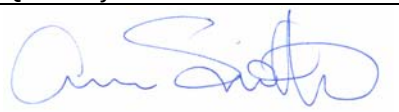
RESEARCH PERFORMANCE PROGRESS REPORT

1. COVER PAGE DATA ELEMENTS: Mandatory

Federal Agency and Organization Element to Which Report is Submitted	**U.S. Department of Energy (DOE)** **National Energy Technology Laboratory (NETL)**
Federal Grant or Other Identifying Number Assigned by Agency	DE-FE0029085
Project Title	Long-Term Methane Emissions Rate Quantification and Alert System for Natural Gas Storage Wells and Fields
PI Name, Title and Contact Information	Ann P. Smith, Vice President apsmith@gsi-net.com; 512.346.4474
Submission Date	January 31, 2018
DUNS Number	181780776
Recipient Organization	GSI Environmental Inc. 9600 Great Hills Trail, Suite 350E Austin, Texas 78759
Project Period	October 1, 2016 to May 31, 2019
Reporting Period End Date	December 31, 2017
Report Term or Frequency	Quarterly
Signature of Submitting Official	

2. ACCOMPLISHMENTS: Mandatory

a) What are the major goals of the project?

The primary goal of the project is to employ a novel combination of complementary measurement methods and technologies to detect and accurately quantify average annual methane emissions from underground natural gas storage facilities, including from above-ground equipment leaks plus seepage at the ground surface from underground leaks.

b) What was accomplished under these goals?

All project goals for the first quarter (Q1) reporting period of October – December 2017 were met. A summary of the activities performed to achieve project goals during Q1 is included below.

- **Technology Transfer:**

  SPE ATCE: Brochures and fact sheeets were disseminated at the Society of Petroleum Engineers Annual Technical Conference and Exhibition (SPE ATCE) on October 9-11, 2017.

  O&G Environmental Conference: Project brochures and fact sheets were disseminated at the O&G Environmental Conference on November 28-19, 2017.

  CH4 Connections Conference: Project borchures and fact sheets were disseminated at the GTI CH4 Connection Conference on December 12-13, 2017.

- **Emission Factor Development:** Component-specific emission factors continue to be calculated from high-flow emission measurements and facility-wide component counts. Emission rate measurements from individual component types (e.g., valves) are being averaged and normalized by the total number of emitting components sampled to develop leaker factors. Population factors are being developed by comparing average component-level emission rates with the total population counts. If variability is large among components of the same type, components may be subdiveded by key parameters.

- **Fieldwide Leak Detection - Campaign 2**

  Field Campaign 2 was completed October 2nd – 13th at a depleted reservoir gas storage facility in Clay Basin, Utah, and October 30th – November 3rd at two salt dome gas storage facilities in the Gulf Coast region. 52 storage wells were screened with a FLIR infrared camera and a Bascom-Turner Gas Explorer for methane emissions; over 280 emitting components were identified. A high flow sampler was used to measure methane emissions from 119 emitting components, 49 control components, and 15 field blanks. Flux chamber testing was conducted at three locations around each investigated well and over 10 locations around the two wells at Clay Basin selected for high resolution monitoring of subsurface methane seepage.

- **High Resolution Subsurface Leak Monitoring**

  The two wells exhibiting the highest levels of ground-level emissions at Clay Basin, Utah, were selected for continuous, high-resolution, remote monitoring of soil conditions indicative of thermogenic methane emissions and related atmospheric conditions. During the week of November 13, 2017, arrays of 27 to 29 temperature and moisture sensors were installed around each monitored well at depths ranging from approximately 20 to 60 inches below ground and connected to a solar-powered weather station providing wireless communications, data logging, and a remote camera. The sensors measure in situ soil temperature and moisture content, which are recorded in 5 min averages. At each well, three of the sensors were installed at the edge of the well pad in the same soil material to measure background soil conditions and to characterize the influence of ambient conditions. Remote data collection became active on November 18, 2017.

c) What opportunities for training and professional development has the project provided?

Cross training, data sharing and collaborative protocol development has occurred between between GSI employees and Colorado State University researchers.

Technology transfer activities improve labor skills of participating engineering and scientific companies and increase managerial education and project efficiency by getting real-time feedback on sampling protocols and data analysis.

d) How have the results been disseminated to communities of interest?

Field activities were shared real-time and immediately following completion of field programs with the DOE Project Manager. Preliminary results from field campaigns were discussed with the operators and project team members.

Presentations and/or meetings regarding the project have been conducted at multiple events since the beginning of the project.

e) What do you plan to do during the next reporting period to accomplish the goals?

Emission rate measurements from individual component types (e.g., valves) will be averaged and normalized by the total number of emitting components sampled to develop leaker factors. Population factors will be developed by comparing average component-level emission rates with the total population counts. If variability is large among components of the same type, components may be subdiveded by key parameters.

Flux chamber testing will be conducted at three locations around each investigated well and over 10 locations around the two wells at Clay Basin selected for high resolution monitoring of subsurface methane seepage.

Continuous, high-resolution, remote monitoring of soil conditions indicative of thermogenic methane emissions and related atmospheric conditions will be performed with in-ground sensors at a facility in the Gulf Coast. The sensors will measure in situ soil temperature and moisture content, recorded in 5 min averages. Three of the sensors will be installed at the edge of the well pad in the same soil material to measure background soil conditions and to characterize the influence of ambient conditions.

TASC calls will be scheduled in the spring of 2018 to discuss preliminary results of data analysis.

3. PRODUCTS: Mandatory

a) Publications, conference papers, and presentations

i. Journal publications.

Not Applicable during this reporting period.

ii. Books or other non-periodical, one-time publications.

Work has begun on development of a technical paper to discuss emission factors at gas storage wells and disaggregated components.

iii. Other publications, conference papers and presentations.

EFD Sponsors Meeting: A presentation was given in Houston, Texas on November 14, 2017 that included a discussion on project accomplishments and challenges. Attendees included representatives from Shell, Chevron, Statoil, HARC, RPSEA, and multiple universities.

b) Website(s) or other Internet site(s)

Not Applicable during this reporting period.

c) Technologies or techniques

Unique in-ground sensor technology provide continuous, high-resolution, remote monitoring of soil conditions indicative of thermogenic methane emissions and related atmospheric conditions. The sensors measure in situ soil temperature and moisture content, which are recorded in 5 min averages.

d) Inventions, patent applications, and/or licenses

Not Applicable during this reporting period.

e) Other products

Not Applicable during this reporting period.

4. PARTICIPANTS & OTHER COLLABORATING ORGNIZATIONS: Optional

a) What individuals have worked on the project?

Name:	Richard L. Bowers
Project Role:	Co-Principal Investigator
Nearest Person Month Worked:	1.5
Contribution to the Project:	Coordinated field activities with project partners.
Funding Support	None
Collaborated with individual in foreign country:	No
Travelled to foreign country:	No

Name:	Taylor Borgfeldt and Victoria Boyd
Project Role:	Technical Field Team Members
Nearest Person Month Worked:	2.0 and 1.5, respectively
Contribution to the Project:	On-site oversight of field activities; Data validation and analysis
Funding Support	None
Collaborated with individual in foreign country:	No
Travelled to foreign country:	No

b) What other organizations have been involved as partners?

Organization Name:	Utah State University
Location of Organization:	Vernal, Utah
Partner's contribution to the project:	Subcontractor leading effort to collect gas emission samples during field trials.
Financial Support:	None
In-kind Support:	None
Facilities	Labs at Bingham Research Center, Utah State University, Vernal, UT
Collaborative Research	None
Personnel Exchanges:	None
More detail on partner and contribution:	None

Organization Name:	Houston Advanced Research Center (HARC)
Location of Organization:	The Woodlands, Texas
Partner's contribution to the project:	Assisted with efforts to coordinate TASC participation.
Financial Support:	None
In-kind Support:	None
Facilities	HARC Labs in the Woodlands, TX
Collaborative Research	None
Personnel Exchanges:	None
More detail on partner and contribution:	None

Organization Name:	Colorado State University
Location of Organization:	Fort Collins, Colorado
Partner's contribution to the project:	Subcontractor assisting in effort to design underground sensor network for high resolution leak monitoring.
Financial Support:	None
In-kind Support:	None
Facilities	CSU Labs in Fort Collins, Colorado
Collaborative Research	None
Personnel Exchanges:	None
More detail on partner and contribution:	None

c) Have other collaborators or contacts been involved?

Not Applicable during this reporting period.

5. IMPACT: Optional

a) What is the impact on the development of the principal discipline(s) of the project?

Data from recently installed below-ground sensors will reveal new insights on spatial and temporal trends of subsurface methane seepage around gas storage wells and new approach to detect and quantfy such leaks.

b) What is the impact on other disciplines?

Not applicable during this reporting period.

c) What is the impact on the development of human resources?

Not applicable during this reporting period.

d) What is the impact on physical, institutional, and information resources that form infrastructure?

Not applicable during this reporting period.

e) What is the impact on technology transfer?

Technology transfer is being performed throughout the project via TASC meetings, focused group meetings with team members and operators, conferences and workshops. These technology transfer activities improve labor skills of participating engineering and scientific companies and increase managerial education and project efficiency by getting real-time feedback on sampling protocols and data analysis.

f) What is the impact on society beyond science and technology?

Better understanding of air emissions sources reduces environmental impacts and minimizes loss to the industry.

g) What dollar amount of the award's budget is being spent in foreign country(ies)?

None.

6. CHANGES/PROBLEMS: Mandatory

a) Changes in approach and reasons for change

Not applicable during this reporting period.

b) Actual or anticipated problems or delays and actions or plans to resolve them

Not applicable during this reporting period.

c) Changes that have a significant impact on expenditures

Not applicable during this reporting period.

d) Significant changes in use or care of human subjects, vertebrate animals, and/or Biohazards

Not Applicable to this Award.

e) Change of primary performance site location from that originally proposed

Not applicable during this reporting period.

7. SPECIAL REPORTING REQUIREMENTS: Mandatory

Not applicable during this reporting period.

8. BUDGETARY INFORMATION: Mandatory

A Cost Status Report is included as Attachment 1. Graphs depicting the status of the budgeted versus cumulative costs of the overall project, technical transfer and cost share are included as Attachment 2.

GSI ENVIRONMENTAL

Research Performance Progress Report

Attachment 1: Cost Plan/Status

DE-FE0029085: Long-Term Methane Emissions Rate Quantification and Alert System for Natural Gas Storage Wells and Fields

Baseline Reporting Quarter	Budget Period 1								Budget Period 2								Budget Period 3					
	Q1		Q2		Q3		Q4		Q1		Q2		Q3		Q4		Q1		Q2		Q3 **	
	10/01/2016 - 12/31/2016		01/01/2017 - 03/31/2017		04/01/2017 - 06/30/2017		07/01/2017 - 09/30/2017		10/01/2017 - 12/31/2017		01/01/2018 - 03/31/2018		04/01/2018 - 06/30/2018		07/01/2018 - 09/30/2018		10/01/2018 - 12/31/2018		01/01/2019 - 03/31/2019		04/01/2019 - 06/30/2019	
	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total	Q4	Cumulative Total	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total	Q4	Cumulative Total	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total
Baseline Cost Plan																						
Federal Share	$ 173,000.00	$ 173,000.00	$ 28,000.00	$ 201,000.00	$ 151,000.00	$ 352,000.00	$ 169,000.00	$ 521,000.00	$ 188,645.00	$ 709,645.00	$ 49,986.00	$ 759,631.00	$ 152,089.00	$ 911,720.00	$ 42,367.00	$ 954,087.00	$ 63,582.00	$ 1,017,669.00	$ 111,628.00	$ 1,129,297.00	$ 79,152.00	$ 1,208,449.00
Non-Federal Share	$ -	$ -	$ 10,500.00	$ 10,500.00	$ 88,000.00	$ 98,500.00	$ 32,500.00	$ 131,000.00	$ -	$ 131,000.00	$ -	$ 131,000.00	$ 142,000.00	$ 273,000.00		$ 273,000.00	$ -	$ 273,000.00	$ -	$ 273,000.00	$ 32,000.00	$ 305,000.00
Total Planned	***$ 173,000.00***	***$ 173,000.00***	***$ 38,500.00***	***$ 211,500.00***	***$ 239,000.00***	***$ 450,500.00***	***$ 201,500.00***	***$ 652,000.00***	***$ 188,645.00***	***$ 840,645.00***	***$ 49,986.00***	***$ 890,631.00***	***$ 294,089.00***	***$ 1,184,720.00***	***$ 42,367.00***	***$ 1,227,087.00***	***$ 63,582.00***	***$ 1,290,669.00***	***$ 111,628.00***	***$ 1,402,297.00***	***$ 111,152.00***	***$ 1,513,449.00***
Actual Incurred Cost																						
Federal Share	$ 113,409.00	$ 113,409.00	$ 274,728.10	$ 388,137.10	$ 123,206.81	$ 511,343.91	$ 103,724.54	$ 615,068.45	$ 241,407.32	$ 856,475.77		$ -		$ -		$ -		$ -		$ -		$ -
Non-Federal Share	$ -	$ -	$ 131,400.00	$ 131,400.00	$ -	$ 131,400.00	$ 4,500.00	$ 135,900.00	$ 230,000.00	$ 365,900.00		$ -		$ -		$ -		$ -		$ -		$ -
Total Incurred Cost	***$ 113,409.00***	***$ 113,409.00***	***$ 406,128.10***	***$ 519,537.10***	***$ 123,206.81***	***$ 642,743.91***	***$ 108,224.54***	***$ 750,968.45***	***$ 471,407.32***	***$ 1,222,375.77***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***
Variance																						
Federal Share	$ (59,591.00)	$ (59,591.00)	$ 246,728.10	$ 187,137.10	$ (27,793.19)	$ 159,343.91	$ (65,275.46)	$ 94,068.45	$ 52,762.32	$ 146,830.77		$ -		$ -		$ -		$ -		$ -		$ -
Non-Federal Share	$ -	$ -	$ 120,900.00	$ 120,900.00	$ (88,000.00)	$ 32,900.00	$ (28,000.00)	$ 4,900.00	$ 230,000.00	$ 234,900.00		$ -		$ -		$ -		$ -		$ -		$ -
Total Variance	***$ (59,591.00)***	***$ (59,591.00)***	***$ 367,628.10***	***$ 308,037.10***	***$ (115,793.19)***	***$ 192,243.91***	***$ (93,275.46)***	***$ 98,968.45***	***$ 282,762.32***	***$ 381,730.77***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***

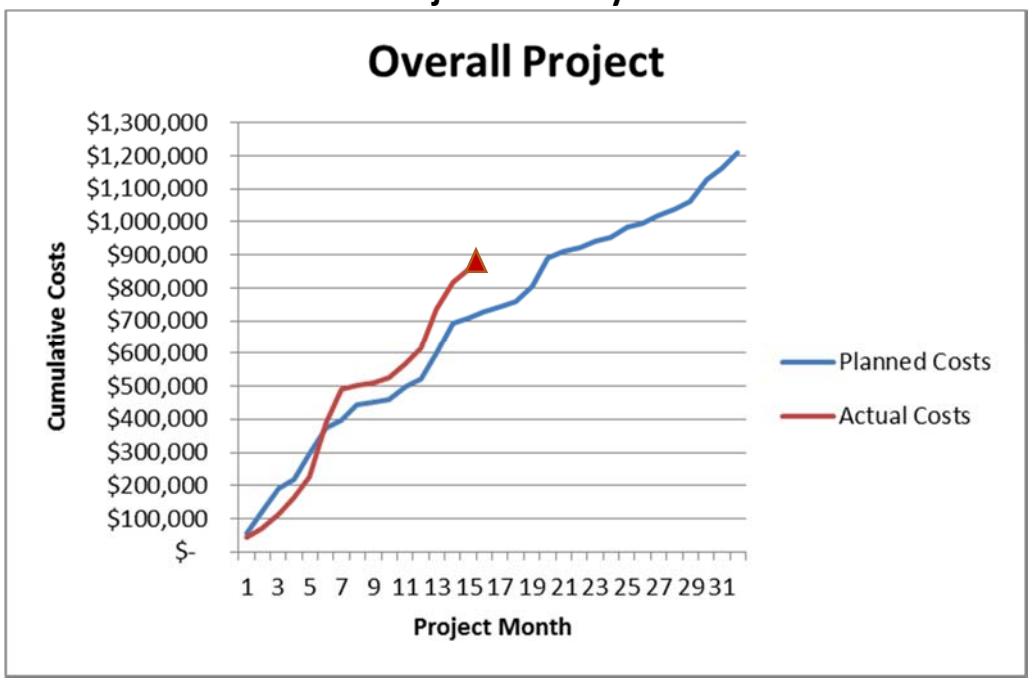
* The project end date is May 31, 2019

GSI ENVIRONMENTAL

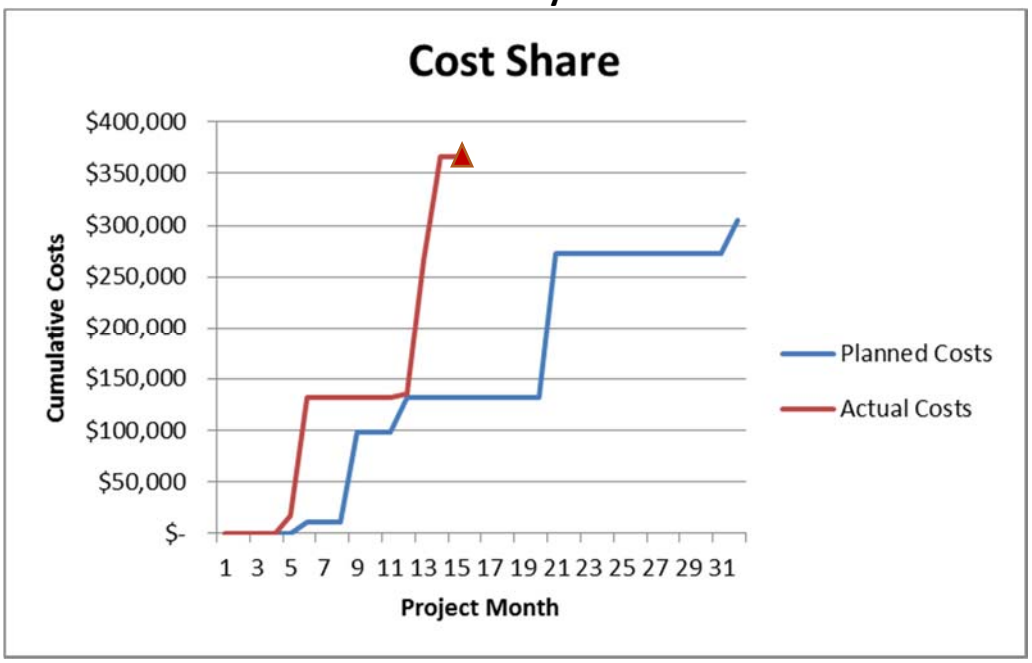
RESEARCH PERFORMANCE PROGRESS REPORT

Attachment 2: Summary Charts of Actual vs. Planned Expenditures
DE-FE0029085: Costs through December 31, 2017

Total Project Costs by Month



Cost Share by Month



DE-FE0029085

Summary Charts of Actual vs. Planned Expenditures
Costs through December 31, 2017, cont.

Technology Transfer by Month