluate feasibility of a **safe**, long-term, economic, and publicly accepted CO<sub>2</sub> storage complex along the mid-Atlantic Offshore OCS.



## Progress to date:

- Initial community benefits plans.
- Compile geotechnical data, common risk segment mapping geological, environmental, infrastructure features.
- Site selection for CO<sub>2</sub> storage hub scenarios.
- Coordination with BOEM/BSEE.
- Discussions with additional industry eager to establish offshore storage resources in the region.

