



RUBY CANYON ENGINEERING

## **Verification Report**

CAR495 Greenville County Landfill Gas Utilization Project

Reporting Period: January 1, 2014 – December 31, 2014

Prepared for:

Greenville Gas Producers, LLC

December 30, 2015

Ruby Canyon Engineering

743 Horizon Ct. Suite 385

Grand Junction, Colorado 81506

(970) 241-9298

## Table of Contents

|     |                                                                    |   |
|-----|--------------------------------------------------------------------|---|
| 1.0 | Introduction.....                                                  | 1 |
| 1.1 | Project Background & Site Description.....                         | 1 |
| 1.2 | Responsible Party.....                                             | 1 |
| 1.3 | Verification Team .....                                            | 1 |
| 1.4 | Objectives .....                                                   | 1 |
| 1.5 | Scope.....                                                         | 2 |
| 1.6 | Verification Criteria.....                                         | 2 |
| 2.0 | Verification Activities Summary .....                              | 2 |
| 3.0 | Verification Findings .....                                        | 3 |
| 3.1 | Assessment of the GHG Emission Reductions Project Operations ..... | 3 |
| 3.2 | GHG Project Boundary (sources, sinks and/or reservoirs) .....      | 3 |
| 3.3 | Project Eligibility Criteria.....                                  | 4 |
| 3.4 | Ownership of Generated Emission Reductions.....                    | 5 |
| 3.5 | GHG Monitoring and Management Systems.....                         | 5 |
| 3.6 | Variance Request .....                                             | 6 |
| 3.7 | Instrument QA/QC.....                                              | 6 |
| 3.8 | Assessment of GHG Emission Reductions Calculations .....           | 6 |
| 4.0 | Verification Results .....                                         | 7 |
| 5.0 | Conclusion .....                                                   | 8 |

## **1.0 Introduction**

Greenville Gas Producers, LLC (GGP) contracted Ruby Canyon Engineering, Inc. (RCE) to perform the verification of the CAR495 Greenville County Landfill Gas Utilization Project (Project) for the reporting period January 1, 2014 through December 31, 2014 to the Climate Action Reserve (Reserve) Landfill Project Protocol Version 3.0 (Protocol). The Project involves greenhouse gas (GHG) emission reductions from the capture and destruction of landfill gas (LFG) via two lean-burn internal combustion engines with an installed capacity of 3.2 MW and an open flare at the Enoree Landfill located near Greer, South Carolina.

### ***1.1 Project Background & Site Description***

The Enoree Landfill (Landfill) is owned and operated by Greenville County. There are two waste-containing cells at the Landfill referred to as Phase I and Phase II. Phase I of the landfill was operational for three years (1991 – 1994). Detailed waste acceptance records were not required during Phase I operation, but the amount of waste in place upon closure is estimated to be 750,000 – 1,000,000 tons (680,000 – 907,000 tonnes).

Phase II of the landfill is about 71 acres in area, with an average depth of 40 feet, and a design capacity of approximately 2,600,000 Mg (2.86 million tons). Phase II began accepting MSW in 1996 and continued until early 2007 when the Landfill was closed and subsequently capped with a high-density polyethylene material cover. The amount of waste in place at the time of closure was 2,573,786 tons (2,334,899 tonnes). The Landfill was constructed with a liner and leachate drainage system designed in compliance with Subtitle D of the Resource Conservation and Recovery Act (RCRA). The flare began operating in August, 2007, and the electricity generation plant was completed in August, 2008.

GGP applied for and was granted a research, development, and demonstration permit for recirculating leachate through injection wells into the waste mass of the Landfill. RCE confirmed that leachate is the only liquid that was added to the Landfill during the reporting period. GGP also collected samples of waste that were analyzed by a third party lab for moisture content. RCE confirmed that the average moisture content of the samples was below the EPA defined threshold of 35% - 65% which is optimal for a bioreactor. Therefore the Landfill is not considered a bioreactor as defined by the Protocol.

### ***1.2 Responsible Party***

Project Developer: Greenville Gas Producers, LLC (GGP)  
Landfill Owner: Greenville County, SC

### ***1.3 Verification Team***

The RCE verification team consisted of the following individuals who were selected based upon verification experience and knowledge of the landfill methane sector.

Lead Verifier: Samantha Phillips  
Team Member: Zach Eyler  
Senior Internal Reviewer: Bonny Crews

### ***1.4 Objectives***

The goal of the verification activities was to ensure that the claimed GHG emission reductions were complete, consistent, accurate, transparent, and permanent and that the Project was in compliance with the Reserve's project additionality, monitoring, and reporting requirements. Furthermore, the verification activities ensure that the data provided to RCE is well documented and free of any material errors or omissions.

## 1.5 Scope

The scope of the verification consisted of the following independent and objective activities:

- Review the reporting period's Project Monitoring Plan;
- Conduct a site visit to the Project location;
- Review the Project data acquisition and quality control procedures;
- Review the Project's baseline emissions and confirm the baseline and Project boundaries;
- Review the Project's evidence of environmental and regulatory requirements to ensure that the Project is additional;
- Review the Project's emission reduction calculations;
- Review the Project documents and data against the criteria listed in Table 1;
- Issue requests for additional documentation, clarifications, and corrective actions as necessary; and
- Issue a verification report, verification statement, and list of findings to GGP and the Reserve.

## 1.6 Verification Criteria

**Table 1 – Summary of Verification Criteria**

| Criteria                        | Details                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Standard of Verification</b> | <ul style="list-style-type: none"><li>• The Reserve Landfill Project Protocol Version 3.0 (December 2, 2009)</li><li>• Errata and Clarifications to Landfill Project Protocol Version 3.0 (June 18, 2015)</li><li>• The Reserve Program Manual (September 1, 2015)</li><li>• The Reserve Verification Program Manual (December 20, 2010)</li></ul> |
| <b>Verification Process</b>     | The Reserve Verification Program Manual and ISO 14064-3 Specification with guidance for the validation and verification of greenhouse gas assertions                                                                                                                                                                                               |
| <b>Level of Assurance</b>       | Reasonable assurance                                                                                                                                                                                                                                                                                                                               |
| <b>Materiality</b>              | 97% accuracy level (less than 3% error) because total annual emission reductions are greater than 25,000 tCO <sub>2</sub> e and less than 100,000 tCO <sub>2</sub> e.                                                                                                                                                                              |

## 2.0 Verification Activities Summary

The Verification process consisted of the following activities as outlined in the verification plan:

- RCE completed a NOVA/COI form to identify any potential conflict of interest with the Project or GGP. The NOVA/COI form was submitted to the Reserve and the COI assessment revealed no conflicts of interest and was approved by the Reserve on January 7, 2015.
- RCE held a verification kick-off meeting with GGP on January 21, 2015. During the kick-off meeting RCE reviewed the verification objectives and process, reviewed the verification schedule, and requested the verification background documents.
- RCE performed a strategic review and risk assessment of the received data and support documents in order to understand the scope and areas of potential risk in the GHG emissions reductions.
- RCE developed a risk-based sampling plan based upon the strategic review and risk assessment. The verification plan and sampling plan were used throughout the verification and were revised as needed based upon additional risk assessments.
- RCE conducted a site visit on February 19, 2015. During the site visit RCE performed key personnel interviews; inspected the Project equipment; and observed the onsite GHG management systems and data gathering, monitoring, and handling practices.
- RCE performed a risk-based desktop review of the submitted verification documents. The desktop review included an assessment of the GHG calculation methods and inputs, source data

completeness, GHG management and monitoring systems, evidence of regulatory compliance, and record retention practices.

- RCE submitted requests for corrective actions, additional documentation, and clarifications to GGP throughout the verification.
- RCE's senior internal reviewer conducted a review of the verification sampling, report, and statement.
- RCE issued a final verification report, verification statement, and list of findings.
- RCE held an exit meeting with GGP on December 30, 2015.

## 3.0 Verification Findings

### 3.1 *Assessment of the GHG Emission Reductions Project Operations*

The Project currently collects LFG from the Landfill and destroys it via combustion in a pair of Caterpillar G3520C gas generator sets (gensets) housed in containers adjacent to the flare skid. An open flare is available to handle destruction of excess LFG or for gas diversion when one or both gensets is offline. The LFG is pulled by a blower located at the flare skid through a gas collection system that consists of 51 wellheads connected by lateral piping to the main header pipe.

During the site visit, RCE did not observe any evidence that Project design or operational boundaries had changed from the previous verification. The landfill remains closed and there were no new LFG collection wells added to the Project.

### 3.2 *GHG Project Boundary (sources, sinks and/or reservoirs)*

The Protocol designates that CO<sub>2</sub> and CH<sub>4</sub> are the only GHGs included from the baseline and Project activities. The project emissions must be deducted from the baseline emissions in order to calculate GHG emission reductions. These GHG sources include methane generated from biodegradation of the landfill waste vented to the atmosphere, methane consumed by soil bacteria through natural oxidation, incomplete combustion of methane via Project destruction devices, fossil fuel use, and electricity use. The sources of GHG emissions reviewed during the verification of the Project are listed in Table 2.

**Table 2 – Summary of the Project GHG Sources, Sinks and Reservoirs**

| Activity        | GHG Sources, Sinks & Reservoirs                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Baseline</b> | <ul style="list-style-type: none"> <li>• CH<sub>4</sub> vented to the atmosphere</li> <li>• Percent methane oxidized by soil bacteria. The landfill incorporates a synthetic cover as part of the final cap system; therefore a 10% oxidation factor is not applied.</li> </ul>                                                                                                                                                                                    |
| <b>Project</b>  | <ul style="list-style-type: none"> <li>• CH<sub>4</sub> from the incomplete combustion of LFG sent to the open flare.</li> <li>• CH<sub>4</sub> from the incomplete combustion of LFG sent to the lean-burn internal combustion engines.</li> <li>• CO<sub>2</sub> from the combustion of fossil fuels used during operation and maintenance of the Project activity.</li> <li>• CO<sub>2</sub> resulting from the consumption of imported electricity.</li> </ul> |

### **3.3 Project Eligibility Criteria**

The Protocol specifies four eligibility rules that a project must meet in order to register emission reductions with the Reserve: Location, Project Start Date, Additionality, and Regulatory Compliance. Below is a summary of the Reserve eligibility requirements and the Project's compliance to each requirement.

- **Eligibility Rule 1: Location**

The Project is a US-based landfill located near the town of Greer in Greenville County, South Carolina, USA. The Project therefore meets this eligibility requirement.

- **Eligibility Rule 2: Project Start Date**

During RCE's first verification of the Project, RCE reviewed the landfill's Air Permit, the South Carolina Office of Environmental Quality Control Construction Permit, and the Temporary Operating Permit which show that the Project began flaring gas on August 1, 2007 and began generating power from LFG combustion on September 1, 2008. RCE confirmed August 1, 2007 as the Project start date.

- **Eligibility Rule 3: Additionality**

Performance Standard Test

Prior to the Project activity, the Enoree Landfill neither collected nor destroyed LFG.

Thus, the Project passes the Performance Standard Test number 1 since it involves:

“Installation of a landfill gas collection system and a new qualifying destruction device at an eligible landfill where landfill gas has never been collected and destroyed prior to the project start date.”

Legal Requirement Test

During the site visit, RCE interviewed the Project Developer about the procedures to ensure that the Project meets environmental compliance requirements and the Legal Requirement Test. Project personnel conduct regular reviews of state, local, and federal LFG regulatory requirements to ensure that the Project is in environmental compliance and that there is no mandate to collect and combust LFG. RCE confirmed that there are currently no local, state, or Federal laws or ordinances requiring the landfill to collect and destroy LFG. RCE also reviewed the Project's Monitoring Plan which defines how the Project continues to exceed the Legal Requirement Test. RCE confirmed that GGP is following their Monitoring Manual procedures to ensure they pass the Legal Requirements Test. Finally, RCE confirmed signature of the Attestation of Voluntary Implementation form which was completed after the reporting period and uploaded to the Reserve website.

The design capacity of the landfill exceeds the 2.5 million Mg threshold and is therefore subject to the New Source Performance Standards (NSPS) for MSW Landfills. The regulation requires that landfills above the threshold size calculate their annual NMOC emissions. The most recent Tier II NMOC emission rate test was conducted when the landfill was closed in 2007. The projected NMOC rate for 2014 was 10.05 Mg/year. Since the landfill is closed this rate is not expected to exceed the regulatory threshold of 50 Mg/year which would trigger mandatory emissions control.

- **Eligibility Rule 4: Regulatory Compliance**

RCE reviewed the procedures described in the Monitoring Plan to ensure that the Project remains in compliance with all applicable local, state, and federal requirements. RCE reviewed the landfill's air permit and the closure construction certificate. There was no evidence of non-compliance found during RCE's review which included utilizing the EPA's enforcement and compliance history online database (ECHO) and contacting South Carolina Department of Health and Environmental Control. RCE confirmed that the procedures for ensuring regulatory compliance in the Monitoring Plan were being properly followed and confirmed signature of the Attestation of Regulatory Compliance which was completed after the reporting period and uploaded to the Reserve website.

### ***3.4 Ownership of Generated Emission Reductions***

RCE reviewed evidence that GGP retains sole ownership of the GHG emission reductions. Ownership documentation consisted of the redacted contract agreement between GGP and the County of Greenville, South Carolina that states GGP is entitled to any emission reduction credits or offsets from the destruction of LFG. RCE also reviewed the purchase power agreement between GGP and the third party contracted to buy electricity generated at the Landfill. The presented evidence clearly demonstrates that GGP holds the legal title and exclusive ownership rights of the emission reductions associated with the Project. Finally, RCE reviewed the completed Attestation of Title which was uploaded to the CAR website following the end of the reporting period.

### ***3.5 GHG Monitoring and Management Systems***

RCE reviewed the data management systems during the site visit and desktop review. RCE completed the majority of the GHG management systems review during the site visit by observing the onsite procedures and interviewing Landfill personnel. The onsite review included an assessment of the Project data collection, processing, and handling procedures; recordkeeping and data storage; quality control and assurance procedures; record retention systems; and a field tour of the Project equipment. The desktop review included a detailed review of the Project monitoring plan and its conformance to Protocol requirements. RCE also confirmed that the Project was implemented according to the Monitoring Plan.

The primary Project data includes the LFG flow to the flare, LFG flow to the engines, temperature of the flare, methane content of the LFG, and kilowatt production of the engines. A Veris Verabar flow meter coupled with a Yokogawa pressure transmitter measures LFG sent to the open flare, downstream of the blowers and methane measurement, at 59°F and 1 atm. RCE confirmed that GGP used equation 5.2 to adjust LFG to the Protocol standard temperature and pressure of 60°F and 1 atm. A Lambda Square Venturi flow meter coupled with a Yokogawa pressure transmitter measures LFG sent to the generators, downstream of the blowers and methane measurement, at 60°F and 1 atm. The methane fraction in the LFG is measured continuously downstream of the blowers with a Siemens Ultramat 23.

There is a redundant Lambda Square Venturi header flow meter on site. RCE did not review any data from this flow meter and GGP did not use this data to calculate emission reductions, however all QA/QC practices were performed.

The temperature of the open flare is measured continuously via a thermocouple and serves as evidence of hourly operational activity. Hourly operational activity is not monitored for each engine separately, however the purchaser of electricity measures total kilowatt production every fifteen minutes. A variance to allow the use of combined operational evidence is discussed below.

Flow and methane content are measured continuously and recorded every 5 minutes and compiled into a database by the SCADA system. The SCADA data files are transferred weekly by the Site Operator to the Operations Manager, who reviews and transfers the data to GGP's Carbon Advisor. The Carbon Advisor

conducts quality checks and incorporates the data into the emission reduction workbook. An electronic chart recorder records 2-minute data that is maintained as a backup in the event of SCADA failure.

During the site visit RCE reviewed GGP's data storage and retention policies and verified they were in conformance with the Protocol requirements and followed the Project monitoring plan.

### ***3.6 Variance Request***

GGP submitted a variance request to the Reserve regarding the Protocol project monitoring requirements. According to the Landfill Project Protocol Version 3.0 Errata and Clarifications, "All destruction devices must have their operational status monitored and recorded at least hourly." Operational status for each individual engine was not tracked for the entire reporting period.

GGP has requested a variance for Greenville County Landfill to allow for both engines to be monitored by a single utility meter. The Reserve granted this variance pursuant to the following conditions:

- The project developer is able to demonstrate that the electricity produced by the engines is proportional to the volume of flow, as confirmed by the verifier.
- The verifier confirms it is physically impossible for landfill gas to vent from the engines while they are not in operation.
- The verifier confirms the monitoring plan is updated to reflect that each engine's operational status will be monitored independently moving forward.

RCE confirmed that the electricity produced by the engines is proportional to the volume of flow and that it is physically impossible for LFG to flow through the engines when not in operation. RCE reviewed updates to the monitoring plan that includes monitoring the operational status of each engine individually.

### ***3.7 Instrument QA/QC***

RCE confirmed that all monitoring equipment was inspected and cleaned quarterly (January 1, 2014, April 1, 2014, July 1, 2014, October 1, 2014, and January 1, 2015) with the as found/as left condition documented per the requirements of the Protocol. The third party field checks to determine the accuracy of the Yokogawa pressure transmitters and continuous methane analyzer were performed on December 10, 2014. The field checks indicated that the pressure transmitters and the continuous gas analyzer were reading within the Protocol required +/- 5% threshold. All three devices were also calibrated on December 10, 2014.

The Veris Verabar and Lambda Square Venturi flow meters are metal perforated tubes and cannot be calibrated. They are only required to be checked for buildup of dust / impurities periodically. Yokogawa leaves calibration frequency up to the user of the pressure transmitters, and therefore GGP follows the Protocol-specified five year requirement. RCE confirmed that the flow meters meet this requirement because they are calibrated by a third party every six months. Siemens recommends using calibration gas annually to calibrate the Ultramat 23 gas analyzer. GGP calibrates the Siemens Ultramat semi-annually exceeding the manufacturer's recommendation for calibration frequency.

### ***3.8 Assessment of GHG Emission Reductions Calculations***

RCE reviewed the emission reduction calculations, Project assumptions, raw data inputs, and accuracy of calculations. RCE first assessed the completeness of the raw data and how the data is transferred to the calculation spreadsheet. Next, the team reviewed the formulas and raw data inputs for accuracy and compliance with the Protocol. RCE sampled selections of data and recalculated the methane destroyed by the Project and compared these values to GGP's values in the assertion spreadsheet.

RCE reviewed checks built into the spreadsheet that accounts for flow only at times when the destruction devices are operational which is defined as thermocouple reading temperatures greater than 500°F for the open flare and as electricity production by either or both of the engines within a single hour.

RCE confirmed that the default destruction efficiency of 96 percent was applied to the open flare and 93.6 percent was applied to the lean-burn internal combustion engines. Application of the 10 percent discount for the oxidation of methane by soil bacteria was not required because the landfill incorporates a synthetic liner as part of the final cap system. RCE reviewed source documentation for Project emissions from purchased electricity and propane, confirmed that appropriate emission and conversion factors were used, and reviewed the use of Protocol equations for Project emissions in the GHG assertion.

All emission reductions occurred from destruction in the two engines, no emission reductions were claimed from destruction of the flare.

RCE recalculated LFG total flow, confirmed correct application of percent methane, recalculated project fossil fuel use, and confirmed use of appropriate conversion factors. All calculations were checked against GGP's calculations with percent differences noted. There were no instances of data substitution during this reporting period. The difference between RCE's and GGP's emission reductions was non-material.

## **4.0 Verification Results**

GGP provided sufficient documentation of its emission reductions, data collection procedures, and monitoring and quality control procedures. The verification process focused on verifying the emission reductions claimed and the source data used by GGP to quantify the emission reductions in accordance with the Reserve Landfill Project Protocol Version 3.0. The following is a summary of the verification results.

The Project reported emission reductions of 73,231 metric tons CO<sub>2</sub>e for the current reporting period. During the final review, RCE identified no material misstatements in the data or emission reduction calculations. The emission reductions verified are listed in Table 3. During the verification process, RCE made requests for corrective actions and supplemental documentation to complete the verification. GGP sufficiently addressed all requests. The details of these requests are documented in RCE's List of Findings provided to the Reserve and GGP.

## 5.0 Conclusion

RCE conducted a risk-based analysis of the CAR495 Greenville County Landfill Gas Utilization Project emission reductions including a strategic review of the Project data and evidence. Based upon the processes and procedures and the evidence collected, RCE concludes that the GHG assertion is a fair representation of the Project emission reductions resulting from the capture and utilization of LFG during the reporting period January 1, 2014 through December 31, 2014 and can be considered:

- In conformance with the Reserve Landfill Project Protocol, Version 3.0,
- Without material discrepancy, and
- Verified to a reasonable level of assurance.

The verified emission reductions are listed in Table 3.

**Table 3 - Emission Reductions Verified for January 1, 2014 through December 31, 2014**

| Baseline Emissions<br>CO <sub>2</sub> e (tonnes) | Project Emissions<br>CO <sub>2</sub> e (tonnes) | Emission Reductions<br>CO <sub>2</sub> e (tonnes) |
|--------------------------------------------------|-------------------------------------------------|---------------------------------------------------|
| 73,562                                           | 331                                             | 73,231                                            |

*Note: Due to rounding, individual values might not equal totals and values are not representative of raw data used in the emission reductions calculation.*

**Lead Verifier Signature**



**Samantha Phillips**

**Senior Internal Reviewer Signature**



**Bonny Crews**