

Environmental Studies Program: Ongoing Study

Field	Study Information
Title	Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico (GOM) (GM-22-01)
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	CSA Ocean Sciences
Total BOEM Cost	\$2,163,987.40 (includes \$384,633 for ship time)
Performance Period	FY 2023–2025
Final Report Due	September 2025
Date Revised	October 17, 2023
Problem	Abandoned oil and gas wells are not typically inspected. If there are abandoned wells that leak, little is known about the environmental impact on the air and water quality.
Intervention	Identify leaks from abandoned wells and measure to determine if the leaks are significant enough to emit air pollution at the sea surface, affect water quality, or have potential to impact coastal areas.
Comparison	Comparison between the air and water quality impacts of the control group and abandoned wells.
Outcome	Assessment of the environmental risks from abandoned oil and gas wells.
Context	Central GOM and Western GOM

BOEM Information Need(s): The mission of the Department of the Interior’s Bureau of Ocean Energy Management (BOEM) is to manage the responsible development of America’s offshore energy and mineral resources. The bureau promotes energy independence, environmental protection and economic development through responsible, science-based management of energy and mineral resources on the U.S. Outer Continental Shelf (OCS). The BOEM needs to determine whether there are abandoned oil and gas wells leaking in the Gulf of Mexico (GOM). Oil and gas activities are authorized under the Outer Continental Shelf Lands Act (OCSLA) and leakage could have long-term impacts to the human and marine environment. According to OCSLA (42 U.S.C. § 1346), BOEM must conduct assessments of environmental impacts related to oil and gas development. The data collected from this study would be used in environmental analyses, prepared pursuant to the National Environmental Policy Act (NEPA), because potential leaks would be identified and measured to examine the environmental risks to the water and air quality. This would also support the Executive Order 14008 Sec. 208 (“Tackling the Climate Crisis at Home and Abroad”), issued January 27, 2021, and Secretary’s Order No. 3399, issued on April 16, 2021 (“Department-Wide Approach to the Climate Crisis and Restoring Transparency and Integrity to the Decision-Making Process”). Furthermore, this information would support BOEM’s emission inventories and Tribal Consultation responsibilities. Native American Tribes have voiced

concerns about the potential for leaks from abandoned wells to contaminate coastal areas, including archaeological sites and other resources.

Background: It has been shown that leaking abandoned oil and gas wells onshore in the United States emit methane (Townsend-Small et al., 2016). In the State of Louisiana “orphan wells” are known with some located in state waters of the GOM (DNR, 2020). Orphan wells are unrestored abandoned oil and gas wells. In the federal waters of the GOM, it is not well understood if abandoned wells are leaking and if this could cause long-term impacts to the air and water quality. The GOM has thousands of abandoned oil and gas wells with some dating back to the 1960s. Due to the large number of wells, few inspections are conducted. Evaluating the environmental risks will support BOEM’s future decommissioning environmental impact statement for the GOM.

A study funded by BOEM (formerly Minerals Management Service) conducted an operational risk assessment on temporarily abandoned or shut-in wells. Their work identified possible leak paths from permanently abandoned wells. They also found wells with sour fluids—those containing significant amounts of hydrogen sulfide—have a significantly higher probability of premature component failure because of higher corrosion rates (Nichol et al., 2000). Often abandoned wells are injected with waste fluids in accordance with the National Pollutant Discharge Elimination System (NPDES) general permit (USEPA, 2017). The risks associated with downhole waste are unknown.

Objectives:

- Investigate the air and water quality at abandoned oil and gas wells in the Gulf Mexico through scientific measurement and characterization.
- Use the scientific data collected from the sampled abandoned oil and gas wells to determine if they are leaking in the Gulf of Mexico and, if so, to what extent.

Methods: Two main cruises would take place. One cruise has been conducted to do geophysical surveys at 6 reference sites and 12 abandoned well sites in year 2023 to confirm abandoned well locations and to ensure reference areas are clear of existing subsea infrastructure and any debris. A second cruise will collect samples and video using a work class Remotely Operated Vehicle (ROV) in year 2024 at the sites.

Visual observations (any visible signs of leakage/gas bubbles, sheens, corrosion, biodiversity, and any additional observations that would provide valuable information) will be conducted using a work class ROV. The following hydrographic parameters would be measured at each site: temperature, conductivity, pressure, fluorescence, turbidity, dissolved oxygen, and dissolved methane.

Multiple physical seawater samples will be taken at each site (including blanks and duplicates) and the following analyte(s) would be analyzed for each sample: volatile organic compounds (benzene, toluene, ethylbenzene, xylene, hexane, heptane, cyclohexane, pentane, and methylcyclohexane), metals (Al, Ag, As, B, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, K, Li, P, Pb, Mg, Mn, Mo, Ni, Sb, Se, Sn, Sr, Ti, V, and Zn), mercury, and dissolved methane.

Canisters will be used to take physical air samples at each site (including blanks and duplicates). Canisters will be analyzed in accordance with US EPA Method TO-15 and analyzed by gas chromatography/mass spectrometry (GC/MS) to determine the concentrations of methane and volatile organic compounds that include benzene, toluene, ethylbenzene, xylenes, hexane, heptane, cyclohexane, pentane, and methylcyclohexane.

A statistical analysis will be conducted on the physical seawater and air sample data with a minimum confidence interval of 90% using either a parametric one-way analysis of variance (ANOVA) or non-parametric Mann Whitney U or Kruskal Wallis tests, as appropriate.

Partnership with other potential groups such as NASA would be considered to see if airborne remote sensing tools and/or satellite imaging may be used to identify the extent of leaks. This could include collaboration with the Carbon Mapper program (<https://carbonmapper.org/>), NASA's DEVELOP methane project, or BOEM/NASA projects. Currently, BOEM is planning to have a cruise scheduled the same time frame as one of the cruises under the Inter-Agency Agreement, and during a Carbon Mapper flight, so the data from this study could be used by NASA.

Specific Research Question(s):

1. How does the air and water quality data compare between the control sites and abandoned oil and gas wells?
2. How does the air and water quality data compare between the sampled abandoned oil and gas wells?
3. Are there any visual observations from the imaging that could suggest why there might be differences in the air and water quality data?
4. If leaking, are there any visible indicators of leakage from the sampled abandoned oil and gas wells?
5. If leaking, is there a correlation between the age of well and potential for leakage?
6. If leaking, do the leaks affect water quality in the vicinity of the well? If so, to what extent from the well?
7. If leaking, do the leaks contribute to air pollution at the sea surface?
8. Do the metocean conditions explain any differences in the measurements?
9. What brief conclusions can be made from the biodiversity observed during imaging around the sampled abandoned oil and gas wells?

Current Status: The first survey cruise was completed and the data is being processed.

Publications Completed: None

Affiliated WWW Sites: None

References:

DNR. Oilfield Site Restoration (OSR) Program. Accessed April 7, 2020. Internet website: <http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=155>

Magen C, Lapham L, Pohlman J, Marshall K, Bosman S, Casso M, Chanton J. 2014. A simple headspace equilibration method for measuring dissolved methane. *Limnology and Oceanography: Methods*. 12:637–650.

Nichol JR, Kariyawasam SN. 2000. Risk Assessment of Temporarily Abandoned or Shut-in Wells. Minerals Management Service. <https://www.bsee.gov/research-record/tap-329-risk-assessment-temporarily-abandoned-or-shut-wells>

- Townsend-Small A, Ferrara TW, Lyon DR, Fries AE, Lamb BK. 2016. Emissions of coalbed and natural gas methane from abandoned oil and gas wells in the United States. *Geophysical Research Letters*. 43:2283–2290. <https://doi.org/10.1002/2015GL067623>.
- USEPA. The NPDES general permit for new and existing sources and new dischargers in the offshore subcategory of the oil and gas extraction point source category for the western and central portion of the outer continental shelf of the Gulf of Mexico (GMG290000); [accessed 2023 July 10]. https://www.epa.gov/system/files/documents/2023-05/2023%20GMG290000%20Final%20Permit%20dated%20and%20signed_508.pdf.