2015 EFD Sponsors' Report

January 11, 2016

The Environmentally Friendly Drilling Systems Program

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INTRODUCTION

The Environmentally Friendly Drilling Systems (EFD) Team is pleased to provide this report to the Sponsors. The report discusses progress, accomplishments and challenges. Our goals for 2016 incorporate direction from our sponsors, following our annual sponsors meeting held on November 11, 2015 and the various EFD workshops held throughout the year. We believe we are successfully meeting our goals of providing (1) new research, (2) information, education and training, and (3) engagement and services to the community—all in the area of sustainable development of energy resources. Our focus is to provide unbiased science to address environmental and societal aspects of all oil and gas activities. Our work is to give all stakeholders the tools needed to demonstrate that safe and environmentally responsive development can (and does) occur.

Our work could not be accomplished without the funding, direction and advice provided by all of our sponsors:

Research Partnership to Secure Energy for America (RPSEA)/National Energy Technology Laboratory
US Fish & Wildlife Service/Texas General Land Office (GLO manages on behalf of the Texas Coastal Land Advisory Board)
Alcoa
Apache
bp
Chevron
Hess
Pioneer Resources
Shell
Statoil
DNV-GL
GE
Halliburton
Huisman
Keane Group
MI SWACO
National Oilwell Varco
Newpark Resources Inc.
Schlumberger
Tenaris

The EFD program also has environmental and regulatory advisors that provide cost share to the overall program, including:

The Nature Conservancy
Environmental Defense Fund
Ducks Unlimited
Texas General Land Office
Texas Commission on Environmental Quality
Texas Railroad Commission

The EFD team maintains a relationship with many more industry and environmental organizations as well as with various local, state and federal agencies across the USA and other governmental entities in other countries. This is an added and valuable benefit EFD provides to all sponsors. Organizations that the EFD team collaborates with include:

International Association of Drilling Contractors
Hart Publications
American Association of Petroleum Geologists
Alamo Area Council of Governments
Consumer Energy Alliance
Groundwater Protection Council
Interstate Oil and Gas Compact Commission
Petroleum Equipment and Services Association
Petroleum Technology Transfer Council
Research Partnership to Secure Energy for America
The Elder Ranch Trust
Texas Water Recyclers Association
Power Across Texas Association
Center for Sustainable Shale Development

Our EFD sponsors fund the program for three years, having the option to renew their membership on an ongoing basis. In addition to the financial support, our sponsors help us manage the overall effort, participating in meetings and research efforts. In return, our sponsors enjoy the following benefits:

- Access to EFD Alliance – EFD expert teams can be established to work with members on specific issues.
- Quarterly Advisors Meetings.
- Engagement in EFD Projects.
- Voice in Program Direction.
- Access to Reports, Review Meetings, etc.
- Networking with Environmental Organizations.
- Networking with Community Groups.
- Communication via EFD Team with Regulators, Legislators, Agencies.
- Direct Focus of Membership Fee – Consortium members may decide where their fees may be used.

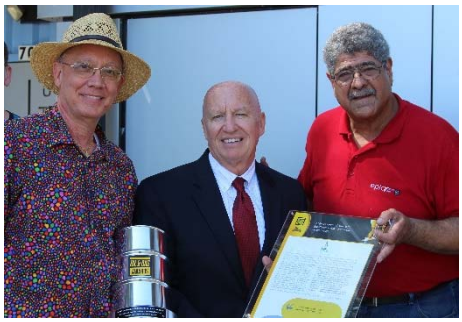
This report discusses the entire EFD program. Begun with funding from the U.S. Department of Energy in 2005 and then receiving funding under the RPSEA Unconventional Natural Gas and Other Petroleum Resources Program in 2009, funding from the US Agency for International Development (USAID) in 2010, additional RPSEA funding in 2012, and funding from the US Department of Interior in 2011, along with funding from various stakeholders, the EFD program ***provides unbiased science and develops solutions to address environmental and societal aspects of oil and gas development***. Featuring an international research team, the program has had many accomplishments. The program has successfully brought together government agencies and regulators, industry, academia, environmental organizations, a variety of associations and the public. As ***RigZone*** reported,

> ***"No other organization in the oil and gas area has ever been able to successfully link this broad spectrum of stakeholders, providing opportunities for communication between groups that normally do not communicate very well."***

During 2015, EFD was featured in the Hess 2014 Sustainability Report.

During 2015, the program was honored by the Oil and Gas Awards with the VZ Environmental Award for Excellence in Environmental Stewardship and was also selected as a finalist for the Best Health, Safety and Environment Program – Onshore by **World Oil**.

A testament to the program's success is the number of speaking invitations and the large number of publications in a broad variety of media. Engaging sponsors and all stakeholders, the EFD team has accomplished it all by being objective and using sound science in supporting workable practices to reach our goals.



Congressman Brady congratulating EFD Team on the VZ Environmental Award for Excellence in Environmental Stewardship.

The EFD team has had several successes throughout the year. Notably, in 2015 the EFD team has:

- **Completed development of the Land Use Site Selection Information Tool (LUSSIT),** a GIS based analytical tool that aggregates a large number of spatially distributed attributes and considerations in the region(s) of interest to support site selection decisions.
- Over 30 demonstration and case study projects completed, on budget, on schedule or underway, including:
  - ***First to successfully employ technology*** and methods that characterize over 256 pollutant emissions all at once from oil and gas operations. (Other instruments and methods only measure one pollutant at a time so you were never able to see the full emissions profile until now.)

  - Demonstrated that operators can recycle up to 80% of the produced brine from fracturing fluids and make them acceptable for re-use in hydraulic fracturing fluids.
  - Engine emissions measurements from dual fuel engines used in hydraulic fracturing operations.
  - Transforming flare gas into electricity through the use of an Organic Rankine Cycle process.
  - **Completed Eagle Ford Perceptions of Oil and Gas Study.**
- 10 workshops and 5 webinars held on a variety of topics, including:
  - Downhole Raman Spectroscopy
  - Utica Shale Play Book Study
  - Monitoring Fugitive Gas Emissions
  - Turning Flaring Gas into Electricity – Field Demonstration
  - Flaring Issues, Solutions and Technologies (FIST)
  - Using Natural Gas Fuel for Drilling and Hydraulic Fracturing
  - Electrification for Oil and Gas Operations
  - EFD Overview Webinar for BLM
- **Supported Sponsors Sustainability and Environmental Awareness initiatives.**
- Provided technical resources to sponsors on water management.
- Provided technical resources to our sponsors on induced seismicity issues.
- Obtained funding and initiated effort to expand the EFD Virtual Site by adding a production pad. Also began development of an offshore virtual safety site.
- **Expanded the BMP website** and the LawAtlas.org comparative law database, adding additional states to the comparative law database.
- **Regularly briefed state officials, Congress and Congressional staff members** on 'hot topic' E&P activities.
- **Expanded the Newsletter network** from 2,500 to over 3,400.

None of the above could have been accomplished without the financial and technical support of your organization as a sponsor. Funding from the industry has enabled the EFD team to meet cost share requirements associated with U.S. Federal funding. **As a sponsor, your $100,000 investment leverages over $16,000,000 of research.**

The EFD program strives to ensure that the technologies included in the program are eventually used in the field. There are two different types of projects carried out in the EFD program: core projects and supplemental projects. All EFD sponsors have full access to the results from the core projects. Supplemental projects are funded by sponsors on a project-to-project basis with the results shared with those that fund the effort. The EFD management team encourages sponsors to take appropriate actions to assist in commercializing promising technologies or processes identified or initiated by this program.

The Core and Supplemental Projects are as follows:

Core	Supplemental
1. EFD Virtual Sites a. EFD Site – Production Pad b. Virtual Offshore Safety Training 2. The Environmentally Friendly Drilling Systems – Technology Integration Program 3. The Coastal Impacts Technology Program 4. EFD – Europe 5. Support to Other Programs a. Advanced Analytical Methods for Air and Stray Gas Emissions and Produced Brine Characterization b. Utica Shale Energy and Environment Laboratory (USEEL)	1. Powered by Natural Gas (PbNG) Operations 2. Flaring Issues, Solutions and Technologies 3. Environmental Issues in Osage County 4. Mississippi State Public Perception Study 5. Assessment of the Environmental, Performance and Economic Impact of a High-Performance Water-based Drilling Fluids System in the Marcellus and Utica Shale Plays 6. Induced Seismicity

Technology transfer is a key element of the Environmentally Friendly Drilling Systems Program. The EFD team is heavily involved in engaging stakeholders at multiple levels. The EFD team is routinely called upon to participate in various roundtables, both in industry and in the public and is actively engaged in planning activities for various conferences, forums and exhibitions.

The EFD Alliance continues to grow. Monthly teleconference calls are held with Alliance members to discuss synergies among research efforts, needs identified by Sponsors and potential collaboration opportunities. Current members include:

Argonne National Laboratory
Los Alamos National Laboratory
Oak Ridge National Laboratory
Sandia National Laboratories
Battelle
Case Western Reserve University
Colorado School of Mines
Lamar University
Mississippi State University
Penn State University
Rice University
Sam Houston State University
Texas A&M University
- Global Petroleum Research Institute
- Institute of Renewable Natural Resources

The Ohio State University
Utah State University
University of Alaska – Fairbanks
University of Arkansas
University of Colorado
- Natural Resources Law Center
- School of Public Health

University of Houston
University of Kentucky
University of Leoben
University of Oklahoma
University of Texas
- Bureau of Economic Geology

West Virginia University
Houston Advanced Research Center

PROGRAM OBJECTIVES

The long term goal of the Environmentally Friendly Drilling Systems (EFD) program is to appropriately address environmental and societal aspects in oil and gas operations. This includes demonstrating how industry is reducing the footprint of operations in environmentally sensitive ecosystems through integration of low-impact site access and operations. Research and technology development also address potential long-term reduction of the environmental footprint associated with operations and reduce drilling and operations expenses. The EFD Team works with industry, regulators, environmental organizations and other stakeholders to develop cost-effective technologies and to provide unbiased science for sound policy that manages environmental risks associated with oil and gas drilling and production activities. Through involvement with the Interstate Oil and Gas Compact Commission and the Groundwater Protection Council, the EFD team provides data, facts and other information concerning the review of rules/regulations. In addition to technology and policy issues, the EFD team performs research on the public perception of operations and practices.

The overall objectives of the program are to:

1. Identify, develop, test and demonstrate new cost-effective technologies that reduce the environmental tradeoffs of E&P operations.
2. Integrate current/emerging technologies into systems with no or very limited environmental tradeoffs.
3. Express the attributes of an optimized system by use of environmental scorecards for various ecosystems that can measure tradeoffs associated with unconventional natural gas production.
4. Develop case studies of applying technologies in environmentally sensitive ecosystems, capturing best practices and lessons learned that will enable replication at other locations.
5. Create and manage a joint project of industry, academic, government and environmental organizations partners to assess methods to mitigate individual costs and develop acceptance of an entire viable system to accomplish this task.

6. Through a technology transfer effort, educate industry, public, government, environmental organizations and others about practices, technologies and systems that enable the production of natural resources in environmentally sensitive areas. Hold various workshops to ensure that the overall program is appropriately focused.
7. Document findings to ensure that the technologies, methodologies and systems developed, reviewed and evaluated are available to all interested parties.

2016 LOOK AHEAD

The EFD Program will be undergoing a year of challenges and transition in 2016. Funding for two major efforts, the Technology Integration Program and the Coastal Impacts Technology Program, will expire in late 2016. With the economic climate change due to oil and gas pricing, some industry sponsors will be lost while others recognize how the EFD program provides significant leveraging of precious research resources.

The EFD Program will continue to keep the main thing the main thing – providing unbiased science. Focused areas of research for 2016 will include:

- Actual field measurements of engine emissions. The EFD Team will take delivery of the intrinsically-safe measurement box (the i-box) during first quarter. With the i-box, the EFD team will be the first research team having the ability to safely measure tail pipe emissions during hydraulic fracturing and drilling operations.
- There are P&A oil and gas wells along the Gulf Coast that are now exposed (or daylighted), along with gathering lines, piping and other infrastructure due to effects of erosion. Long-term exposure to the atmosphere and thermal cycling can jeopardize casing integrity of P&A wells (especially in coastal regions or wetlands), cause mechanical impacts, or expose wells to human tampering. The EFD Team will partner with the Texas General Land Office to submit a proposal in January 2016 to develop a framework for identifying and remediating issues.
- The EFD Virtual Site (www.efdvirtualsite.org) has proven to be an effective means of technology transfer. In 2016 work will continue on two sites, the virtual pad site and the virtual offshore safety site.
- With a proven track record of providing technology transfer, the EFD Team will pull together a Center of Excellence and pursue funding. This may occur in 2016 or early 2017.
- Based on the various public perception studies, a Communications Guideline Document will be developed in 2016.
- With the EFD Scorecard now recognized as a methodology for operating companies to demonstrate how environmental and societal aspects are addressed, a means to increase the use of the Scorecard will be pursued.
- Conduct field demonstration projects of various technologies aimed to reduce flaring.
- Funding for the Water Challenge, analogous to the EPA's Methane Challenge, will be pursued.

EFD POWER BY NATURAL GAS – ENGINE TESTING

Working with the HARC engine science group, EFD carried out additional testing on diesel engines in hydraulic fracturing service. Building on our previous studies with dual fuel diesels, the team tested three additional, Tier 4, diesel engines rounding out a suite of data enabling comparison of emissions characteristics between dual fuel and clean diesel. Our sponsors were the first to see this data, before any open publication. Efforts to publish these data in conference presentations and journal articles are ongoing. Adding to this work EFD will be testing more reciprocating engine platforms, including dual fuel, diesel, and spark-ignited dedicated gas engines.

Key findings from these studies revealed that for dual fuel diesel engines there are:

- **Clear emissions advantages in:**
  - NO_x Oxides of Nitrogen
- **Minor disadvantages in:**
  - CO Carbon Monoxide
  - NMHC Non-Methane Hydrocarbon
  - Crankcase Blow-by Emissions
- **Significant disadvantages in:**
  - CH_4 Non-Combusted Methane (Greenhouse Gas)
  - CH_2O Formaldehyde
  - **Non-Combusted Methane (NCM) is significant, expressed as a percentage of total natural gas fuel supply, as much as 30% at high substitution**

Based on these findings EFD is funding work in the HARC engine lab to better understand dual fuel combustion characteristics and develop solutions to improve efficiency and emissions. Improvements in engine control and exhaust after-treatment aimed at reducing the amount of non-combusted methane emitted in the exhaust stream are being developed and tested. Results of the work will be forthcoming in 2016.

As mentioned above, EFD now has the capability to bring emissions measurement equipment to drilling and fracturing locations. In response to input from our sponsors, EFD commissioned fabrication of a special enclosure for the emissions analyzers. The enclosure is suitable for use in a Class 1, Division 2 hazardous environment, making it intrinsically safe for use in areas where flammable gases may be present. This "i-box" will enable rapid deployment to field locations. The analyzers can also be used to measure many other types of gases, and will be used to test the effectiveness of treatment technologies applied to tank vents and other emissions sources.

Expanded utilization of natural gas to power operations has given rise to a trend toward greater electrification. Power generated with the use of reciprocating engines and turbines has made electrification easier and more attractive as a means of driving drilling and hydraulic fracturing, as well as other oilfield operations. Evolving technologies to more effectively process and utilize field gas will hasten adoption of electrification, reducing dependence on diesel fuel. Along with technologies for power generation, fueling and automation, the environmental and operational benefits associated with electrification were explored at a very successful and well-attended EFD Workshop on "Electrification for Oil and Gas Operations" held in October 2015.

EFD FLARING INITIATIVES, SOLUTIONS, TECHNOLOGIES (FIST) – FLARING MITIGATION

The Environmentally Friendly Drilling Program, Gulf Coast Green Energy, and Hess teamed up earlier this year to field trial the Power+ Generator at an active well site in the Bakken. This technology utilizes the Organic Rankin Cycle (ORC) to convert waste heat into electricity that can be purposed for onsite power needs or sold back to the grid. This technology can be implemented in any situation where waste heat is generated (produced hot water, flare gas, NGLs, etc.).

Produced natural gas, that would otherwise be flared, is sent to a low NOx, hot water boiler. The gas is burned inside a hot water boiler to generate hot water that will be used to excite a working fluid in the ORC heat exchanger inside the Power+ generator. This in turn drives a twin screw expander to create electricity. The Power+ System, which consists of the ORC Generator and the Boiler, was installed at a well site in North Dakota at the beginning of August and ran for 90 straight days. The EFD team monitored the technology during the field trail in order to validate its ability to produce electricity from produced gas, prove that the technology does not interfere with well operations and to determine the environmental impacts associated to the flare gas reduction.

The field trial successfully demonstrated the ability of the Power+ generator to produce onsite power from wasted flare gas. The generator had a cumulative runtime of 1937 hrs, generating roughly 104,000kWh of electricity. An emissions study conducted by Texas A&M studied the effect of the environmental impact of the ORC system. This emissions study concluded that the Power+ System reduced CO by 89%, NOx by 48%, and VOCs by 93%. The emissions study showed that the Power+ generator would meet the goals of the US EPA and North Dakota Department of Health-Air Quality by reducing emissions and providing energy through the reuse of the produced natural gas.

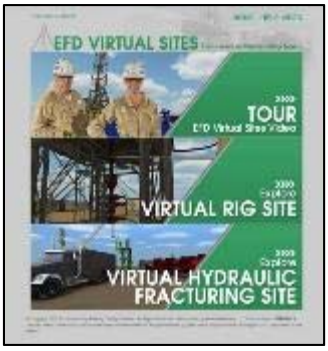
This project was featured in the December issue of the Bakken Magazine, *The Case For New Gas Capture Tech*.

PROJECTS

Core Program

EFD Virtual Sites

Funded by the Mitchell Foundation and National Academy of Sciences



One of the areas of focus within the EFD Core Program is to create and implement a workforce program to develop a workforce skilled in environmental mitigation of exploration and production impacts. In order to reach the largest audience, the EFD Team developed the free, online 'EFD Virtual Site' (www.efdvirtualsite.org). The EFD Virtual Site offers visitors the options to '**Tour**' by watching a short video that explains the oil and gas process, history, and terminology, or '**Explore**' by visiting either the Virtual Drilling Rig or Virtual Hydraulic Fracturing Site. Working with industry, environmental organizations, and academia, the Virtual Rig was launched in 2012. Through an additional grant from the Groundwater Protection Council (GWPC), the EFD Virtual Hydraulic Fracturing site was released in 2014.

The EFD Team is expanding the Virtual Site to include the well pad, production tank battery, along with other equipment that treats and stores oil and gas before it is sold and/or moved by pipeline or other mode of transportation to refineries. Hotspots such as separation and treatment equipment (separators, heater/treaters, valves, controls, thief hatches, etc.), habitat protection, and invasive species prevention plans will be incorporated. Links to the University of Colorado School of Law's Oil and Gas BMP Project website and Comparative Law Database will also be included and updated regularly.

The EFD team is now developing the Virtual Offshore Safety Training (VOST) Site for the middle-skilled O&G worker. ***Using the hot spot identification strategies similar to the EFD Virtual Site, the VOST will demonstrate actions and behaviors that the middle-skilled worker can practice in order to minimize and mitigate environmental impacts from disasters.*** Spill containment and clean up, equipment malfunctions, and exercises aimed to prevent personal and/or environmental harm are examples of potential hot spots on the VOST site. Because the VOST will be interactive, users can learn and retain the skills crucial to short and long term environmental and individual protection.

The Environmentally Friendly Drilling Systems – Technology Integration Program

Funded by RPSEA/DoE-NETL and Industry

The EFD-TIP identifies and facilitates the integration of various projects/programs that can impact the unconventional natural gas developments in an environmentally sensitive and cost-effective manner. Environmental issues are related to land, air, surface and ground water, emissions and societal aspects. Technologies come from a variety of sources: (a) service providers, (b) other RPSEA and NETL funded projects, and (c) tasks related to the EFD Program. The TIP works with other programs and builds upon the successful EFD program's growing network of operators, service companies/suppliers, universities, national labs and environmental organizations.

The goals are:

1. ***Speed the commercial development*** of technology developed through RPSEA programs.

2. Create an ***organizational structure*** that includes a network of regional centers that facilitate and coordinate field deployment of such technologies and document effectiveness of field operations.
3. ***Perform field trials*** so that results could be evaluated efficiently as to benefit both the industry, the organizations with the technology, and the public sector.
4. ***Document and provide the results*** of technology field trials so that promising processes, systems and products could be utilized in a wider range of unconventional natural gas plays.
5. ***Emphasize programs that reduce cost and improve performance***, lessen the environmental impacts, or address the societal issues associated with unconventional natural gas development.
6. ***Include and report on safety improvements in the planning/demonstration of technologies,*** emphasizing technologies that foster a culture of health/safety/environmental protection.

Regional centers provide unbiased science relating to local, regional and national policies and perform case studies of applying the technologies.

The EFD-TIP program seeks sites for field testing. Sponsors can support this effort by providing input and making field sites available for conducting this work. As part of the program, all researchers must complete essential safety training for access to field sites.

The EFD built a regionally and technically diverse subcontractor team of experts; and a team of operators, service companies, regulators, environmental organizations and other subject matter experts that serve on an advisory committee. The committee in a valuable way vets ideas and also helps to identify field test sites and gauge the relevance of various project tasks as they progress.

The EFD-TIP is a $10 million program ($6 million from RPSEA, $4 million in cost share). Various components of the program are discussed in the following. Due to delays in receiving the release of the last traunche of funding, this program was extended into 2016.

Highlights from the program include:

Best Management Practices (www.oilandgasbmps.org, www.lawatlas.org/oilandgas) – Colorado School of Law
The Colorado School of Law continues to expand the Best Management Practices (BMPs) website as well as the comparative law website. These sites provides BMP and other resource information to a wide audience, including industry, community, government and environmental advocates. The database contains over 8,600 BMPs, from nearly 700 source documents in categories such as Wildlife, Water, Air, Health, Soils and Vegetation. Resource and Law & Policy sections provide additional information, such as Hydraulic Fracturing, Economics of BMPs, Reclamation and laws and policies governing oil and gas development in the Intermountain West. In addition to many minor updates, the website project added resource pages on Water Quantity and Compliance/Enforcement, and updated the Law & Policy pages for several Indian Tribes.

EFD West Regional Field Center: Field Trials – Texas A&M University – Institute for Renewable Natural Resources, Global Petroleum Research Institute
The ***EFD West Regional Center*** has established test sites in the Eagle Ford, Barnett, Permian, and Bakken where field tests have already been coordinated and managed by Texas A&M University – Institute for Renewable Natural Resources (IRNR) and the Global Petroleum Research Institute (GPRI). This work includes air emission studies, water treatment technology testing, stray methane migration research and invasive plant mitigation studies. Field trials have been conducted during active drilling, active fracturing, production facilities, well heads and tank farms, at service companies R&D facilities and in partnership with private landowners.

EFD East Regional Field Center: Field Trials – West Virginia University
Two primary field trials have been ongoing in the ***EFD East Regional Field Center***. The first involves an assessment of the environmental, performance and economics of a high-performance water-based drilling fluids system in the Marcellus and Utica shale plays. The second field test is an assessment of the enviornmental impacts of hoirzontal

gas well development operations, examining the effects of large-scale horizontal drilling on surrounding air and water resources.

Water Management Testing – Texas A&M University – Global Petroleum Research Institute
The EFD-TIP team at A&M is testing new water treatment and re-use technologies by field testing processes and products prior to commercial development. The team validates new technology under field-operating conditions and gathers performance data on process systems so that engineering can scale up such systems to full-size commercial operations.

Public Perception Studies – Sam Houston State University, Utah State University, Penn State University and Mississippi State University
This effort is creating a framework and solid foundation for identifying, gathering, and analyzing timely and salient social, economic, and environmental data associated with energy development, and then providing the information to industry and other stakeholders so that the variant social, economic, and environmental impacts can be minimized and/or avoided. In addition, a "Best Practices Communication Toolkit/Handbook" will issue in 2016 with a goal to improve communication and guide the use of effective community engagement activities between industry actors and local community residents/leaders. The scientific knowledge gleaned from this research will produce lasting and profound effects for industry. Successful completion has the potential to accelerate adoption of new and existing technologies, services, practices, and methods, and to assure that these technologies will be accepted by industry, regulators, and the public. Recognizing and pro-actively addressing concerns of key stakeholders and the general public can lessen or avoid unnecessarily long and complicated delays, civil actions, and potential litigation.

Air Quality/Emissions Testing – Texas A&M University-Kingsville (TAMUK), Texas Center for Applied Technology (TCAT – IRNR) and Oak Ridge National Laboratory (ORNL)
The team has tested a broad range of new and existing *in situ* and mobile sensors capable of measuring environmental conditions and can be integrated with the Sensorpedia system. Data sources include monitoring stations, vehicular emission sensors, leak detectors, open source sensors (e.g., from NOAA, USGS, EPA, NASA), enterprise sensors, and human field observations. A prototype wireless sensor network (WSN) for monitoring total non-methane hydrocarbon (TNMH) concentrations using photoionization detectors (PIDs) was established to provide oversight air quality monitoring at an EFD-TIP field test site in DeWitt County, Texas. The wireless sensor network has also been deployed to characterize TNMH concentrations on and near active well pads in LaSalle and Live Oak Counties. The field tests have demonstrated feasibility of using a WSN to obtain continuous real-time air quality monitoring at remote sites, as well as the feasibility of using photovoltaic solar panels to provide power to sensors.

Land Use Site Selection Information Tool (LUSSIT) – University of Arkansas, Latitude Geographics
This project developed a flexible and practical GIS software product for producers and regulators that standardizes the process of placing oil and gas wells and supporting infrastructure while preseving environmental values. The tool has enabled:

- Reduced operator costs
- Improved performance and timelines associated with oil and gas development
- Better assessment of risks associated with infrastructure placement
- Facilitated more efficient regulatory approval methods
- Preserved environmental values
- Incorporated flexible use of operator, regulatory and 3rd party systems and information

Public Health Enhancement Opportunities – Colorado School of Public Health
The work performed included the assessment of data collected by EFD TIP partners from field tests to qualitatively evaluate the public health features of each field test and to compare public health features between tests. The project identified public health tradeoffs for a generic natural gas development site by incorporating public health measurements, including air and surface and ground water, emissions, and social measures.

The Coastal Impacts Technology Program

Funded by US Department of Interior/Managed by the Texas General Land Office on behalf of the Texas Coastal Land Advisory Board (TCEQ, RRC, GLO)

The EFD Coastal Impacts Technology Program, EFD-CITP, was initiated in 2012 as a comprehensive program that identifies environmentally friendly technologies, supporting research to implement and demonstrate impact mitigation potential along the Texas Gulf Coast. Program projects are aimed at developing methodologies and measuring effectiveness of technologies to conserve, protect or restore the natural coastal environment, and to educate the workforce. The goal is to provide a program of research and demonstration that may lead to commercial application of technologies that will reduce environmental impacts of unconventional natural gas and other petroleum exploration and production activities along the Texas Gulf Coast. Objectives include:

- **Technology Road Mapping**: Identify technologies that will reduce the environmental impact of oil and gas activities along the Texas Gulf Coast;
- **Environmental Impact Mitigation**: Evaluate technologies that may mitigate the environmental impacts of oil and gas exploration and production on coastal areas;
- **Inter-state Collaboration**: Coordinate efforts with other producing states to identify, formalize and co-fund collaborations regarding applicable technologies; and
- **Workforce Program**: Create and implement an educational program for the oil and gas industry workforce, focusing on environmental impact mitigation of exploration and production in coastal regions, in particular, the Texas Gulf Coast.

All projects are slated for completion by mid-2016. Highlights include:

Site Restoration: Stakeholder Perceptions of Low-Temperature Geothermal Energy Development in Environmentally Sensitive Coastal Areas in Texas – Texas A&M University

The study addresses the potential impact of societal issues and attitudes surrounding development of low-temperature geothermal energy (LTGE) in an environmentally sensitive area. The purpose of such pre-development research is to effectively mitigate social concerns regarding LTGE if the development of this unconventional energy source is determined to be technically, economically, and environmentally feasible. Historically, the lack of broad-scale stakeholder input has led to public resistance and divisive confrontations that have slowed or terminated the development of energy production initiatives. This study is creating a methodology that could be used to reduce the probability of such actions. The methodology creates guidelines for industry – community development that are applicable whenever new development is envisioned for environmentally sensitive areas.

Site Restoration: Assessing the Ecological Integrity of Wetland Functionality in Response to Energy Exploration and Production Operations on the Upper Texas Gulf Coast – Houston Advanced Research Center

The project addresses the ecological integrity of wetland functionality in response to energy exploration and production operations along the Upper Texas Gulf Coast. Objectives are to prioritize wetland functions dependent on wetland type, location and other factors. Key wetland functions that can be directly impacted by drilling and production activities were included in the tool; examples include coastal flooding mitigation, habitat for wintering waterfowl, and importance for commercial and recreational fishing. The goal is to create a resource for the oil and gas community to access sound wetland science and management strategies in an efficient, interactive, and user-friendly platform.

Air Emissions: Biological Emissions Treatment Technology Deployment to Reduce Air Pollution for Refining Operations – Texas A&M University-Kingsville (TAMUK)

Biological treatment of air emissions is a cost effective and sustainable alternative to high-temperature thermal oxidizers or flares as a means removing Hazardous Air Pollutants and Volatile Organic Compounds for emissions reductions. The project demonstrated the capture and treatment of air pollutants using two-stage biofiltration technology. Biological treatment of waste air achieves pollutant destruction at ambient temperatures and does not generate secondary pollutants that result from flaring and other high-temperature oxidation technologies. In this

study, two types of biological treatment will be used together in tandem. Contaminants are transformed to innocuous products through the action of microorganisms present in the treatment filter media. The project proved the effectiveness of biological air emission treatment for VOC control of certain petrochemical industry emissions.

Site Restoration: Restoring Altered Surface Hydrology at Texas City Prairie Preserve – The Nature Conservancy
The project restored drainage patterns on 2 sites totaling about 30 acres of the preserve by replacing and improving road culverts, trenching existing ditches, and grading land where needed to improve surface flow, and removing drainage impediments that have resulted in areas for water to pool. The objective of this work was to improve site conditions so as to discourage the infestation and reproduction of deep rooted sedge.

Site Restoration: Effects of Age and Depth on Topsoil Properties and Seed Banks Characteristics – Texas A&M University-Kingsville (TAMUK)
This work served as a basis for a related project on restoration of soil mixtures, to experimentally investigate methods for restoration of areas where soil and seed bank have been adversely affected by energy development. Analyses conducted include soil chemical properties, soil biological properties and seed bank composition and dynamics. Data collected will help improve soil storage practices through better understanding of relevant ecosystem processes and recommendations for greater success in site restoration.

Site Restoration: Restoration of Soil Mixtures – Texas A&M University-Kingsville (TAMUK)
In two complementary experimental approaches, restoration guidelines for mixed soils in the coastal counties were developed. Growth medium manipulation and soil amendment practices were examined. In combination with these soil cultural practices, screening for plant species adaptability was conducted in greenhouse studies.

Air Emissions: Thermal Swing Adsorption to Capture Toxic Air Emissions from Point Sources – Texas A&M University-Kingsville (TAMUK)
With the goal of capture and recovery of toxic air emissions from point sources such as oil and condensate storage tank vents, the project involved the development and testing of an innovative thermal-swing adsorption (TSA) system. The system makes use of commercially available granular activated carbon (GAC) as the adsorbent to passively capture gas emissions. The system focuses on the capture of hazardous air pollutants (HAPs) and the recovery of HAPs in liquid form. Electrothermal heating integrated with the system functions to desorb the captured compounds for disposal, treatment or reuse.

Site Restoration: Impacts of Oil and Gas Interests on Environmentally Sensitive Coastal Areas of Texas – Texas A&M University
In an effort to understand and address aspects of oil and gas interests on private land conservation, this research focused on the social dimensions of oil and gas development, and the habitat and fate of endangered species. The objective of the work was to develop a framework to facilitate the incorporation of landowner views, and biodiversity considerations into future oil and gas and development. Key study parameters included the influence of oil and gas experience on attitudes and concerns toward conservation practices, land use decisions and spatial orientation. The work included compilation of best management practices, and development of a spatial decision support tool.

Air Emissions: Capturing Accurate Air Emission Data from Oil and Gas Exploration and Production – Texas A&M University, Institute for Renewal Natural Resources (IRNR)
The project focused on the development of emission factors for dual fuel hydraulic fracturing pump engines. IRNR teamed with HARC and a large-scale oil and gas service provider to conduct a one-of-a-kind study. The study has included three full-scale field trials where direct engine testing and operational data collection occurred for dual fuel and Tier IV diesel engines.

Site Restoration: Evaluation of Invasive Plant Species Control Technologies at Oil and Gas Production Sites in South Texas – Texas A&M University, Institute of Renewable Natural Resources (IRNR)
The objective was to provide the oil and gas industry with a guide (based on cost and effectiveness) that can be used in upstream production project planning for the prevention and mitigation of invasive plants. A final report of the effort will issue in 2016.

Water: Assess of Two Alternative "Smart" Shale Fracturing Fluids: Desalination Concentrate and CO_2 Foam – Texas A&M University-Kingsville (TAMUK)
In this work, two alternatives to the use of fresh water in hydraulic fracturing operations were investigated. First, the feasibility of using desalination concentrate (from brackish groundwater desalination facilities) as hydraulic fracturing fluid was assessed. Second, the feasibility of using nanoparticle-stabilized CO_2 foam as a fracturing fluid was investigated. A final report of the effort will issue in 2016.

Workforce Development: The EFD Virtual Rig Website – Epic Software
The EFD Virtual Site (www.efdvirtualsite.org) enhances environmental awareness among employees. The site allows industry to demonstrate how environmental aspects are addressed. The virtual rig site has 21 hot spots where the viewer may interact with the equipment and/or practices.

Workforce Development: Watershed Education Training (WET) Eco-Art Workshop and Adventure – Artist Boat
Energy production workforce personnel participated in watershed education training focused on the Galveston Bay estuarine system. The place-based and experiential learning modules promote a common lexicon of environmental vocabulary and concepts applicable to all watersheds, estuaries, and wetland regions. Participants engaged in hands-on, place-based, and meaningful watershed experiences through a class in Eco-Art Workshops and outdoor Eco-Art Adventures via kayaks that integrate the disciplines of art and science.

Workforce Development: Stewardship Training in the Coastal Zone for Petrochemical Industrial Workers – Artist Boat
The program provided a regional mechanism for employees of oil and gas companies operating throughout the Galveston Bay region to participate in stewardship-based learning modules designed to develop a common lexicon of environmental vocabulary and concepts, promote permanent corporate and personal investments in maintaining a stewardship ethic based on broad understanding of the coastal environment through placed-based learning, and assure a continued and broadened participation in activities that address the priority environmental issues within the estuaries and watersheds impacted by oil and gas activities. The program centered on the Environmental Literacy Continuum of the Environmental Protection Agency and the science standards identified in the National Oceanic and Atmospheric Administration Ocean Literacy Principles.

Support to Other Programs

Advanced Analytical Methods for Air and Stray Gas Emissions and Produced Brine Characterization
Funded by RPSEA/DoE-NETL and Industry

The EFD Team works with the prime contractor, GSI Environmental Inc., on this project that was initiated in 2013 and formed an advisory team of subject matter experts for each of the 3 major tasks. The project is developing practical and cost-effective methods to address *collectively* three of the most important environmental risks associated with shale gas development. These risks, as expressed by legislators, regulatory agencies, and the general public; are a) potential emissions of volatile air contaminants from produced water impoundments, b) potential impacts of methane and other gases on groundwater resources, and c) ineffective treatment, disposal, or re-use of produced water due to insufficient analytical characterization.

The objective is to develop and evaluate ***scientifically-based protocols*** for the effective sampling, analysis, and interpretation of data during the monitoring and investigation of critical waste streams and potential environmental impacts. This project provides key industry stakeholders with accurate protocols for making informed decisions regarding the monitoring and mitigation of environmental risks. A final report will issue in 2016.

Utica Shale Energy and Environment Laboratory (USEEL)

Funded by DoE-NETL and Industry

The objective of the USEEL project is to create a dedicated research field site as a working laboratory for in situ research in Unconventional Oil and Gas (UOG). USEEL will involve a baseline effort that will document applicable geologic/hydrogeologic and environmental aspects of both the site and the area surrounding the site. Environmental studies will include monitoring the air, noise, light, surface and ground waters, soil, and associated ecosystems. The EFD Team will work with The Ohio State University to ensure that the objectives of the project are met in a timely and economical manner.

Supplemental Projects

Powered by Natural Gas

The EFD team initiated a project in 2014 to investigate the use of natural gas as a primary source for equipment used in drilling and fracturing operations. The objective is to determine how natural gas may be used in operations to reduce emissions and fuel costs, holistically evaluating technologies for power and fueling with respect to overall environmental benefit. The work effort also identifies safety issues/concerns including training and public outreach.

Flaring Issues, Solutions and Technologies (FIST)

As emerging regulations related to the flaring of associated gas during the production of oil wells across the country continue to impact the oil and gas industry operators are faced with potentially having to install and utilize equipment aimed at the reduction of natural gas flaring. While natural gas flaring is seen as a considerably less polluting alternative to venting methane directly into the atmosphere, operators continue to search alternatives to the flaring of natural gas. Evaluating technologies and selecting the correct one for a particular region can be a daunting task. The overall objective of the Flaring Issues, Solutions and Technologies (FIST) project is to develop and demonstrate technologies specifically designed to utilize stranded gas and even reduce or eliminate the need to flare emissions associated with oil production in the first place.

Environmental Issues in Osage County, Oklahoma

The Osage Nation Reservation consists of approximately 1,475,000 acres and is otherwise known as Osage County, Oklahoma. There are literally hundreds of thousands of old oil wells in the county which has been one of the most active areas in the US over the past 100 years. The Osage tribe owns all mineral rights located within Osage County and has an income from all oil and gas found in Osage County. The Bureau of Indian Affairs regulates the oil and gas operations and collects royalties. The Royalties are distributed to the Osage Nation "headright" owners by the Osage Mineral Council.

The EFD Team was invited by The Nature Conservancy (TNC) to offer advice to a number of large landowners, all members of the Osage County Cattlemen's Association (OCCA). Improvements are slowly being made. Current regulations and BIA enforcement lack adequate protection of the land, surface and ground water, air, environment and safety as compared to regulations on all other producing states and the current regulations covering other

Federal lands enforced by the Bureau of Land Management. The current and proposed rules were proposed in 2013 and have still not been promulgated. The rules as drafted still do not incorporate prudent oversight provisions, permitting processes or industry standards followed by all other areas, in particular the State of Oklahoma, where citizens in the remainder of the State outside of Osage County are better protected. Our efforts will continue to support prudent regulations and oversight. The BIA was delinquent in developing a county wide Environmental Impact Assessment that has hindered permitting and added to an unnecessary conflict between operators, landowners and the regulators. EFD will continue to provide comments on these documents.

Mississippi State Public Perception Study

The state is no stranger to the industry as Southwest Mississippi has undergone oil booms in the past. However, the state has not experienced a large amount of activity in many years. New technology as well as changes in legislation have made the state a more attractive possibility for industry growth in an emerging shale play called the Tuscaloosa Marine Shale (TMS).

In preparation for an increase in energy development activities, policy makers must make decisions regarding changing infrastructure needs, environmental regulations, legal issues, economics, and workforce. Elected officials must determine ways to satisfy not only industry needs, but also the desires and needs of the constituents who elected them.

The Mississippi State University Extension Service will conduct a public perception study in order to:

- Gain insight into how the general population views the industry
- Determine the public's concerns regarding the industry
- Determine what the public views as the benefits of the industry
- Develop policy briefs and provide educational training in order to close the communication gaps between the industry and the public's perception of the industry

Assessment of the Environmental, Performance and Economic Impact of a High-Performance Water-based Drilling Fluids System in the Marcellus and Utica Shale Plays

The drilling industry is continuously challenged with new regulations and rules impacting its daily operations. This in turn requires finding new methods as well as new environmentally acceptable products to address day-to-day operational challenges. An important component of drilling is the fluid used in the process. Due to problems associated with drilling through shale formations, especially when drilling highly deviated or horizontal sections, the high lubricity of oil-based drilling fluid is often preferred. However, the use of a non-aqueous based fluid increases the cost of operations due to treatment needs and disposal requirements. An environmentally acceptable drilling fluid that can meet operational demands will improve environmental performance.

Under the auspices of EFD, The Ohio State University and West Virginia University conduced Phase 1 and published a report. Phase 2 is being directed by West Virginia University where students are conducting the analysis for this study. The final results will be presented at the annual American Association of Drilling Engineers (AADE) conference in 2016, they will also be included in the EFD scorecard as these EFD practices may be cost effective, enhance public relations, increase productivity and reduce environmental impacts and potential liabilities.

Induced Seismicity

The EFD Team is documenting various aspects associated with induced seismicity. *StatesFirst Induced Seismicity by Injection Work Group (ISWG)* chartered in 2014 introduced a primer on September 28, 2015, titled "Potential Injection-Induced Seismicity Associated with Oil & Gas Development: A Primer on Technical and Regulatory Considerations Informing Risk Management and Mitigation". The 148 page primer provides a valuable overview of the current state of research and technical understanding of induced seismicity related to Class II disposal wells and

provides guidance in mitigating seismic risks associated with waste water disposal wells. The primer is solely informational. Although further data and study are needed and significant uncertainties exist, regulators and industry can use the tools, knowledge, and expertise in the primer and take steps to inform and protect the public. The EFD Team pulled together a summary report aimed at providing an overview of the information discussed in the primer with the hope that it will help both public and the decision making process. Future reports will aim to provide a broader understanding of the nature and scale of induced seismicity and recommendations as how best to proceed with safe development of resources while minimizing the potential to induce earthquakes.

PUBLICATIONS, PRESENTATIONS AND FORUMS

Technology transfer is a key element of the Environmentally Friendly Drilling Systems Program. The EFD team is heavily involved in engaging stakeholders at multiple levels. Members of the EFD team from Texas A&M University were involved in the EPA hydraulic fracturing study and the US Department of Energy's Energy Advisory Board – Natural Gas Subcommittee. Currently, the EFD team has various members on:

- Interstate Oil and Gas Compact Commission (IOGCC) Public Outreach Committee
- IOGCC Energy Resources, Research and Technology Committee (Chairman)
- National Research Council: Unconventional Hydrocarbon Roundtable
- Eagle Ford Center for Research, Education and Outreach/External Advisory Board
- SPE Fall Technical Program Subcommittee – HSE
- SPE/AAPL Workshop Program Committee
- SPE Oil Field Chemistry Symposium Committee
- Gulf of Mexico Alliance Education & Engagement Committee
- IADC Drilling Engineers Committee (DEC) Board
- IADC HSE Committee
- Research Partnership to Secure Energy for America (RPSEA) Board
- Texas Water Recyclers Association
- American Society of Civil Engineers Environmental and Water Resources Institute
    - Environmental Council and Interdisciplinary Council
    - Environmental Health and Water Quality Technical Committee
    - Technical Committee on Hydraulic Fracturing

The EFD team is routinely called upon to participate in various roundtables, both in industry and in the public and is actively engaged in planning activities for various conferences, forums and exhibitions.

The following is a list of publications, presentations, and forums pulled together by the EFD team.

IF A SPONSOR WOULD LIKE A COPY OF ANY PUBLICATION OR PRESENTATION, PLEASE LET US KNOW AND WE WILL SEND YOU A COPY.

Publications

2015

1. Theodori, Gene L. and A.E. Luloff (October). Perceptions of Oil and Natural Gas Development in the Eagle Ford Shale: A Summary of Findings from a 2015 Survey
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7. Wilcox, Andra, R. Haut, and T. Williams. Environmentally Friendly Drilling Systems Scorecard - SPE-173572-MS.
8. Wilcox, Andra, R. Haut, and T. Williams. Measuring Cost-Effective Practices to Address Environmental and Societal Issues Associated with Oil and Gas Development - SPE-173632-MS.
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10. NORM Workshop Presenters & The NORM Working Group at The Ohio State University (April). Naturally Occurring Radioactive Material (NORM) and Technically Enhanced Radioactive Material (TENORM).
11. Houston Advanced Research Center (January). "The Path to Dual Fuel Conversion." Natural Gas Fuel for Drilling and Hydraulic Fracturing.
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3. Mantrawadi, Nikhil, M. Nijim, D. Resseguie, G. Ogumerem, L. Clapp, A. Martinez. "VOC Emission Monitoring at Eagle Ford Shale Drill Sites Using Wireless Sensor Network for Understanding Emission Generation and Dispersion," Shale Energy Engineering, 374-383 (2014).
4. Potter, Jebadiha E., P. Petrzelka, D. Jackson-Smith, C. Ellis, G.L. Theodori, and C.A. Carmichael. (March) "Community Perceptions of the Oil and Gas Industry in the Eagle Ford Shale Play."
5. Redden, Jim (July) "Shale Technology Review – New Technologies Tackle Drilling Efficiency and HSE Issues." **World Oil Magazine**, Vol. 235 No. 7.
6. Stuver, Susan, Alonzo, Jesse R., Burnett, David B., Haut, Richard C. "*A Better Way to Estimate Emissions from Oil and Gas Sites."*
7. Stuver, Susan, Alonzo, Jesse R., *"White Paper – A Comparison of Air Emission Estimation Methods for Drilling Rig Emissions."*

8. Theodori, Gene. L., A.E. Luloff, Fern K. Willits, and David B. Burnett (April) "Hydraulic Fracturing and the Management, Disposal, and Reuse of Frac Flowback Waters: Views from the Public in the Marcellus Shale." *Energy Research and Social Science* 2:66-74.
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10. Viscomi, Jeremy and R. Haut, Ph.D. (November) "Tools for Turning Stranded Gas into Cash."
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2. Clark, Corrie E., Horner, Robert M., and Harto, Christopher B. - Argonne National Laboratory. Life Cycle Water Consumption for Shale Gas and Conventional Natural Gas. Environ. Sci. Technol., 2013, 47 (20), pp 11829011836. September 4, 2013.
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1. **Rigzone** Articles:
   a. 'First Movers in Eco-Drilling: Going 'Dope'-less', 25 April 2012.
   b. 'First Movers in 'Green' Drilling Series', 23 March 2012.
   c. 'First Movers in Eco-Drilling: What to Do with Those Pesky Drill Cuttings', 21 March 2012.
   d. 'The Great Crew Change Meets Eco-Drilling: Disappearing Roads', 15 February 2012.
2. **Hart E&P Techbook** Article:
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3. C.E. Cooke, Jr., SPE, Cooke Law Firm; J.T. Watters, SPE and L.T. Watters, SPE, CSI Technologies, LLC; S.R. Wann, Danimer Scientific, LLC; D. Zhu, SPE and Y.S. Hwang, SPE, Texas A&M University (2012). "Eco-Friendly Creation

of Propped Hydraulic Fractures" paper SPE 152189 presented at the SPE Hydraulic Fracturing Technology Conference, 06-Feb-12, The Woodlands, TX.
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   b. *'First Movers in 'Green' Drilling: Low-Footprint Rigs',* 17 November 2011.
   c. '*Haut Spearheads Green Drilling Movement',* 3 October 2011.
   d. '*Analysis: Research Group Defines 'Best' Fracking Practices to Ease Concerns*', 6 September 2011.
2. **Hart E&P** Articles:
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3. **Drilling Contractor** Articles:
   a. *'Drilling automation: Is resistance futile?*', 6 July 2011
   b. *'JIP aims to minimize environmental risks, coastal impact through technology',* 24 May 2011.
4. **Discover Magazine** Article
   a. '*Fracking Nation*', May 2011.
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   b. **Dot Earth:** *'A Fracking Method With Fewer Water Woes?',* **New York Times**, 8 November 2011.
   c. *'Shale Gas Fracking Without the Hazards',* **Daily Yonder**, 8 November 2011.
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6. Alonzo, J. and Stuver, S., *Hydraulic Fracturing Phase Emissions Profile (Air Emissions Field Survey No. 1,* Texas A&M Technology Commercial Applications Technology Technical Report to the Environmentally Friendly Drilling Program, December, 2011.
7. Platt, F. M, Burnett, D. B., Vavra, C.J. "*Pretreatment Options for Frac Flowback brine, Plant Testing of Oil Removal Materials*, CSUG/SPE 147417, presented Calgary, CA., November, 2011.
8. Mutz, K.M., Rice, K.L., Walker, L., Palomaki, A.C., Yost, K.D.: "BMPs for Minimizing Environmental Impacts: A Resource for Communities, Government and Industry," paper SPE 147503 presented at the SPE Annual Technical Conference and Exhibition, Denver, CO, 30 October – 2 November.
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16. Haut, R.C.: "We Can Minimize Negative Side-Effects of Shale Drilling", **Houston Chronicle**, 12 February 2011.
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18. Al-Yami A.S., Schubert J., Medina-Cetina Z. and Yu O-Y, (2010), "Members Drilling Expert System for the Optimal Design and Execution of Successful Cementing Practices," Proceedings of the IADC/SPE Asia Pacific Drilling Technology Conference and Exhibition, Ho Chi Minh City, Vietnam, 1–3 November 2010.
19. Yu O.K., Medina-Cetina Z. and Briaud J.L. (2011), "Towards an Uncertainty-Based Design of Foundations for Onshore Oil and Gas Environmentally Friendly Drilling (EFD) Systems," Proceedings of the Geo-Frontiers Conference, Dallas TX USA, March 13-16.
20. Yu O.Y., Medina-Cetina Z., Geikema S., Briaud J.L. and Burnet D., "Causal vs. Non-Causal Selection of Environmentally Friendly Drilling Systems," Journal of Economics and Management of the Society of Petroleum Engineering SPE.
21. Yu O.Y., Medina-Cetina Z., Geikema S., Briaud J.L. and Burnet D., "Risk-Based Selection of Environmentally Friendly Drilling (EFD) Systems," Journal of Systems Engineering.
22. Burnett, D.B, Yu, O.Y., and Schubert, J.J., "Well Design for Environmentally Friendly Drilling Systems: Using a Graduate Student Drilling Class Team Challenge to Identify Options for Reducing Impacts," SPE/IADC 119297, Prepared for presentation at the SPE/IADC Drilling Conference and Exhibition held in Amsterdam, The Netherlands, 17-19 March 2009.

Presentations

2015

2015-12-14 Evaluating Habitat Risk of Total Dissolved Solis Stored in Open Pits, Environmental Defense Fund Research Planning Workshop (Stuver).

2015-11-23 Creating Energy City – A World-Class Training, Education, Research and Technology Testing Center, Lytle City Council and Veterans Association Future Workforce Planning Meeting (Stuver).

2015-11-20 Creating Energy City – A World-Class Training, Education, Research and Technology Testing Center, Port San Antonio Research and Training Workshop (Stuver).

2015-11-18 Overview EFD TIP Program to IDE Technologies (Burnett)

2015-11-18 Use of Miniature Detection Technologies for Produced Water Analytics. Industrial Water (Platt

2015-11-12 Community Perceptions of Geothermal Energy: The Time to Begin is NOW. Texas Renewable Energy Industry Association Convention (Higgins, Burnett)

2015-11-11 EFD Technology Integration 2015 – (Burnett)

2015-11-02 Evaluating Habitat Risk of Total Dissolved Solis Stored in Open Pits, University Lands Research Planning Workshop (Stuver).

2015-10-20 Populations Neighboring Oil and Gas Development in Colorado's Denver-Julesburg Basin: 2015 International Society for Exposure Science, Henderson, NV

2015-10-20 Cumulative Risk around Oil and Gas Development Sites: Estimating Air Exposures and Risks in the Denver Julesburg Basin: 2015 International Society for Exposure Science, Henderson, NV

2015-10-20 A Spatiotemporal Industrial Activity-based Model for Characterizing Residential Exposure to Oil and Natural Gas Extraction in Colorado: 2015 International Society for Exposure Science, Henderson, NV

2015-10-20 An exploratory analysis of BTEX in groundwater samples around oil and gas wells in Colorado: 2015 International Society for Exposure Science, Henderson, NV

2015-10-15 Land Owner Information Needs Concerning Energy Development on Private Lands, Texas Parks and Wildlife Balancing Energy Development and Conservation Planning Charrette (Stuver).

2015-10-14 Developing Protocols and Tools for Testing and Analyzing Produced and Flowback Water for Treatment and Reuse, Panel Discussion at Shale Water Expo 2015, Houston (Williams).

2015-09-29 A Comparison of Emissions Estimation Protocols for Drilling Rigs, Society of Petroleum Engineers Annual Technical Conference and Exhibition (Stuver).

2015-09-29 Stakeholder Engagement and Development of Water Management Strategies: GWPC Annual Meeting, Oklahoma City, OK
2015-09-23 Overview of EFD Program and Application to Gdansk University of Technology (Burnett)
2015-09-08 Cheap Energy from Gas Shales. Outreach Presentation Dallas Geological Society (Burnett)
2015-08-26 Meeting SPE Water Management in a Down Market (Robertson, Burnett, Platt, Vavra)
2015-08-19 Shale Gas Development and Hydraulic Fracturing: Investigating Public Perceptions, Trust, and Community Engagement: XXVI European Society for Rural Sociology Congress, Aberdeen, Scotland
2015-08-19 The Environmentally Friendly Drilling Systems (EFD) Program – EFD Virtual Sites, PBPA RRC & Legislative Personnel: Austin, TX
2015-08-11 Novel Methods for Measurement of Volatile Organic Compounds at Oil and Gas Production Facilities, RPSEA Onshore Technology Workshop and Field Trip, Denver (Stuver)
2015-08-09 Correlates of Perceived Safe Uses of Hydraulic Fracturing Wastewater: Data from the Marcellus Shale: Rural Sociological Society, Madison, WI
2015-08-08 Monitoring Community Action in Pennsylvania's Marcellus Shale Play: Rural Sociological Society, Madison, WI
2015-08-07 Frac(k)ing Communities, Fractured Communications: A Case Study of Interactions between the Oil Industry, Public Officials, and Rural Communities: Rural Sociological Society, Madison, WI
2015-08-06 Simple Chemistry for Simple Answers A&M Water Treatment Workshop (Vavra, Robertson)
2015-08-05 Evaluating Habitat Risk of Total Dissolved Solis Stored in Open Pits, Waste Water Short Course, College Station (Stuver).
2015-07-22 Developing an Environmentally Friendly Workforce, South West Research Institute Collaborative Research Planning Workshop and Tour (Stuver).
2015-07-21 Advanced Methods for Open Path FTIR Technology – Research Update, Unconventional Resources Technology Conference, San Antonio (Stuver).
2015-07 -09 Water Management in the Marcellus & Utica Shales (Vavra Session Chair)
2015-06-18 Community Engaged Research: Developing Partnerships for Assessing the Impacts of Oil and Gas Development in Greeley and Fort Collins, CO, Society for Epidemiologic Research 48th Annual Meeting, Denver, CO
2015-06-17 Position on Environmental Issues, Proenvironmental Ideology, Perception of the Energy Industry, and Engagement in Civic Actions: 21st International Symposium on Society and Resource Management, Charleston, SC
2015-06-11 Environmental Studies at SHAPE Ranch, Dimmit County, Texas, Anadarko and Landowner Environmental Planning Charrette, Houston (Stuver).
2015-06-10 Technology Research, Development, Demonstration and Deployment (TRD3)," as part of the briefing series by the American Geophysical Union, Energy from the Earth: Energy-Water-Land Connections Part 2 – House and Senate, Washington, D.C.
2015-06-05 GPRI Overview: Produced Water Treatment Technology (Burnett)
2015-05-19 Low Temperature Geothermal Produced Water Treatment. SMU Geothermal Institute (Higgins, Burnett)
2015-05-12 Membrane Filtration technology Presentation for BLM. (Webinar Platt)
2015-05-01 Power across Texas Energy Innovation Challenge: Water Quality Requirements for Fracturing Fluids – Analytic Testing Technology (Robertson, Tidwell, Ghannoum, Clapp, Burnett)
2015-04-21 Health Risks Associated with Development of Unconventional Natural Gas Resources: Colorado Studies, National Jewish Hospital, Denver CO
2015-04-13 Congenital Heart Defects and Maternal Proximity to Oil and Gas Development webinar series on Fracking, Natural Gas, and Maternal Health sponsored by the Center for Environmental Health
2015-04-01 Challenges with Air Quality Measurements, AWMA Symposium, San Antonio (Stuver).
2015-03-25 State of Energy Development in Texas and Impact on Water Resources, South Africa Delegation, San Antonio (Stuver).
2015-03-17 Environmentally Friendly Drilling Systems Scorecard: 2015 SPE E&P Health, Safety, Security, & Environment Conference, Broomfield, CO
2015-04-15 Produced Water Treatment; Technology and Analytics Testing, SPE Oil Field Chemistry Symposium (Burnett)

2015-03-11 EFD Virtual Sites; A Learning Tool: Houston IPAA Energy High School – Sophomore Class, Houston, TX
2015-03-09 Update on Advanced Analytical Services for Field Operations Texas A&M Water & Wastewater Workshop (Burnett)
2015-03-07 Greening the Industry: Documenting Results with the Environmentally Friendly Drilling Program Scorecard: SPE/AAPL Enhancing the Community Conversation From Acquisition Through Production Workshop, San Antonio, TX
2015-03-07 Health Risks Associated with Development of Unconventional Natural Gas Resources: Colorado Studies AirWaterGas Teacher Workshop, Boulder CO
2015-03-03 Environmental Impacts of Unconventional Gas Development (Fracturing) U. of Michigan (Burnett)
2015-03-01 Measuring Cost-Effective Practices to Address Environmental and Societal Issues Associated with Oil & Gas Development: SPE Production and Operations Symposium, Oklahoma City, OK
2015-02-24 Methods for Flare Measurement, EFD Workshop, San Antonio (Stuver)
2015-02-15 Knowledge of Hydraulic Fracturing and Support for Natural Gas Drilling: Data from Pennsylvania: Southern Rural Sociological Association, Atlanta, GA
2015-02-03 Energy Development and Ecosystems: Examining Attitudes and Behaviors of the General Public: Society for Range Management annual meeting, Sacramento, CA
2015-01-20 Technology Integration Program: Advanced Produced Water Treatment Research – 2015 Projects Webinar Series (Burnett) Produced Water Society Annual Meeting
2015-01-14 Advanced Produced Water Treatment: Analytical On-Site Services (Burnett, Platt, Vavra)
2015-01-08 Advanced Analytical Protocol for Measurement of Emissions with Open Path Fourier Transform Infrared and Integrated Weather Sensors – Research Update, National Energy Technology Laboratory (Stuver).
2015-01-05 Advanced Analytical Protocol for Measurement of Emissions with Open Path Fourier Transform Infrared and Integrated Weather Sensors – Research Update, Webinar, Department of Energy Air Emission Project Meeting (Stuver).

2014

2014-11-12 Documenting Results with the Environmentally Friendly Drilling Program Scorecard, DEA Meeting, Houston, TX
2014-11-07 Addressing Environmental Issues Associated with Hydraulic Fracturing, Montgomery, TX
2014-11-05 Gas Flaring: Exploring Economically Feasible and Environmentally Friendly Solutions, EUOGS, Lexington, KY
2014-10-23 Addressing Gas Flaring by Utilizing Novel Technologies to Monetize Gas Wellhead -Denver, CO
2014-10-08 Public Perception of the Oil and Gas Industry - Houston, TX
2014-10-08 Monitoring Community Action in Pennsylvania's Marcellus Shale Play – Houston, TX
2014-10-08 Understanding Drivers of Environmental Technology Adoption in the Oil and Gas Industry – Houston, TX
2014-10-08 Managing Energy Development in Mississippi – Houston, TX
2014-10-08 Fractured Communications in the Eagle Ford Shale – Houston, TX
2014-10-06 Comparative Databases for Water Quality and Quantity Regulations Pertaining to Oil and Gas Developments – GWPC Annual Meeting, Seattle, WA
2014-10-06 Virtual Hydraulic Fracturing Site – GWPC Annual Meeting, Seattle, WA
2014-09-24 CH4 Connections: Federal and State Air Quality Rules for Natural Gas Development: The LawAtlas Database – Houston, TX
2014-09-16 Flare Gas: Exploring Economically Feasible & Environmentally Friendly Solutions - Pittsburgh, PA
2014-09-10 Flare Gas: Exploring Economically Feasible & Environmentally Friendly Solutions - Houston, TX
2014-08-27 Flaring Issues, Solutions, and Technologies (F.I.S.T.) - Denver, CO
2014-08-06 The Environmentally Friendly Drilling Systems (EFD) Program, West Texas Legislative Summit – San Angelo, TX

2014-07-21 Feasibility of Using Brackish Groundwater Desalination Concentrates as Hydraulic Fracturing Fluid – ASCE Shale Energy Engineering Conference, Pittsburgh, PA
2014-07-21 VOC Emissions Monitoring in the Eagle Ford Shale Using a Wireless Sensor Network – ASCE Shale Energy Engineering Conference, Pittsburgh, PA
2014-07-17 Rocky Mountain Environmental Health and Safety Peer Group: BMP and LawAtlas Projects – Denver, CO
2014-07-16 Colorado Oil and Gas Conservation Commission: BMP and LawAtlas Projects – Denver, CO
2014-06-24 Monitoring and Characterization of VOCs in Ambient Air near Active Gas Wells in the Eagle Ford Shale – A&WMA 107th Annual Conference
2014-06-11 Shale Gas Development: Trust and Engagement in Individual Civic Actions – 20th International Symposium on Society and Resource Management, Hanover, Germany
2014-06-10 Addressing Environmental Issues and Increasing Environmental Awareness - Shale Development 101, Pittsburgh, PA
2014-06-09 Assessment of Desalination Concentrate as an Alternative Water Supply for Hydraulic Fracturing – 7th International Conference on Environmental Science & Technology, Houston, TX
2014-06-06 Addressing Environmental Issues and Increasing Environmental Awareness - Annual Martz Summer Conference, Boulder, CO
2014-06-04 Geology and Resource Potential of Appalachian Shale Gas and Shale-Hosted Liquids Plays - Unconventional Gas & Oil Development: Economic and Environmental Impacts Meeting, Morgantown, WV
2014-04-28 Analysis and Diagnosis of Membrane Filtration Fouling – 24th Annual Membrane Filtration Short Course, College Station, TX
2014-04-21 Hydraulic Fracturing Flowback Treatment: Primary Treatment Design – 2014 Frank H. Dotterweich Senior Design Conference, Kingsville, TX
2014-04-11 Hydraulic Fracturing and Shale Gas Development: Examining Public Perceptions, Trust, and Community Engagement – SUNY Conversations in the Disciplines Conference, Binghamton, NY
2014-04-11 Monitoring Community Action in Pennsylvania's Marcellus Shale Play – SUNY Conversations in the Disciplines Conference, Binghamton, NY
2014-04-11 The Social and Community Implications of Oil and Gas Development in the Eagle Ford Shale – SUNY Conversations in the Disciplines Conference, Binghamton, NY
2014-04-11 Understanding Drivers of Environmental Technology Adoption in the Oil and Gas Industry – SUNY Conversations in the Disciplines Conference, Binghamton, NY
2014-04-10 Developing Technologies & Best Management Practices to Minimize the Environmental Impacts of Natural Gas Exploration & Production - HSE for Unconventional Oil and Gas, San Antonio, TX
2014-04-08 Air, Water, Land Issues, Global Technology Exchange & GOT Task Area Work Sessions– Florence, IT
2014-03-28 Water Quality Data Presentation at Managing Oil and Gas Development in Mississippi, Natchez, MS.
2014-03-20 Fracking, Water Quality and Public Health: Examining Current Laws and Regulations- The Network for Public Health Law Webinar, St. Paul, MN
2014-03-18 Shale Production and the Environment: Key Issues for Compatibility – ASME Energy Forum, San Diego, CA
2014-03-17 Objective and Perceived Effects of Hydraulic Fracturing and Shale Gas Development: A Sociological Perspective- American Chemical Society National Meeting, Dallas, TX
2014-03-12 Addressing Environmental Issues and Increasing Environmental Awareness- Center for Sustainable Shale Development, Pittsburgh, PA
2014-03-04 Natural Gas Power for Shale Development – Using Natural Gas Fuel for Drilling and Hydraulic Fracturing. 2014 IADC/SPE Drilling Conference, Fort Worth, TX
2014-02-19 New Methods for Air Emission Measurement using Open Path Beam Technologies - Statoil, Houston, TX
2014-02-25 Oil and Gas Hype and Health Hazards - Life Long Learning Institute Symposium; Houston, TX
2014-02-18 Hydraulic Fracturing and Shale Plays: Examining Public Perceptions, Trust, and Community Engagement - Clean Frac'ing Conference, Houston, TX
2014-02-18 The EFD Program: Addressing Environmental Issues and Increasing Environmental Awareness - Clean Frac'ing Conference, Houston, TX

2014-02-17 Advanced Air Emission Inventories for Drilling and Completions - Clean Frac'ing Conference, Houston, TX
2014-02-17 Moderator: Air Innovation Panel Discussion- Clean Frac'ing Conference; Houston
2014-02-14 Social Implications of Hydraulic Fracturing - American Association for the Advancement of Science, Chicago, IL
2014-01-29 Overview of Pearsall Shale Development Activities and their Implications for Water Resources Management in South Texas – Water Management for Shale Plays Mid-Continent 2014, San Antonio, TX

2013

2013-11-15 "Freshwater use and alternatives for hydraulic fracturing operations." - Sustainable Eagle Ford Shale Water and Transportation - Challenges and Solutions Workshop" - Cotulla, TX
2013-11-15 "Groundwater quality mapping in Kenedy County, Texas." - Sustainable Eagle Ford Shale Water and Transportation - Challenges and Solutions Workshop - Cotulla, TX
2013-11-12 "Field tests - Air quality monitoring." Environmentally Friendly Drilling Systems Advisory Committee Meeting - The Woodlands, TX
2013-11-12 "Local Perceptions of the Oil and Gas Industry in the Eagle Ford Shale." Environmentally Friendly Drilling Systems Program – Advisory Committee Meeting. The Woodlands, TX
2013-11-05 "Introduction to air quality topics for oil and gas operations." Supply, Flowback, and Waste Water Treatment Training Course for Hydraulic Fracturing - Kingsville, TX
2013-11-05 "Water treatment and management: Secondary and tertiary." Supply, Flowback, and Waste Water Treatment Training Course for Hydraulic Fracturing - Kingsville, TX
2013-10-29 "Management, Disposal, and Reuse of Produced and Frac Flowback Waters: Views from the General Public" - 9th Annual Practical Short Course on Water Desalination, Process and Wastewater Issues & Technologies - College Station, TX
2013-10-27 "Characterization of desalination plant concentrate discharge impacts on water quality in a Texas coastal area." Professional short-course presentation at the Water Issues & Technologies: Process Water, Wastewater, and Desalination Short Course, Texas A&M University - College Station, TX
2013-10-27 "Characterization of desalination plant concentrate discharge impacts on water quality in a Texas coastal area." Water Issues & Technologies: Process Water, Wastewater, and Desalination Short Course, Texas A&M University - College Station, TX
2013-10-26 "Objective and Perceived Effects of Shale Gas Development." Society of American Foresters 2013 National Convention - Charleston, SC.
2013-09-25 "How Industry is Partnering/Can Partner with the Communities in Which They Serve: A Sociological Perspective." Shale Insight 2013 - Philadelphia, PA
2013-08-15 "Wireless sensor network for monitoring VOC levels near drilling operations." EFD-SRN Joint Air-Water-Gas Workshop - Golden, CO
2013-08-07 "Residents' Views of Natural Gas Drilling in the Pennsylvania Marcellus Shale, 2009 and 2012." 76th Annual Meeting of the Rural Sociological Society- New York, NY.
2013-07-11 FracFocus 2.0 Training - GWPC Stray Gas Incidence & Response Forum and Water Management Unconventional Oil & Gas Forum, Grapevine, TX
2013-06-20 Texas Coastal Impacts Assistance Program - CITP, The Woodlands, TX
2013-06-05 "Hydraulic Fracturing and the Management, Disposal, and Reuse of Frac Flowback Waters: Views from the Pennsylvania Marcellus Shale Region." 19th International Symposium on Society and Resource Management- Estes Park, CO.
2013-05-31 Re-Use of Produced Water & Alternate Water Sources - GAO-NAS Water & Energy, Washington, D.C.
2013-04-25 "VOC monitoring at drilling sites using a wireless senor network." Frank H. Dotterweich 2nd Annual College of Engineering Graduate Student Research Poster Competition - Kingsville, TX
2013-04-18 "Analysis and diagnosis of membrane filtration fouling." 23rd Annual Membrane Filtration Short Course, Texas A&M University - College Station, TX
2013-04-17 "Analysis and diagnosis of membrane filtration fouling." Water & Wastewater: Issues, Challenges, Solutions and New Technologies Short Course - College Station, TX

2013-04-17 "VOC monitoring using wireless sensor networks." Water & Wastewater: Issues, Challenges, Solutions and New Technologies Short Course - College Station, TX

2013-04-10 "The Sociology of Shale Gas Development." Purdue University's Ecological Sciences & Engineering Keystone Series Interdisciplinary Panel on High Volume Shale Gas Extraction- West Lafayette, IN

2013-04-08 EFD Program: Addressing Environmental Issues & Increasing Environmental Awareness - 2013 IADC Conference, New York, NY

2301-02-13 Site Assessment and Baseline Monitoring Measurements in Ohio - EFD Workshop, Columbus, OH

2012

2012-11-14 Proposal: A Study to Identify and Measure the Environmental Impact of Onshore Drilling. Presented to the Drilling Engineering Association http://www.worldoil.com/December-2012-Drilling-advances.html

2012-11-13 Shale Gas: Environmental Baseline and Environmental Monitoring. Presented to Ukraine Government.

2012-10-22 The Environmentally Friendly Drilling Systems Program. Presented at the Eagle Ford Shale Stakeholders Summit, Laredo, TX.

2012-10-17 Demonstrating Technologies that Reduce Environmental Footprints. Presented at the Texas Alliance of Energy Producers, The 21st Century Energy Technology Conference

2012-09-21 Innovation, Safety & Environment culture and how they should impact your career choices - Colorado School of Mines.

2012-07-16 Utica Shale Appalachian Basin Research Consortium (focus on industry-government collaborations) presented to representatives from the Shenhua Group; within the DOE Fossil Energy Global Knowledge Network program.

2012-07-16 Preliminary Results on the Effect of Land-Use Land-Cover Methods of Classification and Data Resolution on SWAT Model Predictive Ability. Poster presented at the 3rd Biennial Colloquium on Hydrologic Science and Engineering of the Consortium of Universities for the Advancement of Hydrologic Science Inc. (CUAHSI), Boulder, CO.

2012-06-19 Environmentally Friendly Drilling: Air & Waste Management Association Annual Conference & Exhibition, San Antonio, TX.

2012-06-18 "Assessing Opposition and Support for Energy Development in Environmentally Sensitive Areas." Presented at the 18th International Symposium on Society and Resource Management in Edmonton, Alberta, Canada.

2012-06-06 Best Management Practices for Oil and Gas Development. Presentation made at The Institute for Energy Law 3rd Law of Shale Plays Conference in Fort Worth, TX.

2012-06-05 The EFD Technology Integration Program *An opportunity to demonstrate, technologies which will reduce the environmental impacts.* IOGCC, Vancouver.

2012-06-05 BMPs on Public Lands: Protecting Water and Wildlife. Public Lands Committee session, Developing North America's Oil and Gas Resources, Interstate Oil and Gas Compact Commission, Midyear Summit, Vancouver, B.C.

2012-06-04 The EFD Technology Integration Program: IOGCC, Vancouver, B.C.

2012-06-03 Developing North America's Oil and Gas Resources. Presented at the Interstate Oil and Gas Compact Commission, Midyear Issues Summit (Public Lands Committee) in Vancouver, B.C.

2012-05-24 Ukraine Shale Gas: Environmental and Regulatory Assessment presentation at the Regional Shale Gas Workshop in Poland, Ukraine and Kyiv.

2012-05-01 An ArcGIS-Server based framework for oil and gas E&P decision support. PowerPoint resented at the ESRI Petroleum User Group (PUG) Meeting, Houston, TX.

2012-04-27 "Public Reaction to Shale Gas Development." Presentation delivered at the Center for Research Excellence in Science and Technology—Research on Environmental Sustainability in Semi-Arid Coastal Areas (CREST-RESSACA) Environmental and Energy Sustainability Conference. Houston, TX.

2012-04-25 Assessing Opposition and Support For Shale Gas Development. Presented at SPE Reducing Environmental Impact of Unconventional Resource Development workshop, San Antonio, TX.

2012-04-25 Energy and the Environment: Application of Framing Theory to Gas Shale Development. Presented at SPE Reducing Environmental Impact of Unconventional Resource Development workshop, San Antonio, TX.

2012-04-24 An ArcGIS-Server based framework for oil and gas E&P decision support. PowerPoint presented at the Mid-America GIS Consortium Biennial Meeting, Kansas City, MO.

2012-04-24 The Industry Must Apply Best Practices for Shale Gas Development. Presented at SPE Reducing Environmental Impact of Unconventional Resource Development workshop, San Antonio, TX.

2012-04-24 Produce Water Analytical Field Trials and Methodology Development. Presented at SPE Reducing Environmental Impact of Unconventional Resource Development workshop, San Antonio, TX.

2012-04-23 Emissions from Oil and Gas Sites are at Risk of being Overestimated. Presented at SPE Reducing Environmental Impact of Unconventional Resource Development workshop, San Antonio, TX.

2012-04-23 Advanced Geoprocessing with Python. Workshop presented at the Mid-America GIS Consortium Biennial Meeting, Kansas City, MO.

2012-04-10 "Water Management in Oil & Gas Unconventional Developments: A Sociological Perspective." Plenary presentation delivered at the 2012 American Association of Drilling Engineers Fluids Technical Conference and Exhibition. Houston, TX.

2012-03-20 Modeling the Effects of Non-Riparian Surface Water Diversions on Flow Conditions in the Little Red Watershed. PowerPoint presented at the 2012 Fayetteville Shale Symposium, Fort Smith, AR.

2012-03-11 *Reading and Writing Spatial Data for the Non-Spatial Programmer*. Poster presented at the PyCon U.S., Santa Clara, CA.

2012-02-17 Ukraine Shale Gas: Regulatory and Environmental Review: Washington, DC

2012-02-07 Creating A Company's Environmental Culture to Improve Performance in the Energy Industry: IADC Health, Safety, Environmental & Training Conference & Exhibition, Houston, TX.

2012-02-05 "A Big Fracing Mess: An Examination of Public Perception of Hydraulic Fracturing." Presented at the annual meeting of the Southern Rural Sociological Association, Birmingham, AL.

2012-01-24 Fact-based Regulation for Environmental Protection in Shale Gas Resource Development: Ground Water Protection Council UIC Conference, Austin, TX.

2012-01-18 Natural Gas Research and Resources at CU Boulder. "Drawing the Blueprint for a Sustainable Natural Gas Future." Presented at the Museum of Nature and Science in Denver, CO.

2011

2011-12-13 Environmentally Friendly Drilling Programs. Presentation given at the Oklahoma Unconventional Resources Forum, Tulsa, OK.

2011-12-08 Environmentally Friendly Drilling: How Texas A&M can Save America, Burnett, D. B., Texas A&M Crisman Institute

2011-12-07 Low Impact O&G Activity; Environmentally Friendly Drilling Systems. Presentation given at the Crisman Institute for Petroleum Research Forum, College Station, TX.

2011-11-30 Intermountain Oil and Gas Best Management Practices. Presentation given at the RPSEA Onshore Production Conference: Technological Keys to Unlocking Additional Reserves, Golden, CO.

2011-11-07 Reducing Environmental Footprints by Providing Unbiased Science for Policy and Cost Effective Operations. Presentation given during panel discussion at the World Shale Gas Conference & Exhibition, Houston, TX.

2011-11-01 Shale Gas – The Energy-Water Nexus. Presented as part of the webinar series Hydraulic Fracturing: Fresh Facts & Critical Choices sponsored by the Clean Water for America Alliance and the American Water Resources Association.

2011-11-02 Providing Science and Solutions to Shale Development. Presentation given during special environmental panel discussion at the SPE Annual Technical Conference and Exhibition, Denver, CO.

2011-11 Eagle Ford Shale: Impact of Gas Shale Development on South Texas Counties, Burnett, D. B., Texas A&M Agri-Life Extension Service

2011-11 Produced Water "Desalination: Science and Solutions, Burnett, D. B. Drilling Engineering Association, Houston, Nov., 2011

2011-11 Technology for Management and Re-Use of Produced Water, Burnett, D. B., McLeroy, K. E., Nieva, Colombia

2011-10-27 Balancing Environmental Tradeoffs – Clearing the Air. Presentation given at the Colorado Oil and Gas Association Western Slope Annual Meeting, Grand Junction, CO.

2011-09 Lowering the Environmental Footprint of E&P Operations: by the Land, Sea(water), and Air, Burnett, D. B., McLeroy, K. E., Brigham Energy, Austin, TX

2011-09 Treatment and Re-Use of Frac Flowback Brine and Produced Water, Burnett, D. B., U. of Wyoming Hydraulic Fracturing Forum Ruckelehouse Energy Institute, Laramie, WY.

2011-08-17 Drilling the Eagle Ford Shale: Science and Solutions, Burnett, D. B., Nathan, V., presented to Friends of the Shale, Laredo, TX

2011-08 Report on Field Trials of Mobile Filtration Unit. Platt, F. M., Burnett, D. B., Texas A&M Membrane/Filtration Short Course Texas, College Station, TX

2011-07 Environmentally Friendly Drilling: South Texas Brine Management Practices, Burnett, D. B., McLeroy, K. E., ConocoPhillips, Houston

2011-07 Lowering the Environmental Footprint of E&P Operations: by the Land, Sea(water), and Air, Burnett, D. B., Chesapeake, Energy, OK City OK

2011-06-28 Testimony given to the Secretary of Energy/Energy Advisory Board/Natural Gas Subcommittee. Washington, DC.

2011-06-06 Examining the Effects of Unconventional Natural Gas Development on Community Attachment, Satisfaction, and Action: Data from the Barnett Shale. Presentation given at the 17th International Symposium on Society and Resource Management, Madison, WI.

2011-06-06 Produced Water Management and Disposal: Toward Beneficial Reuse Practices. Presentation given at the 17th International Symposium on Society and Resource Management, Madison, WI.

2011-06-02 Lowering the Environmental Footprint of E&P Operations: by the Land, Sea(water), and Air. Burnett, D. B., McLeroy, K. E., The Environmentally Friendly Drilling Systems Program, Duke University Nichols School of the Environment

2011-06 Societal Issues Related to Leasing Fort Worth Nature Center for (Barnett Shale) Drilling, Higgins, M. E., Burnett, D. B., International Symposium for Society and Resource Management, Madison, WS.,

2011-05-18 Public Perception and Reaction to Shale Gas Development. Presentation given at the East Texas Energy Expo, Center, TX.

2011-05-13 Creating a Company's Environmental Culture to Improve Performance in the Energy Industry. Presentation given at the IADC Environmental Conference & Exhibition, Trinidad.

2011-05-11 Public Perceptions of Marcellus Shale Knowledge Gaps: Preliminary Findings and New Questions. Paper presented at the Marcellus Shale Multi-State Academic Research Conference. Altoona, PA.

2011-05-08 EPA Technical Workshops Office of Research and for the Hydraulic Fracturing Study: Chemical & Analytical Methods.

2011-05 Desalination as an Alternative to Off-Site Disposal in Conventional Oil, Burnett, D. B., Global Water Intelligence

2011-04-28 Reducing Environmental Footprint in Shale Gas Development – Emerging Technologies. Presentation given at the SPE ATW Workshop, Pittsburgh, PA.

2011-04-19 Environmentally Friendly Drilling Systems. Program review given at RPSEA forum in Denver, CO.

2011-04-19 Shale Gas – The Energy-Water Nexus. Presented at the American Water Resources Association spring specialty conference, Baltimore, MD.

2011-04-07 Mobile Desalination and Disappearing Roads, Burnett, D. B., *Texas A&M Agri-Life Extension Services Workshop, Ft. Stockton, TX*

2011-04-06 Mobile Desalination and Disappearing Roads, Burnett, D. B., TAMU, *Texas A&M Agri-Life Extension Services Workshop, Midland, TX*

2011-04-05 Mobile Desalination and Disappearing Roads, Burnett, D. B., TAMU, *Texas A&M Agri-Life Extension Services Workshop, Ozona, TX*

2011-04 Burnett, D. B., Texas A&M Membrane/Filtration Short Course Texas, College Station, TX

2011-04 Lowering the Environmental Footprint of E&P Operations: By the Land, Sea(water), and Air, Burnett, D. B., Calgary CA.

2011-04 Reducing Environmental Footprint in Gas Shale Operations, Burnett, D. B., SPE Advanced Technology Workshop, Pittsburgh, PA.

2011-03-29 Balancing Environmental Tradeoffs Associated with Natural Gas Production. Presentation given at Cornell University.

2011-02-06 This is All New to Us: Rural Residents' Views on Gas Drilling and Water Resources in an Emerging Energy Hotspot. Paper presented at the Annual Meeting of the Southern Rural Sociological Association. Corpus Christi, TX.

2011-02-01 Environmentally Friendly Drilling Systems Program. Presentation given at the USEA Luncheon Forum, Washington, DC.

2011-02 Reducing Water Needs in Energy Production and Lowering Environmental Footprint of Oil and Gas Development, Haut, R., S. Stuver, S., Burnett, D. B., Alamo Area Council of Governments, San Antonio

2011-01-27 Environmentally Friendly Drilling Systems Program. Presentation given at the SPE Hydraulic Fracturing Forum, The Woodlands, TX.

2011-01-27 Membrane Treatment to Optimize Beneficial Re-Use of Oil Field Brines, Burnett, D. B., Vavra, C.J., Platt, F. J., McLeroy, K. E., SPE Summit Environmental Issues Related to Hydraulic Fracturing, The Woodlands.

2011-01-12 Reducing Water Needs in Energy Production and Lowering Environmental Footprint of Oil and Gas Development, Burnett, D. B., Vavra, C. J., Platt, F. M., presentation to Cleanwater Solutions, LTD., College Station, TX.

2009 – 2010

2010-11-16 Geospatial Decision Support for Reducing Environment Impact in Natural Gas Shale Operations, Managing Fayetteville Shale Play Development Workshop. Workshop held in Fayetteville, AR.

2010-10-28 Decision-Support System for Pad Siting, West Slope Colorado Oil & Gas Association Environmental Summit, Grand Junction, CO.

2010-10-27 Reducing Environmental Impacts in the Fayetteville Shale Play using Geospatial Decision Support, A Spatial Quest: Twenty Years of Mapping the Natural State, Arkansas GIS User's Forum, Hot Springs, AR.

2010-10-25 Natural Gas in the New Energy Economy, Panel discussion part of Clean Energy Day, University of Colorado, Boulder, CO.

2010-10-22 Natural Gas Development and Social Well-Being. Presentation delivered at the Pennsylvania State University, Department of Agricultural Economics and Rural Sociology, M.E. John Lecture Series. University Park, PA.

2010-10-14 Geospatial Decision Support for Reducing Environment Impact in Natural Gas Shale Operations, Opportunities and Obstacles to Reducing the Environmental Footprint of Natural Gas Development in the Uintah Basin. Workshop held in Vernal, UT.

2010-10-14 Intermountain Oil and Gas BMP Project, Presented at the Opportunities and Obstacles to Reducing the Environmental Footprint of Natural Gas Development in the Uintah Basin Conference, Vernal, UT.

2010-10-10 *Minimizing the Surface Footprint for Unconventional Gas,* Presented at the 2010 GCAGS/GCSSEPM Annual Meeting, San Antonio, TX.

2010-09-26 *Water Availability and Management in Shale Gas Operations*, Presented at the Ground Water Protection Council Water/Energy Sustainability Symposium, Pittsburg, PA.

2010-09-22 Public Perception of the Oil and Gas Industry: The Good, the Bad, and the Ugly. Presented at the 2010 Society of Petroleum Engineers Annual Technical Conference and Exhibition. Florence, Italy.

2010-09-01 Water Modeling in the Fayetteville Shale, 17th International Petroleum & BioFuels Environmental Conference, San Antonio, TX.

2010-08-31 *Water Availability and Management in Shale Gas Operations*, Presented at the 17th International Petroleum and Biofuels Conference, San Antonio, TX, August 31-September 2, 2010.

2010-08-31 *The Regulatory Environment*, presented at the 17th International Petroleum and Biofuels Conference, San Antonio, TX, August 31-September 2, 2010.

2010-08-12 *'Deep in the Heart of Texas' Barnett Shale Perceived and Objective Community Level Impacts of Unconventional Gas Development*, Presented at the annual meeting of the Rural Sociological Society, August 12-15, Atlanta, GA.

2010-08-10 Findings for the Publics' Willingness to Adopt Desalination (Purification) of Oilfield Brine. Presented at the 6th Annual Practical Short Course on Water Desalination, Process and Wastewater Issues & Technologies. College Station, TX

2010-07-12 Assessing Opportunities and Barriers to Improving the Environmental Footprint of Oil and Gas Development in Utah. Presented at the Utah Governor's Energy Forum. Salt Lake City, UT.

2010-07-08 *Water Management Technologies & Regulatory Requirements for Different Locations and Environments,* Workshop presented at the 2010 Summer Meeting of the IOGA of New York, Findley Lake, NY.

2010-07-07 *The Inextricable Linkage between Water and Energy,* Presented at the 2010 Summer Meeting of the IOGA of New York, Findley Lake, NY.

2010-07-07 Exploration and Production of Oil and Natural Gas in Environmentally Sensitive Areas: Views from the Public. Presented at the 15th International Symposium on Society and Resource Management. Vienna, Austria

2010-06-24 *Water and Energy Relationships with a Focus on Oil and Gas Produced Water,* Presented at the 10th Biannual Research Review Meeting, National Science Foundation Industry/University Cooperative Research Center for Multiphase Transport Phenomena, East Lansing, MI.

2010-06-17 *Minimizing the Surface Footprint for Unconventional Gas,* Presented at the 2010 Global Unconventional Gas Forum Amsterdam, Netherlands.

2010-06-15 *Water & Energy - Inexorably Entwined Dance Partners, but without Perfect Choreography,* Seminar presented to staff at the Oak Ridge National Laboratory, Oak Ridge, TN.

2010-06-13 *Options for Management of Produced Water,* Presented at the Goldschmidt Conference, Knoxville, TN.

2010-06-07 *Opportunities and Barriers to Environmentally Friendly Energy Exploration and Production Practices in the Uinta Basin,* Presented at the 16th International Symposium on Society and Resource Management, Corpus Christi, TX.

2010-05-25 *Produced Water – Nuisance Byproduct or Valuable Resource?* Presented at the University of Wyoming Produced Water Conference, Laramie, WY.

2010-05-24 *Water & Energy - Inexorably Entwined Dance Partners, but without Perfect Choreography*, seminar presented to staff at the National Renewable Energy Laboratory, Golden, CO.

2010-05-20 Disappearing Roads Competition Finals, Texas A&M University.

2010-04-07 *The Environmentally Friendly Drilling Systems Program,* Presented at the RPSEA Unconventional Natural Gas Forum, Golden, CO.

2010-04-06 Conference Keynote Speaker for the AADE Conference, Houston, TX.

2010-03-18 Houston Association of Professional Landmen (HAPL), Petroleum Club, Houston, Luncheon Presentation.

2010-03-03 *Natural Resources and Environmental Issues and Energy Policy: A Sociologist's Perspective,* Presented at the Center for Environmental Research, Education, and Outreach, Washington State University, Pullman, WA.

2010-02-08 Energy Development, Natural Environments and Quality of Life: The Good, the Bad, and the Ugly as Perceived by Texans. Presented at the Annual Meeting of the Southern Rural Sociological Association. Orlando, FL.

2009-11-05 *From the Past to the Future: The Environmentally Friendly Drilling Systems Program,* Presented at the 2009 IOGA Conference, Buffalo, NY.

2009-11-03 *Environmental Stewardship of Natural Gas Operations,* Presented at the 2009 IPEC Conference, Houston, TX.

2009-11-03 *Causal vs. Non-Causal Selection of Onshore Environmentally Friendly Drilling Systems,* Presented at the 2009 IPEC Conference, Houston, TX.

2009-11-03 *Pretreatment Options for Water Based E&P Wastes,* Presented at the 2009 IPEC Conference, Houston, TX.

2009-11-03 *Environmental Benefits of KERS System with Electrical/Diesel Rigs,* Presented at the 2009 IPEC Conference, Houston, TX.
2009-11-03 *Team Challenge: Environmentally Friendly Drilling Using Low Impact Access Practices for Desert Ecosystems,* Presented at the 2009 IPEC Conference, Houston, TX.
2009-11-03 *Public Opinion on Exploration and Production of Oil and Natural Gas in Environmentally Sensitive Areas,* Presented at the 2009 IPEC Conference, Houston, TX.
2009-11-03 *Constructed Wetland Treatment Systems for Environmentally Friendly Drilling,* Presented at the 2009 IPEC Conference, Houston, TX.
2009-11-03 *A Crystal Ball View of the Energy Industry in 2025: How Environmentalists Hold the Key to America's Future Energy Security,* Presented at the 2009 IPEC Conference, Houston, TX.
2009-10-14 Intermountain Oil and Gas BMP Project, Presented at the Best Practices for Community ad Environmental Protection Workshop, Rifle, CO.

Webinars

2015

2015-12-08 Land Use Site Selection Information Tool (LUSSIT)
2015-11-19 EFD-TIP Review – NETL webinar
2015-10-20 Turning Flare Gas into Electricity using the Organic Rankine Cycle – Field Demonstration
2015-05-12 Introduction to the EFD Program – BLM webinar
2015-01-20 Advanced Produced Water Treatment Research

Workshops

2015

2015-11-11 EFD Annual Sponsors/Advisors Meeting, The Woodlands, TX
2015-11-08 Virtual Pad Site – Austin, TX
2015-10-22 Electrification for Oil & Gas Operations – The Woodlands, TX
2015-09-25 Downhole Raman Spectroscopy – The Woodlands, TX
2015-07-14 Utica Shale Play Book Study – Canonsburg, PA
2015-06-10 Water Management – Utica and Marcellus Shale – Cambridge, OH
2015-06-05 Monitoring Fugitive Gas Emissions – The Woodlands, TX
2015-04-16 Navigating Those Bumps in the Road on the Way to Drilling a Successful Horizontal Well – Morgantown, WV
2015-02-24 Flaring Issues, Solutions and Technologies (FIST) – San Antonio, TX
2015-01-14 Powered by Natural Gas: Flaring Issues, Solutions and Technologies (FIST) – Houston, TX

2014

2014-12-02 Hydraulic Fracturing Geomechanics for Unconventionals: Concepts & Practices – Pittsburgh, PA
2014-11-18 EFCREO Shale Oil & Gas Development Workshop: Management of Water Resources, Air Resources and Oilfield Waste, San Antonio, TX
2014-11-13 EFD Annual Sponsors/Advisors Meeting, The Woodlands, TX
2014-10-23 Addressing Gas Flaring by Utilizing Novel Technologies to Monetize Gas Wellhead - Denver, CO
2014-10-08 Addressing Public Perception of the Oil and Gas Industry Workshop - Houston, TX

2014-10-01 Appalachian Basin Life Cycle Wellbore Integrity: Drilling, Stimulation, Production – Morgantown, WV
2014-09-16 Flare Gas: Exploring Economically Feasible & Environmentally Friendly Solutions - Pittsburgh, PA
2014-09-10 Flare Gas: Exploring Economically Feasible & Environmentally Friendly Solutions - Houston, TX
2014-08-27 Flaring Issues, Solutions, and Technologies (F.I.S.T.) - Denver, CO
2014-06-05 2014 Martz Summer Conference: Water and Air Quality Issues in Oil and Gas Development: The Evolving Framework of Regulation and Management – Boulder, CO
2014-06-05 Application of Stable Isotope Geochemistry in the Petroleum Geosciences – Pittsburgh, PA
2014-05-12 NORM and TNORM: Occurrence, Characterizing, Handling and Disposal – Columbus, OH
2014-04-28 Analysis and Diagnosis of Membrane Filtration Fouling – 24th Annual Membrane Filtration Short Course – College Station, TX
2014-03-11 Shale Gas and the Environment – Morgantown, WV
2014-02-10 ORNL Hydraulic Fracturing Workshop, Oak Ridge, TN
2014-01-22 Short Course on Oil and Gas Law – Boulder, CO
2014-01-16 Land Use Site Selection Information Tool (Regulators) Advisory Committee Meeting – Austin, TX
2014-01-14 Land Use Site Selection Information Tool (Operators) Advisory Committee Meeting – The Woodlands, TX

2013

2013-11-12 EFD Advisory Committee Meeting - The Woodlands, TX
2013-09-05 Powered by Natural Gas - Canonsburg, PA
2013-09-04 Wellbore Integrity - Canonsburg, PA
2013-08-16 Joint EFD-SRN Workshop - Golden, Colorado
2013-07-22 SPE Forum on the Quest to Reduce the Environmental Footprint – Ashville, NC
2013-06-20 Texas Coastal Impact Assistance Program - The Woodlands, TX
2013-05-14 Powered by Natural Gas Workshop - San Antonio, TX
2013-05-07 EFD-EU Workshop - Houston, TX
2013-02-13 Site Assessment & Baseline Monitoring Measurements - Ohio

2012

2012-06-12 EFD Program: Milestone Review held in The Woodlands, TX.
2012-05-17 Best Management Practices for Utica and Marcellus Development Workshop, Morgantown, WV.
2102-05-02 EFD Tour of the Offshore Technology Conference, Houston, TX.

2011

2011-11-10 EFD Program: Managing the Eagle Ford Development Workshop held in Kingsville, TX.
2011-08-17 Eagle Ford Shale Fracturing: Science and Solutions Workshop held in Laredo, TX.
2011-07-26 Lowering the Environmental Footprint of Marcellus Shale Development Workshop held in Morgantown, WV.
2011-05-26 Best Management Practices Workshop held in Boulder, CO.
2011-04-13 Environmentally Friendly Drilling Workshop held at the American Association of Drilling Engineers Conference, Houston, TX.
2011-03-15 Managing the Eagle Ford Development Workshop held in San Antonio, TX.

2009 – 2010

2010-11-16 EFD – Managing Fayetteville Shale Play Development Workshop held at the University of Arkansas, Fayetteville, AR.
2010-10-14 EFD/BMP – Opportunities and Obstacles to Reducing the Environmental Footprint of Natural Gas Development in the Uintah Basin. Workshop held in Vernal, UT.
2010-09-23 EFD Europe Kick-Off Forum held in Florence, Italy
2010-08-24 PTTC-EFD Workshop/Forum held in Pittsburgh, PA.

2010-07-08 *Water Management Technologies & Regulatory Requirements for Different Locations and Environments,* Workshop presented at the 2010 Summer Meeting of the IOGA of New York, Findley Lake, NY.
2010-06-07 *The Eagle Ford Shale,* 16th International Symposium on Society and Resource Management in Corpus Christi, TX.
2010-05-06 Panel Discussion, Natural Gas Solutions Summit, Aspen, CO.
2010-05-05 Panel Discussion, Offshore Technology Conference, Houston, TX.
2009-11-12 *The EFD University/National Laboratory Alliance*, Oak Ridge, TN, Special workshop with employees from the Oak Ridge National Laboratory.
2009-10-14 *Best Practices for Community and Environmental Protection*, Rifle CO, Over 160 participants from academia, industry, environmental organizations, regulators, landowners and others

Exhibits

2015

2015/08/15 Produced Water Treatment: Field Trials *Turbomachinery Convention*
2015/07/20-22 *Unconventional Resources Technology Conference and Exhibition*, San Antonio, TX.

2014

2014/10/18 *Energy Day,* Houston, TX. (exhibited Virtual Rig Site at IPAA/PESA booth)
2014/09/22-23 *Oil 101*, Houston, TX.
2014/08/25-27 *Unconventional Resources Technology Conference and Exhibition*, Denver, CO.
2014/02/17-18 *Clean Frac'ing Conference*, Houston, TX.

2013

2013/08/12-14 *Unconventional Resources Technology Conference and Exhibition*, Denver, CO.

2012

2012/10/17-18 *Texas Energy Alliance Conference,* Houston, TX.

2011

2011/10/15 *Energy Day*, Houston, TX.
2011/09/24-28 *Groundwater Protection Council Annual Forum,* Atlanta, GA.
2011/05/17-18 *East Texas Energy Expo i*n Center, TX.

2010 – 2009

2010/06/07-10 *16th International Symposium on Society and Resource Management,* Corpus Christi, TX.
2010/05/20 *IADC Onshore Drilling Conference & Exhibition,* Omni Houston Hotel Westside, Houston, TX.
2010/01/26-27 *IADC Health, Safety, Environment & Training Conference & Exhibition,* Omni Houston Hotel Westside, Houston, TX.

Awards and Nominations

2015

2015-10 ***Oil and Gas Awards –*** VZ Environmental Award for Excellence in Environmental Stewardship
2015-10 ***Finalist – Best Health, Safety, Environmental Program – Onshore***, World Oil Awards

2014

2014-11 ***Nominated – Protection of the Environment Prize***, Eni Award
2014-11 ***Impact Award Nominee***, 2014 Eagle Ford Excellence Awards, South Texas Energy Economic Roundtable
2014-10 ***Finalist – Best Outreach Program***, World Oil Awards
2014-08 ***Nominated*** – Energy Education Category, IOGCC Chairman's Stewardship Awards

2009

2009-10-05: ***Awarded – Environmental Partnership/Chairman's Stewardship Award***, Interstate Oil and Gas Compact Commission.