REQUEST FOR QUALIFICATIONS
ENGINEERING SERVICES
RFQ NO. 20-1004

catawba county

MAKING. LIVING. BETTER.

Date of Issue: October 28, 2019

Qualifications Statement Due Date: November 22, 2019

Time: 5:00 PM ET

Issued for:
Catawba County Utilities & Engineering
Solid Waste Division
25 Government Drive
Newton, North Carolina 28658
(828) 465-8261

Issued by:
Catawba County Purchasing Manager
25 Government Drive
Newton, North Carolina 28658
(828) 465-8224

INTRODUCTION

Catawba County (hereinafter "County") is soliciting the submittal of qualification statements from experienced Engineering Firms (hereinafter "Firm") interested in providing services for the development of a Request for Proposals (RFP), including written technical specifications, for landfill gas (LFG) utilization at the Blackburn Landfill and Resource Recovery Facility. Eligible firms must have demonstrated experience in RFP development, specification writing, execution, and Energy Developer selection for LFG project development.

Catawba County reserves the right to reject any and all submittals. This submittal request is neither a contractual offer nor a commitment to purchase services. The County assumes no contractual obligation as a result of the issuance of this request, the preparation or submission of a qualifications statement by a Firm, the evaluation of statements or final selection.

PURPOSE

This Request for Qualifications (RFQ) is being issued by County for the purpose of soliciting Statements of Qualifications from firms for providing services in the development of a Request for Proposals (RFP) for LFG utilization, the review and evaluation of responses to the RFP, and technical support and assistance during contract negotiation with the chosen project developer.

RFQ SCHEDULE

The table below shows the *intended* schedule for this RFQ. Catawba County will make every effort to adhere to this schedule.

Event	Responsibility	Date and Time
Issue RFQ	County	October 23, 2019
Submitted Written Questions	Firms	November 6, 2019 at 5:00 PM
Provide Responses to Questions	Firms	November 8, 2019 at 5:00 PM
Submit Proposals	Firms	November 22, 2019 at 5:00 PM
Contract Award	County	TBA
Contract Effective Date	County	Upon execution

The qualifications statement shall be submitted no later than 5:00 p.m. November 22, 2019. No submittals will be accepted after the deadline.

Once the submittals have been reviewed, the County reserves the right to shortlist Firm(s) and request that the Firm(s) conduct a presentation and be interviewed by the selection committee.

RFQ QUESTIONS

Written questions shall be emailed to tinawright@catawbacountync.gov by the date and time specified above. Firms should enter "RFQ # 20-1004 – Questions" as the subject for the email. Questions received prior to the submission deadline date, the County's response, and any additional terms deemed necessary by the County will be posted in the form of an addendum to the Catawba County website, https://www.catawbacountync.gov/county-services/purchasing/bid-notices/ and shall become an Addendum to this RFQ. No information, instruction or advice provided

orally or informally by any County personnel, whether made in response to a question or otherwise in connection with this RFQ, shall be considered authoritative or binding. Firms shall rely *only* on written material contained in an Addendum to this RFQ.

SUBMISSION OF QUALIFICATIONS

The qualifications statement must be submitted with one (1) original, one (1) copy and one (1) electronic copy on flash drive. When responding to this RFQ, please follow all instructions carefully. Please submit proposal contents according to the outline specified. Failure to follow these instructions may be considered a non-responsive submission and may result in immediate elimination from further consideration. The qualifications statement should be sent to the address indicated in the table below.

Mailing address for delivery of proposal via US Postal Service	**Office Address of delivery by any other method (hand delivery, overnight, or any other carrier)**
RFQ Number: RFQ 20-1004 Catawba County Government Center Attn: Purchasing Department Post Office Box 389 Newton, North Carolina 28658	RFQ Number: RFQ 20-1004 Catawba County Government Center Attn: Purchasing Department 25 Government Drive Newton, North Carolina 28658

IMPORTANT NOTE: All qualifications shall be physically delivered to the office address listed above on or before the submission deadline in order to be considered timely, regardless of the method of delivery. **This is an absolute requirement.** All risk of late arrival due to unanticipated delay—whether delivered by hand, U.S. Postal Service, courier or other delivery service is entirely on the Firm(s). It is the sole responsibility of the Firm to have the qualifications physically in this Office by the specified time and date of opening.

BACKGROUND

Blackburn Resource Recovery Facility

The Facility site is 567.95 acres and is located approximately 6 miles south of Hickory, along Rocky Ford Road. The Facility has an approved Permit 1803-MSLF-1997, from the North Carolina Department of Environmental Quality (NCDEQ), Division of Solid Waste Management. Additionally, the Landfill operates under Title V Air Quality Permit No. 08533T10 issued by the NCDEQ. The Facility is owned and operated by Catawba County, North Carolina and consists of four landfill areas, including a closed, unlined landfill that predated Subtitle D regulations, designated as Unit 1; the Subtitle D Municipal Solid Waste (MSW) Landfills, designated as MSW Unit 2 and MSW Unit 3; a closed Construction and Demolition (C&D) Landfill, designated C&D Unit 1; and an active C&D Unit 2. In addition, the County operates a Treatment and Processing Area onsite that grinds green and dry wood, leaves and grass, and manages tires and white goods. Both pre and post Subtitle D MSW Landfill Units 1, 2, and 3 have an active LFG conditioning and collection system that currently provides LFG to three (3) Jenbacher-J320 engine-generator sets.

In January 2019, Cornerstone PLLC prepared a *Landfill Gas Beneficial Use Feasibility Study*, attached hereto as Attachment B, followed by a *Conceptual Design and Proforma for the Potential Renewable Natural Gas Facility at the Blackburn Landfill*, attached hereto as Attachment C, as the County was interested in exploring a LFG to RNG project.

SCOPE OF SERVICES

The Firm shall provide professional engineering services to assist with finding an energy developer who is willing to purchase the raw, untreated landfill gas produced by the Blackburn Landfill. The following tasks comprise the scope of work:

1. Project Kickoff
2. Develop written technical specifications for Request for Proposal (RFP) for sale of landfill gas.
3. Assistance in Responding to RFP Questions.
4. Proposal Evaluation Assistance and Recommendation
5. Contract Negotiation Assistance.

CONTENTS OF QUALIFICATIONS STATEMENT

Qualifications shall be submitted on 8-1/2 x 11 paper, side bound with Table of Contents and reference tabs for key sections.

The qualification statement must be submitted with one (1) original, one (1) copy and one (1) electronic copy on flash drive.

Qualification Statement shall include the following information:

1. Introduction – Letter of Transmittal

- Summarize in a brief and concise manner the Firm's understanding of the scope of work and make a positive commitment to perform the work in a professional and timely manner.

2. Qualifications of Firm

Please provide:

- General work plan that demonstrates the consultant's complete understanding of the scope of work.
- Company's history and experience in solid waste management and design in the last five (5) years as relates to projects of same or similar scope as this project.
- Overall qualifications of project's managers and key personnel.
- Previous project success for projects similar in scope to this project.
- Overall experience with:
  - Developing written technical specifications
  - Solid Waste management regulations
  - Municipal solid waste landfill design, operations and closure.
  - Title V Air permitting, monitoring, and reporting.
  - Landfill gas system design and operation.
- Provide a summary of any litigation, claim(s), or contract dispute(s) filed by or against the Firm in the past five (5) years that are related to the services that the Firm provides in the regular course of business. The summary shall state the nature of the litigation, claim, or contract dispute; a brief description of the case; the outcome or projected outcome; and the monetary amount involved. If no

litigation claim(s) or contract dispute(s) have been filed by or against the Firm in the past five (5) years, please state that.

List any regulatory or license agency sanctions. If no license sanctions against the Firm, please state that.

3. Project Management and Key Personnel

Please provide:

- Firm staff resumes that show experience in North Carolina for staff assigned to this project.
- State of qualifications of the firm and its key personnel who will be assigned to work with the County.
- List of personnel who will work on the project including their specific qualifications and experience on projects of similar scope.
- List any professional training and experience, especially in relation to the type and magnitude of work required for this particular scope of services.
- List any licenses or certifications related to the scope of work described in this Request for Qualifications.
- Describe the Firm's approach to and/or method of cost control and project scheduling.
- Current work load and percentage of availability of key personnel.
- Hourly billing rates charged by your Firm for each position type.

4. References – Past Performance and Existing Contracts

Please provide:

- List of previous and current clients for work similar to this scope of work within the past five (5) years. Include names and location of project, brief description and firm's key personnel's involvement, name of project manager and telephone number, date and value of project. In addition, please complete Attachment A: Reference Disclosure Form and submit with qualifications.

EVALUATION METHOD - SELECTION PROCESS

Catawba County will use the following selection process. This process is designed to ensure that consultants are selected in a fair and uniform manner, those selected for work are qualified and experienced in the professional services desired, and to ensure that every qualified consultant has the opportunity to be considered for providing professional services to Catawba County.

A Selection Committee will evaluate responses to the Request for Qualifications and determine the most qualified applicants. Upon receipt of the packages from respondents, the Selection Committee will review using a scoring program that has been determined by the committee and detailed below. Past performance will be scored based on responses from the references submitted by the responder and/or the experience of Catawba County staff with particular firm's past performance. Only one reviewer will contact any given reference.

The Selection Committee will use the total point scores to rank the prospective Firms. The Selection Committee will determine a list of the most highly qualified Firms based

upon the ranking scores. Once the Firms are selected, authorization will be sought from the Catawba County Board of Commissioners for contract award.

EVALUATION CRITERIA

The Content of Qualifications Statement, as referenced above, shall be evaluated as follows:

Description	Total Possible Points
Qualifications of Firm • Success of Previous Projects (i.e. still in operation, how long in operation, etc…). • Developing Written Technical Specifications • Project Understanding • Overall Solid Waste Experience • Title V Air Permit Experience • Previous/Pending Litigation	30
Project Management and Key Personnel • Experience on similar projects. • Projects on time and in budget. • LFG project development experience. • Professional Training/Qualification • Work Load and Availability • Cost Control/Scheduling • Relevant Licenses/Certifications	60
References – Past Performance and Existing	10
	100 Points

FIRM INSURANCE REQUIREMENTS

The successful Firm will be required to provide the County with Certificates of Insurance meeting the County's insurance requirements as specified below. Failure to provide the required insurance will result in cancellation of the selection and the County will have the right to enter into an agreement with the Firm with the next highest ranking. Firm shall maintain at all times during the term of this Agreement, at the Firm's sole expense:

I. Commercial General Liability Insurance

Firm shall maintain Commercial General Liability insurance written on an occurrence basis, including coverage for products and completed operations liability, contractual liability, liability from independent contractors, property damage liability, bodily injury liability, and personal injury liability with limits of not less than $1,000,000 per occurrence and $2,000,000 annual aggregate. The aggregate limit shall apply separately to each location. The limits may be satisfied by a combination of primary and excess insurance.

II. Business Automobile Insurance

At all times while the Firm's representatives are conducting on-site work, the Firm shall maintain Automobile Liability insurance for any owned, hired, rented, or borrowed vehicle with a limit of not less than $1,000,000 per occurrence for bodily injury and property damage liability. The limit may be satisfied by a combination of primary and excess insurance.

III. Workers Compensation & Employers Liability Insurance

At all times while the Firm's representatives are conducting on-site work, Firm shall maintain statutory Workers Compensation insurance in accordance with the laws of North Carolina. Firm shall also maintain Employers' Liability insurance with limits of not less than $500,000 per accident and $500,000 each employee for injury by disease.

IV. General Requirements

1. Catawba County shall be named as an additional insured under Firm's automobile and general liability insurance. In the event of a loss arising out of, or related to the Firm's services performed under this Agreement, Firm's Liability insurance shall be primary (pay first) with respect to any other insurance which may be available to the County, regardless of how the "other insurance" provisions may read.

2. The Firm's General Liability, Automobile Liability, and Workers Compensation insurance must contain a waiver of subrogation in favor of the County.

3. Firm shall be responsible for insuring all of its own personal property, improvements, and betterments.

4. All insurance policies put forth to satisfy the above requirements shall require the insurer to provide a minimum of sixty (60) days' notice to the County of any material change in coverage, cancellation, or non-renewal.

5. All insurance put forth to satisfy the above requirements shall be placed with insurance companies licensed to provide insurance in the state of North Carolina. Any deductibles or self-insured retentions in the required insurance shall be subject to approval by the County.

6. Prior to beginning the work, Firm shall provide written evidence of insurance as requested by the County to confirm that these insurance requirements are satisfied. Firm agrees to provide complete copies of policies if requested. Failure of Firm to provide timely evidence of insurance, or to place coverage with insurance, or to place coverage with insurance companies acceptable to the County, shall be viewed as Firm's delaying performance entitling the County to all appropriate remedies under the law including termination of the contract.

ATTACHMENT A
REFERENCE DISCLOSURE FORM

Firm shall provide information regarding experience in work similar this scope of work by listing FIVE (5) RECENT CLIENTS, ONLY ONE OF WHICH MAY BE A CATAWBA COUNTY GOVERNMENT LISTING. References should be clients of a similar scale as the services requested in this RFQ.

1. COMPANY NAME: _____

   PERSON TO CONTACT: _____

   TELEPHONE NUMBER: _____

   TYPE OF SERVICE PROVIDED: _____

   SIZE: _____

   JOB DATES:
   BEGINNING_____END_____

---

2. COMPANY NAME: _____

   PERSON TO CONTACT: _____

   TELEPHONE NUMBER: _____

   TYPE OF SERVICE PROVIDED: _____

   SIZE: _____

   JOB DATES:
   BEGINNING_____END_____

---

3. COMPANY NAME: _____

   PERSON TO CONTACT: _____

   TELEPHONE NUMBER: _____

   TYPE OF SERVICE PROVIDED: _____

   SIZE: _____

   JOB DATES:
   BEGINNING_____END_____

---

4. COMPANY NAME: _____

PERSON TO CONTACT: _____

TELEPHONE NUMBER: _____

TYPE OF SERVICE PROVIDED: _____

SIZE: _____

JOB DATES:
BEGINNING_____END_____

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5. COMPANY NAME: _____

PERSON TO CONTACT: _____

TELEPHONE NUMBER: _____

TYPE OF SERVICE PROVIDED: _____

SIZE: _____

JOB DATES:
BEGINNING_____END_____

ATTACHMENT B

cornerstone PLLC

Building lifetime relationships with our clients and employees.

Landfill Gas Beneficial Use Feasibility Study

Catawba County

Blackburn Landfill, Newton, North Carolina

January 2019

Prepared for:
Catawba County
25 Government Drive
Newton, NC 28658

7820 NE Holman Street, Suite B-6
Portland, OR 97218
(877) 633-5520

REPORT CERTIFICATION

Landfill Gas Beneficial Use Feasibility Study

Catawba County

Blackburn Landfill
Newton, NC

The material and data in this report were prepared under the supervision and direction of the undersigned.

CEG Engineering, PLLC

Michael S. Michels, P.E.
Executive Vice President

Paul Stout
Regional Vice President

TABLE OF CONTENTS

APPENDICES

List of Tables, Figures and Drawings

Tables

Figures

1 INTRODUCTION

The Blackburn Landfill (Landfill) is owned and operated by Catawba County (County) and is located at 4017 Rocky Ford Road, Newton, North Carolina. The Landfill's existing infrastructure includes a landfill gas (LFG) collection and control system (GCCS) installed for the collection and destruction of LFG. The LFG is destroyed via flare and an existing beneficial use project consisting of three internal combustion (IC) engines to generate electricity. The rate of payment for the generated electricity has steadily dropped during recent years and coupled with the rising operations and maintenance (O&M) costs of the aging engines, feasibility of the continued operation of the IC engines has come into question. Therefore, the County is exploring the feasibility of beneficially utilizing the collected LFG by other methods. The County has contracted CEG Engineering, PLLC (CEG) to conduct a LFG Beneficial Use Feasibility Study (Feasibility Study). This Feasibility Study estimates the quality and quantity of LFG available for use as a fuel source, reviews LFG beneficial use alternatives, and provides a summary of potential LFG utilization options and incentives that may be available to the County. This Feasibility Study presents a high-level analysis of potential beneficial use projects and end-users, based on feedback from potential end-users and CEG's experience with similar projects. Conceptual drawings have not been completed nor have quotes for construction or equipment been procured. The intention of the high-level analysis is for the County to gain a general sense of profitability of each scenario and develop a short list of projects that may warrant further consideration.

2 EXECUTIVE SUMMARY

CEG has conducted this general evaluation of the Landfill for the purpose of determining the potential options for an LFG beneficial use project, particularly focusing on an LFG to renewable natural gas (RNG) project. This Feasibility Study assesses the future LFG generation and composition, evaluates options for utilizing the LFG in a beneficial use project, and identifies and evaluates parties that may be interested in developing a beneficial use project.

As part of this Feasibility Study, LFG generation modeling was prepared to estimate the quantity of LFG available for use. CEG compared the model to actual LFG collection observed at the Landfill and developed a potential range of future LFG collection. By applying a low LFG collection efficiency rate of 60 percent and high LFG collection efficiency rate of 80 percent, a projection of potential fuel availability was created. Results are discussed in detail in Section 4 of this Feasibility Study. The projected LFG collection rates are based on anticipated future waste intake rates, waste characteristics, waste moisture content (none of which we have control over), and existing LFG flow and composition data provided by the County.

CEG applied the projected rates of LFG collection to currently available utilization technologies, incorporating the quality of LFG historically extracted based on field monitoring and laboratory analysis, and the proximity of potential commercial customers. With this, CEG conducted preliminary budgetary estimates to conduct a high-level analysis of various LFG beneficial use projects at the site. This analysis is meant to eliminate options from further consideration, and/or develop a short-list of options that warrant further analysis.

This Feasibility Study focuses on the implementation of a LFG to RNG project. One of the utilization alternatives is to install a LFG processing facility that will process the collected LFG and create pipeline quality RNG, often referred to as a high-British Thermal Unit (BTU) facility. The RNG can then be delivered to a local high-volume natural gas pipeline and used down-stream at a compressed natural gas (CNG) fueling station. LFG would be dewatered, compressed, conditioned, and delivered to the natural gas pipeline via a dedicated new pipeline from the Landfill or via virtual pipeline using tube trailers. CEG interviewed several developers in the area with existing and potential pipeline injection projects. Various incentives and financial options may exist for the County. The exact disbursement of these incentives between the biogas supplier, processer, pipeline, CNG station operator, and CNG vehicle owner will need to be further explored via project development and contracting.

The high-BTU project may be viable due to the revenues generated from federal and other incentives for conversion of biogas to RNG for use in vehicles. A high-BTU project could

also be implemented due to the interest expressed by developers that have existing pipeline injection projects in the area. However, this project would be dependent on costs of the pipeline, including permitting, right of ways, and reaching agreements with the local utilities for an interconnection. Additional challenges such as utility transmission, pipeline capacity to accommodate the RNG and interconnection requirements such as gas quality testing, pressure, and metering, will need to be considered in future studies or design for this option. Should the LFG quality be proved at the higher quality, LFG to RNG conversion currently has several incentives which would make the option financially attractive. A contract with a CNG fuel user would need to be completed to show that the RNG is used as CNG vehicle fuel. This is necessary for the incentives associated with the production and use of RNG as a vehicle fuel (i.e. RINs). The payback could be less than five years for a project of this nature, depending upon the project structure and financing assumed.

Additionally, high-BTU projects such as a LFG to pipeline project are highly dependent on the LFG quality from the GCCS. Removal of the oxygen and nitrogen (i.e.: air) within LFG that results from the slight overpull on a GCCS to control surface emissions, is extremely difficult and expensive. If the concentration of oxygen and nitrogen within the LFG coming from the GCCS is too high, the cost of removal can become prohibitive. For a high-BTU to pipeline facility, nitrogen up to approximately eight to ten percent can be accommodated for a project of sufficient size.

It should be noted, that the requirement for RNG quality going directly to trucks is much less than that going into a utility pipeline. Thus, if the created RNG could be delivered directly to a fueling station, as opposed to going into the utility pipeline, this option's financial outlook increases significantly. This would involve processing LFG to RNG and conveying it directly to vehicles via a new CNG fueling station to be developed as part of the project. There are several fueling stations near the Landfill, but based on CEG's review, none appear to offer CNG fuel as an option at this time. There is potential with these fuel station owners that a teaming arrangement could be developed where direct use of RNG could be an option in their future. The RNG could be conveyed to these fueling stations via dedicated pipeline, or virtual pipeline, i.e. use of CNG tube trailers and trucking the CNG tube trailers to the CNG stations for dispensing. A small LFG to RNG facility could create RNG that meets the lower fueling standards required for use in a local CNG station. This project would benefit from the incentives for direct (i.e.: without natural gas pipeline injection) RNG utilization in vehicles.

CEG interviewed potential end users and developers that may be interested in the LFG to RNG project. Based on conversations between CEG and these potential end users, Blue Ridge Biofuels, Loves/Trillium, and Evensol have the highest level of interest in the project and potential contracting options that may be financially attractive to the County. They all have existing facilities in the area and have interest in developing their portfolios by teaming with the County to bring the project to fruition. Multiple scenarios exist for the

County's involvement in the project. The County could potentially own the LFG conditioning equipment, pipeline, and/or tube trailers, or the County could simply sell the fuel (raw LFG) to one of the developers at an agreed upon rate and negotiate the distribution of available incentives.

3 FACILITY DESCRIPTION

The Landfill has been operating since 1980 and accepts only Municipal Solid Waste (MSW). The Landfill is permitted to accept a total capacity of 15,000,000 metric tons. If the Landfill maintains its current intake rates, it is expected to reach capacity in 2075. At the end of 2018, the site had received approximately 4.9 million tons of solid waste, per waste intake information provided by the County.

The Landfill operates under Title V Air Quality Permit No. 08533T10 issued by the North Carolina Department of Environmental Quality (NCDEQ) Division of Air Quality (DAQ). The GCCS is subject to New Source Performance Standards (NSPS) for Municipal Solid Waste Landfills, Title 40 of the Code of Federal Regulations (CFR), Part 60 (40 CFR 60), Subpart WWW, and is also subject to the requirements of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Municipal Solid Waste Landfills as provided in 40 CFR 63 Subpart AAAA.

4 LFG MODELLING AND FIELD TESTING

4.1 Field Testing

Laboratory and field sampling of the County's LFG were performed by others in 2012 and 2015. The laboratory results are summarized in Table 4.1 below with the full laboratory analysis reports included as Appendix A.

The LFG composition of the samples was varied between 51 and 57 percent methane, 39 and 41 percent carbon dioxide (CO_2), zero to one percent oxygen (O_2), and two to nine percent balance gas (likely nitrogen). H_2S was relatively low for LFG at 5.04 to 8.46 parts per million by volume (ppmv).

All gas chemistry tests were quite old (year 2012 to 2015) so future studies should include obtaining recent sample and more laboratory testing for these items plus siloxane.

Table 4.1 - Field Sampling Summary

Date	1/27/2015	1/27/2015	2/6/2015	2/6/2015	1/27/2015	3/14/2012
Testing Method	GEM2000	GEM2000	GEM2000	GEM2000	ASTM D1946	ASTM D1946
Methane (%)	55.5	55.5	56.6	56.6	51.54	52.8
Carbon Dioxide (%)	40.8	40.6	40.5	40.6	38.55	39.5
Oxygen (%)	0.6	0.5	0.4	0.4	1.0	0.8
Balance (%)	3.1	3.4	2.5	2.4	8.91	6.9
Testing Method					**ASTM D6228**	**ASTM D6228**
Hydrogen Sulfide (ppm)					5.04	8.46

4.2 LFG Modeling

CEG has evaluated the LFG generation potential for the Landfill utilizing the United States Environmental Protection Agency (USEPA) Landfill Gas Emissions Model (LandGEM) v3.02. The model projections were used to predict the potential range of LFG generation and collection from the GCCS at the Landfill. LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in MSW landfills.

Characteristics of the Landfill that are considered when preparing the LandGEM include annual waste intake rates; waste characteristics such as the types of material accepted and moisture content; annual precipitation and reuse/recirculation of leachate that would

increase liquids within the landfill. For annual waste intake rates, the evaluation utilized available historical waste intake rates for years 1980 to 2014 from the "2015 Catawba GHG Report" (GHG Report) prepared by CDM Smith, dated April 18, 2016; and waste intake rates for 2015 to 2017 were provided in an email dated November 20, 2018 from Catawba County titled "Catawba County Tonnage Email." The landfill capacity is 15,000,000 metric tons, per the GHG Report. For remaining capacity after the historical waste intake values from 1980 to 2017, the yearly waste intake was assumed to be received at a constant rate (no increase applied to the yearly intake) with 184,285 metric tons received per year until closure in 2075.

Assumed low and high collection efficiencies were applied to the LFG generation projections to estimate potential low and high LFG collection rates. These projections provide a bracketing of potential LFG collection rates, from an estimated current collection efficiency of 60 percent to a higher collection efficiency that could potentially be achieved through future GCCS improvements at the Landfill at 80 percent.

At a collection efficiency of 60 percent, the model estimates LFG collection for 2018 as approximately 793 standard cubic feet per minute (scfm), close to the current collection rate of approximately 780 scfm provided by the site on December 5, 2018. The low LFG collection scenario is assumed to be the current conditions at the Landfill since improvements can be made to increase collection efficiency. Per a phone conversation with CDM Smith on November 15, 2018, improvements to the Landfill's GCCS are currently being implemented. Many wells in the Unit 1 area of the Landfill are either completely watered in or silted in, greatly reducing the collection of LFG from this portion of the Landfill. CDM Smith is currently working to install a dewatering system in this area to improve LFG collection efficiency.

The high LFG collection scenario assumes that improvements have been made to the Landfill to increase the collection efficiency. The high collection efficiency is assumed as 80 percent, which is considered industry standard for a well-tuned and maintained wellfield. At an 80 percent collection efficiency, the model estimates an LFG collection rate in 2018 of approximately 1,057 scfm and a peak LFG collection rate of approximately 1,894 scfm in the year 2076.

Table 4.2 provides a projection of potential LFG generation and collection, based upon the projection and applying a low and high collection rate for the GCCS. The LandGEM model results are included in Appendix B. These values are shown for planning purposes and are highly dependent upon future waste intake rates, waste characteristics, moisture content, and construction sequencing.

Table 4.2 – Projected LFG Generation and Extraction Rates 2018 and 2076

Year	LandGEM Projection (scfm)	Low Collection Efficiency-60% (scfm)	High Collection Efficiency-80% (scfm)
2018 (current)	1,321	793	1,057
2076 (peak year)	2,367	1,420	1,894

5 ASSESSMENT OF OPTIONS FOR LFG TO BENEFICIAL USE

5.1 General Classification of LFG Utilization Projects

LFG utilization projects can generally be classified into one of three categories, relative to project economics, the application of technology, and the availability of resources. These project classifications are generally considered as:

- Small Projects (less than 500 scfm): These projects are generally suited to the application of small IC engines or microturbines (often for on-site direct usage), RNG fuel production, or small medium/high BTU direct fire applications (boilers, evaporators, etc.);
- Medium Projects (500 scfm to 2,000 scfm): Projects of this magnitude could involve staged applications of small IC engines or RNG fuel production, however they also lend themselves to a wider range of medium/high BTU direct fire applications, electrical generation through larger IC engines or turbines, and the production of RNG for pipeline transport; and
- Large Projects (more than 2,000 scfm): Projects of this magnitude generally include electrical generation through larger IC engines or turbines, combined-cycle generating facilities, and the production of RNG for pipeline transport.

Note that all flow values are normalized to a common basis of 50 percent methane by volume. This is standard practice in the LFG industry in order to provide relative comparisons of data sets from fuel streams that may have differing methane contents.

LFG beneficial use projects in the US, numbering in the hundreds, utilize LFG as fuel in a variety of ways, including the following:

- Electrical Generation;
- Medium BTU Applications;
- Production of alternative fuels by converting LFG to a high-BTU fuel suitable for pipeline injection; and
- Production of alternative fuels by converting LFG to RNG suitable for direct use in vehicles.

The CEG team has explored gas conditioning options that have the potential to bring positive economic and socio-economic results to the Landfill and reached out to potential end users, which are discussed below.

5.2 Low Feasibility Options

5.2.1 Electrical Generation

Utilizing LFG to generate electricity for export to the power grid has long been a mainstay of LFG beneficial use. Traditionally, these projects were developed because of the relative ease of transport, both on-site and off-site, via the existing electrical grid infrastructure and the use of LFG-to-electric projects to fulfill the requirements of State-mandated renewable portfolio standards for the electrical utilities (mandated minimums of renewable electrical generation in the utilities portfolio). Prices for these projects were largely predicated on wholesale prices and fluctuated substantially based upon the regional "supply" and "need" for renewable power.

There are few incentives in the current market for renewable electric, due to the influx of solar and wind energy projects. In most states, including North Carolina, the utilities are no longer offering enough value in their recent power purchase agreements to make the development of LFG-to-electric projects economically viable.

5.2.2 Medium BTU Applications

Medium BTU applications generally consist of projects where the BTU content of the original biogas is not concentrated. Medium BTU applications that use minimally-processed biogas as a replacement for oil, coal, natural gas, etc. is an application that has been widely developed for LFG beneficial use. For relevant projects, this type of LFG beneficial use application is very appropriate – the fuel price is lower than that of natural gas, however, the processing costs are substantially lower, and the overall delivery process is simpler than observed in many other beneficial use applications.

However, these projects typically require a large consumer of natural gas end-user in relatively close proximity to the landfill. Although some medium BTU pipelines exceed 20 miles in length, the majority are well within a ten-mile radius of a landfill. Unfortunately, there do not appear to be likely candidates near the Landfill to make the development of a medium BTU project economically viable.

Based on the results of the high-level analysis of electrical generation and medium BTU projects, CEG focused efforts on LFG to RNG beneficial use projects. With the growing advancements in technology and high incentives for the production of RNG fuel for vehicles these projects are proving to be economically viable. The results of our high-level analysis are presented in the subsequent sections.

5.3 High BTU Pipeline Injection

Gas utilities have strict quality guidelines for injected gas. Nitrogen and oxygen levels in the LFG must be extremely low, or expensive additional conditioning systems would be required to remove these inert gases. Although this type of development has traditionally been the province of projects with large gas flow rates (generally more than 5,000 scfm), since 2012 the largest development reported is approximately 3,500 scfm, with smaller systems capable of operating at as low as 100 scfm have been successfully implemented. This reflects the relative efficiency and flexibility of the conditioning equipment currently being utilized and its capacity for producing fuel cost-effectively.

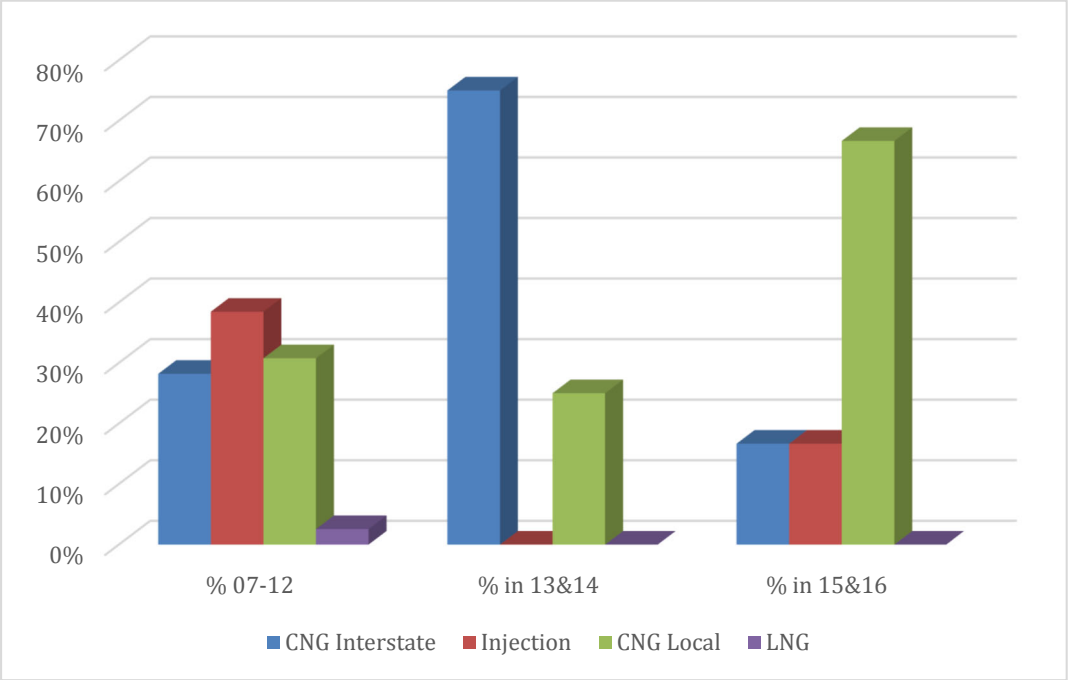
The majority of the fuel sources used for RNG applications are landfills – approximately 40 percent in 2015 - 2016, down from approximately 80 percent in 2013 - 2014. The balance of the fuel is derived from anaerobic digester and wastewater treatment plant facilities.

Within the umbrella of RNG development are four sub-sets of development:

- CNG Interstate;
- CNG Local;
- Liquefied Natural Gas (LNG); and
- RNG pipeline Injection.

Through 2012, the development of CNG for Interstate transport, CNG for local usage, and RNG injection into pipelines were developed at comparable rates, with relatively few LNG projects developed. From 2013 - 2014 there was a spike in interstate CNG projects, however, in 2015 - 2016 local applications of CNG fuel were the predominant development – approximately 60 percent of projects, as shown in Figure 5.1 below (Reference: United States Department of Energy Alternative Fuels Data Center). The predominance of local CNG fueling projects is likely due to the relatively low cost of natural gas – approximately $2.90 per million BTU (MMBTU), down from approximately $4.30/MMBTU in 2014 and more than $8/MMBTU in 2008 (Reference: Henry Hub Spot Index, 2017). The combination of low natural gas pricing and the improvement of heavy-use natural gas engines, suitable for refuse collection vehicles and freight transport, are additional drivers in the development of local CNG fueling projects.

Figure 5.1 - RNG Applications



The processes required for production of high-BTU gas from LFG are substantially more involved and, as a result, more expensive than those needed to prepare medium-BTU gas. The process involves the compression of LFG collected from the wellfield to a pressure dictated by the beneficial end use technology selected. Following compression, the LFG is processed to remove moisture, CO_2, and trace contaminants such as H_2S, siloxane, and condensed organics.

The processes required for production of high-BTU gas are adversely impacted by the oxygen and nitrogen that are typically present in LFG collection systems installed for compliance purposes. LFG collection systems designed for compliance are operated at relatively high vacuum levels in order to minimize emissions of LFG to the atmosphere. As a result, compliance systems inherently draw some amount of atmospheric air containing oxygen and nitrogen into the LFG stream. Collection systems designed specifically for high quality gas collection are operated at lower vacuum, or limit collection to deeper areas of the landfill, in order to avoid drawing air into the system.

Pipeline RNG projects generally require a greater level of processing than do vehicle fuel projects, due to the requirements of the end-use. Vehicle fuel RNG can be processed to a minimum of approximately 94 percent methane, while pipeline injection of RNG requires processing to a minimum of approximately 98 percent methane with lower limits of oxygen, nitrogen, carbon dioxide, siloxanes, and sulfur. For example, to meet Piedmont Natural Gas pipeline injection standards, in addition to the methane content percentage,

oxygen content of the injected gas must be below 0.2 percent and nitrogen below two percent. Each utility has its own particular gas quality requirements for pipeline injection. Piedmont Natural Gas Company, Inc. requirements are relatively standard as compared to the requirements seen nationwide, with California injection requirements being much more difficult to meet and the Midwest requirements typically easier to achieve.

Table 5.2 – Production of High-BTU Gas to Pipeline Injection

	1,000 scfm System
Minimum Methane Quality	50%
LFG Flow (scfm)	1,000
Fuel Production (GGE per Day)	6,000
Nitrogen Rejection Unit	$4,700,000
Gas Conditioning Equipment	$3,100,000
Pipeline Installation to high-volume natural gas pipeline interconnection	$2,000,000 - $3,000,000
Design and Permitting	$900,000
Construction	$2,600,000
Annual H_2S, Siloxane Media Replacement	$90,000
Annual Maintenance	$250,000
Annual Electricity Consumption	$1,200,000
Annual RIN Revenue[2]	$3,000,000

(1) All prices are budgetary estimates.
(2) RIN Revenue Based on current RIN value of $1.90. One RIN = 77,000 BTU. 1 GGE = 111,200 BTU. Therefore, 1 GGE = $2.74 in RIN revenue. *RINs shown are half of the total potential amount. This was done to account for distribution of RINs to the CNG fueling station developer for RNG fueling end use.*
(3) Design and permitting assumed to be ten percent of capital cost.
(4) Construction assumed to be 30 percent of capital cost.

The budgetary estimate presented in Table 5.2 does not take into account incentives from LCFS from California that could significantly impact the project budget.

With the LFG quality information available at this time, it would be a fair assessment to conclude that per the laboratory sample from 2015, at 51.5 percent methane with relatively low nitrogen and minimal oxygen, the LFG quality at the Landfill is likely sufficient for high-BTU projects.

5.3.1 LFG to Vehicle Fuel

RNG vehicle fuel facilities as shown in Figure 5.3, utilize biogas from a range of anaerobic decomposition processes, including LFG, to produce a replacement fuel for conventional CNG vehicle fuel. These facilities are generally scaled in increments from 100 scfm to 800 scfm, producing approximately 500 gasoline gallons equivalent (GGE) to 4,000 GGE of fuel per day respectively. With a relatively small footprint, RNG vehicle fuel facilities provide an effective use of small biogas streams and fit well into both Renewable Fuel and Low Carbon Fuel development programs.

Figure 5.3 - RNG Vehicle Fuel Production and Fueling Facility

In order to produce vehicle-quality RNG, a gas conditioning system is required to remove moisture, H_2S, particulates, siloxanes, and CO_2. The Society of Automotive Engineers sets the minimum quality requirements of CNG vehicle fuel in their SAE-J1616 standard. Currently, based on the data available at this time, the Landfill's LFG quality would be able to meet the standards and not require a nitrogen rejection unit (NRU) to reduce nitrogen to acceptable levels. NRUs are typically cost prohibitive unless paired with much higher LFG flows, approximately 2,000 scfm or more.

Currently, there are no active or public CNG stations in operation within 50 miles of the Landfill. Utilizing a gas conditioning system and fueling station located at the Landfill to fill mobile storage trailers and haul these trailers to one of the two CNG stations located over 50 miles west of the site is not feasible. However, a partnership with a CNG fueling

station developer to construct a CNG fueling station nearby would provide a relatively close location for transport of RNG. In addition, an existing fueling station nearby may be interested in expanding and installing a CNG fueling post that the Landfill could supply with a dedicated pipeline. There are five truck fueling stations nearby. Developing a relationship with one of the stations to provide CNG would allow the Landfill to supply RNG to that station, or potentially multiple stations through transport by tube trailer or dedicated pipeline. This option would allow the Landfill to produce a lower grade RNG that would allow RNG fueling incentives to be applied for.

Table 5.3 outlines two hypothetical LFG to vehicle fuel scenarios for a fueling station to be installed on-site. The scenarios do not include budgetary costs for pipeline installation, or the permitting, design, or modification of existing facilities to accommodate the fueling station.

Table 5.3 – Vehicle Fuel Production Cost Estimate

	200 scfm System	400 scfm System
Minimum Methane Quality	50%	50%
LFG Flow (scfm)	200	400
Fuel Production (GGE per Day)	800	1,600
Gas Conditioning Equipment	$900,000	$1,400,000
Fueling Station Equipment	$500,000	$650,000
Annual H_2S, Siloxane Media Replacement	$60,000	$120,000
Design and Permitting	$150,000	$220,000
Construction	$500,000	$650,000
Annual Maintenance	$40,000	$55,000
Annual Electricity Consumption	$225,000	$400,000
Annual RIN Revenue[2]	$1,500,000	$3,000,000
Annual Fuel Cost Offset[3]	$415,000	$830,000

(1) All prices are budgetary estimates.
(2) RIN Revenue Based on current RIN value of $1.90. One RIN = 77,000 BTU. 1 GGE = 111,200 BTU. Therefore, 1 GGE = $2.74 in RIN revenue.
(3) Based on $1.95/Gasoline Gallon Equivalent minus road tax in North Carolina ($0.351) and Federal Tax ($0.184).
(4) Design assumed to be ten percent of capital cost.
(5) Construction assumed to be 30 percent of capital cost.

It is important to note, that the above project scenarios require CNG vehicles to utilize the RNG in order to monetize the RINs and other incentives. As such, it is key to find sufficient CNG vehicles to utilize the RNG created. CNG hauling trucks to be purchased by the

County in the future would be ideal as this would greatly facilitate reaching an agreement and would not require sharing of any RINs or other incentives.

The above options utilize a budgetary estimate for a basic CNG fueling station at the Landfill, as would be the case if existing vehicles arriving at the Landfill converted to CNG engines and fueled at the Landfill. No budgetary costs are included for conversion of vehicles to CNG or sharing of RINs value with the CNG vehicle fleet owner. As such, these budgetary costs should be reexamined once a final approach for LFG to RNG for vehicles is established.

5.3.2 Additional Market Forces

Numerous forces in today's market are driving biogas to energy projects toward high-BTU systems. The market forces are proving that high-BTU projects, once requiring a minimum of 3,000 scfm inlet to be economically feasible, are now economically feasible at rates as low as 100 scfm of raw inlet biogas.

Abundant Natural Gas. Fracking of shale in the US has resulted in abundant amounts of natural gas, selling recently in October 2018, at $3.28/MMBTU on the Henry Hub. For biogas to high-BTU projects that sell RNG into the natural gas pipeline, several survey respondents reported that their projects are not meeting financial goals set for them because the natural gas price is currently so low.

Transport of RNG Using the Natural Gas Grid. Selling RNG into the natural gas pipeline infrastructure for general use is less financially viable. However, injecting RNG into the pipeline, paying a transport fee, and selling the RNG to a vehicle fueling station owner is proving economically viable. The transport of RNG is supported by the American Gas Association and wheeling fees are very reasonably priced.

Gasoline and Diesel versus CNG/LNG. In recent years, vehicle fueling in the US with CNG and LNG has become a large sector of the fuel industry. CNG/LNG fueling stations are now located along most major interstate highways, with more being built every month. The trend toward the use of CNG or LNG by truckers and owners of heavy duty vehicles has occurred largely because the cost for CNG/LNG is about 65 percent less than diesel, and their vehicles experience less internal wear and tear when using CNG/LNG.

Hundreds of large fleet owners and thousands of small vehicles have made the switch to CNG or LNG fuel. More vehicle conversions to CNG/LNG are occurring all the time resulting in substantial cost reductions and greenhouse gas (GHG) emission reductions, with CNG conversions applicable to residential and relatively "short haul" or local vehicles such as service or collection vehicles and LNG conversions used for "long haul" trucking applications.

Incentives. Incentives for LFG utilization projects come and go (one-time grants or incentives to multi-year tax credits or market incentives) and vary based on how the LFG is utilized (electricity, pipeline, vehicle fuel). A summary of incentives can be found in Section 6 below.

6 ASSESSMENT OF ADDITIONAL FINANCIAL INCENTIVES

Incentives for LFG utilization projects come and go (one-time grants or incentives to multi-year tax credits or market incentives) and vary based on how the LFG is utilized (electricity, pipeline, vehicle fuel). The following incentives apply specifically to LFG utilization projects.

6.1.1 Renewable Fuel Standard

As a result of emission reductions when CNG, LNG, and ethanol are used in vehicles, the US federal government has established the Renewable Fuel Standard (RFS) and Renewable Identification Number (RIN) program, which requires US oil refineries to meet renewable fuel goals. If they cannot meet the goals themselves, they are required to purchase the RINs. The price paid for RINs varies. A 2014 amendment to the RFS created a cellulosic biofuel (D-3) RIN, which is currently trading at about $3.50 per RIN ($5.05 per GGE). D-3 RINs are applicable to landfill, wastewater treatment plant, and agricultural digester biogas.

RINs are available for RNG that is used to fuel vehicles or injected into the interstate pipeline system. As with any federal program, RINs are subject to annual establishment of a quantity to be purchased by fuel producers which make the value of the RINs somewhat uncertain. However, currently, most developers are developing RNG to vehicle projects due to the current high value of RINs. The RIN regulations are fairly consistent through 2022 but wording in the regulation increases uncertainty after 2022.

6.1.2 California Low Carbon Fuel Standard

This incentive is only available if the County's LFG is sent by pipeline into California and a contract with a trucker in California is signed. California Air Resources Board (CARB) created a Low Carbon Fuel Standard (LCFS) credit program to reduce GHG emissions by incentivizing the use of alternative fuels in vehicles. The LCFS program is available to facilities outside the state of California that produce low carbon intensity fuel that is transported to and dispensed in California for fueling vehicles. The value of the LCFS credit is volatile, but results in a revenue incentive for RNG to vehicle fuel projects. The price per credit has fluctuated between a low of $22 per credit as a monthly average at the program's inception in January 2013, to a current value of approximately $184 per credit as a monthly average. This average includes all RNG sources, and it should be noted that LFG based RNG will likely be priced on the low end of the selling range ($115 per credit).

The County could participate in the LCFS program and generate credits by providing RNG to an existing natural gas pipeline that is part of the larger interstate pipeline system that travels through California. Locating an interstate pipeline in the vicinity will be the major

challenge with this approach. If found, a fuel pathway application would need to be submitted to CARB to establish a specific carbon intensity for the CNG produced at the Landfill and its transport to fueling vehicles in California. As with the CFP, a contract with a California CNG fueling station developer will need to be provided to CARB as proof that the RNG produced at the landfill is fueling vehicles in California, offsetting what would otherwise have been diesel with a renewable lower carbon intensity fuel.

A specific carbon intensity and fuel pathway would need to be calculated using the California-modified Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (CA-GREET) model and then approved by CARB. A relatively high carbon intensity value, as compared to biofuels generated from other sources, could be expected. Therefore, finding an owner of a truck fleet that is willing to purchase the LFG to RNG will be difficult due to the competition lower carbon intensity fuels, which provide more financial incentives to the fleet owners. With the difficulties of obtaining a CNG purchaser and finding a fuel pathway from North Carolina to California, it is not recommended to include LCFS credits in the economic analysis of a potential project at the Landfill.

7 POTENTIAL END USERS

CEG contacted a variety of potential end users to discuss scenarios and interest in a LFG to RNG project. The discussions were high-level and focused on developing a short-list of potential end users to be further evaluated. The discussions covered the quality of gas that the potential end user would likely be interested in taking, scenarios of involvement, and the timeframe of project execution. Table 7.1 outlines the results of these calls and a brief summary of the three potential end users CEG is recommending for further evaluation has been included below in the subsequent sections. Detailed logs of all the interviews have been included as an attachment to this Feasibility Study.

Table 7.1 – Potential End User Summary

Potential End Users Contacted	Level of Interest	Quality Desired	End Use
Loves/ Trillium	High	CNG/Pipeline	CNG fueling station if there is a demand or would get involved with pipeline injection.
Evensol	High	Pipeline Quality	Injection into pipeline in conjunction with project starting in 2019.
Blue Ridge Biofuels, LLC	High	TBD	TBD - Requested approval to perform feasibility study and an option to purchase the gas.
Clean Energy Fuels	Moderate	RNG/ Pipeline Quality	Partner with NG Advantage to inject RNG into a pipeline at nearby facility.
ReNew Petra	Moderate	RNG	Tube trailer to Mount Air Landfill or pipeline injection.
Republic Services	Moderate	Raw LFG	Potential interest with RNG developer, Evensol, at the Caldwell County Landfill.
Piedmont Natural Gas Company, Inc.	Low	Pipeline Quality	Does not have a need for gas currently.
Apple, Inc.	Low	TBD	Obtain LCFS credits if low level of interest from other groups

7.1 Love's/Trillium

Trillium indicated they have a Love's truck stop nearby, but they do not typically install CNG fueling stations unless there is a direct need within the area. They stated that if there is a need within the area, perhaps the nearby Target Distribution Center, they would

consider installing a CNG filling station at the truck stop. However, they are not aware of a demand for CNG but stated they could have their business development team provide additional research and determine any nearby demands.

Overall, Trillium is interested in the project and would be open to pipeline injection or other options, regardless of whether it is feasible to construct a CNG fueling station at the Love's Truck Stop. They would be interested in any combination of involvement, including design, build, own, and operate as a whole, or provide assistance in role the County desired. Trillium stated that if a Request for Proposal was prepared, they would likely submit a response.

7.2 Evensol

Evensol has two existing LFG to RNG projects operating for Republic that deliver RNG to a Piedmont pipeline location. They also have a third project at the Caldwell County Landfill in North Carolina that is beginning construction during the first quarter of 2019. The project consists of a gas conditioning facility, generating pipeline quality RNG to be injected into a Piedmont pipeline location. The RNG will be transported from the landfill to the injection location via virtual pipeline. The gas condition facility is expected to intake approximately 2,750 scfm of landfill gas. Originally, Piedmont would not allow the injection of this quantity of gas into their pipeline, as they did not have a demand for this high of a quantity in the area. However, Piedmont has now identified a location within their transmission system where they will allow the injection. Evensol purchased the property around this injection location and will be constructing the decant equipment and injection point to complete the virtual pipeline. This injection location is approximately 18 miles from the Blackburn Landfill, and therefore, it is likely the RNG from the Blackburn Landfill could also be injected at this location.

Overall, Evensol has high interest in working with the County to move forward with the potential project at the Blackburn Landfill. It would be convenient for timing purposes if an agreement could be reached in the coming months, as the Foothills project is moving forward in early 2019. Evensol stated they are open to developing, constructing, and operating the entire project or any portion of the project the County prefers. They also indicated that they would be able to decommission the existing landfill gas to energy facility, if the County so desired. If the County wanted to let Evensol own and operate the full project, they estimated royalties to the County between $300,000-$500,000 per year, based on RIN pricing and overall profits.

7.3 Blue Ridge Biofuels

Blue Ridge Biofuels, LLC (Blue Ridge) has a biodiesel plant adjacent to the electrical generation facility at Blackburn Landfill, operational for approximately five years. Blue Ridge currently utilizes the waste heat off the jackets of the existing generators for use in its

nearby plant. Blue Ridge expressed initial interest to the County for purchasing the heating value (BTUs) from Catawba to use for creating process heat at its plant. Currently, they are more interested in the potential RFS and LCFS credits that could be available through vehicle fuel or interstate pipeline injection. Blue Ridge has submitted a Letter of Intent, dated May 2, 2018, to the County expressing their interest in developing a project with the County.

Blue Ridge currently has connections with entities that are interested in developing or already sell CNG for vehicle use. They are aware of a location that has a demand for approximately 2,000 diesel gallon equivalents (DGE) of CNG. Their next steps would be to conduct an internal feasibility study to evaluate options for transporting the fuel, either via pipeline or tube trailer, depending on the economics. Blue Ridge would consider the costs and benefits of purchasing the raw gas from Catawba and conditioning the LFG itself, then assessing how to efficiently transport and market the fuel. Per the Letter of Intent, Blue Ridge proposes an anticipated target price to purchase LFG at $2.00 per dekatherm plus five percent of profits earned from the sale of the conditioned biogas.

8 SUMMARY OF FINDINGS

CEG has conducted an evaluation of the Landfill for the purpose of determining the potential options for an LFG beneficial use project, particularly focusing on an LFG to RNG project. This Feasibility Study assesses the future LFG generation and composition, evaluates options for utilizing the LFG in a beneficial use project, and identifies and evaluates parties that may be interested in developing a beneficial use project.

LFG generation modeling was prepared to estimate the quality and quantity of LFG available for use. CEG compared the model to actual LFG collection observed at the Landfill and developed a potential range of future LFG collection. By applying a low LFG collection efficiency rate of 60 percent and high LFG collection efficiency rate of 80 percent, a projection of potential fuel availability was created. The projected rates are based on the waste intake rates, waste characteristics, waste moisture content, and existing LFG flow and composition data provided by the County.

CEG interviewed potential end users and developers that may be interested in the LFG to RNG project. Based on conversations between CEG and these potential end users, Blue Ridge Biofuels, Loves/Trillium, and Evensol have the highest level of interest in the project and potential contracting options that may be financially attractive to the County. They all have existing facilities in the area and have interest in developing their portfolios by teaming with the County to bring the project to fruition. Based on the discussions with the parties listed herein, CEG believes if the County elected to move forward with a LFG to RNG project, there would be end-users interested in responding to a Request for Proposal or negotiating directly with the County. Multiple scenarios may exist for the County's involvement in the potential project. The County could potentially own the LFG conditioning equipment, pipeline, and/or tube trailers, or the County could simply sell the LFG to one of the developers at an agreed upon royalty payment, which may or may not be variable depending on the negotiation of the distribution of available incentives.

Based on the findings of this Feasibility Study, CEG believes the County should consider moving forward with the next steps in determining if a LFG to RNG project is desirable, as it is possible that a LFG to RNG project may be profitable. The County may want to pursue in-depth conversations with the potential end users and develop detailed and more accurate economic pro-forma for a few of the options discussed herein. This approach may allow the County to assess what role is desirable in the potential project (i.e. would the County prefer to own/operate or simply provide LFG rights to a developer and negotiate a royalty payment). The County could also seek discussions with even more potential end users. Another option would be for the County to move forward with a Request for Proposal from potential project developers and/or end users. CEG is available to provide assistance in further developing detailed economic pro-formas, seeking out even more potential end users, or could also assist the County in drafting a Request for Proposal.

LIMITATIONS

The work product included in the attached was undertaken in full conformity with generally accepted professional consulting principles and practices and to the fullest extent as allowed by law we expressly disclaim all warranties, express or implied, including warranties of merchantability or fitness for a particular purpose. The work product was completed in full conformity with the contract with our client and this document is solely for the use and reliance of our client (unless previously agreed upon that a third party could rely on the work product) and any reliance on this work product by an unapproved outside party is at such party's risk.

The work product herein (including opinions, conclusions, suggestions, etc.) was prepared based on the situations and circumstances as found at the time, location, scope and goal of our performance and thus should be relied upon and used by our client recognizing these considerations and limitations. CEG shall not be liable for the consequences of any change in environmental standards, practices, or regulations following the completion of our work and there is no warrant to the veracity of information provided by third parties, or the partial utilization of this work product.

APPENDIX A
LABORATORY TEST RESULTS

REIC
RESEARCH ENVIRONMENTAL & INDUSTRIAL CONSULTANTS INC
Post Office Box 286 Beaver WV 25813 800 999 0105
304 255 2500 304 255 2572(fax)
website www reiclabs com
Improving the environment, one client at a time

April 12, 2012

Mr Rodney Hamby
Catawba County
P O Box 389
Newton, NC 28658

RE Landfill Gas Analysis, Blackburn Landfill

Mr Hamby,

Attached please find enclosed results of analysis of the landfill gas at Blackburn Landfill REI Consultants, Inc (REIC) conducted gas sampling on March 14, 2012 Gas analysis was conducted by REIC, Data Analysis Technologies of Plain City, Ohio (sulfur analysis), and Columbia Analytical Services of Simi Valley, California (siloxanes analysis) The gas sample was collected from a port located directly downstream of the blower and upstream of the chiller unit

Please let me know if you have any questions or if I can be of further assistance

Sincerely,
REI Consultants, Inc

Michael Hofe, PE

Environmental Monitoring Dept
(304) 255-2500 Office
(304) 890-2018 Cell
mhofe@reiclabs com

Attachment

Landfill Gas Analysis

Site **Blackburn Landfill** **Sample Date** **03/14/2012**

Gas Stream Profile

Parameter	Result (vol %)
Methane	52 8
Carbon Dioxide	39 5
Oxygen	0 8
Carbon Monoxide	<0 02
Ethane	<0 002
Ethene	<0 02
Acetylene	<0 02
Balance	6 9

Gas Stream Physical Properties

Parameter	Result
Temperature	80 4 °F
Relative Humidity	41 3%

Sulfur Compounds

Parameter	Result (ppmv)
Hydrogen Sulfide	8 46
Carbonyl Sulfide	<0 02
Sulfur Dioxide	<0 03
Methyl Mercaptan	0 190
Ethyl Mercaptan	<0 03
Dimethyl Sulfide	0 38
Carbon Disulfide	0 119
t-Butyl Mercaptan	0 0433
n-Propyl Mercaptan	<0 03
Isobutyl Mercaptan	<0 03
n-Butyl Mercaptan	<0 05
Dimethyl Disulfide	<0 01

Landfill Gas Analysis

Site **Blackburn Landfill** **Sample Date** **03/14/2012**

Halogenated Volatile Organic Compounds (VOCs)

Parameter	Result (mg/m^3*)
1,1,1,2-Tetrachloroethane	<0 03
1 1 1-Trichloroethane	<0 03
1,1,2,2-Tetrachloroethane	<0 03
1,1,2-Trichloroethane	<0 03
1,1-Dichloroethane	<0 03
1 1-Dichloroethene	<0 03
1 1-Dichloropropene	<0 03
1,2,3-Trichlorobenzene	<0 03
1,2,3-Trichloropropane	<0 03
1,2 4-Trichlorobenzene	<0 03
1,2-Dibromo-3-chloropropane	<0 03
1,2-Dibromoethane	<0 03
1 2 Dichlorobenzene	<0 03
1 2-Dichloroethane	<0 03
1 2-Dichloropropane	<0 03
1 3-Dichlorobenzene	<0 03
1 3-Dichloropropane	<0 03
1 4-Dichlorobenzene	0 86
2,2-Dichloropropane	<0 03
2-Chlorotoluene	<0 03
4-Chlorotoluene	<0 03
Bromobenzene	<0 03
Bromochloromethane	<0 03
Bromodichloromethane	<0 03
Bromoform	<0 03
Bromomethane	<0 03
Carbon tetrachloride	<0 03
Chlorobenzene	0 19
Chloroethane	<0 03
Chloroform	<0 03
Chloromethane	<0 03
cis-1,2-Dichloroethene	<0 03
cis-1 3-Dichloropropene	<0 03
Dibromochloromethane	<0 03
Dibromomethane	<0 03
Dichlorodifluoromethane	<0 03
Hexachlorobutadiene	<0 03
Methylene chloride	<0 03
Tetrachloroethene	3 3
trans-1,2-Dichloroethene	<0 03
trans-1 3-Dichloropropene	<0 03
Trichloroethene	0 53
Trichlorofluoromethane	<0 03
Vinyl chloride	<0 03

* expressed as parameter at gas conditions

Landfill Gas Analysis

Site **Blackburn Landfill** **Sample Date** **03/14/2012**

Silicon Compounds

Parameter	Result (mg/m^3 as Silicon*)
Trimethylsilanol	3 1
Hexamethyldisiloxane (L_2)	1 6
Hexamethylcyclotrisiloxane (D_3)	0 27
Octamethyltrisiloxane (L_3)	0 063
Octamethylcyclotetrasiloxane (D_4)	1 4
Decamethyltetrasiloxane (L_4)	<0 016
Decamethylcyclopentasiloxane (D_5)	0 40
Dodecamethylpentasiloxane (L_5)	<0 017
Dodecamethylcyclohexasiloxane (D_6)	0 16

* expressed at gas conditions

Sampling and Analysis Methods

Parameter	Sampling Method	Analysis Method
Major Constituent Gases (Methane Carbon Dioxide Oxygen)	Direct Reading Instrument (GEM 2000)	Direct Read
Minor Constituent Gases (Carbon Monoxide Ethane Ethene, Acetylene)	Tedlar Bag (grab)	GC-TCD
Temperature	Direct Reading Instrument (Dickson TH300)	Direct Read
Relative Humidity	Direct Reading Instrument (Dickson TH300)	Direct Read
Sulfur Compounds	Tedlar Bag (grab)	GC-FPD
VOCs	Charcoal Tube	GC/MS
Silicon Compounds	Sorbent Tube	GC/MS

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Improving the environment, one client at a time...

February 18, 2015

Mr. Barry Edwards, PE
Catawba County
P.O. Box 389
Newton, NC 28658

RE: Landfill Gas Analysis, Blackburn Landfill

Mr. Edwards;

Attached please find results of analysis of landfill gas samples collected by REI Consultants, Inc. (REIC) at Blackburn Landfill on January 27 and February 6, 2015. Gas analysis was conducted by REIC and by Data Analysis Technologies of Plain City, Ohio. The gas samples were collected from ports located downstream of the blower and upstream of the engines.

In addition to the attached laboratory analyses, REIC recorded measurements from Catawba County's LANDTEC GEM2000 landfill gas analyzer during both sampling events. These readings were as follows:

Date and Time	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Balance (%)
1/27/15 1124	55.5	40.8	0.6	3.1
1/27/15 1227	55.5	40.6	0.5	3.4
2/6/15 0939	56.6	40.5	0.4	2.5
2/6/15 1137	56.6	40.6	0.4	2.4

Note that the January 27, 2015 sample analysis results differ slightly from the field readings. The variation is likely due to the introduction of a small amount of air contamination to the gas sample during the collection, transport, handling, and analysis processes.

During the February 6, 2015 event, REIC performed measurements of temperature, relative humidity, and dewpoint using a Dickson TH300 direct reading instrument. Measurements were collected within an insulated chamber fed by a sampling port from the landfill gas pipeline. A summary of these measurements is as follows:

RESEARCH ENVIRONMENTAL & INDUSTRIAL CONSULTANTS, INC.
Post Office Box 286 • Beaver, WV 25813 • 800.999.0105
304.255.2500 • 304.255.2572(fax)
website: www.reiclabs.com
Improving the environment, one client at a time...

Date and Time	Temperature (°F)	Relative Humidity (%)	Dew Point (°F)
2/6/15 0955	46.5	80.0	40.8
2/6/15 1017	51.5	63.7	39.4
2/6/15 1030	52.5	58.7	37.8
2/6/15 1121	50.5	59.3	36.7
2/6/15 1130	52.4	60.3	39.0
2/6/15 1137	49.6	60.1	36.1

The above readings indicate an average humidity ratio of 0.007 lb water per lb dry gas, or approximately 500 lb water per MMscf (60 °F, 1 atm).

If you have any questions or if I can be of further assistance, please feel free to contact me at (304) 255-2500 or mhofe@reiclabs.com.

Sincerely,

Michael Hofe, PE
REI Consultants, Inc.

cc: Rodney Hamby, Catawba County
Jack Chandler, Catawba County

Attachments (2)

ATTACHMENT 1

Data Analysis Technologies Laboratory Report
1/27/2015 Sample

DAT Reports®

Data Analysis Technologies, Inc.
7715 Corporate Blvd.
Plain City, OH 43064
800-733-8644

Sample Analysis Certificate

Client:	REI Consultants, Inc.	Date:	2/10/2015
Address:	225 Airport Industrial Park Road	DAT Project ID:	0115029
	Beaver, WV 25813	Date Received:	1/30/2015

Attn: Mike Hofe
Client Project: Blackburn
Analysis: Multiple

The following samples were received on 1/30/2015:

DAT Sample ID	Client Sample ID	Date Sampled	Matrix
0115029-1	Blackburn Air Samples	1/27/2015	Gas
0115029-2	Blackburn Sorbent Tube Sample	1/27/2015	Solid
0115029-3	Blackburn Sorbent Tube Blank		Solid

Results: See attached summary.

QC: Met the criteria for the method.

Reviewed and approved for release by:

Ronald K. Mitchum, Ph.D.
President, DAT

DAT Reports®

Data Summary

ASTM D1946 / Permanent Gases

Client:	REIC
Client Project:	Blackburn
DAT Project:	0115029
Date Sampled:	1/27/2015
Date Received:	1/30/2015
Date Analyzed:	1/30/3015
Analyst:	CSM

Client Sample ID:	DAT Sample ID:	Analyte:	*Sample MDL, % by volume*	Result, % by volume	Q
Blackburn	0115029- 1	Hydrogen	*0.12*	ND	
		Oxygen	*0.002*	1.00	
		Nitrogen	*0.005*	8.91	
		Carbon monoxide	*0.0019*	ND	
		Methane	*0.0007*	51.54	
		Carbon dioxide	*0.0012*	38.55	
		Ethylene	*0.0012*	ND	
		Ethane	*0.0012*	ND	

Results have been normalized to 100%.
ND = Not detected at the detection limit shown.
J = Value below lowest calibrator.
D = Value obtained from a dilution.

DAT Reports®

Data Summary
GPA 2286

Client: REIC
Client Project: Blackburn
DAT Project: 0115029
Date Sampled: 1/27/2015
Date Received: 1/30/2015
Date Analyzed: 2/6/2015
Analyst: SM

Client Sample ID	DAT Sample ID	Analyte	Detector	Normalized Result, % (vol)	Q	PQL %
Blackburn	0115029- 1	Hydrogen	TCD	ND		1.00000
		Oxygen	TCD	1.0		0.10000
		Nitrogen	TCD	8.9		0.10000
		Carbon Monoxide	TCD	ND		0.10000
		Methane	TCD	51.535		0.10000
		Carbon Dioxide	TCD	38.5		0.10000
		Ethane	TCD	ND		0.10000
		Propane	FID	0.0021		0.00005
		n-Butane	FID	0.00047		0.00005
		Other C4	FID	0.0005		0.00005
		Isopentane	FID	ND		0.00005
		n-Pentane	FID	0.000322		0.00005
		Other C5	FID	0.001		0.00005
		n-Hexane	FID	0.000081		0.00005
		Other C6	FID	0.00063		0.00005
		n-Heptane	FID	0.0001		0.00005
		Other C7	FID	0.00094		0.00005
		Octane	FID	ND		0.00005
		Other C8+	FID	0.0045		0.00005

ND = Not detected in the sample.
D = Value measured from a dilution.

DAT Reports®

ASTM D-6228 / Sulfur Compounds

Client: REIC
Client Project: Blackburn
DAT Project: 0115029
Date Sampled: 1/27/2015
Date Received: 1/30/2015
Date Analyzed: 1/30/2015
Analyst: sm

Client Sample ID: Blackburn
DAT Sample ID: 0115029-1

Analyte:	*Sample MDL, ppm*	Result, ppm	Q
Hydrogen Sulfide	*0.07000*	5.04	
Carbonyl Sulfide	*0.00040*	ND	
Methyl Mercaptan	*0.07000*	0.333	
Ethyl Mercaptan	*0.00060*	0.0113	
Dimethyl Sulfide	*0.02000*	0.379	
Carbon Disulfide	*0.00080*	ND	
n-Propyl Mercaptan	*0.00060*	0.0250	
Ethyl Methyl Sulfide	*0.00060*	0.0162	
Isobutyl Mercaptan	*0.00060*	0.00424	
n-Butyl Mercaptan	*0.00100*	ND	
Dimethyl Disulfide	*0.00016*	0.00744	

ND = Not detected at the detection limit shown.
D = Value calculated from a dilution.
J = Value below lowest calibrator.
B = Trace of this compound was found in the blank.

TO-15 Data Summary

Misc Info	**BlackBurn Air Sample**
Sample Name	**0115029-1 200mL 100x**
Date Acquired	**02/ 6/15 13:53**
Method File	**T015021**
Data File Path	**C:\HPCHEM\1\DATA\0115029B**
Data File Name	**02061401.D**
Sample Multiplier	**100**
Process factor =	**1**

Name	Amount	PQL (ppb)	Q	ug/m3	DL ug/m3
Dichlorodifluoromethane	175.95	20		870.11	98.9
Chloromethane	22.16	20		45.76	41.3
1,2-dichlorotetrafluoroethane	31.02	20		216.83	139.8
Vinyl_chloride	1045.71	20		2673.09	51.1
1,3-Butadiene	ND	20			44.2
Bromomethane	ND	20			77.7
Ethyl Chloride	187.60	20		495.04	52.8
Acetonitrile	3384.25	20		5681.94	33.6
Acrolein	ND	20			45.9
Acetone	2318.11	20		5506.58	47.5
Trichlorofluoromethane	13.62	20		76.54	112.4
Pentane	2210.56	20		6523.17	59.0
Acrylonitrile	ND	20			43.4
1,1-Dichloroethene	8.69	20		34.48	79.3
Methylene Chloride	1097.05	20		3811.20	69.5
Carbon disulfide	57.90	20		180.32	62.3
1,1,2-Trichlorotrifluoroethane	ND	20			153.3
1,1-Dichloroethane	31.19	20		126.23	80.9
Methyl t-butyl ether	ND	20			72.1
Hexane	403.83	20		1423.38	70.5
cis-1,2-Dichloroethene	167.57	20		664.39	79.3
Chloroform	5.18	20		25.30	97.7
Ethane, 1,2-dichloro-	65.73	20		266.02	80.9
1,1,1-Trichloroethane	ND	20			109.1
Benzene	525.98	20		1680.54	63.9
Carbon Tetrachloride	ND	20			125.8
2-Nitropropane	ND	20			72.9
1,2-Dichloropropane	ND	20			92.4
2,2,4-Trimethylpentane	126.97	20		593.22	93.4
Trichloroethylene	79.43	20		426.50	107.4
Methyl isobutyl ketone	ND	20			81.9
cis-1,3-Dichloropropene	ND	20			90.8
trans-1,3-Dichloropropene	ND	20			90.8

Name	ppb	PQL (ppb)	Q	ug/m3	DL ug/m3
1,1,2-Trichloroethane	13.10	20		71.47	109.1
Toluene	4021.44	20		15156.47	75.4
1,2-Dibromoethane	ND	20			153.7
Tetrachloroethylene	47.25	20		320.47	135.6
Chlorobenzene	ND	20			92.1
Ethylbenzene	508.75	20		2209.15	86.8
m/p-Xylene	178.07	20		773.24	86.8
Styrene	51.07	20		217.58	85.2
1,1,2,2-Tetrachloroethane	ND	20			137.3
o-Xylene	68.93	20		299.34	86.8
Cumene	1.62	20	J	7.97	98.3
1,3,5-Trimethylbenzene	ND	20			98.3
1,2,4-Trimethylbenzene,	11.10	20		95.44	171.9
1,3-Dichlorobenzene	ND	20			120.3
1,4-Dichlorobenzene	ND	20			120.3
1,2-Dichlorobenzene	ND	20			120.3
Nitrobenzene	ND	20			100.7
1,2,4-Trichlorobenzene	ND	20			148.4
Naphthalene	ND	20			104.8
Hexachloro-1,3-butadiene	ND	20			213.3
TVOC				50471.76	

Surrogate %R	**%R**
4-bromofluorobenzene	101.62

D=Results obtained from dilution.
J= Below the lowest calibration point (PQL)
E= Exceeds the highest calibration point
B= Found in the blank and not valid for dilution values

Tentatively Identified Compound (LSC) summary

Operator ID: CSM Date Acquired: 6 Feb 15 1:53 pm
Data File: C:\HPCHEM\1\DATA\0115029B\02061401.D
Name: 0115029-1 200mL 100x
Misc: BlackBurn Air Sample
Method: C:\HPCHEM\1\METHODS\T1582602.M
Title: TO-15 8260 IS
Library Searched: C:\DATABASE\NBS75K.L

TIC Top Hit name	**EstConc**
----------	**ppmv**
Ethane, 1,1-difluoro	0.345
Propene	0.261
Propane	0.848
1-Propene, 2-methyl-	0.456
Butane	0.756
unknown hydrocarbon	0.192
Butane, 2-methyl-	2.929
Pentane, 2-methyl-	0.278
2-Butanone	0.292
Furan, tetrahydro-	0.264
Cyclopentane, methyl	0.319
Hexane, 3-methyl-	0.344
Heptane	0.474
Cyclohexane, methyl-	0.253
Heptane, 3-methyl-	0.248
Cyclohexane, 1,3-dimethyl	0.385
Octane	0.366
Heptane, 2,4-dimethyl	0.195
Nonane	0.332
Octane, 2,6-dimethyl	0.316
unknown hydrocarbon	0.348
.alpha.-Pinene	2.999
unknown hydrocarbon	0.815
unknown hydrocarbon	0.243
unknown hydrocarbon	0.349
unknown hydrocarbon	0.491
unknown hydrocarbon	0.314
unknown hydrocarbon	0.554

Siloxanes

Trimethyl silanol (MOH)	1.367
Cyclotetrasiloxane, hexamethyl (D3)	ND
Cyclotetrasiloxane, octamethyl (D4)	0.396
Cyclopentasiloxane, decamethyl (D5)	ND
Disiloxane, hexamethyl (L2,MM)	0.268
Trisiloxane, octamethyl (L3, MDM)	ND

Data Summary Table
Method NIOSH 7903 - Inorganic Acids

Client: REIC
Client Project: Blackburn
DAT Project: 0115029
Date Sampled: 1/27/2015
Date Received: 1/30/2015
Date Prepped: 2/6/2015
Date Analyzed: 2/6/2015
Sampled Liters: 22
Analyst: JK

Client ID:	DAT ID:	Analyte:	*MDL, ug*	Sample Total, ug	*MDL, ugL*	Sample , ug/L	Q
Blackburn	0115029- 2	Hydrogen Fluoride	*0.30*	ND	*0.0136*	ND	
Blackburn	0115029- 2	Hydrogen Cluoride	*0.40*	ND	*0.0182*	ND	
Blackburn	0115029- 2	Hydrogen Bromide	*0.20*	ND	*0.00909*	ND	
Blackburn	0115029- 2	Hydrogen Iodide	*0.20*	ND	*0.00909*	ND	
Field Blank	0115029- FB	Hydrogen Fluoride	*0.30*	ND	*0.0136*	ND	
Field Blank	0115029- FB	Hydrogen Cluoride	*0.40*	ND	*0.0182*	ND	
Field Blank	0115029- FB	Hydrogen Bromide	*0.20*	ND	*0.00909*	ND	
Field Blank	0115029- FB	Hydrogen Iodide	*0.20*	ND	*0.00909*	ND	

ND = Not detected at the reporting limit shown.
D = Value calculated from a dilution.
J = Result less than that of the low standard.

CHAIN OF CUSTODY RECORD

v10-0114 | REIC use ONLY | CLIENT ID _____ DATE _____ SHEET 1 of 1

REIC
Research Environmental & Industrial Consultants, Inc.
MAIN LABORATORY & CORPORATE HEADQUARTERS:
P.O. Box 286 • 225 Industrial Park Rd, Beaver, WV 25813
800-999-0105 • 304-255-2500 • www.reiclabs.com

MID-OHIO VALLEY Service Center
101 17th Street
Ashland, KY 41101
606-393-5027

SHENANDOAH Service Center
1557 Commerce Rd., Ste 201
Verona, VA 24482
540-248-0183

ROANOKE Service Center
3029-C Peters Creek Rd
Roanoke, VA 24019
540-777-1276

MORGANTOWN Service Center
16 Commerce Drive
Westover, WV 26501
304-241-5861

Client: REIC Laboratory PO # _____

Contact Person Mike Hofe Phone (304) 255-2500

Address PO Box 286 City Beaver State WV Zip 25813

Billing Address (if different) Same

City _____ State _____ Zip _____

Site ID & State Blackburn/NC Project ID Landfill Gas Sampler MH

SAMPLE LOG & ANALYSIS REQUEST

TURNAROUND TIME

(•) NORMAL

RUSH TURNAROUND*

( ) 5 DAY ( ) 3 DAY ( ) 2 DAY ( ) 1 DAY

*Rush work needs prior laboratory approval and will incur additional charges

ANALYSIS & METHOD REQUESTED

- D1945 Permanent Gases*
- TO-15 VOCs
- D6228 Sulfur Compounds (w/concentrator)
- Siloxanes
- NIOSH 7903 Fluoride, Chloride, Bromide, Iodide**

SAMPLE ID	No. & Type of Containers	Sampling Date/Time	Matrix	Sample Comp/Grab	a	b	c	d	e	f	g	h
Blackburn	4 bags	1/27/15 1120	Air	Grab	X	X	X	X				
Blackburn	1 tube**	1/27/15 1228	Air	Comp					X			
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								

ENTER PRESERVATIVE CODE(S):

0 None
1 Hydrochloric Acid
2 Nitric Acid
3 Sulfuric Acid
4 Sodium Thiosulfate
5 Sodium Hydroxide/ Sodium Arsenite
6 Sodium Hydroxide
7 Ascorbic Acid
8 Sodium Bisulfate/Methanol
9 Ammonium Chloride
10 _____ *
11 _____ *

* (Use blanks for preservatives not listed.)

COMMENTS:

*Field Readings:
CH4 55.5%
CO2 40.8%
O2 0.6%
**Sample volume 22 L

All analytical requests are subject to REIC's Standard Terms and Conditions.

Temperature at arrival: 17 °C ICED? Y___ N X

Containers provided by: [ ] REIC [ ] Client

	Relinquished by (signature)	Date/Time	Received by (signature)	Date/Time
1		1/28/15 0900		1-30-15 1150
2				
3				

DAT Project #0115029

DAT SAMPLE RECEIVING

7715 Corporate Blvd. Plain City,OH 43064.

Project Number: 0115029

Date Received: 1/30/2015
Client Name: REI Consultants
Tracking number: 1Z26X7130361804853
Custody Seals ? No

Carrier: UPS
Analysis: Multiple
Package Temp: 17 C amb.
COC: ☑ check if COC from client

Sample Information

Client ID	Laboratory ID	Date	Matrix:	Container	Comment
Blackburn Air Samples	0115029-1A/B/C/D	1/27/2015	Gas	1L Tedlar Bag	
Blackburn Sorbent Tube Sample	0115029-2	1/27/2015	Solid	Sorbent Tube	
Blackburn Sorbent Tube Blank	0115029-3		Solid	Sorbent Tube	Not on Chain of Custody

AA

Laboratory Receiving Initials

0115029

1/30/2015 12:04:53 PM

DAT Labs Inc.
Sample Receipt Report

Client/Number: REI Consultants / 11098

Custodian Initial: AA Date: 1-30-2015

Secondary Review: Initials: Date:

The client has been contacted.

_____ Yes _____ No

Upon receipt of samples, check if any of the following discrepancies have been noted.

	Discrepancy Type	*Specify applicable client ID or "all"*
	COC and samples do not match	
	No unique sample identifications	
	Samples received outside of the required temp criteria. **Receipt Temp:** 17 C	
	No preservation type was noted **Correction Factor:** C	
	No date of collection stated **Corrected Temp:** C	
	No time of collection stated	
	The sample collector was not named	
	Sample containers were not appropriate	
	Sample labels were destroyed or unreadable	
	Samples were received outside of holding time	
	There was not enough sample to perform the requested analysis.	
	Samples showed sign of damage or contamination.	
	Aqueous samples for volatile analysis: Headspace? Y N	If Yes, list sample ID(s) in details:

Details: _____

Sample pH for nonvolatile aqueous samples and presence or absence of headspace (Y or N) for VOA aqueous samples shall be recorded at time of sample log-in.
Under no circumstances shall VOA vials be opened at time of sample receipt.

Other Discrepancies:

Sample ID	**Discrepancy**

Container Return

Yes / No

Price:

Size:

Return Spl wt:

[X] ***Upon receipt, the samples met all of DAT's acceptance criteria.*** ***DAT Project #*** Q115029

Effective 05/03/11

DATFRM1049 Revision 5


SAMPLE CUSTODY
(800) 999-0105
REI CONSULTANTS
225 INDUSTRIAL PARK RD
BEAVER WV 25813
1 LBS
1 OF 1
DWT: 10,7,10
SHIP TO:
RON MITCHEM
DATA ANALYSIS TECHNOLOGIES INC
7715 CORPORATE BLVD
PLAIN CITY OH 43064-9212
OH 432 9-30
UPS GROUND
TRACKING #: 1Z 26X 713 03 6180 4853
BILLING: P/P
REF 1:DA
17.0.31
LP2844 60 0A 01/2015
Thanks for your business
REIC
Research Environmental & Industrial Consultants, Inc
1.800.999.0105

ATTACHMENT 2

REIC Laboratory Report
2/6/2015 Sample

REIC

Improving the environment, one client at a time...

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304) 255-2500
Website: www.reiclabs.com

3029-C Peters Creek Road
Roanoke, VA 24019
TEL: 540.777.1276

101 17th Street
Ashland, KY 41101
TEL: 606.393.5027

1557 Commerce Road, Suite 201
Verona, VA 24482
TEL: 540.248.0183

16 Commerce Drive
Westover, WV 26501
TEL: 304.241.5861

Wednesday, February 18, 2015

Mr. Rodney Hamby
COUNTY OF CATAWBA
P O BOX 389
NEWTON, NC 28658

TEL: (828) 465-8200
FAX: (828) 465-8392

RE: LANDFILL GAS

Work Order #: 1502860

Dear Mr. Rodney Hamby:

REI Consultants, Inc. received 2 sample(s) on 2/9/2015 for the analyses presented in the following report.

Sincerely,

Michelle Ellison

Michelle Ellison

REI Consultants, Inc. - Case Narrative

WO#: 1502860

Date Reported: 2/18/2015

Client: COUNTY OF CATAWBA

Project: LANDFILL GAS

The analytical results presented in this report were produced using documented laboratory SOPs that incorporate appropriate quality control procedures as described in the applicable methods. Verification of required sample preservation (as required) is recorded on associated laboratory logs. Any deviation from compliance or method modification is identified within the body of this report by a qualifier footnote which is defined at the bottom of this page.

All sample results for solid samples are reported on an "as-received" wet weight basis unless otherwise noted.

Results reported for sums of individual parameters, such as TTHM and HAA5, may vary slightly from the sum of the individual parameter results, due to rounding of individual results, as required by EPA.

The test results in this report meet all NELAP (and/or VELAP) requirements for parameters except as noted in this report.

Please note if the sample collection time is not provided on the Chain of Custody, the default recording will be 0:00:00. This may cause some tests to be apparently analyzed out of hold.

All tests performed by REIC Service Centers are designated by an annotation on the test code. All other tests were performed by REIC's Main Laboratory in Beaver, WV.

DEFINITIONS:
MCL: Maximum Contaminant Level
MDL: Method Detection Limit; The lowest concentration of analyte that can be detected by the method in the applicable matrix.
Mg/Kg or mg/L: Units of part per million (PPM) - milligram per Kilogram (weight/weight) or milligram per Liter (weight/volume).
NA: Not Applicable
ND: Not Detected at the PQL or MDL
PQL: Practical Quantitation Limit; The lowest verified limit to which data is quantified without qualifications. Analyte concentrations below PQL are reported either as ND or as a number with a "J" qualifier.
Qual: Qualifier that applies to the analyte reported.
TIC: Tentatively Identified Compound, Estimated Concentration denoted by "J" qualifier.
Ug/Kg or ug/L: Units of part per billion (PPB) - microgram per kilogram (weight/weight) or microgram per liter (weight/volume).

QUALIFIERS:
X: Reported value exceeds required MCL
B: Analyte detected in the associated Method Blank at a concentration > 1/2 the PQL
E: Analyte concentration reported that exceeds the upper calibration standard. Greater uncertainty is associated with this result and data should be consider estimated.
H: Holding time for preparation or analysis has been exceeded.
J: Analyte concentration is reported, and is less than the PQL and greater than or equal to the MDL. The result reported is an estimate.
S: % REC (% recovery) exceeds control limits

CERTIFICATIONS:
Beaver, WV: WVDHHR 00412CM, WVDEP 060, VADCLS 00281, KYDEP 90039, TNDEQ TN02926, NCDWQ 466, PADEP 68-00839, VADCLS (VELAP) 460148
Bioassay (Beaver, WV): WVDEP 060, VADCLS(VELAP) 460148, PADEP 68-00839
Roanoke, VA: VADCLS(VELAP) 460150
Verona, VA: VADCLS(VELAP) 460151
Ashland, KY: KYDEP 00094, WVDEP 389
Morgantown, WV: WVDHHR 003112M, WVDEP 387

REI Consultants, Inc. - Analytical Report

WO#: 1502860

Date Reported: 2/18/2015

Client:	COUNTY OF CATAWBA	**Collection Date:**	2/6/2015 11:33:00 AM
Project:	LANDFILL GAS	**Date Received:**	2/9/2015
Lab ID:	1502860-01A	**Matrix:**	Air
Client Sample ID:	BLACKBURN FILTER	**Site ID:**	BLACKBURN/NC

Analysis	Result	MDL	PQL	MCL	Qual	Units	Date Analyzed	NELAP
TOTAL PARTICULATES			**Method: NIOSH 0500**				**Analyst: MH**	
Particulates, Total	ND	0	0.42	NA		mg/m³	2/18/2015 10:27 AM	
ELEMENTS BY ICP			**Method: NIOSH 7300M**				**Analyst: JD**	
Arsenic	ND	0.680	6.80	NA		ppbv	2/12/2015 10:21 AM	
Barium	ND	0.0900	1.86	NA		ppbv	2/12/2015 10:21 AM	
Cadmium	ND	0.0200	0.450	NA		ppbv	2/12/2015 10:21 AM	
Chromium	ND	0.240	4.90	NA		ppbv	2/12/2015 10:21 AM	
Iron	2.17	0.460	4.56	NA	J	ppbv	2/12/2015 10:21 AM	
Lead	ND	0.250	2.46	NA		ppbv	2/12/2015 10:21 AM	
Potassium	9.41	3.26	32.6	NA	J	ppbv	2/12/2015 10:21 AM	
Selenium	ND	0.640	6.45	NA		ppbv	2/12/2015 10:21 AM	
Sodium	14.4	5.54	111	NA	J	ppbv	2/12/2015 10:21 AM	
Tin	ND	0.430	2.15	NA		ppbv	2/12/2015 11:33 AM	
Vanadium	ND	0.250	5.00	NA		ppbv	2/12/2015 10:21 AM	
Zinc	13.8	0.190	1.95	NA		ppbv	2/12/2015 10:21 AM	

REI Consultants, Inc. - Analytical Report

WO#: 1502860

Date Reported: 2/18/2015

Client:	COUNTY OF CATAWBA	**Collection Date:**	2/6/2015 11:33:00 AM
Project:	LANDFILL GAS	**Date Received:**	2/9/2015
Lab ID:	1502860-02A	**Matrix:**	Air
Client Sample ID:	BLACKBURN TUBE	**Site ID:**	BLACKBURN/NC

Analysis	Result	MDL	PQL	MCL	Qual	Units	Date Analyzed	NELAP
MERCURY, Total SW7417B			**Method: SW7471B (2/07)**				**Analyst: CR**	
Mercury	0.016	0.012	0.119	NA	J	ppbv	2/12/2015 11:55 AM	

CHAIN OF CUSTODY RECORD

v10-0114 REIC use ONLY CLIENT ID CAT002 DATE _____ SHEET 1 of 1

REIC
Research Environmental & Industrial Consultants, Inc.
MAIN LABORATORY & CORPORATE HEADQUARTERS:
P.O. Box 286 • 225 Industrial Park Rd, Beaver, WV 25813
800-999-0105 • 304-255-2500 • www.reiclabs.com

MID-OHIO VALLEY Service Center
101 17th Street
Ashland, KY 41101
606-393-5027

SHENANDOAH Service Center
1557 Commerce Rd., Ste 201
Verona, VA 24482
540-248-0183

ROANOKE Service Center
3029-C Peters Creek Rd
Roanoke, VA 24019
540-777-1276

MORGANTOWN Service Center
16 Commerce Drive
Westover, WV 26501
304-241-5861

Client: Catawba County PO # _____

Contact Person Rodney Hamby Phone (304) 255-2500

Address PO Box 389 City Newton State NC Zip 28658

Billing Address (if different) Same

City _____ State _____ Zip _____

Site ID & State Blackburn/NC Project ID Landfill Gas Sampler MH

SAMPLE LOG & ANALYSIS REQUEST

TURNAROUND TIME: ◉ NORMAL

RUSH TURNAROUND*: ○ 5 DAY ○ 3 DAY ○ 2 DAY ○ 1 DAY

*Rush work needs prior laboratory approval and will incur additional charges

ANALYSIS & METHOD REQUESTED: 6010_S As, Ba, Cd, Cr, Fe, Pb, K, Se, Na, Sn, V, Zn *; HG_T_S *

SAMPLE ID	No. & Type of Containers	Sampling Date/Time	Matrix	Sample Comp/Grab	* 0	* 0						
Blackburn	1 filter	2/6/15 1133	Air	Comp	X							
Blackburn	1 tube	2/6/15 1133	Air	Comp		X						
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								
			Choose	Choose								

ENTER PRESERVATIVE CODE(S):

0 None; 1 Hydrochloric Acid; 2 Nitric Acid; 3 Sulfuric Acid; 4 Sodium Thiosulfate; 5 Sodium Hydroxide/ Sodium Arsenite; 6 Sodium Hydroxide; 7 Ascorbic Acid; 8 Sodium Bisulfate/Methanol; 9 Ammonium Chloride; 10 _____ *; 11 _____ *

* (Use blanks for preservatives not listed.)

COMMENTS:
* See Ivan prior to digestion

All analytical requests are subject to REIC's Standard Terms and Conditions.

Temperature at arrival: 20.0 °C ICED? Y___ N X

Containers provided by: [X] REIC [ ] Client

1 Relinquished by (signature)	Date/Time	2 Relinquished by (signature)	Date/Time	3 Relinquished by (signature)	Date/Time
Blaze Hill	2/9/15 0930				
Received by (signature)	Date/Time 2-9-15 9:50	Received by (signature)	Date/Time	Received by (signature)	Date/Time

APPENDIX B
LANDGEM MODEL

COMPUTATION SHEET

PROJECT TITLE:	Blackburn Sanitary Landfill	PROJECT NO:	180694
DESCRIPTION:	Landfill Gas Modeling Projections	SHEET:	1
		OF:	4
PREPARED BY:	DK	CHECKED BY:	JAB
DATE:	11/21/2018	DATE:	12/4/2018

Given:

Landfill gas generation projections have been made utilizing the USEPA's Landfill Gas Emission Model (LandGEM) V3.02. LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of land filled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on USEPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_0 \left[\frac{M_i}{10} \right] (e^{-kt_{ij}})$$

Where:

Q_{CH4} = annual methane generation in the year of the calculation ($m^3/year$)

i = 1-year time increment

n = (year of the calculation) - (initial year of waste acceptance)

j = 0.1-year time increment

k = methane generation rate ($year^{-1}$)

L_o = potential methane generation capacity (m^3/Mg)

M_i = mass of waste accepted in the i^{th} year (Mg)

t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate.

Site Conditions:

An estimate of landfill gas (LFG) generation rates for Blackburn Sanitary Landfill was prepared under the following conditions:

1. USEPA LandGEM Model Version 3.02 for LFG generation rates.
2. The model assumes a closure year of 2075 and a final capacity of 15,000,000 tons per "2015 GHG Report" prepared by CDM Smith. Waste in-place values from 1980 through 2014 from CDM Smith Report. 2015 to 2017 waste in-place values provided by Catawba County in an email dated November 20, 2018. Waste in-place from 2018 through closure were remaining capacity equally divided per year with no increase in yearly tonnage assumed.
3. The landfill has about 46 inches of precipitation annually, therefore, a k value of 0.04 was representing a conventional (non-arid) landfill was selected based on the annual precipitation values from NOAA.
4. The conventional methane generation capacity value of L_o = 100 m^3/Mg was used in the model.
5. Two separate LandGEM models were prepared since the operational time surpassed the 80 year limit. In both cases, the input parameters were kept the same. The LFG was projected to 30-years past closure.
6. The 2018 LFG generation rate is estimated as 1,321 scfm. The peak LFG generation rate is estimated to be 2,367 scfm in 2076.

COMPUTATION SHEET

PROJECT TITLE:	Blackburn Sanitary Landfill	PROJECT NO:	180694
DESCRIPTION:	Landfill Gas Modeling Projections	SHEET:	2
		OF:	4
PREPARED BY:	DK	CHECKED BY:	JAB
DATE:	11/21/2018	DATE:	12/4/2018

Year	Total Degradable Intake Rates (metric tons/year)	Total Waste In-Place (metric tons)	Flow Rates from 1980-2059 waste in place tonnages (scfm)	Flow Rates from 2060 waste in place tonnages (scfm)	Total LFG Flow Rate (scfm)	
1980	42,366	0	0		0	
1981	43,636	42,366	22		22	
1982	44,996	86,002	45		45	
1983	46,357	130,998	67		67	
1984	47,718	177,355	88		88	
1985	49,169	225,073	110		110	
1986	50,621	274,242	132		132	
1987	52,163	324,863	153		153	
1988	53,705	377,026	175		175	
1989	55,338	430,731	196		196	
1990	58,332	486,069	218		218	
1991	119,024	544,401	240		240	
1992	117,887	663,425	294		294	
1993	123,794	781,312	344		344	
1994	131,043	905,106	396		396	
1995	135,036	1,036,149	450		450	
1996	144,688	1,171,185	503		503	
1997	141,930	1,315,873	560		560	
1998	150,688	1,457,803	613		613	
1999	152,208	1,608,491	669		669	
2000	161,756	1,760,699	723		723	
2001	153,727	1,922,455	780		780	
2002	148,263	2,076,182	830		830	
2003	148,349	2,224,445	876		876	
2004	152,031	2,372,794	920		920	
2005	152,539	2,524,825	964		964	
2006	150,005	2,677,364	1,007		1,007	
2007	146,258	2,827,369	1,047		1,047	
2008	130,608	2,973,627	1,083		1,083	
2009	127,006	3,104,235	1,109		1,109	
2010	132,763	3,231,241	1,133		1,133	
2011	129,925	3,364,004	1,159		1,159	
2012	130,907	3,493,929	1,182		1,182	
2013	137,139	3,624,836	1,205		1,205	
2014	133,683	3,761,975	1,230		1,230	
2015	142,288	3,895,658	1,252		1,252	
2016	133,910	4,037,946	1,278		1,278	
2017	139,638	4,171,856	1,299		1,299	
2018	184,285	4,311,494	1,321		1,321	
2019	184,285	4,495,779	1,367		1,367	
2020	184,285	4,680,064	1,411		1,411	
2021	184,285	4,864,349	1,453		1,453	
2022	184,285	5,048,634	1,493		1,493	
2023	184,285	5,232,919	1,532		1,532	
2024	184,285	5,417,204	1,569		1,569	
2025	184,285	5,601,489	1,605		1,605	
2026	184,285	5,785,774	1,639		1,639	
2027	184,285	5,970,059	1,672		1,672	
2028	184,285	6,154,344	1,704		1,704	
2029	184,285	6,338,629	1,734		1,734	
2030	184,285	6,522,914	1,764		1,764	
2031	184,285	6,707,199	1,792		1,792	
2032	184,285	6,891,484	1,819		1,819	
2033	184,285	7,075,769	1,845		1,845	
2034	184,285	7,260,054	1,870		1,870	
2035	184,285	7,444,339	1,894		1,894	

COMPUTATION SHEET

PROJECT TITLE:	Blackburn Sanitary Landfill	PROJECT NO:	180694
DESCRIPTION:	Landfill Gas Modeling Projections	SHEET:	3
		OF:	4
PREPARED BY:	DK	CHECKED BY:	JAB
DATE:	11/21/2018	DATE:	12/4/2018

Year	Total Degradable Intake Rates (metric tons/year)	Total Waste In-Place (metric tons)	Flow Rates from 1980-2059 waste in place tonnages (scfm)	Flow Rates from 2060 waste in place tonnages (scfm)	Total LFG Flow Rate (scfm)	
2036	184,285	7,628,624	1,917		1,917	
2037	184,285	7,812,909	1,939		1,939	
2038	184,285	7,997,194	1,960		1,960	
2039	184,285	8,181,479	1,981		1,981	
2040	184,285	8,365,764	2,000		2,000	
2041	184,285	8,550,049	2,019		2,019	
2042	184,285	8,734,334	2,037		2,037	
2043	184,285	8,918,619	2,055		2,055	
2044	184,285	9,102,904	2,071		2,071	
2045	184,285	9,287,189	2,087		2,087	
2046	184,285	9,471,474	2,103		2,103	
2047	184,285	9,655,759	2,118		2,118	
2048	184,285	9,840,044	2,132		2,132	
2049	184,285	10,024,329	2,146		2,146	
2050	184,285	10,208,614	2,159		2,159	
2051	184,285	10,392,899	2,172		2,172	
2052	184,285	10,577,184	2,184		2,184	
2053	184,285	10,761,469	2,195		2,195	
2054	184,285	10,945,754	2,207		2,207	
2055	184,285	11,130,039	2,217		2,217	
2056	184,285	11,314,324	2,228		2,228	
2057	184,285	11,498,609	2,238		2,238	
2058	184,285	11,682,894	2,247		2,247	
2059	184,285	11,867,179	2,256		2,256	
2060	184,285	12,051,464	2,265	0	2,265	
2061	184,285	12,235,749	2,176	97	2,274	
2062	184,285	12,420,034	2,091	191	2,282	
2063	184,285	12,604,319	2,009	281	2,290	
2064	184,285	12,788,604	1,930	367	2,297	
2065	184,285	12,972,889	1,855	450	2,304	
2066	184,285	13,157,174	1,782	529	2,311	
2067	184,285	13,341,459	1,712	606	2,318	
2068	184,285	13,525,744	1,645	680	2,324	
2069	184,285	13,710,029	1,580	750	2,331	
2070	184,285	13,894,314	1,518	818	2,336	
2071	184,285	14,078,599	1,459	883	2,342	
2072	184,285	14,262,884	1,402	946	2,348	
2073	184,285	14,447,169	1,347	1,006	2,353	
2074	184,285	14,631,454	1,294	1,064	2,358	
2075	184,261	14,815,739	1,243	1,120	2,363	
2076	0	15,000,000	1,194	1,173	2,367	
2077	0	15,000,000	1,148	1,127	2,275	
2078	0	15,000,000	1,103	1,083	2,185	
2079	0	15,000,000	1,059	1,040	2,100	
2080	0	15,000,000	1,018	1,000	2,017	
2081	0	15,000,000	978	960	1,938	
2082	0	15,000,000	940	923	1,862	
2083	0	15,000,000	903	886	1,789	
2084	0	15,000,000	867	852	1,719	
2085	0	15,000,000	833	818	1,652	

COMPUTATION SHEET

PROJECT TITLE:	Blackburn Sanitary Landfill	PROJECT NO:	180694
DESCRIPTION:	Landfill Gas Modeling Projections	SHEET:	4
		OF:	4
PREPARED BY:	DK	CHECKED BY:	JAB
DATE:	11/21/2018	DATE:	12/4/2018

Year	Total Degradable Intake Rates (metric tons/year)	Total Waste In-Place (metric tons)	Flow Rates from 1980-2059 waste in place tonnages (scfm)	Flow Rates from 2060 waste in place tonnages (scfm)	Total LFG Flow Rate (scfm)	
2086	0	15,000,000	801	786	1,587	
2087	0	15,000,000	769	755	1,525	
2088	0	15,000,000	739	726	1,465	
2089	0	15,000,000	710	697	1,407	
2090	0	15,000,000	682	670	1,352	
2091	0	15,000,000	656	644	1,299	
2092	0	15,000,000	630	618	1,248	
2093	0	15,000,000	605	594	1,199	
2094	0	15,000,000	581	571	1,152	
2095	0	15,000,000	559	549	1,107	
2096	0	15,000,000	537	527	1,064	
2097	0	15,000,000	516	506	1,022	
2098	0	15,000,000	495	487	982	
2099	0	15,000,000	476	467	943	
2100	0	15,000,000	457	449	906	
2101	0	15,000,000	439	432	871	
2102	0	15,000,000	422	415	837	
2103	0	15,000,000	406	398	804	
2104	0	15,000,000	390	383	772	
2105	0	15,000,000	374	368	742	

APPENDIX C
CALL LOG SUMMARIES

cornerstone PLLC

7600 Dublin Boulevard, Suite 200, Dublin, CA 94568
T 877.633.5520 | F 877.845.1456 | W www.cornerstoneeg.com

Memorandum

Date and Time:	November 7, 2018; 11:05
Cornerstone Personnel:	Paul Stout
Potential User Company:	Republic
Potential User Contact:	Don Phelps
Contact Title:	Republic GM

General Summary of the Call:

CEG Engineering, PLLC (CEG) gave a brief synopsis of the current scope and project with Catawba County. Currently, Republic Services, Inc. (Republic) operates 47 routes out of their hauling yard at 4062 Section House Road in Hickory, NC. These routes do not all go to Catawba County.

Each truck uses about 4.5 to 5.0 DGE per hour and runs about 10-hour days. Thus, 2,000 to 2,500 DGE are used daily. They pay bulk for Diesel at about $2.45 per DGE.

Republic operates the landfill north of Catawba County, NC, Caldwell County. At that site, there is a third party installing a gas collection and control system (GCCS) and a renewable natural gas (RNG) to pipeline project. Don Phelps of Republic did not know the third party when asked. He did say that CEG should reach out to someone at corporate for the identity of the third party, and what it might take to get Republic to convert to RNG from Diesel. This is not a decision that he can make alone.

The franchise agreement with Catawba is believed to be good for another 13 years or so.

CEG contacted Brian Martz on November 14, 2018. Please see call log dated November 14, 2018 for details.

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Memorandum

Date and Time:	November 13, 2018 – 8:30 PM PST
Cornerstone Personnel:	Paul Stout, Gavin Casson
Potential User Company:	Republic Services
Potential User Contact:	Brian Martz
Contact Title:	Director of Renewable Energy Development

General Summary of the Call:

CEG Engineering, PLLC (CEG) called Brian Martz of Republic Services (Republic) as a follow up to a call that Paul Stout of CEG had with Don Phelps of Republic. Don directed CEG to Bryan as Don cannot make the decision to convert a fleet of trucks to compressed natural gas (CNG). See the call log with Don Phelps dated November 7, 2018 for additional details.

Brian oversees the national renewable natural gas (RNG) and solar development for Republic. Brian mentioned that Caldwell County, NC is currently installing a gas collection and control system (GCCS) and planning to build a renewable natural gas (RNG) project at the site. There may be interest (similar to Surry County Landfill) in taking RNG for their project. Brian suggested that he would discuss with this RNG developer as to their interest to take landfill gas (LFG) from Catawba County, and if interested, would put CEG in touch with the developer.

In regard to Republic converting the fleet being used in Catawba County, Brian stated there were significant efforts in capital reinvestment that would need to take place. Several factors including, size of the fleet, future in the area, etc. He noted that it would be highly unlikely that they would consider converting the fleet. However, he will reach out to others in the NC area to discuss this with them before providing a final answer. If there is interest, he will forward contact information along.

Brian did suggest that he felt we would have little trouble finding a party in the near term that would pick up the RNG via tube trailer, and that any conversion of Republic trucks would take longer than that, and probably not be a high probability for our consideration for the RNG.

Based on the highly unlikely assessment by Brian, CEG does not believe this requires further follow up.

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Memorandum

Date and Time:	November 19, 2018 - 11:30 AM PST
Cornerstone Personnel:	Gavin Casson, Jessica Bernardini, Alex Newell
Potential User Company:	ReNew Petra
Potential User Contact:	Wayne Marshall, Tim Holder
Contact Title:	Managing Director

General Summary of the Call:

CEG Engineering, PLLC, (CEG) gave a brief synopsis of the proposed project with Catawba County. ReNew Petra owns and operates a landfill gas to energy (LFGTE) facility at the Mount Airy Landfill in Surry County. They have 15 years remaining on a 20-year contract with a fixed price for the electric generated with an escalator in the contract. They currently operate at 1100 kW of a 1600 kW system and are looking for ways to meet the full capacity of the system. The vision for this project would be to partially clean the landfill gas (LFG) (moisture and particulate removal at a minimum) and transport via tube trailer to the Mount Airy Project for use in the LFGTE facility. The major hurdle would be reducing the volume enough to lessen the transportation costs to a point that the project is profitable. Currently, there is only particulate and moisture removal at the Mount Airy Landfill, no CO2 removal, which operates at approximately 500 million British thermal units (MMBtu).

ReNew Petra have also been involved in the dialogue with Piedmont regarding pipeline injection from pig farms, dairy farms, etc. Therefore, ReNew Petra is interested and open to ideas for ways to use RNG and inject into a pipeline but have not pursued any projects at this point. Wayne of ReNew Petra also took part in the fuel cell study at Apple (Wayne did not use Apple by name, but it was clear what project he was mentioning). ReNew Petra has also discussed compressed natural gas (CNG) filling stations with some groups in the mid-west but the challenge is finding the volume to justify the upfront costs.

Overall, ReNew Petra is interested in participating in this project as it develops and would like to be a part of the process if they can find a way for it to be economically profitable.

ReNew Petra did not give a specific price point, but more of a general guideline that the RINs, price of natural gas, and/or any LCFS benefits from a pipeline injection would need to balance the costs.

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Memorandum

Date and Time:	November 19, 2018 - 2:30 PM PST
Cornerstone Personnel:	Paul Stout, Gavin Casson, Alex Newell
Potential User Company:	Pilot Station (Clean Energy)
Potential User Contact:	Sean Wine
Contact Title:	Director of Strategic Development & Operations

General Summary of the Call:

CEG Engineering, PLLC (CEG) provided an introduction and synopsis of the proposed project and current scope with Catawba County. Pilot Station (Pilot) is partnered with Clean Energy and are open and always looking to take more renewable natural gas (RNG) into their supply and build their portfolio. Currently, Clean Energy has several places with existing infrastructure in North Carolina where they could inject the RNG. They have users that would take the RNG but would require the RNG to be cleaned to pipeline specifications.

Clean Energy is not interested in development of a compressed natural gas fueling station project. They do not foresee an immediate need for a new CNG fueling station. However, they do anticipate growth in this sector, but it is at least 18-24 months out. They do not have any current use for tube trailers at any existing CNG fueling stations.

However, Clean Energy would be interested in taking the RNG for an existing pipeline injection site. The view for this project would most likely be to work with NG Advantage. They own the majority share of NG Advantage. NG Advantage would provide the transport of the RNG from the landfill to the existing pipeline injection infrastructure. NG Advantage would only provide a rate for the transportation. They would not collect any RINs or other incentives. These incentives would be split between Clean Energy and the County in an approximate 25% (Clean Energy)/75% (County) split. Essentially, the County would clean the landfill gas (LFG) to pipeline quality and sell to Clean Energy who would take ownership at the injection point with NG Advantage providing the virtual pipeline.

Clean Energy did note that they have not seen a successful tube trailer/virtual pipeline project yet. However, they provided a contact at NG Advantage.

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Memorandum

Date and Time:	November 27, 2018 – 8:00 AM PST
Cornerstone Personnel:	Bill Bloomenkranz, Gavin Casson, Alex Newell
Potential User Company:	Piedmont Natural Gas, Division of Duke Energy
Potential User Contact:	David Nester
Contact Title:	Director of Compressed Natural Gas

General Summary of the Call:

CEG Engineering, PLLC (CEG) gave a brief rundown of potential project, existing site infrastructure, and evaluation of other options. Potential direct injection sites have already identified in previous feasibility studies. There is a nearby potential injection location but is located on a transmission line that is not always in use. Another potential injection location is farther from the site and may not be financially feasible for a physical connection via pipeline.

The North Carolina Utilities Commission is running a pilot program to establish renewable natural gas (RNG) injection standards. The draft version of these standards can be found in Docket G9698, which will be emailed to Cornerstone from David Nester of Piedmont Natural Gas. The standards are still in development and the tariff is not set yet.

It was noted that for an injection location to be approved, an interconnection application would be required for submission to Duke/Piedmont. They do not allow injection into distribution lines, only transmission lines. Additionally, a transmission line may not be approved if the particular line does not have consistent flow.

Appendix F of the docket will have information regarding the gas quality requirements.

Duke/Piedmont does not have an existing need for the gas. Therefore, they are not currently purchasing gas from alternative gas sources. The need to purchase additional gas is largely dependent on existing utility customers. Therefore, CEG will need to find an end user that is an existing Duke/Piedmont costumer that is willing to purchase the gas from

the landfill. Duke/Piedmont does not have the ability to transfer gas interstate and gain LCFS credits at this time.

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Memorandum

Date and Time:	November 27, 2018 - 3:00 PM PST
Cornerstone Personnel:	Gavin Casson
Potential User Company:	NG Advantage
Potential User Contact:	Greg Morse
Contact Title:	Senior Director

General Summary of the Call:

CEG Engineering, PLLC (CEG) had a discussion with Greg Morse of NG Advantage (NGA) in regards to the possibilities of a mobile pipeline. CEG was referred to this company from Sean Wine at Clean Energy (see call summary on November 19, 2018). Clean Energy is the majority shareholder of NG Advantage, but the companies operate independently of each other. However, they often team up on projects to provide the best solution for their prospective clients. NGA primarily operates in the northeast but have explored projects in North Carolina. However, none of these projects have come to fruition.

The typical set up for a mobile pipeline project to be successful includes compression equipment at the gas conditioning location, at least two tube trailers for transport of gas from the conditioning location to the injection location, and decompressing equipment at the injection location. The compression equipment at the gas conditioning location where trailers will be loaded typically requires between 4,200 – 5,000 pounds per square inch (psi). These are typically slow fill processes, therefore, at least two tube trailers are required. One tube trailer remains connected to the gas conditioning and compression equipment at all times while the other trailer is used for transport to the injection location. Decompression equipment requirements vary based on the injection location. Average costs of decompression and injection equipment is approximately $400,000.

Tube trailers typically require pipeline quality gas to adhere to the manufacturer warranty requirements. Hauling lesser quality gas will void the warranty of the trailer. However, Greg indicated that vehicle standards would likely be acceptable as long as this was

negotiated with the manufacturer up front. The likelihood of being able to haul raw landfill gas is not favorable and would be difficult regardless of the warranty conditions but based more on the chemical degradation of the trailer liners being exposed to low quality gas.

Often, the owner will purchase the tube trailers and all equipment up front and contract NGA to operate and maintain the equipment. There are many sizes and models available. On average, the tube trailers costs are approximately $100,000 per 100 thousand cubic feet (MCF) capacity. For example, a 350 MCF trailer is approximately $350,000. The cost of operation ranges between $2-$3 per MCF hauled.

It was noted during the conversation that a shorter trip is not necessarily more beneficial from an economic standpoint. A two to four hour round trip is typically ideal assuming that there is enough gas to fill one to two trailers per day. Reasoning is that it takes two to four hours to offload the fuel (depending on size of truck and the decompression requirements) so a shorter trip is not necessarily beneficial as the driver's salary for the full day must be accounted.

NGA is transport only and does not negotiate contracts based on RINs or other incentives. However, it was noted during the conversation that Transco pipeline is near the Blackburn Landfill and may be a viable option for an injection point that would allow the County to take advantage of the California incentives. Greg indicated that the Transco standards are stringent but have been established so they are known up front. The in-state standards with Duke Energy/Piedmont are still in deliberations.

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Memorandum

Date and Time:	November 28, 2018 @ 2:00 PM PST
Cornerstone Personnel:	Jessica Bernardini, Paul Stout, Gavin Casson, Alex Newell
Potential User Company:	Blue Ridge Biofuels, LLC
Potential User Contact:	Woody Eaton (Blue Ridge) and Brad Pleima (Eco Engineers)
Contact Title:	Owner

General Summary of the Call:

CEG Engineering, PLLC (CEG) provided an introduction and synopsis of the proposed project and current scope with Catawba County. Blue Ridge Biofuels, LLC (Blue Ridge) has a biodiesel plant adjacent to the electrical generation facility at Blackburn Landfill. The biodiesel plant has been operational for approximately five years and Blue Ridge currently utilizes the waste heat off the jackets of the existing generators for use in its nearby plant. Initially, Blue Ridge's interest was in purchasing the heating value (BTUs) from Catawba to create process heat at its plant. Currently, they are more interested in the potential RFS and LCFS credits that could be available through vehicle fuel or interstate pipeline injection. Overall, Blue Ridge Biofuels remains interested in a potential partnership with Catawba.

EcoEngineers was also on the call as the consulting engineer for Blue Ridge. EcoEngineers has experience with similar projects in Iowa where utilities do not have physical interstate connections to easily allow for LCFS credits from California to be received. Landfills typically have an intensity of 30-50 carbon intensity (CI). EcoEngineers noted that if solar or wind technologies are on-site that would help decrease CI and create a project that would be easier to get into the California market.

Blue Ridge currently has connections with entities that are interested in developing or already selling CNG for vehicle use. They are aware of a location that has a demand for approximately 2,000 diesel gallon equivalents (DGE) of CNG. Their next steps would be to conduct an internal feasibility study to evaluate options for transporting the fuel, either via pipeline or tube trailer, depending on the economics. Blue Ridge would consider the costs

and benefits of purchasing the raw gas from Catawba and conditioning the LFG itself, then assess how to efficiently transport and market the fuel. If it was to proceed with the feasibility study, Blue Ridge would like an option to purchase the gas prior to commencing work on the study.

Blue Ridge submitted a Letter of Intent to Catawba County. In the Letter of Intent, Blue Ridge is proposing $2 per decatherm (1 decatherm~1 MMBTU) and 5% of profits shared. Profits would include environmental incentives as revenue (i.e. LCFS/RIN credits). For reference, the site currently operates between 900-1200 scfm at approximately 500 BTU/cf, which is roughly equivalent to 5,000 DGE per day (128,400 BTU/DGE).

Blue Ridge has no current contracts with entities that it does business with that would limit the potential deal to produce CNG.

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Memorandum

Date and Time:	December 11, 2018 @ 2:30 PM PST
Cornerstone Personnel:	Paul Stout and Gavin Casson
Potential User Company:	Environmental Energy Solutions (Evensol)
Potential User Contact:	David Wentworth
Contact Title:	Managing Manager

General Summary of the Call:

CEG Engineering, PLLC (CEG) provided an introduction and synopsis of the proposed project and current scope with Catawba County. Environmental Energy Solutions (Evensol) provided a summary of their current projects in the area. Evensol has two existing landfill gas (LFG) to renewable natural gas (RNG) projects operating for Republic that deliver RNG to a Piedmont pipeline location. They also have a third project that is to begin construction during the first quarter of 2019. They are advancing RNG projects at all three of these sites.

Evensol has a project at the Foothill's Landfill (aka. Caldwell County) in North Carolina that will be moving forward in the first quarter of 2019. The project consists of a gas conditioning facility that generates pipeline quality RNG to be injected into a Piedmont pipeline location. The RNG will be transported from the landfill to the injection location via virtual pipeline. The gas condition facility is expected to intake approximately 2,750 standard cubic feet per minute (scfm) of landfill gas. Originally, Piedmont would not allow an injection of this quantity of gas into their pipeline, as they did not have a demand for this high of a quantity in the area. However, Piedmont has now identified a location within their transmission system where they will allow the injection. Evensol purchased the property around this injection location and will be constructing the decant equipment and injection point to complete the virtual pipeline. This injection location is approximately 18 miles from the Blackburn Landfill, and therefore, it is likely the RNG from the Blackburn Landfill could also be injected at this location.

We discussed the possibilities of injection locations closer to the Blackburn Landfill where a physical pipeline may be feasible. Looking at the area at the intersection of Highway 10 and Robinson Road, Evensol agreed this could be a potential injection point. They indicated they would explore this as an option and would likely be preferred to the virtual pipeline if the costs were acceptable. Evensol has a good relationship with Piedmont and would work with them to determine if this location or any alternate locations are suitable for the project.

Overall, Evensol has high interest in working with the County to move forward with the potential project at the Blackburn Landfill. It would be convenient for timing purposes if an agreement could be reached in the coming months, as the Foothills project is moving forward in early 2019. David stated that they would be willing to be involved on many combinations of levels. They are open to developing, constructing, and operating the entire project or any portion of the project the County prefers. David also indicated that they would be able to decommission the existing landfill gas to energy facility, if the County so desired.

We briefly discussed estimated costs and revenue. David indicated if the County wanted to own the gas conditioning equipment, he estimated $20M to get to startup. At that point, Evensol would purchase the RNG and use in one of their projects. If the County wanted to let Evensol own and operate the full project, he estimated royalties to the County between $300,000-$500,000 per year, based on RIN pricing and overall profits. David indicated LCFS credits are not typically granted and he does not consider them when evaluating the feasibility of a project.

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Memorandum

Date and Time:	December 12, 2018 @ 10:30 AM PST
Cornerstone Personnel:	Paul Stout and Gavin Casson
Potential User Company:	Trillium
Potential User Contact:	Charles Love
Contact Title:	Renewable Energy Acquisition

General Summary of the Call:

CEG Engineering, PLLC (CEG) gave an introduction and synopsis of the proposed project and current scope with Catawba County and asked about the nearby Love's truck stop and potential for installing a clean natural gas (CNG) fueling station at that location. Trillium indicated they have a Love's truck stop nearby, but they do not typically install CNG fueling stations unless there is a direct need within the area. They also stated that if there is a need within the area, perhaps the nearby Target Distribution Center, they would consider installing a CNG filling station at the truck stop. They were not aware of a demand for CNG but stated their business development team could provide additional research and determine any nearby demands.

Overall, Charles is interested in the project and would be open to pipeline injection or other options, regardless of it is feasible to construct a CNG fueling station at the Love's Truck Stop. He would be interested in any combination of involvement, including design, build, own, and operate as a whole, or provide assistance in role the County desired. Charles stated that if an RFP was available, he would likely submit a response.

ATTACHMENT C

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MEMO

To:	Jack Chandler – Catawba County Utilities & Engineering
From:	Paul Stout, Helen Vesser, Mike Michels, P.E. – CEG Engineering, PLLC
Date:	July 11, 2019
Subject:	Conceptual Design and Proforma for the Potential Construction of a Renewable Natural Gas Facility at the Blackburn Landfill in Catawba County

Summary

The Blackburn Landfill (Landfill) is owned and operated by Catawba County (County) and is located at 4017 Rocky Ford Road, Newton, North Carolina. The Landfill's existing infrastructure includes a landfill gas (LFG) collection and control system (GCCS) installed for the collection and destruction of LFG. The LFG is destroyed via flare and an existing beneficial use project consisting of three internal combustion (IC) engines to generate electricity. The rate of payment for the generated electricity has steadily dropped during recent years and coupled with the rising operations and maintenance (O&M) costs of the aging engines, feasibility of the continued operation of the IC engines has come into question. Therefore, the County is exploring the feasibility of beneficially utilizing the collected LFG by other methods.

The County has contracted CEG Engineering, PLLC (CEG) to conduct an LFG Beneficial Use Feasibility Evaluation (Feasibility Study). The first phase of this Feasibility Study indicated that an LFG to renewable natural gas (RNG) project likely held the greatest return for a future LFG beneficial use project at the Landfill. This second iteration of the Feasibility Evaluation provides an in-depth review of an LFG to RNG project including the required biogas conditioning equipment and construction costs. This Feasibility Evaluation presents a conceptual design and economic proforma based on an RNG project which treats the LFG and injects the RNG into a pipeline injection site located approximately 18 miles away. Conceptual drawings have been prepared and attached. CEG has also obtained general equipment pricing for the concept level major equipment. We developed a construction budget estimate on the concept plan based on the previous construction estimates for similar facilities previously developed a prior project at the site. Using the construction budget and estimating the O&M costs, CEG developed a 20-year proforma and performed sensitivity analyses in order for the County to gain a general sense of profitability of an LFG to RNG project at the Landfill.

Revenue Generation Potential

RNG projects take the gaseous byproduct from landfills, wastewater treatment plants, digesters and other similar facilities and convert the raw biogas into natural gas equivalent for injection into pipelines or similar infrastructure. Taken a step further as part of our nation's energy security program, financial incentives were put in place to promote ethanol and alternate domestic energy sources for our transportation needs. This morphed into the Renewable Fuel Standard 2 (RFS2) program which is administered by the United States Environmental Protection Agency (USEPA). The RFS2 program promotes refiners and others in the conventional petroleum distribution chain to buy renewable fuels for transportation needs. If LFG was converted into RNG and ultimately sold as vehicle fuel, it has the potential to be worth substantially more than it is today as simply electricity and heat. By way of reference, natural gas is selling for about $2.50 to $3.00 per million Btu (MMBtu) but RNG used for vehicle fuel is selling for $10 to $20 per MMBtu when it is sold with a Renewable Identification Number (RIN).

A RIN is a serial number assigned to biofuel as it is produced. This serial number is required by the USEPA and allows for the tracking of production and trade of biofuels. LFG generated at the Landfill qualifies for a category

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D3 RIN. As of May 2019, Category D3 Biofuel carried a variable value about $1.36/RIN or ~$17.66/MMBtu. With the RIN values of the current market, the revenue generation outlook is positive. However, the market for RINs are volatile and can fluctuate up and down quickly. As such we have incorporated these unknowns for the following proformas by allowing for a loss of five percent RIN value year over year and limiting the RIN revenue to a ten-year outlook.

Another market incentive available to the County is the Low Carbon Fuel Standard (LCFS) credit program created by the California Air Resources Board (CARB) to reduce greenhouse gas (GHG) emissions through incentivizing the use of alternative vehicle fuels. The LCFS program is available to facilities outside the state of California that produce low carbon intensity fuel that is transported to and dispensed within California. The value of the LCFS credit is volatile but results in a revenue incentive for RNG to vehicle fuel projects. The price per credit has fluctuated between a low of $22 per credit ($0.81/MMBtu) as a monthly average at the program's inception in January 2013, to a current value of approximately $185 per credit ($6.77/MMBtu). Based on the current LCFS program, this report provides that LCFS credits will be available for RNG produced at the Landfill based on an assumed carbon intensity score of 60. LFG conditioned into RNG is currently worth approximately $6.77/MMBtu if utilized as vehicle fuel in California. LCFS value was reduced by five percent year over year in the proforma and is limited to ten years, as it's difficult to predict where LCFS will be after ten years.

Project Concept

The project concept is to cease transmitting LFG to the three existing IC engines and instead transmit the raw biogas to a proposed RNG facility tentatively located in the open area immediately North of Rocky Ford Road and West of Landfill Road. The Treated LFG would meet Piedmont Natural Gas Company, Inc. (Piedmont) natural gas pipeline specifications. The RNG would be conveyed via tube trailers (common in the industry) to an RNG injection point in the area currently under development by others. This RNG could also be used as vehicle fuel onsite at some point in the future (however on-site use of this fuel would not allow income from California LCFS, so this option is not deployed in our financial scenarios).

In general, the conditioning equipment would remove the majority of the constituents from the biogas with the exception of the methane. There are several different technologies that can be used for this conditioning process. The most likely families of equipment are described later in this report, but the general process typically includes:

- Particulate matter removal;
- Moisture removal;
- Removal of hydrogen sulfide (H2S);
- Pressurization;
- Removal of carbon dioxide (CO2), nitrogen (N2), volatile organic compounds (VOCs) and siloxane;
- Sale of cleaned up gas to a vehicle fuel user; and
- Combustion of the tail gas streams in a flare or thermal oxidizer.

The sections below describe, in general terms, the technologies that could be used to clean up the biogas and provide some initial financial modeling of the likely capital and operating expenses as well as the revenue potential.

Biogas Conditioning Equipment

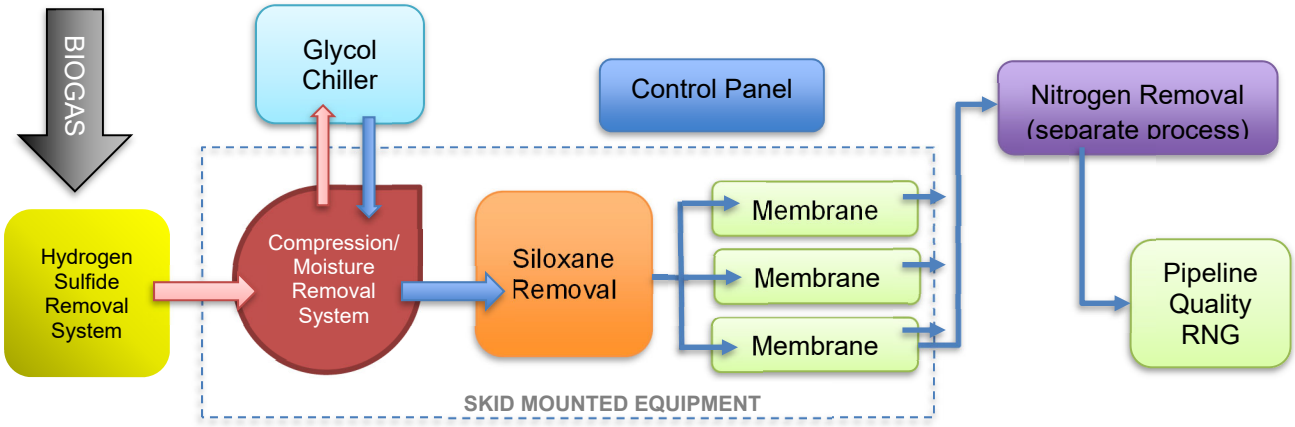
CEG explored three different biogas conditioning technologies for application at the Landfill. These three technologies include membrane filtering, pressure swing adsorption (PSA) and amine washing. The advantages and disadvantages of each system in respect to the application at the Landfill are discussed in further detail below.

Membrane: Membrane filtering technology is often skid mounted and includes components for compression of the gas and removal of CO2, moisture and siloxanes. Gas is first compressed and dried via a series of air and glycol heat exchangers and then sent on to pretreatment. Pretreatment is often necessary with membrane technology to assist in removing large particulates, VOCs, siloxanes (silicon-based molecules that can damage equipment) and H2S. Levels of VOCs present in historical gas data indicate a regenerative system would likely be required to most effectively and economically strip the VOCs and siloxanes from the biogas. Gas would enter one of two vessels with media designed specifically for the removal of VOCs and siloxanes. Operation of the vessels would alternate to allow for the cleaning (regeneration) of media within one vessel using a stream of heated ambient air, supplied by a blower and heater.

Because the heated ambient air stream would be saturated with VOCs and siloxanes, it cannot be released to the atmosphere and must be incinerated using a thermal oxidizer. This waste stream is not continuous and is tied to the frequency of vessel regeneration. In the event future gas testing data shows reduced levels of VOCs and siloxanes, a less intensive process may be employed at a later date that would eliminate the need for this regeneration system. Vessels would instead be filled with non-regenerative media that would be disposed of in the landfill when saturated.

After the biogas has been dried, compressed and passed through pretreatment, the gas then passes to the CO2 removal membranes. The hollow core membranes are specifically designed to allow for fast moving compounds to pass through the walls of its structure, such as CO2 and moisture. The larger, slower methane compound pass through the core. The methane is collected as RNG and the CO2 removed by the membrane is diverted to a flare or thermal oxidizer for combustion. Once the gas passes through the filtering membranes, biomethane will be pipeline or vehicle quality RNG that meets SAE J1616 vehicle fuel specification. A process flow diagram is provided in Figure 1.

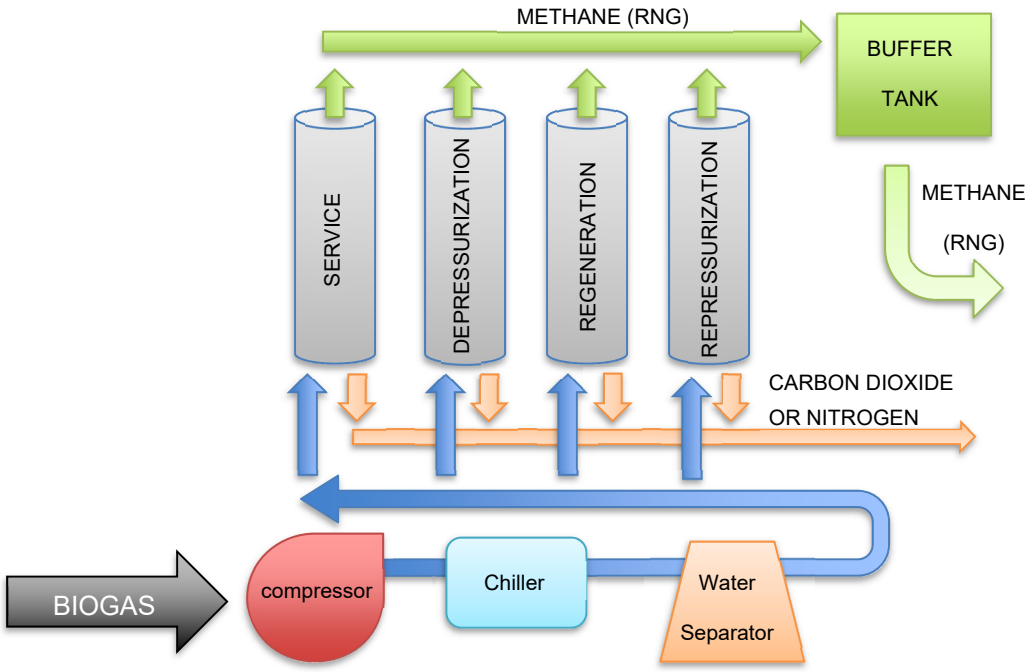
Figure 1. Membrane Technology Process Flow



The simplest and most economical membrane system is one configured to process the gas once through a single set of membranes. This 'single pass' system is optimal for vehicle fuel applications with a finite demand for RNG. CO2 rich tail gas generated by the single pass system contains enough methane that it can be combusted in a standard candlestick or enclosed flare. For pipeline applications, oftentimes with stricter gas quality requirements and no upper limit on demand, a 'double pass' or 'triple pass' membrane unit can be employed to increase the methane capture efficiency of the system and subsequently increase potential revenue. A tradeoff to the double pass or triple pass system is that they are more expensive than the single pass configurations and the tail gas must be supplemented with natural gas and combusted in a thermal oxidizer due to its extremely low methane content.

Pressure Swing Adsorption: PSA technology consists of a multi-vessel batch process that uses an adsorptive material inside each vessel. Each vessel operates in 1 of 4 modes to complete a 4-step cycle. These steps include Service, Depressurization, Regeneration, and Re-pressurization. The vessel in service receives the raw biogas at high pressure and preferentially adsorbs CO2 and other contaminants into the filter media. Once the vessel filter is saturated, it will be regenerated by depressurizing the vessel to extract the low-quality tail gas from the media. The vessel is then re-pressurized before being put back in service. One vessel is always in service as the other vessels rotate through each step in the cycle. Four or more vessels can be used to obtain the most efficient cycle rotation. Systems can be designed with multiple stages to remove CO2 or N2. As with the membrane system, a regenerative VOC/siloxane removal system would likely be required. A process flow diagram is provided in Figure 2.

Figure 2. Pressure Swing Adsorption Technology Process Flow Diagram



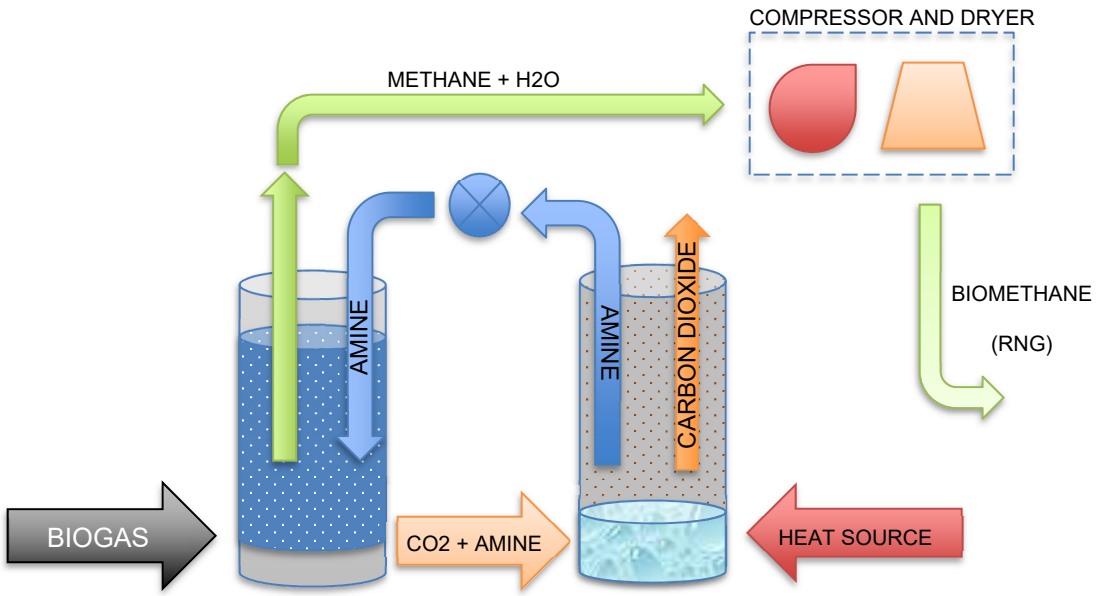
Amine wash system: This technology is based on a two-tower adsorption and desorption system and comes pre-packaged on a large skid (shipping container). This technology can reduce pretreatment equipment needs if the raw biogas meets certain criteria. Typically, H2S pretreatment is included at the inlet to an amine system.

The first tower scrubs the biogas of CO2 and other constituents using an amine wash process. The amine is introduced at the top of tower 1 and is dripped through the rising biogas. CO2 and other constituents become soluble in the amine solution and fall to the bottom of the first tower. The remaining biogas, which is methane rich at high humidity, will be compressed and dried before pipeline or vehicle quality can be achieved. With compression and drying occurring post CO2 removal, the process can be more energy efficient than membrane technologies.

The CO2 combined with the amine solution is then pumped to the second tower where it is stripped from the solution under high heat. The heat source can be an energy drain and requires careful analysis to source the heat for this process. The quality of carbon dioxide can often be reused after this process or it can be released to a flare for combustion. A process flow diagram is provided in Figure 3.

While this technology allows greater methane recovery efficiencies at higher flow rates, the large amount of supplemental heat required makes this technology less efficient for applications without heat recovery opportunities. For this reason, an amine system was not short-listed for further review and will not be discussed in the Financial Proforma section, below.

Figure 3. Amine Solution Technology Process Flow Diagram



Gas Conditioning Equipment at the Landfill

Two scenarios were explored in this feasibility study for the conditioning of LFG. The first scenario looks at membrane system for CO2 removal and a PSA for removing N2. The second assesses a two-Stage PSA system for the removal of both CO2 and N2. RNG will be conditioned to pipeline quality and conveyed either to a pipeline injection station or Compressed Natural Gas (CNG) fueling facility. Both scenarios require a thermal oxidizer supplemented with natural gas for combustion of the tail gas. The drawings attached to this report shows a preliminary process flow for this facility.

Equipment included:

- Hydrogen sulfide removal system;
- Feed compressors;
- VOC/siloxane removal system;
- Glycol Chiller;
- CO2 removal via membrane (Scenario 1) or PSA (Scenario 2);
- PSA N2 removal;
- Thermal oxidizer for tail gas destruction; and
- Building to house conditioning equipment.

Trailer Offload/Pipeline Injection Equipment

RNG generated at the Landfill will be transported to an Evansol pipeline injection site where it will be offloaded from storage trailers and injected into the pipeline. As the RNG exits the storage trailers, it undergoes rapid decompression which results in a large drop in temperature. A trailer decanter reheats the gas to avoid damaging equipment such as valves, regulators and instrumentation. Once a trailer equalizes at pipeline pressure, compressors are used to further empty the trailers while still meeting the pressure requirements of the tariff. Metering and monitoring equipment, including a gas chromatograph and Coriolis flow meter, will also be required to confirm gas quality and quantity before pipeline injection. This is necessary for the pipeline owner to verify minimum quality. These additional elements were included in the economic proformas.

Equipment Included:

- Trailer offload posts;
- Trailer decanter (reheats RNG to compensate against cooling due to rapid decompression);
- Pipeline injection compressors;
- Trailers;
- Interconnecting piping allowance; and
- Allowance for flow/BTU/quality monitoring.

Assumptions for Financial Proforma

Consistent with our approach on many previous RNG to vehicle fuel projects, CEG has obtained budgetary pricing information from various vendors for converting biogas into RNG. Considering vendor pricing, in reference to the reviewed technology, CEG has developed project recommendations. In addition to the Capital cost component of the Landfill, other project costs for brokering and selling the RINS and LCFS market values, and royalty payments to Evensol for injected RNG were included. The County, as the well field operator, must be very diligent to balance the LFG collection wellfield, repair leaks, and operate the well field efficiently to limit nitrogen and oxygen intrusion as the gas treatment cost for removing these constituents will lower the overall profitability of the project.

The quality and quantity of expected biogas was reviewed, and the following assumptions were used in the generation of the financial proformas:

Inlet Biogas Specifications – Landfill, based on 2015 REIC gas analysis

A.	Gas Flow =	1,000 scfm, increasing to 1,200 scfm by 2025
B.	Methane Content (CH4) =	50%
C.	Hydrogen Sulfide (H2S) =	< 10 ppmv
D.	Siloxanes =	4 ppmv
E.	VOCs/Heavy Hydrocarbons =	17 ppmv
F.	Nitrogen =	< 10% by volume

Sales RNG Specifications -Piedmont Natural Gas Company Inc, pipeline tariff dated January 2019

A.	Total Inerts =	< 3.2%
B.	Oxygen (O2) =	< 0.2%
C.	Hydrogen Sulfide (H2S) =	Not Detected
D.	Siloxanes =	Not Detected

Budget Assumptions

- Assumed run time = 95%
- Electricity Rate = $0.084/kWh (NREL.gov)
- Natural Gas Purchase price = $9.53/MMBTU (Energy Information Admin)
- Natural Gas Sales Rate = $3.00/MMBTU
- Annual Inflation Rate = 2%
- RINs
  - RIN Broker Fee: 15%
  - $1.36/RIN / $17.66/MMBTU / $2.27/DGE (May 2019)
  - Sensitivity – deflated by 5%/year
- LCFS
  - RIN Broker Fee: 15%
  - 6.77/MMBTU (May 2019)
  - Sensitivity – deflated by 5%/year
- Royalty Payment to Evansol = $2.00/MMBTU

Proforma Findings

Expected capital and operating expenses associated with the aforementioned biogas conditioning and fueling station equipment (summarized in Attachment A) were used to develop two financial proformas:

Scenario 1 is an LFG to pipeline injectable fuel (RNG) conditioning process using a membrane system for CO2 and a PSA system for N2 removal at the Landfill. Based on the provided assumptions, CEG has determined that this scenario has a four-and-a-half-year simple payback or a 13.6 percent IRR. The project would have an expected net present value (NPV) of $4.5 million, assuming a discount rate of 15 percent. Capital cost for this is roughly $17.4 million.

Scenario 2 is an LFG to pipeline injectable fuel conditioning process using a PSA system for both CO2 and N2 removal at the Landfill. Based on the provided assumptions, CEG has determined that this scenario has a five-and-a-half-year simple payback or a 10.4 percent IRR. The project would have an expected NPV of $3.2 Million, assuming a discount rate of 15 percent. Capital cost for this option is roughly $19.7 million.

Scenarios 1 and 2 both include identical equipment at the pipeline injection station. The proforma results for each scenario are summarized in Table 1, below.

Table 4. Proforma Results Summary

Scenario	Payback (years)	IRR (%)	NPV
1 – Membrane and PSA	4.5	13.6	$4,500,000
2 – PSA Only	5.5	10.4	$3,200,000

Membrane systems for CO2 removal have been designed, constructed, commissioned, and operated successfully at numerous locations throughout the nation. Many project developers with multiple operating RNG facilities utilize this process platform because of its proven reliability and relative ease of operation. Membrane systems have no moving parts and are robust when operated within appropriately specified conditions. While the PSA process is a proven technology for Nitrogen reduction, the process has not achieved reliable wide spread use as a CO2 removal process in LFG applications.

PSA systems also have more “moving parts”. Operations and maintenance costs for PSA CO2 removal applications are not as well documented as with membrane technology. Furthermore, the complicated designs and integration required for a PSA system often exceed the operational skill level of typical LFG utilization project

employees, required new, specialized staff for the operation of the equipment. It is our experience that operating a membrane system, while not as efficient as an PSA in theory can be more effective for the owner over the long term because of the relative ease of operation and maintenance.

Sensitivity Analysis

CEG performed sensitivity analysis on the Scenario 1 proforma, evaluating the effects of changing capital cost, gas flows, RIN pricing, LCFS pricing, and electricity cost. See Attachment D for the results of the sensitivity analysis. Base case proforma has an initial LFG inlet flow of 1.000 standard cubic feet per minute (SCFM), increasing at 50 SCFM annually each year, with an IRR of 14 percent. If we assume that 1,000 SCFM does not increase at all, the IRR drops from 14 percent to nine percent. If capex increases by 50 percent, the IRR drops to 3.5 percent. When the electricity cost is increased from $0.843 cents/kWh to $0.15/kWh, the IRR drops from 14 percent to six percent. The biggest risk factor is the RIN and LCFS incentives due to the volatility in the market. If CEG assumes that the RIN pricing drops down from $1.36 to $0.85/RIN, the IRR drops down to two percent. If the LCFS pricing drops from $6.77 down to $0.65/MMBtu, the IRR drops to three percent. If the market for LCFS and RIN disappears, or prices decrease substantially, the project would experience negative cash flows, as income from the gas sales would not be sufficient to make the project profitable.

Conclusions

This report provides the initial information to allow the County to make an informed decision to proceed with either County funds or to issue an RFP to energy developers for them to develop the project. All scenarios explored in this feasibility study have the potential to generate revenue for the County. Estimated return on investment for each project is anticipated to be between four and a half and five and a half years. A summary of the two scenarios can be found in Attachment A.

The proforma indicates the project is profitable, but the profitability is largely dependent on the RIN and LCFS market pricing. Due to the continued volatility in pricing and the falling prices in these markets, CEG believes the project is one of higher risk. If the County desires to move forward with County funds, we recommend preparing a 30 percent design and then refining the appropriate cost estimates.

Outside of the RIN & LCFS pricing, which is difficult to predict, CEG has been conservative in our assumptions due to the early nature of this project. Conservative assumptions include:

1. Conservative budgetary estimates for all equipment. Obtaining firm pricing may result in lower capital costs than shown in the proformas.
2. A ten percent contingency on top of our budgetary estimates.
3. Operating cost estimates for parts and labor was estimated to be conservatively high.

The following estimated milestone schedule contemplates moving forward with project implementation at the landfill site. Based on our experience this milestone schedule may be impacted by numerous outside influences such as county approvals, permitting delays from government agencies, material (steel) shortages/tariffs etc.

County approval of facility plan	August 1, 2019
Commence 30 percent design	August 15, 2019
Gain County approval of concept	September 1, 2019
Coordinate with Piedmont, Evansol	September 1, 2019
Submit permits	October 1, 2019
Order long lead Equipment	October 1, 2019
Complete design	January 1,2020

Mobilize and prepare site	April 1, 2020
Complete underground infrastructure	May 1, 2020
Prefabrication of process piping	June thru September 2020
Complete concrete foundations	August 1, 2020
Complete metal building shell	September 1, 2020
Take delivery and set equipment	September 1, 2020
Mechanical electrical installation	September through November 2020
First fills and commissioning	November 2020
Final Completion	December 2020

We look forward to discussing the equipment technologies further and refining the milestone schedule if warranted. Also, if the County decides this project is too risky for its own funding then we recommend the County issue a request for proposal to energy developers to learn of their interest and what royalty the developers may offer the County.

Attachments: Drawings 1: Conceptual Design Plans
Attachment A – Proforma Summary
Attachment B – Scenario 1 Proforma
Attachment C – Scenario 2 Proforma
Attachment D – Sensitivity Analysis

DRAWINGS

CONCEPTUAL PLANS FOR THE

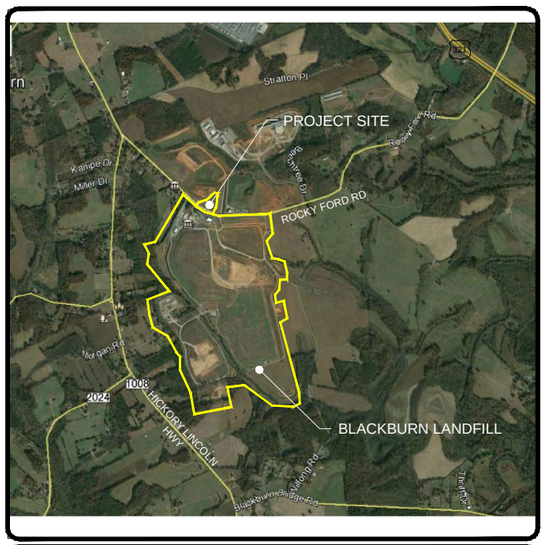
LANDFILL GAS TO RENEWABLE NATURAL GAS

PREPARED FOR:

CATAWBA COUNTY

AT THE BLACKBURN LANDFILL, CATAWBA COUNTY, NORTH CAROLINA

MAY 2019



LOCATION MAP

PREPARED BY:

cornerstone PLLC

DOING BUSINESS AS :
CEG ENGINEERING, PLLC
100 Crystal Run Road, Suite 101
Middletown, New York 10941
Tel. (877) 294-9070

SHEET INDEX

CEG PROJECT # 180649

CONCEPTUAL - NOT FOR CONSTRUCTION

MICHAEL S. MICHELS, P.E.

NC P.E. Lic. No. 040437 Date

1" 1/2" 0"

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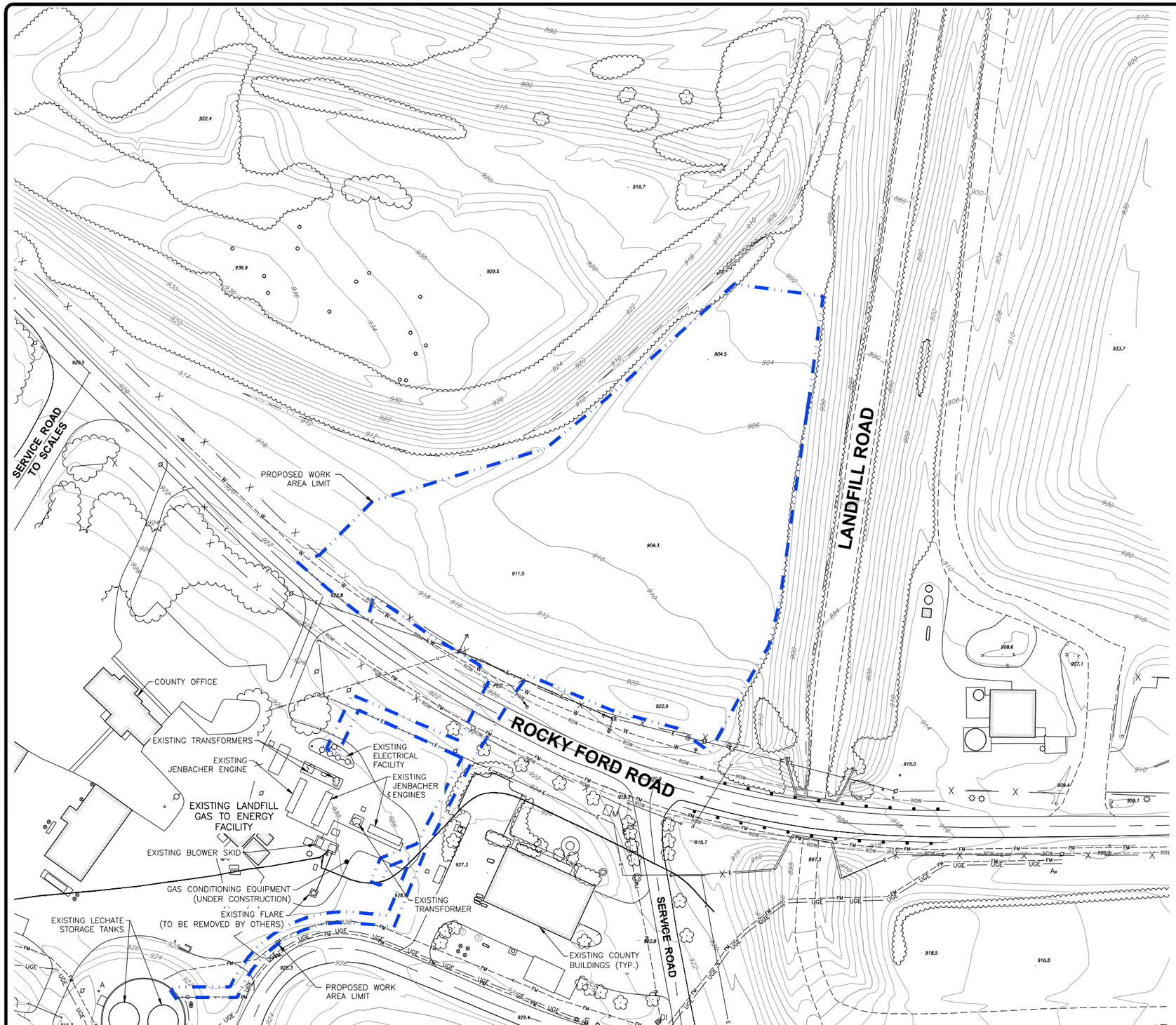

N

0 60 120

SCALE IN FEET

LEGEND

- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- EXISTING RIGHT-OF-WAY
- EXISTING PARCEL LINES
- PROPOSED WORK AREA
- EXISTING FENCE
- EXISTING DRAINAGE SWALE
- EXISTING CULVERT
- ROADWAY CENTERLINE
- EXISTING SPOT ELEVATION
- GUARD RAIL
- APPROXIMATE LOCATION OF EXISTING SEWER LINES
- APPROXIMATE LOCATION OF EXISTING WATER LINES
- APPROXIMATE LOCATION OF EXISTING GAS LINES
- APPROXIMATE LOCATION OF UNDERGROUND FIBER OPTIC CABLE LINE
- APPROXIMATE LOCATION OF UNDERGROUND ELECTRIC LINE
- APPROXIMATE LOCATION OF OVERHEAD ELECTRIC LINE
- APPROXIMATE LOCATION OF UNDERGROUND TELEPHONE LINES
- APPROXIMATE LOCATION OF OVERHEAD TELEPHONE LINES
- RIGHT-OF-WAY
- APPROXIMATE LOCATION OF OVERHEAD UTILITY LINE
- TREELINE
- SHRUBLINE

NOTES:

1. TOPOGRAPHIC DATA SHOWN PROVIDED BY McGILL ASSOCIATES, ASHLAND NC., DATE OF PHOTOGRAPHY: MAY 11, 2015.
2. THE EXISTING UTILITIES SHOWN ON THESE PLANS ARE APPROXIMATE, INCOMPLETE, AND SHALL NOT BE RELIED UPON BY THE CONTRACTOR. CONTACT "NC811-CALL BEFORE YOU DIG" ORGANIZATION] AT 1-800-632-4949 AND ANY NON-PARTICIPATING UTILITY COMPANIES AT LEAST 48 HOURS BEFORE CONSTRUCTION. THE CONTRACTOR SHALL EXCAVATE AND VERIFY THE HORIZONTAL AND VERTICAL LOCATIONS OF ALL UTILITIES AND OTHER EXISTING FEATURES IN OR NEAR THE AREA OF WORK, WHETHER INDICATED ON THESE DRAWINGS OR NOT. SHOULD A CONFLICT EXIST, THE CONTRACTOR SHALL NOTIFY THE ENGINEER AS SOON AS POSSIBLE. THE CONTRACTOR SHALL AVOID DISTURBING ANY UTILITIES AND THE CONTRACTOR SHALL REPAIR DAMAGE TO EXISTING UTILITIES AT THE CONTRACTOR'S EXPENSE.

CONCEPTUAL PLAN

DOING BUSINESS AS :
CEG ENGINEERING, PLLC
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Middletown, New York 10941
Tel. (877) 294-9070

MICHAEL S. MICHELS, P.E.

N.C.P.E. Lic. No. 040437 Date

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE MAY 2019
DRAWN BY MDC
DESIGNED BY
CHECKED BY MSM
APPROVED BY MSM

cornerstone PLLC

CATAWBA COUNTY
BLACKBURN LANDFILL
CATAWBA COUNTY, NORTH CAROLINA

LANDFILL GAS TO RENEWABLE NATURAL GAS
EXISTING CONDITIONS

SHEET NO. **1**

PROJECT NO. 180649

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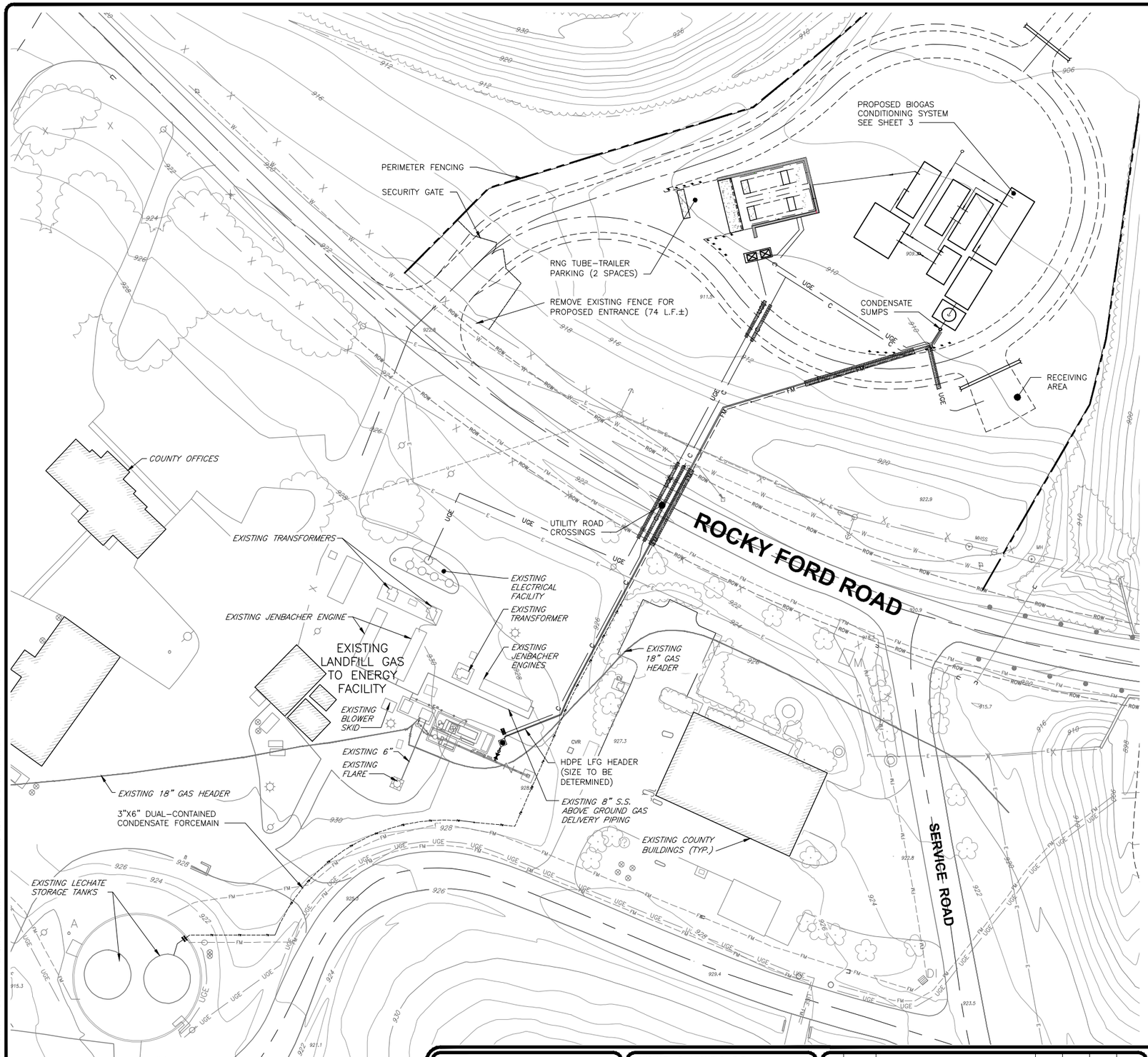

N

0 40 80

SCALE IN FEET

LEGEND

- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- EXISTING RIGHT–OF–WAY
- EXISTING PARCEL LINES
- EXISTING FENCE
- EXISTING DRAINAGE SWALE
- EXISTING CULVERT
- ROADWAY CENTERLINE
- EXISTING SPOT ELEVATION
- GUARD RAIL
- APPROXIMATE LOCATION OF EXISTING SEWER LINES
- APPROXIMATE LOCATION OF EXISTING WATER LINES
- APPROXIMATE LOCATION OF EXISTING GAS LINES
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- APPROXIMATE LOCATION OF OVERHEAD ELECTRIC LINE
- APPROXIMATE LOCATION OF UNDERGROUND TELEPHONE LINES
- APPROXIMATE LOCATION OF OVERHEAD TELEPHONE LINES
- RIGHT–OF–WAY
- APPROXIMATE LOCATION OF OVERHEAD UTILITY LINE
- TREELINE
- SHRUBLINE
- FENCE
- GRAVEL ROADWAY
- GRAVEL SHOULDER
- ROADWAY CENTERLINE
- ROAD CROSSING
- HEADER
- FORCEMAIN
- UNDERGROUND ELECTRICAL CONDUIT
- UNDERGROUND CONTROL CONDUIT
- CONDENSATE
- CONDENSATE SUMP
- CONCRETE PADS
- GRAVEL SURFACE

NOTES:

1. TOPOGRAPHIC DATA SHOWN PROVIDED BY McGILL ASSOCIATES, ASHLAND NC., DATE OF PHOTOGRAPHY: MAY 11, 2015.
2. ROCKY FORD ROAD CROSSING SHALL BE COMPLETED IN ACCORDANCE WITH NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES (JANUARY 2012) SECTION 1540 – ENCASEMENT AND SECTION 1550 – TRENCHLESS INSTALLATION OF UTILITIES. BORE AND JACK METHODS IN ACCORDANCE WITH THE SPECIFICATIONS SHALL BE EMPLOYED BY THE CONTRACTOR.
3. THE EXISTING UTILITIES SHOWN ON THESE PLANS ARE APPROXIMATE, INCOMPLETE, AND SHALL NOT BE RELIED UPON BY THE CONTRACTOR. CONTACT "NC811–CALL BEFORE YOU DIG" ORGANIZATION AT 1–800–632–4949 AND ANY NON–PARTICIPATING UTILITY COMPANIES AT LEAST 48 HOURS BEFORE CONSTRUCTION. THE CONTRACTOR SHALL EXCAVATE AND VERIFY THE HORIZONTAL AND VERTICAL LOCATIONS OF ALL UTILITIES AND OTHER EXISTING FEATURES IN OR NEAR THE AREA OF WORK, WHETHER INDICATED ON THESE DRAWINGS OR NOT. SHOULD A CONFLICT EXIST, THE CONTRACTOR SHALL NOTIFY THE ENGINEER AS SOON AS POSSIBLE. THE CONTRACTOR SHALL AVOID DISTURBING ANY UTILITIES AND THE CONTRACTOR SHALL REPAIR DAMAGE TO EXISTING UTILITIES AT THE CONTRACTOR'S EXPENSE.
4. NO ABOVE–GROUND WORK EXCEPT THE DRIVEWAY APPROACH MAY BE PERFORMED WITHIN THE ROCKY FORD ROAD RIGHT–OF–WAY.

CONCEPTUAL PLAN

DOING BUSINESS AS :
CEG ENGINEERING, PLLC
100 Crystal Run Road, Suite 101
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Tel. (877) 294-9070

MICHAEL S. MICHELS, P.E.

N.C.P.E. Lic. No. 040437 Date

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE MAY 2019
DRAWN BY MDC
DESIGNED BY
CHECKED BY MSM
APPROVED BY MSM

PREPARED BY:
CEG ENGINEERING, PLLC

CATAWBA COUNTY
BLACKBURN LANDFILL
CATAWBA COUNTY, NORTH CAROLINA

LANDFILL GAS TO RENEWABLE NATURAL GAS
SITE PLAN - OPTION 1

SHEET NO. **2**
PROJECT NO. 180649

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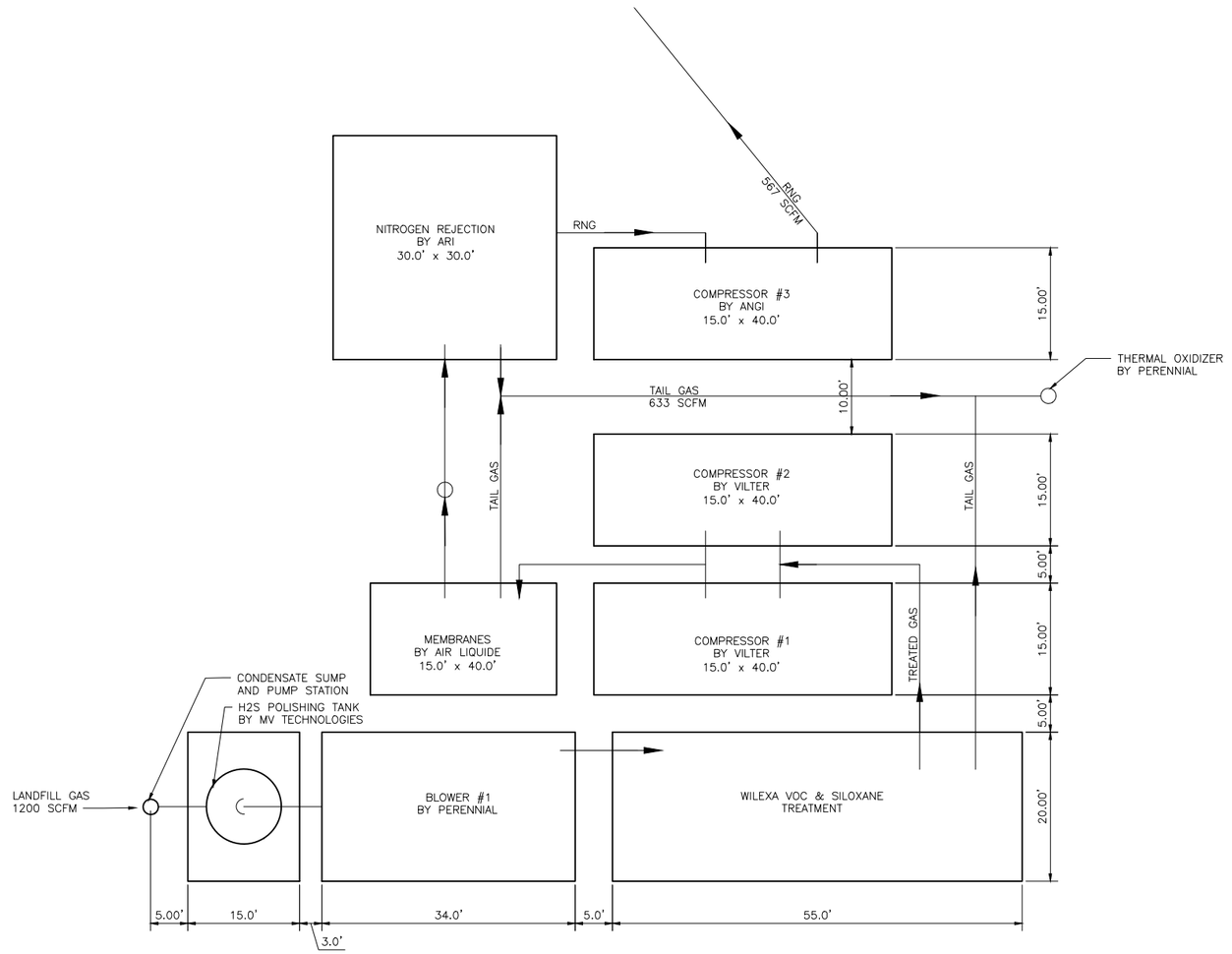

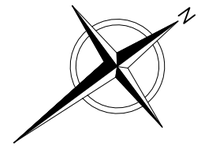

0 5 10
SCALE IN FEET

NOTE:

1. DIMENSIONS ARE EQUIPMENT FOUNDATIONS. EQUIPMENT SKIDS ARE SMALLER.

CONCEPTUAL PLAN

DOING BUSINESS AS :
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MICHAEL S. MICHELS, P.E.

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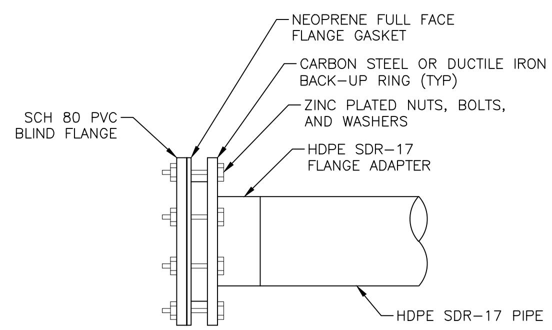
CHECKED BY MSM
APPROVED BY MSM

PREPARED BY:
CEG ENGINEERING, PLLC

CATAWBA COUNTY
BLACKBURN LANDFILL
CATAWBA COUNTY, NORTH CAROLINA

LANDFILL GAS TO RENEWABLE NATURAL GAS
GENERAL ARRANGEMENT - OPTION 1

SHEET NO. **3**
PROJECT NO. 180649

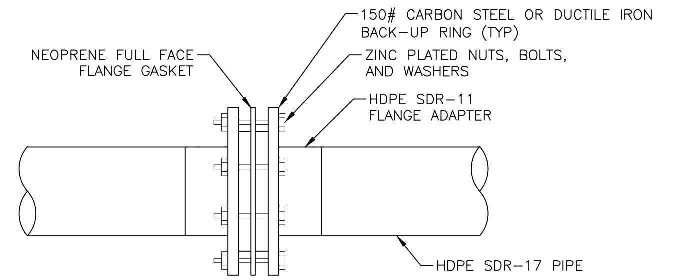


NOTE:

5 MIL PLASTIC SHALL BE TAPED AROUND ALL BURIED FLANGE CONNECTIONS.

BLIND FLANGE

DETAIL 1 / DS1
SCALE: NOT TO SCALE

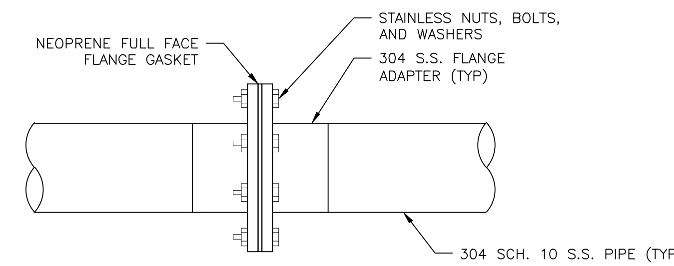


NOTES:

1. 5 MIL PLASTIC SHALL BE TAPED AROUND ALL BURIED FLANGE CONNECTIONS.
2. IF VALVE IS LOCATED BETWEEN FLANGES SHALL INCLUDE APPROPRIATE SPACERS.
3. VALVE IS ASAHI TYPE 57 BUTTERFLY VALVE (2"-14"). GEAR OPERATED, PVC BODY PPDISK, NITRILE OR VITON SEATS AND SEALS.
4. VALVE INCLUDES HDPE FLANGE ADAPTER AND DUCTILE IRON BACKUP RING WITH GALVANIZED OR ZINC PLATED NUTS, BOLTS AND WASHERS. THE VALVE WILL REQUIRE HDPE VALVE SPACERS OR ROUTERED FLANGE ADAPTER TO ALLOW VALVE TO FULLY OPEN.

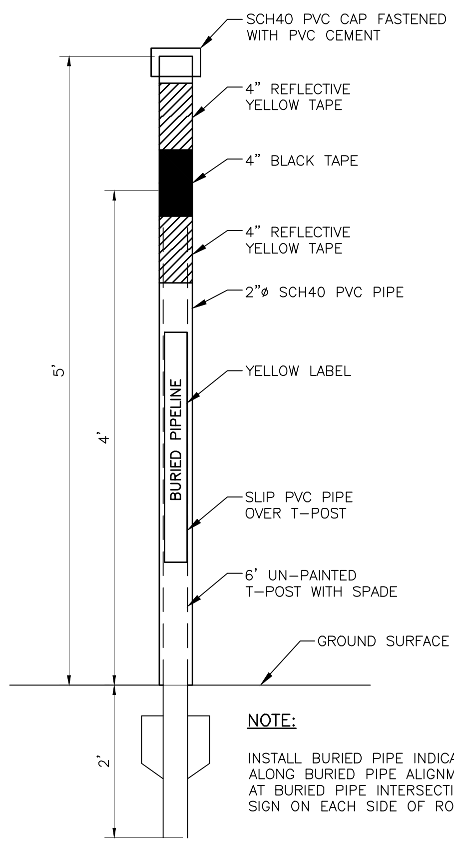
HDPE FLANGE CONNECTION

DETAIL 2 / DS1
SCALE: NOT TO SCALE



304 STAINLESS STEEL FLANGE ASSEMBLY AT LEACHATE STORAGE TANK

DETAIL 3 / DS1
SCALE: NOT TO SCALE

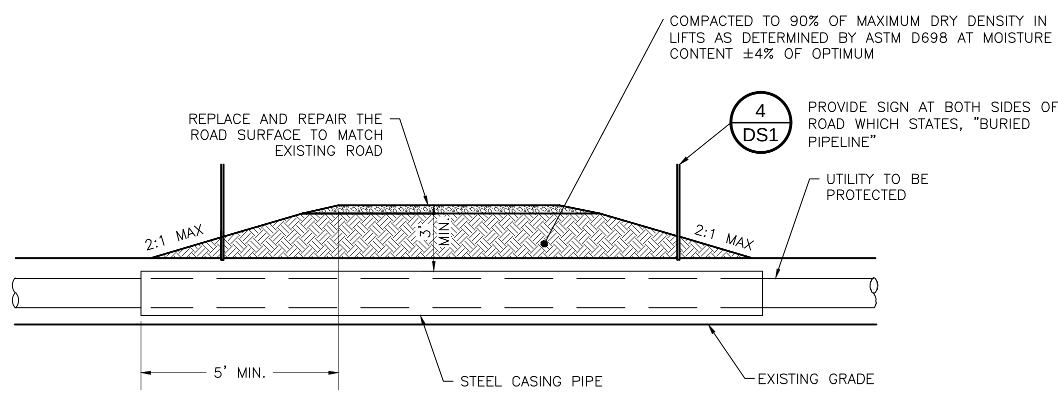


NOTE:

INSTALL BURIED PIPE INDICATOR EVERY 20' ALONG BURIED PIPE ALIGNMENT, AS WELL AS AT BURIED PIPE INTERSECTIONS, INSTALL ONE SIGN ON EACH SIDE OF ROAD CROSSINGS.

BURIED PIPE INDICATOR

DETAIL 4 / DS1
SCALE: NOT TO SCALE



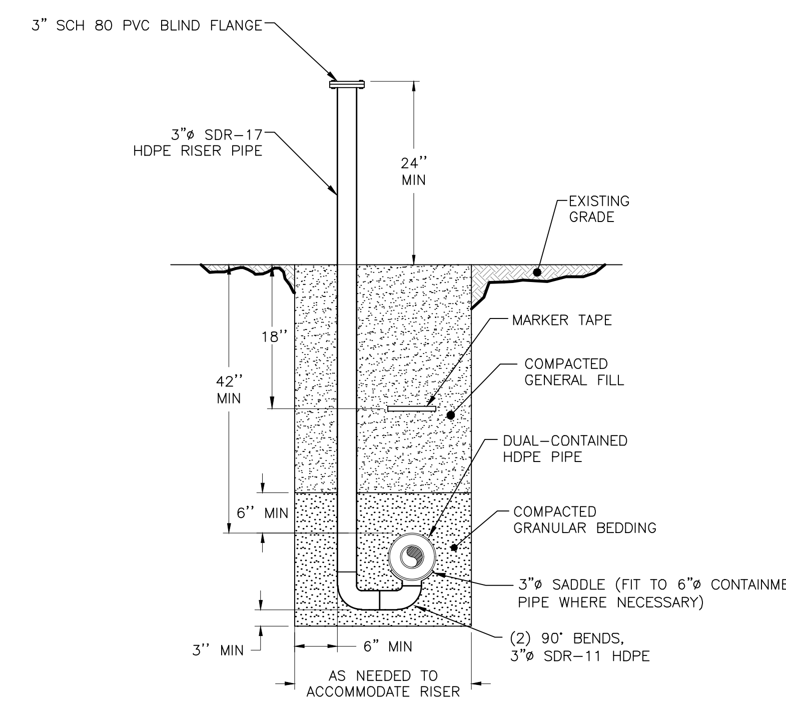
PIPE SCHEDULE	
8" LFG PIPE	24"ø D.I. CLASS 55 PIPE
2" WATER SUPPLY	6" 16 GA CMP MIN.
POWER FEED CABLE	6" 16 GA CMP MIN.
LIGHTING & COMMUNICATIONS CONDUITS	1" PVC MIN. SEE SHEET E-201
6" CONDENSATE FORCEMAIN	12" 16 GA CMP MIN.
POWER SUPPLY CABLE	4" 16 GA CMP MIN.

NOTES:

1. CONTRACTOR TO LAY OUT THE PIPE, CABLE AND CONDUIT TO CONFORM TO FIELD CONDITIONS, PROVIDED 18" MINIMUM COVER.
2. ROCKY FORD ROAD CROSSING CASINGS SHALL MEET NORTH CAROLINA DOT STANDARDS.

TYPICAL UTILITY ROAD CROSSING CASING

DETAIL 5 / DS1
SCALE: NOT TO SCALE



NOTE:

CONTRACTOR TO INSTALL WITNESS PIPE AT ALL LOW POINTS IN THE FORCEMAIN.

FORCEMAIN SECONDARY CONTAINMENT WITNESS PIPE

DETAIL 6 / DS1
SCALE: NOT TO SCALE

CONCEPTUAL PLAN

DOING BUSINESS AS :
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Tel. (877) 294-9070

MICHAEL S. MICHELS, P.E.
N.C.P.E. Lic. No. 040437 Date

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

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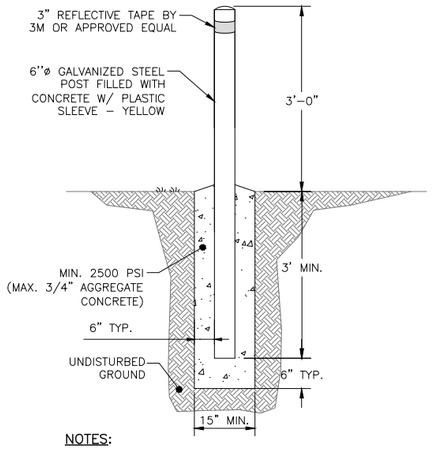
cornerstone PLLC

CATAWBA COUNTY
BLACKBURN LANDFILL
CATAWBA COUNTY, NORTH CAROLINA

LANDFILL GAS TO RENEWABLE NATURAL GAS
LANDFILL GAS DETAILS

SHEET NO. **DS1**
PROJECT NO. 180649

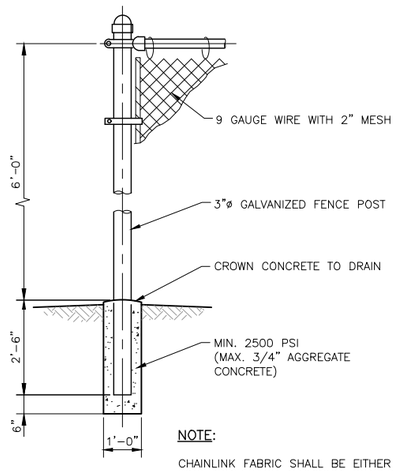


NOTES:

1. BOLLARD SPACING SHALL NOT EXCEED 5 FEET O.C.
2. BOLLARDS SHALL BE LOCATED GREATER THAN 3 FEET FROM THE OBJECT BEING PROTECTED.

BOLLARD

DETAIL 1 / DS2
SCALE: NOT TO SCALE



NOTE:

CHAINLINK FABRIC SHALL BE EITHER ZINC–COATED OR ALUMINUM–COATED STEEL WIRE FENCE FABRIC.

PERIMETER FENCE

DETAIL 2 / DS2
SCALE: NOT TO SCALE

CONCEPTUAL PLAN

DOING BUSINESS AS :
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MICHAEL S. MICHELS, P.E.
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cornerstone PLLC

CATAWBA COUNTY
BLACKBURN LANDFILL
CATAWBA COUNTY, NORTH CAROLINA

LANDFILL GAS TO RENEWABLE NATURAL GAS
CIVIL DETAILS

SHEET NO.
DS2
PROJECT NO.
180649

EXISTING BLOWER/FLARE SKID

FLARE

~40" W.C.
1400-1700 SCFM
53% CH4

SUCTION BLOWER

10" SCH. 10 304 S.S.

5"-10" W.C.
120° F MAX.

MANUAL VALVE

COUNTY GAS CHROMOGRAPH

G
C

EXISTING LEACHATE STORAGE TANKS

2- 1/4" S.S. SAMPLE LINES

DUAL CONTAINED FORCE MAIN

ROCKY FORD ROAD

BIOGAS CONDITIONING SYSTEM

OPTION 1 - MEMBRANE SYSTEM + PSA SYSTEM

H2S REMOVAL → BLOWER → VOC/SILOXANE REMOVAL → COMPRESSOR # 1 / COMPRESSOR # 2 → MEMBRANE CO2 REMOVAL → PSA NITROGEN REMOVAL

MEDIA DISPOSAL IN LANDFILL

TAIL GAS

TAIL GAS

THERMAL OXIDIZER

SUPPLEMENTAL NATURAL GAS

COMPRESSOR # 3

NG TUBE-TRAILER

STORAGE VESSEL

OPTION 2 - PSA SYSTEM

H2S REMOVAL → BLOWER → VOC/SILOXANE REMOVAL → CO2, N2&O2 REMOVAL (PSA SYSTEM)

MEDIA DISPOSAL IN LANDFILL

TAIL GAS

TAIL GAS

THERMAL OXIDIZER

SUPPLEMENTAL NATURAL GAS

LEGEND

- BLACKBURN LANDFILL/COUNTY OWNED
- QUADROGEN LFG TREATMENT SYSTEM
- FCE FUEL CELL SYSTEM
- SYSTEM/SKID BORDER
- LFG GAS (UNTREATED)
- LFG GAS (IN TREATMENT)
- LFG GAS (TREATED)
- CONDENSATE PIPE (DUAL CONTAINED)

CONCEPTUAL PLAN

DOING BUSINESS AS :
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Middletown, New York 10941
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MICHAEL S. MICHELS, P.E.

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cornerstone PLLC

CATAWBA COUNTY
BLACKBURN LANDFILL
CATAWBA COUNTY, NORTH CAROLINA

LANDFILL GAS TO RENEWABLE NATURAL GAS
PROCESS DIAGRAM

SHEET NO. **P1**

PROJECT NO. 180649

File: X:\PROJECTS\CATAWBA COUNTY\180684 - FEASIBILITY STUDY_Project Drawings\180684-S-P1_PROCESS DIAGRAM-Rev1.dwg Layout: SHEET P1 User: tarlos.chijnov Jun 06, 2019 - 1:51pm

ATTACHMENT A

PROFORMA SUMMARY

cornerstone PLLC

Catawba County Landfill - Renewable Natural Gas Facility

Prepared for Catawba County

	Scenario 1	Scenario 2
	Membrane + ARI N2 & O2 Removal	ARI CO2, N2 & O2 Removal
PROFORMA RESULTS (20 years)		
Net Present Value (NPV)	$4,532,065	$3,295,306
Payback (years)	4.5	5.5
Internal Rate of Return (IRR)	13.6%	10.4%
FUEL PRODUCTION (Year 2021)		
Anticipated RNG Production		
MMBtu/Day	720	720
MMBtu/year	262,800	262,800
CAPITAL EXPENSE (Year 2020)		
DESCRIPTION	**COST**	**COST**
LFG Conditioning System		
H2S Removal	$130,000	$130,000
VOC Siloxane Removal	$395,000	$395,000
Feed Compression into trailer to 4000 psig	$800,000	$800,000
ARI NRU system for O2 and N2 Removal	$2,900,000	$6,003,000
Air Liqude for CO2 Removal	$1,800,000	$0
LFG Low Pressure Storage Vessel	$113,000	$113,000
Gas Analyzer	$200,000	$200,000
Thermal Oxidizer	$215,000	$215,000
Natural Gas Pipeline	$500,000	$500,000
Building	$1,000,000	$1,000,000
Trailer Offload/Pipeline Inection Station		
Interconnecting Piping Allowance	$100,000	$100,000
Trailer Offload Posts	$60,000	$60,000
Trailers	$1,100,000	$1,100,000
Trailer Decanter	$130,000	$130,000
Allowance for Flow/BTU Monitoring	$100,000	$100,000
Other Costs		
Engineering/Permitting/Startup (10% CapEx)	$954,300	$1,084,600
Construction (30% CapEx)	$4,771,500	$5,423,000
Contingency (10% CapEx)	$954,300	$1,084,600
Contractors Overhead and Profit	$1,145,160	$1,301,520
Total Capital Cost	**$17,368,260**	**$19,739,720**

ANNUAL OPERATING EXPENSES (Year 2021)		
DESCRIPTION	**COST**	**COST**
Electricity ($/year)	$942,089	$919,935
Natural Gas ($/year)	$250,448	$250,448
Media ($/year)	$40,000	$40,000
Parts & Labor ($/year)	$331,060	$331,060
RIN/LCFS Broker Fee ($/year)	$865,324	$865,324
Operating Expenses		
$/year	**$2,428,922**	**$2,406,768**
$/MMBTU (not including RIN Broker Fees)	**$12.29**	**$12.19**

ATTACHMENT B

SCENARIO 1 PROFORMA

Scenario 1 - Biogas to RNG - (Membrane + ARI N2 & O2 Removal)

cornerstone PLLC

Annual Inflation Rate	2%
Depreciation Rate	0%
Fuel Price Increase	2%
Income Tax Rate	0.0%
NPV	**$ 4,532,065**
IRR	**13.6%**

Assumptions Methane % 50%

Payback (yrs) 4.5

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inputs	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Landfill Gas																					
Total Collected Landfill Gas (scfm)	1,000	1,000	1,050	1,100	1,150	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Total Collected Digester Gas (scfm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quantity Available for End Use (scfm)	1,000	1,000	1,050	1,100	1,150	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Quantity Processed (scfm)	1,000	1,000	1,050	1,100	1,150	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Quantity Processed (MMBTU)	262,800	262,800	275,940	289,080	302,220	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360
RNG Available for Sale (MMBTU)	237,177	236,114	247,920	259,726	271,532	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337
Equipment																					
Equipment Availability (%)	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Equipment Methane Efficiency (%)	95.0%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%
Operating Cost																					
Electricity ($/year)		$ 942,089	$ 960,931	$ 980,150	$ 999,753	$ 1,019,748	$ 1,040,143	$ 1,060,946	$ 1,082,165	$ 1,103,808	$ 1,125,884	$ 1,148,402	$ 1,171,370	$ 1,194,797	$ 1,218,693	$ 1,243,067	$ 1,267,928	$ 1,293,287	$ 1,319,153	$ 1,345,536	$ 1,372,446
Natural Gas ($/year)		$ 250,448	$ 255,457	$ 260,567	$ 265,778	$ 271,093	$ 276,515	$ 282,046	$ 287,686	$ 293,440	$ 299,309	$ 305,295	$ 311,401	$ 317,629	$ 323,982	$ 330,461	$ 337,071	$ 343,812	$ 350,688	$ 357,702	$ 364,856
Media ($/year)		$ 40,000	$ 40,800	$ 41,616	$ 42,448	$ 43,297	$ 44,163	$ 45,046	$ 45,947	$ 46,866	$ 47,804	$ 48,760	$ 49,735	$ 50,730	$ 51,744	$ 52,779	$ 53,835	$ 54,911	$ 56,010	$ 57,130	$ 58,272
Parts & Labor ($/year)		$ 331,060	$ 337,681	$ 344,435	$ 351,324	$ 358,350	$ 365,517	$ 372,827	$ 380,284	$ 387,890	$ 395,647	$ 403,560	$ 411,631	$ 419,864	$ 428,261	$ 436,827	$ 445,563	$ 454,474	$ 463,564	$ 472,835	$ 482,292
RIN/LCFS Broker Fee ($/year)		$ 865,324	$ 863,161	$ 859,051	$ 853,193	$ 845,774	$ 803,486	$ 763,311	$ 725,146	$ 688,888	$ 654,444	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
County Royalty Payments ($/year)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Satellite RNG Royalty Payments ($/year)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total O&M ($/year)		$ 2,428,922	$ 2,458,031	$ 2,485,818	$ 2,512,496	$ 2,538,263	$ 2,529,824	$ 2,524,177	$ 2,521,228	$ 2,520,893	$ 2,523,088	$ 1,906,017	$ 1,944,137	$ 1,983,020	$ 2,022,681	$ 2,063,134	$ 2,104,397	$ 2,146,485	$ 2,189,415	$ 2,233,203	$ 2,277,867
Evensol Unloading RNG ($/MMBTU)		$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00
Total O&M ($/MMBTU)		$ 12.29	$ 11.91	$ 11.57	$ 11.25	$ 10.96	$ 10.93	$ 10.91	$ 10.90	$ 10.90	$ 10.90	$ 8.73	$ 8.86	$ 9.00	$ 9.14	$ 9.28	$ 9.43	$ 9.58	$ 9.73	$ 9.88	$ 10.04
Revenue																					
Fuel Cost Offset ($/MMBTU)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Natural Gas (injected RNG) Sales ($/MMBTU)		$ 3.00	$ 3.06	$ 3.12	$ 3.18	$ 3.25	$ 3.31	$ 3.38	$ 3.45	$ 3.51	$ 3.59	$ 3.66	$ 3.73	$ 3.80	$ 3.88	$ 3.96	$ 4.04	$ 4.12	$ 4.20	$ 4.28	$ 4.37
RIN Sale ($/MMBTU)		$ 17.66	$ 16.78	$ 15.94	$ 15.14	$ 14.39	$ 13.67	$ 12.98	$ 12.33	$ 11.72	$ 11.13	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
LCFS Sale ($/MMBTU)		$ 6.77	$ 6.43	$ 6.11	$ 5.80	$ 5.51	$ 5.24	$ 4.98	$ 4.73	$ 4.49	$ 4.27	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Economic Analysis

RINs for First 10 Years

Annual O&M Cost	$ -	$ 2,901,151	$ 2,953,871	$ 3,005,270	$ 3,055,559	$ 3,104,938	$ 3,096,499	$ 3,090,851	$ 3,087,903	$ 3,087,567	$ 3,089,763	$ 2,472,692	$ 2,510,812	$ 2,549,695	$ 2,589,355	$ 2,629,809	$ 2,671,072	$ 2,713,159	$ 2,756,089	$ 2,799,877	$ 2,844,542
Depreciation Expense	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Investment TOTAL	**$ 17,368,260**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
LFG Conditioning System																					
H2S Removal	$ 130,000																				
VOC Siloxane Removal	$ 395,000																				
Compression into trailer to 4000 psig	$ 800,000																				
ARI system for O2 and N2 removal	$ 2,900,000																				
Air Liquide for CO2 removal	$ 1,800,000																				
LFG Low Pressure Storage Vessel	$ 113,000																				
Gas Analyzer Building	$ 200,000																				
Thermal Oxidizer	$ 215,000																				
Natural Gas Pipeline	$ 500,000																				
Building	$ 1,000,000																				
Trailer Offload/Pipeline Injection Station																					
Interconnecting Piping Allowance	$ 100,000																				
Trailer Offload Posts	$ 60,000																				
Trailers	$ 1,100,000																				
Trailer Decanter	$ 130,000																				
Allowance for Flow/BTU Monitoring	$ 100,000																				
Other Costs																					
Engineering/Permitting/Startup (10% CapEx)	$ 954,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Construction (50% CapEx)	$ 4,771,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contingency (10% CapEx)	$ 954,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contractors Overhead and Profit	$ 1,145,160	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Revenue	$ -	$ 6,477,171	$ 6,513,042	$ 6,537,660	$ 6,552,411	$ 6,558,576	$ 6,295,053	$ 6,045,994	$ 5,810,702	$ 5,588,514	$ 5,378,803	$ 1,036,160	$ 1,056,883	$ 1,078,021	$ 1,099,581	$ 1,121,573	$ 1,144,004	$ 1,166,884	$ 1,190,222	$ 1,214,026	$ 1,238,307
Fuel Cost Offset		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Natural Gas (injected RNG) Sale		$ 708,343	$ 758,636	$ 810,656	$ 864,455	$ 920,080	$ 938,482	$ 957,252	$ 976,397	$ 995,925	$ 1,015,843	$ 1,036,160	$ 1,056,883	$ 1,078,021	$ 1,099,581	$ 1,121,573	$ 1,144,004	$ 1,166,884	$ 1,190,222	$ 1,214,026	$ 1,238,307
RIN Sale		$ 4,170,333	$ 4,159,907	$ 4,140,098	$ 4,111,870	$ 4,076,115	$ 3,872,309	$ 3,678,694	$ 3,494,759	$ 3,320,021	$ 3,154,020	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
LCFS Sale	$ -	$ 1,598,495	$ 1,594,499	$ 1,586,906	$ 1,576,086	$ 1,562,381	$ 1,484,262	$ 1,410,049	$ 1,339,546	$ 1,272,569	$ 1,208,940	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Sale of existing gensets	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net Revenue and Income- Scenario 1	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Gross Revenue	-	6,477,171	6,513,042	6,537,660	6,552,411	6,558,576	6,295,053	6,045,994	5,810,702	5,588,514	5,378,803	1,036,160	1,056,883	1,078,021	1,099,581	1,121,573	1,144,004	1,166,884	1,190,222	1,214,026	1,238,307
Expenses	$0	($2,901,151)	($2,953,871)	($3,005,270)	($3,055,559)	($3,104,938)	($3,096,499)	($3,090,851)	($3,087,903)	($3,087,567)	($3,089,763)	($2,472,692)	($2,510,812)	($2,549,695)	($2,589,355)	($2,629,809)	($2,671,072)	($2,713,159)	($2,756,089)	($2,799,877)	($2,844,542)
Net Revenue	**$0**	**3,576,020**	**$3,559,171**	**$3,532,391**	**$3,496,851**	**$3,453,638**	**$3,198,554**	**$2,955,143**	**$2,722,799**	**$2,500,947**	**$2,289,041**	**($1,436,532)**	**($1,453,929)**	**($1,471,674)**	**($1,489,774)**	**($1,508,236)**	**($1,527,067)**	**($1,546,275)**	**($1,565,867)**	**($1,585,851)**	**($1,606,235)**
Depreciation	$0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Operating Income	$0	$3,576,020	$3,559,171	$3,532,391	$3,496,851	$3,453,638	$3,198,554	$2,955,143	$2,722,799	$2,500,947	$2,289,041	($1,436,532)	($1,453,929)	($1,471,674)	($1,489,774)	($1,508,236)	($1,527,067)	($1,546,275)	($1,565,867)	($1,585,851)	($1,606,235)
Interest & Other Exp.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$2	$3	$4	$5	$6	$7	$8	$9	$10
Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income	**$0**	**$3,576,020**	**$3,559,171**	**$3,532,391**	**$3,496,851**	**$3,453,638**	**$3,198,554**	**$2,955,143**	**$2,722,799**	**$2,500,947**	**$2,289,041**	**($1,436,531)**	**($1,453,927)**	**($1,471,671)**	**($1,489,770)**	**($1,508,231)**	**($1,527,061)**	**($1,546,268)**	**($1,565,859)**	**($1,585,842)**	**($1,606,225)**
Cash Analysis																					
Net Income	$0	$3,576,020	$3,559,171	$3,532,391	$3,496,851	$3,453,638	$3,198,554	$2,955,143	$2,722,799	$2,500,947	$2,289,041	($1,436,531)	($1,453,927)	($1,471,671)	($1,489,770)	($1,508,231)	($1,527,061)	($1,546,268)	($1,565,859)	($1,585,842)	($1,606,225)
Capital Expenditures	($17,368,260)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation	$0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Working Capital	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Principal & Interest	$17,368,260	($2,249,269)	($2,249,269)	($2,249,269)	($2,249,269)	($2,249,269)	($2,249,269)	($2,249,269)	($2,249,269)	($2,249,269)	($2,249,269)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value	$0																				
Net Cash Flow	**$0**	**$1,326,751**	**$1,309,901**	**$1,283,122**	**$1,247,582**	**$1,204,369**	**$949,285**	**$705,874**	**$473,530**	**$251,678**	**$39,771**	**($1,436,531)**	**($1,453,927)**	**($1,471,671)**	**($1,489,770)**	**($1,508,231)**	**($1,527,061)**	**($1,546,268)**	**($1,565,859)**	**($1,585,842)**	**($1,606,225)**
Discount Rate	15%																				
NPV	$4,532,065																				
Principal and Interest																					
Loan Amount	$17,368,260																				
Interest Rate	5%																				
Loan Term	10																				
Loan Starting Balance		$17,368,260	$15,987,404	$14,537,505	$13,015,111	$11,416,597	$9,738,158	$7,975,797	$6,125,318	$4,182,314	$2,142,161										
Principal Payment		$1,380,856	$1,449,899	$1,522,394	$1,598,514	$1,678,439	$1,762,361	$1,850,479	$1,943,003	$2,040,153	$2,142,161										
Load Ending Balance		$15,987,404	$14,537,505	$13,015,111	$11,416,597	$9,738,158	$7,975,797	$6,125,318	$4,182,314	$2,142,161	$0										
Interest		$868,413.00	$799,370.19	$726,875.25	$650,755.55	$570,829.87	$486,907.91	$398,789.85	$306,265.89	$209,115.72	$107,108.05										
P&I		$2,249,269	$2,249,269	$2,249,269	$2,249,269	$2,249,269	$2,249,269	$2,249,269	$2,249,269	$2,249,269	$2,249,269										
IRR of net income	($17,368,260)	$3,576,020	$3,559,171	$3,532,391	$3,496,851	$3,453,638	$3,198,554	$2,955,143	$2,722,799	$2,500,947	$2,289,041	($1,436,531)	($1,453,927)	($1,471,671)	($1,489,770)	($1,508,231)	($1,527,061)	($1,546,268)	($1,565,859)	($1,585,842)	($1,606,225)
(10 years)	13.58%																				

ATTACHMENT C

SCENARIO 2 PROFORMA

Scenario 2 - Biogas to RNG - (ARI CO2, N2 & O2 Removal)

cornerstone PLLC

Annual Inflation Rate	2%
Depreciation Rate	0%
Fuel Price Increase	2%
Income Tax Rate	0.0%
NPV	**$ 3,295,306**
IRR	**10.4%**

Assumptions Methane % 50%

Payback (yrs) 5.5

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Inputs																					
Landfill Gas																					
Total Collected Landfill Gas (scfm)	1,000	1,000	1,050	1,100	1,150	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Total Collected Digester Gas (scfm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quantity Available for End Use (scfm)	1,000	1,000	1,050	1,100	1,150	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Quantity Processed (scfm)	1,000	1,000	1,050	1,100	1,150	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Quantity Processed (MMBTU)	262,800	262,800	275,940	289,080	302,220	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360	315,360
RNG Available for Sale (MMBTU)	237,177	236,114	247,920	259,726	271,532	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337	283,337
Equipment																					
Equipment Availability (%)	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Equipment Methane Efficiency (%)	95.0%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%	94.6%
Operating Cost																					
Electricity ($/year)		$ 919,935	$ 938,334	$ 957,101	$ 976,243	$ 995,768	$ 1,015,683	$ 1,035,997	$ 1,056,717	$ 1,077,851	$ 1,099,408	$ 1,121,396	$ 1,143,824	$ 1,166,701	$ 1,190,035	$ 1,213,835	$ 1,238,112	$ 1,262,874	$ 1,288,132	$ 1,313,894	$ 1,340,172
Natural Gas ($/year)		$ 250,448	$ 255,457	$ 260,567	$ 265,778	$ 271,093	$ 276,515	$ 282,046	$ 287,686	$ 293,440	$ 299,309	$ 305,295	$ 311,401	$ 317,629	$ 323,982	$ 330,461	$ 337,071	$ 343,812	$ 350,688	$ 357,702	$ 364,856
Media ($/year)		$ 40,000	$ 40,800	$ 41,616	$ 42,448	$ 43,297	$ 44,163	$ 45,046	$ 45,947	$ 46,866	$ 47,804	$ 48,760	$ 49,735	$ 50,730	$ 51,744	$ 52,779	$ 53,835	$ 54,911	$ 56,010	$ 57,130	$ 58,272
Parts & Labor ($/year)		$ 331,060	$ 337,681	$ 344,435	$ 351,324	$ 358,350	$ 365,517	$ 372,827	$ 380,284	$ 387,890	$ 395,647	$ 403,560	$ 411,631	$ 419,864	$ 428,261	$ 436,827	$ 445,563	$ 454,474	$ 463,564	$ 472,835	$ 482,292
RIN/LCFS Broker Fee ($/year)		$ 865,324	$ 863,161	$ 859,051	$ 853,193	$ 845,774	$ 803,486	$ 763,311	$ 725,146	$ 688,888	$ 654,444	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
County Royalty Payments ($/year)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Satellite RNG Royalty Payments ($/year)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total O&M ($/year)		$ 2,406,768	$ 2,435,434	$ 2,462,769	$ 2,488,986	$ 2,514,283	$ 2,505,364	$ 2,499,227	$ 2,495,780	$ 2,494,936	$ 2,496,612	$ 1,879,011	$ 1,916,592	$ 1,954,923	$ 1,994,022	$ 2,033,902	$ 2,074,580	$ 2,116,072	$ 2,158,394	$ 2,201,561	$ 2,245,593
Evensol Unloading RNG ($/MMBTU)		$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00
Total O&M ($/MMBTU)		$ 12.19	$ 11.82	$ 11.48	$ 11.17	$ 10.87	$ 10.84	$ 10.82	$ 10.81	$ 10.81	$ 10.81	$ 8.63	$ 8.76	$ 8.90	$ 9.04	$ 9.18	$ 9.32	$ 9.47	$ 9.62	$ 9.77	$ 9.93
Revenue																					
Fuel Cost Offset ($/MMBTU)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Natural Gas (injected RNG) Sales ($/MMBTU)		$ 3.00	$ 3.06	$ 3.12	$ 3.18	$ 3.25	$ 3.31	$ 3.38	$ 3.45	$ 3.51	$ 3.59	$ 3.66	$ 3.73	$ 3.80	$ 3.88	$ 3.96	$ 4.04	$ 4.12	$ 4.20	$ 4.28	$ 4.37
RIN Sale ($/MMBTU)		$ 17.66	$ 16.78	$ 15.94	$ 15.14	$ 14.39	$ 13.67	$ 12.98	$ 12.33	$ 11.72	$ 11.13	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
LCFS Sale ($/MMBTU)		$ 6.77	$ 6.43	$ 6.11	$ 5.80	$ 5.51	$ 5.24	$ 4.98	$ 4.73	$ 4.49	$ 4.27	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Economic Analysis

RINs for First 10 Years

Annual O&M Cost	$ -	$ 2,878,997	$ 2,931,274	$ 2,982,221	$ 3,032,049	$ 3,080,957	$ 3,072,039	$ 3,065,902	$ 3,062,455	$ 3,061,610	$ 3,063,287	$ 2,445,686	$ 2,483,266	$ 2,521,598	$ 2,560,697	$ 2,600,577	$ 2,641,255	$ 2,682,747	$ 2,725,068	$ 2,768,236	$ 2,812,267
Depreciation Expense	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Investment TOTAL	**$ 19,739,720**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
LFG Conditioning System																					
H2S Removal	$ 130,000																				
VOC Siloxane Removal	$ 395,000																				
Compression into trailer to 4000 psig	$ 800,000																				
ARI system for CO2, O2 and N2 removal	$ 6,003,000																				
Air Liquide for CO2 removal																					
LFG Low Pressure Storage Vessel	$ 113,000																				
Gas Analyzer Building	$ 200,000																				
Thermal Oxidizer	$ 215,000																				
Natural Gas Pipeline	$ 500,000																				
Building	$ 1,000,000																				
Trailer Offload/Pipeline Injection Station																					
Interconnecting Piping Allowance	$ 100,000																				
Trailer Offload Posts	$ 60,000																				
Trailers	$ 1,100,000																				
Trailer Decanter	$ 130,000																				
Allowance for Flow/BTU Monitoring	$ 100,000																				
Other Costs																					
Engineering/Permitting/Startup (10% CapEx)	$ 1,084,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Construction (50% CapEx)	$ 5,423,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contingency (10% CapEx)	$ 1,084,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contractors Overhead and Profit	$ 1,301,520	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Revenue	$ -	$ 6,477,171	$ 6,513,042	$ 6,537,660	$ 6,552,411	$ 6,558,576	$ 6,295,053	$ 6,045,994	$ 5,810,702	$ 5,588,514	$ 5,378,803	$ 1,036,160	$ 1,056,883	$ 1,078,021	$ 1,099,581	$ 1,121,573	$ 1,144,004	$ 1,166,884	$ 1,190,222	$ 1,214,026	$ 1,238,307
Fuel Cost Offset		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Natural Gas (injected RNG) Sale		$ 708,343	$ 758,636	$ 810,656	$ 864,455	$ 920,080	$ 938,482	$ 957,252	$ 976,397	$ 995,925	$ 1,015,843	$ 1,036,160	$ 1,056,883	$ 1,078,021	$ 1,099,581	$ 1,121,573	$ 1,144,004	$ 1,166,884	$ 1,190,222	$ 1,214,026	$ 1,238,307
RIN Sale		$ 4,170,333	$ 4,159,907	$ 4,140,098	$ 4,111,870	$ 4,076,115	$ 3,872,309	$ 3,678,694	$ 3,494,759	$ 3,320,021	$ 3,154,020	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
LCFS Sale	$ -	$ 1,598,495	$ 1,594,499	$ 1,586,906	$ 1,576,086	$ 1,562,381	$ 1,484,262	$ 1,410,049	$ 1,339,546	$ 1,272,569	$ 1,208,940	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Sale of existing gensets	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net Revenue and Income- Scenario 2	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Gross Revenue	-	6,477,171	6,513,042	6,537,660	6,552,411	6,558,576	6,295,053	6,045,994	5,810,702	5,588,514	5,378,803	1,036,160	1,056,883	1,078,021	1,099,581	1,121,573	1,144,004	1,166,884	1,190,222	1,214,026	1,238,307
Expenses	$0	$ (2,878,997)	$ (2,931,274)	$ (2,982,221)	$ (3,032,049)	$ (3,080,957)	$ (3,072,039)	$ (3,065,902)	$ (3,062,455)	$ (3,061,610)	$ (3,063,287)	$ (2,445,686)	$ (2,483,266)	$ (2,521,598)	$ (2,560,697)	$ (2,600,577)	$ (2,641,255)	$ (2,682,747)	$ (2,725,068)	$ (2,768,236)	$ (2,812,267)
Net Revenue	**$0**	**3,598,174**	**$3,581,768**	**$3,555,440**	**$3,520,362**	**$3,477,619**	**$3,223,014**	**$2,980,092**	**$2,748,247**	**$2,526,904**	**$2,315,517**	**($1,409,526)**	**($1,426,383)**	**($1,443,577)**	**($1,461,115)**	**($1,479,004)**	**($1,497,251)**	**($1,515,862)**	**($1,534,846)**	**($1,554,210)**	**($1,573,960)**
Depreciation	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operating Income	$0	$3,598,174	$3,581,768	$3,555,440	$3,520,362	$3,477,619	$3,223,014	$2,980,092	$2,748,247	$2,526,904	$2,315,517	($1,409,526)	($1,426,383)	($1,443,577)	($1,461,115)	($1,479,004)	($1,497,251)	($1,515,862)	($1,534,846)	($1,554,210)	($1,573,960)
Interest & Other Exp.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$2	$3	$4	$5	$6	$7	$8	$9	$10
Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income	**$0**	**$3,598,174**	**$3,581,768**	**$3,555,440**	**$3,520,362**	**$3,477,619**	**$3,223,014**	**$2,980,092**	**$2,748,247**	**$2,526,904**	**$2,315,517**	**($1,409,525)**	**($1,426,381)**	**($1,443,574)**	**($1,461,111)**	**($1,478,999)**	**($1,497,245)**	**($1,515,855)**	**($1,534,838)**	**($1,554,201)**	**($1,573,950)**
Cash Analysis																					
Net Income	$0	$3,598,174	$3,581,768	$3,555,440	$3,520,362	$3,477,619	$3,223,014	$2,980,092	$2,748,247	$2,526,904	$2,315,517	($1,409,525)	($1,426,381)	($1,443,574)	($1,461,111)	($1,478,999)	($1,497,245)	($1,515,855)	($1,534,838)	($1,554,201)	($1,573,950)
Capital Expenditures	$ (19,739,720)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Depreciation	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Working Capital	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Principal & Interest	$ 19,739,720	($2,556,384)	($2,556,384)	($2,556,384)	($2,556,384)	($2,556,384)	($2,556,384)	($2,556,384)	($2,556,384)	($2,556,384)	($2,556,384)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value	$0																				
Net Cash Flow	**$0**	**$1,041,790**	**$1,025,384**	**$999,056**	**$963,977**	**$921,235**	**$666,630**	**$423,708**	**$191,863**	**($29,480)**	**($240,867)**	**($1,409,525)**	**($1,426,381)**	**($1,443,574)**	**($1,461,111)**	**($1,478,999)**	**($1,497,245)**	**($1,515,855)**	**($1,534,838)**	**($1,554,201)**	**($1,573,950)**
Discount Rate	15%																				
NPV	$3,295,306																				
Principal and Interest																					
Loan Amount	$ 19,739,720																				
Interest Rate	5%																				
Loan Term	10																				
Loan Starting Balance		$ 19,739,720	$ 18,170,322	$ 16,522,454	$ 14,792,193	$ 12,975,418	$ 11,067,805	$ 9,064,811	$ 6,961,668	$ 4,753,367	$ 2,434,651										
Principal Payment		$1,569,398	$1,647,868	$1,730,261	$1,816,774	$1,907,613	$2,002,994	$2,103,143	$2,208,301	$2,318,716	$2,434,651										
Load Ending Balance		$ 18,170,322	$ 16,522,454	$ 14,792,193	$ 12,975,418	$ 11,067,805	$ 9,064,811	$ 6,961,668	$ 4,753,367	$ 2,434,651	$ 0										
Interest		$ 986,986.00	$ 908,516.10	$ 826,122.70	$ 739,609.63	$ 648,770.91	$ 553,390.25	$ 453,240.57	$ 348,083.39	$ 237,668.36	$ 121,732.57										
P&I		$2,556,384	$2,556,384	$2,556,384	$2,556,384	$2,556,384	$2,556,384	$2,556,384	$2,556,384	$2,556,384	$2,556,384										
IRR of net income	$ (19,739,720)	$3,598,174	$3,581,768	$3,555,440	$3,520,362	$3,477,619	$3,223,014	$2,980,092	$2,748,247	$2,526,904	$2,315,517	($1,409,525)	($1,426,381)	($1,443,574)	($1,461,111)	($1,478,999)	($1,497,245)	($1,515,855)	($1,534,838)	($1,554,201)	($1,573,950)
(10 years)	10.4%																				

ATTACHMENT D

SENSITIVITY ANALYSIS

Option 1 (Air Liquide Membranes + PSA)

Gas Flow Scenarios			
Initial gas flow (scfm)	IRR	Net Present Value	Assumptions
700	1.3%	$ (1,292,091.83)	50 scfm increase per year plateau at 900
1,000	8.8%	$ 2,290,293.13	Consistent througout the years
1,000*	13.6%	$ 4,532,064.82	Current system with a 50 scfm increase per year plateau at 1,200
1,000	14.6%	$ 5,073,057.22	100 scfm increase per year plateau at 1,200
1,100	12.9%	$ 4,231,678.68	Consistent througout the years
1,100	15.6%	$ 5,623,060.73	50 scfm increase per year plateau at 1,200
1,200	16.7%	$ 6,173,064.23	1,200 throughout the years

*Base Case

RIN Incentives			
Intitial RIN Price	% annual change	IRR	Net Present Value
$ 1.36	10.0%	27.6%	$ 15,166,465.90
$ 1.36	5.0%	23.0%	$ 10,768,607.33
$ 1.36	0.0%	18.3%	$ 7,288,842.23
$ 1.36*	-5.0%	13.6%	$ 4,532,064.82
$ 1.36	-10.0%	8.7%	$ 2,342,660.15
$ 1.00	-5.0%	5.7%	$ 659,235.81
$ 0.85	-5.0%	2.0%	$ (954,442.94)
$ 2.00	-5.0%	25.7%	$ 11,417,094.17

*Base case

CAP EX		
Total Construction Cost	IRR	Net Present Value
$ 26,333,216.00	3.5%	$ (534,721.71)
$ 21,395,738.00	8.2%	$ 2,255,827.07
$ 18,926,999.00	11.3%	$ 3,651,101.46
17368260*	13.6%	$ 4,532,064.82
$ 15,635,347.00	16.5%	$ 5,511,467.31
$ 13,989,521.00	19.9%	$ 6,441,650.24
$ 11,520,782.00	26.5%	$ 7,836,924.63
$ 8,229,130.00	40.4%	$ 9,697,290.48

*Base case

LCFS Incentives			
Intitial LCFS Price	% annual change	IRR	Net Present Value
$ 6.77	20.0%	25.6%	$ 13,430,463.96
$ 6.77	5.0%	17.7%	$ 6,922,540.74
$ 6.77	0.0%	15.5%	$ 5,588,741.66
$ 6.77*	-5.0%	13.6%	$ 4,532,064.82
$ 6.77	-10.0%	11.9%	$ 3,692,862.79
$ 2.50	-5.0%	6.4%	$ 994,988.57
$ 0.65	-5.0%	3.0%	$ (537,468.35)
$ 8.00	-5.0%	15.5%	$ 5,550,941.59

*Base case

O&M		
Electricity cost per KWh	IRR	Net Present Value
$ 0.200	-0.3%	$ (1,510,719.00)
$ 0.150	6.4%	$ 1,100,682.82
$ 0.100	12.0%	$ 3,712,084.65
$ 0.0843*	13.6%	$ 4,532,064.82
$ 0.075	14.5%	$ 5,017,785.56
$ 0.050	16.9%	$ 6,323,486.47
$ 0.010	20.5%	$ 8,412,607.93
$ -	21.4%	$ 8,934,888.30

*Base case