Verification Report for Loyd Ray Farms
Yadkinville, North Carolina

Climate Action Reserve—CAR893

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1. Introduction

This report is provided to Duke University (Duke) as a deliverable of the Climate Action Reserve (CAR) project verification process. This report covers the verification of the Duke Carbon Offsets Initiative - Loyd Ray Farms – CAR893 (the Project) for the period from July 1, 2014 through June 30, 2016. First Environment, Inc. (First Environment) conducted the verification from the date of the kickoff meeting through November 29, 2017.

The Project has elected to be verified in accordance with reporting and verification cycle Option 3 as allowed under Section 7.3.4 of the U.S. Livestock Project Protocol, v3.0. The Project submitted a monitoring plan and monitoring report for the interim 12-month period, which was subsequently accepted by the CAR.

2. Objectives

The purpose of this verification was, through review of appropriate evidence, to establish that:

- the Project conforms to the requirements of the verification criteria, including all eligibility requirements, discussed in Section 4 of this report; and
- the data reported are accurate, complete, consistent, transparent, and free of material error or omission.

3. Verification Scope

Specific scope metrics for the verification are outlined in the table below:

Geographic Boundaries	Loyd Ray Farms, Yadkinville, NC
Emission Reduction Sources, Project Emissions, and Greenhouse Gases	Emissions reductions (expressed in units of Carbon Dioxide equivalents (CO_2e)) resulting from methane destruction; Project emissions of methane from the animal waste management system; Project emissions of CO_2 from purchased electricity.
Reporting Period	July 1, 2014 through June 30, 2016
Data Sources	Metered Data and Emissions Reduction Calculations

4. Standards Used to Verify Emissions (Criteria)

The following table outlines the guidance and protocols used to conduct this verification:

Standard of Verification	• Climate Action Reserve U.S. Livestock Project Protocol, Version 3.0, September 29, 2010 (CAR Protocol) • Climate Action Reserve Program Manual, September 1, 2015 • Livestock Project Protocol Version 3.0 Errata and Clarifications, November 16, 2017 (Errata and Clarification)

Verification Process	• Section 8 of the CAR Protocol • Climate Action Reserve Verification Program Manual, February 8, 2017 • Errata and Clarification • ISO 14064-3: Specification with guidance for the validation and verification of greenhouse gas assertions, 2006
Level of Assurance	• Reasonable assurance
Materiality	• Misstatements greater than five percent of the Project's emission reductions assertion are considered material • Qualitative non-conformities with the CAR Protocol are also considered material

5. Overview of the Verification Process

The verification process was utilized to gain an understanding of the Project's emission sources and reductions and to evaluate and verify the collection and handling of data, the calculations that lead to the results, and the means for reporting the associated data and results.

The following verification process was used:

- conflict of interest review;
- selection of Verification Team;
- initial interaction and kick-off meeting with project developer;
- development of the verification and sampling plan;
- review of management and data collection system;
- site visit;
- assessment of raw data and calculations for period under review;
- follow-up interaction with the project developer for corrective action, clarification, or supplemental data as needed; and
- final statement and report submittal.

5.1. Conflict of Interest Review

Prior to beginning any verification project, First Environment conducts an evaluation to identify any potential conflicts of interest associated with the Project. No potential conflicts were found for this Project. First Environment also received authorization from CAR to proceed with verification activities for the project developer in a notification dated September 15, 2016.

5.2. Verification Team

First Environment's Verification Team consisted of the following individuals who were selected based on their verification experience, as well as familiarity with livestock operations:

Lead Verifier – Michael Carim
Verifier – Jeff Daley
Senior Internal Reviewer – James Wintergreen

5.3. Verification Kick-off

The verification was initiated with a kick-off meeting on October 25, 2016 with Duke. The meeting focused on confirming the scope, schedule, and data required for verification.

5.4. Development of the Verification Plan

The team formally documented its verification plan as well as determined the data-sampling plan. The verification plan was developed based on the discussion of key elements of the project verification process during the kick-off meeting. Duke was afforded the opportunity to comment on the key elements of the plan for verification. Based on items discussed and agreed upon with Duke, the plan identified the First Environment project team members, project level of assurance, materiality threshold, and standards of evaluation and reporting for the verification. It also provided an outline of the verification process and established project deliverables. A separate data-sampling plan was designed to review all project elements in areas of potentially high risk of inaccuracy or non-conformance.

5.5. Site Visit

Mr. Michael Carim conducted a site visit on November 15, 2016 to assess the Project's data management systems and interview personnel relevant to the Project.

5.6. Emissions Reduction Data and Calculation Assessment

This assessment used information and insights gained during the previous steps to evaluate the collected data and the reported emissions reduction quantities, and identify if either contained material or immaterial misstatements.

5.7. Corrective Actions and Supplemental Information

The team issued requests for corrective action and clarification during the verification process. Duke provided sufficient responses to all requests.

5.8. Verification Reporting

Verification reporting, represented by this report, documents the verification process and identifies its findings and results. Verification reporting consists of this report for Duke, a verification statement, and a list of findings to be submitted to the Climate Action Reserve.

6. Site's Conformance with Verification Criteria

6.1. Project Description

The Project consists of the installation and operation of a biogas control system (BCS) at Loyd Ray Farms in Yadkinville, North Carolina. The Project treats manure generated by grow/finish swine in a covered lagoon digester.

Historically, hog manure was stored in an anaerobic lagoon at the farm. In 2011, a new pit was dug and a cover was installed above to create the digester system. Biogas collected from the digester is used to generate electricity or is combusted in an open flare. The Project currently operates one microturbine generator for power production and an auxiliary flare to burn excess gas. No solids are separated from the digester effluent stream; all effluent is directed to an aeration pond.

6.2. Eligibility

The Project meets the eligibility requirements set forth in the CAR Protocol, as described below.

6.2.1. Ownership and Title

Loyd Ray Farms owns and operates the biogas control system (BCS) and associated combustion devices. Loyd Ray Farms has entered into an agreement with Duke that indicates Duke holds rights to all of the carbon offsets generated by the Project. First Environment reviewed contractual evidence of ownership of emission reduction credits to assess proof of title. Additionally, First Environment relied on the Attestation of Title completed by Duke for the current reporting period. The Attestation is on file with CAR and was reviewed to confirm that it was completed correctly.

6.2.2. Project Start Date

First Environment confirmed that the Project meets CAR's start date requirements. The Project's start date is September 23, 2011, which was confirmed through a review of documentation related to completion of BCS construction and combustion device commissioning in May 2011. Accordingly, the start date selected is within six months of the first production and destruction of methane in the BCS.

6.2.3. Anaerobic Baseline

First Environment confirmed during the site visit for the Project that the pre-project baseline lagoon was greater than one meter in depth, sufficient to prevent algal oxygen production and create an oxygen-free bottom layer. No lagoon covers were present in the baseline scenario and all waste generated was treated in the anaerobic lagoon.

6.2.4. Additionality

The Project passes both the Performance Standard Test and the Legal Requirements Test, as described below.

6.2.4.1. Performance Standard Test

The Project consists of the installation of a BCS that captures and destroys methane gas from manure treatment and/or storage facilities on swine operations and therefore exceeds the performance standard defined by the CAR Protocol.

6.2.4.2. Legal Requirements Test

The Project was assessed against and met the criteria specified in the CAR Protocol's Legal Requirements Test during the verification of the Project's first reporting period. Livestock projects are not required to demonstrate the absence of legal requirements mandating the project during the remainder of the first crediting period after their initial verification.

6.2.5. Regulatory Compliance

The compliance status of the Project was confirmed by Duke personnel during the verification process. A search of the US EPA's ECHO database on November 27, 2016 did not locate an entry for Loyd Ray Farms in the database. Semi-annual and annual State compliance reports were reviewed, all of which indicated the facility was in compliance with permit requirements during the reporting period. The high-level reviews performed indicated that the Project was in

compliance with relevant requirements and no regulatory violations occurred during the reporting period.

Additionally, First Environment relied on the Attestation of Regulatory Compliance completed by Duke for the current reporting period. The Attestation is on file with CAR and was reviewed to confirm that it was completed correctly.

6.2.6. Project Location

The Project is located in Yadkinville, North Carolina and therefore meets the geographic eligibility requirements for project location in the CAR Protocol.

6.3. Project Performance Against CAR Protocol and Project Management System

The Project was implemented in conformity with the CAR Protocol. Duke developed and implemented a Monitoring Plan to track relevant project parameters and data sources. The Monitoring Plan, including the Project Diagram, was reviewed to determine compliance with the protocol requirements. Based on observations made during the site visit and review of relevant project documentation, First Environment found the Monitoring Plan and Project Diagram to meet the requirements set forth by the CAR Protocol and the Project to be implemented in accordance with the Monitoring Plan.

The Project uses the CAR Livestock Calculation Tool, Beta Version 3.0i (CAR Tool) provided by CAR for the quantification of emission reductions; therefore, project monitoring focuses on collecting the data and information required to populate the CAR Tool. First Environment found that required data inputs into the calculation tool are monitored in accordance with the requirements of the CAR Protocol.

6.3.1. Project Monitoring

The Project monitors several site-specific variables in order to populate the CAR Tool. Monthly animal populations and animal masses are tracked by Loyd Ray Farms and reported to Duke. Average monthly temperature is obtained from National Weather Service records for a nearby weather station located in Statesville, North Carolina.

Biogas flow to the flare and microturbine is continuously monitored using two Rosemount 8800D Series Vortex flow meters installed upstream of each combustion device. Flow data are automatically corrected from ambient conditions to a standard temperature and pressure of 60°F and one atmosphere of pressure. A data logger records totalized flow every 15 minutes.

Biogas flow is directed primarily to the microturbine. Should the microturbine be unable to consume biogas, it is directed to an open flare for destruction. Gas flow to the flare is ignited by a continuous sparker. Flare temperature is measured by a thermocouple; data are recorded by the data logger every 15 minutes to demonstrate destruction device operability.

Operability of the microturbine is determined through kilowatt-hour production data monitored continuously and recorded once every 15 minutes.

Methane concentration measurements are taken at least quarterly, consistent with the requirements of the CAR Protocol. The Project uses either a BlueSens continuous gas analyzer for gas quality monitoring, or determines quarterly methane concentration from bag samples/laboratory analysis during quarters when the continuous analyzer was not used. The

continuous analyzer was in use from July to October 2014. Lab analyses of bag biogas samples collected at least quarterly from the BCS were used for all other portions of the reporting period.

Table 1 summarizes the project monitoring system parameters and monitoring equipment employed by the Project.

TABLE 1: Monitoring Equipment

Parameter	Monitoring Equipment/Sources	Frequency of Measurement	Frequency of Recording	Recording Device
Livestock Population (P_L,L)	Monthly reports	Monthly	Monthly	Monthly livestock reports
Typical Animal Mass (TAM)	Monthly reports	Monthly	Monthly	Monthly livestock reports
Average monthly temperature at location of the operation (T)	National Weather Service data for Statesville, North Carolina	Monthly	Monthly	National Weather Service Records
Biogas Flow (F)	Rosemount flow meters	Continuous	Fifteen minutes	Data logger
Methane concentration of biogas ($CH_{4,CONC}$)	BlueSens Gas Analyzer Bag Samples – Laboratory analysis	Continuous At least quarterly	Fifteen minutes At least quarterly	Data logger Laboratory analysis reports

6.3.2. Instrument Quality Assurance/Quality Control

Duke's instrument quality assurance/quality control (QA/QC) plan for the Project's monitoring equipment complies with CAR's requirements, except where noted below:

Flow meters are cleaned and inspected at least quarterly with as-found/as-left conditions documented, and are calibrated at least once every three years in accordance with manufacturer's recommendations. Neither flow meter was field checked for calibration accuracy within two months prior to the end date of the reporting period; as such, Duke requested a variance from CAR as discussed in Section 6.5 below.

The manufacturer of the flow meters recommends calibration at least every three years. The flare flow meter was maintained in accordance with manufacturer's recommendations during the reporting period. Documentation was not available to demonstrate that the microturbine flow meter was maintained in accordance with manufacturer's recommendations throughout the reporting period; as such, Duke requested a variance from CAR as discussed in Section 6.5 below.

When the continuous gas analyzer was in use, it was cleaned and inspected quarterly with as-found/as-left conditions documented. However, the analyzer was not calibrated by the manufacturer in accordance with the manufacturer's annual calibration recommendation nor was it field checked for calibration accuracy at any point during the reporting period. As a result, Duke requested a variance from CAR as discussed in Section 6.5 below.

Table 2 shows the dates during the current reporting period when instrument QA/QC was performed.

TABLE 2: Flow Instrument QA/QC

Monitoring Equipment	Calibration	Field Calibration Checks	Inspected/Cleaned
Microturbine flow meter (S/N 0252105)	10/31/2014; 12/18/2015	None – See Variance in Section 6.5	7/25/2014; 9/4/2014; 9/26/2014; 12/15/2014; 1/21/2015; 4/1/2015; 5/21/2015; 7/29/2015; 10/18/2015; 12/17/2015; 3/30/2016; 4/15/2016
Flare flow meter (S/N 0171764)	6/18/2012; 10/31/2014 12/18/2015	None – See Variance in Section 6.5	7/25/2014; 9/4/2014; 9/26/2014; 12/15/2014; 1/21/2015; 4/1/2015; 5/21/2015; 7/29/2015; 10/18/2015; 12/17/2015; 3/30/2016; 4/15/2016
BlueSens BCP-CH4 Methane Analyzer (S/N 1049D9394100006B)	7/31/2013 2/24/2015	None – See Variance in Section 6.5	7/25/2014; 9/4/2014; 9/26/2014; 12/15/2014; 4/1/2015

6.4. Emissions Reduction Calculation Assessment

Emission reduction calculations were reviewed to ensure accuracy in the raw data used as inputs. During the site visit and through a review of evidence provided, First Environment verified all variables that exist as user inputs into the CAR Tool.

6.4.1. Modeled Baseline Methane Calculations

In the baseline scenario, emissions were modeled in accordance with the equations in the CAR Protocol using the CAR Tool. The modeled baseline parameters are shown in Table 3 below.

TABLE 3: Baseline Parameters

Manure Treatment System Variables	Source
VS_L	*Grow/finish swine:* values included in the CAR Tool v3.0i
$Mass_L$	*Grow/finish swine:* site-specific values for TAM
P_L	Monthly herd inventories
$MS_{AS,L}$ / $MS_{L,nAS}$ / $MS_{L,BCS}$	Determined from site-specific conditions (see further discussion below)
Temperature	National Weather Service records
$B_{o,L}$	Table B.3 in Appendix B of the CAR Protocol
MCF_{ep} / MCF_S / MCF_{nAS}	Table B.6 in Appendix B of the CAR Protocol

A site-specific TAM was used to determine $Mass_L$. The parameter is determined from averages of weights recorded for hogs placed in barns during the reporting period.

The values of $MS_{AS,L,}$ $MS_{L,nAS}$, and $MS_{L,BCS}$ are determined from site-specific conditions, with the values varying according to the different manure management systems implemented in the baseline and project scenarios. The values assigned to $MS_{AS,L,}$ $MS_{L,nAS}$, and $MS_{L,BCS}$ in the

calculations were verified during the site visit through interviews with the project personnel, observations at the farm, and through follow-up discussions with Duke.

During the verification site visit, farm management indicated that while liquids may be drained, solids would not be removed from the baseline lagoons in the absence of the BCS.

6.4.2. Metered Baseline Methane Calculations

The amount of methane destroyed was also calculated from metered data for biogas collected.

Gas flow data to the microturbine and flare are measured continuously and recorded every 15 minutes. Totals are aggregated on a monthly and annual basis for entry into the CAR calculation tool. Meters correct gas flows from ambient conditions to standard reference conditions of 60°F and one atmosphere of pressure.

Methane concentration is determined at least quarterly from readings taken by either the continuous analyzer or determined from laboratory analysis of biogas samples.

A default destruction efficiency of 96 percent is assigned to the open flare and a default destruction efficiency of 99.5 percent is applied for the microturbine. Monthly BDE is calculated based on the flow-weighted destruction efficiency of the combustion devices.

No data substitution was performed during the reporting period.

6.4.3. Project Emission Calculation

The project emissions were modeled in accordance with the equations in the CAR Protocol using the CAR Tool. The project emissions consist of emissions from the following sources:

- Biogas Control System ($PE_{CH4,BCS,y}$),
- Liquid Digester Effluent Storage and Treatment ($PE_{CH4,EF,y}$),
- Manure Treatment Systems ($PE_{CH4,LS,y}$),
- Fossil Fuel and Electricity consumption ($CO_{2,MSC}$).

Biogas collection efficiency was assigned a default value of 95 percent, consistent with the value prescribed by the CAR Protocol for a covered lagoon.

Project emissions of CO_2 associated with purchased electricity are assigned a value of zero because the quantity of electricity generated by the Project is greater than the quantity consumed throughout the reporting period.

Project emissions of CO_2 from fossil fuel use are assigned a value of zero because no new emission sources were created as a result of project implementation.

6.4.4. Total Methane Emission Reductions

Copies of the raw data used in the calculations were compared with the data used in the final calculations and tested for transcription or mathematical errors. A risk-based sample of raw data sources and calculations over the entire verification period were reviewed. First Environment performed recalculations of emission reductions for the entire reporting period to assess whether they were free of material misstatement. First Environment found the emission reduction calculations to be free of material misstatement.

Modeled methane reductions were compared to the total metered quantity of methane destroyed over the reporting period. Based on the outputs from the CAR Tool, metered methane reductions were determined to be the lesser amount and therefore are equal to the total amount of methane reductions for the reporting period.

The Project applied for a Zero-Credit Reporting Period for the time period from July 1, 2012 through June 30, 2014 and no emission reduction credit was generated. First Environment is reasonably assured that project emissions were not greater than baseline emissions during the Zero-Credit Reporting Period.

6.5. Approved Variance or Deviations

Duke requested a variance from the CAR Protocol for the current reporting period for various issues, as noted in 6.3.2 above. Table 4 summarizes the specific conditions of the variance approval and First Environment's verification conclusion.

Table 4: Assessment of Variance Requirements

Variance Requirement	Verification Conclusion
The verifier confirms that the results of the December 18, 2015 and December 20, 2016 field checks reveal the flow meters to be reading within the +/- 5% accuracy tolerances prescribed by the protocol.	First Environment confirmed that calibration events performed in December 2015 and December 2016 showed both flow meters to be operating accurately within the +/- 5% accuracy tolerance prescribed by the protocol.
The verifier confirms that the field check for calibration accuracy requirement is integrated into the project developer's Monitoring Plan for all applicable meters.	First Environment confirmed that Section 3.04 of the Monitoring Plan includes requirements for all gas flow meters to undergo a calibration accuracy check during the last two months of the reporting period.
The verifier confirms that a process for obtaining and storing calibration certificates is integrated into the project developer's Monitoring Plan for all applicable meters.	First Environment confirmed that the monitoring plan identifies processes and responsibilities for the generation, documentation, and retention of instrument QA/QC records.
The verifier confirms that the project implemented an appropriate quarterly methane sampling procedure, which conforms to the monitoring requirements listed in Section 6 of the Livestock Project Protocol Version 3.0, following the removal of the Blue Sens methane analyzer.	After the Blue Sens instrument was removed from service, on a quarterly basis biogas samples were collected on site and analyzed at a lab to determine the methane concentration in biogas. This sampling procedure is in conformance with the monitoring requirements listed in Section 6 of the Livestock Project Protocol Version 3.0.

7. Verification Conclusion

Based on the evidence collected and the assessments performed, First Environment concludes that the Project's GHG emissions reductions achieved through the destruction of methane for the period from July 1, 2014 through June 30, 2016 can be considered with a reasonable level of assurance:

- in conformance with the verification criteria, and
- without material discrepancy.

Verified results show:

July 1 to December 31, 2014	Total
$BE_{CH4} - PE_{CH4}$ (tCH_4)	271.621
$CH_{4,destroyed}$ (tCH_4)*	50.685
BE_{CO2MSC} (tCO_2)	0
PE_{CO2MSC} (tCO_2)	0
Total Emissions Reductions (tCO_2e)	1,064

* Lesser of two results used in emission reduction calculations

January 1 to December 31, 2015	Total
$BE_{CH4} - PE_{CH4}$ (tCH_4)	273.852
$CH_{4,destroyed}$ (tCH_4)*	93.095
BE_{CO2MSC} (tCO_2)	0
PE_{CO2MSC} (tCO_2)	0
Total Emissions Reductions (tCO_2e)	1,955

*Lesser of two results used in emission reduction calculations

January 1 to June 30, 2016	Total
$BE_{CH4} - PE_{CH4}$ (tCH_4)	139.723
$CH_{4,destroyed}$ (tCH_4)*	56.138
BE_{CO2MSC} (tCO_2)	0
PE_{CO2MSC} (tCO_2)	0
Total Emissions Reductions (tCO_2e)	1,179

*Lesser of two results used in emission reduction calculations

8. Lead Verifier Signature

Michael Carim
Senior Associate

9. Senior Internal Reviewer Signature

James Wintergreen
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