JENNINGS EXHIBIT NO. 1
*****REDACTED VERSION*****

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

DOCKET NO. E-7, SUB 1229

In the Matter of Application of Duke Energy Carolinas, LLC for Approval of Renewable Energy and Energy Efficiency Portfolio Standard (REPS) Compliance Report and Cost Recovery Rider Pursuant to N.C. Gen. Stat. § 62-133.8 and Commission Rule R8-67	DUKE ENERGY CAROLINAS, LLC 2019 RENEWABLE ENERGY & ENERGY EFFICIENCY PORTFOLIO STANDARD COMPLIANCE REPORT

DUKE ENERGY CAROLINAS, LLC
RENEWABLE ENERGY AND ENERGY EFFICIENCY
PORTFOLIO STANDARD ("REPS")
COMPLIANCE REPORT

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(A) INTRODUCTION

Duke Energy Carolinas, LLC ("Duke Energy Carolinas," "DEC," or the "Company") submits its Renewable Energy and Energy Efficiency Portfolio Standard ("REPS") Compliance Report ("Compliance Report") in accordance with N.C. Gen. Stat. § 62-133.8 and Commission Rule R8-67(c). This Compliance Report provides the required information for 2019 calendar year reporting period.[1] As part of its REPS Compliance Plan, filed in Docket No. E-100, Sub 157, Duke Energy Carolinas plans to provide services to native load priority wholesale customers that contract with the Company for services to meet the REPS requirements, including delivery of renewable energy resources and compliance planning and reporting. These native load priority wholesale customers – including distribution cooperatives and municipalities – may rely on Duke Energy Carolinas to provide this renewable energy delivery service in accordance with N.C. Gen. Stat. § 62-133.8(c)(2)e.

This Compliance Report provides the required information in aggregate for the Company and the following wholesale customers for whom the Company provided renewable energy resources and compliance reporting services: Blue Ridge Electric Membership Corporation, Rutherford Electric Membership Corporation, Town of Dallas, Town of Forest City, and Town of Highlands ("Wholesale").

[1] Pursuant to NCUC Rule R8-67(c)(1), this Compliance Report reflects Duke Energy Carolinas' efforts to meet the REPS requirements for the previous calendar year.

(B) REPS COMPLIANCE REPORT

I. RENEWABLE ENERGY CERTIFICATES

The table below reflects the renewable energy certificates ("RECs") used to comply with N.C. Gen. Stat. § 62-133.8(d) for the year 2019.

[BEGIN CONFIDENTIAL]

[END CONFIDENTIAL]

II. ACTUAL 2019 TOTAL NORTH CAROLINA RETAIL SALES AND YEAR-END NUMBER OF ACCOUNTS, BY CUSTOMER CLASS

North Carolina Retail Sales (MWh)	2019
Duke Energy Carolinas	58,642,521
Wholesale	2,621,460
Total MWh Sales	**61,263,981**

2019 Year-end Number of REPS Accounts			
Account Type	Duke Energy Carolinas	Wholesale	Total
Residential	1,758,736	135,173	1,893,909
General	251,638	15,141	266,779
Industrial	4,762	189	4,951

III. AVOIDED COST RATES

The avoided cost rates below, applicable to energy received pursuant to power purchase agreements, represent the annualized avoided cost rates in Schedule PP or PP-N (NC), Distribution Interconnection, approved in the following avoided cost proceedings:

ANNUALIZED TOTAL CAPACITY AND ENERGY RATES (CENTS PER KWH)						
Docket No.:	**E-100 Sub 148 (Current)**	**E-100, Sub 140**	**E-100, Sub 136**	**E-100, Sub 127**	**E-100, Sub 117**	**E-100, Sub 106**
Year filed:	2016	2014	2012	2010	2008	2006
Variable Rate	3.26	4.32	4.98	5.48	6.4	5.4
5 Year	N/A	4.52	5.19	5.63	6.39	5.46
10 Year	3.86	5.15	5.52	6.28	6.42	5.51
15 Year	N/A	5.62	5.84	6.63	6.56	5.64

IV. ACTUAL TOTAL AND INCREMENTAL COSTS INCURRED IN 2019

REPS compliance costs incurred for calendar year 2019 comprise the cost of energy purchases and the cost of purchases of various types of RECs, the cost of solar distributed generation at Duke Energy Carolinas-owned facilities, and other reasonable and prudent costs incurred to meet the requirements of the REPS statute. In addition, annual Solar Rebate Program costs incurred pursuant to N.C. Gen. Stat. § 62-155 are recovered in the REPS rider as directed in N.C. Gen. Stat. § 62-133.8(h)(1)d.

Actual Costs Incurred	Energy and REC Costs	Other	Total Costs
REPS compliance - avoided cost	$ 79,364,959	$ 0	$ 79,364,959
REPS compliance – incremental cost	$ 29,508,739	$ 2,229,681	$ 31,738,420 (a)
REPS compliance - total cost	**$ 108,873,698**	**$ 2,229,681**	**$ 111,103,379**
Solar Rebate Program cost	$ 0	$ 886,014	$ 886,014 (b)
Incremental REPS compliance costs and Solar Rebate Program costs for REPS rider recovery		(a) + (b) above	**$ 32,624,434**

V. ACTUAL INCREMENTAL COSTS COMPARISON TO THE ANNUAL COST CAP AS OF THE PREVIOUS CALENDAR YEAR

Account Type	Total 2018 Year-end number of Retail Accounts[(1)]	Annual Per-Account Cost Cap	Total Annual Cost Cap
Residential	1,866,080	$27	$ 50,384,167
General	262,147	$150	$ 39,322,037
Industrial	4,957	$1000	$ 4,957,270
Total annual REPS Compliance cost cap - 2019			**$ 94,663,474**
Incremental REPS Compliance costs incurred - 2019			(a) **$ 31,738,420**

(1) Includes number of retail accounts for Duke Energy Carolinas and its Wholesale REPS customers.

VI. STATUS OF COMPLIANCE WITH REPS REQUIREMENTS

Pursuant to N.C. Gen. Stat. § 62-133.8(b) for Duke Energy Carolinas retail and N.C. Gen. Stat. § 62-133.8(c) for the Company's Wholesale REPS customers, the REPS requirement for calendar year 2019 is set at 10% of 2018 North Carolina ("NC") retail sales. To comply with the combined REPS obligation for Duke Energy Carolinas Retail and its Wholesale REPS customers, the Company submitted 6,170,047 RECs for retirement, including 23,822 Senate Bill 886 ("SB886") RECs, each of which counts for two poultry waste and one general requirement REC. Accordingly, the Company submitted for retirement the equivalent of 6,217,691 RECs, representing 10% of combined 2018 retail megawatt-hour sales of 62,176,891. Details of the composition of RECs retired to meet the total REPS compliance requirement are contained in Section I. of this report.

Pursuant to N.C. Gen. Stat. § 62-133.8(d), for calendar year 2019, at least 0.20% of total NC retail sales (measured according to prior calendar year NC retail sales) shall be supplied by a combination of new solar electric facilities and new metered solar thermal energy facilities. As a result, 124,357 solar RECs were submitted for retirement to meet the solar set-aside requirement. 1,018,480 additional solar RECs were submitted for retirement toward compliance with the general requirement (the total REPS requirement net of the solar, poultry, and swine set-aside obligations).

In its December 16, 2019 *Order Modifying the Swine and Poultry Waste Set-Aside Requirements and Providing Other Relief* and its February 13, 2020 *Errata Order* ("2019 Delay Orders") issued in Docket No. E-100, Sub 113, the Commission modified the swine waste set-aside requirement for 2019 to 0.04% of total NC retail sales, and specified that the requirement applies to electric public utilities only, not to electric membership cooperatives or municipalities (which were excused from the swine waste set-aside requirement for 2019). To comply with the swine waste set-aside requirement applicable to DEC's NC retail sales, the Company submitted for retirement 23,793 swine RECs.

The 2019 Delay Orders also reduced the 2019 poultry waste set-aside requirement to 500,000 MWh state-wide, and set the 2020 and 2021 levels at 700,000 MWh and 900,000 MWh, respectively. In its December 16, 2019 *Order Establishing 2019, 2020, and 2021 Poultry Waste Set-Aside Requirement Allocation* issued in Docket No. E-100, Sub 113, the Commission directed the annual aggregate poultry waste set-aside requirement to be allocated among electric power suppliers and utility compliance aggregators according to the load ratio share calculations shown on Appendix A to the order. These percentages were applied to the modified 2019 state-wide requirement to determine the swine waste set-aside requirements applicable to DEC NC retail customers and to the

Company's Wholesale customers for the 2019 reporting year. The Company submitted for retirement 176,285 poultry waste RECs along with 23,822 SB 886 RECs, which count as 47,644 poultry waste set-aside RECs. Accordingly, the Company submitted the equivalent of 223,929 poultry RECs for compliance, and met its 2019 poultry waste set-aside requirement.

VII. IDENTIFICATION OF RECs CARRIED FORWARD

The table below reflects all RECs generated through year-end 2019, excluding those RECs that have already been retired to meet compliance, that the Company has banked for use in compliance in future years.

[BEGIN CONFIDENTIAL]

[END CONFIDENTIAL]

VIII. DATES AND AMOUNTS OF ALL PAYMENTS MADE FOR RENEWABLE ENERGY CERTIFICATES

Confidential Appendix 1 provides the dates and amounts of payments made for RECs for calendar year 2019.

(C) METHODOLOGY FOR DETERMINING NUMBER OF CUSTOMERS AND CUSTOMER CAP

In its *Order Approving REPS Riders*, issued in Docket No. E-7, Sub 872 (December 15, 2009), the Commission approved the following method of determining number of customer accounts as proposed by Duke Energy Carolinas. For purposes of defining which accounts will be assessed a REPS charge, and determining account totals by class that will be included in calculating its annual cap on costs incurred to comply with REPS requirements, the Company implemented the method described below. The Company defines "account" as an "agreement," or "tariff rate," between Duke Energy Carolinas and a customer to determine the monthly REPS charge for each account, and to compare the charges per account for a twelve-month period to the applicable annual per-account cost cap established in N.C. Gen. Stat. § 62-133.8(h)(4). The same definition applies when compiling account totals by class, to which the annual per-account caps are applied to determine the overall cap for total annual compliance costs incurred established in N.C. Gen. Stat. § 62-133.8(h)(3). There is a limited number of exceptions to this definition of account. The following service schedules should not be considered accounts for purposes of the per-account charge because of the near certainty that customers served under these schedules already will pay a per-account charge under another residential, general service or industrial service agreement and because they represent small auxiliary service loads. The following agreements fall within this exception[2]:

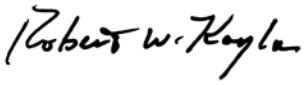
- Outdoor Lighting Service (Schedule OL)
- Floodlighting Service (Schedule FL and FL-N)
- Street and Public Lighting Service (Schedule PL)
- Yard Lighting (Schedule YL)
- Governmental Lighting (Schedule GL)
- Nonstandard Lighting (Schedule NL)
- Off-Peak Water Heating (Schedule WC is a sub-metered service)
- Non-demand metered, nonresidential service, provided on Schedule SGS, at the same premises, with the same service address, and with the same

[2] Lighting service schedules have been updated to reflect the addition of new schedules Governmental Lighting service (Schedule GL) and Nonstandard Lighting service (Schedule NL) and the cancellation of Street Lighting service (Schedule SL) as approved by the Commission on December 7, 2009 in Docket No. E-7, Sub 909, *Order Granting General Rate Increase and Approving Amended Stipulation*.

account name as an agreement for which a monthly REPS charge has been applied.

Within the Wholesale customer group, Blue Ridge Electric Membership Corporation, Rutherford Electric Membership Corporation, and Town of Forest City have proposed a methodology for determining Wholesale year-end number of accounts that is generally consistent with that proposed by Duke Energy Carolinas. The Town of Highlands and Town of Dallas propose to define an account in the manner the information is reported to the Energy Information Administration for annual electric sales and revenue reporting.

Respectfully submitted this 25th day of February, 2020.



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Dates and Amounts of Payments for RECs - Calendar Year 2019

Counterparty and Payment Dates (BEGIN CONFIDENTIAL)		**REC Cost**
[redacted]		
Apr-2019	$	1,380
Aug-2019	$	1,700
Dec-2019	$	1,084
Feb-2019	$	1,080
Jan-2019	$	744
Jul-2019	$	1,604
Jun-2019	$	1,692
Mar-2019	$	872
May-2019	$	1,504
Nov-2019	$	1,200
Oct-2019	$	1,560
Sep-2019	$	1,504
[redacted]		
Apr-2019	$	1,984
Aug-2019	$	2,492
Dec-2019	$	1,676
Feb-2019	$	1,592
Jan-2019	$	1,012
Jul-2019	$	2,356
Jun-2019	$	2,476
Mar-2019	$	1,284
May-2019	$	2,208
Nov-2019	$	1,704
Oct-2019	$	2,340
Sep-2019	$	2,272
[redacted]		
Apr-2019	$	4,055
Aug-2019	$	4,885
Dec-2019	$	3,060
Feb-2019	$	2,935
Jan-2019	$	1,800
Jul-2019	$	4,645
Jun-2019	$	4,900
Mar-2019	$	2,500
May-2019	$	4,380
Nov-2019	$	3,360
Oct-2019	$	4,605
Sep-2019	$	4,530
[redacted]		
Apr-2019	$	4,225
Aug-2019	$	4,995
Dec-2019	$	3,310
Feb-2019	$	3,265
Jan-2019	$	2,125
Jul-2019	$	4,815
Jun-2019	$	5,155
Mar-2019	$	2,660
May-2019	$	4,465
Nov-2019	$	3,545
Oct-2019	$	4,765
Sep-2019	$	4,730
[redacted]		
Apr-2019	$	2,484
Aug-2019	$	2,052
Dec-2019	$	1,600
Feb-2019	$	2,008
Jan-2019	$	2,156
Jul-2019	$	2,520
Jun-2019	$	2,716
Mar-2019	$	2,000
May-2019	$	2,420
Nov-2019	$	676

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Counterparty and Payment Dates		REC Cost
Oct-2019	$	432
Sep-2019	$	1,704
[redacted]		
Apr-2019	$	6,176
Feb-2019	$	3,676
Jan-2019	$	4,336
Jul-2019	$	672
Mar-2019	$	12,452
May-2019	$	1,180
Sep-2019	$	2,016
[redacted]		
Apr-2019	$	1,900
Aug-2019	$	2,225
Dec-2019	$	1,585
Feb-2019	$	1,458
Jan-2019	$	1,055
Jul-2019	$	2,133
Jun-2019	$	2,358
Mar-2019	$	1,130
May-2019	$	2,048
Nov-2019	$	1,663
Oct-2019	$	2,190
Sep-2019	$	2,128
[redacted]		
Apr-2019	$	1,740
Aug-2019	$	2,144
Dec-2019	$	1,304
Feb-2019	$	1,284
Jan-2019	$	824
Jul-2019	$	2,024
Jun-2019	$	2,132
Mar-2019	$	1,080
May-2019	$	1,952
Nov-2019	$	1,452
Oct-2019	$	1,964
Sep-2019	$	2,012
[redacted]		
Apr-2019	$	2,772
Aug-2019	$	1,856
Dec-2019	$	1,528
Feb-2019	$	2,520
Jan-2019	$	2,216
Jul-2019	$	2,160
Jun-2019	$	2,432
Mar-2019	$	2,320
May-2019	$	2,740
Nov-2019	$	944
Oct-2019	$	620
Sep-2019	$	1,192
[redacted]		
Apr-2019	$	-
Aug-2019	$	-
Dec-2019	$	-
Feb-2019	$	-
Jan-2019	$	-
Jul-2019	$	-
Jun-2019	$	-
Mar-2019	$	-
May-2019	$	-
Nov-2019	$	-
Oct-2019	$	-
Sep-2019	$	-
[redacted]		
Apr-2019	$	2,876

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Counterparty and Payment Dates		**REC Cost**
Aug-2019	$	3,384
Dec-2019	$	1,980
Feb-2019	$	1,944
Jan-2019	$	1,356
Jul-2019	$	3,152
Jun-2019	$	2,940
Mar-2019	$	1,764
May-2019	$	2,920
Nov-2019	$	2,312
Oct-2019	$	2,916
Sep-2019	$	3,044
[redacted]		
Apr-2019	$	2,476
Aug-2019	$	2,916
Dec-2019	$	1,856
Feb-2019	$	1,856
Jan-2019	$	1,296
Jul-2019	$	2,728
Jun-2019	$	3,040
Mar-2019	$	1,472
May-2019	$	2,700
Nov-2019	$	1,948
Oct-2019	$	2,772
Sep-2019	$	2,508
[redacted]		
Apr-2019	$	1,578
Aug-2019	$	1,805
Dec-2019	$	1,288
Feb-2019	$	1,233
Jan-2019	$	893
Jul-2019	$	1,748
Jun-2019	$	1,933
Mar-2019	$	1,010
May-2019	$	1,675
Nov-2019	$	1,303
Oct-2019	$	1,740
Sep-2019	$	1,725
[redacted]		
Apr-2019	$	4,105
Aug-2019	$	4,690
Dec-2019	$	2,955
Feb-2019	$	3,025
Jan-2019	$	1,985
Jul-2019	$	4,480
Jun-2019	$	4,995
Mar-2019	$	2,535
May-2019	$	4,140
Nov-2019	$	3,400
Oct-2019	$	4,350
Sep-2019	$	4,260
[redacted]		
Apr-2019	$	2,210
Aug-2019	$	2,600
Dec-2019	$	1,070
Feb-2019	$	1,175
Jan-2019	$	870
Jul-2019	$	2,330
Jun-2019	$	2,605
Mar-2019	$	1,265
May-2019	$	2,205
Nov-2019	$	1,675
Oct-2019	$	2,080
Sep-2019	$	2,175
[redacted]		

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Apr-2019	$	2,340
Aug-2019	$	2,600
Dec-2019	$	1,628
Feb-2019	$	1,548
Jan-2019	$	1,116
Jul-2019	$	2,552
Jun-2019	$	2,728
Mar-2019	$	1,364
May-2019	$	2,316
Nov-2019	$	1,800
Oct-2019	$	2,388
Sep-2019	$	2,300
[redacted]		
Apr-2019	$	61,128
Aug-2019	$	75,500
Dec-2019	$	144,540
Feb-2019	$	75,228
Jan-2019	$	66,096
Jul-2019	$	69,808
Jun-2019	$	132,732
Mar-2019	$	71,240
May-2019	$	64,392
Oct-2019	$	56,280
Sep-2019	$	70,944
[redacted]		
Apr-2019	$	2,544
Aug-2019	$	2,944
Dec-2019	$	1,936
Feb-2019	$	1,744
Jan-2019	$	1,216
Jul-2019	$	2,924
Jun-2019	$	3,100
Mar-2019	$	1,524
May-2019	$	2,692
Nov-2019	$	2,120
Oct-2019	$	2,732
Sep-2019	$	2,888
[redacted]		
Dec-2019	$	32,500
[redacted]		
Apr-2019	$	691
Aug-2019	$	17,569
Dec-2019	$	980
Feb-2019	$	1,275
Jan-2019	$	861
Jul-2019	$	15,057
Jun-2019	$	1,034
Mar-2019	$	1,490
May-2019	$	987
Nov-2019	$	1,264
Oct-2019	$	14,959
Sep-2019	$	16,097
[redacted]		
Apr-2019	$	3,224
Aug-2019	$	3,788
Dec-2019	$	2,504
Feb-2019	$	2,484
Jan-2019	$	1,684
Jul-2019	$	3,584
Jun-2019	$	3,752
Mar-2019	$	1,956
May-2019	$	3,472
Nov-2019	$	2,648
Oct-2019	$	3,480

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Sep-2019	$	3,440
[redacted]		
Apr-2019	$	3,340
Aug-2019	$	2,332
Dec-2019	$	1,528
Feb-2019	$	2,580
Jan-2019	$	644
Jul-2019	$	2,824
Jun-2019	$	5,388
Mar-2019	$	2,712
May-2019	$	4,300
Nov-2019	$	1,128
Oct-2019	$	624
Sep-2019	$	580
[redacted]		
Aug-2019	$	115,700
Jul-2019	$	69,382
Jun-2019	$	62,444
May-2019	$	16,220
Nov-2019	$	120,950
Oct-2019	$	113,356
Sep-2019	$	115,137
[redacted]		
Apr-2019	$	544
Aug-2019	$	996
Dec-2019	$	448
Feb-2019	$	388
Jan-2019	$	296
Jul-2019	$	776
Jun-2019	$	832
Mar-2019	$	360
May-2019	$	696
Nov-2019	$	464
Oct-2019	$	588
Sep-2019	$	840
[redacted]		
Apr-2019	$	2,980
Aug-2019	$	3,680
Dec-2019	$	2,112
Feb-2019	$	1,932
Jan-2019	$	1,228
Jul-2019	$	3,696
Jun-2019	$	4,036
Mar-2019	$	1,744
May-2019	$	3,300
Nov-2019	$	2,404
Oct-2019	$	3,328
Sep-2019	$	3,364
[redacted]		
Apr-2019	$	10,361
Aug-2019	$	9,787
Dec-2019	$	9,257
Feb-2019	$	10,719
Jan-2019	$	9,626
Jul-2019	$	9,572
Jun-2019	$	10,060
Mar-2019	$	9,443
May-2019	$	9,701
Nov-2019	$	9,701
Oct-2019	$	9,315
Sep-2019	$	9,558
[redacted]		
Apr-2019	$	69,230
Aug-2019	$	66,977

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Dec-2019	$	62,405
Feb-2019	$	72,025
Jan-2019	$	63,935
Jul-2019	$	65,010
Jun-2019	$	66,132
Mar-2019	$	58,181
May-2019	$	69,151
Nov-2019	$	64,694
Oct-2019	$	64,534
Sep-2019	$	69,166
[redacted]		
Mar-2019	$	8,431
[redacted]		
Dec-2019	$	7,939
[redacted]		
Apr-2019	$	1,296
Aug-2019	$	1,496
Dec-2019	$	964
Feb-2019	$	952
Jan-2019	$	644
Jul-2019	$	1,376
Jun-2019	$	1,476
Mar-2019	$	796
May-2019	$	1,312
Nov-2019	$	1,080
Oct-2019	$	1,416
Sep-2019	$	1,368
[redacted]		
Apr-2019	$	167,476
Aug-2019	$	74,160
Feb-2019	$	164,316
Jul-2019	$	85,980
Jun-2019	$	102,680
May-2019	$	59,228
Nov-2019	$	66,384
Oct-2019	$	69,932
Sep-2019	$	106,196
[redacted]		
Apr-2019	$	4,070
Aug-2019	$	2,690
Dec-2019	$	2,960
Feb-2019	$	2,900
Jan-2019	$	1,950
Jul-2019	$	2,950
Jun-2019	$	4,055
Mar-2019	$	2,485
May-2019	$	4,110
Nov-2019	$	3,230
Oct-2019	$	4,175
Sep-2019	$	3,660
[redacted]		
Apr-2019	$	21,449
Aug-2019	$	21,084
Dec-2019	$	20,864
Feb-2019	$	21,321
Jan-2019	$	18,014
Jul-2019	$	20,590
Jun-2019	$	21,120
Mar-2019	$	19,384
May-2019	$	20,499
Nov-2019	$	20,188
Oct-2019	$	20,846
Sep-2019	$	21,431
[redacted]		

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Apr-2019	$	2,050
Aug-2019	$	2,345
Dec-2019	$	1,543
Feb-2019	$	1,385
Jan-2019	$	1,033
Jul-2019	$	1,853
Jun-2019	$	2,200
Mar-2019	$	1,280
May-2019	$	2,055
Nov-2019	$	1,745
Oct-2019	$	2,260
Sep-2019	$	2,373
[redacted]		
Apr-2019	$	10,102
Aug-2019	$	11,531
Dec-2019	$	7,693
Feb-2019	$	7,468
Jan-2019	$	4,540
Jul-2019	$	10,873
Jun-2019	$	11,836
Mar-2019	$	5,910
May-2019	$	10,487
Nov-2019	$	7,516
Oct-2019	$	10,150
Sep-2019	$	10,198
[redacted]		
Apr-2019	$	3,875
Aug-2019	$	4,710
Dec-2019	$	3,155
Feb-2019	$	2,935
Jan-2019	$	2,025
Jul-2019	$	3,735
Jun-2019	$	5,035
Mar-2019	$	2,380
May-2019	$	4,110
Nov-2019	$	3,305
Oct-2019	$	4,565
Sep-2019	$	4,415
[redacted]		
Apr-2019	$	1,060
Aug-2019	$	1,645
Dec-2019	$	1,345
Feb-2019	$	1,090
Jan-2019	$	1,210
Jul-2019	$	3,520
Mar-2019	$	1,400
May-2019	$	1,600
Nov-2019	$	1,415
Oct-2019	$	1,550
Sep-2019	$	1,870
[redacted]		
Apr-2019	$	32,462
Aug-2019	$	27,412
Dec-2019	$	24,410
Feb-2019	$	30,670
Jan-2019	$	28,539
Jul-2019	$	27,505
Jun-2019	$	24,457
Mar-2019	$	26,435
May-2019	$	28,203
Nov-2019	$	25,900
Oct-2019	$	24,620
Sep-2019	$	29,018
[redacted]		

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Counterparty and Payment Dates		**REC Cost**
Apr-2019	$	2,232
Aug-2019	$	2,644
Dec-2019	$	1,448
Feb-2019	$	1,388
Jan-2019	$	876
Jul-2019	$	2,564
Jun-2019	$	2,732
Mar-2019	$	1,296
May-2019	$	2,284
Nov-2019	$	1,828
Oct-2019	$	2,400
Sep-2019	$	2,432
[redacted]		
Aug-2019	$	1,249
Dec-2019	$	770
Jul-2019	$	1,135
Jun-2019	$	2,154
May-2019	$	2,264
Nov-2019	$	883
Oct-2019	$	1,133
Sep-2019	$	1,164
[redacted]		
Feb-2019	$	-
[redacted]		
Apr-2019	$	784
Aug-2019	$	1,492
Dec-2019	$	612
Feb-2019	$	656
Jan-2019	$	600
Jul-2019	$	1,404
Jun-2019	$	1,480
Mar-2019	$	896
May-2019	$	1,336
Nov-2019	$	756
Oct-2019	$	900
Sep-2019	$	1,396
[redacted]		
Apr-2019	$	163,785
[redacted]		
Apr-2019	$	4,000
Aug-2019	$	4,625
Dec-2019	$	3,105
Feb-2019	$	3,010
Jan-2019	$	2,255
Jul-2019	$	4,535
Jun-2019	$	4,780
Mar-2019	$	2,510
May-2019	$	4,195
Nov-2019	$	3,360
Oct-2019	$	4,340
Sep-2019	$	4,365
[redacted]		
Apr-2019	$	3,064
Aug-2019	$	3,516
Dec-2019	$	2,240
Feb-2019	$	2,268
Jan-2019	$	1,432
Jul-2019	$	3,396
Jun-2019	$	3,708
Mar-2019	$	1,840
May-2019	$	3,180
Nov-2019	$	2,456
Oct-2019	$	3,384
Sep-2019	$	3,280

Counterparty and Payment Dates		REC Cost
[redacted]		
Jan-2019	$	22,149
May-2019	$	19,906
Oct-2019	$	22,219
Sep-2019	$	21,762
[redacted]		
Feb-2019	$	7,859
[redacted]		
Apr-2019	$	3,252
Aug-2019	$	3,800
Dec-2019	$	2,472
Feb-2019	$	2,484
Jan-2019	$	1,764
Jul-2019	$	3,600
Jun-2019	$	3,824
Mar-2019	$	2,064
May-2019	$	3,404
Nov-2019	$	2,804
Oct-2019	$	3,636
Sep-2019	$	3,352
[redacted]		
Apr-2019	$	2,188
Aug-2019	$	2,420
Dec-2019	$	1,492
Feb-2019	$	1,392
Jan-2019	$	832
Jul-2019	$	2,460
Jun-2019	$	2,604
Mar-2019	$	1,276
May-2019	$	2,344
Nov-2019	$	1,748
Oct-2019	$	2,356
Sep-2019	$	2,404
[redacted]		
Apr-2019	$	1,932
Aug-2019	$	2,284
Dec-2019	$	1,292
Feb-2019	$	1,256
Jan-2019	$	816
Jul-2019	$	2,172
Jun-2019	$	2,336
Mar-2019	$	1,176
May-2019	$	1,988
Nov-2019	$	1,416
Oct-2019	$	2,052
Sep-2019	$	2,008
[redacted]		
Apr-2019	$	27,828
Aug-2019	$	23,664
Dec-2019	$	24,396
Feb-2019	$	31,574
Jan-2019	$	25,980
Jul-2019	$	23,832
Jun-2019	$	26,016
Mar-2019	$	29,016
May-2019	$	26,136
Nov-2019	$	22,800
Oct-2019	$	24,100
Sep-2019	$	21,180
[redacted]		
Apr-2019	$	63,298
Aug-2019	$	62,030
Dec-2019	$	63,324
Feb-2019	$	64,186

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Jan-2019	$	65,132
Jul-2019	$	57,133
Jun-2019	$	46,757
Mar-2019	$	61,979
May-2019	$	55,332
Nov-2019	$	57,387
Oct-2019	$	60,787
Sep-2019	$	61,649
[redacted]		
Apr-2019	$	1,295
Aug-2019	$	758
Dec-2019	$	740
Jan-2019	$	12,622
Jul-2019	$	647
Jun-2019	$	716
Mar-2019	$	749
May-2019	$	686
Nov-2019	$	787
Oct-2019	$	753
Sep-2019	$	512
[redacted]		
Apr-2019	$	3,860
Aug-2019	$	1,240
Dec-2019	$	1,804
Feb-2019	$	4,132
Jan-2019	$	3,548
Jul-2019	$	2,624
Jun-2019	$	1,928
Mar-2019	$	3,212
May-2019	$	3,592
Nov-2019	$	864
Oct-2019	$	284
Sep-2019	$	1,812
[redacted]		
Apr-2019	$	1,618
Aug-2019	$	1,886
Dec-2019	$	1,213
Feb-2019	$	1,195
Jan-2019	$	790
Jul-2019	$	1,829
Jun-2019	$	1,906
Mar-2019	$	1,008
May-2019	$	1,721
Nov-2019	$	1,337
Oct-2019	$	1,712
Sep-2019	$	1,753
[redacted]		
Apr-2019	$	3,108
Aug-2019	$	3,688
Dec-2019	$	2,404
Feb-2019	$	2,380
Jan-2019	$	1,736
Jul-2019	$	3,612
Jun-2019	$	3,852
Mar-2019	$	2,020
May-2019	$	3,380
Nov-2019	$	2,612
Oct-2019	$	3,464
Sep-2019	$	3,232
[redacted]		
Apr-2019	$	3,104
Aug-2019	$	3,836
Dec-2019	$	2,244
Feb-2019	$	2,192

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Jan-2019	$	1,476
Jul-2019	$	3,336
Jun-2019	$	3,904
Mar-2019	$	1,956
May-2019	$	3,284
Nov-2019	$	2,688
Oct-2019	$	3,260
Sep-2019	$	3,568
[redacted]		
Apr-2019	$	2,925
Aug-2019	$	5,410
Dec-2019	$	3,120
Feb-2019	$	3,100
Jan-2019	$	2,200
Jul-2019	$	4,955
Jun-2019	$	5,435
Mar-2019	$	2,615
May-2019	$	3,455
Nov-2019	$	3,555
Oct-2019	$	4,235
Sep-2019	$	4,445
[redacted]		
Apr-2019	$	1,600
Aug-2019	$	1,655
Dec-2019	$	1,215
Feb-2019	$	1,185
Jan-2019	$	690
Jul-2019	$	1,685
Jun-2019	$	1,910
Mar-2019	$	995
May-2019	$	1,645
Nov-2019	$	1,200
Oct-2019	$	1,660
Sep-2019	$	1,580
[redacted]		
Apr-2019	$	1,495
Aug-2019	$	1,705
Dec-2019	$	1,110
Feb-2019	$	1,100
Jan-2019	$	680
Jul-2019	$	1,620
Jun-2019	$	1,765
Mar-2019	$	885
May-2019	$	1,615
Nov-2019	$	1,170
Oct-2019	$	1,570
Sep-2019	$	1,585
[redacted]		
Apr-2019	$	1,272
Aug-2019	$	1,332
Dec-2019	$	968
Feb-2019	$	916
Jan-2019	$	540
Jul-2019	$	1,360
Jun-2019	$	1,536
Mar-2019	$	788
May-2019	$	1,356
Nov-2019	$	948
Oct-2019	$	1,300
Sep-2019	$	1,212
[redacted]		
Apr-2019	$	1,308
Aug-2019	$	1,572
Dec-2019	$	1,064

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Feb-2019	$	1,028
Jan-2019	$	728
Jul-2019	$	1,480
Jun-2019	$	1,652
Mar-2019	$	804
May-2019	$	1,424
Nov-2019	$	1,092
Oct-2019	$	1,492
Sep-2019	$	1,428
[redacted]		
Apr-2019	$	1,324
Aug-2019	$	1,652
Dec-2019	$	936
Feb-2019	$	900
Jan-2019	$	624
Jul-2019	$	1,564
Jun-2019	$	1,648
Mar-2019	$	816
May-2019	$	1,452
Nov-2019	$	1,104
Oct-2019	$	1,388
Sep-2019	$	1,492
[redacted]		
Apr-2019	$	1,284
Aug-2019	$	1,452
Dec-2019	$	988
Feb-2019	$	968
Jan-2019	$	652
Jul-2019	$	1,468
Jun-2019	$	1,472
Mar-2019	$	792
May-2019	$	1,360
Nov-2019	$	1,024
Oct-2019	$	1,352
Sep-2019	$	1,344
[redacted]		
Feb-2019	$	-
[redacted]		
Apr-2019	$	1,436
Aug-2019	$	1,464
Dec-2019	$	1,252
Feb-2019	$	1,380
Jan-2019	$	1,212
Jul-2019	$	1,312
Jun-2019	$	1,064
Mar-2019	$	1,216
May-2019	$	1,292
Nov-2019	$	1,180
Oct-2019	$	1,344
Sep-2019	$	1,352
[redacted]		
Mar-2019	$	8,389
[redacted]		
Apr-2019	$	1,208
Aug-2019	$	1,512
Dec-2019	$	744
Feb-2019	$	716
Jan-2019	$	404
Jul-2019	$	1,456
Jun-2019	$	1,548
Mar-2019	$	700
May-2019	$	1,348
Nov-2019	$	936
Oct-2019	$	1,292

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Counterparty and Payment Dates		REC Cost
Sep-2019	$	1,312
[redacted]		
Apr-2019	$	3,304
Aug-2019	$	3,764
Dec-2019	$	2,624
Feb-2019	$	2,412
Jan-2019	$	1,560
Jul-2019	$	3,760
Jun-2019	$	4,180
Mar-2019	$	2,020
May-2019	$	3,556
Nov-2019	$	2,736
Oct-2019	$	3,716
Sep-2019	$	3,588
[redacted]		
Apr-2019	$	11,915
Aug-2019	$	7,028
Dec-2019	$	9,572
Feb-2019	$	11,310
Jan-2019	$	8,443
Jul-2019	$	9,497
Jun-2019	$	10,958
Mar-2019	$	9,597
May-2019	$	11,739
Nov-2019	$	6,272
Oct-2019	$	4,484
Sep-2019	$	6,978
[redacted]		
Apr-2019	$	14,661
Aug-2019	$	10,731
Dec-2019	$	9,673
Feb-2019	$	14,912
Jan-2019	$	10,250
Jul-2019	$	14,459
Jun-2019	$	16,222
Mar-2019	$	13,023
May-2019	$	12,998
Nov-2019	$	5,189
Oct-2019	$	4,257
Sep-2019	$	7,658
[redacted]		
Apr-2019	$	22,128
Aug-2019	$	21,360
Dec-2019	$	10,464
Feb-2019	$	25,380
Jan-2019	$	25,296
Jul-2019	$	19,884
Jun-2019	$	21,444
Mar-2019	$	22,332
May-2019	$	18,408
Nov-2019	$	14,052
Oct-2019	$	8,580
Sep-2019	$	20,316
[redacted]		
Apr-2019	$	12,016
Aug-2019	$	8,665
Dec-2019	$	9,018
Feb-2019	$	12,142
Jan-2019	$	9,678
Jul-2019	$	11,361
Jun-2019	$	1,234
Mar-2019	$	12,872
Nov-2019	$	8,136
Oct-2019	$	8,917

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Counterparty and Payment Dates		REC Cost
Sep-2019	$	9,522
[redacted]		
Apr-2019	$	10,896
Aug-2019	$	27,806
Dec-2019	$	20,848
Feb-2019	$	10,222
Jan-2019	$	14,918
Jul-2019	$	27,914
Jun-2019	$	29,235
May-2019	$	27,186
Nov-2019	$	21,037
Oct-2019	$	23,841
Sep-2019	$	27,536
[redacted]		
Apr-2019	$	3,405
Aug-2019	$	4,030
Dec-2019	$	2,505
Feb-2019	$	2,290
Jan-2019	$	1,545
Jul-2019	$	3,820
Jun-2019	$	3,935
Mar-2019	$	2,125
May-2019	$	3,460
Nov-2019	$	2,880
Oct-2019	$	3,645
Sep-2019	$	3,790
[redacted]		
Aug-2019	$	-
Feb-2019	$	-
Jan-2019	$	-
Jul-2019	$	-
Jun-2019	$	-
Mar-2019	$	-
May-2019	$	-
Sep-2019	$	-
[redacted]		
Apr-2019	$	1,336
Aug-2019	$	1,708
Dec-2019	$	1,076
Feb-2019	$	1,068
Jan-2019	$	748
Jul-2019	$	1,600
Jun-2019	$	1,700
Mar-2019	$	840
May-2019	$	1,480
Nov-2019	$	1,192
Oct-2019	$	1,556
Sep-2019	$	1,520
[redacted]		
Apr-2019	$	3,312
Aug-2019	$	3,756
Dec-2019	$	2,532
Feb-2019	$	2,344
Jan-2019	$	1,828
Jul-2019	$	3,536
Jun-2019	$	3,816
Mar-2019	$	2,120
May-2019	$	3,320
Nov-2019	$	2,732
Oct-2019	$	3,488
Sep-2019	$	3,508
[redacted]		
Apr-2019	$	3,925
Aug-2019	$	4,525

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Dec-2019	$	2,775
Feb-2019	$	2,700
Jan-2019	$	1,715
Jul-2019	$	4,245
Jun-2019	$	3,940
Mar-2019	$	2,360
May-2019	$	3,375
Nov-2019	$	3,145
Oct-2019	$	3,980
Sep-2019	$	4,240
[redacted]		
Apr-2019	$	1,350
Aug-2019	$	1,715
Dec-2019	$	1,229
Feb-2019	$	1,253
Jan-2019	$	911
Jul-2019	$	1,640
Jun-2019	$	1,829
Mar-2019	$	1,022
May-2019	$	1,528
Nov-2019	$	1,307
Oct-2019	$	1,710
Sep-2019	$	1,580
[redacted]		
Apr-2019	$	2,452
Aug-2019	$	1,420
Dec-2019	$	1,216
Feb-2019	$	2,436
Jan-2019	$	2,172
Jul-2019	$	1,704
Jun-2019	$	1,924
Mar-2019	$	2,144
May-2019	$	2,288
Nov-2019	$	768
Oct-2019	$	596
Sep-2019	$	1,008
[redacted]		
Apr-2019	$	-
Aug-2019	$	-
Dec-2019	$	-
Feb-2019	$	-
Jan-2019	$	-
Jul-2019	$	-
Jun-2019	$	-
Mar-2019	$	-
May-2019	$	-
Nov-2019	$	-
Oct-2019	$	-
Sep-2019	$	44,684
[redacted]		
Apr-2019	$	3,416
Aug-2019	$	4,132
Dec-2019	$	2,464
Feb-2019	$	2,076
Jan-2019	$	1,432
Jul-2019	$	3,968
Jun-2019	$	4,156
Mar-2019	$	1,796
May-2019	$	3,488
Nov-2019	$	2,740
Oct-2019	$	3,588
Sep-2019	$	3,540
[redacted]		
Apr-2019	$	3,852

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Counterparty and Payment Dates		**REC Cost**
Aug-2019	$	1,944
Dec-2019	$	1,812
Feb-2019	$	3,292
Jan-2019	$	1,740
Jul-2019	$	1,616
Jun-2019	$	2,928
Mar-2019	$	2,548
May-2019	$	3,324
Nov-2019	$	936
Oct-2019	$	328
Sep-2019	$	1,448
[redacted]		
Apr-2019	$	4,320
Aug-2019	$	5,245
Dec-2019	$	3,195
Feb-2019	$	3,145
Jan-2019	$	2,230
Jul-2019	$	4,800
Jun-2019	$	4,955
Mar-2019	$	2,690
May-2019	$	4,375
Nov-2019	$	3,640
Oct-2019	$	4,540
Sep-2019	$	4,700
[redacted]		
Apr-2019	$	2,020
Aug-2019	$	2,444
Dec-2019	$	1,520
Feb-2019	$	1,516
Jan-2019	$	1,024
Jul-2019	$	2,292
Jun-2019	$	2,420
Mar-2019	$	1,292
May-2019	$	2,060
Nov-2019	$	1,704
Oct-2019	$	2,152
Sep-2019	$	2,276
[redacted]		
Apr-2019	$	2,000
Aug-2019	$	2,432
Dec-2019	$	1,452
Feb-2019	$	1,444
Jan-2019	$	932
Jul-2019	$	2,276
Jun-2019	$	2,436
Mar-2019	$	1,240
May-2019	$	2,024
Nov-2019	$	1,668
Oct-2019	$	2,136
Sep-2019	$	2,060
[redacted]		
Apr-2019	$	3,144
Aug-2019	$	3,628
Dec-2019	$	2,376
Feb-2019	$	2,344
Jan-2019	$	1,628
Jul-2019	$	3,612
Jun-2019	$	3,784
Mar-2019	$	1,924
May-2019	$	3,268
Nov-2019	$	2,476
Oct-2019	$	2,876
Sep-2019	$	3,264
[redacted]		

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Apr-2019	$	2,058
Aug-2019	$	2,263
Dec-2019	$	1,538
Feb-2019	$	1,508
Jan-2019	$	1,035
Jul-2019	$	1,983
Jun-2019	$	2,095
Mar-2019	$	1,265
May-2019	$	1,978
Nov-2019	$	1,703
Oct-2019	$	2,143
Sep-2019	$	2,050
[redacted]		
Apr-2019	$	3,248
Aug-2019	$	3,736
Dec-2019	$	2,500
Feb-2019	$	2,436
Jan-2019	$	1,824
Jul-2019	$	3,684
Jun-2019	$	3,864
Mar-2019	$	2,064
May-2019	$	3,468
Nov-2019	$	2,760
Oct-2019	$	3,712
Sep-2019	$	3,656
[redacted]		
Apr-2019	$	1,701
Aug-2019	$	1,942
Dec-2019	$	959
Feb-2019	$	1,206
Jan-2019	$	756
Jul-2019	$	1,850
Jun-2019	$	2,009
Mar-2019	$	1,033
May-2019	$	1,710
Nov-2019	$	1,386
Oct-2019	$	1,739
Sep-2019	$	1,841
[redacted]		
Apr-2019	$	1,086
Aug-2019	$	1,263
Dec-2019	$	831
Feb-2019	$	779
Jan-2019	$	546
Jul-2019	$	1,135
Jun-2019	$	318
Mar-2019	$	681
May-2019	$	706
Nov-2019	$	918
Oct-2019	$	1,121
Sep-2019	$	1,213
[redacted]		
Apr-2019	$	1,771
Aug-2019	$	1,260
Dec-2019	$	463
Jul-2019	$	1,083
Jun-2019	$	1,385
May-2019	$	1,215
Nov-2019	$	969
Oct-2019	$	1,229
Sep-2019	$	1,118
[redacted]		
Aug-2019	$	14,738
Dec-2019	$	34,738

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Jan-2019	$	149,220
Jul-2019	$	26,577
Jun-2019	$	103,596
Mar-2019	$	35,594
May-2019	$	49,626
Oct-2019	$	28,176
Sep-2019	$	18,647
[redacted]		
Feb-2019	$	-
[redacted]		
Apr-2019	$	1,012
Aug-2019	$	1,412
Dec-2019	$	1,052
Feb-2019	$	828
Jan-2019	$	756
Jul-2019	$	1,420
Jun-2019	$	1,604
Mar-2019	$	1,068
May-2019	$	1,428
Nov-2019	$	1,308
Oct-2019	$	1,400
Sep-2019	$	1,536
[redacted]		
Apr-2019	$	3,505
Aug-2019	$	4,575
Dec-2019	$	2,775
Feb-2019	$	2,820
Jan-2019	$	1,850
Jul-2019	$	4,240
Jun-2019	$	4,580
Mar-2019	$	2,415
May-2019	$	3,855
Nov-2019	$	3,180
Oct-2019	$	4,070
Sep-2019	$	3,930
[redacted]		
Feb-2019	$	-
[redacted]		
Apr-2019	$	3,364
Aug-2019	$	1,048
Dec-2019	$	1,144
Feb-2019	$	3,652
Jan-2019	$	2,780
Jul-2019	$	1,300
Jun-2019	$	2,100
Mar-2019	$	3,184
May-2019	$	2,968
Nov-2019	$	464
Oct-2019	$	880
Sep-2019	$	324
[redacted]		
Aug-2019	$	1,734
Nov-2019	$	8,058
Oct-2019	$	6,264
Sep-2019	$	3,873
[redacted]		
Apr-2019	$	4,792
Aug-2019	$	3,688
Dec-2019	$	3,048
Feb-2019	$	5,332
Jan-2019	$	5,164
Jul-2019	$	4,120
Jun-2019	$	4,548
Mar-2019	$	5,432

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Counterparty and Payment Dates		REC Cost
May-2019	$	5,368
Nov-2019	$	1,296
Oct-2019	$	1,992
Sep-2019	$	2,832
[redacted]		
Apr-2019	$	6,240
Aug-2019	$	2,356
Dec-2019	$	2,100
Feb-2019	$	6,848
Jan-2019	$	5,644
Jul-2019	$	3,636
Jun-2019	$	5,204
Mar-2019	$	6,688
May-2019	$	5,760
Nov-2019	$	452
Oct-2019	$	1,064
Sep-2019	$	1,896
[redacted]		
Apr-2019	$	11,572
Aug-2019	$	4,436
Dec-2019	$	4,716
Feb-2019	$	8,148
Jan-2019	$	7,524
Jul-2019	$	6,772
Jun-2019	$	7,568
Mar-2019	$	9,176
May-2019	$	8,044
Nov-2019	$	1,892
Oct-2019	$	2,448
Sep-2019	$	3,036
[redacted]		
Aug-2019	$	1,911
Nov-2019	$	7,585
Oct-2019	$	6,693
Sep-2019	$	1,414
[redacted]		
Apr-2019	$	440
Aug-2019	$	558
Dec-2019	$	323
Feb-2019	$	76
Jan-2019	$	14
Jul-2019	$	525
Jun-2019	$	573
Mar-2019	$	25
May-2019	$	493
Nov-2019	$	368
Oct-2019	$	518
Sep-2019	$	504
[redacted]		
Jan-2019	$	58,196
[redacted]		
Apr-2019	$	4,559
Aug-2019	$	43,701
Jan-2019	$	39,973
Nov-2019	$	7,355
Oct-2019	$	31,299
[redacted]		
Nov-2019	$	1,903
Oct-2019	$	12
[redacted]		
Nov-2019	$	330
[redacted]		
Nov-2019	$	18,963
[redacted]		

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Counterparty and Payment Dates		**REC Cost**
Apr-2019	$	3,328
Aug-2019	$	4,108
Dec-2019	$	2,420
Feb-2019	$	2,564
Jan-2019	$	1,804
Jul-2019	$	3,840
Jun-2019	$	4,216
Mar-2019	$	2,120
May-2019	$	3,552
Nov-2019	$	2,864
Oct-2019	$	3,828
Sep-2019	$	3,428
[redacted]		
Feb-2019	$	6,305
[redacted]		
Apr-2019	$	7,648
Aug-2019	$	1,992
Dec-2019	$	1,748
Feb-2019	$	6,308
Jan-2019	$	6,972
Jul-2019	$	3,276
Jun-2019	$	3,808
Mar-2019	$	5,652
May-2019	$	6,284
Nov-2019	$	808
Oct-2019	$	452
Sep-2019	$	1,360
[redacted]		
Apr-2019	$	4,272
Aug-2019	$	744
Dec-2019	$	348
Feb-2019	$	3,888
Jan-2019	$	3,760
Jul-2019	$	1,716
Jun-2019	$	2,940
Mar-2019	$	3,480
May-2019	$	3,984
Oct-2019	$	180
Sep-2019	$	388
[redacted]		
Apr-2019	$	440
Aug-2019	$	736
Dec-2019	$	636
Feb-2019	$	392
Jan-2019	$	152
Jul-2019	$	644
Jun-2019	$	336
Mar-2019	$	280
May-2019	$	416
Nov-2019	$	204
Oct-2019	$	224
Sep-2019	$	512
[redacted]		
Apr-2019	$	320,963
Aug-2019	$	357,377
Dec-2019	$	314,374
Feb-2019	$	352,002
Jan-2019	$	286,025
Jul-2019	$	232,790
Jun-2019	$	291,572
Mar-2019	$	219,611
May-2019	$	318,449
Nov-2019	$	857,550
Oct-2019	$	479,798

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Counterparty and Payment Dates		REC Cost
Sep-2019	$	360,325
[redacted]		
Apr-2019	$	4,484
Aug-2019	$	5,046
Dec-2019	$	4,979
Feb-2019	$	6,593
Jan-2019	$	3,791
Jul-2019	$	2,035
Jun-2019	$	302
Mar-2019	$	9,796
May-2019	$	4,659
Nov-2019	$	6,039
Oct-2019	$	3,593
Sep-2019	$	3,450
[redacted]		
Apr-2019	$	2,512
Aug-2019	$	2,752
Dec-2019	$	1,728
Feb-2019	$	1,752
Jan-2019	$	1,160
Jul-2019	$	2,688
Jun-2019	$	2,960
Mar-2019	$	1,492
May-2019	$	2,620
Nov-2019	$	1,960
Oct-2019	$	2,600
Sep-2019	$	2,468
[redacted]		
Mar-2019	$	8,601
[redacted]		
Apr-2019	$	1,790
Aug-2019	$	2,100
Dec-2019	$	1,375
Feb-2019	$	1,265
Jan-2019	$	985
Jul-2019	$	2,040
Jun-2019	$	2,125
Mar-2019	$	1,140
May-2019	$	1,845
Nov-2019	$	1,490
Oct-2019	$	1,935
Sep-2019	$	1,930
REI 2, LLC	$	912,754
Aug-2019	$	167,643
Jul-2019	$	102,667
Jun-2019	$	92,354
May-2019	$	24,096
Nov-2019	$	186,395
Oct-2019	$	171,675
Sep-2019	$	167,924
[redacted]		
Nov-2019	$	2,893
[redacted]		
Apr-2019	$	13,059
Jul-2019	$	8,278
Nov-2019	$	10,814
Oct-2019	$	71
[redacted]		
Apr-2019	$	2,695
Aug-2019	$	2,890
Dec-2019	$	1,660
Feb-2019	$	1,930
Jan-2019	$	1,370
Jul-2019	$	2,875

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Counterparty and Payment Dates		REC Cost
Jun-2019	$	3,110
Mar-2019	$	1,635
May-2019	$	2,690
Nov-2019	$	1,905
Oct-2019	$	2,225
Sep-2019	$	2,035
[redacted]		
Apr-2019	$	4,100
Aug-2019	$	5,130
Dec-2019	$	3,165
Feb-2019	$	3,150
Jan-2019	$	2,210
Jul-2019	$	4,800
Jun-2019	$	5,245
Mar-2019	$	2,605
May-2019	$	4,370
Nov-2019	$	3,575
Oct-2019	$	4,785
Sep-2019	$	4,300
[redacted]		
Apr-2019	$	2,610
Aug-2019	$	1,700
Dec-2019	$	1,355
Jan-2019	$	950
Jul-2019	$	4,855
Mar-2019	$	1,300
Oct-2019	$	3,055
[redacted]		
Apr-2019	$	1,118
Aug-2019	$	2,405
Dec-2019	$	1,060
Feb-2019	$	457
Mar-2019	$	594
May-2019	$	810
Oct-2019	$	664
Sep-2019	$	743
[redacted]		
Apr-2019	$	866
Aug-2019	$	1,028
Dec-2019	$	678
Feb-2019	$	631
Jan-2019	$	476
Jul-2019	$	965
Jun-2019	$	1,019
Mar-2019	$	549
May-2019	$	881
Nov-2019	$	725
Oct-2019	$	949
Sep-2019	$	916
[redacted]		
Mar-2019	$	7,901
[redacted]		
Apr-2019	$	1,320
Aug-2019	$	1,644
Dec-2019	$	736
Feb-2019	$	600
Jan-2019	$	316
Jul-2019	$	1,552
Jun-2019	$	1,676
Mar-2019	$	732
May-2019	$	1,444
Nov-2019	$	1,044
Oct-2019	$	1,488
Sep-2019	$	1,492

Counterparty and Payment Dates		REC Cost
[redacted]		
Apr-2019	$	3,096
Aug-2019	$	3,836
Dec-2019	$	1,900
Feb-2019	$	1,808
Jan-2019	$	1,100
Jul-2019	$	3,520
Jun-2019	$	3,904
Mar-2019	$	1,760
May-2019	$	3,420
Nov-2019	$	2,436
Oct-2019	$	3,368
Sep-2019	$	3,400
[redacted]		
Apr-2019	$	3,870
Aug-2019	$	4,570
Dec-2019	$	2,980
Feb-2019	$	2,870
Jan-2019	$	1,970
Jul-2019	$	4,365
Jun-2019	$	4,820
Mar-2019	$	2,430
May-2019	$	4,170
Nov-2019	$	3,200
Oct-2019	$	4,350
Sep-2019	$	4,285
[redacted]		
Mar-2019	$	8,589
[redacted]		
Apr-2019	$	2,740
Aug-2019	$	3,428
Dec-2019	$	2,188
Feb-2019	$	2,032
Jan-2019	$	1,356
Jul-2019	$	3,208
Jun-2019	$	3,600
Mar-2019	$	1,760
May-2019	$	3,092
Nov-2019	$	2,200
Oct-2019	$	3,176
Sep-2019	$	3,112
[redacted]		
Apr-2019	$	1,432
Aug-2019	$	580
Dec-2019	$	804
Feb-2019	$	1,464
Jan-2019	$	1,296
Jul-2019	$	896
Jun-2019	$	208
Mar-2019	$	1,284
May-2019	$	1,464
Nov-2019	$	308
Oct-2019	$	132
Sep-2019	$	512
[redacted]		
Apr-2019	$	3,196
Aug-2019	$	3,936
Dec-2019	$	2,440
Feb-2019	$	2,332
Jan-2019	$	1,728
Jul-2019	$	3,716
Jun-2019	$	3,956
Mar-2019	$	2,052
May-2019	$	3,300

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Nov-2019	$	2,680
Oct-2019	$	3,664
Sep-2019	$	3,448
[redacted]		
Apr-2019	$	384
Aug-2019	$	496
Dec-2019	$	516
Feb-2019	$	440
Jan-2019	$	476
Jul-2019	$	496
Jun-2019	$	508
Mar-2019	$	476
May-2019	$	480
Nov-2019	$	112
Oct-2019	$	416
Sep-2019	$	560
[redacted]		
Apr-2019	$	3,352
Aug-2019	$	4,028
Dec-2019	$	2,040
Feb-2019	$	2,440
Jan-2019	$	1,708
Jul-2019	$	3,884
Jun-2019	$	4,128
Mar-2019	$	2,092
May-2019	$	3,428
Nov-2019	$	2,796
Oct-2019	$	3,672
Sep-2019	$	3,788
[redacted]		
Apr-2019	$	600
Aug-2019	$	15,825
Jan-2019	$	4,800
Jun-2019	$	23,325
Mar-2019	$	17,175
Nov-2019	$	6,525
Oct-2019	$	1,050
[redacted]		
Apr-2019	$	4,010
Aug-2019	$	4,390
Dec-2019	$	3,080
Feb-2019	$	3,070
Jan-2019	$	2,065
Jul-2019	$	3,920
Jun-2019	$	4,225
Mar-2019	$	2,520
May-2019	$	3,840
Nov-2019	$	3,360
Oct-2019	$	3,910
Sep-2019	$	3,945
[redacted]		
Apr-2019	$	26,534
Aug-2019	$	27,437
Dec-2019	$	20,153
Feb-2019	$	20,387
Jan-2019	$	17,283
Jul-2019	$	28,810
Jun-2019	$	31,033
Mar-2019	$	20,044
May-2019	$	27,320
Nov-2019	$	21,482
Oct-2019	$	25,857
Sep-2019	$	26,071
[redacted]		

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Apr-2019	$	804
Aug-2019	$	1,023
Dec-2019	$	512
Feb-2019	$	512
Jan-2019	$	285
Jul-2019	$	1,023
Jun-2019	$	1,023
Mar-2019	$	475
May-2019	$	877
Nov-2019	$	621
Oct-2019	$	877
Sep-2019	$	914
[redacted]		
Apr-2019	$	37,934
Aug-2019	$	44,448
Dec-2019	$	29,437
Feb-2019	$	29,455
Jan-2019	$	24,208
Jul-2019	$	43,359
Jun-2019	$	46,127
Mar-2019	$	28,101
May-2019	$	39,962
Nov-2019	$	31,016
Oct-2019	$	37,286
Sep-2019	$	39,089
[redacted]		
Apr-2019	$	3,969
Aug-2019	$	4,719
Dec-2019	$	2,575
Feb-2019	$	2,682
Jan-2019	$	1,932
Jul-2019	$	4,827
Jun-2019	$	4,934
Mar-2019	$	2,253
May-2019	$	4,290
Nov-2019	$	3,111
Oct-2019	$	4,183
Sep-2019	$	4,291
[redacted]		
Apr-2019	$	3,428
Aug-2019	$	3,920
Dec-2019	$	2,216
Feb-2019	$	2,536
Jan-2019	$	1,776
Jul-2019	$	3,796
Jun-2019	$	4,056
Mar-2019	$	2,080
May-2019	$	3,492
Nov-2019	$	2,836
Oct-2019	$	3,648
Sep-2019	$	3,608
[redacted]		
Apr-2019	$	3,252
Aug-2019	$	4,120
Dec-2019	$	2,600
Feb-2019	$	2,180
Jan-2019	$	1,764
Jul-2019	$	4,016
Jun-2019	$	4,064
Mar-2019	$	1,944
May-2019	$	3,608
Nov-2019	$	2,884
Oct-2019	$	3,780
Sep-2019	$	3,872

Counterparty and Payment Dates		REC Cost
[redacted]		
Apr-2019	$	1,925
Aug-2019	$	2,220
Dec-2019	$	1,478
Feb-2019	$	1,448
Jan-2019	$	945
Jul-2019	$	2,105
Jun-2019	$	2,340
Mar-2019	$	1,155
May-2019	$	2,068
Nov-2019	$	1,515
Oct-2019	$	2,095
Sep-2019	$	2,023
[redacted]		
Apr-2019	$	348
Aug-2019	$	288
Dec-2019	$	144
Feb-2019	$	268
Jan-2019	$	164
Jul-2019	$	380
Jun-2019	$	480
Mar-2019	$	216
May-2019	$	356
Nov-2019	$	104
Oct-2019	$	176
Sep-2019	$	212
[redacted]		
Apr-2019	$	1,735
Aug-2019	$	1,697
Dec-2019	$	1,352
Feb-2019	$	1,325
Jan-2019	$	914
Jul-2019	$	1,780
Jun-2019	$	2,014
Mar-2019	$	1,067
May-2019	$	1,863
Nov-2019	$	1,438
Oct-2019	$	1,856
Sep-2019	$	1,760
[redacted]		
Apr-2019	$	352,532
Aug-2019	$	316,026
Dec-2019	$	343,256
Feb-2019	$	312,358
Jan-2019	$	295,230
Jul-2019	$	299,512
Jun-2019	$	314,762
Mar-2019	$	317,960
May-2019	$	311,552
Nov-2019	$	390,136
Oct-2019	$	187,654
Sep-2019	$	351,246
[redacted]		
Apr-2019	$	448,916
Aug-2019	$	465,946
Dec-2019	$	494,466
Feb-2019	$	436,214
Jan-2019	$	349,092
Jul-2019	$	422,092
Jun-2019	$	485,920
Mar-2019	$	334,040
May-2019	$	497,876
Nov-2019	$	478,758
Oct-2019	$	328,090

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Sep-2019	$	427,730
[redacted]		
Apr-2019	$	91,938
Aug-2019	$	61,866
Feb-2019	$	109,494
Jan-2019	$	76,314
Jul-2019	$	79,296
Jun-2019	$	104,580
Mar-2019	$	107,520
May-2019	$	68,670
Oct-2019	$	46,410
Sep-2019	$	57,456
[redacted]		
Apr-2019	$	3,880
Aug-2019	$	4,275
Dec-2019	$	2,600
Feb-2019	$	2,530
Jan-2019	$	1,775
Jul-2019	$	3,545
Jun-2019	$	4,545
Mar-2019	$	2,300
May-2019	$	4,055
Nov-2019	$	2,620
Oct-2019	$	4,140
Sep-2019	$	4,205
[redacted]		
Apr-2019	$	1,706
Aug-2019	$	1,895
Dec-2019	$	1,276
Feb-2019	$	1,303
Jan-2019	$	927
Jul-2019	$	1,807
Jun-2019	$	1,960
Mar-2019	$	1,062
May-2019	$	1,683
Nov-2019	$	1,332
Oct-2019	$	1,694
Sep-2019	$	1,710
[redacted]		
Apr-2019	$	1,292
Aug-2019	$	1,708
Dec-2019	$	928
Feb-2019	$	872
Jan-2019	$	552
Jul-2019	$	1,612
Jun-2019	$	1,712
Mar-2019	$	816
May-2019	$	1,416
Nov-2019	$	1,140
Oct-2019	$	1,432
Sep-2019	$	1,516
[redacted]		
Apr-2019	$	15,206
Aug-2019	$	14,980
Dec-2019	$	14,913
Feb-2019	$	15,484
Jan-2019	$	14,193
Jul-2019	$	14,531
Jun-2019	$	13,957
Mar-2019	$	14,064
May-2019	$	15,079
Nov-2019	$	14,785
Oct-2019	$	14,172
Sep-2019	$	14,929

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Counterparty and Payment Dates		**REC Cost**
[redacted]		
Apr-2019	$	2,232
Aug-2019	$	2,416
Feb-2019	$	1,712
Jan-2019	$	1,080
Jul-2019	$	2,428
Jun-2019	$	2,560
Mar-2019	$	1,376
May-2019	$	2,312
Sep-2019	$	1,364
[redacted]		
Apr-2019	$	1,276
Aug-2019	$	1,552
Dec-2019	$	880
Feb-2019	$	896
Jan-2019	$	612
Jul-2019	$	1,440
Jun-2019	$	1,548
Mar-2019	$	784
May-2019	$	1,384
Nov-2019	$	1,044
Oct-2019	$	1,432
Sep-2019	$	1,368

[END CONFIDENTIAL]

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			EMF Period							
			January 1, 2019 - December 31, 2019				September 1, 2020 - August 31, 2021			
Line No.	Renewable Resource	RECs only	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										

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			EMF Period January 1, 2019 - December 31, 2019				EMF Period September 1, 2020 - August 31, 2021			
Line No.	Renewable Resource	RECs only	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
	[redacted]									

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			EMF Period							
			January 1, 2019 - December 31, 2019				September 1, 2020 - August 31, 2021			
Line No.	Renewable Resource	RECs only	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										

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			EMF Period							
			January 1, 2019 - December 31, 2019				September 1, 2020 - August 31, 2021			
Line No.	Renewable Resource	RECs only	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										

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EMF Period

Line No.	Renewable Resource	RECs only	January 1, 2019 - December 31, 2019 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	September 1, 2020 - August 31, 2021 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										

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Compliance Costs

			EMF Period January 1, 2019 - December 31, 2019				EMF Period September 1, 2020 - August 31, 2021			
Line No.	Renewable Resource	RECs only	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
	[redacted]									

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1229

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2019 - December 31, 2019 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	EMF Period September 1, 2020 - August 31, 2021 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										
186	Other Incremental (see Jennings Exhibit No. 3 for Incremental Cost worksheet}				$ 1,406,748				$ 1,465,200	
187	Billing Period estimated receipts related to contract performance				$ -	Note 1			$ (1,000,000)	Note 1
188	Solar Rebate Program (see Jennings Exhibit No. 3 for cost detail)				$ 886,014				$ 1,744,750	
189	Research (see Jennings Exhibit No. 3 for Research cost detail)				$ 822,933				$ 926,500	
190	**Total Other Incremental and Research Cost**				**$ 3,115,695**				**$ 3,136,450**	
[redacted]										
192	EMF Period actual credits for receipts related to contracts - to Williams Exhibit No.4 - footnote (3)				$ (1,118,900)	Note 1				

Note 1: EMF Period contract receipts are not included in the under/overcollection calculation on Williams Exhibit No. 2, instead they are credited directly to customer class on Williams Exhibit No. 4. Estimated contract receipts are included in Billing Period total other incremental cost as a reduction in REPS charges proposed for the Billing Period.

Footnotes: [redacted]

REDACTED VERSION

Line No.	Incremental Cost Worksheet:	EMF Period January 1, 2019 - December 31, 2019	Billing Period September 1, 2020 - August 31, 2021
	Labor by activity:		
1	[redacted]		
2			
3			
4			
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22			
23	**Total Other Incremental Cost**	**$ 1,406,748**	**$ 1,465,200**
	Solar Rebate Program Cost Detail (recovery in REPS pursuant to G.S. 62-155(f)): (1)		
24	Annual Amortization of Incentives Provided to Customers, plus return on unamortized balance	$ 841,750	$ 1,636,420
25	Annual Amortization of Program Administrative Labor Costs, plus return on unamortized balance	[redacted]	
26	Annual Amortization of Program Administrative Contract Labor & Other Administrative Costs, plus return on unamortized balance		
27	**Total Solar Rebate Program Cost**	**$ 886,014**	**$ 1,744,750**

(1) All annual Solar Rebate Program costs reflect amortization of incurred costs over 20 years, including a return on the unamortized balance.

Information in italics is confidential

REDACTED VERSION

Line No.	Incremental Cost Worksheet:	EMF Period January 1, 2019 - December 31, 2019	Billing Period September 1, 2020 - August 31, 2021
	Research Cost Detail:		
28	CAPER PV Synchronous Generator - Clemson University	[redacted]	
29	Closed Loop Biomass - American Forest Management		
30	Coalition for Renewable Natural Gas Membership		
31	DER Risks to Transformers and Transmission		
32	Eos Energy Storage Technology Development - McAlpine		
33	EPRI - DER Interconnection Standards & Practices		
34	EPRI - PV monitoring project (1-106700)		
35	EPRI Membership		
36	ETO - Mitigation of Transformer High Inrush Current		
37	IEEE 1547 Conformity Assessment Test		
38	Loyd Ray Farms - Duke University		
39	NCSU - Adopting DVAR to Mitigate PV Impact on a Distribution System		
40	NCSU - ETO - Feeder Anti-islanding Detection Using HIL Modeling and Simulation		
41	NCSU - ETO - Grid-forming Battery Energy Storage System Characterization & Testing		
42	NCSU - Interactions of PV Installations with Distribution Systems		
43	NCSU - Membership fee Future Renewable Electric Energy Delivery & Mgmt Center (FREEDM Center)		
44	NREL - Carbon-free resource integration study		
45	PNNL – Dynamic Var Compensator ("DVC") Pilot		
46	Research Triangle Institute - Biogas Utilitzation in NC		
47	Rocky Mountain Institute - eLab		
48	**Total Research Cost**	**$ 822,933**	**$ 926,500**
49	**Total Other Incremental Cost**	$ 1,406,748	$ 1,465,200
50	Projected credits for receipts related to contract amendments/liquidated damages, etc	$ -	$ (1,000,000)
51	**Total Other Incremental Cost and other credits**	$ 1,406,748	$ 465,200
52	**Total Solar Rebate Program Cost**	$ 886,014	$ 1,744,750
53	**Total Research Cost**	$ 822,933	$ 926,500
54	**Grand Total - Other Incremental, Solar Rebate Program, and Research Cost, other credits**	**$ 3,115,695**	**$ 3,136,450**
55	EMF Period actual credits for receipts related to contracts - see **Note 1**	$ (1,118,900)	
56	**Net Other Incremental, Solar Rebate Program and Research Cost**	**$ 1,996,795**	**$ 3,136,450**

Note 1: EMF Period contract receipts are not included in the under/overcollection calculation on Williams Exhibit No. 2, instead they are credited directly to customer class on Williams Exhibit No. 4. Estimated contract receipts are included in Billing Period total other incremental cost as a reduction in REPS charges proposed for the Billing Period.

CAPER

Center for Advanced Power Engineering Research
2017-2019 Research Project Report

Development and Demonstration of a 40kW Photovoltaic Synchronous Generator (PVSG)

Prepared by:

Dr. Alex Huang (PI), UT Austin

Dr. Ramtin Hadidi (Co-PI), Clemson University

Project Period:

Start Date: 4/1/2017

Completion Date: 10/31/2019

Project # EHP-02-PG

CAPER

Center for Advanced Power Engineering Research
2017-2019 Research Project Report

Table of Contents

CAPER

Center for Advanced Power Engineering Research
2017-2019 Research Project Report

1 Project Objectives

The project objective is to design and develop a 40 kW ultracapcitor energy storage system that works in parallel with commercial grid following PV inverters. The entire system behaves like a grid forming PV Synchronous Generator (PVSG). It is a significant step needed to make all PV systems to provide both Voltage and Frequency support to the grid.

2 Project Team and Tasks

UT Austin Team	
Role	**Name**
Faculty Advisor	Dr. Alex Huang
Graduate Students	Yizhe Xu (graduated), Xiangjun Quan(graduated) and Chengjing Li

Clemson Team	
Role	**Name**
Faculty Advisor	Dr. Ramtin Hadidi
Graduate Students	Puspal Hazra

3 Project Description and Outcomes

3.1 Background, Research Objectives and Major Accomplishments

As the renewable energy and distributed generation penetration increases in utility power grids, the traditional control approach for these resources needs a fundamental change in order to maintain overall grid stability. Traditionally, PV inverters are designed as a grid following current source, providing no ancillary services to maintain the grid stability. For very high PV penetration levels, PV power plants will replace traditional synchronous generator and they must also provide grid frequency support and regulation capability. This effectively requires a totally new generation of PV inverter technology.

Dr. Huang's team has previously developed a single phase PVSG, this work has been accomplished and one paper was published. See paper in "Integration of DC Microgrids as Virtual Synchronous Machines into the AC Grid," in *IEEE Transactions on Industrial Electronics*, vol. 64, no. 9, pp. 7455-7466, Sept. 2017.

In this CAPER project, a novel AC coupled solution that transforms an existing grid following PV system to a grid forming one without any hardware and software modification of the PV inverter is proposed and implemented. The resulting system, the Photovoltaic Synchronous Generator (PVSG), is achieved by an AC coupled supercapacitor-based energy storage system (ESS). The following major accomplishments have been made in CAPER project:

1- A 40 kW/480V ultra capacitor ESS is designed, developed, and tested.
2- Together with a commercial PV system, the 40 kW PVSG system is tested and demonstrated in October 2019 at UT Austin in 2019. Duke Energy, Austin Energy representatives participated in the demonstration.
3- In Feb 2020, the 40 KW PVSG system was also demonstrated to representatives from ERCOT
4- A novel control for the PVSG was developed with robust inertia and primary frequency response capability.
5- Following papers are published.
   [1] X. Quan *et al.*, "Novel Power Control of Voltage-Controlled Inverters for Grid Inertia Support," in 2019 IEEE Applied Power Electronics and Exposition (APEC), Anaheim, CA, USA, 2019, pp. 927-931.
   [2] X. Quan *et al.*, "Photovoltaic Synchronous Generator (PVSG): Architecture and Control Strategy for A Grid-Forming PV Energy System," in *IEEE Journal of Emerging and Selected Topics in Power Electronics*. doi: 10.1109/JESTPE.2019.2953178 is published.
   [3] X. Quan, A. Q. Huang and H. Yu, "A Novel Order Reduced Synchronous Power Control for Grid-Forming Inverters," in IEEE Transactions on Industrial Electronics. doi: 10.1109/TIE.2019.2959485

[4] P. Hazra and R. Hadidi, "Inertial response enhancement of a microgrid using Photovoltaic Synchronous Generator," 2018 IEEE Electronic Power Grid (eGrid), Charleston, SC, Nov. 2018, pp. 1-4.

3.2 PVSG Description

The system diagram of the implemented three-phase PVSG is shown in Fig. 1. Fig. 2 displays the schematic illustration of the proposed PVSG whose equivalent circuit diagram is shown in Fig. 3.

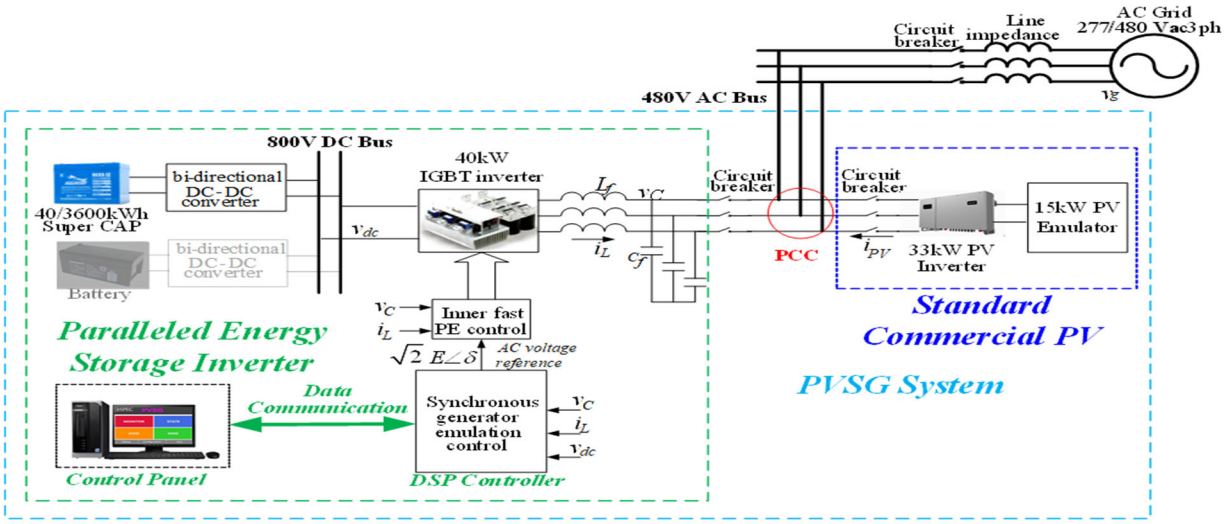

Fig. 1. System Diagram of the implemented three-phase PVSG system.

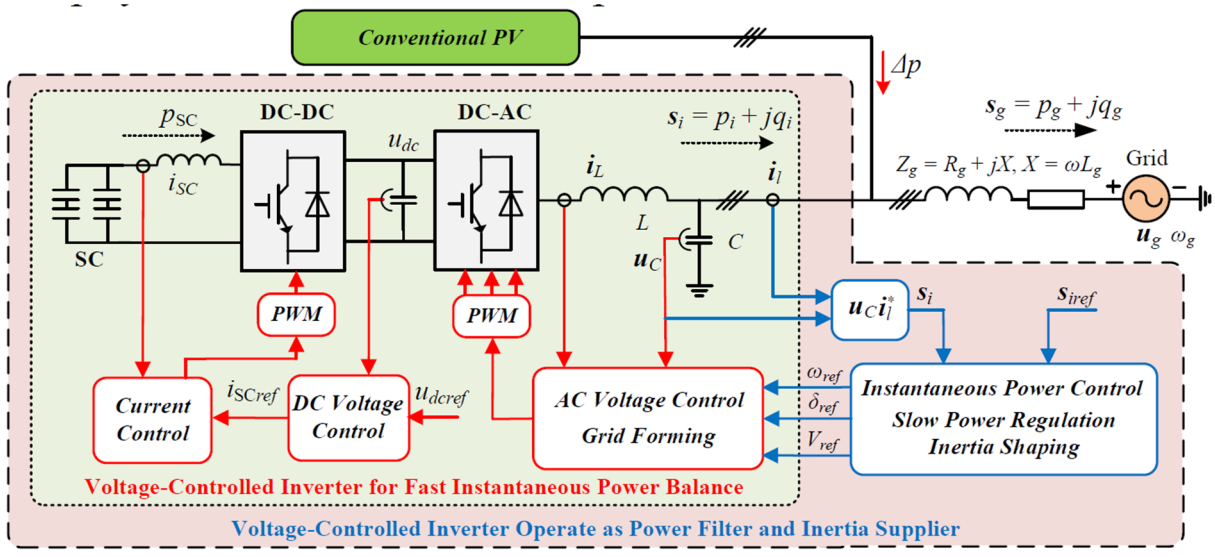

Fig. 2. Illustration of the proposed PVSG by paralleled grid-forming inverter.

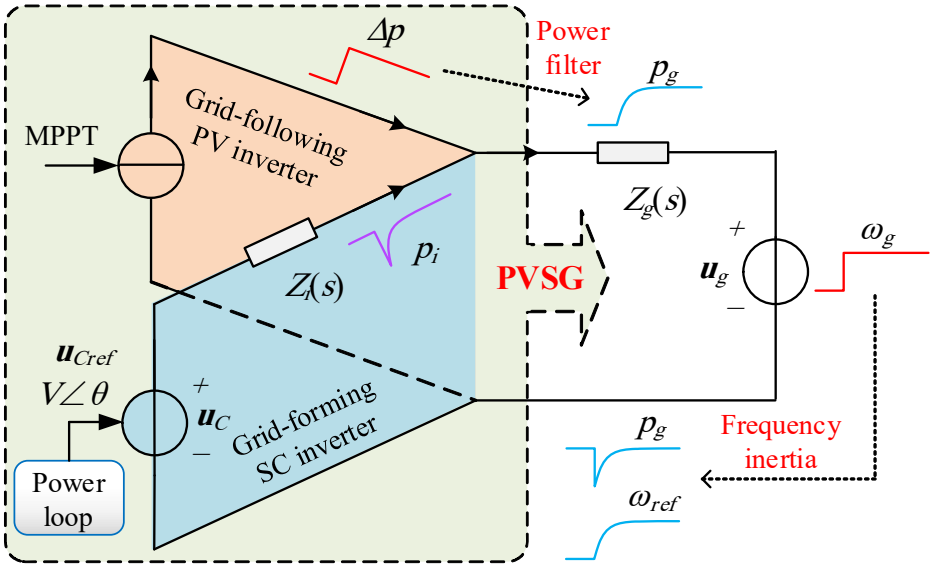

Fig. 3. Equivalent circuit diagram of the proposed PVSG and the functionality illustration of the power filter and frequency inertia.

The PVSG includes a grid following PV (and/or load) in parallel with a grid-forming inverter with SC on the DC side. The control of the PV is a standard grid-following MPPT controlled inverter system. PVSG controls are implemented in the SC inverter which can be further divided into two parts. The first one is the fundamental voltage and current control with fast dynamic response which achieves the automatic and fast response to the power intermittence and grid frequency variations, as shown by red parts in Fig. 2. The second part implements the slow power control to emulate the inertia hence achieving power filter and frequency inertia, as shown by the blue parts in Fig. 2. The proposed inertia solution includes frequency inertia and power filter as demonstrated in Fig. 3. These two functions are used to alleviate power demand of kinetic energy of SG in event of power and frequency variations. Therefore, they need a very fast and short time active power injection/absorbing to/from the grid when PV power or frequency changes suddenly. To this end, the response of the grid-forming inverter should be as fast as possible to avoid the requirement of step power from grid. As shown in Fig. 3, the conventional grid-following PV system achieves the MPPT control, while the added inverter operates as a voltage source whose amplitude and frequency are adjusted by the power loop. The proposed control diagram of the PVSG is illustrated in Fig. 4, for detailed design of AC-DC, DC-DC, and power flow controllers design please refer to [2]. TABLE I lists the system parameters and the experimental setup is displayed in Fig. 5.

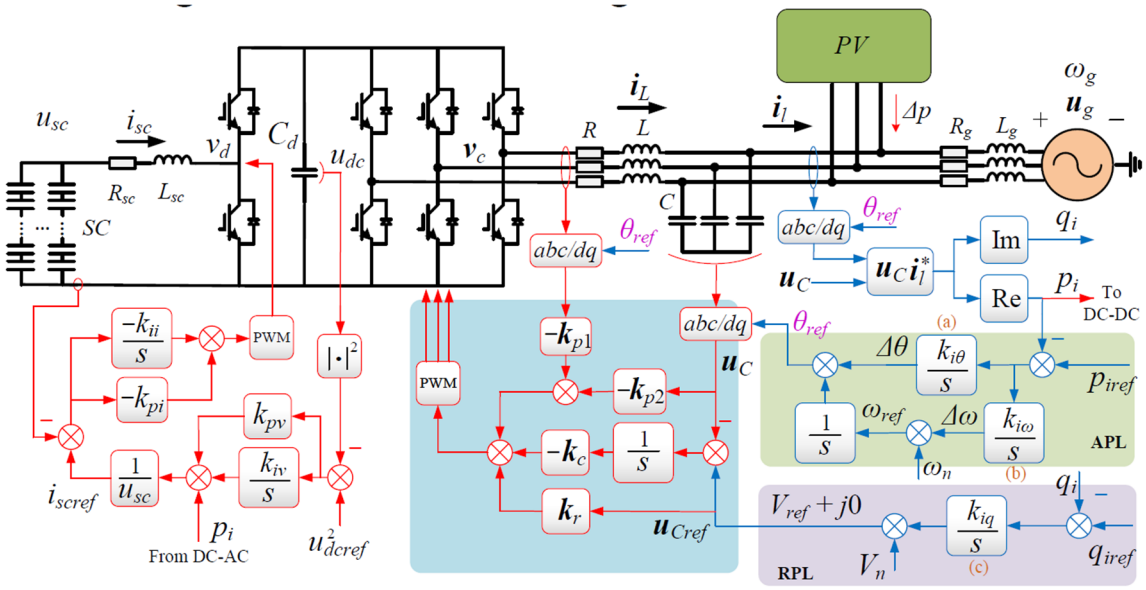

Fig. 4. Control of the proposed PVSG by paralleled grid-forming inverter.

Table 1. Circuit Parameters of the PVSG System

Parameter		Value
L	Inductance of AC filter	1 mH
C	Capacitance of ACfilter	54 μF
R	Inductor resistance	0.05 Ω
L_g	Grid-side inductance	1.5 mH
L_{sc}	SC-side inductance	1.8 mH
SC	Super capacitance	2 F
C_d	DC link capacitance	3300 μF
f_s	Switching frequency	16,000 Hz
	Voltage ph-ph RMS/ frequency	480 V / 60 Hz
	DC link voltage	830 V

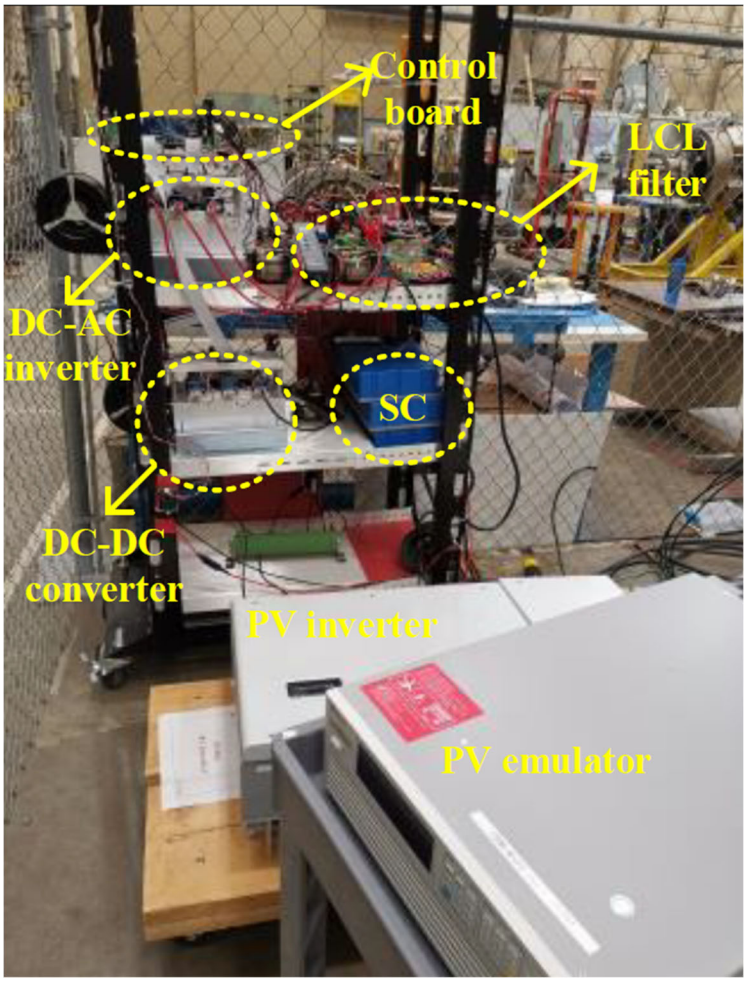

Fig. 5. Experiment setup.

3.3 Experimental Test Results

The experimental test results are shown in Fig. 6 and Fig. 7. In these tests, the PVSG system is connected to three-phase 480 V Austin Energy grid. In Fig. 6, it can be seen that by variation in the grid's frequency, shown in middle figure, the Super Capacitor (SC) system injects or absorbs active power, shown in top figure with red color, to provide inertia to the grid frequency. Also, this system is capable of reactive power compensation where the reactive power injected/absorbed by SC inverter is shown in top figure by green. In Fig. 7, it can be seen that by although a sudden change has happened in PV generation, the grid frequency is smoothed by the PVSG system.

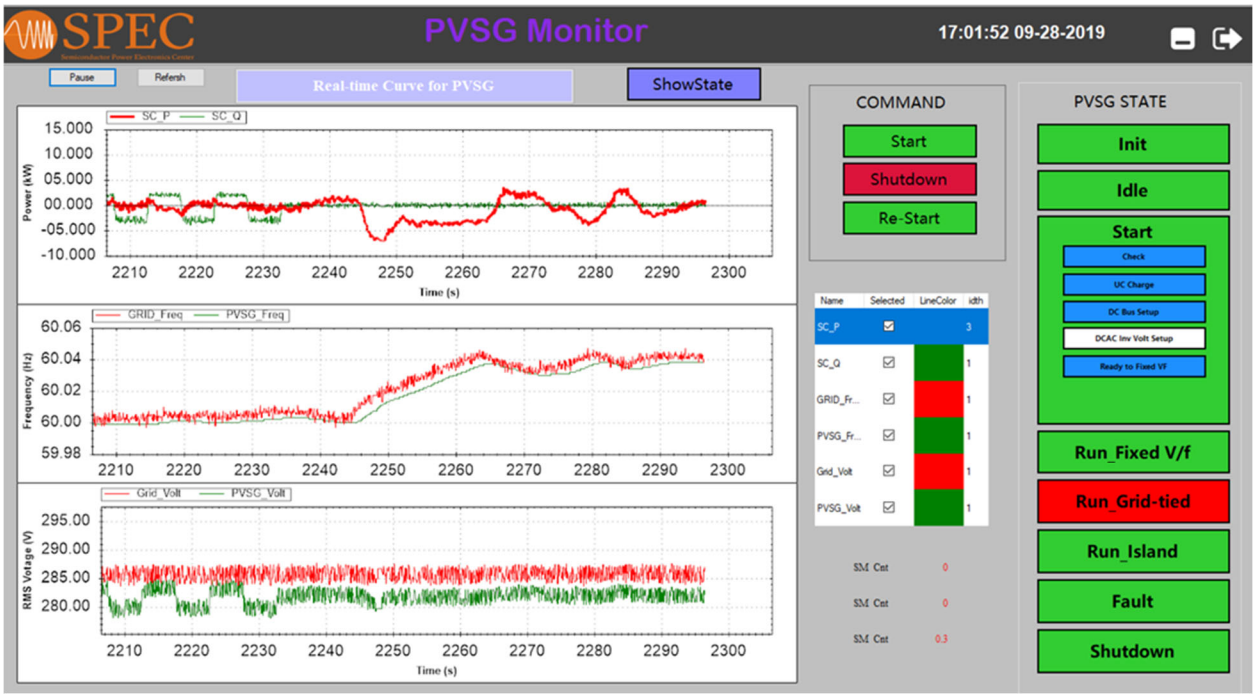

Fig. 6. Experimental test results shown by developed software.

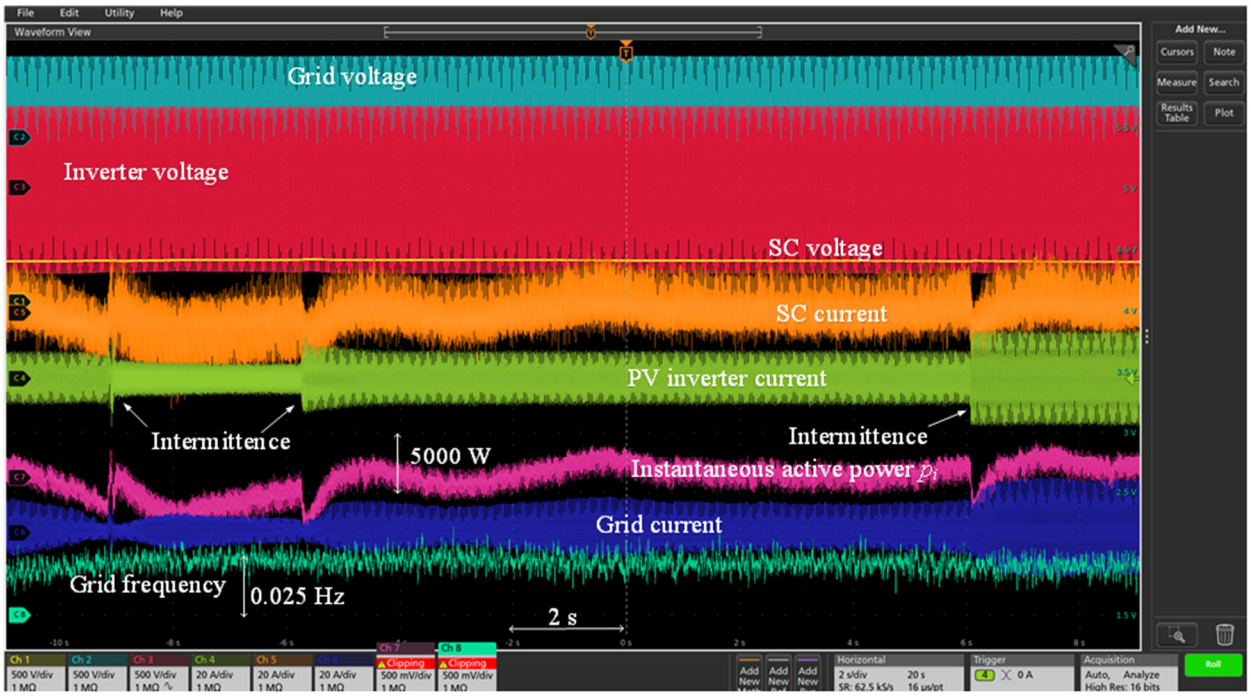

Fig. 7. Experimental results shown by oscilloscope.

3.4 System Studies with PVSG

The system study has been performed in two microgrid test systems to show the effectiveness of the PVSG solution. Fig. 8 shows the first system. The synchronous machine is rated at 52.5 kVA,460 V L-L RMS, 1800 RPM and PVSG unit is rated at 40 kVA.

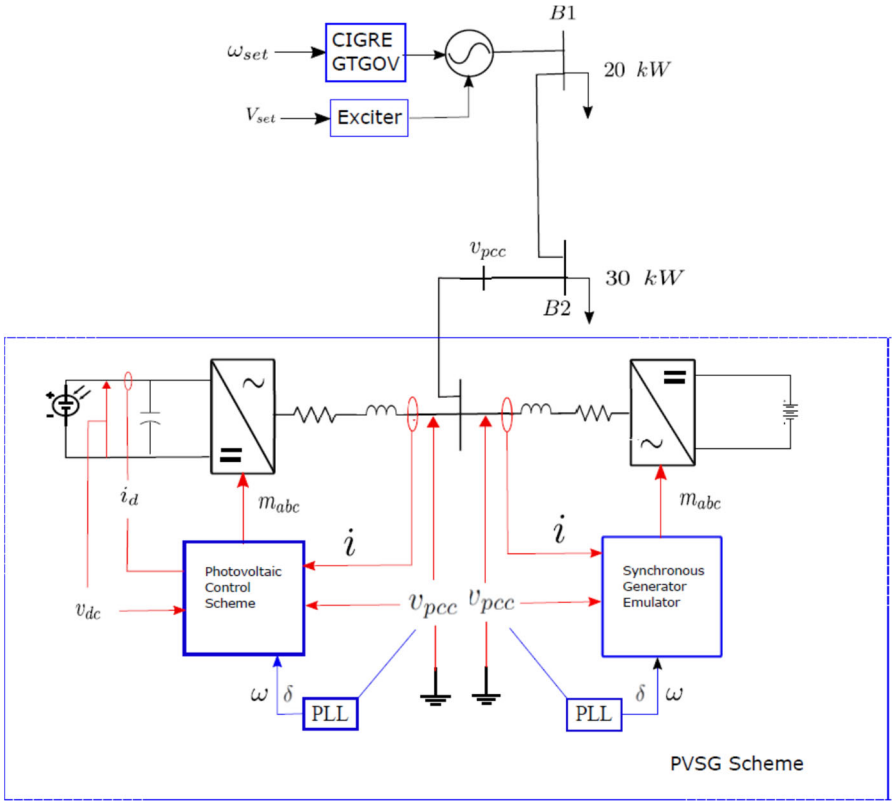

Fig. 8. Microgrid Test System for 40kVA PVSG system.

Figure 9 shows the response of PVSG units subject to power set point change in photovoltaic inverter from 0.4 p.u.to 0.3 p.u. at t=50s. This creates an under frequency disturbance. Figure 10 compares frequency deviation in a system with a PVSG unit and one without synchronous generator emulator part which clearly shows the improvement in frequency response. Figure 11 shows the frequency response of PVSG units subject to power set point change in photovoltaic inverter from0.4 p.u. to 0.5 p.u. at t=50s. This creates an under frequency disturbance. Figure 12 compares frequency deviation in a system with a PVSG unit and one without synchronous generator emulator part which clearly shows the improvement in frequency response. All plots are in per unit.

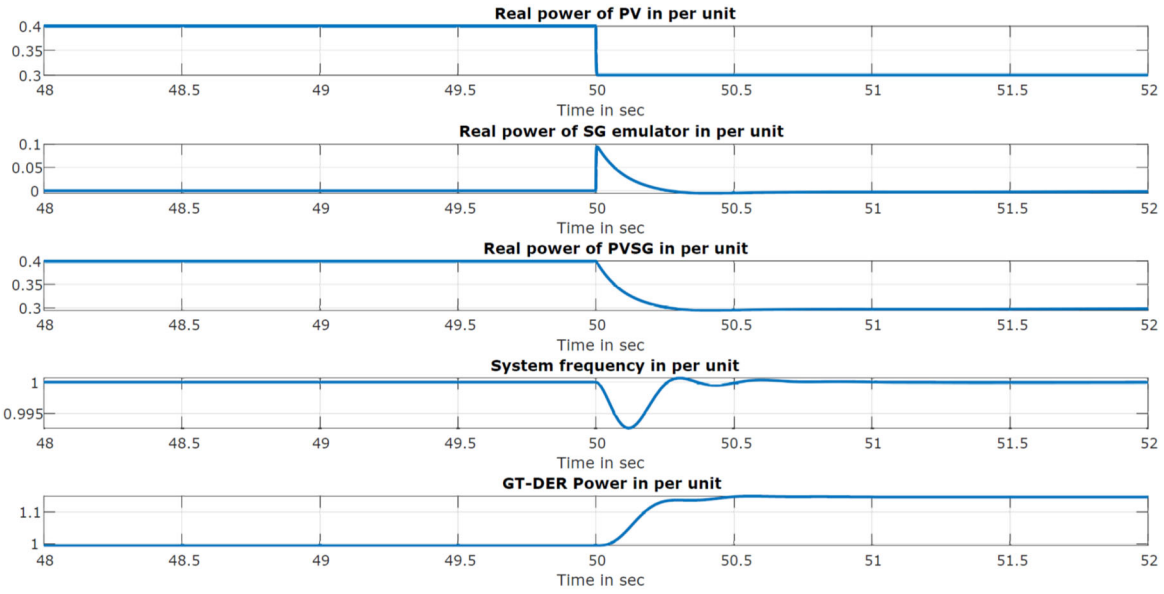

Fig. 9. Time-domain response of different components subject to power set point change in photovoltaic inverter from 0.4 p.u.to 0.3 p.u. at t=50s.

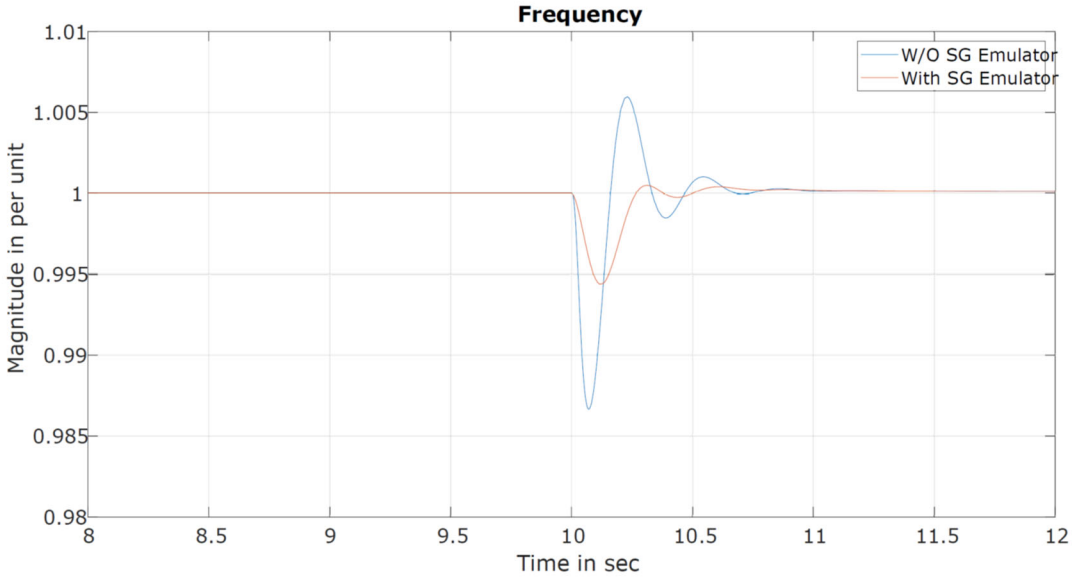

Fig. 10. Frequency comparison for a system with and without the synchronous generator emulator part.

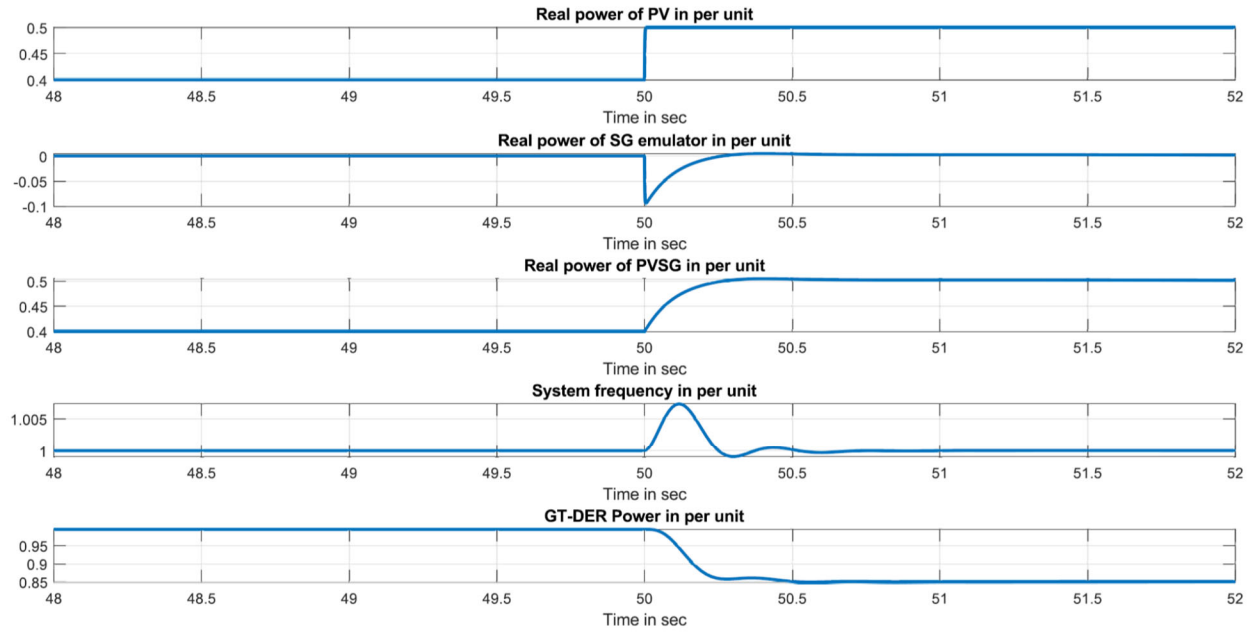

Fig. 11. Time-domain response of different components subject to power set point change in photovoltaic inverter from 0.4 p.u.to 0.5 p.u. at t=50s.

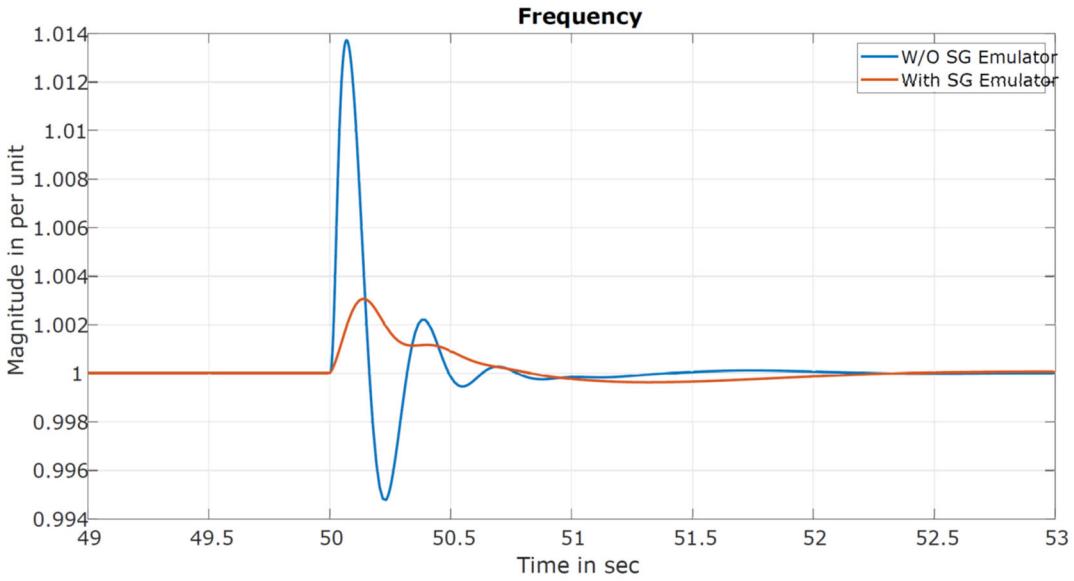

Fig. 12. Frequency comparison for a system with and without the synchronous generator emulator part.

A second test system is considered for studying the effect of larger PVSG unit on the system behavior and response. IEEE 13 node system is selected for the study as shown in Figure 13.

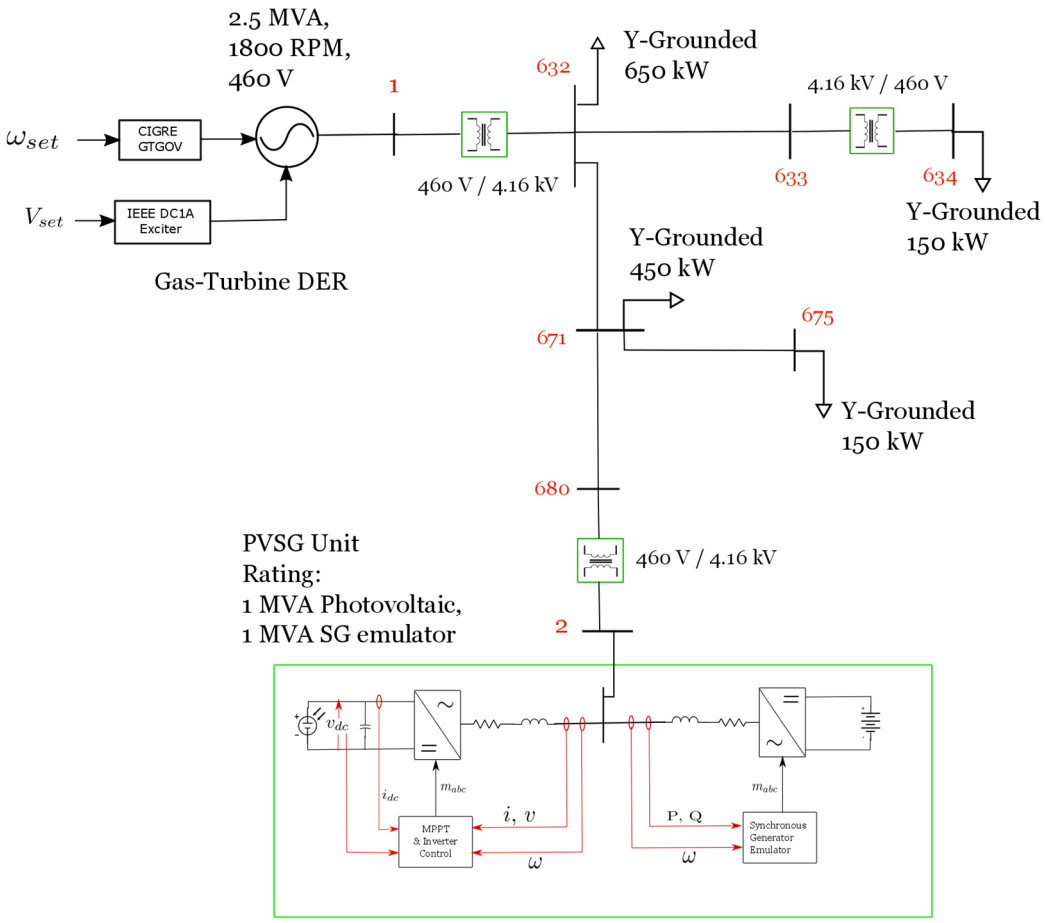

Fig. 13. Modified IEEE 13 node system for PVSG unit integration study.

The system frequency response to PV power reduction without SG emulator part in steps of 160kw until 640 kw are shown in Figure 14. The same step reduction in PV output is applied in a system with PVSG and the frequency responses are capture in Figure 15. It is clear from Figures 14 and 15 that frequency dip has been improve significantly for a system with PVSG. The real power output of PVSG unit and real power response of the gas turbine with PVSG unit are shown in Figures 16 and 17 due to this PV set point changes. Fig 16 shows smooth response of PVSG unit as a step change of PV inverter which results to better inertia support for the system.

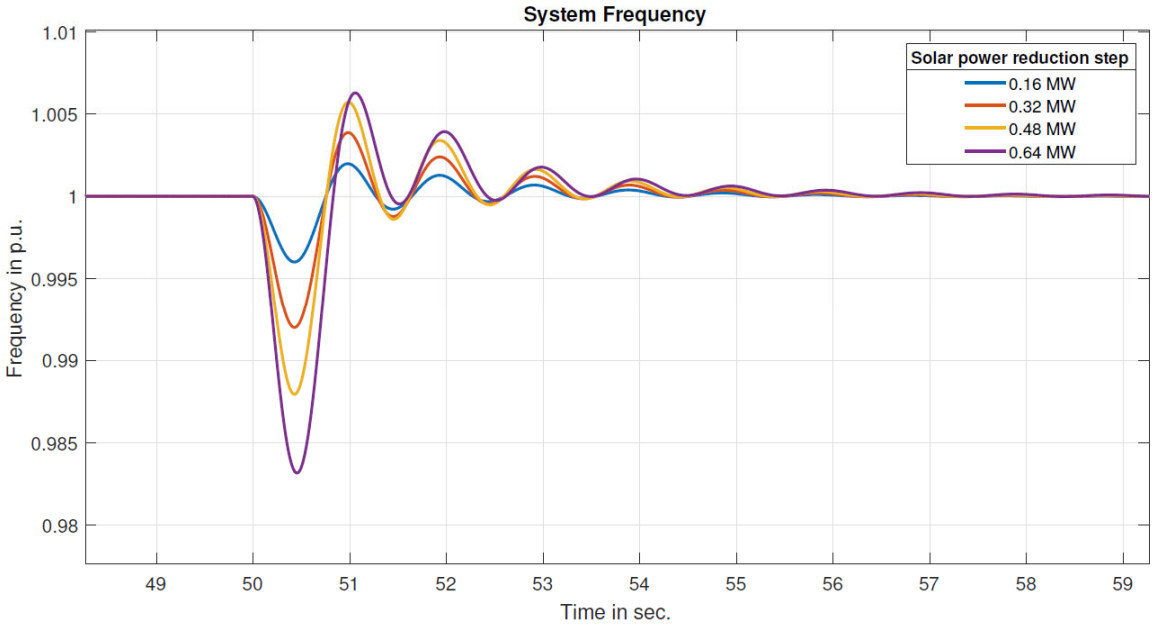

Fig. 14. Time-domain frequency response to step changes in PV inverter set-point with steps of 160 kW in the system without SG emulator.

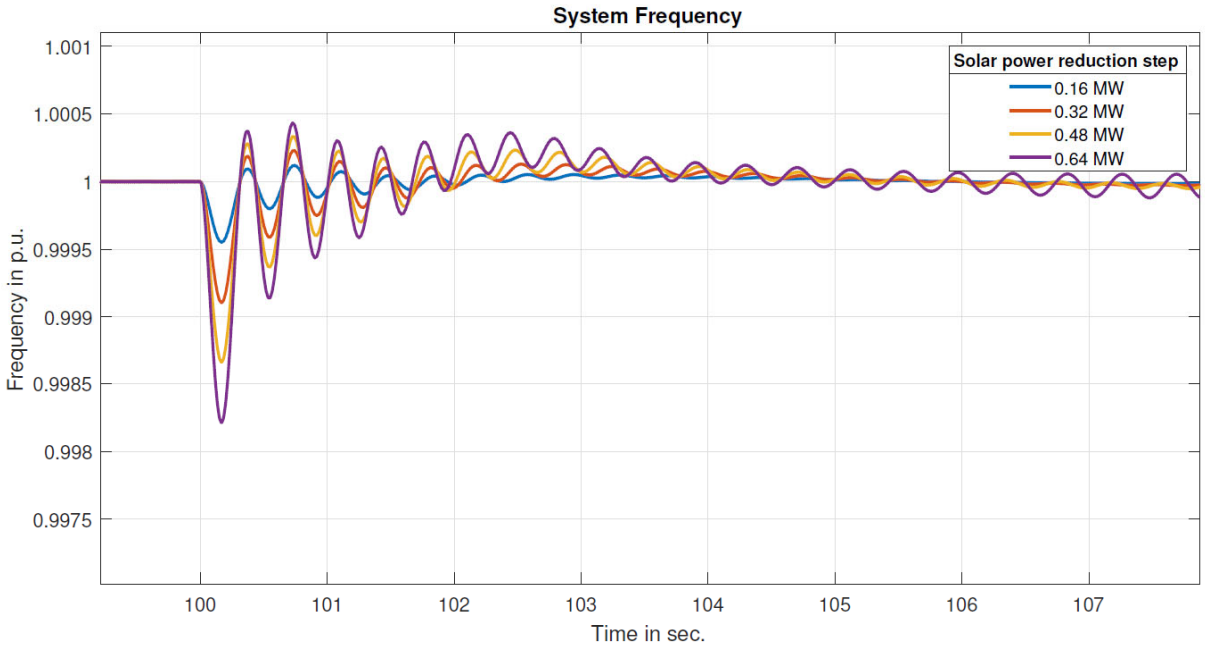

Fig. 15. Time-domain frequency response to step changes in PV inverter set-point with steps of 160 kW in the system with SG emulator.

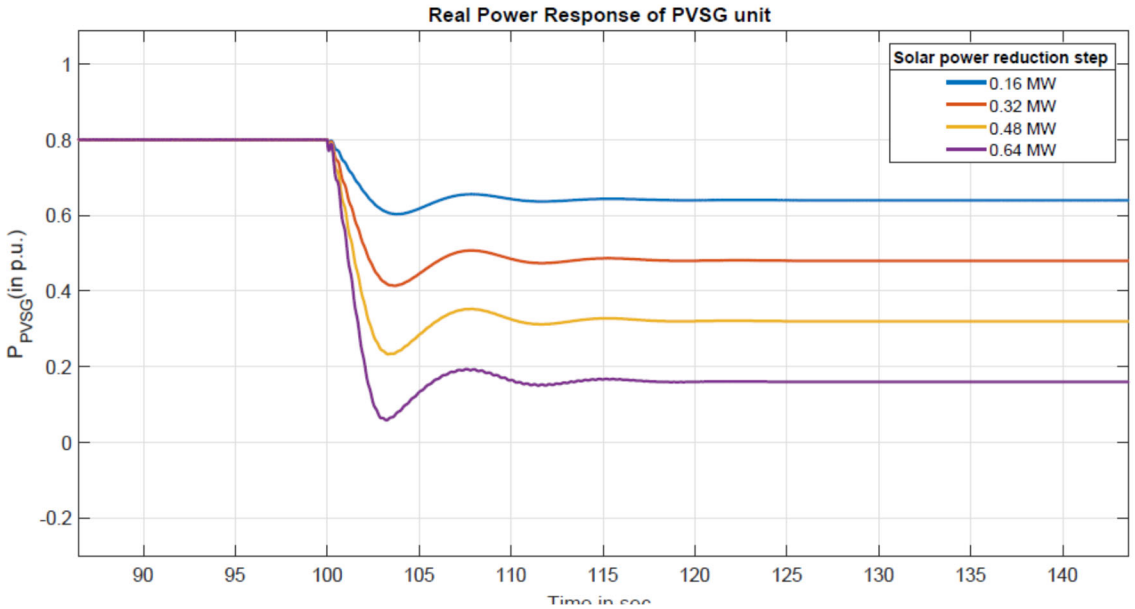

Fig. 16. Time-domain PVSG power response to step changes in PV inverter set-point with steps of 160 kW in the system with SG emulator.

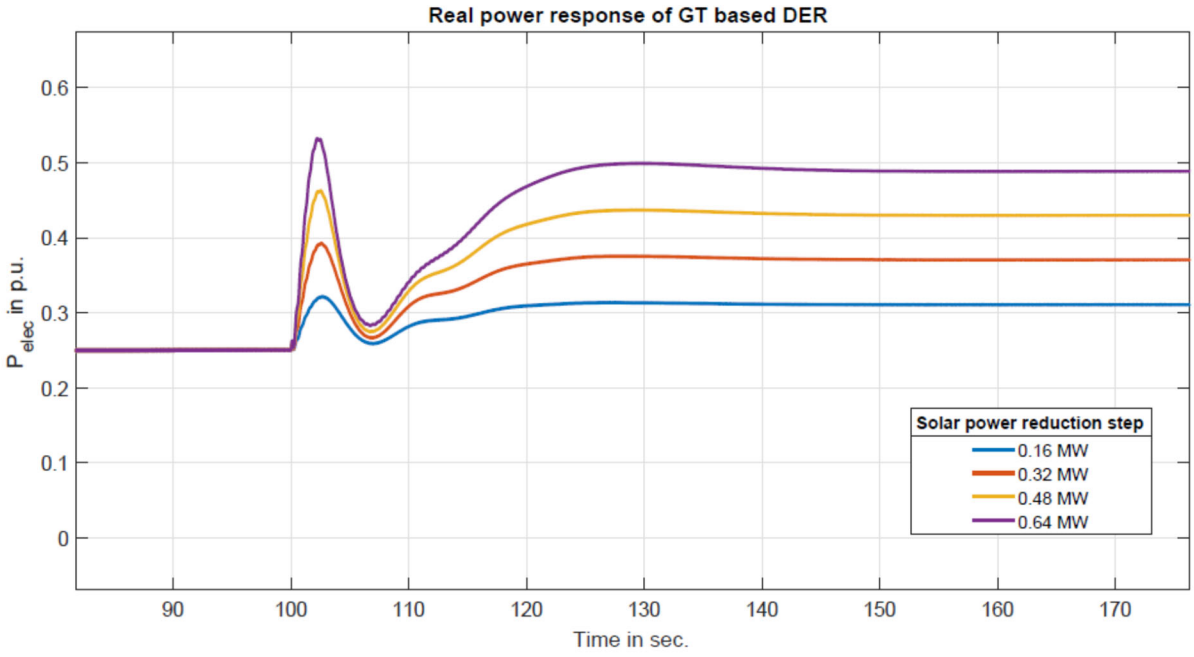

Fig. 17. Time-domain gas turbine power response to step changes in PV inverter set-point with steps of 160 kW in the system with SG emulator.

3.5 Technical Presentations and Live Demonstration

Several technical presentation and live demonstration of the PVSG system conducted for the researchers from academia, DOE, and industry at CAPER meetings and also in Semiconductor Power Electronics Center (SPEC), University of Texas at Austin, Austin, TX that are illustrated in the following figures.

Fig. 18. Project Progress presentation at Fall 2018 CAPER meeting in Charleston, November 15, 2018.

Fig. 19. Project Progress presentation at spring 2019 CAPER meeting in Raleigh on Mach 28, 2019.

Fig. 20. Project final presentation at Fall 2019 CAPER meeting in Charlotte on November 15, 2019.

Fig.21. Live PVSG Demonstration to Duke Energy, Austin Energy, and Clemson University on October 7, 2019.

Fig.22. PVSG Demonstration to DOE guests on November 7, 2019 and January 29, 2020.

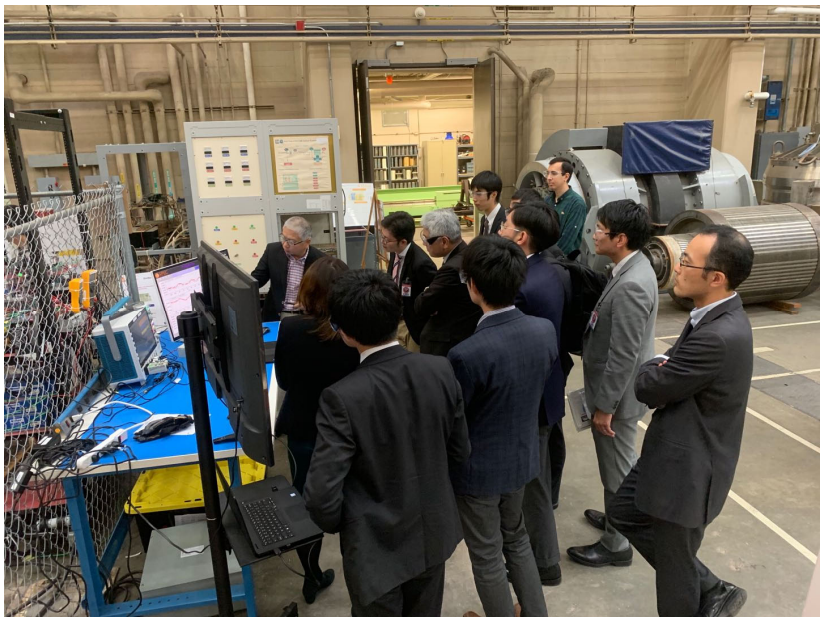

Fig.23. Demonstration to Japanese researchers from NEDO, TEPCO, Chubu Electric Power Company, Chugoku Electric Power Company, Kyushu Electric Power Company, Kansai Electric Power Company, Japan Electrical Manufacturers' Association and Mitsubishi Research Institute, Inc on November 18, 2019.

Fig.24. Live PVSG Demonstration to ERCOT and Austin Energy on February 4, 2020.

JENNINGS CONFIDENTIAL EXHIBIT NO. 5

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 6

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 7

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 8

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL

Loyd Ray Farms, Inc.
Innovative Animal Waste Management System
Permit No. AWI990031
Permit Compliance Semi-Annual Report

January 1, 2019 – June 30, 2019 Semi-Annual Reporting Period

Submitted July 31, 2019

Submitted on Behalf of:
Loyd Ray Farms, Inc.
2049 Center Rd.
Boonville, NC 27011

This Annual Compliance Report provides an overview of the manner in which the subject facility, Loyd Ray Farms, has maintained compliance with the conditions of the Innovative Animal Waste Management System permit for the reporting period from January 1, 2019 through June 30, 2019. During this reporting period, the system was operated in accordance with the Innovative Swine Waste Treatment System and subject to the requirements thereof. Additionally, detailed site visits recording maintenance and repairs completed during the second half of 2018, from July 1 through December 31, 2018 are also included in this report.

In summary, From January 1, 2019 through June 30, 2019, although the processes that comprise the innovative swine waste treatment system were periodically fundamentally operational, and the electricity generation was capable for some of the reporting period, difficulties with the SCADA system after a power outage disrupted much of the data for this reporting period, much of which was unrecoverable. Overall, the system was less functional than the previous reporting period, as repairs on the digester pump and digester cover were necessary, but the monitoring team made every effort to keep things running as efficiently as possible in accordance with power generation, and from the perspectives of greenhouse gas emission reduction and environmental performance. The maintenance activities were a little more accelerated as the system is getting older, however the repairs

made at the end of this period should keep the system functioning well for quite some time. Actual observation logs of system performance are exhibited in the operator log attached to this report. (Appendix A). In addition to addressing compliance with the conditions of the permit, the following summaries provide an overview of the system operations including graphs of systems performance, the Microturbine performance, and biogas levels (page 3). Sampling and reporting requirements per the Innovative Animal Waste Management System Permit No. AW1990031 can be found on (pages 30--32). For each requirement, this report records on-site monitoring that occurred, with a brief explanation for each farm site visit. The Operations Log data for January through March 15th is missing, as the data lost from the SCADA system and computer was unrecoverable, but starting with March 15th, it appears on (pages 19-27).

Also due to SCADA issues during the reporting period, it was impossible to estimate the uptime of the environmental treatment system, or microturbine output production. Downtime resulted from maintenance activities which are further described in the Operations Logs (Pages 19-27).

This report was completed on behalf of Loyd Ray Farms, Inc., by Cavanaugh & Associates, P.A., under the direction of the Duke Carbon Offsets Initiative (DCOI). Please contact Matthew Arsenault with any questions at 919-613-7466 (Matthew.Arsenault@duke.edu). A copy of this report will be provided to Loyd Ray Farms, Inc., and will be maintained on-site with the other permit compliance documentation.

Overview of System

The animal waste treatment system installed at Loyd Ray Farms is designed to meet the Environmental Performance Standards set forth by North Carolina law for new and expanded swine facilities through the use of nitrification/denitrification and further treatment. This report confirms on a semi-annual basis that the innovative waste management system is in compliance with NC Department of Environmental Quality and its divisions, to insure that the utilization of the anaerobic digester technology to turn raw animal waste into biogas for the purpose of reducing greenhouse gas emissions minimizes the overall environmental impact of the swine farm, and explains the occurrences of operations, and testing requirements over the six month period, to monitor the system, as it continues to produce renewable energy, generate carbon offsets, and reduce odor on the farm. The report is designed to not only show a synopsis of the maintenance activities on the farm, but also to supply the analysis of the system's performance and further describe the results of the monitoring and testing activities.

During this compliance period, ambient air analyses during the Spring and Summer months were accomplished on March 14, 2019 and June 13th, 2019, respectively, details of the monitoring events have been added to this report (pages 35-40). The air emissions from water surfaces were found to be in compliance and show that the system is performing according to expectations.

Overview of System Maintenance and Repairs

Maintenance and repairs completed during the second half of 2018, from July 1 through December 31, were included in the Semi-Annual report submitted to NCDENR DWR in January of 2019; and are hereby incorporated by reference. For the time period from January 1, 2019 through June 30, 2019, which is the period covered by this report, most processes that comprise the innovative swine waste treatment system were operational, however, as mentioned the system was less functional due to necessary repairs to the digester pump, digester cover and to the SCADA system. Unfortunately, because of the data system crash in April, we could not recover the data from January 1st through April 9th, so the graphs represent only the dates

for which recorded data was available from the SCADA system. The same is true for the period of June 20th through June 27th due to an internet connectivity issue. The SCADA system started recording again on June 28th, the date of the repair.

Figure 1. below depicts the Microturbine Output in kilowatt hours (kWh) during the compliance period. Biogas flow is also monitored and recorded for the system. The biogas may only be disposed of through use by the microturbine and flare, controlled release through venting, or leaks from the system, which cannot be measured. The following graph illustrates the measured biogas usage for the system. During the months of January through April 9th, the zero-flow recorded is indicative of the disruption with the data acquisition system, which has rarely occurred during the entirety of the monitoring. The following chart normally depicts the same dataset for the duration of the reporting period, however, because we were experiencing difficulties with the SCADA system particularly from the beginning of January to April 9th, the results are perceived as no flow, however the system was under operation and working for much of that time period. The microturbine output was averaging about 50 per kilowatt hour for most of the monitoring period that was recorded, but again is missing the information from June 20th to June 27th.

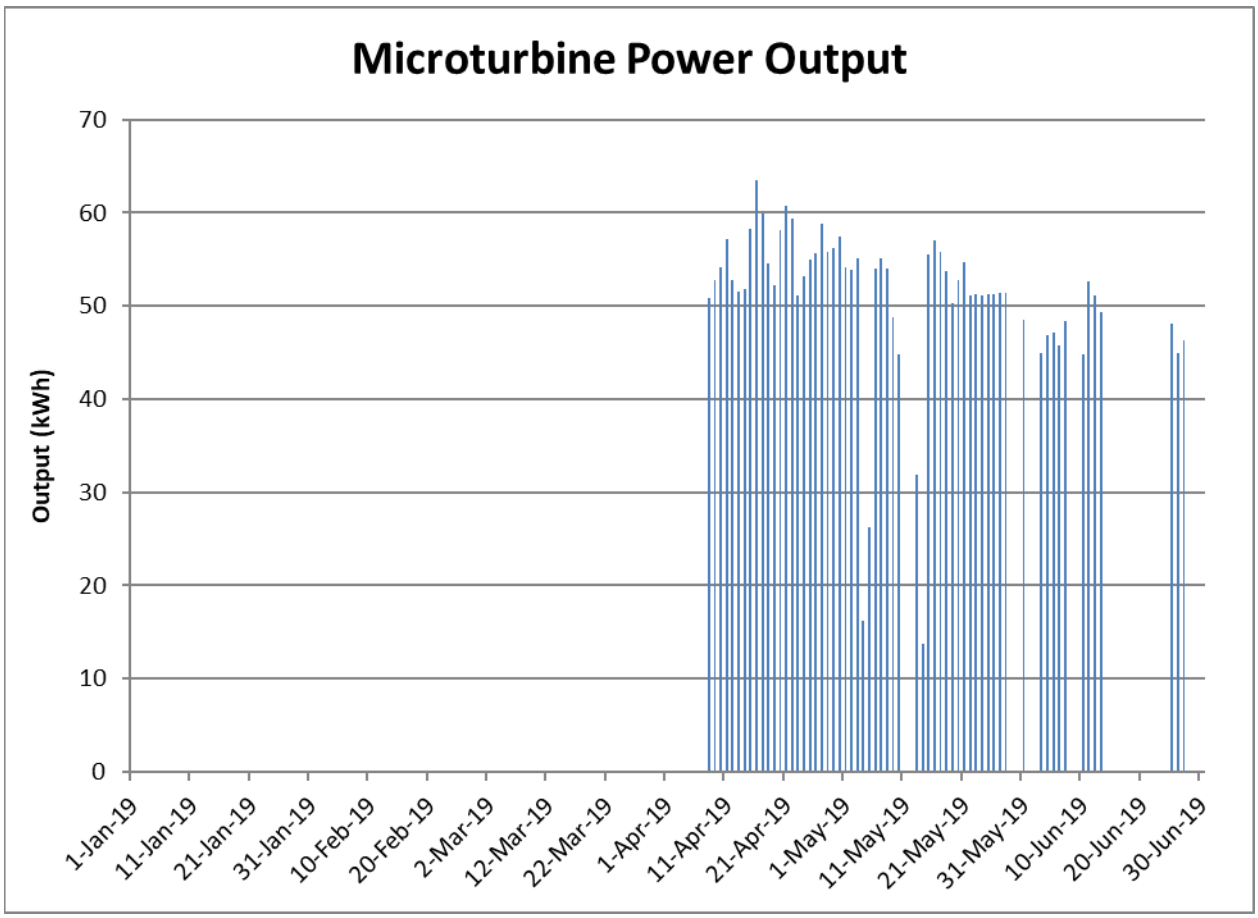

Figure 1. Microturbine Output in Kilowatt Hours (KWh) (January 1, 2019 -June 30, 2019)

Figure 2., *Measured Biogas Flow and Flare Usage*, which follows, depicts the dataset relative to the measured biogas flow and flare usage, which utilizes the same dataset for the duration of the compliance period. Similar to the Microturbine Output graph above, this graph also depicts the data loss for the months of January through April 9th and the period from June 20th through June 27th, of the reporting period. Once the required maintenance activities were accomplished, and the system returned to operational, the performance was normalized. The volume of gas is measured in standard cubic feet per minute (SCFM). Prior to May 1st, the system was averaging approximately 20 SCFM of biogas flow, which increased to an average of 23 SCFM in the months of May and June, with a few intermittent spikes on days of very high gas flow reaching to 30 SCFM or above.

The following graph illustrates the measured biogas usage for the system. Flare usage, as indicated by measured flow to the flare meter, for the reporting period may also be surmised from the graph. The flare was not operational from early April through June 30th due to a blockage in the flare's flame arrestor. It should be noted that days that indicate zero flow may also indicate a disruption with the data acquisition system, as described above. Microturbine flow is shown in red.

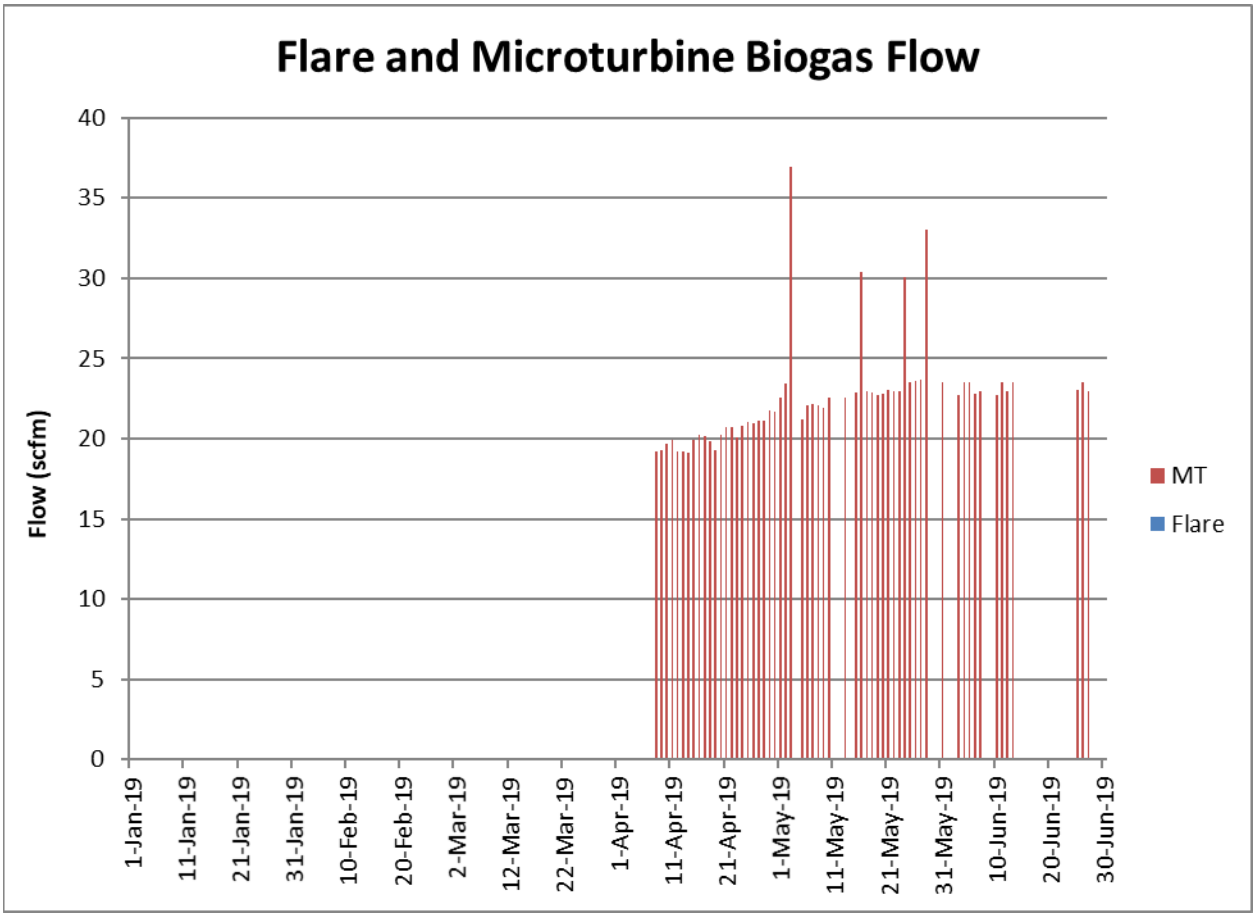

Figure 2. Measured Biogas Flow and Flare Usage (SCFM)

Environmental Treatment System

Figure 3. below, **Environmental Treatment System Uptime**, depicts the operation of the aeration system that performs the nitrification function for the monitoring period. The environmental treatment system was running for most of that period, although the inconsistent data makes it impossible to estimate an overall uptime. The data for the time period prior to April 9th was lost due to the SCADA issues. Just after April 9th, the data estimates the environmental treatment system reached its culmination point and was operating for almost 22 hours per day, but went down again in the start of May. The Loyd Ray Farms Inspection and Operation Log Sheets detail the activities which required repairs, which included repair of the digester pump, the breaker, and ordering new circuit boards for installation. Unfortunately, the SCADA issues were not resolved until the last few days of this monitoring period.

Figure 3., *Environmental Treatment System Uptime*, normally reflects the uptime for the compliance year (January 2019-June 30, 2019), but the percentage is hard to estimate due to the recording issues aforementioned in this report. Extraordinary circumstances caused the circuit board fans to cause systematic shutdowns, which required manual reboots, however, it could not continue running for long.

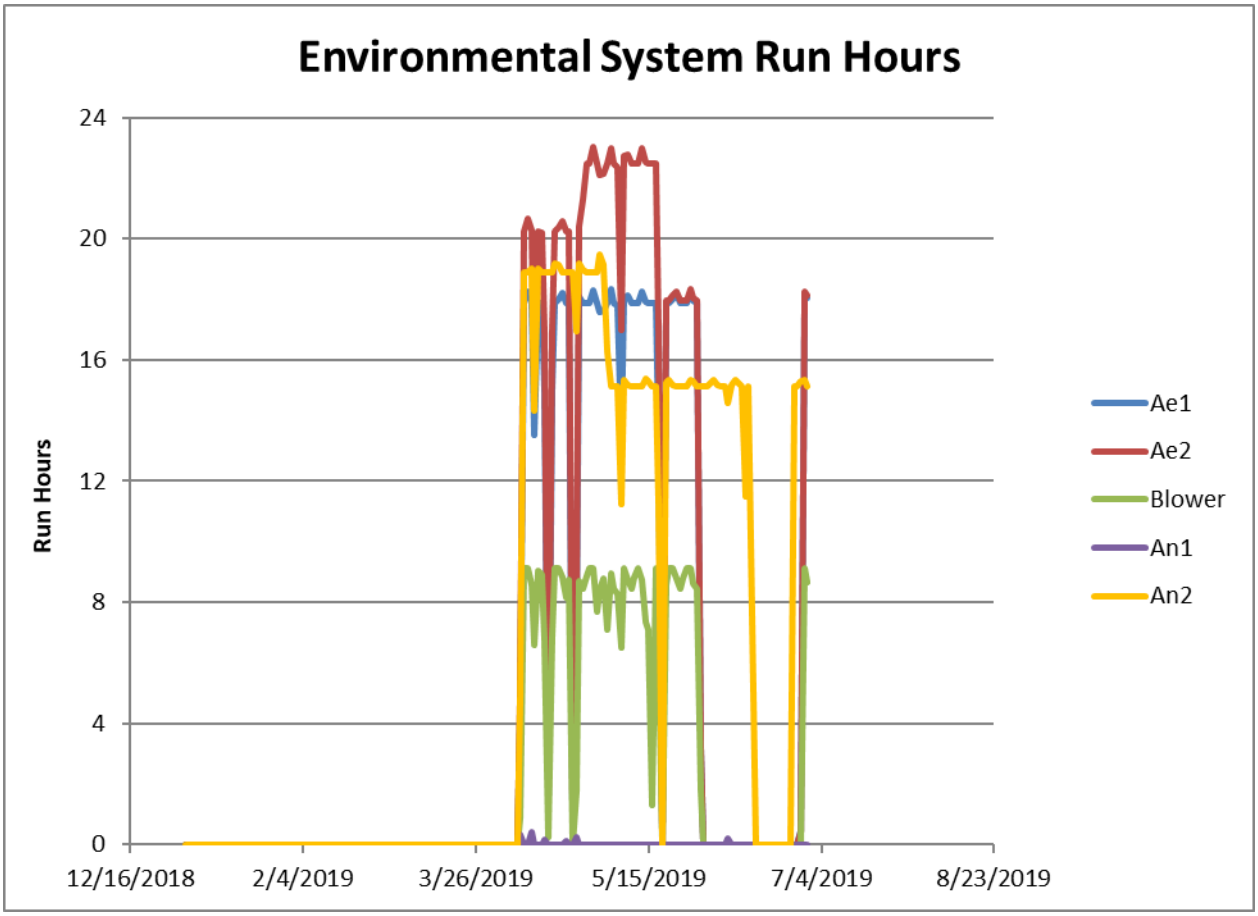

Figure 3. Environmental Treatment System Uptime (January 1, 2019 -June 30, 2019)

Figure 4., *Microturbine Run Hours*, normally reflects the uptime for the compliance period (January 2019-June 30, 2019), but the percentage is hard to estimate due to the recording issues aforementioned in this report.

The missing data from January through April 9th shows downtime. After April 10th, the monitoring indicates that the microturbine was running almost 24 hours daily, but was short-lived only until the start of May when problems arose with the digester pump, and the SCADA issues could not immediately be resolved.

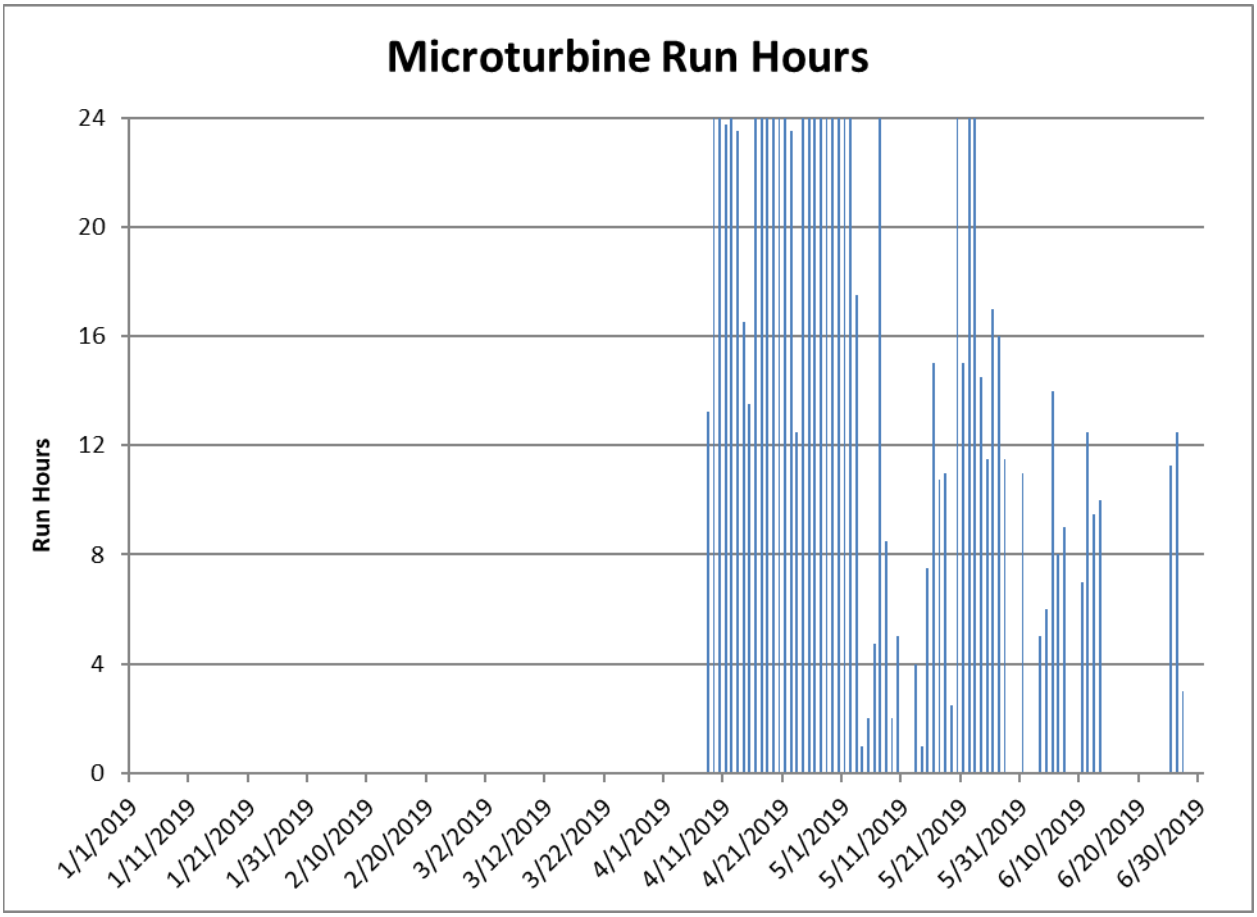

Figure 4. Microturbine Run Hours (January 1, 2019 -June 30, 2019)

Overview of System Maintenance and Repairs

Overall, the biogas system and the environmental treatment system operated in compliance with the requirements of the permit during the reporting period. We did, however, encounter some problems with transmission of the data due to weather-related occurrences which caused the Microturbine to fault, and precipitated frequent site visits to reboot the system. We also recorded some biogas conditioning skid downtime due to the hot weather. All maintenance which required troubleshooting by site visits or outside technical support appears in the log below, as maintained and recorded physically in the **Loyd Ray Farms Inspection and Operation Log Sheets**. In this six-month period we also experienced SCADA data acquisition system downtime, which impaired our ability to record all the data from the operating systems. During this time, monitoring was a little more labor-intensive for the Cavanaugh team who did their best to monitor the system in person, and log

the activities in the report. While several efforts were made to repair the SCADA system, the SCADA repair, which required work on the circuit boards, was not fully accomplished until June 28th, at the end of this recording period. The electrical technician working on the circuit boards determined, in his opinion, that the turbine SCADA issues, which were initiated by storm damage, may be a result of an errata in the SCADA programming; likely a result of a loss of the SCADA computer hard drive and reinstallation of the software. Unfortunately, we were unable to recover a portion of the lost data, and thus, there is a gap in the Operation Log Sheets from January through March 15th.

In early April, the Cavanaugh monitoring team requested a necessary repair of the digester mixing pump. In anaerobic digester systems, the mixing pump is crucial for recirculating the sludge so it does not separate into layers, and keeps the sludge moving to prevent incomplete digestion, scum formations or settling of the feedstock composition into layers. It took some time to get the technician out to the farm but after diagnosing the problem, the technician explained that the mixing pump loses prime due to high sludge levels, and found that the rotating unit of the pump needed to be replaced. While the digester pump was not working properly it created pockets of gas all over that we were unable to vent, and it was more gas than the microturbine could burn. All replacement parts were identical parts of the existing pump, as were the filters that were replaced. Another purchase was a water removal cover pump to remove extra water on the cover, which again was the replacement of the same pump previously used.

Another major expense this year was the digester cover repair which was necessary because of storm damage. After a visit to do an analysis of what the work entailed, Plastic Fusion Fabricators submitted a price proposal estimating the cost of repairs, which were approved by Duke University and accomplished by Plastic Fusion Fabricators at the end of May.

The summary of the detailed operations log of on-site activities and monitoring for the period of January 1, 2019 through June 30, 2019 is presented as follows. The site was monitored by Kevin Harward and Marvin Cavanaugh in January 2019, by Marvin with backup from Steve Cavanaugh from February through May 30, 2019, and by Ben Cauthen and Steve Cavanaugh with coaching by Marvin Cavanaugh in June. The records below described the observances, and the presence of others who visited Loyd Ray Farms to do testing or repairs.

Date	Observation
7-2-2018	Monitored system remotely
7-25-2018	Site Visit to meet with Alex Gusnes of E-finity. We serviced the Microturbine (MT) and replaced air filter and the faulty fan we had been running. We found a faulty Rosemount meter which was registering incorrectly going to the MT. Also pumped surface water and did a site inspection.
7-27-2018	After remote monitoring, did a site visit. Pumped surface water and did a walk around site check. Turned flare on with 10 CMF going to flare.
7-30-2018	After remote monitoring, did site visit. Pumped surface water and performed site check. Flare off the balloon is getting low, as 5 of the 9 hog farms are empty. I installed a temporary

	cover for gas MH and dug a small ditch to help divert water away from the MH. Most operations automatic, with the exception of flush pumps by hand.
7-31-2018	Remote system monitoring during storms and heavy rainfall.
8-1-2018	Remote system monitoring, then site visit to inspect and review storm damage. After 6 inches of rain, worked all day with all entities to try and restore system back to normal operations. Monitored operations after storm damage trying to keep it running
8-2-2018	Remote system monitoring, then site visit to review storm damage. After 6 inches of rain, worked all day with all entities to try and restore system back to normal operations. Monitored operations after storm damage trying to keep operations running in stable mode.
8-3-2018	Monitored system remotely, checking to make sure post storm operations are normal.
8-6-2018	Monitored system remotely, then site visit to try and start the system. The gas balloon is growing, I started the flare, and pumped surface water and nursed the system to run. It failed twice due to heat, the outside temperature was in the 90's today.
8-7-2018	Monitored system remotely, then site visit to restart and monitor the operations. I shut the Flare off, as the balloon reach the level needed to shed rain. Pumped surface water and nursed the system to run. Communicated with reps at Unison and E-finity. A technician from E-finity is scheduled to be here on Thursday.
8-11-2018	Monitored system remotely, then site visit to do a restart after skid shut down because the MT would not start remotely. I ran a test and found that the MT failed to restart automatically after a skid shut down, so I started the flare. I will do a follow-up email with Nick at Unison.
8-13-2018	Site visit to do a restart of system with E-finity. We had a good start up, but now a skid warning for 33/342 reheat temp at 2:45 p.m. Will do a follow up email to Nick at Unison.
8-14-2018	Site visit to do a restart of system with E-finity. After the heat up at 2:45 p.m. yesterday, the skid was restarted, but the MT would not start, so I shut it down. I have restarted the skid today and will get E-finity to unblock the MT, and re-start it. Did a walk around inspected the system and started the auto pump for surface water.
8-16-2018	Monitored system remotely, Site inspection. Started the surface water pump. During the night, the Flare would not start. I turned on the mail at the MT, and it ran fine. I took influent, digester and effluent samples.
8-19-2018	Monitored system remotely, we had a shut-down today (Sunday). This was due to the outside temperature, after it cooled, I accomplished a successful restart of both the skid and the MT.

8-20-2018	Walk around inspection and site visit, operations are working normally.
8-21-2018	Monitoring system remotely, experienced a couple of shut downs, but was able to restart remotely.
8-22-2018	Monitoring system remotely, experienced a couple of shut downs, but was able to get back on line remotely.
8-23-2018	Site visit to meet with Matt Arsenault, Alex Gusner of Duke University, and Sarah Lanier (a student there). We took samples from the Lagoon Basin and Digester and also gas samples. I performed a site inspection and restarted the automatic pump and another non-automatic pump to handle surface water on the cover. System operations are normal.
8-27-2018	Site visit to do an On-site inspection, system and ground check. I worked on the camera with little success, system operating normally.
8-29-2018	After remote monitoring, did a site visit, tried to adjust the camera, system operations are running normally.
8-30-2018	System monitored remotely, then Site visit to do a system and ground check. Found the Unison system down. I tried to hard boot it, with no success. Unison is scheduled to be here on 9-10-2018, and I will call Unison to discuss.
9-5-2018	Remote monitoring this week.
9-10-2018	Site Visit. Met Marty Kass of Unison there to do service work. Flare is burning gravity gas. We found out we had no power. I called Salem Electric to do an emergency visit. They think the transformer is bad, and are checking on a source for a replacement one.
9-11-2018	We are still without power. Marty Kass of Unison, and Keith and Bryan from ProPump were on site, and I asked them to assess the no-electricity situation. They found the phase converter was bad, which showed like a bad transformer. They took down the two-phase converters and will ship them off to be rebuilt. They are also troubleshooting to change the flush pump from 3-phase to single phase, and are working to rebuild the IT. Marty Kass of Unison could not finish his service, and went to another job close by.
9-12-2018	ProPump returned with the converter rig for the flush pump and wired it inside the building to the pump with Kevin's help. We were able to get it back online and were able to flush.
9-13-2018	Flare is burning gravity gas. Kevin and Marvin worked to unclog the digester pump, but it is still clogged.
9-14-2018	Flare is burning gravity gas. Site visit to monitor operations and to prep for upcoming Tropical Storm Florence, which may be a hurricane.
9-15-2018	Monitored system remotely, flare is burning gravity gas.

9-15-2018	Monitored system remotely, then site visit to check system and water levels, flare is burning gravity gas.
9-16-2018	Remote monitoring, Flare is burning gravity gas, Site visit to check system and water levels.
9-17-2018	Remote monitoring, Flare is burning gravity gas
9-18-2018	After remote monitoring, went to Site to do a system and ground check. Found digester pump still clogged, tried to back flush system, but was not able to get valves open. The balloon is growing so I vented for one hour. The auto bilge pump failed, so I pumped surface water with two pumps for two hours.
9-22-2018	Remote monitoring, then site visit to check gas levels. Still flaring, but only had to vent once.
9-23-2018	Monitored system remotely, No Site visit today. System is still flaring, but not venting, only once.
9-24-2028	Monitored system remotely, No Site visit today. System is still flaring, but not venting, only once.
9-25-2018	Site visit to do a system and ground check, and found the digester pump still clogged, tried to backflush to see if I could unclog. I am still flaring but vented only once. The auto bilge pump failed so I pumped surface water with two pumps for the entire visit.
9-26-2018	Site visit to do a system and ground check, and found the digester pump still clogged, tried to backflush to see if I could unclog. I am still flaring but vented only once. The auto bilge pump failed so I pumped surface water with two pumps for the entire visit.
9-27-2018	Site visit to do a system and ground check, and found the digester pump still clogged, tried to backflush to see if I could break it free. I finally got the Digester pump to work, and plan to let it run all night to get it cleaned out. Still flaring the gas, vented only once. The auto bilge pump still failing, so I pumped surface water with two pumps for the entire visit.
9-28-2018	Site visit to do a system and ground check. Found the digester pump still working, so I moved it to the auto cycle. Pumped surface water during the site visit, vented at 2 ports for two hours.
10-1-2018	Site visit for system and ground check. Found digester pump still working, so I kept it on the auto cycle. Pumped surface water during the site visit.
10-2-2018	Site visit for a system and ground check. Operations are normal and the digester pump, remains on auto cycle. Pumped surface water. Conducted a tour of Duke University students and professors who came to observe operations.

10-3-2018	Site visit for a system and ground check. Digester pump still operating correctly, remains on auto cycle. Pumped excess surface water during the site visit.
10-4-2018	Monitored system remotely, no Site visit today.
10-5-2018	Site Visit to do a system and ground check and found our digester pump still working so I kept it on the auto cycle. Pumped surface water during site visit. Vented at two ports for 2 hours
10-6 & 10-7	Monitored system remotely without incidence.
10-8-2018	Site Visit to do a system and ground check and found digester pump still working so I kept it on the auto cycle. Pumped surface water during site visit. Met with Josh Amon to get the repaired Digester Pump installed. We worked on getting pumps unclogged, we are going to try to run as long as possible but not leave them unattended for a while, as sometimes they clog up and no fluid is being pumped.
10-9-2018	Site Visit for system and ground check, digester pump still working. Pumped surface water during site visit. I changed the timers and after the Digester pump restarted with a prime, I am going to try it through the evening.
10-10-2018	Site Visit to do a system and ground check and found our digester pump still working. Pumped surface water during site visit. I changed the timers and after the Digester pump restarted with a prime I am going to try it through another evening.
10-11-2018	Pumped surface water during site visit. I changed the timers and after the Digester pump restarted with a prime I am going to try it through another evening. Heavy rains from Michael with some flooding in the ditch. Mr. Bryant not happy with the ditch. Lost power for an hour or so all back running and seeing breaks in the clouds
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10-12-2018	Pumped surface water during site visit. I changed the timers and after the Digester pump restarted with a prime I am going to try it through another evening. The Flare continues to run on gravity gas flow of 8-10 CFM I needed to vent today at two ports for 2.5 hours
10-14-2018	Monitored system remotely, particularly the flare.
10-15-2018	Site Visit to do a system and ground check and found our digester pump still working. Pumped surface water during site visit. The timers are working well with the restart of the Digester pumps. I am going to leave them as they are for now. The Flare continues to run on gravity gas flow of 8-10 CFM. No venting since Friday 10-12-2018.
10-17-2018	Pumped surface water during site visit. The timers are working well with the restart of the Digester pumps. I am going to leave them as they are for now. The Flare continues to run on gravity gas flow of 8-10 CFM. No venting since Friday 10-12-2018.
10-18-2018	Remote monitoring
10-19-2018	Pumped surface water during site visit. The timers are working well with the restart of the Digester pumps. I am going to leave them as they are for now. I worked on Drainage some. The Flare continues to run on gravity gas flow of 8-10 CFM. No venting since Friday 10-12-2018.
10-21-2018	The Flare continues to run on gravity gas flow of 8-10 CFM. No venting since Friday 10-12-2018.
10-22-2018	Site Visit to do a system and ground check and found our digester pump still working. Timers continue to work well, worked on drainage more. No venting since Friday 10-12-2018.
	Site Visit, no changes since yesterday.
10-24-2018	Site Visit, Pumped surface water during site visit. The timers are working well with the restart of the Digester pumps. The Flare continues to run on gravity gas flow of 8-10 CFM. No venting since Friday 10-12-2018.
10-25-2018	Site Visit, no change since yesterday.
10-26-2018	Site Visit needed to check system the team viewer was not working dependably we need to install cameras ASAP to save on visits. Timers still operating correctly to restart pumps. No venting since 10-12-2018.
10-28-2018	Monitored system remotely.
10-29-2018	The Flare continues to run on gravity gas flow of 8-10 CFM. No venting since Friday 10-12-2018. Technicians from ProPump were on site installing the Phase converters and setting up for the wiring changeover of Flush Pump from 1 Phase back to 3 Phase

10-30-2018	ProPump was on site installing the Phase converters and setting up for the wiring changeover of Flush Pump from 1 Phase back to 3 Phase, Kevin Harward joined us to assist. We put boat in Basin for the wiring change on the Flush Pump.
10-31-2018	Site visit, Kevin Harward came to the farm to install a power part on the Unison system. We attempted to start the system, but the chiller had a failure and would not start. We are trying to get help resolving the problem. ProPump will probably need to come back and help with the SCADA. Kevin and I moved the hose to push some of the digester sludge water to the Lagoon
11-1-2018	Site visit to accomplish a manual restart after an overnight failure, then working with folks from ProPump, trying to get SCADA to communicate with the Unison skid. The MT and skid were running again and no flare. Talked to ProPump via phone to set up for the SCADA repair.
11-3-2018	Steve Cavanaugh made a Site visit to start the conditioner. The MT failed after several tries it shut down.
11-4-2018	Site visit to start conditioner and MT. I found conditioner running but the MT not running and SCADA not recording properly. The MT failed after several tries it shut down. I then did a hard boot and it has been running since 11:05 AM. The MT is producing 59.6 output 54.9 on 18.3 CFM. I will monitor and keep records of output until SCADA can be fixed.
11-5-2018	Bryan from ProPump came to farm to work on SCADA, I was able to talk him through a restart. He had to drain the water from the gas pump on the south end of the skid and then the skid would start. I made a site visit to meet with Bryan. We were able to get the Skid and SCADA communicating and we are now running full bore. We have a lot of gas and I plan to stay as long as possible running both flare wide open; and the MT wide open burning about 50 CFM. I shut the Flare off at 4:30 PM
11-7-2018	I turned the flare off before I left on Monday and monitored remotely all-day Tuesday. Site visit today, the gas is still up, and the MT has been running since Monday.
11-8-2018	Site visit today, had a power blip that shut off team viewer, when I got to the site there were no alarms and the computer was back up the skid was just sitting there and not running, and the MT was in standby mode. Started the skid and when it was ready and sending to the MT; the MT would not start it was on, but not starting. I had to shut-off the breaker as before and when I turned it back on the MT started automatically. The gas volume is still up, and I will return tomorrow, and we may need to flare. Eight of the 9 hog houses are full of animals, loaded one out just now leaving the 8. The MT has been running since Monday,
11-9-2018	Site visit today, we have been running up until around 12:33PM we had a skid fault of high condensate at 741. I reset and restarted skid and the MT came on as it is supposed to at 2:00 PM. I started the flare to run while I am on site as the gas volume is still up. I did a walk around and up on the cover all is well. I installed a replacement fridge today. I received a new camera and will try and install it next week.

11-10-2018	Remote monitoring all day; we had three shutdowns and then late we had a MT fault. No site visit
11-11-2018	Site visit to restart the MT, as remote monitoring indicated a fault on the screen and the breaker had tripped. I had cut the skid off when the MT was in fault, so I restarted it, reset the breaker and opened the Flare valve. Everything restarted as it should have.
11-12-2018	Site visit to restart the MT I found a fault showing on the screen and the breaker had tripped. I had cut the skid off when the MT was in fault, so I restarted it, reset the breaker and opened the Flare valve. Everything restarted as it should have. This is the same as yesterday. I started the Gravity-flow Flare and it is running 10+ CFM, even though it does not seem to register on SCADA
11-13-2018	Remote monitoring, shutdown today, will do a site visit tomorrow.
11-14-2018	On Site Visit, I started the Gravity Flow Flare and it is running 10+ CFM even though it does not seem to register on SCADA and I am glad because we had a shut down on Tuesday.
11-15-2018	Site visit to restart system it refused to restart, but after 3 tries, I finally got the system restarted.
11-16-2018	Site Visit, due to shut-downs this week. I started the Gravity Flow Flare and it is running 10+ CFM even though it does not seem to register on SCADA and I am glad because we had a shut down on Tuesday and Wednesday and another during the evening on Thursday. Site visit to restart system and I found that the skid is not communicating with the SCADA and I am unable to start and stop or monitor skid data. I was able to re-start the skid and the flare continues to burn on gravity as above. The MT started as it should, and is running fine. I will monitor but if we shut down then it will be Sunday before I can manually restart. We need to burn all the gas that we can, the volume is high.
11-18-2018	During the evening on Thursday and again after site visit on Friday we had shut-downs. Monitored off and on Saturday, Flare burned at 10+CFM all the time. We need to burn all the gas that we can the volume is high. Site visit to try and restart system I had to do a hard boot of the Skid and the MT before I could get the System to run properly. When I did the hard boot on the Skid the communication with SCADA came back?? We are up and running again.
11-19-2018	Site visit to try and restart system Kevin restarted and was able to re-establish the communication Skid to SCADA by resetting at the panel several times. The MT started as it should at 12:52 PM. We started the flare through the conditioner and opened 2 vents at 1:45 PM. We had a shutdown at 3:16 PM and a quick restart. We shut the vents off at 3:45 venting for 2 hours. I cut the flare off coming through the Skid and restarted the Gravity Flow Flare and it is running 10+ CFM.

11-20-2018	Kevin and Marvin did a Site visit and took quarterly water samples. Had to reset the communications on the Unison panel as it shut down yesterday, acting like power is lost on the panel or something is going bad. Able to restart Skid and MT at 10:30a.m. Contacted Unison to let them know the issues hopefully get it fixed and or schedule a site visit soon. Think we have 2 bad level switches on the skid, they keep tripping-off and on, for 5- 30 seconds, once they are on for 30 seconds, the alarm is tripped, one is a high-level switch and is causing a shut down, again will let Unison know. We installed the new camera and set it up on team viewer. We did a walk around and up on top to check for leaks
11-21-2018	We did a site visit to restart same problem shutdown for condensate that is not there and faults out, so we cannot restart remotely but have to go to site to manually restart. Gravity Flare is burning at 10+ CFM
11-22-2018	Monitored system remotely most of week, trying to burn all the gas we can while the volume is high.
11-26-2018	Had to reset the communications on the Unison panel which shut down yesterday, acting like power is lost on the panel or something is going bad, was able to restart Skid and MT at 4:00PM. I emailed Unison to try to troubleshoot site issues and requested a site visit hopefully to get it fixed as soon as possible. Think we have 2 bad level switches on the skid, they keep tripping off. We did a site visit to restart, without success. The same problem occurred; shutdown for condensate that is not there, and the system short circuits, or faults out, disrupting the normal flow of the system, so we cannot restart remotely but must visit the site manually to restart. Gravity Flare is burning at 10+ CFM Started venting at two vents at 4:05 PM and closed them at 5:05 PM. By the time I got home at 8 it shut down.
11-27-2018	Monitored all during the night to see if flare was continuing to burn at 10 CFM. Site visit today to restart the system. I shut off the Gravity Flare at 11:00 AM and opened the valve and flared with gas through the skid at feed=28.4 and flow = 21.4 CFM. The skid is running with the fault light showing on SCADA, but the MT and skid are running full. Every shut down, or system failure, is requiring an on-site visit. At 2:00 PM I went back to Gravity Flare at 10+ CFM. The skid and MT have been running 4 hours. The red fault light is still showing on SCADA, but the system is running, and it will continue to fault out. We need to burn gas and make KWs. System shutdown at 3:10p.m. Flare continued to burn at 10+ CFM
11-28-2018	Monitored all during the night to see if flare was continuing to burn at 10 CFM. Site visit today to restart the system. I shut off the Gravity Flare at 2:38p.m. and opened the valve and flared with gas through the skid at feed=30.4 and flow = 25.4 CFM. The skid is running with the fault light showing on SCADA, but the MT and skid are running full. At 2:00p.m., I shut the system down and did a hard boot and this time the fault light on SCADA picture of the skid went off and the Unison screen started registering data. At 2:08 p.m., we are running full bore. Back to Gravity Flare at 10+ CFM. The skid and MT have been running 4 hours. The red fault light is still showing on SCADA, but the system is running, and after troubleshooting I discovered we need to burn gas and make KWs. System shutdown at 3:10p.m., re-fired at 4:10p.m., shutdown@5:27p.m., restart at 8:57-shutdown@11:57p.m. Flare continued to burn at 10+ CFM.

11-30 through 12-2-2018	Monitored all during the day and night to see if flare was continuing to burn at 10 CFM
12-3-2018	Monitored all during the night to see if flare was continuing to burn at 10 CFM. Site visit to restart system started at 11:45a.m. --Flared using skid at 24CFM 12:45p.m. until 3:50p.m. Reset gravity Flare at 10+ CFM for the night.
12-4-2018	Monitored during the night to see if flare was continuing to burn at 10 CFM. Site visit to meet with tech from Unison. Worked with Curt Schiesl of Unison to try to resolve the problem with the skid. I shut the flare off at 9:00a.m. He changed out switches and tried all kinds of things to keep it running. He had to order parts shipped overnight, and will continue troubleshooting tomorrow.
12-5-2018	Monitored system with Curt Schiesl, Field Service and Start-up Technician for Unison by computer and phone as he continued to try and fix the problem with the skid. He left for his home stating that he thought the problem was that the Phase converters were overheating. We had a shut down and panel fault as before.
12-6-2018	Site visit to restart the system and found we had a shutdown but no loss of power to panel, it just faulted as before. All I had to do to start the skid and MT running was to press the start button. I still do not have any data on skid panel screen, but we are running. We had a shutdown and showing no power to Unison panel. I did a hard boot to PC and after a short pause the Unison panel lit up with information, it ran for about 30 minutes and shutdown still showing power to the Unison panel. I restarted without any numbers and it is running; if and when we have a shutdown, it will have to be restarted by onsite visit. I started the Gravity Flare burning at 10+ CFM and plan for it to run until Monday regardless of what the Skid and/or the MT does.
12-11-2018	Site visit to restart the system and found we had a shutdown, but no loss of power to panel. The Gravity Flare has been burning at 10+ CFM continuously since I left on 12-06. I met with Norman and Bryan of ProPump and plan for it to run until Monday regardless of what the Skid and or the MT does.
12-12-2018	Site visit, met with ProPump and we continued to troubleshoot along with Doug from Unison.
12-13-2018	Site visit to restart the system and found we had a shutdown, but no loss of power to panel. The Gravity Flare has been burning at 10+ CFM continuously since I left on 12-06. Met with Bryan from ProPump and we continued to troubleshoot along with Doug from Unison. We added some new parts and it seemed to be fixed. Then in the evening we continued to have shut downs, Flare still running.
12-14-2018	The Gravity Flare has been burning at 10+ CFM continuously since I left on 12-06. Bryan from ProPump came to site and he installed a part and we were running. I monitored and sent text to Norman and Bryan of ProPump, and Doug from Unison. We added some new parts and it seemed to be fixed. Then in the evening we continued to have shut downs. Flare still

	running. I monitored all weekend during that time I lost communication due to a power Failure by Surry-Yadkin, Flare continued to burn.
12-17-2018	Site visit to restart the system and found we had a shutdown but no loss of power to panel. The Gravity Flare continued to burn all weekend. At 10.0+ CFM. I met with Bryan of ProPump and we spent the day troubleshooting system with concentration on Phase converter. With the help of a conventional fan we were able to cool Phase converter enough to run until we could get parts to repair. Started running at 10:50a.m. We shut the gravity flare off on the restart of the Skid and MT and ran the flare hard until 3:15 PM.
12-18-2018	Monitored system remotely by SCADA and Camera The system has been running from 11:00a.m. Monday without a shut down. Gravity Flare is off.
12-19-2018	Site visit to do a system check, the parts did not arrive, so after the inspection and repair of a small leak, I traveled home to return tomorrow. Gravity Flare is off.
12-20-2018	Site visit to do a system check. I met with Bryan of ProPump and he installed fans and circuit boards in Phase converter. We restarted system and we are up and running. The Gravity Flare is off.
12-21-2018	Site visit to do a system check. I met with Matt Arsenault of Duke U. We have been running solid since we replaced PC Fans yesterday. The Gravity Flare is off.
12-30-2018	Site visit to do a system inspection. The Gravity Flare is off. System was working but computer was down.
12-31-2018	Site visit to do a system check The Gravity Flare is off. System was working but computer was down again. Rebooted it again Checked and verified with Team Viewer home computer
	NOTE: The Data from 1-1-2019 through 3-14-2019 could not be recovered after the SCADA system shut down. We have restarted the log from the information available.
3-15-2019	Site visit for site inspection and monitoring water levels. We are still keeping the riser in the Basin to assist control of backflow from the Lagoon. I found that the computer was not working, as the hard drive is destroyed. I disconnected the unit and carried it to the Repair center. I am pumping surface water while I am on site.
3-17-2019	Site visit for site inspection and monitoring water levels. We are still keeping the riser in the Basin to assist control of backflow from the Lagoon. I installed the repaired computer with the new Hard Drive and tried to retrieve the data from backup but did not have the proper permissions. I am pumping surface water while I am on site

3-18-2019	Site visit for site inspection and monitoring water levels which are getting a little high, so I diverted some water to Lagoon. We are still keeping the riser in the Basin to assist control of backflow from the Lagoon. I tried the old LRF computer but it would not accomplish what I needed. I am pumping surface water while I am on site
3-20-2019	Site visit for site inspection and monitoring water levels which is so low, I have set the system to put all waste water into the Digester. We are still keeping the riser in the Basin to assist control of backflow from the Lagoon. The conditioner had shut down at 5:11 AM on 3-19-2019. On Site visit required as computer has crashed. I have called ProPump to get SCADA setup on the new Hard drive. I am pumping surface water while I am on site
3-22-2019	Site visit for site inspection and monitoring water levels we are low so I have set the system to put all waste water into the Digester. We are still keeping the riser in the Basin to assist control of backflow from the Lagoon. The conditioner has been running since our restart on March 20th. On site visits needed since computer crash. I have called ProPump to get SCADA setup on the new Hard drive. I am pumping surface water while I am on site. Ollie Frazier is scheduled to visit the farm on Tuesday the 26th to install data from BU. ProPump is scheduled to visit the farm on Thursday the 28th to install SCADA and tune up.
3-24-2019	Site visit for site inspection and monitoring water levels we are low, my observation was exactly the same as the visit on 3-22-2019.
	Ollie Frazier came to farm at 10:30 AM to work on restoring data back to computer. I conducted a site inspection and monitoring water levels we are low so I have set the system to put all waste water into the Digester. ProPump is scheduled to visit the farm on Thursday the 28th to install SCADA and tune up.
3-28-2019	Mike Nealy (of ProPump)visited the Farm at 8:30 AM to work on restoring data back to computer and to install SCADA and tune up. We could not get all the meters/gauges to show data on the computer but the camera is working and the power gauge is recording the power production which helps us to monitor remotely. I conducted a site inspection and monitoring water levels we are low so I have set the system to put all waste water into the Digester. We are still keeping the riser in the Basin to assist control of back flow from the Lagoon. The conditioner has been running since our restart on March 20th, but we shut down and did a restart today. I am pumping surface water while I am on site. I am still waiting on Josh Amon
4-2-2019	Marvin is working with Mike Nealy (of ProPump) to get SCADA working properly after the crash. The conditioner has been running since our restart on March 28th . We had to shut down and then restart on the 28th. I am pumping surface water while I am on site. I am still waiting on Josh Amon
4-5-2019	Marvin worked with Mike Nealy (of ProPump) to get SCADA working properly after the crash. I visited the Farm this afternoon to conduct a site inspection for monitoring water levels. We are low in the Basin so I have kept the system set to put all waste water into the Digester. We are still keeping the riser in the Basin to assist control of back flow from the Lagoon. The conditioner has been running since our restart on March 28th .We had to shut

	down and then restart on the 28th. I am pumping surface water while I am on site. I am still waiting on Josh Amon.

4-8-2019	Marvin visited the Farm today to conduct a site inspection for monitoring water levels. I worked with Mike Nealy (ProPump) remotely to get SCADA running properly after the crash. We have some data recorders running but not all. Mike pulled SCADA settings from the old DU computer and we picked up more meters that were working. We are needing to vent and run the gravity flare. We lost power causing a shutdown but when we booted back up the SCADA data was recording. The waste water levels are steady in the Basin, so I have kept the system set to put all wastewater into the Digester. We are still keeping the riser in the Basin to assist control of back flow from the Lagoon. The conditioner has been running since our restart on March 28th, except for a brief Power outage at 3:10PM. I am pumping surface water while I am on site. I am still waiting on Josh Amon for Digester pump repair.
4-11-2019	Tuesday and Wednesday I remotely monitored the system and worked with Mike and Gus trying to get data for reports, since we have been experiencing difficulties due to the crash. I visited the Farm today to conduct a site inspection for monitoring water levels. We needed to vent some today for 2 hours, as was the case Monday, we have been running the gravity flare since Monday, April 8th. It is only putting 7CFM but that helps to keep the balloon level at a good volume. The wastewater levels are steady in the Basin so I have kept the system set to put all wastewater into the Digester. We are still keeping the riser in the Basin to assist control of back flow from the Lagoon. The conditioner has been running since our restart on March 28th. I am pumping surface water while I am on site. I am still waiting on Josh Amon for Digester pump repair.
4-14-2019	Friday and Saturday Marvin remotely monitored the system and worked with Mike and Gus trying to get data for reports, we are experiencing difficulties due to the crash. I visited the Farm today to conduct a site inspection for monitoring water levels. We needed to vent some today for 2 hours as was the case Monday and Thursday, we have been running the gravity flare since Monday the 8th. It is only putting 7 CFM but that helps to keep the balloon level at a good volume. The wastewater levels are rising in the Basin so I opened Lagoon valve ½ way to send some waste to the Lagoon. We are still keeping the riser in the Basin to assist control of backflow from the Lagoon. The conditioner has been running since our restart on March 28th. With only two very short breaks due to storms not more than 20 minutes of down time. I am still waiting on Josh Amon for Digester pump repair.
4-15-2019	Site visit today to meet folks from Michigan State for Verification and Ollie (C&A) and Matt (Duke U) I remotely monitored the system during the night Sunday we had bad storms and lost connectivity with the MT. I rebooted this morning and we are running. The data is still not recording as it should. We are experiencing difficulties due to the crash. I visited the Farm today to conduct a site inspection for monitoring water levels. We needed to vent some today for 1 hour. We have been running the gravity flare since Monday the 8th. It is only putting 7 CFM but that helps to keep the balloon level at a good volume. Today I switched back to send everything going into the Digester. We are still keeping the riser in the Basin to assist control of backflow from the Lagoon. The conditioner has been running since our restart on March 28th. With only two very short breaks due to storms not more than 20

	minutes of down time, but this last time, we were down 9 hours. I am still waiting on Josh Amon for Digester Repair.
4-16-2019	Site visit to turn Basin pumps back on the water levels in the basin are low the back feed from the lagoon is off not flowing as before. The data is still not recording as it should. We are experiencing difficulties due to the crash. I visited the Farm today to conduct a site inspection for monitoring water levels. We needed to vent for 1 hour. We have been running the gravity flare since Monday the 8th. It is only putting 7 CFM but that helps to keep the balloon level at a good volume. All flush waste is going to the digester. We are still keeping the riser in the Basin to assist control of back flow from the Lagoon. The conditioner has been running since our restart on March 28th. With only two very short breaks due to storms not more than 20 minutes of down time and this last time down 9 hours. I am still waiting on Josh Amon for Digester pump repair.
4-20-2019	Marvin has been closely monitoring our site and system remotely by Team Viewer Wednesday until now. I made a Site visit to monitor system gas bubble is getting very high so I will vent for two hours to drop the level some to take care of the coming sunny day Sunday. The data is still not recording as it should. We are experiencing difficulties due to the crash. I conducted a site inspection for monitoring water levels. We have been running the gravity flare since Monday the 8th. It is only putting 7 CFM but that helps to keep the balloon level at a good volume. All flush waste is going to the digester. We are still keeping the riser in the Basin to assist control of back flow from the Lagoon. The conditioner has been running since our restart on March 28th. With only two very short breaks due to storms not more than 20 minutes of down time and this last time down 9 hours. I am still waiting on Josh Amon for Digester pump repair
4-22-2019	Marvin has been closely monitoring our Site and system remotely by Team Viewer Saturday until now. Site visit to monitor system gas bubble is getting very high, so I will vent for three hours to drop the level. We had too much on a sunny day Sunday and the cover pulled some on the North side next to the Lagoon. I have notified Mathew of Duke University and the Cavanaugh team. The data is still not recording as it should. We are experiencing difficulties due to the crash. I conducted a site inspection for monitoring water levels. We have been running the gravity flare since Monday the 8th. It is only putting 7 CFM but that helps to keep the balloon level at a good volume. All flush waste is now going to the Lagoon. We are still keeping the riser in the Basin to assist control of back flow from the Lagoon. Today I had to get the boat in the Basin to unclog the weep holes in the riser. The conditioner has been running since our restart on March 28th. With only two very short breaks due to storms not more than 20 minutes of down time and this last time down 9 hours. I am still waiting on Josh Amon for Digester pump repair.
4-23-2019	Marvin is monitoring the site remotely by Team Viewer off and on during the time that I am away. Site visit to monitor system and to lower the gas bubble for flushing out the cross over pipe from Digester to Basin. I will vent from 11:15 until 4:15 PM. The data is still not recording as it should. We are experiencing difficulties due to the crash. I conducted a site inspection for monitoring water levels. We have been running the gravity flare since Monday

	the 8th. It is only putting 7 CFM but that helps to keep the balloon level at a good volume. All flush waste is now going to the Lagoon. We were back in the boat today and with the help from LRF We removed top 2/3rds of the riser to help refill the basin for flushing. The MT faulted out around 8:00 PM and would not start remotely; I rebooted it this morning around 11:30 AM and have been running since. Larry Hice (of Plastic Fusion) called and is sending Al Corbet to assess the damage. I am still waiting on Josh Amon for Digester pump repair.
4-24-2019	After monitoring remote, did a Site visit to meet with Al Corbet (Plastic Fusion) to assess the damage. He took photos and measured the distances and did a complete walk around and will work up data and schedule a time for the repair. My visit today was also to monitor system and to lower the gas bubble for flushing out the crossover pipe from Digester to Basin. I will vent from 11:30 until 5:00 PM using 3 ports. The data is still not recording as it should. We are experiencing difficulties due to the crash. I conducted a site inspection for monitoring water levels. We have been running the gravity flare since Monday the 8th. It is only putting 7 CFM but that helps to keep the balloon level at a good volume. All flush waste is now going to the Lagoon. The MT has been running since the reboot on 4/23/19 at 11:00 AM. I am still waiting on Josh Amon for Digester pump repair. I worked on flushing the cross over pipe without any success.
4-25-2019	Remote monitoring then Site visit today to continue flushing the crossover pipe but the showers started so I disconnected the Pump and moved it inside. I will work on it next week. SCADA is still not recording as it should. We are experiencing difficulties due to the crash. I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. The MT has been running since the reboot on 4/23/19 at 11:00 AM. I was able to reach Josh Amon today and explained the situation with the Digester pump. He will try to get to us as soon as possible.
4-29-2019	Remote monitoring, then Site visit today to continue flushing the X over pipe . SCADA is still not recording as it should. We are experiencing difficulties due to the crash. I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. The MT has been running since the reboot on 4/23/19 at 11:00 AM. Today I met with Mr. Loyd Bryant to go over a letter about his permit he received. Plastic Fusion is scheduled to repair cover the end of this week. I am using the digester pump to move waste to the Lagoon by the way of the crossover pipe. I cannot vent anymore the gas is hung up in pockets and it is more than the MT can burn.
4-30-2019	Continued monitoring remotely by Team Viewer off and on during the day. Site visit today to continue to flush the crossover pipe using the surface water pump and the gas power trash pump. SCADA is still not recording as it should. We are experiencing difficulties due to the crash. I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. The MT has been running since the reboot on 4/23/19 at 11:00 AM. I was able to reach Josh Amon today and explained the situation with the Digester pump. He will try to get to us as soon as possible. Today I talked with Mr. Bryant to go over a letter about his insurance that he received. Plastic Fusion is scheduled to

	repair cover the end of this week. I am using the digester pump to move waste to the Lagoon. I was able to do a small amount of venting at the crossover, but elsewhere gas is blocked by the waste in the digester. We have pockets of gas all over but not able to vent and it is more than the MT can burn. I am pumping surface water off.
5-1-2019	Remote monitoring by Team Viewer, then site visit for monitoring water levels. I met the rental company who delivered equipment to repair damage and will bring a generator tomorrow. Plastic Fusion is scheduled to work on the cover repair tomorrow . I am using the digester pump to move waste to the Lagoon. I was able to do a small amount of venting at the X over but elsewhere gas is blocked by the waste in the digester. We have pockets of gas all over but not able to vent and it is more than the MT can burn. I am pumping surface water off
5-2-2019	Remote monitoring by Team Viewer, then site visit today to monitor water levels, and flush the Digester intake using the gas-powered trash pump. SCADA is still not recording as it should. I have reported it to Mike Nealy of ProPump. The rental company delivered the Generator to repair damage. Buddy with Plastic fusion came in this morning and the rest of the crew will be on site and are scheduled work on the cover repair tomorrow . I am using the digester pump to move waste to the Lagoon. I was able to do a small amount of venting at the X over but elsewhere gas is blocked by the waste in the digester. We have pockets of gas all over but not able to vent and it is more than the MT can burn. The MT shut down and I rebooted it.
5-3-2019	Remote monitoring then, I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. The MT has been running since the reboot on 4/23/19 at 11:00 AM. Buddy and the rest of the Plastic Fusion crew were here bright and early to do the repair. I am using the digester pump to move waste to the Lagoon. Buddy and crew finished up this evening and I was able to restart the MT. I am headed home and will monitor from home remotely.
5-4-2019	Remote monitoring then, Site visit today to reboot MT and get back online with production of KWs. SCADA is still not recording as it should. I have reported it to Mike Nealy of ProPump. We are experiencing difficulties due to the Computer crash. I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. The MT shut down yesterday and I rebooted it before leaving yesterday. I shut down during the evening since SCADA is not recording properly I am not sure of the time. I am still waiting on Josh Amon to repair the Digester pump. I have rebooted the MT and trimmed down the flow back to the lagoon. I am headed home and will monitor from home
5-5-2019	The MT shut down yesterday and I rebooted it before leaving yesterday. It shut down during the evening since SCADA is not recording properly I am not sure of the time. I am waiting on Josh Amon to repair the Digester pump. I have rebooted the MT and trimmed down the flow back to the lagoon. I am headed home and will monitor from home
5-6-2019	Remotely monitoring by Team Viewer off and on during the time that I am away. Site visit today to reboot MT and get back online with production of KWs. I found that the Phase Converter was down. SCADA is still not recording as it should. I have reported it to Mike

	Nealy of ProPump. I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. The MT shut down yesterday and I rebooted it before leaving. It shut down during the evening since SCADA is not recording properly I am not sure of the time. I am still waiting for Josh Amon to repair the Digester pump. I have rebooted the MT and trimmed down the flow back to the lagoon. I am headed home and will monitor from home
5-8-2019	Site visit today to reboot MT and get back online with production of KWs. I found that the breaker had tripped. I worked with Mike Nealy on Tuesday on the SCADA and we had it going but later that day we lost the graph, so SCADA is still not recording as it should, Mike is aware of the problem. I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. The MT shut down last night and I am rebooting now. I am waiting on Josh Amon to repair the Digester pump. I have rebooted the MT and trimmed down the flow back to the lagoon. I am headed home and will monitor from home.
5-10-2019	Site visit today to reboot MT and get back online with production of KWs. I found that the breaker had tripped. I worked Dean of LRF to reset breakers on Thursday but it would not keep running it continues to trip the Breaker, I reported to Mike Nealy on Wednesday that we are still having issues with the graph, so SCADA is still not recording as it should. I conducted a site inspection for monitoring water levels. The gravity flare is off. All flush waste is now going to the Lagoon. I am waiting on Josh Amon to repair the Digester pump. I have rebooted the MT and trimmed down the flow back to the lagoon. I am headed home and will monitor from home.
5-13-2019	Marvin conducted a site inspection for monitoring water levels. Gas is gaining on us, so I vented today, the gravity flare is off. All flush waste is now going to the Lagoon. I am waiting on Josh Amon to repair the Digester pump. We had a MT shutdown tripped breaker at 1:08 PM restart at 1:56 PM. I have rebooted the MT and trimmed down the flow back to the lagoon. I am headed home and will monitor from home
5-14-2019	Marvin conducted a site inspection for monitoring water levels. Gas is gaining on us so I vented today using one vent. The gravity flare is off. All flush waste is now going to the Lagoon. I am waiting on Josh Amon to repair the Digester pump. We had a MT shutdown tripped breaker at 1:08 PM restart at 1:56 PM yesterday, so I rebooted the MT and trimmed down the flow back to the lagoon. I am headed home and will monitor from home
5-15-2019	Site visit today to meet with Keith Owens of ProPump to troubleshoot our MT issue. We are installing a Fuse disconnect box and hopefully we can get it installed Wednesday, SCADA is still not recording as it should. I conducted a site inspection for monitoring water levels. Gas is gaining on us so I vented today using 1 vent. The gravity flare is off. All flush waste is now going to the Lagoon. I am waiting on Josh Amon to repair the Digester pump. We installed the disconnect Box and fired up the Chiller and conditioner. We fired the MT as soon as the temp got down. Started at 3:28pm and down at 3:44pm. Restart at 3:56pm, The Phase converter started tripping out. We found that the fans seem to be bad. We have two so Keith will install tomorrow while tonight we will use a window fan to cool. I will monitor all during the night.
5-16-2019	Site visit today to meet with Keith Owens of ProPump to install the repairs once install we still had to change out the breaker and ordered circuit boards for the PC. We installed a Fuse

	disconnect box and the circuit breaker, to attempt to fix the SCADA. I conducted a site inspection for monitoring water levels. Gas is gaining on us so I vented today using 1 vent. The gravity flare is off. All flush waste is now going to the Lagoon. We installed the two Fans also. We got it all running and headed for home I will monitor all during the night. I am waiting on Josh Amon to repair the Digester pump.
5-17 to 5-18-2019	Marvin has been closely monitoring our Site and system remotely by Team Viewer off and on during the time that I am away. Site visit today to restart the MT
5-19-2019	Site visit today to restart the MT and found the computer down. We had so much heat that the conditioner would not chill enough to keep running. I returned home and restarted in the PM after it cooled down.
5-20-2019	Site visit today to meet with Ollie Frazier and have him BU the system computer. We pumped waste to lagoon and updated him about what there is to do on a site visit. I had started the system in the cool of the day Sunday and it is still running.
5-21-2019	I continued to monitor the system and with the help of LRF staff was able to keep water level in check; the system does not like hot weather. I have had to reboot the system when the Conditioner shuts down due to heat
5-24-2019	Marvin has been closely monitoring our Site and system remotely by Team Viewer off and on during the time that I am away. I continued to monitor the system and with the help of LRF staff was able to keep water level in check the system does not like hot weather. I have had to reboot the system when the Conditioner shuts down due to heat. I restarted tonight after my stay in Baptist doing heart test at 11:34 PM in the cool of the evening
5-25-2019	Remote monitoring, I continued to monitor the system and with the help of LRF staff was able to keep water level in check the system does not like hot weather. I have had to reboot the system when the Conditioner shuts down due to heat. I restarted tonight in the cool of the evening at 10:46 pm, however it had shut down at 8:35 am.
5-30-2019	Ben Cauthen and Steve Cavanaugh were on site to try entering skid into a summer setting, I briefed Ben on the system by remote. At 12:40 AM on Friday I was able to start system and the MT
6/4/2019	Ben emailed Larry Hice (Plastic Fusion) regarding cover repair and payment. Larry Hice replied, “Yes we did complete the repair and left the cover functioning fine. The invoice was processed the end of last month and mailed to Cavanaugh. Total for the repair was $16,925.00.”
6/4/2019	Ben called Josh Amon (Preferred Sources) regarding mixing pump repair. Josh said the mixing pumps have been discontinued so getting parts is difficult. The pumps sometimes lose prime due to high sludge levels. Ben will meet Josh on-site on June 7th at 7 am.
6/4/2019	Ben called Andrew. No answer. Ben will try again tomorrow.
6/6/2019	Ben emailed Jeff McGuire (ProPump) to explain the SCADA issues and request a quote for a service call by Mike Nealy. Also asked for a flame arrestor quote.

6/6/2019	Ben reached out to Kevin Harward regarding the sampling he was previously responsible for.
6/6/2019	Ben emailed Phil Rucker (Cooperative Extension) to describe the help that is needed at Loyd Ray. Phil will try to find a person who can fill the position.
6/7/2019	Ben met Preferred Sources (Josh Amon) at LRF to diagnose the mixing pump problem. The rotating unit needs to be replaced. Josh sent a quote for replacing the rotating unit ($6,130 + tax).
6/7/2019	Ben replaced the two blower filters with new filters. The new filters were already at LRF.
6/7/2019	Ben spoke with Kevin Harward regarding manure sampling. Ben needs to pick up sampling materials from R&A Labs then collect the samples.
6/10/2019	Ben called R&A Labs to confirm manure sampling procedure. Ben will pick up and return supplies to R&A Labs on June 25th to complete quarterly sampling.
6/10/2019	Ben ordered a utility pump for removing stormwater from the digester cover: WAYNE 57729-WYNP WAPC250 1/4 HP Automatic ON/OFF Water Removal Pool Cover Pump ($176.96).
6/23/2019	Ben purchased a check valve and fitting for the WAYNE stormwater pump ($47.76).
6/25/2019	Ben collected manure samples and delivered the samples to R&A Labs.
6/25/2019	Ben scheduled the Unison service work with Don Weeden. Unison will send a service tech to the farm the week of July 15th ($6,485). Ben sent Don pressure and temperature readings.
6/27/2019	Ben spoke with Keith Owens (ProPump). Bryan will repair the circuit boards on 6/28. The parts were ordered previously and arrived on 6/27.
6/28/2019	Bryan (ProPump) completed the circuit board repair. Ben spoke with Mike Nealy while at the farm. Mike stated that the lost data is not recoverable since the computer hard drive was lost. The turbine SCADA issues are a result of the SCADA programming.

As previously mentioned, the age of the system, normal wear and tear on the equipment required some failures such as the digester pump. The system was evaluated and a Corrective Maintenance List was made to facilitate the system operating in a cohesive manner, and to prevent failures in the future.

Cavanaugh & Associates has also created a spreadsheet of necessary repair needs which should be accomplished the Summer of 2019. While some of these items were able to be repaired on a temporary basis, the long-term repair solution would ideally fix the problem listed, and prolong the system life. Cavanaugh is working to secure pricing for the necessary repairs, if they did not occur before this report end, we have listed the date that the repair should be accomplished by. Although these repairs are not compliance issues, we are listing them here to inform the report, that we have some upcoming pending service items remaining from this report period. We will make every effort to keep the biogas and environmental system running as efficiently as possible and are hoping the repairs can be accomplished without interruption to the system.

Corrective Maintenance List

Item	Problem	Immediate Repair	Long-Term	Contact(s)	Action	Cost
1. Flare	Gas flow to the flare is almost totally blocked.	Remove flame arrestor to clean blockage then reinstall. May need to replace flame arrestor. ProPump just built a flare for Cavanaugh, so they can assist if needed.	Assess the flare's condition to determine if purchasing a new flare is warranted.	ProPump – Jeff McGuire; Cavanaugh	Cavanaugh remove flame arrestor, potentially with ProPump, to repair or replace. Complete or schedule repair by August 1, 2019.	
2. Chiller Unit	The chiller is cooling slowly and will not reach set point in high ambient temperatures.	Troubleshoot problem with Johnson Thermal. Replace compressor or resolve other issue.	Complete upkeep and preventative maintenance.	Johnson Thermal Systems	Cavanaugh to troubleshoot problem with JTS / schedule JTS for repair. Schedule repair by July 1, 2019.	$6,485 (Unison tech to service chiller and skid)
1. Digester Waste Inlet Pipe	Inlet pipe is blocked. Waste cannot be pumped into digester.	Remove blockage from the pipe, or more likely, remove sludge from the digester by using mixing pumps with firehose connection.	Monitor digester sludge level and prevent flushed manure and inorganic materials from creating blockages. Sludge should be removed every other year.	Andrew; Cavanaugh	Cavanaugh contact Andrew to schedule sludge removal. Cavanaugh pump sludge to lagoon. Complete as soon as lagoon capacity allows.	
2. Digester Mixing Pump	One digester mixing pump is not functioning.	Repair broken components in the mixing pump.	Complete preventative maintenance on both mixing pumps.	Preferred Sources – Josh Amon	Cavanaugh follow up with Josh about previously scheduled repair. Josh to complete repair when rotating unit arrives.	$6,130 + tax ($5,030 + tax for rotating unit; estimated 6 hours labor)
2. SCADA Malfunction	SCADA system is not recording data. There is a malfunction with the microturbine controls.	SCADA system is not recording data for the microturbine and the microturbine	Monitor SCADA system.	ProPump – Mike Neely	Cavanaugh contact ProPump to troubleshoot problem and schedule repair.	

		controls appear to be losing connection.			Complete repair by July 1, 2019.	
1. Pipe between Digester and Aeration Basin	Pipe between the digester and aeration basin may be blocked.	Remove blockage from the pipe, or more likely, remove sludge from the aeration basin by using aeration pumps and existing buried 4" line / valve back to manhole.	Prevent blockages by monitoring sludge level.	Cavanaugh	Cavanaugh to assess blockage after sludge removal / remove blockage if it still exists. Complete after sludge removal occurs.	
3. Control Panel Circuit Board	Burns were found behind a circuit board.	Replace circuit boards, possibly with used ones.	Monitor to prevent happening again.	ProPump – Keith Owens	Cavanaugh to follow up with Keith Owens about replacing circuit boards. Complete repair by July 1, 2019.	
3. Farm Flush Pumps	The aeration basin pump is being used to flush the barns. The water level in the aeration basin must be monitored and a valve to the lagoon must be manually turned to control the level.	Continue using aeration basin pump for flushing operations.	Install new pumps in the lagoon or find better management method for the water level in the aeration basin.	Loyd Bryant; Andrew	Cavanaugh to work with Loyd and Andrew to find a long-term flushing solution. Complete plan by August 1, 2019.	
1. Digester Cover	Digester cover pulled out of the trench.	Plastic Fusion has repaired the cover and grass has been reseeded.	Monitor gas level to ensure the cover does not pull out of the trench.	Plastic Fusion Fabricators	Cavanaugh to follow up with PFF to confirm the repair is complete and PFF has received payment. Estimate was	$16,925 for PFF and $915 for Wiles Grading and Landscaping. $17,840 total.

					$16,925 - $23,925.	
3. Blower Filter	Blower filter needs replacement.	Replace blower filter.	Replace blower filter at properly scheduled intervals.	Cavanaugh	Cavanaugh will replace blower filter. Complete by July 1, 2019.	$150 ($75 per filter)
3. SCADA Performance Data	Two months of performance data were not recorded or are not accessible.	Work with ProPump to locate data or correct cause of data loss.	Correct problem to ensure data loss does not occur again.	ProPump – Mike Neely; Cavanaugh	Cavanaugh will confirm data loss with Duke U and contact ProPump to attempt data recovery. Complete by July 1, 2019.	

The following table lists the compliance requirements as per the permit for the subject system, and the performance / compliance relative to each requirement:

	Description of Monitoring Requirement	Status	Result
1	Maintenance of adequate records by Permittee to track the amount of sludge/separated solids disposed.	N/A	No solids or sludge disposal occurred during the reporting period; with the exception that some sludge returned to the anaerobic digester for further breakdown in accordance with the Division approved Operations & Maintenance Plan.
2	Inspection of entire Innovative System waste collection, treatment, and storage structures and runoff control measures at a frequency to insure proper operation but at least monthly and after all storm events of greater than one (1) inch in 24 hours; Permittee maintenance of inspection log or summary including at least the date and time of inspection, observations made, and any maintenance, repairs, or corrective actions taken by Permittee.	☑	Inspections and observations conducted by representatives of Loyd Ray Farms, Inc., Cavanaugh & Associates, P.A., and DCOI. Observations recorded, and actions taken to adjust the operation of the System are recorded in log book kept onsite, and emailed in.
3	Maintenance of a log of all operational changes made to the Innovative System including at least the process parameter that was changed, date and time of the change, reason for the change, and all observations	☑	Log book entries, as described in item #2, above, maintained on site; copies attached to report (Appendix A)

	made both at the time of the change and subsequently as a result of the change by Permittee/ Permittee's designee.		
4	Representative Standard Soil Fertility Analysis to be conducted annually on each application site receiving animal waste.	☑	NCDA&CS Agronomic Division Report No. FY19-W005280, shows the results of the Predictive Home & Garden Soil Report for Loyd Ray Farms. The samples were compiled on 2/21/2019, and were completed on 3/05/2019, which are added to this report, they can also be accessed here: http://www.ncagr.gov/agronomi/
Wastewater Analysis			
5	Quarterly tests shall be conducted once within each of the following windows w/ at least sixty (60) days between any 2 sampling events. Water quality samples include analysis of copper, zinc, total suspended solids, pH, total nitrogen, TKN, NO2 + NO3, phosphorus, ammonia, and fecal coliform.		
	Quarter 3 (July 1 – September 30) *Data previously submitted with Semi-Annual Compliance Report*	☑	Sample Collected: 8/17/2018 Sample Analyzed: 9/18/2018 Results Reported: 9/18/2018 Results included in the attached report from Research & Analytical Laboratories, Inc. (Appendix B)
	Quarter 4 (October 1 – December 31) *Data previously submitted with Semi-Annual Compliance Report*	☑	Sample Collected: 11/20/2018 Sample Analyzed: 12/20/2018 Results Reported: 12/20/2018 Results included in the attached report from Research & Analytical Laboratories, Inc. (Appendix B) Retest of Fecal Coliform: Sample Collected: 1 /9/2019 Sample Analyzed: 1/11/2019 Sample Reported: 1/11/2019
	Quarter 1 (January 1 – March 30)	☑	Sample Collected: 2/15/2019 Sample Analyzed: 3/5/2019 Results Reported: 3/5/2019 Results included in the attached report from Research & Analytical Laboratories, Inc. (Appendix B)
	Quarter 2 (April 1 – June 30)	☑	Sample Collected: 6/25/2019 Sample Analyzed: 6/25/2019 Results Reported: 7/12/2019

Performed at a minimum of twice a year for the first two years to determine the calibration coefficient for the mass balance as described in the Monitoring Plan submitted March 17, 2010. Ambient air sampling shall be scheduled in summer and winter seasons.			
	Spring Season Ambient Air Sampling	☑	A Spring season ambient air sample taken on March 14, 2019 by Duke University is included in this report. Results included in the Explanation of Results and Sampling Methods.
	Waste Treatment and Storage System	☑	
	Barns	☑	
	Sprayfields	☐	*Not Measured*
	2nd Summer Season Ambient Air Sampling	☑	A second summer season ambient air sample taken on June 13, 2019. A winter analysis will be completed this fall, allowing a shift in sampling timing. Results included in the attached Explanation of Results and Sampling Methods.
	Waste Treatment System	☑	
	Barn Exhaust	☑	
	Sprayfields	☐	*Not Measured*
Odor Sampling			
6	Permittee shall monitor for odor compliance quarterly at both upwind and downwind locations on the property boundary. Permittee shall document monitoring locations on a site map, indicating prevailing wind direction, for each monitoring event.		
	Quarter 3 (July 1 – September 30) *Data previously submitted with Semi-Annual Compliance Report*	☑	Odor sampled June 26, 2018 Results included in the attached Explanation of Results and Sampling Methods.
	Quarter 4 (October 1 – December 31) *Data previously submitted with Semi-Annual Compliance Report*	☑	Odor sampled Results included in the attached Explanation of Results and Sampling Methods.
	Quarter 1 (January 1 – March 30)	☑	Odor sampled March 14th, 2019. Results included in below under Odor Emissions, and in the Explanation of Results and Sampling Methods.
	Quarter 2 (April 1 – June 30)	☑	Odor sampled June 13th, 2019. Results included in below under Odor Emissions, and in the Explanation of Results and Sampling Methods.
Record Keeping			

7	All records, including operation, maintenance, and repair records, shall be maintained on site and in chronological and legible form for a minimum of five (5) years by the Permittee; records shall be maintained on forms provided by or approved by the Division and shall be readily available for inspection.	☑	A copy of the report and all monitoring records are maintained in a binder in the System Control Building; the electronic form combines inspection and operations records on a single form, entitled "Loyd Ray Farms Inspection, Operations & Maintenance Log Sheet" which are being collected electronically, and submitted to the Regional Office via email.

EXPLANATION OF RESULTS AND SAMPLING METHODS

1. Amount of Sludge or Separated Solids Disposed
N/A. No disposal of sludge or separated solids was required from the Innovative System during the 7/1/2018 – 6/30/2019 reporting period. Some sludge was returned from the aeration basin to the anaerobic digester for further breakdown, as per usual and typical operations, in accordance with the division Operation and Maintenance Manual.

2. Log of System Inspections
See Operator Log Book, Appendix A. (digitally attached)

3. Log of Operational Changes to the Innovative System
See Operator Log Book, Appendix A. (digitally attached)

4. Results of Standard Soil Fertility Analysis
The Soil Fertility Analysis was conducted by LRF in 2018 which is included in Appendix C of this report. NCDA & CS Agronomic Division, analyze independent swine lagoon liquid samples in a Predictive Waste Report. The Loyd Ray Farms analysis on February 21, 2019 as stated in the reports completed on March 5, 2019. The actual test results and recommendations can be found in Appendix C.

Two separate reports, by NCDA & CS Agronomic Division, analyze independent soil samples which were taken at Loyd Ray Farms on October 22, 2018, as stated in the reports completed on November 1, 2018. The actual test results and recommendations for each sample can be found in Appendix C. The following tables are compiled to easily view the aggregated results.

Loyd Ray Farms Report No. FY19-SL009268

	Sample #	1A 01	1B 02	IC03	3A	3B	3C	9B
HM	Percent humic matter	0.41	0.41	0.41	0.41	0.36	0.42	0.51
W/V	Weight per volume	1.12	1.15	1.16	1.08	1.10	1.09	1.08
1	Cation exchange capacity	7.2	7.4	7.6	9.8	9.4	10.2	9.4
9	Manganese Index	165	167	172	119	120	140	232
Zn-1	Zinc Index	782	486	443	542	492	629	499

Cu-I	Copper Index	135	143	137	102	106	128	110
128	Sulfur Index	32	32	32	31	32	34	33
P-1	**Phosphorus Index**	**53**	**57**	**56**	**84**	**91**	**92**	**86**
K-1	**Potassium Index**	41	39	41	**474**	**50**	**363**	**345**
pH	**Acidity**	**6.4**	**7.2**	**7.2**	**7.2**	**7.2**	**7.0**	**6.7**

Loyd Ray Farms Report No. FY19-SL009269

	Sample #	**2**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**
HM	Percent humic matter	0.41	0.41	0.46	0.41	0.51	0.36	0.51	0.51
W/V	Weight per volume	1.07	1.08	1.10	1.04	1.07	1.02	1.07	1.10
CEC	Cation exchange capacity	10.7	10.7	12.1	11.2	9.9	11.4	9.0	8.8
Mn-I	Manganese Index	153	150	131	162	198	166	222	224
Zn-1	Zinc Index	616	608	1601	735	569	696	475	445
Cu-I	Copper Index	147	141	128	121	105	114	108	108
S-I	Sulfur Index	36	35	36	35	32	33	32	29
P-1	**Phosphorus Index**	**87**	**89**	**116**	**90**	**88**	**91**	**85**	**83**
K-1	**Potassium Index**	**535**	**539**	**643**	**574**	**595**	**618**	**334**	**351**
pH	**Acidity**	**7.1**	**7.1**	**7.2**	**7.2**	**7.3**	**7.3**	**6.8**	**6.8**

In almost all samples, the Phosphorus Index (P-I) and Potassium Index (K-I), were found to be *Above Optimum*. The range for *Optimum* is between 50 and 70, Sample 1B 02, and 1C 03 were a little below the *Optimum* range, but all others were very desirable. All of the samples in the 0269 group, in bold lettering above, exceeded those limits, and were *Above Optimum.* All of the samples in the 0268 group were at least at *Optimum* level, and many of which were in the *Above Optimum* range. The pH test for acidity results were higher than the 5.8 to 6.5 *Optimum* range, averaging about 7.1 on Report #FY19-SL009269. Similarly, the Sample # FY19-SL009268, was also in the *Optimum* range, averaging about 6.9.
The exact agronomist's comments and recommendations for fertilizer application can be found in the Actual Soil Reports See **Appendix C.**

5. Results of Water and Air Quality Sampling

a. Results of Waste Water Analysis
Water quality samples from the effluent were taken in each quarter, a synopsis of the results is found below. Samples were analyzed by Research Analytical Laboratories, Inc. in Kernersville. The 4th quarter sample of 2018, as well as 1st and 2nd quarters of 2019 resulted in higher fecal coliform counts than expected, and thus, additional samples were taken. While the re-sampling was done in July 2019, we have added it to the report for clarity. The following table compares the results of the water quality analysis of the final effluent from the Innovative System:

Parameter	8/17/2018	11/21/2018	2/21/2019	6/25/2019
TOT N	1080	972	2,230	720
TKN	1080	972	2,320	720
NO_2+NO_3	0.27	<.05	0.27	0.3333
TP	62.2	215	71	39.7
NH3-N	689	702	1,940	398
COPPER	0.088	0.334	0.801	0.105
ZINC	0.489	2.32	5.6	0.322
TS	848	1300	4,340	242
FECAL	1,400,000	33,000,000	1,100,000	10,000
pH	7.98	8.06	8.04	8.12

1. In 2018, The fecal coliform count for most of the sampling events exceeded the permit limit, and this has not been resolved. Almost all other constituent parameters as recorded above are decreasing since the beginning of the year, as indicated in the final effluent recordings in the chart above. The chart above describes the waste water analyses that is required to be conducted on a quarterly basis. These parameters are: total N, NH_3-N, NO_3-N/NO_2-N, total P, % solids, copper, zinc, pH and pathogens. Samples are to be taken from the digester and the effluent (leaving the aeration basin). All sampling was conducted:
    1. Sample ID: Effluent 1; Fecal Coliform – MPN = 1,400,000 MPN/100mL 8-17-2018
    2. Sample ID: Effluent 1; Fecal Coliform – MPN = 33,000,000 MPN/100mL 11-21-2018

2. Given the resampling produced fecal coliform counts that were quite high compared to the permit limit, an additional resampling event was conducted on January 9, 2019. Again, a composite sample was obtained of the effluent, split into three (3) sample bottles, then sent to the laboratory for analysis. The results are as follows:
    1. Sample ID: Effluent #1; Fecal Coliform – MPN = 40,0000 MPN/100mL
    2. Sample ID: Effluent #2; Fecal Coliform – MPN = 1,700,000 MPN/100mL
    3. Sample ID: Effluent #3; Fecal Coliform – MPN = 330,000 MPN/100mL

3. In 2019, the Fecal Coliform was again tested, and still exceeded the permit limits.
    1. Sample ID: Effluent #1; Fecal Coliform – MPN = 1,100,000 MPN/100mL
    2. Sample ID: Effluent #2; Fecal Coliform – MPN = 10,000 MPN/100mL

    According to the data presented, the fecal coliform levels are decreasing over time, but tend to be less during the hotter months, and highest over the coldest months of the year.

The results were much improved over the previous fecal coliform samples.

Ammonia Emissions

While precise ammonia emissions are hard to calculate, Odor was monitored by Duke University to comply with Section I.6.b.ii of the Swine Animal Waste Management Permit. Duke University's Dr. Marc Deshusses took Spring and Summer ambient Air Samples on March 14, 2019, and June 13, 2019, respectively, both results were found to be in compliance, and are further described below. Odor panelist rules were listed in the previous report and are not repeated here, but several measurements for wind speed and direction were taken to ensure that data were representative

Odor Sampling #1

Odor was monitored to comply with Section I.6.b.ii of the Swine Animal Waste Management Permit. One monitoring event was conducted on March 14, 2019.

Sampling took place at about noon. It was an overcast mild day (60° F) with moderate to strong wind (sustained 3.7 m/s with gusts at 4.5 m/s). Several measurements for wind speed and direction were taken. The predominant wind direction and sampling points for odor were selected as shown in Figure 5.

Odor was monitored by Marc Deshusses. Odor panelist rules were listed in an earlier report and are not repeated here. Odor was monitored using a Nasal Ranger (http://www.nasalranger.com/) field olfactometer, following the manufacturer recommended instructions.

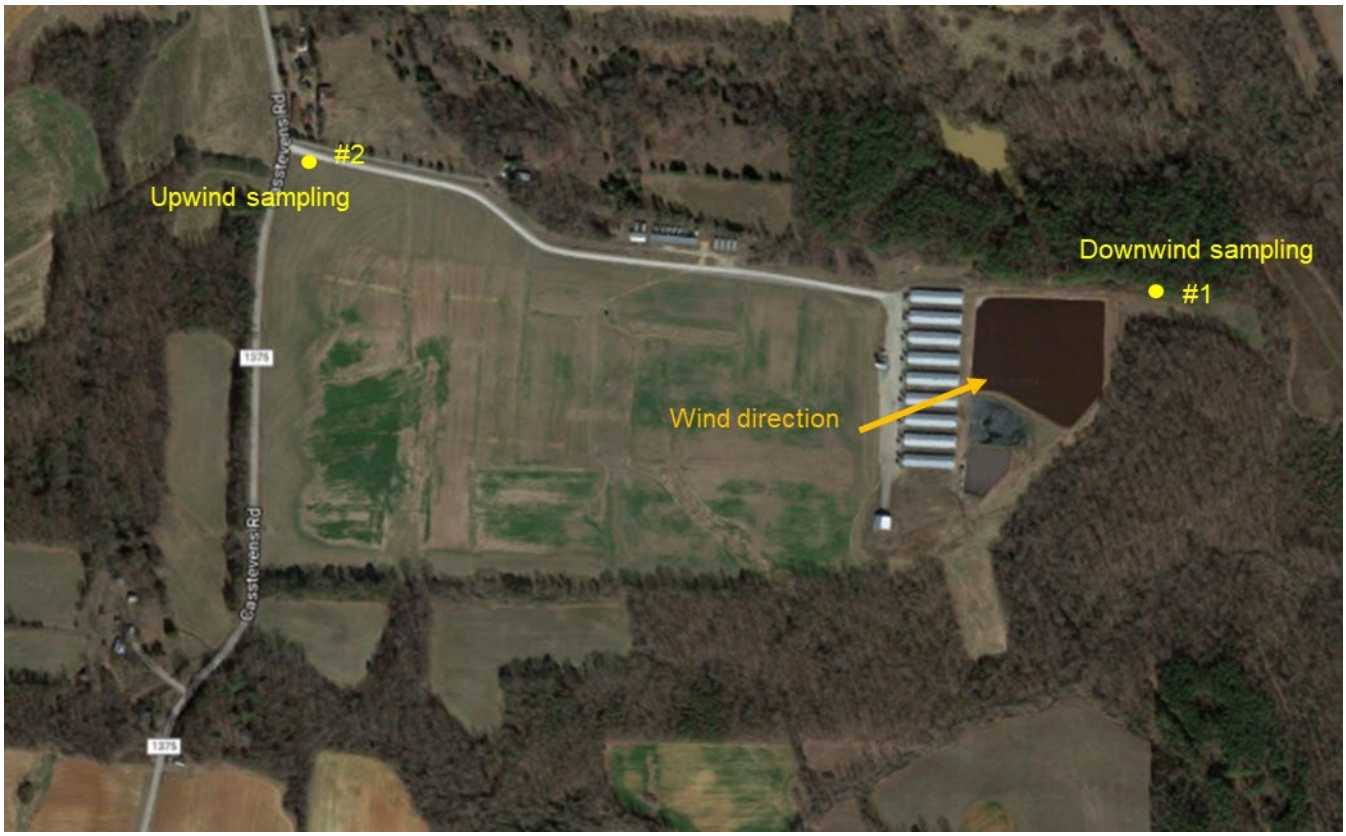

Figure 5. Aerial view of the facility and location of the monitoring points for odor for the March 14, 2019 sampling. The location was about 50 yards downwind of the little hunting hut. The arrows indicate the prevailing wind direction the day of the sampling.

Sampling upwind

Odor could not be detected at the 2 D/T level. This indicates that the odor level was lower than 2 D/T. Then the Nasal Ranger was taken off the nose and ambient air was sniffed and compared to odorless air from the Nasal Ranger. This was to determine whether a difference could be detected between ambient air and odorless air from the Nasal Ranger. No significant difference could be detected.

Sampling downwind

No odor could be detected at the 2 D/T level at location #1. This indicates that the odor level was lower than 2 D/T. Then the Nasal Ranger was taken off the nose and ambient air was sniffed and compared to odorless air from the Nasal Ranger. This was to determine whether a difference could be detected between ambient air and odorless air from the Nasal Ranger. There was a faint odor with sulfur notes possibly coming from the lagoon, but as mentioned before these odors were below the 2 D/T level.

These results indicate that odor levels complied with Section I.6.b.ii of the Swine Animal Waste Management Permit.

Odor Sampling #2

Odor was monitored to comply with Section I.6.b.ii of the Swine Animal Waste Management Permit. One monitoring event was conducted on June 13, 2019.

Sampling took place at about 9:15 am. It was a nice clear day, somewhat cool for the season (78° F) with very variable wind, from no wind to mild gusts of 2 m/s. Several measurements for wind speed and direction were taken. The average wind speed was 1.3 m/s, the predominant wind direction and sampling points for odor were selected as shown in Figure 6.

Odor was monitored by Marc Deshusses. Odor panelist rules were listed in the previous report and are not repeated here. Odor was monitored using a Nasal Ranger (http://www.nasalranger.com/) field olfactometer, following the manufacturer recommended instructions.

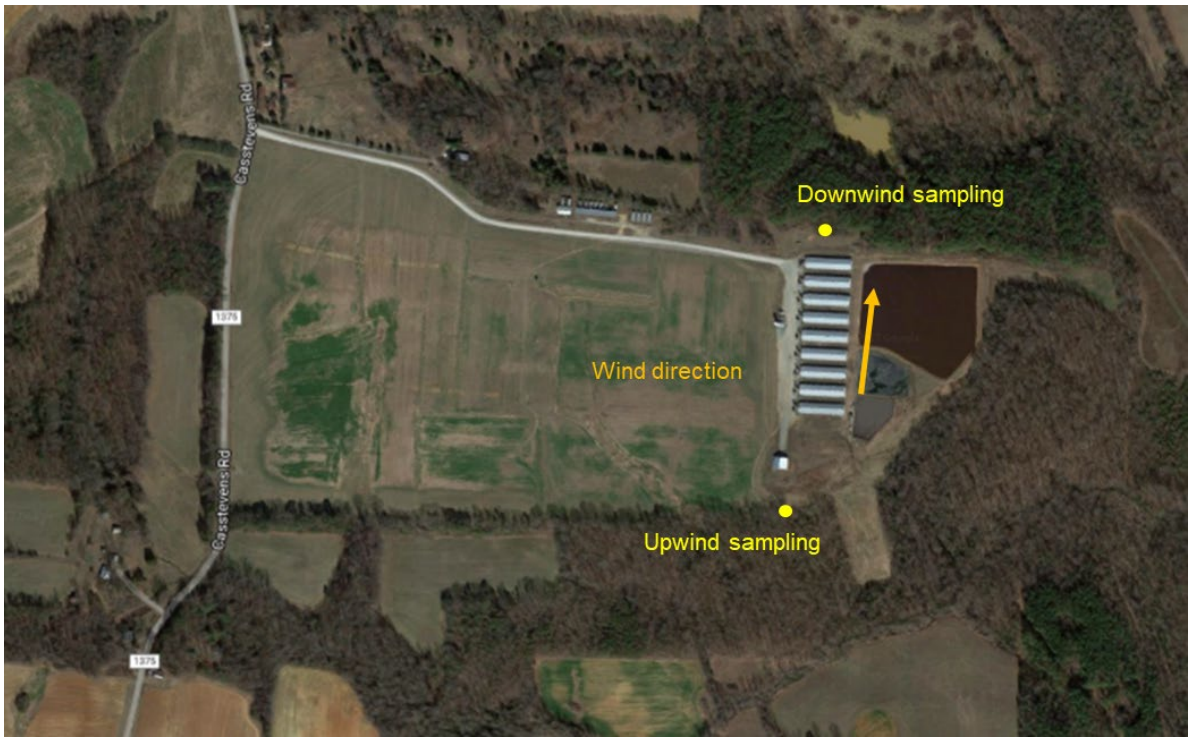

Figure 6. Aerial view of the facility and location of the monitoring points for odor for the June 26, 2018 sampling. The arrows indicate the prevailing wind direction the day of the sampling.

Sampling upwind

Odor could not be detected at the 2 D/T level. This indicates that the odor level was lower than 2 D/T. Then the Nasal Ranger was taken off the nose and ambient air was sniffed and compared to odorless air from the Nasal Ranger. This was to determine whether a difference could be detected between ambient air and odorless air from the Nasal Ranger. No significant difference could be detected.

Sampling downwind

No odor could be detected at the 2 D/T level at the downwind. This indicates that the odor level was lower than 2 D/T. Then the Nasal Ranger was taken off the nose and ambient air was sniffed and compared to odorless air from the Nasal Ranger. This was to determine whether a difference could be detected between ambient air and odorless air from the Nasal Ranger. There was a faint piggery/barn odor with notes of sulfur, but as mentioned before these odors were below the 2 D/T level.

These results indicate that odor levels complied with Section I.6.b.ii of the Swine Animal Waste Management Permit.

Emissions from Animal Waste Treatment and Storage System

Ammonia nitrogen emissions from the aeration basin and lagoon were quantified to determine if significant volatilization of NH_3-N occurred from this part of the waste management system. Emissions from the water surfaces were determined using a buoyant convective flux chamber (BCFC) which method was described in detail and illustrated with pictures in the February 15, 2012 report. Sampling took place on June 13, 2019 between 9:40 am and 11:30 am. It was a nice clear day, somewhat cool for the season (78° F) with very variable wind, from no wind to mild gusts of 2 m/s.

Results were as follows:

- Size of the chamber: 52.1 cm wide by 52.1 cm long and 2.5 cm in headspace height.
- Air sampling flow rate: 3 L/min
- **Average ammonia concentrations** in sweep air from the aeration basin while aeration was off: **45 ppm** (3 samples) or on average in mass concentration 0.026 g-N/m^3
- Ammonia concentrations in sweep air while aeration was on was not measured, earlier monitoring indicated that ammonia concentration in sweep air during aeration was slightly lower.

The total emission from the aeration basin can be calculated from the air sampling flow rate, the surface of the chamber and the surface area of the aeration basin. The latter surface is nominally 24,500 ft^2 (or 2277 m^2). Emission rate is calculated as follows:

NH_3 emission rate = NH_3 concentration × Sampling flow rate × Aeration basin area / Buoyant chamber area

After unit conversion, one obtains values of 38.5 g/h. This corresponds to a NH_3 emission rate of **6.47 kg NH_3-N/week.** This is a low value compared to the **allowable emissions of 106 kg NH_3-N/week** from the swine waste treatment and storage structures as specified in Section I.6.a.i of the Swine Animal Waste Management Permit.

Surface emission rate of NH_3 from the **lagoon** was determined following the same method. Average concentration of ammonia in the sweep air (with the same chamber and at the same flowrate of 3 L/min) was 57 ppm (2 samples). With the surface area of the lagoon (19,425 m^2), emission of NH_3 from the lagoon are estimated to be **69.92 kg NH_3-N/week**.

Results for the emissions from the aeration basin and the lagoon are summarized in the table below. Total ammonia (TAN) in the aeration basin and lagoon at the time of sampling is also reported for information. The concentrations of TAN were low; they reflect the fact that many of the barns were not populated with swine. Altogether, these numbers show the system is performing as expected.

	Aeration basin	**Lagoon**
Surface area	2277 m^2	4.8 acres = 19,425 m^2
TAN	345 mg-N/L	380 mg-N/L
Emission rate	6.47 kg NH_3-N/week	69.92 kg NH_3-N/week
Total emission (lagoon + aeration basin)	**76.39 kg NH_3-N/week**	

Thus, together lagoon and aeration basin contribute to the emission of **76.39 kg NH_3-N/week**. This is well below the allowable 106 kg NH_3-N/week.

Emissions from the Barns

Ammonia emissions from the barns were also determined on June 13, 2019. It should be noted that accurate determination of emissions from animal houses is a difficult exercise. This is because of the variable nature of the emission, the difficulty in accurately measuring air flow from the fans on the animal houses, and the fact that fan operation is automated, i.e., they are turned on and off automatically triggered by a thermostat. Thus, uncertainties on the numbers reported below exist and can be important.

Ammonia in the exhaust air from the barns was determined using Draeger tubes. Details on the concentrations and number of fans on at the time of sampling are shown in the table below. It should be noted that a majority of barns were empty, and that these barns did not have any fans on. Only three barns were populated and had ventilation fans on. The others were not measured.

Barn	NH_3 Concentration (ppm)	Small Fans working	Large Fans working
1		0	0
2	**4**	**0**	**2**
3		0	0
4		0	0
5		0	0
6	**4.1**	**1**	**2**
7	**5**	**1**	**2**
8		0	0
9		0	0

The total emission of ammonia can be estimated by multiplying the ammonia concentration in each of the barn's exhausts by the exhaust flowrate of that barn (33,000 cfm for large fans and 13,000 cfm for the small fans). At the time of sampling, total exhaust flow was 224,000 cfm and concentrations ranged from 4 to 5 ppm (see Table above). The calculated total weekly ammonia emissions from the barns was **159 kg NH_3-N/week.**

Adding the emission from the treatment system and the lagoon (**76.4 kg NH_3-N/week**) to the emissions from the barns (**159 kg NH_3-N/week**) amounts to a **total of 235.3 kg NH_3-N/week** from the swine farm**.** This is below the allowable value of 476 kg NH_3-N/week specified in Section I.6.a.iii of the Swine Animal Waste Management Permit.

This Semi-annual Compliance Report is compiled and respectfully submitted by:

William G. “Gus” Simmons, Jr., P.E.
Cavanaugh & Associates, P.A.
1-877-557-8923

Attachments:

Appendix A – PDF of Actual Operator log sheets
Appendix B – Sample Collection Dataset
Appendix C - Soil Report

Appendix A.

Operations and Maintenance Log – Digitally Attached

Appendix B.
Wastewater Sample Reports

(Digitally Attached)

Appendix C.

NCDA & CS Agronomic Division Soils Report

Loyd Ray Farms, Inc.
Innovative Animal Waste Management System
Permit No. AWI990031
Permit Compliance Semi-Annual Report

July 1, 2019 – December 31, 2019 Semi-Annual Reporting Period

Submitted January 31, 2020

Submitted on Behalf of:
Loyd Ray Farms, Inc.
2049 Center Rd.
Boonville, NC 27011

This Semi-Annual Compliance Report provides an overview of the manner in which the subject facility, Loyd Ray Farms, has maintained compliance with the conditions of the Innovative Animal Waste Management System permit for the reporting period from July 1, 2019 through December 31, 2019. During this reporting period, the system was operated in accordance with the Innovative Swine Waste Treatment System and subject to the requirements thereof.

Overview of System

The animal waste treatment system installed at Loyd Ray Farms is designed to meet the Environmental Performance Standards set forth by North Carolina law for new and expanded swine facilities through the use of nitrification/denitrification and further treatment. This report is provided to confirm, as applicable, on a semi-annual basis that the innovative waste management system is in compliance with NC Department of Environmental Quality and its divisions, to insure that the utilization of the anaerobic digester technology to turn raw animal waste into biogas for the purpose of reducing greenhouse gas emissions minimizes the overall environmental impact of the swine farm, and explains the occurrences of operations, and testing requirements over the six month period, to monitor the system, as it continues to produce renewable energy, generate carbon offsets, and reduce odor on the farm. The report is designed to not only show a synopsis of the maintenance

activities on the farm, but also to supply the analysis of the system's performance and further describe the results of the monitoring and testing activities.

In addition to addressing compliance with the conditions of the permit, the following summaries provide an overview of the system operations including graphs of environmental system performance, microturbine performance, and biogas usage (pages 4-5), and lists all sampling and reporting requirements per the Innovative Animal Waste Management System Permit No. AW1990031 (pages 8-10). For each requirement, this report records on-site monitoring that occurred, with a brief explanation for each farm site visit (pages 6-8) for this reporting period. Additionally, detailed site visits recording maintenance and repairs completed during the second half of 2019, from July 1 through December 31, 2019 are also included in this report.

In summary, from July 1, 2019 through December 31, 2019, all processes that comprise the Innovative System were not fully operational, and electricity generation did not occur for the greater percentage of the reporting period. More intensive maintenance activities were required for some components, such as the anaerobic digester mixing pumps and the biogas conditioning skid, which is not abnormal for a system that has been operating for nearly ten years. Biogas production was lower than what is typically expected due to low hog populations throughout the summer, barn flushing system issues, and a blockage in the anaerobic digester manure collection piping (stemming from the barn flushing issues), which all led to lower manure supply to the digester. Various repairs were made to the system to continue operations as much as possible, and additional repairs are required to return the system to full operation. Those repairs include changing the digester mixing pumps' rotating unit and electric motor, replacing the biogas flare, and various repairs to the biogas conditioning skid. Quotes have been obtained for these repairs and are currently under review. Pending the decisions made regarding the costs and specified repairs, several system components may undergo repairs to bring the system back to expected operating conditions in the next reporting period. Additional observations of system performance are included below and exhibited in the operator logs attached to this report in Appendix A.

During this compliance period, ambient air analyses were accomplished on September 27, 2019, and December 31, 2019, details of the monitoring events have been added to this report (pages 12-16). The air emissions from water surfaces were found to comply and were lower than the permit allows and show that the system is performing according to expectations.

This report was completed on behalf of Loyd Ray Farms, Inc., by Cavanaugh & Associates, P.A., under the direction of the Duke Carbon Offsets Initiative (DCOI). Please contact Matthew Arsenault at 919-613-7466 (Matthew.Arsenault@duke.edu) with any questions. A copy of this report will be provided to Loyd Ray Farms, Inc., and will be maintained on-site with the other permit compliance documentation.

Environmental Treatment System

Figure 1, Environmental Treatment System Uptime, depicts the operation of the aeration system that performs the nitrification function and the anaerobic digester mixing pumps for the monitoring period. The environmental treatment system performed well throughout most of July, although low effluent supply to the aeration basin from the anaerobic digester caused system faults and operational issues during the remainder of the reporting period. The aeration basin mixing pumps eventually lost prime due to the low liquid level in the basin and were turned off in August to avoid continued faults and equipment damage. The liquid level in the basin can be restored to normal by removing the blockage from the anaerobic digester manure collection piping which will allow digester effluent to flow to the aeration basin. The liquid level was reduced because the farm uses recycle water from the aeration basin for barn flushing operations and no effluent was transferred from the digester to the basin. The blockage was not removed from the digester manure collection piping during the first half of the reporting period because the farm had low hog populations and flushing system issues. In addition, the biogas

conditioning skid required repairs to the heat exchangers and chiller unit to ensure reliable operation. Those repairs were completed on July 16, 2019 and July 30, 2020. The farm resolved its flushing system issues in the latter half of the reporting period and the hog population was increased nearer to expected numbers. A quote has been obtained for removing the blockage and actions are expected to be taken in the next reporting period (January 1, 2020 through June 30, 2020) to resolve the issue.

One anaerobic digester mixing pump performed reliably for the beginning of the reporting period up to mid-September. The mixing pump experienced rotating unit failure in mid-September and was no longer able to function. The other mixing pump was repaired by Preferred Sources on August 16, 2020 by replacing the rotating unit. The pump was then identified to have a problem with the electric motor. Preferred Sources replaced the motor capacitors on September 19, 2020 which did not resolve the issue. It was then determined that the entire electric motor must be replaced. A quote has been received from Preferred Sources for replacing the rotating unit and electric motor and a decision on replacing the components is expected to be made in the next reporting period (January 1, 2020 through June 30, 2020). The environmental system operational issues are reflected in the graph depicting system uptime below.

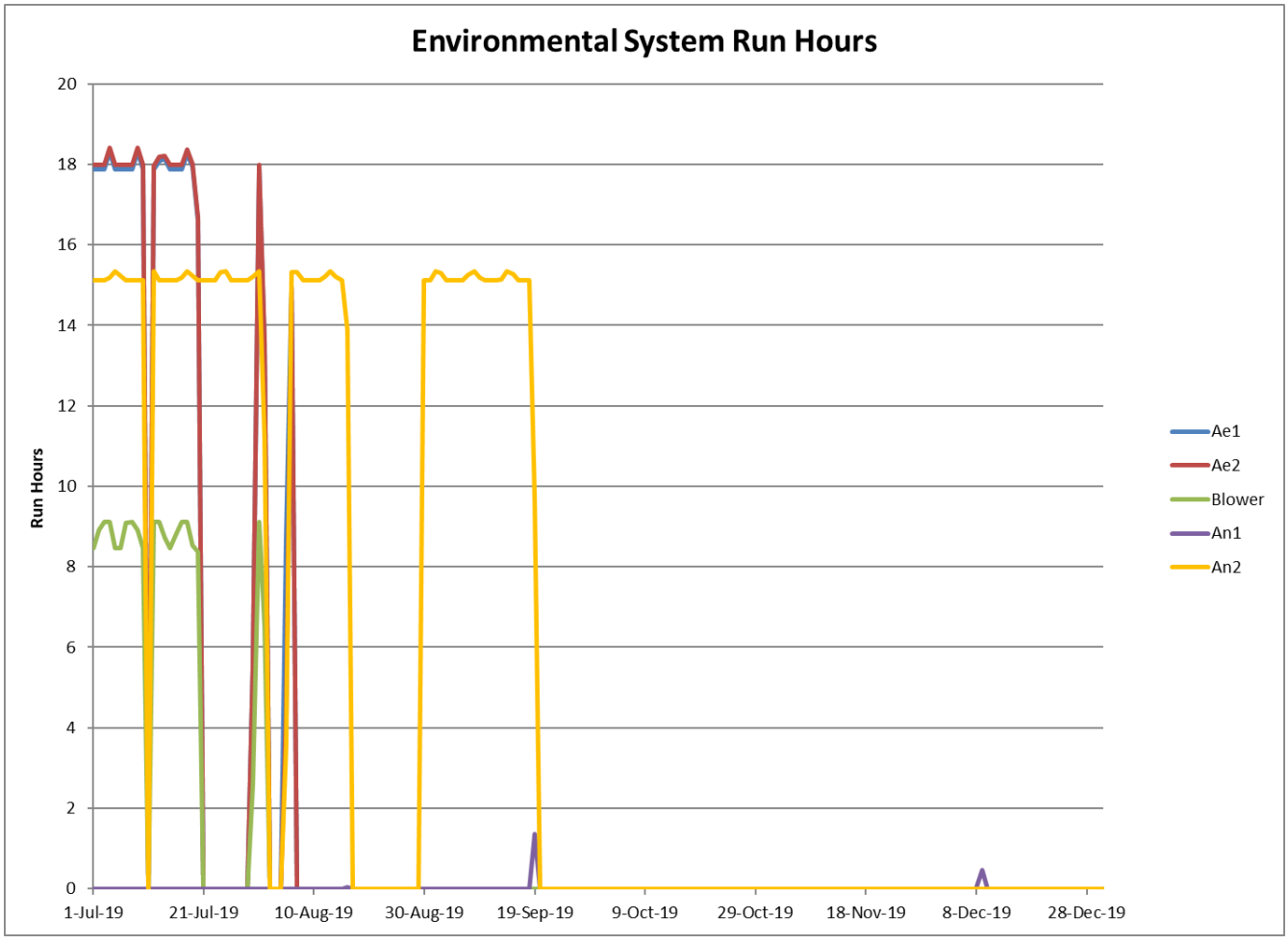

Figure 1. Environmental Treatment System Uptime (July 1, 2019 -December 31, 2019)

Biogas Production and Usage

Figure 2 below depicts the Microturbine Output in kilowatt hours (kWh) during the reporting period. Biogas may only be utilized through use by the microturbine and flare, controlled release through venting, or leaks from the system, which cannot be measured. Power was generated by the microturbine intermittently throughout July, August, and September when biogas quantities were sufficient for the microturbine to operate. The anaerobic digester did not produce sufficient volumes of biogas to supply the microturbine during October, November, and December so the microturbine was not operated. The digester did not perform to expectations due to low manure supply from the hog barns and a blockage in the digester manure collection piping. The microturbine performed reliably when operated, although, as stated and reflected in the graph below, low biogas volumes prevented it from operating for much of the reporting period.

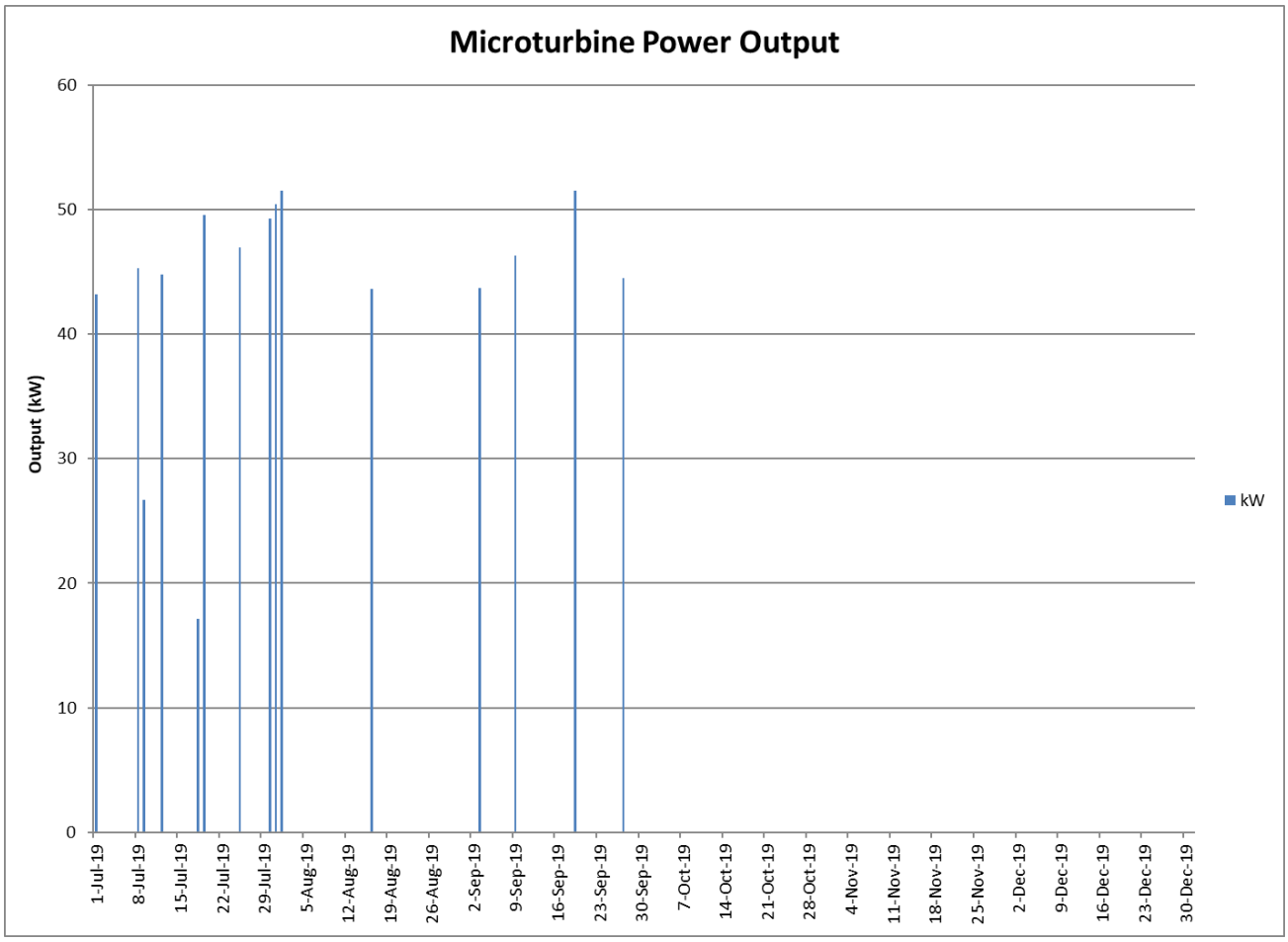

Figure 2. Microturbine Output (kW) (July 1, 2019 -December 31, 2019)

Figure 3, Measured Biogas Flow and Flare Use, depicts measured biogas usage in the microturbine and flare for the duration of the reporting period. As reflected above in the section describing microturbine output, the anaerobic digester did not produce projected biogas volumes due to manure supply issues. The biogas flare was not operated during the reporting period because a blockage in the flare's flame arrestor prevented biogas flow. The normal procedure for removing such a blockage from the flame arrestor is to disassemble the flare, remove the flame arrestor, replace or clean the flame arrestor, then reassemble the flare. Due to corrosion around the

flare fittings, the flare cannot be disassembled and reassembled and needs to be completely replaced which represents a major capital expenditure. The flare will need to be replaced for continued long-term operation. A quote has been obtained for replacing the flare and is currently under review to determine if the flare should be replaced according to the quoted specifications or if another quote should be obtained. It is anticipated that a decision regarding the flare replacement will be made in the next reporting period (January 1, 2020 through June 30, 2020) and new flare equipment may be purchased pending the decision. There has not been a pressing need to replace the flare because the digester has not produced sufficient gas to supply the microturbine and flare and thus the flare has not been needed for biogas combustion. The lack of biogas usage in the flare is reflected in the graph below. The microturbine used biogas for power generation at various times throughout the reporting period as reflected in Figures 2 and 3. Again, due to manure supply issues and lack of biogas production in the digester, the biogas flow to the microturbine was much lower than is typically expected and has been historically reported.

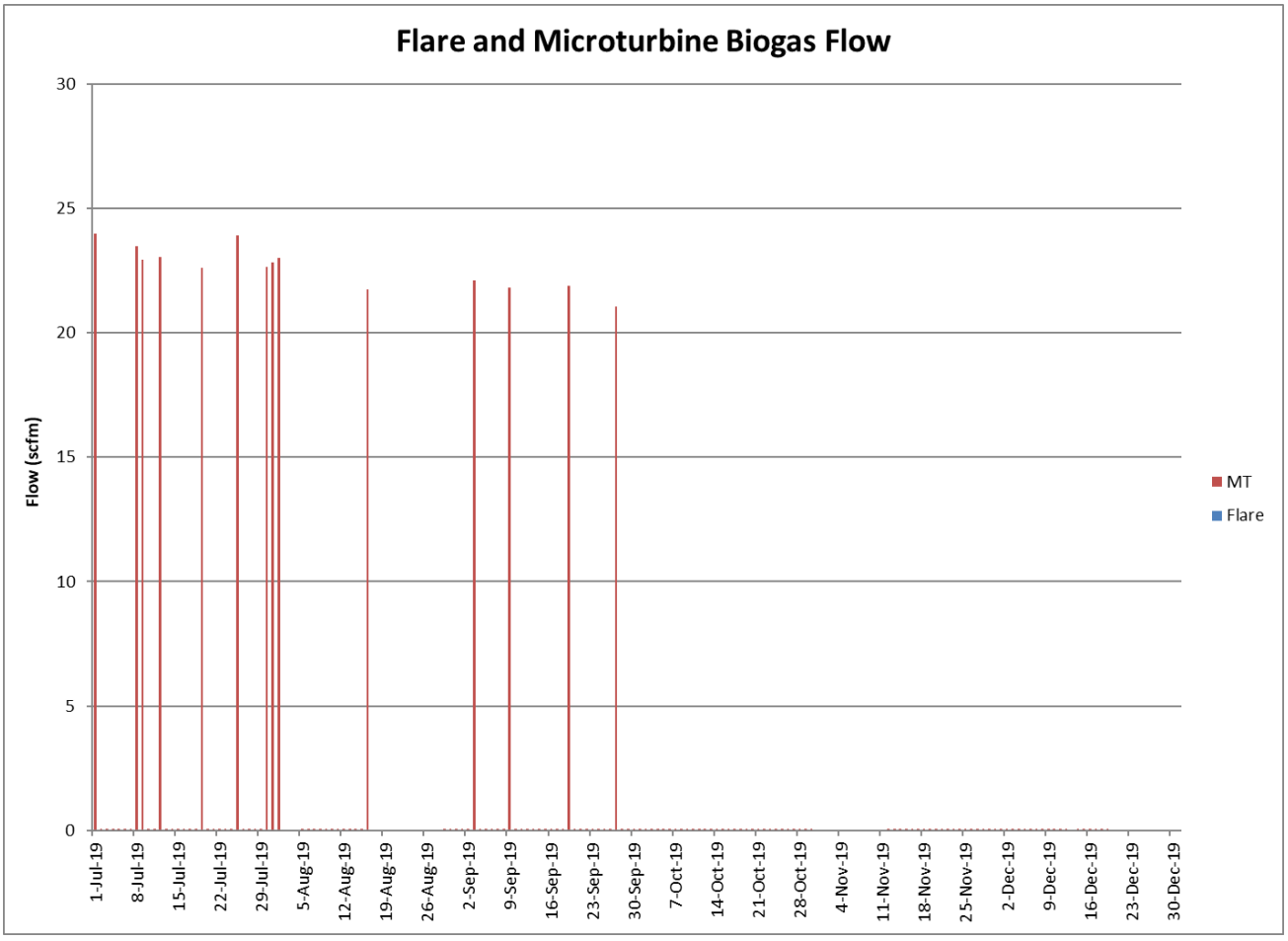

Figure 3. Measured Biogas Flow and Flare Use (July 1, 2019 -December 31, 2019)

Overview of System Maintenance and Repairs

Overall, the biogas system and the environmental treatment system remained under compliance but did not perform to expectations due to manure supply issues to the anaerobic digester. All maintenance exceptions appear in the log below, as maintained and recorded physically in the **Loyd Ray Farms Inspection and Operation**

Log Sheets. While remote monitoring occurs on a daily basis, those activities are not normally captured in the report. We will note here only occurrences which required a site visit to resolve, or how the technicians would troubleshoot any problems that arose. If a system alert precipitated a site visit, we have indicated how the monitoring team went about troubleshooting the problem, and logged the experience required to make the corrections. Oftentimes, Cavanaugh's team was able to resolve the issue, but if a representative from either Unison, the biogas skid provider, or another service technician, such as an electrician, was required for further assessment or repairs, we have also noted the dates of their presence, how they troubleshooted the problem, and if replacement, new or rebuilt parts were required. Please note that the system required more frequent service than usual as some of the components in the system, commissioned in 2011, are approaching their expected service life, however most of the service activities are viewed as normal operations and maintenance (O&M), and in all instances, no new system components were added to normal operations.

In summary, maintenance activities during this reporting period were completed to repair the anaerobic digester mixing pumps, the biogas conditioning skid and chiller unit, and the biogas piping, among other minor issues. Technicians from Preferred Sources assessed the digester mixing pump issues and made necessary repairs. A technician from Unison Solutions performed a service visit for the conditioning skid and a technician from Professional Air Systems performed a service visit for the chiller unit. The biogas piping repairs were coordinated by a technician from ProPump & Controls. The dates of these repairs are reflected in the operator logs and summary table below.

The summary of the detailed operations log of on-site activities and monitoring for the period of July 1, 2019 through December 31, 2019 is presented as follows:

Date	Observation
7-16-2019	Ben met Unison Solutions tech on site for biogas conditioning skid repairs. Also met ProPump & Controls tech on site to assess biogas flare repairs. Discovered small biogas leak in the condensate manhole near the building. Shut off gas flow to the manhole.
7-17-2019	Ben met Unison Solutions tech and ProPump and Controls tech on site for biogas leak repairs. Disassembled the manhole and repaired the leak by replacing the valve and collar. Repaired the manhole to original condition and opened the biogas valve. Biogas was no longer leaking.
7-30-2019	I met chiller tech from Professional Air Systems on site for chiller repairs. The tech did not identify any major issues but added refrigerant to the system to fill it. He replaced the chiller inlet and outlet glycol pressure gauges.
8-16-2019	Ben Cauthen met Preferred Sources at the farm to repair the rotating unit in anaerobic mixing pump 1. Preferred Sources completed the repair by approximately 9:30 AM. They then tested the pump and discovered the motor was drawing excessively high amperage. They tested the ohms of the starting components (capacitors) and didn't find an issue. One of the leads on a capacitor broke. Preferred Sources is going to order four new capacitors and replace the starting assembly. Mixing pump 1 is off until the capacitors are replaced.

	The aeration basin level is very low. The environmental system is turned off because the aerobic pumps lost prime due to the low liquid level. The farm used the basin liquid to flush hog houses without returning any liquid to the basin. The digester inlet must be reopened to allow waste to flow to the basin. The digester is producing very little gas due to the blocked inlet. Five of nine hog houses are filled with hogs.
8-29-2019	1. Digester Inlet Pipe a. I attempted to snake a piece of pipe into the inlet pipe today but couldn't get it to feed into the pipe. The manure in the manhole is very thick and is covering the pipe to the digester and the pipe to the lagoon. The 12" collection pipe is still visible as is the 4" forcemain from the aeration basin pumps. 2. Digester to Aeration Basin Pipe a. I'm not sure if this pipe is clogged but sludge may be blocking the inlet and outlet. 3. Conditioning Skid a. I could not get the conditioning skid to start today. The inlet heat exchanger discharge temp would not drop below 85°F. The operating range is 35 to 75°F. I'm not sure what the set point is for the skid to start. b. The temperature usually drops to at least 75°F even when it's very hot outside, and it isn't that hot today. The heat exchanger is cooling less now than it was before. The chiller appears to be running correctly and the glycol discharge pressure is correct. The chiller tech did not find anything wrong with the chiller except adding about 1 pound of freon. c. I haven't ran the skid in about 2 weeks. The inlet heat exchanger may have a blockage, which is what we suspected before. Maybe leaving the skid idle for a couple weeks somehow made the blockage worse. The Unison tech thought the chiller was the problem when he was here about a month ago and didn't attempt to repair the heat exchanger. 4. Flare a. I couldn't test the flare today since the skid wouldn't run. I didn't try to knock the flame arrestor with a pipe. 5. Digester Mixing Pumps a. Josh Amon is supposed to replace the capacitors in mixing pump 1 which will hopefully get it running. If not, the entire motor will need to be replaced. b. The rotating unit on mixing pump 2 sounds very rough. It should be replaced or rebuilt, although that's a $6,500 repair so I'm holding off for now. It's still functioning. 6. Environmental System a. The entire environmental system is turned off due to the very low aeration basin level. The pumps lost prime and are not functioning.
9-19-2019	Preferred Sources replaced the starting components in digester mixing pump 1. The pump pulled 22-27 amps after the capacitors were replaced. The pump is pulling above normal

	amperage meaning there is likely a more significant issue with the motor. I turned the pump off and will leave it off. Digester mixing pump 2 will not prime. We attempted to prime the pump with a hose and mixing pump 1, but neither approach worked. There is likely an issue with the rotating unit on the pump. Steve and I inspected the site and discussed decommissioning and the plan going forward. I completed Q3 manure sampling and returned the samples to R&A Labs.
9-27-2019	Performed a complete system check and operated the skid and turbine for several hours. Met Matt and Emma from Duke University and explained the system to them. Matt performed odor sampling for Q3.
10-23-2019	Met Yadtel tech to update router to match Yadtel's new specs. Efinity will need to replace the router to repair the internet. No internet is available now.
12-9-2019	Performed manure sampling to fulfill quarterly requirement. Met NCDEQ employees for inspection.
12-20-2019	Performed annual sludge survey to measure digester sludge accumulation. Repaired internet with Yadtel.

The following table lists the compliance requirements as per the permit for the subject system, and the performance / compliance relative to each requirement:

	Description of Monitoring Requirement	Status	Result
1	Maintenance of adequate records by Permittee to track the amount of sludge/separated solids disposed.	N/A	No solids or sludge disposal occurred during the reporting period.
2	Inspection of entire Innovative System waste collection, treatment, and storage structures and runoff control measures at a frequency to insure proper operation but at least monthly and after all storm events of greater than one (1) inch in 24 hours; Permittee maintenance of inspection log or summary including at least the date and time of inspection, observations made, and any maintenance, repairs, or corrective actions taken by Permittee.	☑	Inspections and observations conducted by representatives of Loyd Ray Farms, Inc., Cavanaugh & Associates, P.A., and DCOI. Observations recorded, and actions taken to adjust the operation of the System are recorded in log book kept onsite, and emailed in.
3	Maintenance of a log of all operational changes made to the Innovative System including at least the process parameter that was changed, date and time of the change, reason for the change, and all observations made both at the time of the change and	☑	Log book entries, as described in item #2, above, maintained on site; copies attached to report (Appendix A).

	subsequently as a result of the change by Permittee/ Permittee's designee.		
4	Representative Standard Soil Fertility Analysis to be conducted annually on each application site receiving animal waste.	☐	An NCDA&CS Agronomic Division Report showing results of the Predictive Home & Garden Soil Report for Loyd Ray Farms was not available for the compliance period. Predictive Waste Reports completed on 7/31/2019 and 11/13/2019 are attached to this report and can also be accessed here: http://www.ncagr.gov/agronomi/
Wastewater Analysis			
5	Quarterly tests shall be conducted once within each of the following windows w/ at least sixty (60) days between any 2 sampling events. Water quality samples include analysis of copper, zinc, total suspended solids, pH, total nitrogen, TKN, NO2 + NO3, phosphorus, ammonia, and fecal coliform.		
	Quarter 3 (July 1 – September 30)	☑	Sample Collected: 9/19/2019 Sample Analyzed: 9/19/2019 Results Reported: 10/2/2019 Results included in the attached report from Research & Analytical Laboratories, Inc. (Appendix B)
	Quarter 4 (October 1 – December 31)	☑	Sample Collected: 12/9/2019 Sample Analyzed: 12/9/2019 Results Reported: 1/13/2020 Results included in the attached report from Research & Analytical Laboratories, Inc. (Appendix B)
Ambient Air Sampling			
	Fall Season Ambient Air Sampling	☑	A fall season ambient air sample was taken on September 27, 2019. Results are included in the Explanation of Results and Sampling Methods.
	Waste Treatment and Storage System	☑	
	Barns	☑	
	Sprayfields	☐	
	Winter Season Ambient Air Sampling	☑	A second ambient air sample (winter analysis) was completed on December 31, 2019. Results are included in the Explanation of Results and Sampling Methods.
	Waste Treatment System	☑	

	Barn Exhaust	☑	
	Sprayfields	☐	
Odor Sampling			
6	Permittee shall monitor for odor compliance quarterly at both upwind and downwind locations on the property boundary. Permittee shall document monitoring locations on a site map, indicating prevailing wind direction, for each monitoring event.		
	Quarter 3 (July 1 – September 30)	☑	Odor sampled by Duke University on December 31, 2019. Results are included in the Explanation of Results and Sampling Methods.

EXPLANATION OF RESULTS AND SAMPLING METHODS

1. Amount of Sludge or Separated Solids Disposed and Measured
N/A. No disposal of sludge or separated solids was required from the Innovative System during the 7/1/2019-12/31/2019 reporting period.

Marvin Cavanaugh and Ben Cauthen of Cavanaugh & Associates, P.A. completed a sludge survey of the anaerobic digester on December 20, 2019. Sludge depth was measured from the two centermost digester vents at the locations depicted below. The depth at Location 1 was measured as 2’ and the depth at Location 2 was measured as 2’-6”.

Figure 4. Loyd Ray Farms anaerobic digester sludge survey locations from December 20, 2019.

2. Log of System Inspections
See Operator Log Book, Appendix A.

3. Log of Operational Changes to the Innovative System
See Operator Log Book, Appendix A.

4. Results of Standard Soil Fertility Analysis
There were no Soil Reports published by NCDA&CS Agronomic Division during the July 1, 2019 through December 31, 2019 compliance period. Soil samples were previously taken at Loyd Ray Farms on October 22, 2018 and the soil analysis results were included in the January 31, 2019 Semi-Annual Compliance Report. NCDA&CS Agronomic Division Predictive Waste Reports completed on 7/31/2019 and 11/13/2019 are attached to this report.

5. Results of Water and Air Quality Sampling

a. Results of Wastewater Analysis
Water quality samples were taken in each quarter and a synopsis of the results is found below and in Appendix B. Samples were analyzed by Research Analytical Laboratories, Inc. in Kernersville, NC. The following table compares the results of the water quality analysis of the final effluent from the Innovative System:

Parameter	9/19/2019	12/9/2019
TOT N	1630	852
TKN	1630	852
NO_2+NO_3	<0.05	0.757
TP	69.4	36.8
NH_3-N	852	436
COPPER	0.059	0.026
ZINC	0.224	0.086
TS	102	120
FECAL	<18	3
pH	8.59	8.44

The chart above describes the wastewater analyses that are required to be conducted on a quarterly basis. These parameters are total N, NH_3-N, NO_3-N/NO_2-N, total P, % solids, copper, zinc, pH and pathogens. Samples are to be taken from the raw manure, the digester, and the effluent (leaving the aeration basin).

b. **The Results of Air Sampling**

Duke University took Fall and Winter ambient Air Samples on September 27, 2019, and December 31, 2019, respectively, the results of which are described below.

Odor Sampling THIRD QUARTER

Odor was monitored to comply with Section I.6.b.ii of the Swine Animal Waste Management Permit. One monitoring event was conducted on September 27, 2019.

Sampling took place at about 11:40 am. It was slightly overcast day, temperature was 80° F with very variable wind 1.2 –2.5 m/s and average at about 2 m/s. The predominant wind direction and sampling points for odor were selected as shown in Figure 1.

Odor was monitored by Emma Fulop and Matthew Arsenault. Odor was monitored using a Nasal Ranger (http://www.nasalranger.com/) field olfactometer, following the manufacturer recommended instructions.

Figure 5. Aerial view of the facility and location of the monitoring points for odor for the September 27, 2019 sampling. The arrows indicate the prevailing wind direction the day of the sampling.

Sampling upwind
Odor could not be detected at the 2 D/T level. This indicates that the odor level was lower than 2 D/T. Then the Nasal Ranger was taken off the nose and ambient air was sniffed and compared to odorless air from the Nasal Ranger. This was to determine whether a difference could be detected between ambient air and odorless air from the Nasal Ranger. No significant difference could be detected.

Sampling downwind
No odor could be detected at the 2 D/T level at the downwind. This indicates that the odor level was lower than 2 D/T. However ambient air without Nasal Ranger had faint barn odors while still being below the 2 D/T level.

These results indicate that odor levels complied with Section I.6.b.ii of the Swine Animal Waste Management Permit.

Odor Sampling FOURTH QUARTER

Odor was monitored to comply with Section I.6.b.ii of the Swine Animal Waste Management Permit. One monitoring event was conducted on December 31, 2019.

Sampling took place at about 10:30 am. It was a nice cold (50° F) clear and windy day. The wind was strong with steady winds of 4 m/s and gusts of up to 10 m/s. Several measurements for wind speed and direction were taken. The average wind speed was about 6 m/s, the predominant wind direction and sampling points for odor were selected as shown in Figure 2.

Odor was monitored by Marc Deshusses. Odor panelist rules were listed in the previous report and are not repeated here. Odor was monitored using a Nasal Ranger (http://www.nasalranger.com/) field olfactometer, following the manufacturer recommended instructions.

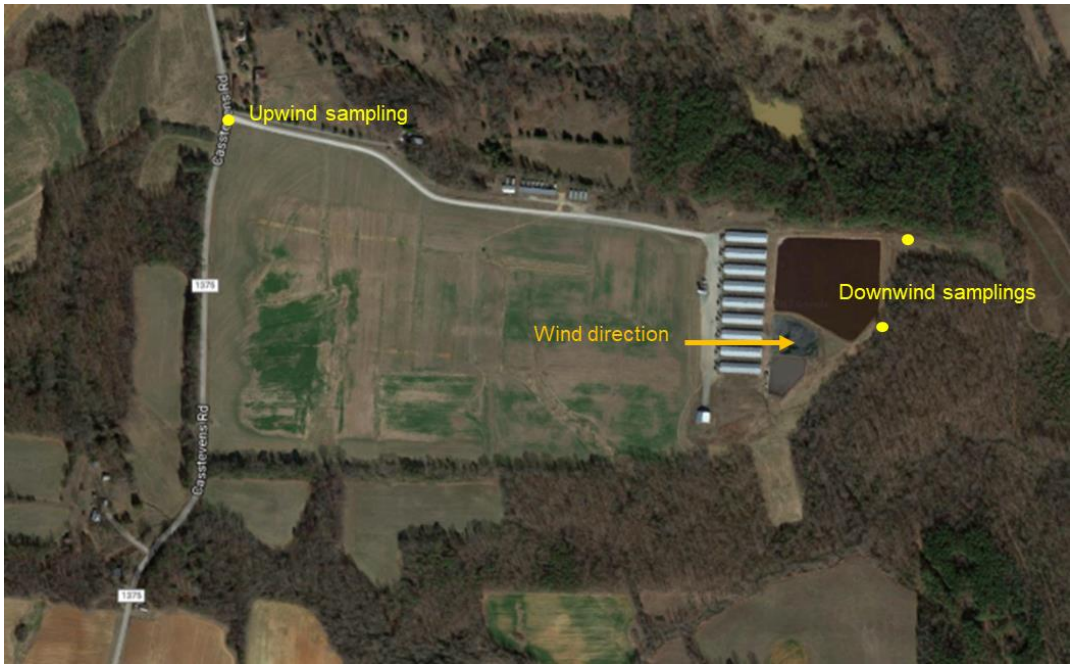

Figure 6. Aerial view of the facility and location of the monitoring points for odor for the December 31, 2019 sampling. The arrows indicate the prevailing wind direction the day of the sampling.

Sampling upwind

Odor could not be detected at the 2 D/T level. This indicates that the odor level was lower than 2 D/T. Then the Nasal Ranger was taken off the nose and ambient air was sniffed and compared to odorless air from the Nasal Ranger. This was to determine whether a difference could be detected between ambient air and odorless air from the Nasal Ranger. No significant difference could be detected.

Sampling downwind

Two sampling points were selected. Odor sensation without the olfactometer seemed variable probably because of the wind. No odor was consistently detected at the 2 D/T level at the downwind locations. This indicates that the odor level was lower than 2 D/T. Then the Nasal Ranger was taken off the nose and ambient air was sniffed and compared to odorless air from the Nasal Ranger. This was to determine whether a difference could be detected between ambient air and odorless air from the Nasal Ranger. There was a faint piggery/barn odor depending on wind gusts, but as mentioned before these odors were below the 2 D/T level.

These results indicate that odor levels complied with Section I.6.b.ii of the Swine Animal Waste Management Permit.

Emissions from Animal Waste Treatment and Storage System

Ammonia nitrogen emissions from the aeration basin and lagoon were quantified to determine if significant volatilization of NH_3-N occurred from this part of the waste management system. Emissions from the water surfaces were determined using a buoyant convective flux chamber (BCFC) which method was described in detail and illustrated with pictures in the February 15, 2012 report. Sampling took place on December 31, 2019. Sampling took place between 11 am and noon. It was a nice cold (50° F) clear and windy day. The wind was strong with steady winds of 4 m/s and gusts of up to 10 m/s. The average wind speed was about 6 m/s,

Results were as follows:

- Size of the chamber: 52.1 cm wide by 52.1 cm long and 2.5 cm in headspace height.
- Air sampling flow rate: 2.9 L/min
- **Average ammonia concentrations** in sweep air from the aeration basin while aeration was off: **0.9 ppm** (2 samples) or on average in mass concentration 0.51 mg-N/m^3. We note here that this concentration is much lower than what was measured in earlier testing, possibly because of the lower use of the aeration basin.
- Ammonia concentrations in sweep air while aeration was on was not measured, earlier monitoring indicated that ammonia concentration in sweep air during aeration was slightly lower.

The total emission from the aeration basin can be calculated from the air sampling flow rate, the surface of the chamber and the surface area of the aeration basin. The latter surface is nominally 24,500 ft^2 (or 2277 m^2) but was reduced to 1600 m^2 for these calculations as the level of water in the aeration basin was low. Emission rate is calculated as follows:

NH_3 emission rate = NH_3 concentration × Sampling flow rate × Aeration basin area / Buoyant chamber area
After unit conversion, one obtains values of 0.52 g/h. This corresponds to a NH_3 emission rate of **0.088 kg NH_3-N/week.** This is a low value compared to the **allowable emissions of 106 kg NH_3-N/week** from the swine waste treatment and storage structures as specified in Section I.6.a.i of the Swine Animal Waste Management Permit. Surface emission rate of NH_3 from the **lagoon** was determined following the same method. Average concentration of ammonia in the sweep air (with the same chamber and at the same flowrate of 2.9 L/min) was 2.4 ppm (2 samples). With the surface area of the lagoon (19,425 m^2), emission of NH_3 from the lagoon are estimated to be **2.85 kg NH_3-N/week**.

Results for the emissions from the aeration basin and the lagoon are summarized in the table below. Total ammonia (TAN) in the aeration basin and lagoon at the time of sampling is also reported for information. The concentrations of TAN were low; they reflect the fact that many of the barns were not populated with swine. Altogether, these numbers show the system is performing as expected.

	Aeration basin	**Lagoon**
Surface area	1600 m^2	4.8 acres = 19,425 m^2
Emission rate	0.088 kg NH_3-N/week	2.85 kg NH_3-N/week
Total emission (lagoon + aeration basin)	**2.93 kg NH_3-N/week**	

Thus, together lagoon and aeration basin contribute to the emission of **2.93 kg NH_3-N/week**. This is well below the allowable 106 kg NH_3-N/week.

Emissions from the Barns
Ammonia emissions from the barns were also determined on December 31, 2019. It should be noted that accurate determination of emissions from animal houses is a difficult exercise. This is because of the variable nature of the emission, the difficulty in accurately measuring air flow from the fans on the animal houses, and the fact that fan operation is automated, i.e., they are turned on and off automatically triggered by a thermostat. Thus, uncertainties on the numbers reported below exist and can be important.

Ammonia in the exhaust air from the barns was determined using Draeger tubes. Details on the concentrations and number of fans on at the time of sampling are shown in the table below.

Barn	NH_3 Concentration (ppm)	Small Fans working	Large Fans working
1	7.5	1	1
2	8	1	1
3	ND	0	0
4	4	1	0
5	3.4	1	0
6	9	1	0
7	12.5	1	1
8	8.3	1	1
9	10	0	2

The total emission of ammonia can be estimated by multiplying the ammonia concentration in each of the barn's exhausts by the exhaust flowrate of that barn (33,000 cfm for large fans and 13,000 cfm for the small fans). At the time of sampling, total exhaust flow was 289,000 cfm and concentrations ranged from 4 to 12.5 ppm (see Table above). One barn is noted ND (not determined) because both fans were off. The calculated total weekly ammonia emissions from the barns was **411 kg NH_3-N/week.**

Adding the emission from the treatment system and the lagoon (**2.93 kg NH_3-N/week**) to the emissions from the barns (**411 kg NH_3-N/week**) amounts to a **total of 414 kg NH_3-N/week** from the swine farm**.** This is below the allowable value of 476 kg NH_3-N/week specified in Section I.6.a.iii of the Swine Animal Waste Management Permit.

Additional Observations

As noted above, there are several critical repairs required to return the Innovative System to full operation, including removing the blockage from the anaerobic digester manure collection piping, replacing components on both digester mixing pumps, and replacing the biogas flare. Those repairs would require significant spending and quotes have been received and are currently being reviewed. The Innovative System owner, Duke University, is currently determining the appropriate actions for the operation of the system going forward as the contract with Loyd Ray Farms to operate the system is nearing the end of its ten year term. Duke is reviewing the costs and benefits of continuing operation of the system long-term to determine appropriate repairs during 2020.

Loyd Ray Farms has maintained compliance with the conditions of the Innovative Animal Waste Management System permit since the blockage in the manure collection piping caused the farm to divert manure to the existing lagoon and resume operations as were done before the installation of the Innovative System.

This Semi-annual Compliance Report is compiled and respectfully submitted by:

Benjamin K Cauthen

Benjamin K. Cauthen, E.I.
Cavanaugh & Associates, P.A.
1-877-557-8923

Attachments:

Appendix A – PDF of Actual log sheets
Appendix B – Wastewater Sample Collection Dataset
Appendix C – Predictive Waste Reports

APPENDIX A – Operation and Log Sheets

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

IMPORTANT: AN INSPECTION, OPERATIONS & MAINTENANCE LOG SHOULD BE COMPLETED FOR EVERY SITE VISIT; PLEASE REVIEW PREVIOUS LOG ENTRY AND PROVIDE INFORMATION TO UPDATE OR RESOLVE ANY ON-GOING ISSUES NOTED (INCLUDING BUT NOT LIMITED TO MAINTENANCE, REPAIRS, OR CORRECTIVE ACTIONS).

Entry Made By: Ben Cauthen	**07-16-2019 Tuesday**	**Visit Start Time 8:00 AM**	**Visit Stop Time 2:30 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 85 °F**		
Precip Past 24 hours: 0.00 inches in gauge		**Wind: (mph): 0-2 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Ben met Unison Solutions tech on site for biogas conditioning skid repairs. Also met ProPump & Controls tech on site to assess biogas flare repairs. Discovered small biogas leak in the condensate manhole near the building. Shut off gas flow to the manhole.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Blower	☒ Auto ☐ Hand On ☐ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☒ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60Hz**	
Jet Motive Pump # 2		**60Hz**	
Blower		**30Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No					
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No					
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC	**PIT 331** 88 to 110psig	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F	**TE 311** 40 to 115 F	**TE 321** 35 to 75 F	**TE 331** 80 to 220 F	**TE 341** 33 to 45 F	**TE 342** 65 to 90 F	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Curt Schiesl	**Unison Solutions**	
Mark Roberts	**ProPump & Controls**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

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Entry Made By: Ben Cauthen	**07-17-2019 Wednesday**	**Visit Start Time 8:00 AM**	**Visit Stop Time 3:30 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 90 °F**		
Precip Past 24 hours: 0.00 inches in gauge		**Wind: (mph): 0 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Ben met Unison Solutions tech and ProPump and Controls tech on site for biogas leak repairs. Disassembled the manhole and repaired the leak by replacing the valve and collar. Repaired the manhole to original condition and opened the biogas valve. Biogas was no longer leaking.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Blower	☒ Auto ☐ Hand On ☐ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☒ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60Hz**	
Jet Motive Pump # 2		**60Hz**	
Blower		**30Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No					
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No					
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC	**PIT 331** 88 to 110psig	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F	**TE 311** 40 to 115 F	**TE 321** 35 to 75 F	**TE 331** 80 to 220 F	**TE 341** 33 to 45 F	**TE 342** 65 to 90 F	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Curt Schiesl	**Unison Solutions**	
Mark Roberts	**ProPump & Controls**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

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Entry Made By: Ben Cauthen	**07-30-2019 Tuesday**	**Visit Start Time 9:00 AM**	**Visit Stop Time 1:30 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 85 °F**		
Precip Past 24 hours: 0.00 inches in gauge		**Wind: (mph): 0 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

I met chiller tech from Professional Air Systems on site for chiller repairs. The tech did not identify any major issues but added refrigerant to the system to fill it. He replaced the chiller inlet and outlet glycol pressure gauges.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Blower	☒ Auto ☐ Hand On ☐ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☒ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60Hz**	
Jet Motive Pump # 2		**60Hz**	
Blower		**30Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No					
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No					
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC	**PIT 331** 88 to 110psig	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F	**TE 311** 40 to 115 F	**TE 321** 35 to 75 F	**TE 331** 80 to 220 F	**TE 341** 33 to 45 F	**TE 342** 65 to 90 F	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Keith Simpson	**Professional Air Systems**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

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Entry Made By: Ben Cauthen	**08-16-2019 Friday**	**Visit Start Time 8:30 AM**	**Visit Stop Time 11:30 AM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 80 °F**		
Precip Past 24 hours: 0.00 inches in gauge		**Wind: (mph): 0-2 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Ben met Preferred Sources at the farm to repair the rotating unit in anaerobic mixing pump 1. Preferred Sources completed the repair by approximately 9:30 AM. They then tested the pump and discovered the motor was drawing excessively high amperage. They tested the ohms of the starting components (capacitors) and didn't find an issue. One of the leads on a capacitor broke. Preferred Sources is going to order four new capacitors and replace the starting assembly. Mixing pump 1 is off until the capacitors are replaced.

The aeration basin level is very low. The environmental system is turned off because the aerobic pumps lost prime due to the low liquid level. The farm used the basin liquid to flush hog houses without returning any liquid to the basin. The digester inlet must be reopened to allow waste to flow to the basin. The digester is producing very little gas due to the blocked inlet.

Five of nine hog houses are filled with hogs.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault
Blower	☐ Auto ☐ Hand On ☒ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☒ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**

Jet Motive Pump # 1		**60Hz**	
Jet Motive Pump # 2		**60Hz**	
Blower		**30Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No	21.8 cfm	21.8 cfm	101.7 psi	99.6 psi	
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No	95810 rpm	1175 F		94 F	43.4 kw
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC -0.1	**PIT 331** 88 to 110psig 97.39	**PIT 351** 88 to 110 psig 91.8	**Pressure Differential** **2.0**	**Panel Door**	**HM 331** Hours 7060	
Temperature Data	**TE 141** 32 to 45 F 35.1	**TE 311** 40 to 115 F 83.1	**TE 321** 35 to 75 F 46.6	**TE 331** 80 to 220 F 186.5	**TE 341** 33 to 45 F 35.2	**TE 342** 65 to 90 F 88.3	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Josh Amon	**Preferred Sources**	
Brian Metot	**Preferred Sources**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

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Entry Made By: Ben Cauthen	**08-29-2019 Thursday**	**Visit Start Time 12:30 PM**	**Visit Stop Time 2:30 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 85 °F**		
Precip Past 24 hours: 0.00 inches in gauge		**Wind: (mph): 0-2 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

1. Digester Inlet Pipe
    a. I attempted to snake a piece of pipe into the inlet pipe today but couldn't get it to feed into the pipe. The manure in the manhole is very thick and is covering the pipe to the digester and the pipe to the lagoon. The 12" collection pipe is still visible as is the 4" forcemain from the aeration basin pumps.
2. Digester to Aeration Basin Pipe
    a. I'm not sure if this pipe is clogged but sludge may be blocking the inlet and outlet.
3. Conditioning Skid
    a. I could not get the conditioning skid to start today. The inlet heat exchanger discharge temp would not drop below 85°F. The operating range is 35 to 75°F. I'm not sure what the set point is for the skid to start.
    b. The temperature usually drops to at least 75°F even when it's very hot outside, and it isn't that hot today. The heat exchanger is cooling less now than it was before. The chiller appears to be running correctly and the glycol discharge pressure is correct. The chiller tech did not find anything wrong with the chiller except adding about 1 pound of freon.
    c. I haven't ran the skid in about 2 weeks. The inlet heat exchanger may have a blockage, which is what we suspected before. Maybe leaving the skid idle for a couple weeks somehow made the blockage worse. The Unison tech thought the chiller was the problem when he was here about a month ago and didn't attempt to repair the heat exchanger.
4. Flare
    a. I couldn't test the flare today since the skid wouldn't run. I didn't try to knock the flame arrestor with a pipe.
5. Digester Mixing Pumps
    a. Josh Amon is supposed to replace the capacitors in mixing pump 1 which will hopefully get it running. If not, the entire motor will need to be replaced.
    b. The rotating unit on mixing pump 2 sounds very rough. It should be replaced or rebuilt, although that's a $6,500 repair so I'm holding off for now. It's still functioning.
6. Environmental System
    a. The entire environmental system is turned off due to the very low aeration basin level. The pumps lost prime and are not functioning.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	Operational Status
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault
Blower	☐ Auto ☐ Hand On ☒ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☒ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	Set Point	Current	Modified Set Pt	Notes
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	Run Time	Set Speed	Notes
Jet Motive Pump # 1		**60Hz**	
Jet Motive Pump # 2		**60Hz**	
Blower		**30Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	Operational Status				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No	0 cfm	0 cfm			
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No					
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC -0.1	**PIT 331** 88 to 110psig 97.39	**PIT 351** 88 to 110 psig 91.8	**Pressure Differential** **2.0**	**Panel Door**	**HM 331** Hours 7060	
Temperature Data	**TE 141** 32 to 45 F 35.1	**TE 311** 40 to 115 F 83.1	**TE 321** 35 to 75 F 46.6	**TE 331** 80 to 220 F 186.5	**TE 341** 33 to 45 F 35.2	**TE 342** 65 to 90 F 88.3	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig

Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

IMPORTANT: AN INSPECTION, OPERATIONS & MAINTENANCE LOG SHOULD BE COMPLETED FOR EVERY SITE VISIT; PLEASE REVIEW PREVIOUS LOG ENTRY AND PROVIDE INFORMATION TO UPDATE OR RESOLVE ANY ON-GOING ISSUES NOTED (INCLUDING BUT NOT LIMITED TO MAINTENANCE, REPAIRS, OR CORRECTIVE ACTIONS).

Entry Made By: Ben Cauthen	**09-19-2019 Thursday**	**Visit Start Time 9:00 AM**	**Visit Stop Time 1:00 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Intermittent Clouds 70 °F**		
Precip Past 24 hours: 0.00 inches in gauge	**Wind: (mph): 0 mph**		

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Preferred Sources replaced the starting components in digester mixing pump 1. The pump pulled 22-27 amps after the capacitors were replaced. The pump is pulling above normal amperage meaning there is likely a more significant issue with the motor. I turned the pump off and will leave it off.

Digester mixing pump 2 will not prime. We attempted to prime the pump with a hose and mixing pump 1, but neither approach worked. There is likely an issue with the rotating unit on the pump.

Steve and I inspected the site and discussed decommissioning and the plan going forward.

I completed Q3 manure sampling and returned the samples to R&A Labs.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault
Blower	☐ Auto ☐ Hand On ☒ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60 Hz**	
Jet Motive Pump # 2		**60 Hz**	

Blower		**30 Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No	22 cfm	22 cfm	102.3 psi	100.2 psi	
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No	95866 rpm	1175 F		76 F	51.1 kW
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC -0.2	**PIT 331** 88 to 110psig 102.3	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F 34.8	**TE 311** 40 to 115 F 87.6	**TE 321** 35 to 75 F 41.1	**TE 331** 80 to 220 F 204.6	**TE 341** 33 to 45 F 36.1	**TE 342** 65 to 90 F 106.7	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig 100	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Steve Cavanaugh	**Cavanaugh**	
Brian Metot	**Preferred Sources**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

IMPORTANT: AN INSPECTION, OPERATIONS & MAINTENANCE LOG SHOULD BE COMPLETED FOR EVERY SITE VISIT; PLEASE REVIEW PREVIOUS LOG ENTRY AND PROVIDE INFORMATION TO UPDATE OR RESOLVE ANY ON-GOING ISSUES NOTED (INCLUDING BUT NOT LIMITED TO MAINTENANCE, REPAIRS, OR CORRECTIVE ACTIONS).

Entry Made By: Ben Cauthen	**09-27-2019 Friday**	**Visit Start Time 11:00 AM**	**Visit Stop Time 1:00 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 84 °F**		
Precip Past 24 hours: 0.00 inches in gauge		**Wind: (mph): 2-4 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Performed a complete system check and operated the skid and turbine for several hours. Met Matt and Emma from Duke University and explained the system to them. Matt performed odor sampling for Q3.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault
Blower	☐ Auto ☐ Hand On ☒ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60 Hz**	
Jet Motive Pump # 2		**60 Hz**	

Blower		**30 Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No	20.8 cfm	20.8 cfm	101.6 psi	99.7 psi	
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No	95964 rpm	1175 F		97 F	42.5 kW
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC -0.2	**PIT 331** 88 to 110psig 101.7	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F 41.6	**TE 311** 40 to 115 F 98.5	**TE 321** 35 to 75 F 47.8	**TE 331** 80 to 220 F 215.1	**TE 341** 33 to 45 F 43.8	**TE 342** 65 to 90 F 113.5	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig 99.5	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Matt Arsenault	**Duke University**	
Emma Fulop	**Duke University**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

IMPORTANT: AN INSPECTION, OPERATIONS & MAINTENANCE LOG SHOULD BE COMPLETED FOR EVERY SITE VISIT; PLEASE REVIEW PREVIOUS LOG ENTRY AND PROVIDE INFORMATION TO UPDATE OR RESOLVE ANY ON-GOING ISSUES NOTED (INCLUDING BUT NOT LIMITED TO MAINTENANCE, REPAIRS, OR CORRECTIVE ACTIONS).

Entry Made By: Ben Cauthen	**10-23-2019 Wednesday**	**Visit Start Time 9:30 AM**	**Visit Stop Time 11:30 AM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 60 °F**		
Precip Past 24 hours: 0.00 inches in gauge		**Wind: (mph): 4 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Met Yadtel tech to update router to match Yadtel's new specs. Efinity will need to replace the router to repair the internet. No internet is available now.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault
Blower	☐ Auto ☐ Hand On ☒ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60 Hz**	
Jet Motive Pump # 2		**60 Hz**	

Blower		**30 Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No					
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No					
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC	**PIT 331** 88 to 110psig	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F	**TE 311** 40 to 115 F	**TE 321** 35 to 75 F	**TE 331** 80 to 220 F	**TE 341** 33 to 45 F	**TE 342** 65 to 90 F	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Yadtel Tech	**Yadtel**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

IMPORTANT: AN INSPECTION, OPERATIONS & MAINTENANCE LOG SHOULD BE COMPLETED FOR EVERY SITE VISIT; PLEASE REVIEW PREVIOUS LOG ENTRY AND PROVIDE INFORMATION TO UPDATE OR RESOLVE ANY ON-GOING ISSUES NOTED (INCLUDING BUT NOT LIMITED TO MAINTENANCE, REPAIRS, OR CORRECTIVE ACTIONS).

Entry Made By: Ben Cauthen	**12-09-2019 Monday**	**Visit Start Time 9:30 AM**	**Visit Stop Time 1:30 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Raining 50 °F**		
Precip Past 24 hours: inches in gauge		**Wind: (mph): 0 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Performed manure sampling to fulfill quarterly requirement. Met NCDEQ employees for inspection.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault
Blower	☐ Auto ☐ Hand On ☒ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60 Hz**	
Jet Motive Pump # 2		**60 Hz**	

Blower		**30 Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No					
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No					
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC	**PIT 331** 88 to 110psig	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F	**TE 311** 40 to 115 F	**TE 321** 35 to 75 F	**TE 331** 80 to 220 F	**TE 341** 33 to 45 F	**TE 342** 65 to 90 F	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Marvin Cavanaugh	**Cavanaugh**	

LOYD RAY FARMS INSPECTION, OPERATIONS & MAINTENANCE LOG SHEET

IMPORTANT: AN INSPECTION, OPERATIONS & MAINTENANCE LOG SHOULD BE COMPLETED FOR EVERY SITE VISIT; PLEASE REVIEW PREVIOUS LOG ENTRY AND PROVIDE INFORMATION TO UPDATE OR RESOLVE ANY ON-GOING ISSUES NOTED (INCLUDING BUT NOT LIMITED TO MAINTENANCE, REPAIRS, OR CORRECTIVE ACTIONS).

Entry Made By: Ben Cauthen	**12-20-2019 Friday**	**Visit Start Time 10:10 AM**	**Visit Stop Time 2:30 PM**
Condition: Temperature	☐ Partly Cloudy ☐ Balmy **Sunny 40 °F**		
Precip Past 24 hours: 0 inches in gauge		**Wind: (mph): 4 mph**	

PURPOSE OF VISIT/ITEMS INSPECTED, OPERVATIONS

Performed annual sludge survey to measure digester sludge accumulation. Repaired internet with Yadtel.

ENVIRONMENTAL SYSTEM OBSERVATIONS:

Equipment Observed:	**Operational Status**
Fluidyne Aeration System, Including:	
Jet Motive Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault
Blower	☐ Auto ☐ Hand On ☒ Off ☐ In Fault:
CP-1 (Control Panel)	☒ Auto ☐ Hand On ☐ Off ☐ In Fault
Flush Pumps	☐ Auto ☒ Hand On ☐ Off ☐ In Fault
Digester Mixing Pumps	☐ Auto ☐ Hand On ☒ Off ☐ In Fault

CP-1 DATA & SET POINTS;

Cycles	**Set Point**	**Current**	**Modified Set Pt**	**Notes**
Static	**60**	**60**		
Anoxic	**90**	**90**		
Aerobic	**180**	**180**		
Blower	☐ Continuous ☒ Cycle			
Jet Motive Pumps	☐ Continuous ☒ Both ☐ Pump #1 ☐ Pump # 2			
Digester Pumps	☐ Continuous ☒ Both ☐ Sequential			

MOTOR DATA:

Aerobic	**Run Time**	**Set Speed**	**Notes**
Jet Motive Pump # 1		**60 Hz**	
Jet Motive Pump # 2		**60 Hz**	

Blower		**30 Hz**	
Anaerobic			
Mixing Pump 4A		**60 Hz**	
Mixing Pump 4B		**60 Hz**	

BIOGAS & POWER SYSTEMS OBSERVATIONS:

Equipment Observed:	**Operational Status**				
Unison Gas Skid	Flow Rate	Total Flow	Comp. Press.	Outlet Press.	Gauge Press.
Fault? ☐ Yes ☒ No					
Microturbine	Speed	Exit Temp	Inlet Pressure	Inlet Temp	Power Out
Fault? ☐ Yes ☒ No					
Biogas System	BlueSens%	Flare On	Flare Flow	Total Flow	Flare Temp
		☐ Y ☒ N			

UNISON GAS CONDITIONING LOG

Pressure Data	**PIT 311** -5 to 10 inWC	**PIT 331** 88 to 110psig	**PIT 351** 88 to 110 psig	**Pressure Differential**	**Panel Door**	**HM 331** Hours	
Temperature Data	**TE 141** 32 to 45 F	**TE 311** 40 to 115 F	**TE 321** 35 to 75 F	**TE 331** 80 to 220 F	**TE 341** 33 to 45 F	**TE 342** 65 to 90 F	**TE 31** 35 to 115 F
Glycol Piping	**TI 141** 32 to 45 F	**PI 141** 35 to 52 psig	**FI 141** 2.5 to 3.5 gpm	**TI 142** 35 to 50 F	**PI 142** 33 to 50 psig	**TI 111** 38 to 52 F	**PI 111** 30 to 48 psig
Oil Piping	**PI 231** 90 to 110 psig	**TI 231** 178 to 215 F	**PI 232** 85 to 105 psig	**TI 232** 130 to 180 F	**PI 233** 80 to 100 psig	**TI 233** 168 to 185 F	**PI 234** 78 to 100psig
Gas Piping	**PIT 311** -10 to10inWC	**TI 311** 40 to 115 F	**TI 321** 35 to 75 F	**PDI 321** 0 to 6 inWC	**PI 331** 90 to 110 psig	**TI 331** 80 to 220 F	**PI 332** 90 to 110psig
Gas Piping	**TI 341** 80 to 220 F	**PI 341** 90 to 110 psig	**TI 342** 115 to 155 F	**PI 342** 90 to 110 psig	**TE 343** 33 to 45 F	**PI 343** 90 to 110 psig	
Gas Piping	**TI 351** 65 to 90 F	**PI 351** 88 to 15 psig	**Check Indicators**	**LI 721**	**LI 231**	**LI 741**	

PERSONNEL PRESENT:

Name	***Affiliation***	***Phone Number/Email***
Ben Cauthen	**Cavanaugh**	
Marvin Cavanaugh	**Cavanaugh**	
Yadtel Service Tech	**Yadtel**	

APPENDIX B – Wastewater Sample Collection Dataset

Research & Analytical Laboratories, Inc.
PO Box 473
Kernersville, NC 27285
Phone 336.996.2841 Fax 336.996.0326
Email: info@randalabs.com

INVOICE

15766M

Date: October 04, 2019

Bill To:
Cavanaugh & Associates
PO Box 11197
Winston Salem, NC 27116

Attention: Accounts Payable

DESCRIPTION		AMOUNT
Project: LRF		
Samples collected: 09/19/19		
Analysis of three (3) samples for:		
Ammonia Nitrogen	**$20.00/sample**	$60.00
Copper, Total	**$20.00/sample**	$60.00
Fecal Coliform- MPN	**$50.00/sample**	$150.00
Nitrate + Nitrite	**$20.00/sample**	$60.00
PH	**$10.00/sample**	$30.00
Total Kjedjahl Nitrogen	**$20.00/sample**	$60.00
Total Phosphorous	**$20.00/sample**	$60.00
Total Suspended Solids	**$15.00/sample**	$45.00
Zinc, Total	**$20.00/sample**	$60.00
		$ 585.00

Make all checks payable to: **Research & Analytical Laboratories, Inc.**

TERMS: NET 30
"Past due invoices accrue interest at 1 1/2% interest per month until paid, should collection be required, customer agrees to pay all expenses incurred including attorney fees."

Research & Analytical Laboratories, Inc.

Report of Analysis

10/2/2019

For: **Cavanaugh & Associates**
PO Box 11197
Winston-Salem, NC 27116

Attn: Lynda Hall

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 NC #37701 DIRECTOR CERTIFIED ANALYSIS

Client Sample ID: Influent
Site: Cavanaugh & Assoc

Lab Sample ID: 72291-01
Collection Date: 9/19/2019 12:30

Parameter	Method	Result	Units	Rep Limit	Analyst	Analysis Date/Time	
Ammonia Nitrogen	SM 4500 NH3 D-1997	1130	mg/L	0.1	FK	9/26/2019	
Copper, Total	EPA 200.7	22.0	mg/L	0.005	JF	9/24/2019	
Fecal Coliform - MPN	SM 9221 C E-2006	700000	MPN/100ml	2	BJ	9/19/2019	1625
Nitrate + Nitrite	SM 4500 NO3 E-2000	0.257	mg/L	0.05	DW	9/20/2019	1310
pH	SM 4500 H+B-2000	7.18	Std. Units		LP	9/20/2019	1347
Total Kjedjahl Nitrogen	SM 4500 N Org B (NH3 D-1997)	2100	mg/L	1	FK	9/23/2019	
Total Nitrogen	Calc	2100	mg/L	1			
Total Phosphorous	SM 4500 P E-1999	265	mg/L	0.05	BJ	9/27/2019	
Total Suspended Solids (TSS)	SM 2540 D-1997	14000	mg/L	5	AW	9/24/2019	
Zinc, Total	EPA 200.7	22.8	mg/L	0.01	JF	9/24/2019	

NA = not analyzed

Research & Analytical Laboratories, Inc.

Report of Analysis

10/2/2019

For: **Cavanaugh & Associates**
PO Box 11197
Winston-Salem, NC 27116

Attn: Lynda Hall

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 NC #37701 DIRECTOR CERTIFIED ANALYSIS

Client Sample ID: Digester
Site: Cavanaugh & Assoc

Lab Sample ID: 72291-02
Collection Date: 9/19/2019 12:35

Parameter	Method	Result	Units	Rep Limit	Analyst	Analysis Date/Time	
Ammonia Nitrogen	SM 4500 NH3 D-1997	2160	mg/L	0.1	FK	9/26/2019	
Copper, Total	EPA 200.7	27.3	mg/L	0.005	JF	9/24/2019	
Fecal Coliform - MPN	SM 9221 C E-2006	<19.4	mpn/g TS	19.4	BJ	9/19/2019	1625
Nitrate + Nitrite	SM 4500 NO3 E-2000	0.339	mg/L	0.05	DW	9/20/2019	1310
pH	SM 4500 H+B-2000	7.49	Std. Units		LP	9/20/2019	1348
Total Kjedjahl Nitrogen	SM 4500 N Org B (NH3 D-1997)	3150	mg/L	1	FK	9/23/2019	
Total Nitrogen	Calc	3150	mg/L	1			
Total Phosphorous	SM 4500 P E-1999	2660	mg/L	0.05	BJ	9/27/2019	
Total Suspended Solids (TSS)	SM 2540 D-1997	83600	mg/L	5	AW	9/25/2019	
Zinc, Total	EPA 200.7	193	mg/L	0.01	JF	9/24/2019	

NA = not analyzed

Research & Analytical Laboratories, Inc.

Report of Analysis

10/2/2019

For: **Cavanaugh & Associates**
PO Box 11197
Winston-Salem, NC 27116

Attn: Lynda Hall

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 NC #37701 DIRECTOR CERTIFIED ANALYSIS

Client Sample ID: Effluent
Site: Cavanaugh & Assoc

Lab Sample ID: 72291-03
Collection Date: 9/19/2019 12:40

Parameter	Method	Result	Units	Rep Limit	Analyst	Analysis Date/Time	
Ammonia Nitrogen	SM 4500 NH3 D-1997	852	mg/L	0.1	FK	9/26/2019	
Copper, Total	EPA 200.7	0.059	mg/L	0.005	JF	9/24/2019	
Fecal Coliform - MPN	SM 9221 C E-2006	<18	MPN/100ml	18	BJ	9/19/2019	1625
Nitrate + Nitrite	SM 4500 NO3 E-2000	<0.05	mg/L	0.05	DW	9/20/2019	1320
pH	SM 4500 H+B-2000	8.59	Std. Units		LP	9/20/2019	1352
Total Kjedjahl Nitrogen	SM 4500 N Org B (NH3 D-1997)	1630	mg/L	1	FK	9/23/2019	
Total Nitrogen	Calc	1630	mg/L	1			
Total Phosphorous	SM 4500 P E-1999	69.4	mg/L	0.05	BJ	9/27/2019	
Total Suspended Solids (TSS)	SM 2540 D-1997	102	mg/L	5	AW	9/24/2019	
Zinc, Total	EPA 200.7	0.224	mg/L	0.01	JF	9/24/2019	

NA = not analyzed

Jennings Exhibit No. 10
Docket No. E-7, Sub 1229

OFFICIAL COPY

Feb 25 2020

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical / Process Consultations
Phone (336) 996-2841

CHAIN OF CUSTODY RECORD

COMPANY: Cavanaugh + Associates
STREET ADDRESS: PO Box 11197
CITY, STATE, ZIP: Winston Salem, NC 27116
CONTACT: Lynda Hall
PHONE: 276-952-5209
JOB NO.:
PROJECT: Loyd Ray Farm
SAMPLER NAME (PLEASE PRINT): Ben Cauthen
SAMPLER SIGNATURE: Ben Cauthen

SAMPLE NUMBER (LAB USE ONLY)	DATE	TIME	COMP	GRAB	TEMP °C	RES Cl (mg/L)	CHLORINE REMOVED (Y or N)	SAMPLE MATRIX (S or W)	SAMPLE LOCATION / I.D.	NO. OF CONTAINERS	WATER / WASTEWATER: 2L G (BNA, Herb. / Pest.)	2 40ml Vials (VOA) HCL	250ml G (TOX)	250ml P (TOC) H_2SO_4	1L P,G (BOD, TSS, Unpreserved, etc.)	1L G (Phenol, Oil & Grease) H_2SO_4	1L P,G (COD, N, P) H_2SO_4	1L P,G (Metals, Hardness) HNO_3	1L P,G (CYANIDE) NaOH	Sterile P,G (Coliform)	MISC.	REQUESTED ANALYSIS
7229101	9-19-19	12:30							Influent (Raw)	(4)												TN
																						TKN
																						NO_2+NO_3
02		12:35							Digestr													Total Phosphorus
																						NH_3N
																						fecal-MPN
03		12:40							Effluent (AB)													~~Copper~~
																						Zinc
																						TSS
																						pH

RELINQUISHED BY	DATE/TIME	RECEIVED BY
Ben Cauthen	9-19-19 1415	

REMARKS:

SAMPLE TEMPERATURE AT RECEIPT 3.0 °C

Research & Analytical Laboratories, Inc.
PO Box 473
Kernersville, NC 27285
Phone 336.996.2841 Fax 336.996.0326
Email: info@randalabs.com

INVOICE

15927M

January 13, 2020

Bill To:
Cavanaugh & Associates
PO Box 11197
Winston Salem, NC 27116

Attention: Accounts Payable

DESCRIPTION		AMOUNT
Project: LRF		
Samples collected: 12/09/19		
Analysis of three (3) samples for:		
Ammonia Nitrogen	**$20.00/sample**	$ 60.00
Copper, Total	**$20.00/sample**	60.00
Fecal Coliform- MPN	**$50.00/sample**	150.00
Nitrate + Nitrite	**$20.00/sample**	60.00
PH	**$10.00/sample**	30.00
Total Kjedjahl Nitrogen	**$20.00/sample**	60.00
Total Phosphorous	**$20.00/sample**	60.00
Total Suspended Solids	**$15.00/sample**	45.00
Zinc, Total	**$20.00/sample**	60.00
		$ 585.00

Make all checks payable to: **Research & Analytical Laboratories, Inc.**

TERMS: NET 30
"Past due invoices accrue interest at 1 1/2% interest per month until paid, should collection be required, customer agrees to pay all expenses incurred including attorney fees."

Research & Analytical Laboratories, Inc.

Report of Analysis

1/12/2020

For: **Cavanaugh & Associates**
PO Box 11197
Winston-Salem, NC 27116

Attn: Lynda Hall

Client Sample ID: Aerobic
Site: Cavanaugh & Assoc

Lab Sample ID: **75741-01**
Collection Date: 12/9/2019 9:30

Parameter	Method	Result	Units	Rep Limit	Analyst	Analysis Date/Time	
Ammonia Nitrogen	SM 4500 NH3 D-1997	436	mg/L	0.1	FK	12/30/2019	
Copper, Total	EPA 200.7	0.026	mg/L	0.005	SK	12/19/2019	
Fecal Coliform - MPN	SM 9221 C E-2006	3	MPN/100ml	2	BJ	12/9/2019	1525
Nitrate + Nitrite	SM 4500 NO3 E-2000	0.757	mg/L	0.05	DW	12/10/2019	1550
pH	SM 4500 H+B-2000	8.44	Std. Units		LP	12/10/2019	1700
Total Kjedjahl Nitrogen	SM 4500 N Org B (NH3 D-1997)	852	mg/L	1	FK	12/30/2019	
Total Nitrogen	Calc	852	mg/L	1			
Total Phosphorous	SM 4500 P E-1999	36.8	mg/L	0.05	BJ	12/27/2019	
Total Suspended Solids (TSS)	SM 2540 D-1997	120	mg/L	5	AW	12/10/2019	
Zinc, Total	EPA 200.7	0.086	mg/L	0.01	SK	12/19/2019	

NA = not analyzed

Research & Analytical Laboratories, Inc.

Report of Analysis

1/12/2020

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 NC #37701 DIRECTOR CERTIFIED ANALYSIS

For: **Cavanaugh & Associates**
PO Box 11197
Winston-Salem, NC 27116

Attn: Lynda Hall

Client Sample ID: Digestor
Site: Cavanaugh & Assoc

Lab Sample ID: **75741-02**
Collection Date: 12/9/2019 9:30

Parameter	Method	Result	Units	Rep Limit	Analyst	Analysis Date/Time	
Ammonia Nitrogen	SM 4500 NH3 D-1997	2050	mg/L	0.1	FK	12/30/2019	
Copper, Total	EPA 200.7	17.7	mg/L	0.005	SK	12/19/2019	
Fecal Coliform - MPN	SM 9221 C E-2006	240	MPN/100ml	2	BJ	12/9/2019	1525
Nitrate + Nitrite	SM 4500 NO3 E-2000	<0.05	mg/L	0.05	DW	12/13/2019	1300
pH	SM 4500 H+B-2000	7.89	Std. Units		LP	12/10/2019	1703
Total Kjedjahl Nitrogen	SM 4500 N Org B (NH3 D-1997)	2450	mg/L	1	FK	12/30/2019	
Total Nitrogen	Calc	2450	mg/L	1			
Total Phosphorous	SM 4500 P E-1999	3670	mg/L	0.05	BJ	12/27/2019	
Total Suspended Solids (TSS)	SM 2540 D-1997	68000	mg/L	5	AW	12/11/2019	
Zinc, Total	EPA 200.7	164	mg/L	0.01	SK	12/19/2019	

NA = not analyzed

Research & Analytical Laboratories, Inc.

Report of Analysis

1/12/2020

For: **Cavanaugh & Associates**
PO Box 11197
Winston-Salem, NC 27116

Attn: Lynda Hall

RESEARCH & ANALYTICAL LABS. SIDNEY L. CHAMPION NC #34 NC #37701 DIRECTOR CERTIFIED ANALYSIS

Client Sample ID: Raw
Site: Cavanaugh & Assoc

Lab Sample ID: 75741-03
Collection Date: 12/9/2019 9:30

Parameter	Method	Result	Units	Rep Limit	Analyst	Analysis Date/Time	
Ammonia Nitrogen	SM 4500 NH3 D-1997	745	mg/L	0.1	FK	12/30/2019	
Copper, Total	EPA 200.7	52.0	mg/L	0.005	SK	12/19/2019	
Fecal Coliform - MPN	SM 9221 C E-2006	22000000	MPN/100ml	2	BJ	12/9/2019	1525
Nitrate + Nitrite	SM 4500 NO3 E-2000	<0.05	mg/L	0.05	DW	12/13/2019	1320
pH	SM 4500 H+B-2000	7.63	Std. Units		LP	12/10/2019	1704
Total Kjedjahl Nitrogen	SM 4500 N Org B (NH3 D-1997)	1050	mg/L	1	FK	12/30/2019	
Total Nitrogen	Calc	1050	mg/L	1			
Total Phosphorous	SM 4500 P E-1999	162	mg/L	0.05	BJ	12/27/2019	
Total Suspended Solids (TSS)	SM 2540 D-1997	3300	mg/L	5	AW	12/10/2019	
Zinc, Total	EPA 200.7	44.1	mg/L	0.01	SK	12/19/2019	

NA = not analyzed

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical / Process Consultations
Phone (336) 996-2841

CHAIN OF CUSTODY RECORD

COMPANY: Cavanaugh & Associates	JOB NO.
STREET ADDRESS: PO Box 11197	PROJECT: Loyd Ray Farm
CITY, STATE, ZIP: Winston Salem, NC, 27116	SAMPLER NAME (PLEASE PRINT): Ben Cauthen
CONTACT: Lynda Hall PHONE: 877-557-8923	SAMPLER SIGNATURE: Ben Cauthen

SAMPLE NUMBER (LAB USE ONLY)	DATE	TIME	COMP	GRAB	TEMP °C	RES Cl (mg/L)	CHLORINE REMOVED (Y or N)	SAMPLE MATRIX (S or W)	SAMPLE LOCATION / I.D.	NO. OF CONTAINERS	REQUESTED ANALYSIS
75741-01	12/4/13	9:30am							Aerobic	4	TN
	↓	↓									TKN
											NO2 + NO3
-02									Digestor	4	T-Phos
											NH3-N
	↓	4									fecal-mpn
-03									Raw	4	Copper
											Zinc
											TSS
											pH

WATER / WASTEWATER | MISC.

2L G (BNA, Herb. / Pest.) | 2 40ml Vials (VOA) HCL | 250ml G (TOX) | 250ml P (TOC) H_2SO_4 | 1L P, G (BOD, TSS, Unpreserved, etc.) | 1L G (Phenol, Oil & Grease) H_2SO_4 | 1L P, G (COD, N, P) H_2SO_4 | 1L P, G (Metals, Hardness) HNO_3 | 1L P, G (CYANIDE) NaOH | Sterile P, G (Coliform)

RELINQUISHED BY	DATE/TIME	RECEIVED BY
Ben Cauthen	12/9 1:50	1355 Sy Yates
RELINQUISHED BY	DATE/TIME	RECEIVED BY

REMARKS:
nice

SAMPLE TEMPERATURE AT RECEIPT 3.8 °C

APPENDIX C – NCDA&CS Agronomic Division Predictive Waste Reports (Source: www.ncagr.gov/agronomi/)

Predictive

Waste Report

Links to Helpful Information

Farm: 2094

Sampled: 07/26/2019
Received: 07/29/2019
Completed: 07/31/2019

Client: Loyd Bryant
Loyd Ray Farms Inc
2049 Center Rd.
Boonville, NC 27011
Yadkin County

Advisor:

PALS #: 205223

PALS #:

OFFICIAL COPY

Feb 25 2020

Sample Information

ID: 001
Code: ALS
Description: Swine Lagoon Liq.
Grower Comments: swine waste water

Nutrient Measurements are given in units of parts per million (ppm), unless utherwise specifed.

Nitrogen (N)	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo
Total N:	24.0	927	38.4	18.7	17.2	1.17	0.11	0.32	0.09	0.59	-
Total Kjeldahl N: 263											
Inorganic:											
NH_4-N											
NO_3-N											

SS (10^{-5} S/cm)	EC (mS/cm)	pH (Unitless)	BD (lb/yd³)	CCE (%)	ALE (1000 gal)	C:N (Unitless)	DM (%)
-	-	8.14	-	-	-	-	-

Other Results

C	Al	Na	Cl
-	0.54	249	-

Estimate of Nutrients Available for First Year (lb/1000 gal)

Application Method:	N	P_2O_5	K_2O	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo
Irrigation	1.10	0.46	9.28	0.32	0.16	0.14	0.01	0.00	0.00	0.00	0.01	-

Other Results (lb/1000 gal)

Al	Na	Cl
0.00	2.07	-

North Carolina Tobacco Trust Fund Commission

Reprogramming of the laboratory-information-management system that makes this report possible is being funded through a grant from the North Carolina Tobacco Trust Fund Commission.

Jennings Exhibit No. 10
Docket No. E-7, Sub 1229

Thank you for using agronomic services to manage nutrients and safeguard environmental quality.
- Steve Troxler, Commissioner of Agriculture.

Understanding the Waste Report

Nutrient concentrations and other data on this report are provided so that waste materials can be applied at agronomic rates, thereby supplementing or reducing fertilizer application and preventing environmental contamination. In reading the **Laboratory Results** section, remember that materials with < 15% dry matter (generally liquids) are analyzed as received; all other wastes are dried first. Values in the **Estimate of Nutrients Available for First Crop** section are based on the type of waste and method of application you specify and reflects the fact that only 40-60% of the nitrogen becomes available within one year of application. The remainder *may or may not* ever become available.

ALE is Agricultural Lime Equivalence. The ALE indicates the amount of the waste material that provides a limiting effect equivalent to one ton of agricultural grade limestone.
BD is Bulk Density in lb/yd³.
CCE is Calcium Carbonate Equivalence and is used to determine ALE.
C:N ratio is the Carbon:Nitrogen ratio.

DM% is percent Dry Matter [for semi-solid and solid waste, this value facilitates conversion of dry-basis concentrations (ppm) back to wet-basis of original sample].
EC (Electrical Conductivity) measures salinity, or soluble salts (SS).
pH measures basicity/acidity.

Al	= Aluminum	**Cu**	= Copper	**NH_4-N**	= Ammonium -N
As	= Arsenic	**Fe**	= Iron	**Ni**	= Nickel
B	= Boron	**K**	= Potassium	**NO_3-N**	= Nitrate -N
Ca	= Calcium	**Mg**	= Magnesium	**P**	= Phosphorus
Cd	= Cadmium	**Mn**	= Manganese	**Pb**	= Lead
Cl	= Chloride	**Mo**	= Molybdenum	**S**	= Sulfur
Cr	= Chromium	**N**	= Nitrogen	**Se**	= Selenium
		Na	= Sodium		

meq/L = milliequivalent per liter; **mS** = millisiemens; **ppm** = parts per million or mg/L; **S** = siemens; **T** = trace (<0.005 lb/unit)

Additional information: www.ncagr.gov/agronomi/pdffiles/uwaste.pdf & www.ncagr.gov/agronomi/pdffiles/wasteguide.pdf

Predictive

Waste Report

Links to Helpful Information

Client: Loyd Bryant
Loyd Ray Farms Inc
2049 Center Rd.
Boonville, NC 27011
Yadkin County

Advisor:

Sampled: Not Provided
Received: 11/08/2019
Completed: 11/13/2019

Farm: 2094

PALS #: 205223

PALS #:

OFFICIAL COPY

Feb 25 2020

Sample Information

ID: 001
Code: ALS
Description: Swine Lagoon Liq.
Grower Comments: Not Provided

Nutrient Measurements are given in units of parts per million (ppm), unless utherwise specifed.

Nitrogen (N)	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo
Total N:	16.2	756	30.5	15.0	19.1	0.42	0.08	0.24	0.10	0.62	-
Total Kjeldahl N: 173											
Inorganic:											
NH_4-N											
NO_3-N											

Other Results

C	Al	Na	Cl
-	0.23	210	-

SS (10^{-5} S/cm)	EC (mS/cm)	pH (Unitless)	BD (lb/yd³)	CCE (%)	ALE (1000 gal)	C:N (Unitless)	DM (%)
-	-	8.03	-	-	-	-	-

Estimate of Nutrients Available for First Year (lb/1000 gal)

Application Method:	N	P_2O_5	K_2O	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo
Irrigation	0.72	0.31	7.57	0.26	0.13	0.16	0.00	0.00	0.00	0.00	0.01	-

Other Results (lb/1000 gal)

Al	Na	Cl
0.00	1.75	-

North Carolina
Tobacco Trust Fund Commission

Jennings Exhibit No. 10
Docket No. E-7, Sub 1229

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C:N ratio is the Carbon:Nitrogen ratio.

DM% is percent Dry Matter [for semi-solid and solid waste, this value facilitates conversion of dry-basis concentrations (ppm) back to wet-basis of original sample].
EC (Electrical Conductivity) measures salinity, or soluble salts (SS).
pH measures basicity/acidity.

Al = Aluminum
As = Arsenic
B = Boron
Ca = Calcium
Cd = Cadmium
Cl = Chloride
Cr = Chromium

Cu = Copper
Fe = Iron
K = Potassium
Mg = Magnesium
Mn = Manganese
Mo = Molybdenum
N = Nitrogen
Na = Sodium

NH_4-N = Ammonium -N
Ni = Nickel
NO_3-N = Nitrate -N
P = Phosphorus
Pb = Lead
S = Sulfur
Se = Selenium

meq/L = milliequivalent per liter; **mS** = millisiemens; **ppm** = parts per million or mg/L; **S** = siemens; **T** = trace (<0.005 lb/unit)

Additional information: www.ncagr.gov/agronomi/pdffiles/uwaste.pdf & www.ncagr.gov/agronomi/pdffiles/wasteguide.pdf

JENNINGS CONFIDENTIAL EXHIBIT NO. 11

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 12

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 13

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 14

DOCKET NO. E-7, SUB 1229

CONFIDENTIAL – FILED UNDER SEAL