2022 Annual Gulf Coast Ecosystem Restoration Council Report

Texas RESTORE Centers of Excellence

(October 01, 2021 - September 30, 2022)

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I. Executive Summary

As the Texas Governor's appointee to the RESTORE Council, Commissioner Toby Baker of the TCEQ has established two Centers of Excellence in Texas in accordance with the requirements set forth in the RESTORE Act and U.S. Treasury regulations.

Texas OneGulf

The mission of the Texas OneGulf (OG) Center of Excellence is to gather and improve knowledge about the Gulf of Mexico to inform decision-making around the challenges to environmental and economic sustainability of the Gulf of Mexico and its impact on the health and well-being of Texans and the nation. Texas OneGulf is designed with the capacity and flexibility to address all five disciplines denoted in Section 1605 of RESTORE. For this reporting period, OG was awarded funding and has begun activities on one project which is currently active and has two projects pending Highlights for this reporting period include activities associated with the one on-going project, Geospatial Framework and Analysis for Coastal Resilience, for the South Texas Coastal Bend area, as well as preparation for additional projects that are expected to commence soon.

Subsea Systems Institute

The Subsea Systems Institute (SSI) is a Center of Excellence formed under the Restore Act and represents a collaboration between the University of Houston, Rice University and NASA/Johnson Space Center. The mission of SSI is to improve the safety and efficiency of offshore energy development by conducting translational engineering and technology development for offshore energy production. The key outcomes from the work of the SSI are:

- Unbiased third-party validation to build public trust in the safety and operation of offshore energy production;
- Deployment of advantaged safest technologies for offshore energy development to ensure safety and operational excellence in offshore applications;
- The attraction of talent for jobs and investment in the local, state, and national economy reinforce Houston and the state of Texas's reputation as the Energy Capital of the World.

For this reporting period, SSI has completed work on six projects and have begun activities related to additional projects expected to start later this year.

II. Programmatic Elements

A. Award Recipient

In 2020 TCEQ, on behalf of Commissioner Baker and the Governor, received Grant II award from Treasury with an end date of August 31, 2024. That award addresses all five disciplines denoted in Section 1605 of RESTORE (1605). An amendment to this award was issued in April 2022, adding $6,460,267 to the grant for a Grant II total of $9,965,167.

Annual TCEQ accomplishments include:

- began sub-awarding process for six Proposals of Grant Activities to the Centers, two from OG and four from SSI;
- reviewed SSI's Request for Proposals for posting;
- participated in OG's Notice of Funding Availability activities;
- monitored activities associated with all seven active projects and two operational GADs (Grant Activity Description);
- monitored and reviewed deliverables submitted by Centers;
- responded to inquiries from Centers;
- reviewed invoices and processed eligible expenditures for reimbursement;
- generated and submitted required federal reporting;
- participated, along with the Centers, in a meeting requested by Treasury to discuss CofE activities, as well as possible date extension for Grant II; and
- held End-of-Year meetings with each of the two Centers to discuss detailed reviews of the progress for each of the active projects and to discuss upcoming and longer-term activities and goals.

B. Award Subrecipient(s)

Texas OneGulf Consortium

The nine participants in the Texas OneGulf Consortium include:

- Texas A&M University Corpus Christi, Harte Research Institute for Gulf of Mexico Studies;
- Texas A&M University at Galveston, Marine Biology, Science and Engineering Departments;
- University of Houston Law Center, Center for U.S. and Mexican Law;
- Texas A&M University, Center for Translational Environmental Health Research (CTEHR);
- Gulf of Mexico Coastal Ocean Observing System-Regional Association (GCOOS);
- University of Texas Medical Branch at Galveston, Sealy Center for Environmental Health and Medicine (UTMB);
- Texas A&M University, Geochemical and Environmental Research Group (GERG);
- University of Texas Rio Grande Valley, Biological and Environmental Sciences; and
- Texas State University, The Meadows Center for Water and the Environment.

The five participants in the Texas OneGulf Agency Council include:

- Texas Commission on Environmental Quality (TCEQ)
- Texas Division on Emergency Management
- Texas General Land Office

- Texas Parks and Wildlife Department
- Texas Water Development Board

PROJECTS
TCEQ monitored activities associated with the operational Grant Activity Description (GAD) and one project GAD. The agency is also developing proposed GADs for two additional projects.

GAD 1-22150, General Operations of Center of Excellence project, project, principals Dr. Kateryna Wowk Porter (Harte) and Dr. David Yoskowitz (Harte). TCEQ issued a notice to commence (NTC) on 01/20/2021. The project Scope of Work is to operate the CoE and perform research on the Gulf Coast Region as defined in 31 CFR 34.2. OneGulf will perform research across all five of the CoE disciplines and will use the information to help state and local officials make decisions that will benefit Texas. Status of performance and annual accomplishments include:

- Met the reporting requirements of the COE and continues to oversee the day-to-day operations and administration of the COE.
- Updated and revised the Texas OneGulf Network of Experts (TONE) list
- Created the Texas OneGulf Agency Council (TOAC) member list and listserv.
- Annually updated the Strategic Research and Action Plan (SRAP) in consultation with the Texas OneGulf Consortium Leadership Group (TOCL) and TOAC.
- TOCL Engagement Meetings to discuss co-production
- Planned, hosted, and completed the Texas OneGulf Workshop Series: TONE Integration for OneGulf Solutions to advance interdisciplinary collaboration and co-production between TONE and decision makers and end users.
- Funded projects in the best interest of the state of Texas:
    - Continued development and execution of two selected projects from first Notice of Funding Availability (NoFA) and;
    - Released second NoFA.

GAD 2-23371, Geospatial Framework and Analysis for Coastal Resilience, South Texas Coastal Bend project, principals Dr. Kateryna Wowk Porter (Harte) and Dr. Jim Gibeaut (Harte). TCEQ issued a NTC on 06/10/2021. The project Scope of Work is to improve the science and practice of resilience through completing a quantitative and qualitative resilience assessment template for civic infrastructure, facilities, natural assets and disaster risk factors for three Coastal Bend counties (Nueces, Kleberg and Kenedy). These counties lack capacity to conduct this work. The purpose of the project is to develop data and assessment for a web-based, user-friendly, and visually-compelling tool that is extensible and scalable to a wide range of communities. This tool can integrate with existing and future climatological, oceanographic and meteorological models to assess flood,

inundation and sea-level rise, and can form the basis for a standard approach to risk assessment and mitigation for communities and their co-located assets.

- Launched and began initial assessments.
- Held monthly meetings with county officials and webtool developer.
- Coordinated stakeholder engagement.
- Developed the GIS Team and Architecture for the GeoRED platform.
- Held community meetings.
- Secured web developer.
- Completed website mockup.

Subsea Systems Institute

The six participants in the SSI Consortium include:

- University of Houston
- Rice University
- National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC)
- Texas Southern University
- Lone Star College System
- Houston Community College

PROJECTS

TCEQ monitored activities associated with the operational GAD and six project GADs. The agency is also developing proposed GADs for four additional projects.

GAD 1- 22029, Subsea Systems Institute General Operations and Administration of the Center of Excellence, principal Ramanan Krishnamoorti. TCEQ issued a NTC on October 5, 2020. The project Scope of work is to oversee the Subsea Systems Institute's activities associated with the project activity for its GADs

- Met the reporting requirements of the COE and continues to oversee the day-to-day operations and administration of the COE, including all project GADs.
- Funded projects in the best interest of the state of Texas

GAD 2- 22981, Multi-port Energy Router Using Intelligent Transformers (MERIT) to Interconnect Renewable Resources and Subsea Oil and Gas Factories via HVDC Link, principals Dr. Harish Krishnamoorthy & Dr. Kaushik Rajashekara (University of Houston). TCEQ issued a NTC on March 1, 2021, with a project end date of March 31, 2022. The Scope of work facilitates the co-location of renewable resources (wind, wave, floating solar, etc.), energy storage (batteries), and subsea processing systems regardless of distance from shore or depth of installation. The project also explores the control strategy of the MERIT system to reduce the intermittent renewable energy sources, to ensure the safety and stability of the grid interconnection.

- An electrical architecture was designed and developed for MERIT to interconnect hybrid renewable energy sources, with subsea loads, including wind and fuel cells. An optimal 2-layer control strategy was also designed for the Wind Turbine Generation (WTG) and Battery Energy Storage (BES) systems, integrated with the MERIT system.
- A three-port solid-state transformer-based scaled-down prototype was also developed using a medium-frequency transformer.
- SSI evaluated the fault-limiting performance of the coupled inductor-based fast switching direct current (DC) circuit breakers for the protection subsea high voltage direct current (HVDC) transmission system.

Designed resistive superconducting fault current limiter integrated with HVDC circuit breaker to reduce current rating and power. The proposed MERIT system incorporates the features like instantaneous voltage compensation, power outage compensation, fault isolation, and bi-directional power flow capability. Widespread implementation of the developed synergies will improve the economics of both renewables and oil and gas projects and can lead to over 50% reduction in the emissions caused by the activities in oil and gas production.

GAD 3- 22982, Asset Integrity of Valves and Bolted Connections, principals Dr. Zheng Chen and Dr. Gangbing Song (University of Houston). TCEQ issued an NTC on March 1, 2021 with a project end date of June 15, 2022. The Scope of Work is to develop robotics that will enable valve inspection and operation for offshore oil platforms. To develop tapping-listening approaches to detecting the looseness of the flange.

- Developed a ground service robot that can climb stairs and track lanes in oil platforms and a vision-based lane tracking for the robot to track lanes in oil platforms.
- Developed a vision-based recognition algorithm to locate valves for inspection and a valve inspection tool that can detect stuck valves while operating them.
- Developed a machine-learning-based underwater percussion method for flange looseness detection and designed a manipulator to enable the implementation of underwater percussion.
- Conducted comprehensive testing after integration of key components.

Timely unmanned inspection and operation of valves is the key to extending the lifetime of offshore assets and ensuring safety if assets are considered for repurposing for renewable energy development and reefing.

GAD 4- 23426, High Accuracy Localization and Underwater Communication, principals Dr. Aaron Becker, Dr. Miao Pan, and Dr. Julien Leclerc (University of Houston). TCEQ issued an NTC on April 6, 2021, with a project end date of April 30, 2022. The Scope of Work is twofold, 1) develop methods to perform short distance, high accuracy localization underwater using MI (Magnetic Induction), and 2) use triaxial coil antennas mounted on autonomous underwater agents to

transmit and receive signals conveying information and determine the position and orientation.

- New receiver circuitry allows transmission detections over larger distances than before.
- The conformal coil performance is almost identical to that of the antennas completely enclosed. Using conformal coils is recommended to reduce the amount of added buoyancy to the system.
- MI-based synchronization can provide accurate reference clock for distributed underwater nodes in many applications, such as distributed MIMO acoustic communications or localization.

Current underwater localization methods, such as acoustics and optics, have multi-path fading and line-of-sight requirements constraints. Even though the MI approach cannot propagate far, it is less susceptible to environmental parameters. This project aims to fill the gap for high accuracy localization and robust communication needs at short distances (less than ten meters). However, better hardware implementation and calibration are needed to improve the accuracy of the results.

GAD 5-23428, Developing Bio-Inspired Buoyancy Control for Subsea Service AUVs, principals Dr. Zheng Chen (University of Houston) and Dr. Fathi Ghorbel, (Rice University). TCEQ issued a NTC on April 6, 2021, with a project end date of August 31, 2022. The Scope of Work is to develop bio-inspired buoyancy control for an underwater service robot that can adapt its volume to achieve neural buoyancy state and change its orientation. The research focuses on the problem of fine buoyancy control by exploring new enabling ideas from soft robotics.

- Designed and fabricated a prototype of a buoyancy control device (BCD) enabled by reversible fuel cells;
- Modeled the nonlinear dynamics of, and developed appropriate nonlinear control laws for the BCD;
- Integrated the BCD with an AUV to demonstrate depth control with hard and soft actuators;
- Demonstrated underwater service robotics that can pick up, move, and drop a tool with adaptive buoyancy control to save energy.

Service robot with efficient buoyancy control will save energy for AUVs when they deliver and replace tools to subsea infrastructures, which will extend the lifetime of subsea infrastructures and ensure safety if assets are considered for repurposing for renewable energy development and reefing.

GAD 6- 24162, Sensors Based on Organic Electrochemical Transistors (OECTs) for Deep Sea Leakage and Chemical Detection, principals Dr. Haleh Ardebili (University of Houston) and Dr. Rafael Verduzco (Rice University. The TCEQ issued a NTC on June 14, 2021 with a project end date of August 31, 2022. The Scope of Work is to design, fabricate, and model compact, low cost and

autonomous chemical sensors for early detection of leakages and spills in subsea applications.

- The OECT sensor is a reliable and practical device to detect oil spills and leakage in subsea applications.
- Hydrocarbon-based materials such as methanol, ethanol, propanol, and butanol are detected in seawater solution in a concentration range of 0.01 M to 7 M.
- Polyaniline-based molecular imprinted polymers (PANI-MIPs) demonstrate promising performance for target detection. The PANI-MIP gate electrode could detect the perfluorooctanesulfonic acid (PFOA) in synthetic seawater over a wide dynamic range.
- The electrochemical RC circuit model can simulate the adsorption of molecules on the gate electrode which increases the voltage drop at the electrode-electrolyte interface and impacts the gate capacitance.

Pipeline networks are the most efficient method to transport oil, gas, and other liquids but leaks are common and oftentimes go undetected. A better leak detection method will improve the safety and efficiency of offshore oil and gas production and could be used in the future to monitor for leaks when carbon or hydrogen is stored offshore.

GAD 7- 24163, High-Energy and High-Power Quasi-Solid-State Lithium Batteries for Subsea Applications, principals Dr. Pulickel Ajayan and Dr. Babu Ganguli (Rice University. TCEQ issued a NTC on June 14, 2021, with a project end date of August 31, 2022. The Scope of Work is to fabricate quasi-solid-state lithium battery by balancing power and energy to be operable at wide temperature range and high pressure.

- Stabilizing high voltage/high-capacity battery based on layered cathodes with h-BN layer coating of optimized thickness for extreme environment and subsea applications.

Will provide safe and reliable power supply for charging underwater unmanned vehicles, well monitoring, decommissioning applications to extend operation of offshore infrastructure including repurposing for renewable energy development and reefing.

III. Financial Elements

A. Award Recipient

During this reporting period, the following has been expended and obligated of the total $9,965,167 grant award:

<u>TCEQ</u>

- TCEQ's total budget is $392,291. Through September 2022, $110,416.51 (28.15%) has been expended.

OneGulf

- RESTORE Center of Excellence (OneGulf) contract was executed November 16, 2020. Amendment 1 was executed August 3, 2022, increasing the total from $1,612,450 to $4,882,412. Through September 2022, $298,515.35 has been expended.

- $860,159.00 of the total $4,882,412 (17.62%) has been obligated to Texas A&M University Corpus Christi - Texas OneGulf.

Subsea Systems Institute

- RESTORE Center of Excellence (Subsea Systems Institute) contract was executed October 5, 2020. Amendment 2 was executed August 3, 2022, increasing total from $1,612,450 to $4,690,464. Through September 2022, $795,163.87 has been expended.

- $1,271,627.38 of the total $4,690,464 (27.11%) has been obligated to University of Houston – Subsea System Institute (SSI).

B. Award Subrecipient(s)

Center	Project	Awarded	Expended	Lower Tier Subawardee	Amount
Texas OneGulf	1-22150	$427,585.00	$202,793.06	Amazee	$11,600.00
Texas OneGulf	2-23371	$432,574.00	$95,722.29	Coastal Bend Council of Governments	$55,000.00
Subsea Systems Institute	1-22029	$490,022.00	$153,265.43	N/A	N/A
Subsea Systems Institute	2-22981	$139,500.00	$138,386.67	N/A	N/A
Subsea Systems Institute	3-22982	$139,500.00	$139,437.47	N/A	N/A
Subsea Systems Institute	4-23426	$139,500.00	$139,243.29	N/A	N/A
Subsea Systems Institute	5-23428	$128,264.80	$56,593.62	Rice University	$56,664.80
Subsea Systems Institute	6-24162	$127,190.58	$113,987.20	Rice University	$55,315.58

Subsea Systems Institute	7-24163	$107,650.00	$54,250.19	Rice University	$93,900.00

IV. Gulf Coast Ecosystem Restoration Council Element

A. Leveraging Multipliers

Texas OneGulf Consortium

Other funds are being used to expand the project on Geospatial Framework and Analysis for Coastal Resilience, South Texas Coastal Bend GAD No. #2 (582-21-23371), including $800,000 from U.S. Economic Development Administration and cost-share in the amount of $181,006 from Texas A&M University Corpus Christi and $19,094 from the Coastal Bend Council of Governments. The funds are being used to expand the tool to an additional four counties: Aransas, Bee, Refugio and San Patricio.

Coordination between RESTORE Centers of Excellence

Texas OneGulf has played a leading role in establishing coordination between both designated and presumptive COE's from all five Gulf states. There is a monthly call between the Centers, where the focus has been on joint research activities.

The Gulf Restoration Science Programs Ad Hoc Coordination Forum, hosted by the NOAA RESTORE Science Program, provides a venue for all Gulf science programs to come together to develop common data management, share funding opportunities and look for synergies and activities that can be shared. The Texas OneGulf Executive Director and Coordinator participates in the monthly call and attends events like Gulf of Mexico Conference. These face to face meetings serve to enhance coordination and joint actions, reduce duplication and afford opportunities to leverage individual actions.

The Texas OneGulf Director also leads a working group under the Coordination Forum on understanding the impact of science.

SSI

An Advisory Board has been established to guide and support the strategic planning and technical direction of SSI. Membership is on a volunteer basis drawn primarily from industry. This committee supports the strategic planning for SSI.

SSI participates in the Gulf Restoration Science Program Ad Hoc Coordination Forum hosted by NOAA RESTORE Science Program. A bi-monthly meeting for synthesis, integration, and working with other regional research programs to share and integrate scientific findings.

SSI participates in the monthly RESTORE Act Centers of Excellence (COE) meeting. Five states (AL, FL, MS, LA, and TX) form the six Centers of Excellence. These centers collaborate to discuss and address priority research questions for the Gulf. COEs are intricately tied with their respective state agencies, allowing for genuine knowledge co-production that benefits each state locally and, more broadly, Gulf-wide.

SSI participates in the Gulf of Mexico Conference (GoMCon). GoMCon emphasizes the intersection of scientific research and the management of human and natural systems of the Gulf of Mexico. A great resource for researchers, resource managers, and stakeholders to collaborate on the natural resources of the Gulf of Mexico.