



Delaware CO₂ Budget Trading Program

Offset Project Monitoring and Verification Report Instructions

Avoided Methane from Agricultural Manure Management

March 2019



**DNREC – Division of Air Quality Form
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1. Overview

To demonstrate the achievement of CO₂-equivalent emissions reductions from an agricultural manure management offset project that has received a consistency determination from the Delaware Department of Natural Resources and Environmental Control (Department), a Project Sponsor must submit to the Department in accordance with these instructions a fully completed *Offset Project Monitoring and Verification Report – Avoided Methane Emissions from Agricultural Manure Management* (“*M&V Report*”), consisting of the coversheet and all forms and related attachments. Following these instructions will ensure that the *M&V Report* contains all necessary information and is submitted properly.

The Project Sponsor should review the CO₂ Budget Trading Program regulations at 7 DE Reg. 1147 addressing offset projects and the award of CO₂ allowances. All offset application materials and other documents are available at: <https://dnrec.alpha.delaware.gov/air/greenhouse-gas/offsets/>

2. Submission Instruction

Submit one (1) complete hardcopy original *Consistency Application* as well as an electronic copy in the form of a CD disk to the Department at the location specified below. Submit hardcopies of forms requiring signatures as originally-signed copies and scan such signed forms for electronic submission. Facsimiles of the *M&V Report* are not acceptable under any circumstances.

***CO₂ Budget Trading Program
DNREC Division of Air Quality
100 W. Water Street, Suite 6A
Dover, Delaware 19904***

The *M&V Report* has three parts, as described below. Each part comprises specified forms and required documentation. The *M&V Report* has been created as a Microsoft Word document with editable fields. Enter information directly into the fields provided or submit information or documentation as an attachment, as directed. Include headers on all attachments indicating the form to which each is attached, the offset project name, and offset project ID code.

The Project Sponsor should save an electronic copy for his or her file to serve as a reference for any necessary remediation.

3. M&V Report Forms

The *M&V Report* consists of nine (9) forms, including coversheet, divided into three parts, as follows:

Part 1. General Information Forms

- Coversheet
- Form 1.1 – General Information
- Form 1.2 – Project Sponsor Attestations
- Form 1.3 – Project Sponsor Statement
- Form 1.4 – Disclosure of Greenhouse Gas Emissions Data Reporting



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Part 2. Category-Specific Information and Documentation Forms

- Form 2.1 – Demonstration of Conformance with M&V Plan
- Form 2.2 – Determination of Emissions Reduction

Part 3. Independent Verification Form

- Form 3.1 – General Information
- Form 3.2 – Independent Verifier Certification Statement and Report

The following instructions address each of the forms in numerical order. Note that the forms themselves include many embedded instructions.

Part 1. General Information Forms

The five (5) forms, including coversheet, in Part 1 of the *M&V Report* address general requirements applicable to agricultural manure management offset projects. Instructions for the Part 1 forms are provided below.

Coversheet

Enter the offset project name and ID code in the editable text fields.

Check the boxes to indicate which forms are being submitted. For information about entering the Project Sponsor, offset project name and offset project ID code, and RGGI COATS account name and number, see instructions below for Form 1.1, General Information.

Submit all forms including the Coversheet. If a required form is not submitted, the *M&V Report* will not be considered complete for commencement of review by the Department.

Form 1.1. General Information

Enter the requested information in the editable text fields in the Form. If a text field is not applicable or is unanswerable, enter “NA.” Note the following:

Offset Project ID Code: Enter the offset project ID code. The offset project ID code is the alphanumeric code generated when the Project Sponsor creates a record of the offset project in the RGGI CO₂ Allowance Tracking System (RGGI COATS). See the RGGI COATS User’s Guide for more information about creating an offset project record in RGGI COATS, available at: <https://rggi-coats.org/eats/rggi/>

Project Information: Enter project information. The name of the offset project should be the same name entered by the Project Sponsor when creating a project record in RGGI COATS. The project location entered should be the primary location of the project if the project consists of actions at multiple locations. The summary narrative of the project should indicate all locations where project actions occur or will occur.



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Project Sponsor: Identify the Project Sponsor and provide his or her contact information. The Project Sponsor is the natural person who is the Authorized Account Representative for the RGGI COATS general account identified in the *Consistency Application*.

Project Sponsor Organization: Provide the full legal name of the organization the Project Sponsor represents, including any alternative names under which the organization also may be doing business (e.g., John Doe Enterprises, Inc., d/b/a JDE). If the Project Sponsor is representing himself or herself as an individual, enter “NA”.

RGGI COATS General Account Name and Number: Enter the RGGI COATS general account name and number. The RGGI COATS general account identified in the *Consistency Application* is the RGGI COATS account into which any awarded CO₂ offset allowances related to the offset project will be transferred.

Form 1.2 Project Sponsor Attestations

Sign and date the form. Submit the originally signed form as part of the paper hardcopy *M&V Report*. Scan the signed and dated form for submission as part of the electronic version of the *M&V Report*.

Form 1.3 Project Sponsor Agreement

Sign and date the form. Submit the originally signed form as part of the paper hardcopy *M&V Report*. Scan the signed and dated form for submission as part of the electronic version of the *M&V Report*.

Form 1.4 Disclosures of Greenhouse Gas Emissions Data Reporting

Check the appropriate box in the form to indicate whether greenhouse gas emissions data related to the offset project have been or will be reported to any voluntary or mandatory programs other than the CO₂ Budget Trading Program. For each program for which data have been or will be reported, provide the program name, the program type (voluntary or mandatory), program contact information (website or street address), the categories of data reported, the frequency of reporting, when the reporting began or will begin, and reporting status (prior, current, future). The Project Sponsor must disclose future reporting related to current commitments made to voluntary programs as well as future reporting mandated by current statutes, regulations, or judicial or administrative orders.

Part 2. Category-Specific Information and Documentation Forms

The two (2) forms in Part 2 of the *M&V Report* address category-specific requirements and documentation for agricultural manure management offset projects. Instructions for the Part 2 forms are provided below.

Form 2.1 Demonstration of Conformance with M&V Plan

Provide documentation as an attachment to Form 2.1 that procedures and protocols specified in the M&V Plan were performed and records specified in the M&V Plan were generated and retained. Check the boxes in the tables on Form 2.1 to indicate that the referenced documentation is provided as an attachment to Form 2.1. Each attachment must



include a header that identifies it as an attachment to Form 2.1, identifies the appropriate table number and the reference number in the left-hand column of the table, and includes the offset project name and offset project ID code.

Form 2.2 Determination of Emissions Reduction

Provide documentation of CO₂-equivalent emissions reductions achieved during the reporting period. Enter requested information where indicated in Form 2.2 and attach documentation to Form 2.2, as directed below. Each attachment must include a header that indicates it is an attachment to Form 2.2 and identifies the offset project name and offset project ID code. Multiple attachments may be integrated into a single document, as appropriate, as long as each element is clearly identified, as specified below. For submission of the electronic version of the *M&V Report*, spreadsheets must be provided as a distinct electronic file or files (distinct spreadsheets may be incorporated into a single spreadsheet file, as appropriate, as long as each spreadsheet element is clearly identified, as specified below). Check the boxes in Form 2.2 to indicate that requested documentation is attached.

1. **Baseline Emissions.** Enter calculated baseline methane emissions during the reporting period for all facilities supplying manure and/or organic food waste influent to the anaerobic digester, in short tons of CO₂-equivalent, where indicated in the form. For each reporting month, enter values for the data parameters identified in the form, as a sum of each parameter (except for the van't Hoff-Arrhenius factor), for all facilities supplying manure and/or organic food waste influent to the anaerobic digester. Enter the calculated methane emissions in short tons of CO₂-equivalent for each reporting month, for all facilities supplying manure and/or organic food waste influent to the anaerobic digester. Attach a spreadsheet that documents the calculation of baseline CO₂-equivalent emissions for each facility and the sum of CO₂-equivalent emissions for all facilities. The spreadsheet must also document for each facility the calculation of each monthly data parameter identified in the form and specify the units for all relevant data parameters, as specified below.

For each facility, document calculation of baseline methane emissions for each month of the reporting period in accordance with the procedures at a. through g. below. The baseline methane emissions (in CO₂e) represent potential emissions due to methane production under site-specific anaerobic storage and weather conditions.

$$\text{Baseline Emissions (short tons CO}_2\text{e)} = [(V_m \times M)/2000] \times \text{GWP}$$

Where:

- V_m = Volume of methane produced (scf) each month from decomposition of volatile solids
- M = Mass of methane per cubic foot (lbs/scf) (note that 0.04246 lbs/scf is the default value at one atmosphere and 68°F (20°C))
- GWP = CO₂e global warming potential of methane (28)

- a. **Volatile Solids Decomposed.** Document calculation of the estimated amount (kg) of volatile solids decomposed each month under the uncontrolled anaerobic storage baseline scenario in accordance with the following equation:

$$VS_{\text{dec}} = VS_{\text{avail}} \times f$$

Where:

- VS_{dec} = volatile solids decomposed each month (kg)
- VS_{avail} = volatile solids available for decomposition in manure or organic food waste storage each month (kg)
- f = van't Hoff-Arrhenius factor for the specific month



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- b. Application of van't Hoff-Arrhenius Factor. Document calculation of the van't Hoff-Arrhenius factor for each month, which specifies conversion efficiency of volatile solids to methane, in accordance with the following equation:

$$f = \exp\{[E(T_2 - T_1)] / [(GC \times T_1 \times T_2)]\}$$

Where:

- f = van't Hoff-Arrhenius factor
E = activation energy constant (15,175 cal/mol)
T₂ = average monthly ambient temperature (in Kelvin) for facility where manure or organic food waste is generated if reported temperature is greater than 5°C
T₁ = 303.15 K (30°C converted to K)
GC = ideal gas constant (1.987 cal/(K•mol))

If reported temperature is less than 5°C, as determined from the nearest National Weather Service certified weather station for the facility where manure or organic food waste is managed, then f equals 0.104.

- c. Volatile Solids Available for Decomposition. Document calculation of the volatile solids available for decomposition in manure or organic food waste storage for each month in accordance with the following equation:

$$VS_{avail} = VS_p + \frac{1}{2} VS_{in} - VS_{out}$$

Where:

- VS_{avail} = volatile solids available for decomposition each month
VS_p = volatile solids present in manure or organic food waste storage at beginning of the month (kg)
VS_{in} = volatile solids added to manure or organic food waste storage during the course of the month (kg); multiply this number by the factor of ½ to represent the average mass of volatile solids available for decomposition for the entire duration of the month
VS_{out} = volatile solids removed from manure or organic food waste storage for land application or export

- d. Mass of Volatile Solids Available at Start of Month. Document calculation of the volatile solids present in manure or organic food waste storage at the beginning of each month in accordance with the equation below:

$$VS_p = (M_m \times TS\% \times VS\%)_p$$

Where:

- VS_p = volatile solids present in manure or organic food waste storage at beginning of each month (kg)
M_m = mass (kg) of manure or organic food waste present in storage at the beginning of the month
TS% = concentration (percent) of total solids in manure and organic food waste as determined through U.S. EPA 160.3 testing method (U.S. EPA Method Number 160.3, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))
VS% = concentration (percent) of volatile solids in total solids as determined through U.S. EPA 160.4 testing method (U.S. EPA Method Number 160.4, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))



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- e. Mass of Volatile Solids Added During Month. Document calculation of the volatile solids added to manure or organic food waste storage during the course of each month in accordance with the following equation:

$$VS_{in} = (M_m \times TS\% \times VS\%)_{in}$$

Where:

- VS_{in} = volatile solids added to manure or organic food waste storage during the course of each month (kg)
 M_m = mass (kg) of manure or organic food waste added to storage at the beginning of the month
 $TS\%$ = concentration (percent) of total solids in manure and organic food waste as determined through U.S. EPA 160.3 testing method (U.S. EPA Method Number 160.3, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))
 $VS\%$ = concentration (percent) of volatile solids in total solids as determined through U.S. EPA 160.4 testing method (U.S. EPA Method Number 160.4, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))

- f. Mass of Volatile Solids Removed During Month. Document calculation of the volatile solids removed from manure or organic food waste storage for land application or export for each month (document assumed value based on practices the farm employed prior to the commencement of the offset project consistent with standard practice) in accordance with the following equation:

$$VS_{out} = (M_m \times TS\% \times VS\%)_{out}$$

Where:

- VS_{out} = volatile solids removed from manure or organic food waste storage during the course of each month (kg)
 M_m = mass (kg) of manure or organic food waste removed from storage during the month
 $TS\%$ = concentration (percent) of total solids in manure and organic food waste as determined through U.S. EPA 160.3 testing method (U.S. EPA Method Number 160.3, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))
 $VS\%$ = concentration (percent) of volatile solids in total solids as determined through U.S. EPA 160.4 testing method (U.S. EPA Method Number 160.4, Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020))

- g. Volume of Methane Produced. Document calculation of the volume of methane produced from degradation of volatile solids each month in accordance with the following equation:

$$V_m = (VS_{dec} \times B_o) \times 35.3147 \text{ (cubic feet per cubic meter)}$$

Where:

- V_m = volume of methane produced (scf)
 VS_{dec} = volatile solids decomposed (kg)
 B_o = manure or organic food waste type-specific maximum methane generation constant (m³ methane/kg VS_{dec}). For dairy cow manure, $B_o = 0.24 \text{ m}^3 \text{ methane/kg VS}_{dec}$. For other types of manure, use the methane generation constants cited in U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010, Annex 3.11, Table 180 (U.S. EPA, February 2017).



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2. Methane Emissions Captured and Destroyed Using Anaerobic Digester. Attach a spreadsheet documenting the data sources and calculations used to quantify the annual volume of methane emissions (in standard cubic feet of methane and CO₂-equivalent) captured and destroyed by the anaerobic digester. Indicate whether methane concentration of digester biogas is continuously monitored.

If a direct continuous monitoring system is measuring methane concentration of recovered digester biogas, the spreadsheet must include the following data and calculations:

- Daily methane recovery (in standard cubic feet of methane) from the continuous monitoring system for each day in the reporting period
- Sum of the daily methane recovery (in standard cubic feet of methane) on a monthly basis
- Sum of the monthly methane recovery to obtain total annual methane recovery (in standard cubic feet of methane per year and short tons of CO₂-equivalent per year) from the digester

If a direct continuous monitoring system is monitoring digester biogas flow only, the spreadsheet must include the following data and calculations:

- Tabulation of daily digester biogas flow (in standard cubic feet) from the continuous monitoring system for each day in the reporting period
- Sum of daily digester biogas flow on a weekly basis (in standard cubic feet)
- Weekly methane concentration measurements (in percent of sample by volume) using calibrated digester biogas analyzer
- Weekly methane recovery (in standard cubic feet of methane), obtained by multiplying the weekly digester biogas flow rate by the respective week's methane concentration measurement (in percent of sample by volume)
- Sum of weekly methane recovery (in standard cubic feet of methane) on a monthly basis
- Sum of monthly methane recovery to obtain total annual methane recovery from the digester (in standard cubic feet of methane and short tons of CO₂-equivalent)

3. Transport CO₂-Equivalent Emissions. If the offset project is a regional-type digester, attach a spreadsheet documenting quantification of CO₂ emissions due to transportation of manure and/or organic food waste from the off-site facilities where the manure and/or organic food waste was generated to the anaerobic digester. The spreadsheet must specify data sources and calculations. To determine transport CO₂ emissions, the spreadsheet must document use of one of the following two methods:

- a. Method 1: Emission factors for type and quantity of fuel used
Identify data sources and calculations used to determine fuel use for all shipments of manure and organic food waste from off-site facilities to the anaerobic digester during the reporting period. Specify how transport miles and quantity of fuel used for each shipment were determined and recorded. Specify the emissions factors used, which may include:
- Diesel fuel: 22.912 lbs CO₂/gallon
 - Gasoline: 19.878 lbs CO₂/gallon
 - Other fuel: emission factor approved by the Department
- b. Method 2: Emission factors for type of fuel used by the ton-mile
Identify data sources and calculations used to determine total tons of manure and organic food waste transported from off-site facilities for input into the anaerobic digester during the reporting period. Specify how transport tons, transport miles, and fuel type used for each shipment were determined and recorded. Specify the emissions factors used, which may include:



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- Diesel fuel: 0.131 lbs CO₂ per ton-mile
 - Gasoline: 0.133 lbs CO₂ per ton-mile
 - Other fuel: emission factor approved by the Department
4. Determination of Emissions Reductions. Enter the emissions reductions achieved by the offset project in short tons of CO₂-equivalent where indicated in Form 2.2. Emissions reductions are equivalent to the annual baseline methane emissions or annual methane captured and destroyed by the anaerobic digester (both in short tons of CO₂-equivalent), whichever is less. For regional-type digesters, emissions reductions must be the net emissions reductions achieved after subtraction of any transport-related CO₂ emissions.

Part 3. Independent Verification Form

The two (2) forms in Part 3 of the *M&V Report* addresses requirements and documentation related to the independent verifier general information and certification statement and report. Instructions for the forms in Part 3 are provided below.

Form 3.1 General Information

Enter the requested information in the editable text fields in the form. If a text field is not applicable or is unanswerable, enter “NA.”

Form 3.2 Independent Verifier Certification Statement and Report

An accredited verifier must sign and date the form. Submit the originally signed form as part of the paper hardcopy of the *M&V Report*. Scan the signed and dated form for submission as part of the electronic version of the *M&V Report*.

Provide the independent verifier report as an attachment to Form 3.2. The verifier report must include a header that indicates it is an attachment to Form 3.2 and includes the offset project name and offset project ID code.

The verifier report must document the following:

1. The verifier has reviewed the entire *M&V Report* and evaluated the contents of the report in relation to the applicable requirements of 7 DE Reg. 1147-10.
2. The verifier has evaluated the adequacy and validity of information supplied by the Project Sponsor to determine CO₂-equivalent emissions reductions in accordance with 7 DE Reg. 1147-10.5, and the documentation required in the *M&V Report*.
3. The verifier has evaluated the adequacy and consistency of methods used by the Project Sponsor to quantify, monitor, and verify CO₂-equivalent emissions reductions in accordance with 7 DE Reg. 1147-10.5 and the Monitoring and Verification Plan submitted as part of the *Consistency Application*.

The verifier report must include the following contents, in the order listed below:

- Cover page with report title and date
- Table of contents
- List of acronyms and abbreviations
- Executive summary



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- Description of objective of report
- Identification of the client, including name, address, and other contact information
- Identification of the offset project
- Description of evaluation criteria (applicable regulatory provisions and documentation required in the *Consistency Application*)
- Description of the review and evaluation process, including any site visits and interviews
- Identification of individuals performing the verification work, including the verification team leader and key personnel, and contact information for the team leader
- Description of the materials provided to the verifier by the Project Sponsor
- Evaluation conclusions and findings, including level of assurance provided