Mon Apr 11 16:26:12 EDT 2022
EPAExecSec <EPAExecSec@epa.gov>
FW: 60 Day Notice of Intent to File Citizen Suit Under 42 USC 7604
To: "CMS.OEX" <cms.oex@epa.gov>

From: William Haak <whh@haaklawllc.com>
Sent: Monday, April 11, 2022 2:43 PM
To: Regan, Michael <Regan.Michael@epa.gov>; Shore, Debra <Shore.Debra@epa.gov>
Cc: Bott Moore, April <abott@taftlaw.com>
Subject: 60 Day Notice of Intent to File Citizen Suit Under 42 USC 7604

Dear Administrator Regan and Regional Administrator Shore:

Please see the attached 60 day notice of intent to file a citizen suit under Section 304 of the Clean Air Act.

This notice pertains to the Emerald Bioenergy, LLC facility in Cardington, Ohio.

Thank you for your attention to this matter.

William H. Haak
Attorney for Westfield Township, Morrow County, Ohio

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Via Certified Mail and Electronic Mail

April 11, 2022

Michael S. Regan, Administrator
United States Environmental Protection Agency
Mail Code: 1101A
1200 Pennsylvania Avenue, NW
Washington, DC 20460
Email: regan.michael@epa.gov

Debra Shore, Regional Administrator
United States Environmental Protection Agency Region V
77 West Jackson Boulevard
Chicago, Illinois 60604
Email: shore.debra@epa.gov

Laurie A. Stevenson, Director
Ohio Environmental Protection Agency
50 West Town Street
Columbus, Ohio 43215
Email: laurie.stevenson@epa.ohio.gov

Emerald Bioenergy, LLC
c/o CH&K Agent Service, Inc.
1 South Main Street – Suite 1300
Dayton, Ohio 45402

Renergy, Inc.
c/o Alexander Ringler
1156 Herr Road
Fairborn, Ohio 45324

Ringler Energy LLC
c/o Alex Ringler
1297 County Road 159
Ashley, Ohio 43003

Ringler Feedlots, LLC
c/o B&L Agent Services, Inc.
475 Metro Place South – Suite 150
Dublin, Ohio 43017

Ringler Livestock, LLC
c/o William D. Short
7 North Main Street
Marengo, Ohio 43334

Re: 60 Day Notice of Intent to File a Citizen Suit Under 42 U.S. Code 7604

Dear Administrator Regan, Regional Administrator Shore, Director Stevenson, *Et al.*:

This letter is being submitted on behalf of Westfield Township, Morrow County, Ohio to notify you, pursuant to Section 304 of the Clean Air Act (CAA), 42 U.S. Code 7604, of the Township's intent to sue the United States Environmental Protection Agency (USEPA), the Ohio Environmental Protection Agency (Ohio EPA), Emerald Bioenergy, LLC, Renergy, Inc., Ringler Energy LLC, Ringler Feedlots, LLC, and Ringler Livestock, LLC (collectively referred to hereinafter as "the Emerald Entities") for violations of the CAA. Specifically, USEPA and Ohio EPA have failed to perform non-discretionary duties in connection with permitting and regulating ammonia emissions to the ambient air from six (6) digestate storage ponds (or "lagoons") owned and/or operated by the Emerald Entities. Each of these digestate storage ponds are operated in support of a single anaerobic biodigester located at 2279 County Road 156, Cardington, Ohio. The Emerald Entities installed and have operated these ponds without Permits to Install and Operate (PTIOs) as required by Ohio's State Implementation Plan (SIP).

I. FACTUAL BACKGROUND

From 2013 to the present, the Emerald Entities have owned and operated an anaerobic biodigester located at 2279 County Road 156, Cardington, Morrow County, Ohio. The electricity generated by the biodigester allegedly powers operations on adjacent property(ies). Electricity is also allegedly provided to the wholesale electric grid. The Emerald Entities identify their operations in court filings as constituting a "public utility" as that term is defined in applicable provisions of the laws and regulations of the State of Ohio.

The biodigester processes various waste materials including (but not limited to) animal wastes, biosolids, energy crops, fats, oils and greases, food scraps, and food waste to produce methane that is combusted to create electrical energy. When solid and liquid waste materials are fed into the digester, digestate (the digested solid and liquid waste materials in the digester) is transferred via various means from the digester into any one of the 6 digestate storage ponds owned and operated by the Emerald Entities. The 6 ponds total 31,193,354 gallons of digestate storage capacity. Each of these ponds is uncovered and open to the ambient air. The Emerald Entities sometimes remove digestate from the ponds for agricultural land application as fertilizer.

The 6 digestate storage ponds are all located in Westfield Township, Morrow County, Ohio, within an area roughly bounded by Morrow County Road 156 on the West, Ohio State Route 746 (also known as Morrow County Road 155 and/or Waldo-Fulton Road) on the North, U.S. Route 42 on the East, and Morrow County Road 159 (also known as Westfield-Fulton Road) on the South. Because the digestate storage ponds operate in support of the biodigester (which the Emerald Entities identify as a "public utility" in court filings) and are integral to its operation, the ponds are <u>not</u> "agricultural production" activities as that term is defined in applicable provisions of the laws and regulations of the State of Ohio. Given this, the ponds emit regulated "air contaminants" as that term is defined in Ohio Rev. Code 3704.01(B), and constitute regulated "air contaminant sources" as that term is defined in Ohio Rev. Code 3704.01(C).

The 6 digestate storage ponds are identified in National Pollutant Discharge Elimination System (NPDES) Permit Number 4IN00204*BD issued by Ohio EPA on March 29, 2021 (attached as Appendix A) as follows (with capacity and ownership information added):

Pond Identifier	Digestate Capacity	Owner of Record
Pond 1 (L1)	5,485,068 gallons	Ringler Feedlots, LLC
Pond 2 (L2)	387,693 gallons	Ringler Energy LLC
Pond 3 (L3)	331,764 gallons	Ringler Livestock LLC
Pond 4 (L4)	2,857,143 gallons	Ringler Livestock LLC
Pond 5 (L5)	1,362,000 gallons	Ringler Livestock LLC
Pond 7 (L7)	20,769,686 gallons	Ringler Feedlots, LLC

Each of the 6 digestate storage ponds routinely receives digestate from the biodigester owned and/or operated by the Emerald Entities. Given this, the ponds are functionally interrelated to the biodigester. In addition, each of the 6 digestate storage ponds is situated on real property owned by the Emerald Entities. The ponds are, therefore, under common control. Finally, each of the 6 digestate storage ponds is situated on real property sharing common boundaries and located contiguous and/or adjacent to the biodigester. (See map reflecting the location of each digestate storage pond and associated real property owned by the Emerald Entities attached as Appendix B.)

Beginning in 2013 when the Emerald Entities commenced operation of the Cardington biodigester, the citizens of Westfield Township began to routinely experience strong and offensive odors believed to be emanating from the facility. Since the biodigester commenced operation, well over one hundred (100) odor complaints have been made to Ohio EPA. These complaints pertained to objectionable odors attributed to the biodigester and associated digestate storage ponds owned and/or operated by the Emerald Entities.

II. CURRENT AIR PERMITTING OF EMERALD'S CARDINGTON FACILITY

On November 19, 2018, Ohio EPA issued PTIO Number P0125003 (attached as Appendix C) to Emerald for its Cardington facility. Emerald's PTIO identified two (2) emissions units: 1) an anaerobic digester; and, 2) a digester gas-fired engine. The PTIO does <u>not</u> identify any of the associated digestate storage ponds as air contaminant emissions units, and the PTIO does not contain any substantive terms and/or conditions applicable to the digestate ponds.

III. THE "POTENTIAL TO EMIT" AMMONIA FROM THE DIGESTATE PONDS

Technical papers regarding digestate storage ponds indicate that such ponds emit significant amounts of ammonia. The amount of ammonia emitted is a function of the total nitrogen in either the digester feedstock or in the digestate discharged to the pond. Emission factors have been published to enable both regulatory agencies and regulated entities to estimate with reasonable accuracy the ammonia PTE from the open storage of digestate generated by anaerobic digestion of waste at biodigester facilities. Sources of such emission factors include the following technical documents: 1) Bell, M.W., *et al. Ammonia emissions from an anaerobic digestion plant estimated using atmospheric measurements and dispersion modelling*. Waste Management, Elsevier (2016); and, 2) the European Environment Agency's *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019* and its discussion of emissions from the biological treatment of waste from anaerobic digestion at biogas facilities. (These papers are attached as Appendix D and Appendix E, respectively.)

According to NPDES Permit Number 4IN00204*BD, the maximum feed rate for the Cardington biodigester is 50,120 gallons per day based upon the biodigester's capacity. For purposes of calculating an ammonia PTE for the facility's digestate storage ponds, this daily throughput represents the biodigester's maximum production rate. Based upon this maximum production rate coupled with total Kjeldahl nitrogen (TKN) and ammonia (NH_3) data from digestate discharge monitoring reports (DMRs) the Emerald Entities submitted to Ohio EPA pursuant to the facility's NPDES permit, the ammonia PTE for the digestate storage ponds can be calculated utilizing two different approaches published in the above-referenced papers.

A. Ammonia Emission Estimates Based Upon the Emission Factor Contained in the *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019*

Table 3.3 of the Guidebook is entitled "*Table 3.3 Tier 2 EFs for source category 5.B.2 Biological treatment of waste — anaerobic digestion at biogas facilities; storage of digestate (open storage).*" Table 3.3 gives the following emission factor for the NH_3 emissions from the open storage of digestate:

$$NH_3 \text{ emissions} = 0.0266 \text{ kg } NH_3\text{-N per kg N in feedstock}$$

The maximum daily feed rate for the Cardington facility's biodigester is 50,120 gallons/day. In the DMR data submitted by the Emerald Entities for their Cardington facility during the period from January 2017 through December 2021, the TKN values for the digestate varied from a low 3,920 mg/kg on July 31, 2021 to a high of 141,000 mg/kg on January 31, 2017. The TKN is a measure of the total nitrogen (N) in the sample.

The NH_3 emission factor is expressed in units of kg-NH_3 per kg N in the feedstock. The TKN values in the DMRs are for the digestate, not for the feedstock to the digester. For the calculation of the NH_3 emissions from the digestate storage ponds, the TKN values for the digestate storage ponds are assumed to be representative of the TKN values for the digester feedstock. This conservative assumption produces an artificially <u>low</u> NH_3 emissions estimate because the TKN values for the feedstock would logically always be higher than the values for the digestate discharged from the digester to the ponds.

Assuming (conservatively) that a gallon of digestate weighs the same as a gallon of water:

max. feed rate = (50,120 gallons/day)(8.34 lbs/gallon)(1.0 kg/2.2 lbs) = 190,000 kg feed/day
max. TKN at max. feed rate = (190,000 kg feed/day)(141,000 mg TKN/kg feed)(1.0 kg TKN/10^6 mg TKN)
= 26,790 kg TKN in feed/day
NH_3 PTE = (0.0266 kg NH_3-N/kg N in feed)(26,790 kg TKN in feed/day)(2.2 lbs/kg) = **<u>1,567 lbs NH_3/day</u>**

The NH_3 emission rate of 1,567 lbs NH_3/day is the NH_3 PTE for <u>each</u> of the 6 digestate storage ponds given the maximum feed rate to the biodigester is 50,120 gallons per day and the TKN concentration in that feed is 141,000 mg/kg. The facility's NPDES permit does not prohibit all or a portion of the digestate on any given day from being discharged to any of the 6 digestate storage ponds. Each of the 6 ponds could receive all of the digestate discharged from the biodigester on any given day. Therefore, the NH_3 PTE for each of the digestate storage ponds is 1,567 lbs NH_3/day.

B. Ammonia Emission Estimates Based Upon the Model Referenced in Table 3 of the Paper by Bell, M.W., *et al*. *Ammonia emissions from an anaerobic digestion plant estimated using atmospheric measurements and dispersion modelling.*

Table 3 of the paper is entitled "*Intercomparison of the chemical composition and estimated emission rates of the Deerdykes digestate with different digestates reported in the literature. Deerdykes emission rates are calculated using the Borka et al. (2000) model.*" The NH_3 emission rates for this Table were calculated using the Borka *et al.* (2000) model. That model is defined in the following paragraph from the technical paper entitled "*Development of an Empirical Model for Ammonia Emissions from Slurry in Cattle Houses*":

> "From these simple regressions the following multi-factorial emission model was developed:
>
> $$E = 17.254 * 1.060^{tS} * LD^{.274} * TAN$$
>
> Legend:
> E emission [mg NH_3 m^{-2} hr^{-1}]
> LD air exchange rate [m^3 hr^{-1} m^{-2}]
> tS substrate temperature [°C]
> TAN NH_4^{+} / NH_3-N-concentration of substrate [g N kg^{-1}]
>
> The control experiments and the calculated statistical error of the model showed that the uncertainty of the model does not exceed ±30 %."

In the DMR data submitted by the Emerald Entities for their Cardington facility during the period from January 2017 through December 2021, the NH_3 values for the digestate varied from a low of 1,150 mg/kg on November 30, 2021 to a high of 70,400 mg/kg on January 31, 2017. NH_3 values are assumed to represent total ammoniacal concentrations in the digestate.[1]

In calculating the NH_3 emission rates for the digestate storage ponds, the substrate temperature was assumed to be 15.5 degrees C (60 degrees F). Also, the highest air exchange rate used in the calculations for the Deerdykes digestate in Table 3 was used (alpha = 1.5). Since the digestate is stored in uncovered ponds, the actual air exchange rate for the ponds would be expected to be much higher than the value used in these calculations.

The surface areas of each of the six digestate storage ponds are:

Pond Identifier	Surface Area
Pond 1 (L1)	8,250 square meters
Pond 2 (L2)	1,431 square meters
Pond 3 (L3)	1,171 square meters
Pond 4 (L4)	5,119 square meters
Pond 5 (L5)	3,037 square meters
Pond 7 (L7)	22,668 square meters

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[1] Hill Laboratories, "*Nitrogen Species*" (https://www.hill-laboratories.com/assets/Documents/Technical-Notes/Environmental/Nitrogen-Species-Tech-note-34247v2View.pdf)

The hourly ammonia emission rate per square meter for each pond is calculated using the following equation:

$E = 17.254 * 1.060^{tS} * LD^{.274} * TAN$

$= (17.254)(1.060^{15.5})(1.5^{.274})(70.4) \text{ mg } NH_3 \text{ m}^{-2} \text{ hr}^{-1}$
$= (17.254)(2.47)(1.12)(70.4) \text{ mg } NH_3 \text{ m}^{-2} \text{ h}^{-1}$
$= 3{,}360 \text{ mg } NH_3 \text{ m}^{-2} \text{ hr}^{-1}$

Given this, the daily ammonia PTE for each pond is calculated as follows:

Pond 1 (L1)

(3,360 mg NH_3/m^2 hr)(8,250 m^2)(gr/1,000 mg)(lb/454 gr)(24 hr/day) = **1,465 lbs NH_3/day**

Pond 2 (L2)

(3,360 mg NH_3/m^2 hr)(1,431 m^2)(gr/1,000 mg)(lb/454 gr)(24 hr/day) = **254 lbs NH_3/day**

Pond 3 (L3)

(3,360 mg NH_3/m^2 hr)(1,171 m^2)(gr/1,000 mg)(lb/454 gr)(24 hr/day) = **208 lbs NH_3/day**

Pond 4 (L4)

(3,360 mg NH_3/m^2 hr)(5,119 m^2)(gr/1,000 mg)(lb/454 gr)(24 hr/day) = **909 lbs NH_3/day**

Pond 5 (L5)

(3,360 mg NH_3/m^2 hr)(3,037 m^2)(gr/1,000 mg)(lb/454 gr)(24 hr/day) = **539 lbs NH_3/day**

Pond 7 (L7)

(3,360 mg NH_3/m^2 hr)(22,668 m^2)(gr/1,000 mg)(lb/454 gr)(24 hr/day) = **4,025 lbs NH_3/day**

Ammonia is an "air contaminant" as that term is defined in Ohio's SIP at Ohio Rev. Code 3704.01(B), and a "toxic air contaminant" pursuant to Ohio Admin. Code Rule 3745-114-01. Broadly, an air contaminant source is "*de minimis*" under Ohio's SIP at Ohio Rev. Code 3704.011(A) and Ohio Admin. Code Rule 3745-15-05 if emissions of particulate matter, nitrogen oxides, organic compounds, sulfur dioxide, carbon monoxide, lead, or any other air contaminant from that source do not exceed ten (10) pounds per day, and the source does not emit more than one (1) ton per year of hazardous air pollutants. In light of the foregoing calculations, the 6 digestate storage ponds owned and/or operated by the Emerald Entities are clearly not *de minimis* sources of ammonia.

IV. ALLEGED VIOLATIONS OF THE CAA

Westfield Township alleges that USEPA, Ohio EPA, and/or the Emerald Entities have violated and continue to violate both the CAA and the State of Ohio's SIP as follows:

1. From 2013 to the present, the Emerald Entities have operated the 6 digestate storage ponds associated with the Cardington biodigester facility as air emissions sources without PTIOs in violation of the State of Ohio's SIP. USEPA and Ohio EPA have allowed the Emerald Entities to install and operate these 6 digestate storage ponds in violation of Ohio Admin. Code Rule 3745-31-02 of the State of Ohio's SIP.

2. From 2013 to the present, the Emerald Entities have emitted ammonia from the 6 digestate storage ponds associated with the biodigester and have not complied with the Ohio EPA Division of Air Pollution Control's Air Toxics Policy (attached as Appendix F). USEPA and Ohio EPA have allowed the Emerald Entities to emit ammonia from these 6 digestate storage ponds without complying with Ohio's Air Toxics Policy and Ohio Admin. Code Rule 3745-114-01 of the State of Ohio's SIP.

3. From 2013 to the present, the Emerald Entities have operated the 6 digestate storage ponds associated with the Cardington biodigester – each of which is an air contaminant source installed on or after August 3, 2006 with an ammonia PTE greater than ten (10) tons per year – without employing "best available technology" (BAT) as that term is defined in the State of Ohio's SIP and as required by Ohio Admin. Code Rule 3745-31-05(A)(3). USEPA and Ohio EPA have allowed the Emerald Entities to operate these 6 digestate storage ponds during this time without considering and employing BAT (which may include, but may not be limited to, a cover over each pond with secondary control consisting of a packed bed scrubber) in violation of Ohio Admin. Code Rule 3745-31-05(A)(3) of the State of Ohio's SIP.

V. PARTY GIVING NOTICE

The party giving notice, including its full name, address and telephone number is as follows (note that Westfield Township should be contacted only through undersigned counsel):

Westfield Township, Morrow County, Ohio
Township House
848 County Road 21
Ashley, Ohio 43003
Phone: 216.772.3532 c/o Haak Law LLC (*the Township has no phone*)

Counsel for Westfield Township consents to electronic service whenever permissible. If physical service is required by any applicable statute, regulation, or rule of procedure, Westfield Township consents to service in care of April Bott Moore, Esq. at Taft Law (address, below).

VI. CONCLUSION

Unless the violations of the Clean Air Act and Ohio's SIP alleged above are promptly remedied, Westfield Township intends to file suit in the United States District Court for the Southern District of Ohio sixty (60) days after your receipt of this letter. Please contact either or both of the undersigned legal counsel for the parties to further discuss the bases for our claims, or to explore options for timely and amicable resolution of this matter in lieu of litigation.

Sincerely,

Will H. Haak

William H. Haak
Haak Law LLC
Cleveland, Ohio
Attorney for Westfield Township
Phone: 216.772.3532
Email: whh@haaklawllc.com

Sincerely,

April Bott Moore

April Bott Moore*
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65 E. State Street – Suite 1000
Columbus, Ohio 43215
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Phone: 614.221.2838
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**Admitted to Practice in Ohio*

cc: Bob Hodanbosi, Ohio EPA, DAPC (robert.hodanbosi@epa.ohio.gov)
Mike Hopkins, Ohio EPA, DAPC (mike.hopkins@epa.ohio.gov)
Drew Bergman, Ohio EPA, Legal (drew.bergman@epa.ohio.gov)

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Appendix A

Renergy, Inc. / Emerald Bioenergy, LLC
NPDES Permit 4IN00204*BD

Application No. OH0142492

Issue Date: March 29, 2021

Effective Date: May 1, 2021

Expiration Date: April 30, 2026

Ohio Environmental Protection Agency
Authorization to Discharge Under the
National Pollutant Discharge Elimination System

In compliance with the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et. seq., hereinafter referred to as the "Act"), and the Ohio Water Pollution Control Act (Ohio Revised Code Section 6111),

Renergy, Inc.

is authorized by the Ohio Environmental Protection Agency, hereinafter referred to as "Ohio EPA," to treat, store, transfer, or beneficially use digester effluent and biosolids generated at Emerald Bioenergy, LLC located at 2279 County Road 156, Cardington, Ohio, Morrow County in accordance with the conditions specified in Parts I, II, and III of this permit.

This permit is conditioned upon payment of applicable fees as required by Section 3745.11 of the Ohio Revised Code.

This permit and the authorization to discharge shall expire at midnight on the expiration date shown above. In order to receive authorization to discharge beyond the above date of expiration, the permittee shall submit such information and forms as are required by the Ohio EPA no later than 180 days prior to the above date of expiration.

____
Laurie A. Stevenson
Director

Total Pages: 42

Part I, A. - INTERNAL MONITORING REQUIREMENTS

1. Biomass Monitoring to Anaerobic Digester. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor the biomass leaving the feedstock equalization tank prior to the anaerobic digester at Station Number 4IN00204601, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 601 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
51028 - Hydraulic Loading Rate (HLR) - GPD	50120	-	-	-	-	-	-	1/Week	Continuous	All
70318 - Sludge Solids, Percent Total - %	-	-	-	-	-	-	-	1/Week	Composite	All
70322 - Sludge Solids, Percent Volatile - %	-	-	-	-	-	-	-	1/Week	Composite	All
80116 - COD, Soluble - mg/l	-	-	-	-	-	-	-	1/Week	Composite	All
99981 - Organic Loading Rate (OLR) - lb/cf/day	-	-	-	-	-	-	-	1/Week	Continuous	All

NOTES for Station Number 4IN00204601:

a. The organic loading rate (OLR) shall be reported as a weekly average. OLR = [volume of biomass feed (GPD) x decimal fraction total solids x 8.34 (lb/gallon) x decimal fraction volatile solids] ÷ digester volume (cubic feet)

b. The hydraulic loading rate (HLR) shall be reported as a weekly average.

Part I, A. - INTERNAL MONITORING REQUIREMENTS

2. Anaerobic Digester Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor the biomass in the anaerobic digester at Station Number 4IN00204602, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 602 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00400 - pH - S.U.	-	-	-	-	-	-	-	3/Week	Composite	All
00410 - Alkalinity, Total (CaCO3) - mg/l	-	-	-	-	-	-	-	3/Week	Composite	All
72026 - Detention Time, days - days	-	15	-	-	-	-	-	1/Week	Continuous	All
99978 - Temperature, In Sludge - F	-	68	-	-	-	-	-	1/Day	Continuous	All
99980 - Volatile Fatty Acids (VFA) - mg/l	-	-	-	-	-	-	-	3/Week	Composite	All

NOTES for Station Number 4IN00204602:
a. Temperature shall be the daily minimum.
b. Minimum detention time or mean cell residence time (MCRT) shall be calculated as described in the SOP required by Part II. E.

Part I, A. - INTERNAL MONITORING REQUIREMENTS

4. Anaerobic Digester Effluent Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor the effluent from the anaerobic digester at Station Number 4IN00204603, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 603 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00157 - Solids, Total Volatile - % Removed	-	38	-	-	-	-	-	1/Week	Calculated	All
00552 - Oil and Grease, Hexane Extr Method - mg/l	-	-	-	-	-	-	-	1/Month	Composite	All
70322 - Sludge Solids, Percent Volatile - %	-	-	-	-	-	-	-	1/Week	Composite	All
80116 - COD, Soluble - mg/l	-	-	-	-	-	-	-	1/Week	Composite	All
99979 - Foreign Matter, percent - %	1.0	-	-	-	-	-	-	1/Month	Composite	All

NOTES for Station Number 4IN00204603:

a. Foreign matter (inert) sampling shall be performed in accordance with the alternative screening waiver issued on June 24, 2015.

Part I, A. - POND MONITORING REQUIREMENTS

5. Pond Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor pond L1 at Station Number 4IN00204604, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 604 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
82564 - Freeboard - feet	-	-	-	-	-	-	-	1/Week	Total	All
99977 - Maximum Operating Level (MOL), Sludge - mgals	5.48507	-	-	-	-	-	-	1/Week	Total	All

Part I, A. - POND MONITORING REQUIREMENTS

5. Pond Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor pond L2 at Station Number 4IN00204605, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 605 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
82564 - Freeboard - feet	-	-	-	-	-	-	-	1/Week	Total	All
99977 - Maximum Operating Level (MOL), Sludge - mgals	0.38769	-	-	-	-	-	-	1/Week	Total	All

Part I, A. - POND MONITORING REQUIREMENTS

5. Pond Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor pond L3 at Station Number 4IN00204606, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 606 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
82564 - Freeboard - feet	-	-	-	-	-	-	-	1/Week	Total	All
99977 - Maximum Operating Level (MOL), Sludge - mgals	0.33176	-	-	-	-	-	-	1/Week	Total	All

Part I, A. - POND MONITORING REQUIREMENTS

5. Pond Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor pond L4 at Station Number 4IN00204607, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 607 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
82564 - Freeboard - feet	-	-	-	-	-	-	-	1/Week	Total	All
99977 - Maximum Operating Level (MOL), Sludge - mgals	2.85714	-	-	-	-	-	-	1/Week	Total	All

Part I, A. - POND MONITORING REQUIREMENTS

5. Pond Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor pond L5 at Station Number 4IN00204608, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 608 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
82564 - Freeboard - feet	-	-	-	-	-	-	-	1/Week	Total	All
99977 - Maximum Operating Level (MOL), Sludge - mgals	1.36200	-	-	-	-	-	-	1/Week	Total	All

Part I, A. - POND MONITORING REQUIREMENTS

5. Pond Monitoring. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor pond L7 at Station Number 4IN00204609, and report to the Ohio EPA in accordance with the following table.

Table - Internal Monitoring Station - 609 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
82564 - Freeboard - feet	-	-	-	-	-	-	-	1/Week	Total	All
99977 - Maximum Operating Level (MOL), Sludge - mgals	20.76969	-	-	-	-	-	-	1/Week	Total	All

Part I, B. - MONITORING REQUIREMENTS FOR BENEFICIAL USE

1. Beneficial Use Monitoring - During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor the digester effluent or biosolids prior to land application at Station Number 4IN00204581, and report to the Ohio EPA in accordance with the following table.

Table - Sludge Monitoring - 581 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00400 - pH - S.U.	-	-	-	-	-	-	-	1/Month	Composite	All
00611 - Ammonia (NH3) In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
00627 - Nitrogen Kjeldahl, Total In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
00668 - Phosphorus, Total In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
00938 - Potassium In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
01003 - Arsenic, Total In Sludge - mg/kg	75	-	-	-	-	-	-	1/Month	Composite	All
01028 - Cadmium, Total In Sludge - mg/kg	85	-	-	-	-	-	-	1/Month	Composite	All
01043 - Copper, Total In Sludge - mg/kg	4300	-	-	-	-	-	-	1/Month	Composite	All
01052 - Lead, Total In Sludge - mg/kg	840	-	-	-	-	-	-	1/Month	Composite	All
01068 - Nickel, Total In Sludge - mg/kg	420	-	-	-	-	-	-	1/Month	Composite	All
01093 - Zinc, Total In Sludge - mg/kg	7500	-	-	-	-	-	-	1/Month	Composite	All
01148 - Selenium, Total In Sludge - mg/kg	100	-	-	-	-	-	-	1/Month	Composite	All
51129 - Sludge Fee Weight - dry tons	-	-	-	-	-	-	-	1/Month	Total	All
70316 - Sludge Weight - Dry Tons	-	-	-	-	-	-	-	1/Month	Total	All
71921 - Mercury, Total In Sludge - mg/kg	57	-	-	-	-	-	-	1/Month	Composite	All
78465 - Molybdenum In Sludge - mg/kg	75	-	-	-	-	-	-	1/Month	Composite	All

NOTES for Station Number 4IN00204581:

a. Monitoring is required when digester effluent or biosolids are removed for beneficial use. The monitoring data shall be reported monthly on each Electronic Discharge Monitoring Report (eDMR). The monitoring data can be collected at any time during the reporting period.

b. Samples shall be collected and analyzed close enough to the time of beneficial use to be reflective of the current quality of the effluent or biosolids, but not so close that the results of the analysis are not available prior to beneficial use.

c. Metal pollutant analysis must be completed during each reporting period, whether effluent or biosolids are removed from the treatment works or not, or the number of composite samples collected and reported shall be increased prior to the next beneficial use event to account for the reporting period(s) in which beneficial use did not occur, unless all previously accumulated effluent or biosolids have been removed and disposed of via a landfill, through incineration or by transfer to another treatment works.

d. If metal analysis has not been completed previously during each reporting period: when effluent or biosolids are removed from the treatment works, all metal analysis results shall be reported on the applicable eDMR by entering the separate results on different days within the DMR with a note to indicate the actual day(s) when the samples were collected.

e. If no effluent or biosolids are removed from the treatment works for beneficial use during the reporting period, the permittee shall report under station 581 by selecting the "No Discharge" check box on the data entry form.

f. Sludge weight. To convert from gallons of liquid effluent or biosolids to dry tons: dry tons= gallons x 8.34 (lb/gallon) x 0.0005 (tons/lb) x decimal fraction total solids.

g. Units of mg/kg are on a dry weight basis.

Part I, B. - MONITORING REQUIREMENTS FOR TRANSFER TO REGIONAL STORAGE FACILTY

2. Biosolids Monitoring - Class B biosolids transferred to a regional storage facility. During the period beginning on the effective date of this permit and lasting until the expiration date, the permittee shall monitor the biosolids prior to transfer to an NPDES permitted Class B biosolids regional storage facility at Station Number 4IN00204582, and report to the Ohio EPA in accordance with the following table.

Table - Sludge Monitoring - 582 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00400 - pH - S.U.	-	-	-	-	-	-	-	1/Month	Composite	All
00611 - Ammonia (NH3) In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
00627 - Nitrogen Kjeldahl, Total In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
00668 - Phosphorus, Total In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
00938 - Potassium In Sludge - mg/kg	-	-	-	-	-	-	-	1/Month	Composite	All
01003 - Arsenic, Total In Sludge - mg/kg	75	-	-	-	-	-	-	1/Month	Composite	All
01028 - Cadmium, Total In Sludge - mg/kg	85	-	-	-	-	-	-	1/Month	Composite	All
01043 - Copper, Total In Sludge - mg/kg	4300	-	-	-	-	-	-	1/Month	Composite	All
01052 - Lead, Total In Sludge - mg/kg	840	-	-	-	-	-	-	1/Month	Composite	All
01068 - Nickel, Total In Sludge - mg/kg	420	-	-	-	-	-	-	1/Month	Composite	All
01093 - Zinc, Total In Sludge - mg/kg	7500	-	-	-	-	-	-	1/Month	Composite	All
01148 - Selenium, Total In Sludge - mg/kg	100	-	-	-	-	-	-	1/Month	Composite	All
51129 - Sludge Fee Weight - dry tons	-	-	-	-	-	-	-	1/Month	Total	All
70316 - Sludge Weight - Dry Tons	-	-	-	-	-	-	-	1/Month	Total	All
71921 - Mercury, Total In Sludge - mg/kg	57	-	-	-	-	-	-	1/Month	Composite	All
78465 - Molybdenum In Sludge - mg/kg	75	-	-	-	-	-	-	1/Month	Composite	All

NOTES for Station Number 4IN00204582:

a. Monitoring is required when Class B biosolids are transferred to a regional storage facility. Class B biosolids PR And VAR requirements shall be met prior to being transferred to a permitted Class B biosolids regional storage facility. The monitoring data shall be reported monthly on each Electronic Discharge Monitoring Report (eDMR). The monitoring data can be collected at any time during the reporting period and may be the same data as reported under the 581 monitoring station.

b. Samples of the biosolids shall be collected and analyzed close enough to the time of transfer to a regional storage facility to be reflective of the current quality of the biosolids, but not so close that the results of the analysis are not available prior to the beneficial use of biosolids.

c. Metal pollutant analysis must be completed during each reporting period, whether biosolids are removed from the treatment works or not, or the number of composite samples collected and reported shall be increased prior to the next beneficial use event to account for the reporting period(s) in which beneficial use did not occur, unless all previously accumulated biosolids have been removed and disposed of via a landfill, through incineration or by transfer to another treatment works.

d. If metal analysis has not been completed previously during each reporting period: when biosolids are removed from the treatment works, all metal analysis results shall be reported on the applicable eDMR by entering the separate results on different days within the DMR with a note to indicate the actual day(s) when the samples were collected.

e. If no biosolids are removed from the treatment works for transfer to a regional storage facility during the reporting period, the permittee shall report under station 582 by selecting the "No Discharge" check box on the data entry form.

f. Sludge weight is a calculated total for the year. To convert from gallons of liquid biosolids to dry tons of biosolids: dry tons= gallons x 8.34 (lb/gallon) x 0.0005 (tons/lb) x decimal fraction total solids.

g. Units of mg/kg are on a dry weight basis.

Part I, B. - MONITORING REQUIREMENTS FOR LANDFILL

3. Digester effluent, Sludge, or Biosolids Monitoring. During the period beginning on the effective date of this NPDES permit and lasting until the expiration date, the permittee shall monitor the digester effluent, sewage sludge, or biosolids that are removed for disposal in a mixed solid waste landfill at Station Number 4IN00204586, and report to the Ohio EPA in accordance with the following table.

Table - Sludge Monitoring - 586 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
51129 - Sludge Fee Weight - dry tons	-	-	-	-	-	-	-	1/Year	Total	December

Notes for Station Number 4IN00204586:

a. Monitoring is required when digester effluent, sewage sludge, or biosolids are removed from the permittee's facility for disposal in a solid waste landfill. The total Sludge Fee Weight of effluent, sewage sludge, or biosolids disposed of in a solid waste landfill for the entire year shall be reported on the December Electronic Discharge Monitoring Report (eDMR).

b. If no digester effluent, sewage sludge, or biosolids are removed from the Permittee's facility for disposal in a solid waste landfill during the year, select the "No Discharge" check box on the data entry form.

c. Sludge fee weight means sludge weight, in dry U.S. tons, excluding any admixtures such as liming material or bulking agents.

Part I, B. - MONITORING REQUIREMENTS FOR TRANSFER

4. Digester effluent, Sludge, or Biosolids Monitoring. During the period beginning on the effective date of this NPDES permit and lasting until the expiration date, the permittee shall monitor the digester effluent, sewage sludge, or biosolids that are removed for transfer to another NPDES permit holder for treatment at Station Number 4IN00204588, and report to the Ohio EPA in accordance with the following table. Station 588 shall not be used to report biosolids transferred to a Class B biosolids regional storage facility.

Table - Sludge Monitoring - 588 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
70316 - Sludge Weight - Dry Tons	-	-	-	-	-	-	-	1/Year	Total	December

NOTES for Station Number 4IN00204588:

a. Monitoring is required when digester effluent, sewage sludge, or biosolids are removed from the permittee's facility for transfer to another NPDES permit holder. The total sludge weight or sludge volume transferred to another NPDES permit holder for the entire year shall be reported on the December Electronic Discharge Monitoring Report (eDMR).

b. If no digester effluent, sewage sludge, or biosolids are removed from the Permittee's facility for transfer to another NPDES permit holder during the year, select the "No Discharge" check box on the data entry form.

c. Sludge weight is a calculated total for the year. To convert from gallons of liquid effluent, sewage sludge, or biosolids to dry tons: dry tons= gallons x 8.34 (lb/gallon) x 0.0005 (tons/lb) x decimal fraction total solids.

Part I, B. - SLUDGE OR BIOSOLIDS MONITORING REQUIREMENTS

6. Monitoring of Material from Digester Clean-out. During the period beginning on the effective date of this NPDES permit and lasting until the expiration date, the permittee shall monitor the material that is removed from the anaerobic digester during clean-out at Station Number 4IN00204589, and report to the Ohio EPA in accordance with the following table.

Table - Sludge Monitoring - 589 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00400 - pH - S.U.	-	-	-	-	-	-	-	When Disch.	Composite	December
00611 - Ammonia (NH3) In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
00627 - Nitrogen Kjeldahl, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
00668 - Phosphorus, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
00938 - Potassium In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
01003 - Arsenic, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
01028 - Cadmium, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
01043 - Copper, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
01052 - Lead, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
01068 - Nickel, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
01093 - Zinc, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
01148 - Selenium, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
04174 - Free Liquids, In Sludge - Pass = 0 Fail = 1	-	-	-	-	-	-	-	When Disch.	Composite	December
31641 - Fecal Coliform in Sludge - MPN/G	-	-	-	-	-	-	-	When Disch.	Multiple Grab	December
51129 - Sludge Fee Weight - dry tons	-	-	-	-	-	-	-	When Disch.	Total	December
70316 - Sludge Weight - Dry Tons	-	-	-	-	-	-	-	When Disch.	Total	December
70318 - Sludge Solids, Percent Total - %	-	-	-	-	-	-	-	When Disch.	Composite	December
71921 - Mercury, Total In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
78465 - Molybdenum In Sludge - mg/kg	-	-	-	-	-	-	-	When Disch.	Composite	December
99973 - Sludge Volume, to regional storage facility - gals	-	-	-	-	-	-	-	When Disch.	Total	December
99974 - Sludge Weight, to regional storage facility - dry tons	-	-	-	-	-	-	-	When Disch.	Total	December
99975 - Sludge Volume, to approved beneficial use sites - gals	-	-	-	-	-	-	-	When Disch.	Total	December
99976 - Sludge Weight, to approved beneficial use sites - dry tons	-	-	-	-	-	-	-	When Disch.	Total	December
99979 - Foreign Matter, percent - %	-	-	-	-	-	-	-	When Disch.	Composite	December

NOTES for Station Number 4IN00204589:

a. Monitoring is required when material is removed from the anaerobic digester during a clean-out prior to beneficial use or transfer to a regional storage facility to confirm classification as Class B biosolids. The monitoring data shall be reported on Electronic Discharge Monitoring Report (eDMR). The total sludge weight removed shall be reported under 70316. The sludge weight for each use category shall be reported under 99973, 99974, 99975, or 99976, as applicable.

b. Samples of the clean-out material shall be collected and analyzed close enough to the time of beneficial use or transfer to a regional storage facility to confirm classification as Class B biosolids, but not so close that the results of the analysis are not available prior to beneficial use or transfer to a regional storage facility. Only material that meets the limits set forth in this table shall be considered Class B biosolids eligible to be beneficially used or transferred to a regional storage facility.

c. Free Liquid, In Sludge, shall be used to report the results of the paint filter liquids test using SW-846 Test Method 9095B. Only biosolids that have no liquid detected, i.e. pass the paint filter test, are eligible for regional storage at a dry storage facility. For reporting, Pass = 0 and Fail = 1

d. If no material is removed from the treatment works during a digester clean-out, the permittee shall report under station 589 by selecting the "No Discharge" check box on the data entry form.

e. For sludge weight, to convert from gallons of liquid biosolids to dry tons of biosolids: dry tons= gallons x 8.34 (lb/gallon) x 0.0005 (tons/lb) x decimal fraction total solids

Part I, B. - GROUNDWATER MONITORING REQUIREMENTS

5. Groundwater Monitoring. During the period beginning on the effective date of this NPDES permit and lasting until the expiration date, the permittee shall monitor the piezometer, PZ-1 at Station Number 4IN00204701, and report to the Ohio EPA in accordance with the following table.

Table - Well Monitoring - 701 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00011 - Water Temperature - F	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00070 - Turbidity - J.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00094 - Conductivity - Umho/Cm	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00400 - pH - S.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00610 - Nitrogen, Ammonia (NH3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00615 - Nitrogen, Nitrite (NO2) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00620 - Nitrogen, Nitrate (NO3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00625 - Nitrogen Kjeldahl, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00665 - Phosphorus, Total (P) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00929 - Sodium, Total (Na) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00937 - Potassium, Total (K) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00940 - Chloride, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00945 - Sulfate, (SO4) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
31648 - E. coli - #/100 ml	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
70300 - Residue, Total Filterable - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual

NOTES for Station Number 4IN00204701:
a. Sampling shall be performed in the months of June and December.
b. The following parameters shall be monitored in the field: conductivity, pH, temperature, and turbidity. All other parameters shall be monitored in a laboratory.

Part I, B. - GROUNDWATER MONITORING REQUIREMENTS

6. Groundwater Monitoring. During the period beginning on the effective date of this NPDES permit and lasting until the expiration date, the permittee shall monitor the piezometer, PZ-2 at Station Number 4IN00204702, and report to the Ohio EPA in accordance with the following table.

Table - Well Monitoring - 702 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00011 - Water Temperature - F	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00070 - Turbidity - J.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00094 - Conductivity - Umho/Cm	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00400 - pH - S.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00610 - Nitrogen, Ammonia (NH3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00615 - Nitrogen, Nitrite (NO2) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00620 - Nitrogen, Nitrate (NO3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00625 - Nitrogen Kjeldahl, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00665 - Phosphorus, Total (P) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00929 - Sodium, Total (Na) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00937 - Potassium, Total (K) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00940 - Chloride, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00945 - Sulfate, (SO4) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
31648 - E. coli - #/100 ml	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
70300 - Residue, Total Filterable - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual

NOTES for Station Number 4IN00204702:
a. Sampling shall be performed in the months of June and December.
b. The following parameters shall be monitored in the field: conductivity, pH, temperature, and turbidity. All other parameters shall be monitored in a laboratory.

Part I, B. - GROUNDWATER MONITORING REQUIREMENTS

7. Groundwater Monitoring. During the period beginning on the effective date of this NPDES permit and lasting until the expiration date, the permittee shall monitor the piezometer, PZ-3 at Station Number 4IN00204703, and report to the Ohio EPA in accordance with the following table.

Table - Well Monitoring - 703 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00011 - Water Temperature - F	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00070 - Turbidity - J.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00094 - Conductivity - Umho/Cm	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00400 - pH - S.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00610 - Nitrogen, Ammonia (NH3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00615 - Nitrogen, Nitrite (NO2) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00620 - Nitrogen, Nitrate (NO3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00625 - Nitrogen Kjeldahl, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00665 - Phosphorus, Total (P) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00929 - Sodium, Total (Na) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00937 - Potassium, Total (K) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00940 - Chloride, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00945 - Sulfate, (SO4) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
31648 - E. coli - #/100 ml	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
70300 - Residue, Total Filterable - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual

NOTES for Station Number 4IN00204703:

a. Sampling shall be performed in the months of June and December.

b. The following parameters shall be monitored in the field: conductivity, pH, temperature, and turbidity. All other parameters shall be monitored in a laboratory.

Part I, B. - GROUNDWATER MONITORING REQUIREMENTS

8. Groundwater Monitoring. During the period beginning on the effective date of this NPDES permit and lasting until the expiration date, the permittee shall monitor the piezometer, PZ-4 at Station Number 4IN00204704, and report to the Ohio EPA in accordance with the following table.

Table - Well Monitoring - 704 - Final

Effluent Characteristic	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day					
Parameter	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly	Measuring Frequency	Sampling Type	Monitoring Months
00011 - Water Temperature - F	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00070 - Turbidity - J.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00094 - Conductivity - Umho/Cm	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00400 - pH - S.U.	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00610 - Nitrogen, Ammonia (NH3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00615 - Nitrogen, Nitrite (NO2) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00620 - Nitrogen, Nitrate (NO3) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00625 - Nitrogen Kjeldahl, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00665 - Phosphorus, Total (P) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00929 - Sodium, Total (Na) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00937 - Potassium, Total (K) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00940 - Chloride, Total - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
00945 - Sulfate, (SO4) - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
31648 - E. coli - #/100 ml	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual
70300 - Residue, Total Filterable - mg/l	-	-	-	-	-	-	-	2/Year	Grab	Semi-annual

NOTES for Station Number 4IN00204703:
a. Sampling shall be performed in the months of June and December.
b. The following parameters shall be monitored in the field: conductivity, pH, temperature, and turbidity. All other parameters shall be monitored in a laboratory.

Part I.C. SCHEDULE OF COMPLIANCE

1. STABILITY

Not later than 6 months from the effective date of this permit, the permittee shall submit a plan to implement a method to demonstrate a stable digestate. (Event code 34099)

a. Ohio EPA will review the plan and provide comments to the permittee. The permittee shall respond to any comments as noted by Ohio EPA within 14 days of receipt.

b. Within 14 days of notification of acceptance of this plan by Ohio EPA, the permittee shall initiate implementation of the plan, including any revisions necessary to address Ohio EPA comments, and submit an NPDES permit modification request for the inclusion of alternative stability assessment parameters.

2. ODOR MITIGATION PLAN

a. The permittee shall submit to Ohio EPA for acceptance an Odor Mitigation Plan (OMP) for the purpose of optimizing operations to reduce air emissions thereby reducing nuisance odors. The OMP shall include:

. i. An evaluation of all potential sources that may contribute to off-site odors. Potential odor sources include, but are not limited to, delivery trucks, feedstock receiving station, effluent loading areas, effluent trucks, captured air handling system, malfunctioning/improperly maintained biofilter, pressure relief valves, venting from tanks (feedstock and digester), leak detection system, ponds, and routine maintenance;

. ii. An evaluation of possible odor source reduction measures to be implemented at the potential odor sources or during potentially odorous activities;

. iii. An evaluation of operational improvements or facility modifications that could be used to minimize off-site odors from or during the potential odor sources;

. iv. A proposed schedule for implementing any recommended odor mitigation measures identified through the evaluation process.

b. The plan shall be submitted to Ohio EPA for acceptance no later than 2 months from the effective date of this permit. (Event Code 34099)

. i. Ohio EPA will review the plan and provide comments to the permittee. The permittee shall respond to any comments as noted by Ohio EPA within 30 days of receiving Ohio EPA comments.

c. Upon acceptance of the OMP by Ohio EPA, the permittee shall implement the recommended measures, improvements, and modifications in accordance with the plan and schedule specified in the OMP. A complete Permit-to-Install (PTI) application and approvable detail plans must be submitted where required.

Part II, OTHER REQUIREMENTS

A. Description of the required sampling stations are as follows:

Sampling Station	Description
4IN00204581	Beneficial use of digester effluent or Class B biosolids
4IN00204582	Class B biosolids transferred to an NPDES permitted regional storage facility
4IN00204586	Landfilling of digester effluent, sewage sludge, or biosolids
4IN00204588	Transferring digester effluent, sewage sludge, or biosolids to another NPDES permit holder for treatment
4IN00204601	Biomass leaving feedstock equalization tank, prior to anaerobic digester
4IN00204602	Biomass in anaerobic digester
4IN00204603	Effluent from anaerobic digester
4IN00204604	Pond 1 (L1) 40°26'40.027" N, 82°57'33.818" W
4IN00204605	Pond 2 (L2) 40°26'40.376" N, 82°57'37.379" W
4IN00204606	Pond 3 (L3) 40°26'39.088" N, 82°57'38.059" W
4IN00204607	Pond 4 (L4) 40°26'13.898" N, 82°57'23.411" W
4IN00204608	Pond 5 (L5) 40°26'14.885" N, 82°57'28.444" W
4IN00204609	Pond 7 (L7) 40°26'37.172" N, 82°57'28.757" W
4IN00204701	Piezometer 1 (PZ-1) East corner of L7
4IN00204702	Piezometer 2 (PZ-2) South corner of L7
4IN00204703	Piezometer 3 (PZ-3) North corner of L7
4IN00204704	Piezometer 4 (PZ-4) West corner of L7

B. All treatment, storage, transfer, disposal or beneficial use of digester effluent or biosolids by the Permittee shall comply, as applicable, with Chapter 6111 of the Ohio Revised Code, Chapter 3745 of the Ohio Administrative Code (OAC), any further requirements specified in this national pollutant discharge elimination system (NPDES) permit, and any other pertinent actions of the Director.

C. If sewage sludge or biosolids are received as a feedstock, the permittee shall demonstrate pathogen reduction (PR) using alternative P-4, anaerobic digestion in accordance with OAC 3745-40-04(B)(4).

D. If sewage sludge or biosolids are received as a feedstock, vector attraction reduction (VAR) shall be met using alternative VAR-1, a minimum of 38% volatile solids reduction in accordance with OAC 3745-40-04 (C)(1).

E. If sewage sludge or biosolids are received as a feedstock, an SOP that details how PR and VAR are met as described in OAC 3745-40-09(C) shall be submitted to Ohio EPA for acceptance within 60 days of the effective date of this permit. This SOP shall include how the mean cell residence time for each digester is calculated.

F. This NPDES permit is for the beneficial use of effluent or Class B biosolids generated from the anaerobic digestion of animal wastes, biosolids, energy crops (i.e. grain, hay, silage, spilled and soiled feed, and stover), fats, oils, and greases (FOG), food scraps, food waste, glycerin byproducts from bio-diesel production, sewage sludge, stillage byproducts from ethanol production, and yard waste for the purpose of producing energy from methane generation. All other feedstocks must be separately approved by Ohio EPA

G. Upon issuance of this permit, the permittee shall begin submitting a monthly tracking sheet to Ohio EPA by the 20th day of the month following the month-of-interest. The tracking sheet shall include, at a minimum, the following for each feedstock load received:

1. Date received
2. Type of feedstock
3. Amount delivered
4. Location accepted (liquid or solids receiving station, biomass tank, or digester)

H. A Facility Operational Plan shall be maintained at the facility and made available to Ohio EPA upon request. This plan shall include, at a minimum, the following:

1. Facility overview and process flow diagram that describes material management such as feedstock unloading procedures, feedstock mixing procedures, digester feed rate determination, and target operating conditions, e.g. digester time and temperature range, pH, and VFA/Alk ratio.

2. Standard Operating Procedures (SOPs) for routine maintenance for treatment and odor mitigation components.

3. SOPs for emergency conditions that threaten the environment.

4. SOPs for land application that address, at a minimum, the following:
a. Compliance with applicable site restrictions.
b. Minimization of off-site odors.
c. Injection and incorporation procedures.
d. Soil sampling procedures.
e. Agronomic rate calculations.
f. Development and distribution of Notice and Necessary Information Sheets (NANIs).
g. Sign placement.
h. Calibration of land application equipment.
i. Use of mobile storage tanks.
j. Monitoring of sites with subsurface tile drainage.
k. Use of drag hoses.
l. Tracking of biosolids from multiple facilities to one beneficial use site.

5. A spill contingency plan that establishes measures and procedures to respond to a spill event at the facility, storage facility, or at beneficial use sites in order to minimize discharges to surface waters, and to prevent public exposure to the spilled material. This plan shall, at a minimum, include:
a. Emergency contact information.
b. Notification protocol.
c. Types and locations of equipment that will be used to clean a spill.
d. Procedures for preventing discharges to waters of the state.
e. Response and remediation procedures.

6. Copies of annual training logs with staff signatures showing that they have received training for the plans outlined in Part II. H.

I. A summary of changes to the Facility Operational Plan that have been made during each calendar year shall be submitted with the annual sludge report required by Part II. X.

J. A Sampling Plan shall be submitted to Ohio EPA for acceptance within 60 days of the effective date of this permit. This plan shall include, at a minimum, the following for all required sampling:
1. Sample collection or monitoring locations
2. Sample or monitoring frequency
3. Sample collection or monitoring procedures
4. Sample storage and preservation procedures

(EVENT CODE 22099)

K. For composite samples, a minimum of six grab samples shall be collected at such times and locations, and in such fashion, as to be representative.

L. By the 20th of each month the permittee shall submit to Ohio EPA, a graph showing both biogas production and the concentration of Volatile Fatty Acids (VFA) per day for the previous month.

M. Effluent Ponds

1. Only effluent that has been treated by anaerobic digestion at Emerald BioEnergy, LLC shall be stored in the ponds noted in Part II Item A. No other feedstocks shall be placed directly into the ponds.

2. The levels of the ponds shall not exceed the gallons available at the approved maximum operating level (MOL) listed below.

.	Gallons at Approved MOL
Pond 1 (L1)	5,485,068
Pond 2 (L2)	387,693
Pond 3 (L3)	331,764
Pond 4 (L4)	2,857,143
Pond 5 (L5)	1,362,000
Pond 7 (L7)	20,769,686

3. Effluent shall not be transferred to a pond when the level is at or above MOL.

4. Should any pond level go above the MOL, the permittee shall immediately notify Ohio EPA and take appropriate action to bring the level below MOL.

5. Each pond must be equipped with a depth marker that clearly indicates the approved MOL and freeboard. The depth marker shall be labeled in inches and easily accessed and read.

6. Adequate storage volume shall be provided and maintained to enable the facility to comply with the MOL requirement and minimum facility storage requirement of at least 120 days. No later than September 15 of each year, the permittee shall evaluate the storage capacity in the ponds and complete a storage evaluation form to be submitted to Ohio EPA by November 1. The storage evaluation shall demonstrate that by December 1, the MOL and minimum facility storage will be maintained in each pond. Failure to submit the evaluation or to take actions the evaluation indicates are necessary shall be considered a violation of this permit.
(Event Code 95999)

7. Mixing/Agitation of the ponds shall be limited to normal weekday business hours (8am to 5pm).

8. The ponds shall be inspected for structural integrity (including evidence of erosion, leakage, animal damage, problems of emerging vegetation) on a monthly basis. Inspection records shall be maintained and made available to Ohio EPA for review upon request. If the permittee or Ohio EPA determines that the soil liners have be impacted by erosion or other structural issues, the liner must be repaired and re-certified by a professional engineer.

9. The ponds must be maintained to discourage vectors. Control of vegetation around the perimeter and within the ponds shall be routinely performed to allow for visual inspection and access to the ponds, to eliminate mosquito habitats, and to prevent roots from damaging the pond liners. Should nuisance vectors associated with the ponds occur, as determined by Ohio EPA, the permittee shall immediately implement all approved corrective action to address the situation.

10. Fencing, other access control devices, and signage required by the applicable PTI for each pond shall be maintained throughout the life of the facility.

N. The permittee shall submit the agronomic rate calculations for each authorized beneficial use site no later than on the day that beneficial use commences at the site. The agronomic rate calculations shall include, at a minimum, the nutrient concentrations of the biosolids, soil phosphorus test results, soil types, crop types, expected crop yield, crop nitrogen requirements, all nutrient sources used at the field, and the total percent solids of liquid biosolids. This information shall be submitted through email to Ohio EPA- Central Office. Ohio EPA may request additional information be included in the agronomic rate submittals.

O. The permittee shall submit a notice of beneficial use site application and receive authorization to beneficially use Class B biosolids at beneficial use sites within Delaware, Marion, Morrow, or Union Counties prior to the beneficial use of Class B biosolids. Beneficial use of biosolids in counties not listed requires a modification of this permit. Notice of Class B beneficial use site applications shall be submitted in accordance with OAC 3745-40-06. Beneficial use of Class B biosolids shall comply with OAC 3745-40-08.

P. The treatment, storage, transfer, disposal or beneficial use of digester effluent or biosolids shall not result in the generation of a nuisance odor, as determined by Ohio EPA. Should a nuisance odor be generated at the facility, a storage facility, or a beneficial use site, all necessary corrective actions to eliminate nuisance odors, including the installation of appropriate odor control equipment in accordance with an approved PTI, shall be immediately implemented.

Q. After acceptance of the initial Odor Mitigation Plan (OMP) in accordance with Part 1, C. Item 2, the permittee shall submit an OMP annual report to Ohio EPA by March 1 of each year. This report shall include a discussion on the effectiveness of the OMP and any revisions made during the year.

R. If groundwater monitoring indicates an increasing trend in concentration(s) for the parameter(s) monitored for Stations 4IN00204701 though 4IN00204704, the permittee shall, within thirty (30) days of being notified by Ohio EPA, submit an evaluation report of the source(s) of the increase including all sources considered, the methods used in the evaluation, and a corrective action plan if an identified source is associated with the Renergy facility, ponds, or operations. The corrective action plan shall be immediately implemented upon authorization of the plan from Ohio EPA

S. Any unauthorized discharge to waters of the state shall be reported to Ohio EPA by e-mail or telephone within thirty minutes of discovery in accordance with Part III.2.

T. Any conditions that result in an unauthorized discharge, reportable spill, or release from the facility, during transport, during activities related to storage, or during the beneficial use shall be reported to Ohio EPA by email or telephone within 24 hours of discovery and, if applicable, within 30 minutes of discovery in accordance with Part III.12.B.2. Reports of the event shall be submitted in accordance with OAC 3745-40-12. For the purposes of this permit, a reportable spill is defined as a spill that is greater than 50 gallons, has entered or has the potential to enter waters of the state, has impacted or has the potential to impact human health, or has occurred on a public roadway or high potential public exposure site. Any spill that does not meet the definition of reportable spill shall be contained and cleaned immediately.

U. Any issue outside of normal operations at the treatment works such as digester upset, systemic methanogen lethality, air release, foaming or rapid volume expansion events, tank ruptures, or explosions shall be reported to Ohio EPA by email or telephone within 24 hours of discovery. For the purposes of this permit, air release is defined as an emission that exceeds one hour in duration or two hours total during a 24-hour period. An air release does not represent normal operations of the facility's vents or emergency pressure relief valves. The issue may require that feedstock acceptance be halted or a failure analysis be performed. Within five days of discovery of any issue, the permittee shall submit a report to Ohio EPA that details the following information:

1. The name of the permittee and a contact name and telephone number.
2. The time(s) at which the issue occurred and was discovered.
3. The characteristics of the issue that occurred.
4. The circumstances that created the issue.
5. The name and telephone number for the person(s) who have knowledge of the issue.
6. What remedial steps have been or will be implemented to address the issue and prevent its recurrence.

V. The permittee shall not store or stockpile sewage sludge, feedstocks, or biosolids at the facility outside of treatment processes or permitted storage locations. Class B biosolids may be stored at authorized beneficial use sites in accordance with OAC 3745-40-07 or an approved PTI for a mobile storage tank.

W. Any regional or off-site storage facility that is proposed for the storage of biosolids generated by the permittee must be approved by Ohio EPA prior to the storage of biosolids in accordance with OAC 3745-40-07. The permittee shall submit PTI and NPDES permit applications, as applicable, for the regional storage facility to Ohio EPA for review and approval that shall include engineered plans, design details, supplemental information required by rule, and any additional information requested by Ohio EPA.

X. No later than March 1 of each calendar year, the Permittee shall submit an annual sludge report summarizing the sewage sludge disposal, use, storage, or treatment activities of the Permittee during the previous calendar year. The report shall be submitted through the Ohio EPA eBusiness Center, Division of Surface Water NPDES Permit Applications service.

Y. If sewage sludge or biosolids are no longer accepted for treatment and the permittee wishes to no longer be required to comply with OAC 3745-40, the permittee shall submit, at a minimum, the following:

1. A plan to Ohio EPA for acceptance that details how the biosolids in the ponds will be removed to a point that no longer requires compliance with OAC 3745-40.

2. An application for a land application management plan (LAMP) for the land application of the effluent that no longer contains sewage sludge or biosolids.

3. An application for a PTI for any equipment that will be utilized to treat or land apply digester effluent that does not contain sewage sludge or biosolids.

Z. The permittee shall notify Ohio EPA within 7 days when the facility is no longer being actively operated.

AA. A closure plan shall be submitted if the facility will be permanently closed and may require pond closures in accordance with an approved PTI.

BB. Documents shall be submitted to:

Ohio EPA - Central Office
Division of Surface Water, Biosolids Program
biosolids@epa.ohio.gov

PART III - GENERAL CONDITIONS

1. DEFINITIONS

"Daily discharge" means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

"Average weekly" discharge limitation means the highest allowable average of "daily discharges" over a calendar week, calculated as the sum of all "daily discharges" measured during a calendar week divided by the number of "daily discharges" measured during that week. Each of the following 7-day periods is defined as a calendar week: Week 1 is Days 1 - 7 of the month; Week 2 is Days 8 - 14; Week 3 is Days 15 - 21; and Week 4 is Days 22 - 28. If the "daily discharge" on days 29, 30 or 31 exceeds the "average weekly" discharge limitation, Ohio EPA may elect to evaluate the last 7 days of the month as Week 4 instead of Days 22 - 28. Compliance with fecal coliform bacteria or E coli bacteria limitations shall be determined using the geometric mean.

"Average monthly" discharge limitation means the highest allowable average of "daily discharges" over a calendar month, calculated as the sum of all "daily discharges" measured during a calendar month divided by the number of "daily discharges" measured during that month. Compliance with fecal coliform bacteria or E coli bacteria limitations shall be determined using the geometric mean.

"85 percent removal" means the arithmetic mean of the values for effluent samples collected in a period of 30 consecutive days shall not exceed 15 percent of the arithmetic mean of the values for influent samples collected at approximately the same times during the same period.

"Absolute Limitations" Compliance with limitations having descriptions of "shall not be less than," "nor greater than," "shall not exceed," "minimum," or "maximum" shall be determined from any single value for effluent samples and/or measurements collected.

"Net concentration" shall mean the difference between the concentration of a given substance in a sample taken of the discharge and the concentration of the same substances in a sample taken at the intake which supplies water to the given process. For the purpose of this definition, samples that are taken to determine the net concentration shall always be 24-hour composite samples made up of at least six increments taken at regular intervals throughout the plant day.

"Net Load" shall mean the difference between the load of a given substance as calculated from a sample taken of the discharge and the load of the same substance in a sample taken at the intake which supplies water to given process. For purposes of this definition, samples that are taken to determine the net loading shall always be 24-hour composite samples made up of at least six increments taken at regular intervals throughout the plant day.

"MGD" means million gallons per day.

"mg/l" means milligrams per liter.

"ug/l" means micrograms per liter.

"ng/l" means nanograms per liter.

"S.U." means standard pH unit.

"kg/day" means kilograms per day.

"Reporting Code" is a five digit number used by the Ohio EPA in processing reported data. The reporting code does not imply the type of analysis used nor the sampling techniques employed.

"Quarterly (1/Quarter) sampling frequency" means the sampling shall be done in the months of March, June, August, and December, unless specifically identified otherwise in the Effluent Limitations and Monitoring Requirements table.

"Yearly (1/Year) sampling frequency" means the sampling shall be done in the month of September, unless specifically identified otherwise in the effluent limitations and monitoring requirements table.

"Semi-annual (2/Year) sampling frequency" means the sampling shall be done during the months of June and December, unless specifically identified otherwise.

"Winter" shall be considered to be the period from November 1 through April 30.

"Bypass" means the intentional diversion of waste streams from any portion of the treatment facility.

"Summer" shall be considered to be the period from May 1 through October 31.

"Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

"Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

"Sewage sludge" means a solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works as defined in section 6111.01 of the Revised Code. "Sewage sludge" includes, but is not limited to, scum or solids removed in primary, secondary, or advanced wastewater treatment processes. "Sewage sludge" does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator, grit and screenings generated during preliminary treatment of domestic sewage in a treatment works, animal manure, residue generated during treatment of animal manure, or domestic septage.

"Sewage sludge weight" means the weight of sewage sludge, in dry U.S. tons, including admixtures such as liming materials or bulking agents. Monitoring frequencies for sewage sludge parameters are based on the reported sludge weight generated in a calendar year (use the most recent calendar year data when the NPDES permit is up for renewal).

"Sewage sludge fee weight" means the weight of sewage sludge, in dry U.S. tons, excluding admixtures such as liming materials or bulking agents. Annual sewage sludge fees, as per section 3745.11(Y) of the Ohio Revised Code, are based on the reported sludge fee weight for the most recent calendar year.

2. GENERAL EFFLUENT LIMITATIONS

The effluent shall, at all times, be free of substances:

A. In amounts that will settle to form putrescent, or otherwise objectionable, sludge deposits; or that will adversely affect aquatic life or water fowl;

B. Of an oily, greasy, or surface-active nature, and of other floating debris, in amounts that will form noticeable accumulations of scum, foam or sheen;

C. In amounts that will alter the natural color or odor of the receiving water to such degree as to create a nuisance;

D. In amounts that either singly or in combination with other substances are toxic to human, animal, or aquatic life;

E. In amounts that are conducive to the growth of aquatic weeds or algae to the extent that such growths become inimical to more desirable forms of aquatic life, or create conditions that are unsightly, or constitute a nuisance in any other fashion;

F. In amounts that will impair designated instream or downstream water uses.

3. FACILITY OPERATION AND QUALITY CONTROL

All wastewater treatment works shall be operated in a manner consistent with the following:

A. At all times, the permittee shall maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee necessary to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with conditions of the permit.

B. The permittee shall effectively monitor the operation and efficiency of treatment and control facilities and the quantity and quality of the treated discharge.

C. Maintenance of wastewater treatment works that results in degradation of effluent quality shall be scheduled during non-critical water quality periods and shall be carried out in a manner approved by Ohio EPA as specified in the Paragraph in the PART III entitled, "UNAUTHORIZED DISCHARGES".

4. REPORTING

A. Monitoring data required by this permit shall be submitted monthly on Ohio EPA 4500 Discharge Monitoring Report (DMR) forms using the electronic DMR (e-DMR) internet application. e-DMR allows permitted facilities to enter, sign, and submit DMRs on the internet. e-DMR information is found on the following web page:

http://www.epa.ohio.gov/dsw/edmr/eDMR.aspx

Alternatively, if you are unable to use e-DMR due to a demonstrated hardship, monitoring data may be submitted on paper DMR forms provided by Ohio EPA. Monitoring data shall be typed on the forms. Please contact Ohio EPA, Division of Surface Water at (614) 644-2050 if you wish to receive paper DMR forms.

B. DMRs shall be signed by a facility's Responsible Official or a Delegated Responsible Official (i.e. a person delegated by the Responsible Official). The Responsible Official of a facility is defined as:

1. For corporations - a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions for the corporation; or the manager of one or more manufacturing, production or operating facilities, provided the manager is authorized to make management decisions which govern the operation of the regulated facility including having explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

2. For partnerships - a general partner;

3. For a sole proprietorship - the proprietor; or,

4. For a municipality, state or other public facility - a principal executive officer, a ranking elected official or other duly authorized employee.

For e-DMR, the person signing and submitting the DMR will need to obtain an eBusiness Center account and Personal Identification Number (PIN). Additionally, Delegated Responsible Officials must be delegated by the Responsible Official, either on-line using the eBusiness Center's delegation function, or on a paper delegation form provided by Ohio EPA. For more information on the PIN and delegation processes, please view the following web page:

http://epa.ohio.gov/dsw/edmr/eDMR.aspx

C. DMRs submitted using e-DMR shall be submitted to Ohio EPA by the 20th day of the month following the month-of-interest. DMRs submitted on paper must include the original signed DMR form and shall be mailed to Ohio EPA at the following address so that they are received no later than the 15th day of the month following the month-of-interest:

Ohio Environmental Protection Agency
Lazarus Government Center
Division of Surface Water - PCU
P.O. Box 1049
Columbus, Ohio 43216-1049

D. If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified in Section 5. SAMPLING AND ANALYTICAL METHODS, the results of such monitoring shall be included in the calculation and reporting of the values required in the reports specified above.

E. Analyses of pollutants not required by this permit, except as noted in the preceding paragraph, shall not be reported to the Ohio EPA, but records shall be retained as specified in Section 7. RECORDS RETENTION.

5. SAMPLING AND ANALYTICAL METHOD

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored flow. Test procedures for the analysis of pollutants shall conform to regulation 40 CFR 136, "Test Procedures For The Analysis of Pollutants" unless other test procedures have been specified in this permit. The permittee shall periodically calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals to insure accuracy of measurements.

6. RECORDING OF RESULTS

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

A. The exact place and date of sampling; (time of sampling not required on EPA 4500)

B. The person(s) who performed the sampling or measurements;

C. The date the analyses were performed on those samples;

D. The person(s) who performed the analyses;

E. The analytical techniques or methods used; and

F. The results of all analyses and measurements.

7. RECORDS RETENTION

The permittee shall retain all of the following records for the wastewater treatment works for a minimum of three years except those records that pertain to sewage sludge disposal, use, storage, or treatment, which shall be kept for a minimum of five years, including:

A. All sampling and analytical records (including internal sampling data not reported);

B. All original recordings for any continuous monitoring instrumentation;

C. All instrumentation, calibration and maintenance records;

D. All plant operation and maintenance records;

E. All reports required by this permit; and

F. Records of all data used to complete the application for this permit for a period of at least three years, or five years for sewage sludge, from the date of the sample, measurement, report, or application.

These periods will be extended during the course of any unresolved litigation, or when requested by the Regional Administrator or the Ohio EPA. The three year period, or five year period for sewage sludge, for retention of records shall start from the date of sample, measurement, report, or application.

8. AVAILABILITY OF REPORTS

Except for data determined by the Ohio EPA to be entitled to confidential status, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the appropriate district offices of the Ohio EPA. Both the Clean Water Act and Section 6111.05 Ohio Revised Code state that effluent data and receiving water quality data shall not be considered confidential.

9. DUTY TO PROVIDE INFORMATION

The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking, and reissuing, or terminating the permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

10. RIGHT OF ENTRY

The permittee shall allow the Director or an authorized representative upon presentation of credentials and other documents as may be required by law to:

A. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit.

B. Have access to and copy, at reasonable times, any records that must be kept under the conditions of the permit.

C. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit.

D. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location.

11. UNAUTHORIZED DISCHARGES

A. Bypass Not Exceeding Limitations - The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs 11.B and 11.C.

B. Notice

1. Anticipated Bypass - If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

2. Unanticipated Bypass - The permittee shall submit notice of an unanticipated bypass as required in paragraph 12.B (24 hour notice).

C. Prohibition of Bypass

1. Bypass is prohibited, and the Director may take enforcement action against a permittee for bypass, unless:

a. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

b. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

c. The permittee submitted notices as required under paragraph 11.B.

2. The Director may approve an anticipated bypass, after considering its adverse effects, if the Director determines that it will meet the three conditions listed above in paragraph 11.C.1.

12. NONCOMPLIANCE NOTIFICATION

A. Exceedance of a Daily Maximum Discharge Limit

1. The permittee shall report noncompliance that is the result of any violation of a daily maximum discharge limit for any of the pollutants listed by the Director in the permit by e-mail or telephone within twenty-four (24) hours of discovery.

The permittee may report to the appropriate Ohio EPA district office e-mail account as follows (this method is preferred):

Southeast District Office:	sedo24hournpdes@epa.state.oh.us
Southwest District Office:	swdo24hournpdes@epa.state.oh.us
Northwest District Office:	nwdo24hournpdes@epa.state.oh.us
Northeast District Office:	nedo24hournpdes@epa.state.oh.us
Central District Office:	cdo24hournpdes@epa.state.oh.us
Central Office:	co24hournpdes@epa.state.oh.us

The permittee shall attach a noncompliance report to the e-mail. A noncompliance report form is available on the following web site under the Monitoring and Reporting - Non-Compliance Notification section:

http://epa.ohio.gov/dsw/permits/individuals.aspx

Or, the permittee may report to the appropriate Ohio EPA district office by telephone toll-free between 8:00 AM and 5:00 PM as follows:

Southeast District Office:	(800) 686-7330
Southwest District Office:	(800) 686-8930
Northwest District Office:	(800) 686-6930
Northeast District Office:	(800) 686-6330
Central District Office:	(800) 686-2330
Central Office:	(614) 644-2001

The permittee shall include the following information in the telephone noncompliance report:

a. The name of the permittee, and a contact name and telephone number;

b. The limit(s) that has been exceeded;

c. The extent of the exceedance(s);

d. The cause of the exceedance(s);

e. The period of the exceedance(s) including exact dates and times;

f. If uncorrected, the anticipated time the exceedance(s) is expected to continue; and,

g. Steps taken to reduce, eliminate or prevent occurrence of the exceedance(s).

B. Other Permit Violations

1. The permittee shall report noncompliance that is the result of any unanticipated bypass resulting in an exceedance of any effluent limit in the permit or any upset resulting in an exceedance of any effluent limit in the permit by e-mail or telephone within twenty-four (24) hours of discovery.

The permittee may report to the appropriate Ohio EPA district office e-mail account as follows (this method is preferred):

Southeast District Office:	sedo24hournpdes@epa.state.oh.us
Southwest District Office:	swdo24hournpdes@epa.state.oh.us
Northwest District Office:	nwdo24hournpdes@epa.state.oh.us
Northeast District Office:	nedo24hournpdes@epa.state.oh.us
Central District Office:	cdo24hournpdes@epa.state.oh.us
Central Office:	co24hournpdes@epa.state.oh.us

The permittee shall attach a noncompliance report to the e-mail. A noncompliance report form is available on the following web site:

http://www.epa.ohio.gov/dsw/permits/permits.aspx

Or, the permittee may report to the appropriate Ohio EPA district office by telephone toll-free between 8:00 AM and 5:00 PM as follows:

Southeast District Office:	(800) 686-7330
Southwest District Office:	(800) 686-8930
Northwest District Office:	(800) 686-6930
Northeast District Office:	(800) 686-6330
Central District Office:	(800) 686-2330
Central Office:	(614) 644-2001

The permittee shall include the following information in the telephone noncompliance report:

a. The name of the permittee, and a contact name and telephone number;

b. The time(s) at which the discharge occurred, and was discovered;

c. The approximate amount and the characteristics of the discharge;

d. The stream(s) affected by the discharge;

e. The circumstances which created the discharge;

f. The name and telephone number of the person(s) who have knowledge of these circumstances;

g. What remedial steps are being taken; and,

h. The name and telephone number of the person(s) responsible for such remedial steps.

2. The permittee shall report noncompliance that is the result of any spill or discharge which may endanger human health or the environment within thirty (30) minutes of discovery by calling the 24-Hour Emergency Hotline toll-free at (800) 282-9378. The permittee shall also report the spill or discharge by e-mail or telephone within twenty-four (24) hours of discovery in accordance with B.1 above.

C. When the telephone option is used for the noncompliance reports required by A and B, the permittee shall submit to the appropriate Ohio EPA district office a confirmation letter and a completed noncompliance report within five (5) days of the discovery of the noncompliance. This follow up report is not necessary for the e-mail option which already includes a completed noncompliance report.

D. If the permittee is unable to meet any date for achieving an event, as specified in a schedule of compliance in their permit, the permittee shall submit a written report to the appropriate Ohio EPA district office within fourteen (14) days of becoming aware of such a situation. The report shall include the following:

1. The compliance event which has been or will be violated;

2. The cause of the violation;

3. The remedial action being taken;

4. The probable date by which compliance will occur; and,

5. The probability of complying with subsequent and final events as scheduled.

E. The permittee shall report all other instances of permit noncompliance not reported under paragraphs A or B of this section on their monthly DMR submission. The DMR shall contain comments that include the information listed in paragraphs A or B as appropriate.

F. If the permittee becomes aware that it failed to submit an application, or submitted incorrect information in an application or in any report to the director, it shall promptly submit such facts or information.

13. RESERVED

14. DUTY TO MITIGATE

The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

15. AUTHORIZED DISCHARGES

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than, or at a level in excess of, that authorized by this permit shall constitute a violation of the terms and conditions of this permit. Such violations may result in the imposition of civil and/or criminal penalties as provided for in Section 309 of the Act and Ohio Revised Code Sections 6111.09 and 6111.99.

16. DISCHARGE CHANGES

The following changes must be reported to the appropriate Ohio EPA district office as soon as practicable:

A. For all treatment works, any significant change in character of the discharge which the permittee knows or has reason to believe has occurred or will occur which would constitute cause for modification or revocation and reissuance. The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements. Notification of permit changes or anticipated noncompliance does not stay any permit condition.

B. For publicly owned treatment works:

1. Any proposed plant modification, addition, and/or expansion that will change the capacity or efficiency of the plant;

2. The addition of any new significant industrial discharge; and

3. Changes in the quantity or quality of the wastes from existing tributary industrial discharges which will result in significant new or increased discharges of pollutants.

C. For non-publicly owned treatment works, any proposed facility expansions, production increases, or process modifications, which will result in new, different, or increased discharges of pollutants.

Following this notice, modifications to the permit may be made to reflect any necessary changes in permit conditions, including any necessary effluent limitations for any pollutants not identified and limited herein. A determination will also be made as to whether a National Environmental Policy Act (NEPA) review will be required. Sections 6111.44 and 6111.45, Ohio Revised Code, require that plans for treatment works or improvements to such works be approved by the Director of the Ohio EPA prior to initiation of construction.

D. In addition to the reporting requirements under 40 CFR 122.41(l) and per 40 CFR 122.42(a), all existing manufacturing, commercial, mining, and silvicultural dischargers must notify the Director as soon as they know or have reason to believe:

1. That any activity has occurred or will occur which would result in the discharge on a routine or frequent basis of any toxic pollutant which is not limited in the permit. If that discharge will exceed the highest of the "notification levels" specified in 40 CFR Sections 122.42(a)(1)(i) through 122.42(a)(1)(iv).

2. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the "notification levels" specified in 122.42(a)(2)(i) through 122.42(a)(2)(iv).

17. TOXIC POLLUTANTS

The permittee shall comply with effluent standards or prohibitions established under Section 307 (a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement. Following establishment of such standards or prohibitions, the Director shall modify this permit and so notify the permittee.

18. PERMIT MODIFICATION OR REVOCATION

A. After notice and opportunity for a hearing, this permit may be modified or revoked, by the Ohio EPA, in whole or in part during its term for cause including, but not limited to, the following:

1. Violation of any terms or conditions of this permit;

2. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

3. Change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge.

B. Pursuant to rule 3745-33-04, Ohio Administrative Code, the permittee may at any time apply to the Ohio EPA for modification of any part of this permit. The filing of a request by the permittee for a permit modification or revocation does not stay any permit condition. The application for modification should be received by the appropriate Ohio EPA district office at least ninety days before the date on which it is desired that the modification become effective. The application shall be made only on forms approved by the Ohio EPA.

19. TRANSFER OF OWNERSHIP OR CONTROL

This permit may be transferred or assigned and a new owner or successor can be authorized to discharge from this facility, provided the following requirements are met:

A. The permittee shall notify the succeeding owner or successor of the existence of this permit by a letter, a copy of which shall be forwarded to the appropriate Ohio EPA district office. The copy of that letter will serve as the permittee's notice to the Director of the proposed transfer. The copy of that letter shall be received by the appropriate Ohio EPA district office sixty (60) days prior to the proposed date of transfer;

B. A written agreement containing a specific date for transfer of permit responsibility and coverage between the current and new permittee (including acknowledgement that the existing permittee is liable for violations up to that date, and that the new permittee is liable for violations from that date on) shall be submitted to the appropriate Ohio EPA district office within sixty days after receipt by the district office of the copy of the letter from the permittee to the succeeding owner;

At anytime during the sixty (60) day period between notification of the proposed transfer and the effective date of the transfer, the Director may prevent the transfer if he concludes that such transfer will jeopardize compliance with the terms and conditions of the permit. If the Director does not prevent transfer, he will modify the permit to reflect the new owner.

20. OIL AND HAZARDOUS SUBSTANCE LIABILITY

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Clean Water Act.

21. SOLIDS DISPOSAL

Collected grit and screenings, and other solids other than sewage sludge, shall be disposed of in such a manner as to prevent entry of those wastes into waters of the state, and in accordance with all applicable laws and rules.

22. CONSTRUCTION AFFECTING NAVIGABLE WATERS

This permit does not authorize or approve the construction of any onshore or offshore physical structures or facilities or the undertaking of any work in any navigable waters.

23. CIVIL AND CRIMINAL LIABILITY

Except as exempted in the permit conditions on UNAUTHORIZED DISCHARGES or UPSETS, nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

24. STATE LAWS AND REGULATIONS

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by Section 510 of the Clean Water Act.

25. PROPERTY RIGHTS

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state, or local laws or regulations.

26. UPSET

The provisions of 40 CFR Section 122.41(n), relating to "Upset," are specifically incorporated herein by reference in their entirety. For definition of "upset," see Part III, Paragraph 1, DEFINITIONS.

27. SEVERABILITY

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

28. SIGNATORY REQUIREMENTS

All applications submitted to the Director shall be signed and certified in accordance with the requirements of 40 CFR 122.22.

All reports submitted to the Director shall be signed and certified in accordance with the requirements of 40 CFR Section 122.22.

29. OTHER INFORMATION

A. Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information.

B. ORC 6111.99 provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $25,000 per violation.

C. ORC 6111.99 states that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit including monitoring reports or reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $25,000 per violation.

D. ORC 6111.99 provides that any person who violates Sections 6111.04, 6111.042, 6111.05, or division (A) of Section 6111.07 of the Revised Code shall be fined not more than $25,000 or imprisoned not more than one year, or both.

30. NEED TO HALT OR REDUCE ACTIVITY

40 CFR 122.41(c) states that it shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with conditions of this permit.

31. APPLICABLE FEDERAL RULES

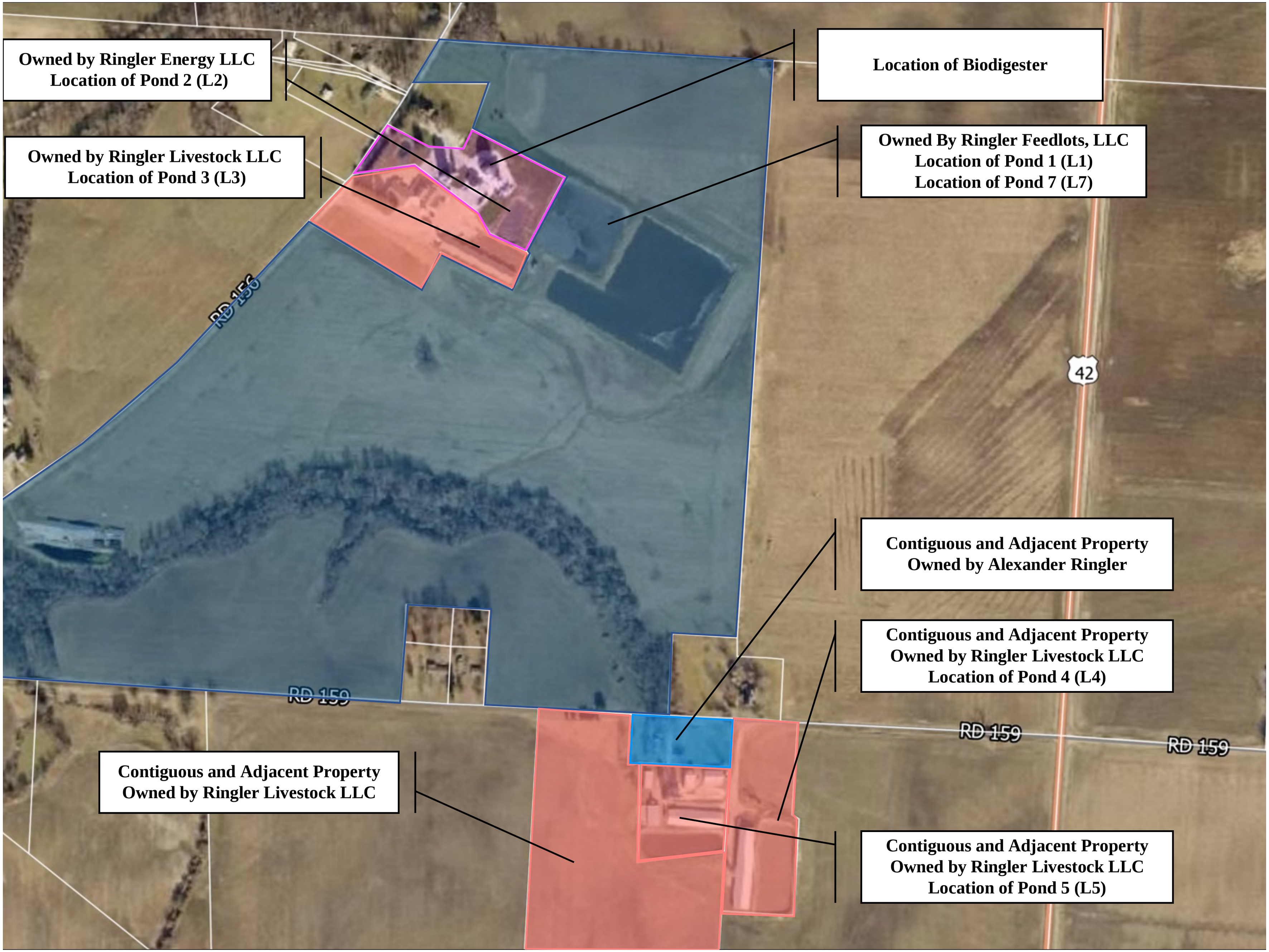
All references to 40 CFR in this permit mean the version of 40 CFR which is effective as of the effective date of this permit.

32. AVAILABILITY OF PUBLIC SEWERS

Not withstanding the issuance or non-issuance of an NPDES permit to a semi-public disposal system, whenever the sewage system of a publicly owned treatment works becomes available and accessible, the permittee operating any semi-public disposal system shall abandon the semi-public disposal system and connect it into the publicly owned treatment works.

Appendix B

Map of Emerald Digestate Storage Ponds


Owned by Ringler Energy LLC
Location of Pond 2 (L2)
Owned by Ringler Livestock LLC
Location of Pond 3 (L3)
Location of Biodigester
Owned By Ringler Feedlots, LLC
Location of Pond 1 (L1)
Location of Pond 7 (L7)
RD 156
42
Contiguous and Adjacent Property
Owned by Alexander Ringler
Contiguous and Adjacent Property
Owned by Ringler Livestock LLC
Location of Pond 4 (L4)
RD 159
RD 159
RD 159
Contiguous and Adjacent Property
Owned by Ringler Livestock LLC
Contiguous and Adjacent Property
Owned by Ringler Livestock LLC
Location of Pond 5 (L5)

Appendix C

Emerald Bioenergy, LLC
PTIO Number P0125003

Ohio Environmental Protection Agency

John R. Kasich, Governor
Mary Taylor, Lt. Governor
Craig W. Butler, Director

11/19/2018

Certified Mail

No	TOXIC REVIEW
No	SYNTHETIC MINOR TO AVOID MAJOR NSR
No	CEMS
No	MACT/GACT
No	NSPS
No	NESHAPS
No	NETTING
No	MODELING SUBMITTED
No	SYNTHETIC MINOR TO AVOID TITLE V
No	FEDERALLY ENFORCABLE PTIO (FEPTIO)
No	SYNTHETIC MINOR TO AVOID MAJOR GHG

Alex Ringler
Emerald Bioenergy, LLC formerly Ringler Energy, LLC
461 State Route 61
Marengo, OH 43334

RE: FINAL AIR POLLUTION PERMIT-TO-INSTALL AND OPERATE
Facility ID: 0159000407
Permit Number: P0125003
Permit Type: Initial Installation
County: Morrow

Dear Permit Holder:

Enclosed please find a final Ohio Environmental Protection Agency (EPA) Air Pollution Permit-to-Install and Operate (PTIO) which will allow you to install, modify, and/or operate the described emissions unit(s) in the manner indicated in the permit. Because this permit contains conditions and restrictions, please read it very carefully. In this letter you will find the information on the following topics:

- **How to appeal this permit**
- **How to save money, reduce pollution and reduce energy consumption**
- **How to give us feedback on your permitting experience**
- **How to get an electronic copy of your permit**
- **What should you do if you notice a spill or environmental emergency?**

How to appeal this permit

The issuance of this PTIO is a final action of the Director and may be appealed to the Environmental Review Appeals Commission pursuant to Section 3745.04 of the Ohio Revised Code. The appeal must be in writing and set forth the action complained of and the grounds upon which the appeal is based. The appeal must be filed with the Commission within thirty (30) days after notice of the Director's action. The appeal must be accompanied by a filing fee of $70.00, made payable to "Ohio Treasurer Josh Mandel," which the Commission, in its discretion, may reduce if by affidavit you demonstrate that payment of the full amount of the fee would cause extreme hardship. Notice of the filing of the appeal shall be filed with the Director within three (3) days of filing with the Commission. Ohio EPA requests that a copy of the appeal be served upon the Ohio Attorney General's Office, Environmental Enforcement Section. An appeal may be filed with the Environmental Review Appeals Commission at the following address:

Environmental Review Appeals Commission
30 East Broad Street, 4th Floor
Columbus, OH 43215

How to save money, reduce pollution and reduce energy consumption

The Ohio EPA is encouraging companies to investigate pollution prevention and energy conservation. Not only will this reduce pollution and energy consumption, but it can also save you money. If you would like to learn ways you can save money while protecting the environment, please contact our Office of Compliance Assistance and Pollution Prevention at (614) 644-3469. Additionally, all or a portion of the capital expenditures related to installing air pollution control equipment under this permit may be eligible for financing and State tax exemptions through the Ohio Air Quality Development Authority (OAQDA) under Ohio Revised Code Section 3706. For more information, see the OAQDA website: www.ohioairquality.org/clean_air

How to give us feedback on your permitting experience

Please complete a survey at www.epa.ohio.gov/survey.aspx and give us feedback on your permitting experience. We value your opinion.

How to get an electronic copy of your permit

This permit can be accessed electronically via the eBusiness Center: Air Services in Microsoft Word format or in Adobe PDF on the Division of Air Pollution Control (DAPC) Web page, www.epa.ohio.gov/dapc by clicking the "Search for Permits" link under the Permitting topic on the Programs tab.

What should you do if you notice a spill or environmental emergency?

Any spill or environmental emergency which may endanger human health or the environment should be reported to the Emergency Response 24-HOUR EMERGENCY SPILL HOTLINE toll-free at (800) 282-9378. Report non-emergency complaints to the appropriate district office or local air agency.

If you have any questions regarding your permit, please contact Ohio EPA DAPC, Central District Office at (614)728-3778 or the Office of Compliance Assistance and Pollution Prevention at (614) 644-3469.

Sincerely,

Michael E. Hopkins

Michael E. Hopkins, P.E.
Assistant Chief, Permitting Section, DAPC

Cc: Ohio EPA-CDO

Ohio Environmental
Protection Agency

FINAL

Division of Air Pollution Control
Permit-to-Install and Operate

for

Emerald Bioenergy, LLC formerly Ringler Energy, LLC

Facility ID:	0159000407
Permit Number:	P0125003
Permit Type:	Initial Installation
Issued:	11/19/2018
Effective:	11/19/2018
Expiration:	11/19/2028

Ohio Environmental Protection Agency

Division of Air Pollution Control
Permit-to-Install and Operate

for

Emerald Bioenergy, LLC formerly Ringler Energy, LLC

Table of Contents

Authorization

Facility ID:	0159000407
Application Number(s):	A0061467
Permit Number:	P0125003
Permit Description:	PTIO for two units: anaerobic digester, and digester gas-fired engine.
Permit Type:	Initial Installation
Permit Fee:	$800.00
Issue Date:	11/19/2018
Effective Date:	11/19/2018
Expiration Date:	11/19/2028
Permit Evaluation Report (PER) Annual Date:	Jan 1 - Dec 31, Due Feb 15

This document constitutes issuance to:

Emerald Bioenergy, LLC formerly Ringler Energy, LLC
2881 CR 156
Cardington, OH 43315

of a Permit-to-Install and Operate for the emissions unit(s) identified on the following page.

Ohio Environmental Protection Agency (EPA) District Office or local air agency responsible for processing and administering your permit:

Ohio EPA DAPC, Central District Office
50 West Town St., 5th Floor
P.O. Box 1049
Columbus, OH 43216-1049
(614)728-3778

The above named entity is hereby granted this Permit-to-Install and Operate for the air contaminant source(s) (emissions unit(s)) listed in this section pursuant to Chapter 3745-31 of the Ohio Administrative Code. Issuance of this permit does not constitute expressed or implied approval or agreement that, if constructed or modified in accordance with the plans included in the application, the described emissions unit(s) will operate in compliance with applicable State and federal laws and regulations.

This permit is granted subject to the conditions attached hereto.

Ohio Environmental Protection Agency

Craig W. Butler

Craig W. Butler
Director

Authorization (continued)

Permit Number: P0125003
Permit Description: PTIO for two units: anaerobic digester, and digester gas-fired engine.

Permits for the following Emissions Unit(s) or groups of Emissions Units are in this document as indicated below:

Emissions Unit ID:	**B003**
Company Equipment ID:	Engine #1
Superseded Permit Number:	
General Permit Category and Type:	Not Applicable
Emissions Unit ID:	**P001**
Company Equipment ID:	P001
Superseded Permit Number:	
General Permit Category and Type:	Not Applicable

A. Standard Terms and Conditions

1. What does this permit-to-install and operate ("PTIO") allow me to do?

This permit allows you to install and operate the emissions unit(s) identified in this PTIO. You must install and operate the unit(s) in accordance with the application you submitted and all the terms and conditions contained in this PTIO, including emission limits and those terms that ensure compliance with the emission limits (for example, operating, recordkeeping and monitoring requirements).

2. Who is responsible for complying with this permit?

The person identified on the "Authorization" page, above, is responsible for complying with this permit until the permit is revoked, terminated, or transferred. "Person" means a person, firm, corporation, association, or partnership. The words "you," "your," or "permittee" refer to the "person" identified on the "Authorization" page above.

The permit applies only to the emissions unit(s) identified in the permit. If you install or modify any other equipment that requires an air permit, you must apply for an additional PTIO(s) for these sources.

3. What records must I keep under this permit?

You must keep all records required by this permit, including monitoring data, test results, strip-chart recordings, calibration data, maintenance records, and any other record required by this permit for five years from the date the record was created. You can keep these records electronically, provided they can be made available to Ohio EPA during an inspection at the facility. Failure to make requested records available to Ohio EPA upon request is a violation of this permit requirement.

4. What are my permit fees and when do I pay them?

There are two fees associated with permitted air contaminant sources in Ohio:

PTIO fee. This one-time fee is based on a fee schedule in accordance with Ohio Revised Code (ORC) section 3745.11, or based on a time and materials charge for permit application review and permit processing if required by the Director.

You will be sent an invoice for this fee after you receive this PTIO and payment is due within 30 days of the invoice date. You are required to pay the fee for this PTIO even if you do not install or modify your operations as authorized by this permit.

Annual emissions fee. Ohio EPA will assess a separate fee based on the total annual emissions from your facility. You self-report your emissions in accordance with Ohio Administrative Code (OAC) Chapter 3745-78. This fee assessed is based on a fee schedule in ORC section 3745.11 and funds Ohio EPA's permit compliance oversight activities. For facilities that are permitted as synthetic minor sources, the fee schedule is adjusted annually for inflation. Ohio EPA will notify you when it is time to report your emissions and to pay your annual emission fees.

5. When does my PTIO expire, and when do I need to submit my renewal application?

This permit expires on the date identified at the beginning of this permit document (see "Authorization" page above) and you must submit a renewal application to renew the permit. Ohio EPA will send a renewal notice to you approximately six months prior to the expiration date of this permit. However, it is very important that you submit a complete renewal permit application (postmarked prior to expiration of this permit) even if you do not receive the renewal notice.

If a complete renewal application is submitted before the expiration date, Ohio EPA considers this a timely application for purposes of ORC section 119.06, and you are authorized to continue operating the emissions unit(s) covered by this permit beyond the expiration date of this permit until final action is taken by Ohio EPA on the renewal application.

6. What happens to this permit if my project is delayed or I do not install or modify my source?

This PTIO expires 18 months after the issue date identified on the "Authorization" page above unless otherwise specified if you have not (1) started constructing the new or modified emission sources identified in this permit, or (2) entered into a binding contract to undertake such construction. This deadline can be extended by up to 12 months, provided you apply to Ohio EPA for this extension within a reasonable time before the 18-month period has ended and you can show good cause for any such extension.

7. What reports must I submit under this permit?

An annual permit evaluation report (PER) is required in addition to any malfunction reporting required by OAC rule 3745-15-06 or other specific rule-based reporting requirement identified in this permit. Your PER due date is identified in the Authorization section of this permit.

8. If I am required to obtain a Title V operating permit in the future, what happens to the operating provisions and PER obligations under this permit?

If you are required to obtain a Title V permit under OAC Chapter 3745-77 in the future, the permit-to-operate portion of this permit will be superseded by the issued Title V permit. From the effective date of the Title V permit forward, this PTIO will effectively become a PTI (permit-to-install) in accordance with OAC rule 3745-31-02(B). The following terms and conditions of this permit will no longer be applicable after issuance of the Title V permit: Section B, Term 1.b) and Section C, for each emissions unit, Term a)(2).

The PER requirements in this permit remain effective until the date the Title V permit is issued and is effective, and cease to apply after the effective date of the Title V permit. The final PER obligation will cover operations up to the effective date of the Title V permit and must be submitted on or before the submission deadline identified in this permit on the last day prior to the effective date of the Title V permit.

9. What are my obligations when I perform scheduled maintenance on air pollution control equipment?

You must perform scheduled maintenance of air pollution control equipment in accordance with OAC rule 3745-15-06(A). If scheduled maintenance requires shutting down or bypassing any air pollution control equipment, you must also shut down the emissions unit(s) served by the air pollution control equipment during maintenance, unless the conditions of OAC rule 3745-15-06(A)(3) are met. Any emissions that exceed permitted amount(s) under this permit (unless specifically exempted by rule) must be reported as deviations in the annual permit evaluation report (PER), including nonexempt excess emissions that occur during approved scheduled maintenance.

10. Do I have to report malfunctions of emissions units or air pollution control equipment? If so, how must I report?

If you have a reportable malfunction of any emissions unit(s) or any associated air pollution control system, you must report this to the [DO/LAA] in accordance with OAC rule 3745-15-06(B). Malfunctions that must be reported are those that result in emissions that exceed permitted emission levels. It is your responsibility to evaluate control equipment breakdowns and operational upsets to determine if a reportable malfunction has occurred.

If you have a malfunction, but determine that it is not a reportable malfunction under OAC rule 3745-15-06(B), it is recommended that you maintain records associated with control equipment breakdown or process upsets. Although it is not a requirement of this permit, Ohio EPA recommends that you maintain records for non-reportable malfunctions.

11. Can Ohio EPA or my local air agency inspect the facility where the emission unit(s) is/are located?

Yes. Under Ohio law, the Director or his authorized representative may inspect the facility, conduct tests, examine records or reports to determine compliance with air pollution laws and regulations and the terms and conditions of this permit. You must provide, within a reasonable time, any information Ohio EPA requests either verbally or in writing.

12. What happens if one or more emissions units operated under this permit is/are shut down permanently?

Ohio EPA can terminate the permit terms associated with any permanently shut down emissions unit. "Shut down" means the emissions unit has been physically removed from service or has been altered in such a way that it can no longer operate without a subsequent "modification" or "installation" as defined in OAC Chapter 3745-31.

You should notify Ohio EPA of any emissions unit that is permanently shut down by submitting a certification that identifies the date on which the emissions unit was permanently shut down. The certification must be submitted by an authorized official from the facility. You cannot continue to operate an emission unit once the certification has been submitted to Ohio EPA by the authorized official.

You must comply with all recordkeeping and reporting for any permanently shut down emissions unit in accordance with the provisions of the permit, regulations or laws that were enforceable during the period of operation, such as the requirement to submit a PER, air fee emission report, or malfunction report. You must also keep all records relating to any permanently shutdown emissions unit, generated while the emissions unit was in operation, for at least five years from the date the record was generated.

Again, you cannot resume operation of any emissions unit certified by the authorized official as being permanently shut down without first applying for and obtaining a permit pursuant to OAC Chapter 3745-31.

13. Can I transfer this permit to a new owner or operator?

You can transfer this permit to a new owner or operator. If you transfer the permit, you must follow the procedures in OAC Chapter 3745-31, including notifying Ohio EPA or the local air agency of the change in ownership or operator. Any transferee of this permit must assume the responsibilities of the transferor permit holder.

14. Does compliance with this permit constitute compliance with OAC rule 3745-15-07, "air pollution nuisance"?

This permit and OAC rule 3745-15-07 prohibit operation of the air contaminant source(s) regulated under this permit in a manner that causes a nuisance. Ohio EPA can require additional controls or modification of the requirements of this permit through enforcement orders or judicial enforcement action if, upon investigation, Ohio EPA determines existing operations are causing a nuisance.

15. What happens if a portion of this permit is determined to be invalid?

If a portion of this permit is determined to be invalid, the remainder of the terms and conditions remain valid and enforceable. The exception is where the enforceability of terms and conditions are dependent on the term or condition that was declared invalid.

B. Facility-Wide Terms and Conditions

1. This permit document constitutes a permit-to-install issued in accordance with ORC 3704.03(F) and a permit-to-operate issued in accordance with ORC 3704.03(G).

    a) For the purpose of a permit-to-install document, the facility-wide terms and conditions identified below are federally enforceable with the exception of those listed below which are enforceable under state law only.

        (1) None.

    b) For the purpose of a permit-to-operate document, the facility-wide terms and conditions identified below are enforceable under state law only with the exception of those listed below which are federally enforceable.

        (1) None.

2. The Ohio EPA has determined that this facility is subject to the requirements of 40 CFR Part 63, Subpart ZZZZ - National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. Although Ohio EPA has determined that this Generally Available Control Technology NESHAP (GACT) applies, at this time Ohio EPA does not have the authority to enforce this standard. Instead, U.S. EPA has the authority to enforce this standard. Please be advised, that all requirements associated with this rule are in effect and shall be enforced by U.S. EPA. For more information on the area source rules, please refer to the following U.S. EPA website: http://www.epa.gov/ttn/atw/area/arearules.html.

3. The emissions unit, B003, contained in this permit are subject to 40 CFR Part 60, Subpart JJJJ - Standards of Performance (NSPS) for Stationary Spark Ignition (SI) Internal Combustion Engines (ICE). The complete NSPS requirements may be accessed via the internet from the Electronic Code of Federal Regulations (e-CFR) website http://www.ecfr.gov.

C. Emissions Unit Terms and Conditions

1. B003, Engine #1

Operations, Property and/or Equipment Description:

2001 Guascor SI RICE – fueled with digester gas (1,215 HP; 904 KW and Input at 8.42 mmBtu/hr)

a) This permit document constitutes a permit-to-install issued in accordance with ORC 3704.03(F) and a permit-to-operate issued in accordance with ORC 3704.03(G).

(1) For the purpose of a permit-to-install document, the emissions unit terms and conditions identified below are federally enforceable with the exception of those listed below which are enforceable under state law only.

a. See b)(1)b., b)(1)h., and d)7.

(2) For the purpose of a permit-to-operate document, the emissions unit terms and conditions identified below are enforceable under state law only with the exception of those listed below which are federally enforceable.

a. None.

b) Applicable Emissions Limitations and/or Control Requirements

(1) The specific operation(s), property, and/or equipment that constitute each emissions unit along with the applicable rules and/or requirements and with the applicable emissions limitations and/or control measures are identified below. Emissions from each unit shall not exceed the listed limitations, and the listed control measures shall be specified in narrative form following the table.

	Applicable Rules/Requirements	Applicable Emissions Limitations/Control Measures
a.	OAC rule 3745-31-05(A)(3), as effective June 30, 2008	The nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compound (VOC) standards established pursuant to this rule are equivalent to the standards established in 40 CFR Part 60, Subpart JJJJ. Emissions of sulfur dioxide (SO_2) shall not exceed 0.33 pounds per million Btu (lb/mmBtu). The particulate emissions (PE) standard established pursuant to this rule is equivalent to the standards established in OAC rule 3745-17-11(B)(5)(b). See b)(2)a., c)(1), and c)(2) .

	Applicable Rules/Requirements	Applicable Emissions Limitations/Control Measures
b.	OAC rule 3745-31-05(A)(3)(a)(ii), as effective June 30, 2008	The Best Available Technology (BAT) requirements under 3745-31-05(A)(3) do not apply to PE since the potential to emit is less than 10 tons per year. See b)(2)b.
c.	OAC rule 3745-17-07(A)(1)	Visible PE from any stack shall not exceed 20% opacity, as a 6-minute average, except as provided by rule.
d.	OAC rule 3745-17-11(B)(5)(b)	PE shall not exceed 0.062 pound per million Btu (lb/mmBtu) of actual heat input for a stationary large internal combustion engine.
e.	OAC rule 3745-18-06(B)	See b)(2)c.
f.	40 CFR Part 60, Subpart JJJJ [In accordance with 40 CFR 60.4230(a)(5), this emissions unit is a spark ignition landfill/digester gas lean burn engine greater than or equal to 500 horsepower (HP) and less than 1,350 HP] Emission standards for NO_x, CO, and VOC adapted from Table 1 to Subpart JJJJ of Part 60.	The exhaust emissions from this engine shall not exceed the following when burning digester gas: Emissions of nitrogen oxides (NO_X) shall not exceed 2.0 gram per horsepower–hour (g/hp-hr) or 150 ppmvd at 15% O_2. Emissions of carbon monoxide (CO) shall not exceed 5.0 g/hp-hr or 610 ppmvd at 15% O_2. Emissions of volatile organic compounds (VOC) shall not exceed 1.0 g/hp-hr or 80 ppmvd at 15% O_2. See b)(2)d and b)(2)e.
g.	40 CFR 60.1 – 19 (40 CFR 60.4246)	Table 3 to Subpart JJJJ of 40 CFR Part 60 – Applicability of Subpart A to Subpart JJJJ shows which parts of the General Provisions in 40 CFR 60.1-19 apply.
h.	OAC rule 3745-114-01	See d)(7).

(2) Additional Terms and Conditions

a. This Best Available Technology (BAT) emission limit applies until U.S. EPA approves Ohio Administrative Code (OAC) paragraph 3745-31-05(A)(3)(a)(ii) (the less than 10 tons per year BAT exemption) into the Ohio State Implementation Plan (SIP).

b. These requirements apply once U.S. EPA approves OAC rule 3745-31-05(A)(3)(a)(ii) (the less than 10 tons per year BAT exemption) into the Ohio State Implementation Plan (SIP).

c. Stationary internal combustion engines (ICE) equal to, or less than, ten (10) mmBtu per hour total rated heat input capacity are exempt from paragraphs (D), (F) and (G) of this rule and from rules 3745-18-07 to 3745-18-94 of the Administrative Code.

d. The spark ignition (SI) ICE is subject to and shall be operated in compliance with the requirements of 40 CFR Part 60, Subpart JJJJ, the standards of performance for stationary SI ICE. The engine shall be certified by the manufacturer to meet the applicable limits of 40 CFR 60.4231.

If the engine was not certified at the factory, the emission standard for the “owner/operator” should be referenced as from 60.4233(e).

e. The permittee shall comply with the applicable requirements under 40 CFR Part 60, Subpart JJJJ, including the following sections.

60.4233	Emission standards
60.4243(b)	Demonstrate compliance

c) Operational Restrictions

(1) The permittee shall burn only natural gas, or digester gas with a minimum heat content of 500 Btu / scf, in this emissions unit.

(2) Digester gas combusted in this emissions unit shall not exceed 1,000 parts per million on a volume basis (ppm_v) of hydrogen sulfide.

d) Monitoring and/or Recordkeeping Requirements

(1) The permittee shall perform daily checks, when the emissions unit is in operation firing digester gas and when the weather conditions allow, for any visible particulate emissions from the stack serving this emissions unit. The presence or absence of any visible emissions shall be noted in an operations log. If visible emissions are observed, the permittee shall also note the following in the operations log:

a. the color of the emissions;

b. whether the emissions are representative of normal operations;

c. if the emissions are not representative of normal operations, the cause of the abnormal emissions;

d. the total duration of any visible emission incident; and

e. any corrective actions taken to minimize or eliminate the visible emissions.

If visible emissions are present, a visible emission incident has occurred. The observer does not have to document the exact start and end times for the visible emission incident under item (d) above or continue the daily check until the incident has ended. The observer may indicate that the visible emission incident was continuous during the observation period (or, if known, continuous during the operation of the emissions unit). With respect to the documentation of corrective actions, the observer may indicate that no corrective actions were taken if the visible emissions were representative of normal operations, or specify the minor corrective actions that were taken to ensure that the emissions unit continued to operate under normal conditions, or specify the corrective actions that were taken to eliminate abnormal visible emissions.

(2) For each day during which the permittee burns a fuel other than natural gas and/or digester gas, the permittee shall maintain a record of the type and quantity of fuel burned in this emissions unit.

(3) The permittee shall maintain monthly records of the natural gas and digester gas fuel usage in this unit in millions of standard cubic feet (MMSCF).

(4) The permittee shall maintain monthly records of the heat content of the digester gas, in Btu / scf.

(5) The permittee shall monitor and record hydrogen sulfide concentrations when operating the emissions unit with digester gas using one of the two following options:

Option 1: Weekly sampling using a gas detector tube or portable gas monitoring meter. The permittee shall perform monitoring in accordance with the manufacturer's instructions for use of the associated sampling system. Any deviations from the manufacturer's instructions should be recorded with the concentration results of the sampling.

Option 2: Continuous digester gas monitoring system. The permittee may install a sampling and analysis system to continuously monitor and record the H_2S content of the digester gas. The permittee shall properly install, operate, and maintain a continuous digester gas H_2S monitoring device and recorder that measures and records the H_2S concentrations in the digester gas when the emissions unit is in operation, including periods of startup and shutdown. The H_2S monitoring device and recorder shall be capable of satisfying the performance requirements specified in 40 CFR Part 60, Appendix B, Performance Specification 5 and shall be capable of accurately measuring the H_2S concentration. The H_2S monitoring device and recorder shall be installed, calibrated, operated, and maintained in accordance with the manufacturer's recommendations, instructions, and the operating manuals, with any modifications deemed necessary by the permittee.

Whenever the monitored value for hydrogen sulfide exceeds the lower limit of the accuracy of the monitoring system as measured by either of the above monitoring options, the permittee shall promptly investigate the cause of the deviation. The permittee shall maintain records of the following information for each investigation:

a. the date and time the deviation began;

b. the magnitude of the deviation at that time;

c. the date the investigation was conducted;

d. the name(s) of the personnel who conducted the investigation; and

e. the findings and recommendations.

In response to each required investigation to determine the cause of a deviation, the permittee shall take prompt corrective action to bring the hydrogen sulfide concentration below the maximum limit specified in this permit, unless the permittee determines that corrective action is not necessary and documents the reasons for that determination and the date and time the deviation ended. The permittee shall maintain records of the following information for each corrective action taken:

f. a description of the corrective action;

g. the date the corrective action was completed;

h. the date and time the deviation ended;

i. the total period of time (in minutes) during which there was a deviation;

j. hydrogen sulfide readings immediately after the corrective action was implemented; and

k. the name(s) of the personnel who performed the work.

Investigation and records required by this paragraph do not eliminate the need to comply with the requirements of OAC rule 3745-15-06 if it is determined that a malfunction has occurred.

(6) The permittee shall comply with the applicable monitoring and record keeping requirements under 40 CFR Part 60, Subpart JJJJ, including the following sections.

60.4243(e)	Emergency operations, special record keeping
60.4245(a)	Record keeping requirements

(7) Modeling to demonstrate compliance with, the Toxic Air Contaminant Statute, ORC 3704.03(F)(4)(b), was not necessary because the emissions units maximum annual emissions for each toxic air contaminant, as defined in OAC rule 3745-114-01, will be less than 1.0 ton per year. OAC Chapter 3745-31 requires permittees to apply for and obtain a new or modified permit to install prior to making a "modification" as defined by OAC rule 3745-31-01. The permittee is hereby advised that changes in the composition of the materials, or use of new materials, that would cause the emissions of any toxic air

contaminant to increase to above 1.0 ton per year may require the permittee to apply for and obtain a new permit to install.

e) Reporting Requirements

(1) The reports required by this permit may be submitted through Ohio EPA's eBusiness Center: Air Services online web portal; or they may be mailed as a hard copy to Ohio EPA Central District Office.

(2) The permittee shall submit an annual Permit Evaluation Report (PER) to Ohio EPA Central District Office by the due date identified in the Authorization section of this permit. The PER shall cover a reporting period of no more than twelve months for each air contaminant source identified in this permit.

(3) The permittee shall identify the following information in the annual permit evaluation report in accordance with the monitoring requirements in d)(1), d)(2), d)(4) and d)(5):

a. all periods of time during which the permittee burns a fuel other than natural gas or digester gas in this emissions unit and the type and quantity of fuel burned;

b. each month during which digester gas with a minimum heat content of less than 500 Btu / scf was burned in this emissions unit;

c. each period during which digester gas containing an H_2S concentration greater than allowed by 1,000 ppmv was burned;

d. all days during which any visible particulate emissions were observed from the stack serving this emissions unit; and,

e. any corrective actions taken to minimize or eliminate the visible particulate emissions.

(4) The permittee shall submit reports and such other notifications to the Ohio EPA as are required pursuant to 40 CFR Part 60, Subpart JJJJ, per the following sections:

60.4245(c)	Reporting requirements
60.4245(d)	Reporting requirements

These reports and other notifications shall be submitted to Ohio EPA Central District Office.

f) Testing Requirements

(1) Compliance with the Emissions Limitations and/or Control Requirements specified in section b) of these terms and conditions shall be determined in accordance with the following methods:

a. Emissions Limitation:
SO_2 shall not exceed 0.33 lb/mmBtu

Applicable Compliance Method:
The permittee shall demonstrate compliance with the emissions limitation through the required monitoring and recordkeeping in d)(5) and using the following equation:

$E = (1 / \text{digester gas heat content}) * (10^6 \text{ Btu} / 1 \text{ mmBtu}) * (H_2S \text{ ppm}_V / 1{,}000{,}000) * 0.088 \text{ lb } H_2S/\text{ft}^3 \ H_2S * 1.88 \text{ lb } SO_2/\text{lb } H_2S = SO_2 \text{ lb/hr}$

Where:

E = SO_2 emissions rate, lb/mmBtu

Digester gas heat content = average heat content of digester gas in Btu/scf from d)(4).

H_2S ppm_V = average concentration of H_2S in digester gas, from d)(5).

If required, sulfur dioxide emissions shall be determined according to test Methods 1 - 4, and 6 as set forth in 40 CFR, Part 60 Appendix A.

b. Emissions Limitation:

Visible PE shall not exceed 20% opacity as a six-minute average, except as provided by rule.

Applicable Compliance Method:

If required, compliance with the stack visible particulate emissions limitation shall be determined through visible emissions observations performed in accordance with U.S. EPA Method 9.

c. Emission Limitations:

PE shall not exceed 0.062 lb/mmBtu.

Applicable Compliance Method:

If required, compliance with the particulate emissions limitation shall be determined in accordance with U.S. EPA Reference Methods 1-4 and 5, as applicable, of 40 CFR Part 60, Appendix A.

d. Emission Limitations:

The exhaust emissions from this engine when burning biodigester gas shall not exceed:

3.0 g/hp-hr or 220 ppmvd at 15% O_2 of NOx
5.0 g/hp-hr or 610 ppmvd at 15% O_2 of CO

1.0 g/hp-hr or 80 ppmvd at 15% O_2 of VOC

Applicable Compliance Method:
Compliance with the emission standards shall be demonstrated in accordance with the testing requirements in section f)(2).

(2) The permittee shall conduct, or have conducted, emission testing for this emissions unit in accordance with the procedures specified in 40 CFR 60.4244 and the following requirements:

a. The emission testing shall be conducted within 180 days after issuance of the permit. Subsequent performance testing shall be conducted every 8,760 hours of engine operation or 3 years, whichever comes first.

b. Each performance test conducted shall be conducted within 10% and 100% peak (or the highest achievable) load and according to the requirements in 40 CFR 60.8 and under specific conditions that are specified by Table 2 of Subpart JJJJ.

c. The following test method(s) shall be employed, in accordance with **Table 2 of Subpart JJJJ**, to demonstrate compliance with the allowable mass emission rates:

i. Method 1 or 1A of 40 CFR Part 60, Appendix A or ASTM Method D6522-00 to select the sampling port location and the number of traverse points.

ii. Method 2 of 40 CFR Part 60, Appendix A or Method 19 of 40 CFR Part 60, Appendix A to determine the exhaust flowrate of the engine.

iii. Method 3, 3A, or 3B of 40 CFR Part 60, Appendix A or ASTM Method D6522-00 to measure O_2 at the exhaust stack.

iv. Method 4 of 40 CFR Part 60, Appendix A; or Method 320 of 40 CFR Part 63, Appendix A; or ASTM D6348-03 to measure the moisture content at the exhaust stack.

v. Method 10 of 40 CFR Part 60, Appendix A; or Method 320 of 40 CFR Part 63, Appendix A; or ASTM Method D6522-00; or ASTM D6348-03 to measure CO at the exhaust stack.

vi. Method 7E of 40 CFR Part 60, Appendix A; or Method 320 of 40 CFR Part 63, Appendix A; or ASTM Method D6522-00; or ASTM D6348-03 to measure NOx at the exhaust stack.

vii. Method 25A with Method 18 (for methane or ethane determination and subsequent subtraction from THC determined via Method 25A) of 40 CFR Part 60, Appendix A; or Method 25A fitted with a hydrocarbon cutter as described in 40 CFR 1065.265; or Method 18 of 40 CFR 60, Appendix A; or Method 320 of 40 CFR Part 63, Appendix A; or ASTM D6348-03 to measure VOC at the exhaust stack.

d. During the emission testing, the emissions unit shall be operated under operational conditions approved in advance by Ohio EPA Central District Office. Operational conditions that may need to be approved include, but are not limited to, the production rate, the type of material processed, material make-up (digester gas or natural gas, etc.), or control equipment operational limitations (power output, fuel consumption rate, etc.). In general, testing shall be done under “worst case” conditions expected during the life of the permit. As part of the information provided in the “Intent to Test” notification form described below, the permittee shall provide a description of the emissions unit operational conditions they will meet during the emissions testing and describe why they believe “worst case” operating conditions will be met. Prior to conducting the test(s), the permittee shall confirm with Ohio EPA Central District Office that the proposed operating conditions constitute “worst case”. Failure to test under the approved conditions may result in Ohio EPA not accepting the test results as a demonstration of compliance.

e. Not later than 60 days prior to the proposed test date(s), the permittee shall submit an "Intent to Test" notification to Ohio EPA Central District Office. The "Intent to Test" notification shall describe in detail the proposed test methods and procedures, the emissions unit operating parameters, the time(s) and date(s) of the test(s), and the person(s) who will be conducting the test(s). Failure to submit such notification for review and approval prior to the test(s) may result in Ohio EPA Central District Office's refusal to accept the results of the emission test(s).

f. Personnel from Ohio EPA Central District Office shall be permitted to witness the test(s), examine the testing equipment, and acquire data and information necessary to ensure that the operation of the emissions unit and the testing procedures provide a valid characterization of the emissions from the emissions unit and/or the performance of the control equipment.

g. A comprehensive written report on the results of the emission test(s) shall be signed by the person or persons responsible for the tests and submitted to Ohio EPA Central District Office within 30 days following completion of the test(s). The permittee may request additional time for the submittal of the written report, where warranted, with prior approval from Ohio EPA Central District Office.

g) Miscellaneous Requirements

(1) None.

2. P001, Flare

Operations, Property and/or Equipment Description:

Anaerobic Digester - 14.52 mmBtu/hr Flare

a) This permit document constitutes a permit-to-install issued in accordance with ORC 3704.03(F) and a permit-to-operate issued in accordance with ORC 3704.03(G).

(1) For the purpose of a permit-to-install document, the emissions unit terms and conditions identified below are federally enforceable with the exception of those listed below which are enforceable under state law only.

a. b)(1)b.,and b)(2)b.

(2) For the purpose of a permit-to-operate document, the emissions unit terms and conditions identified below are enforceable under state law only with the exception of those listed below which are federally enforceable.

a. None.

b) Applicable Emissions Limitations and/or Control Requirements

(1) The specific operation(s), property, and/or equipment that constitute each emissions unit along with the applicable rules and/or requirements and with the applicable emissions limitations and/or control measures are identified below. Emissions from each unit shall not exceed the listed limitations, and the listed control measures shall be specified in narrative form following the table.

	Applicable Rules/Requirements	Applicable Emissions Limitations/Control Measures
a.	OAC rule 3745-31-05(A)(3), as effective June 30, 2008	Emissions of carbon monoxide (CO) shall not exceed 0.31 pounds per million BTU (lb/mmBtu). Emissions of volatile organic compounds (VOC) shall not exceed 0.66 lb/mmBtu. Emissions of sulfur dioxide (SO_2) shall not exceed 0.33 lb/mmBtu. Emissions of nitrogen oxides (NOx) shall not exceed 0.068 lb/mmBtu. See b)(2)a., b(2)c. b)(2)g., c)(1), and c)(2).
b.	OAC rule 3745-31-05(A)(3)(a)(ii), as effective June 30, 2008	The Best Available Technology (BAT) requirements under OAC rule 3745-31-05(A)(3) do not apply to the NOx emissions from this air contaminant

	Applicable Rules/Requirements	Applicable Emissions Limitations/Control Measures
		source since the potential to emit is less than 10 tons/year. See b)(2)b.
c.	OAC rule 3745-17-11(B)	See b)(2)f.
d.	OAC rule 3745-17-07(A)	See b)(2)g.
e.	OAC rule 3745-18-06(E)	The emission limitations of this rule are less stringent than the emission limitations established by OAC rule 3745-31-05(A)(3).

(2) Additional Terms and Conditions

a. This Best Available Technology (BAT) emission limit applies until U.S. EPA approves Ohio Administrative Code (OAC) paragraph 3745-31-05(A)(3)(a)(ii) (the less than 10 tons per year BAT exemption) into the Ohio State Implementation Plan (SIP).

b. These requirements apply once U.S. EPA approves OAC paragraph 3745-31-05(A)(3)(a)(ii) (the less than 10 tons per year BAT exemption) as part of the Ohio SIP.

c. The emissions from the digestion process shall be vented to the flare when the combined heat and power unit (B003) is not firing digester gas. The permittee shall not allow biogas pressure to build in any tank that would induce emergency venting through tank pressure relief valves to the atmosphere.

d. Anaerobic digesters, including all associated equipment and grounds, shall be designed, operated, and maintained so as to prevent the emission of objectionable odors.

e. The permittee shall properly install, operate, and maintain a device to continuously monitor the flare pilot flame or electric arc ignition when the emissions unit is in operation. The monitoring device and any recorder shall be installed, calibrated, operated, and maintained in accordance with the manufacturers recommendations, instructions, and operating manuals.

f. The uncontrolled mass rate of particulate emissions from this emissions unit is less than 10 pounds per hour. Pursuant to OAC rule 3745-17-11(A)(2)(a)(ii), Figure II of OAC rule 3745-17-11 does not apply. In addition, Table I of OAC rule 3745-17-11 does not apply because the process weight rate is equal to zero. Process weight is defined in OAC rule 3745-17-01(B)(17).

g. This emissions unit is exempt from the visible PE limitations specified in OAC rule 3745-17-07(A) pursuant to OAC rule 3745-17-07(A)(3)(h), because the emissions unit is not subject to the requirements of OAC rule 3745-17-11.

h. The NO_x emissions limitations were developed to reflect the potential to emit for this emissions unit. Therefore, monitoring, recordkeeping, and reporting requirements are not necessary to demonstrate compliance with these emissions limitations.

c) Operational Restrictions

(1) Digester gas combusted in the flare serving this emissions unit shall not exceed 1,000 parts per million on a volume basis (ppm_v) of hydrogen sulfide.

(2) Digester gas combusted in the flare serving this emissions unit shall not have a heat content less than 500 Btu/scf.

(3) The permittee shall use an ultraviolet (UV) flame eye detector to monitor for the presence of a flame and an electric arc ignition system.

d) Monitoring and/or Recordkeeping Requirements

(1) The permittee shall monitor and record hydrogen sulfide concentrations when operating the emissions unit with digester gas using one of the two following options:

Option 1: Weekly sampling using a gas detector tube or portable gas monitoring meter. The permittee shall perform monitoring in accordance with the manufacturer’s instructions for use of the associated sampling system. Any deviations from the manufacturer’s instructions should be recorded with the concentration results of the sampling.

Option 2: Continuous digester gas monitoring system. The permittee may install a sampling and analysis system to continuously monitor and record the H_2S content of the digester gas. The permittee shall properly install, operate, and maintain a continuous digester gas H_2S monitoring device and recorder that measures and records the H_2S concentrations in the digester gas when the emissions unit is in operation, including periods of startup and shutdown. The H_2S monitoring device and recorder shall be capable of satisfying the performance requirements specified in 40 CFR Part 60, Appendix B, Performance Specification 5 and shall be capable of accurately measuring the H_2S concentration. The H_2S monitoring device and recorder shall be installed, calibrated, operated, and maintained in accordance with the manufacturer's recommendations, instructions, and the operating manuals, with any modifications deemed necessary by the permittee.

Whenever the monitored value for hydrogen sulfide exceeds the lower limit of the accuracy of the monitoring system as measured by either of the above monitoring options, the permittee shall promptly investigate the cause of the deviation. The permittee shall maintain records of the following information for each investigation:

a. the date and time the deviation began;

b. the magnitude of the deviation at that time;

c. the date the investigation was conducted;

d. the name(s) of the personnel who conducted the investigation; and

e. the findings and recommendations.

In response to each required investigation to determine the cause of a deviation, the permittee shall take prompt corrective action to bring the hydrogen sulfide concentration below the maximum limit specified in this permit, unless the permittee determines that corrective action is not necessary and documents the reasons for that determination and the date and time the deviation ended. The permittee shall maintain records of the following information for each corrective action taken:

f. a description of the corrective action;

g. the date the corrective action was completed;

h. the date and time the deviation ended;

i. the total period of time (in minutes) during which there was a deviation;

j. hydrogen sulfide readings immediately after the corrective action was implemented; and

k. the name(s) of the personnel who performed the work.

Investigation and records required by this paragraph do not eliminate the need to comply with the requirements of OAC rule 3745-15-06 if it is determined that a malfunction has occurred.

(2) The permittee shall maintain monthly records of the heat content of the digester gas, in Btu/scf.

(3) The permittee shall maintain daily records of all periods of time during which the electric arc system was inoperable or there was no flare pilot flame when digester gas was present in the feedstock equilibrium tank, primary digester, or dual-purpose tank, and the combined heat and power unit was not firing digester gas.

(4) The permittee shall monitor and record the volume of digester gas flared in standard cubic feet per year, and shall calculate and record the annual heat input to the flare in million Btu.

e) Reporting Requirements

(1) The reports required by this permit may be submitted through Ohio EPA's eBusiness Center: Air Services online web portal; or they may be mailed as a hard copy to the appropriate district office or local air agency.

(2) The permittee shall submit the PER in the form and manner provided by the director by the due date identified in the Authorization section of this permit. The PER shall cover a reporting period of no more than twelve-months for each air contaminant source identified in this permit.

(3) The permittee shall identify the following information in the annual PER in accordance with the monitoring requirements in d)(1), d)(2) and d)(3):

a. all periods of time during which the flare's electric arc ignition system was not functioning properly or there was no flare pilot flame when digester gas was present in the feedstock equilibrium tank, primary digester, or dual-purpose tank, and the combined heat and power unit was not firing digester gas;

b. any monthly record showing that digester gas with a minimum heat content of less than 500 Btu / scf was burned in this emissions unit; and,

c. each period during which digester gas containing an H_2S concentration greater than allowed by c)(1) was burned.

f) Testing Requirements

(1) Compliance with the Emissions Limitations and/or Control Requirements specified in section b) of these terms and conditions shall be determined in accordance with the following methods:

a. Emissions limitation:

Emissions of CO shall not exceed 0.31 lb/mmBtu.

Applicable compliance method:

Compliance shall be demonstrated using the emissions factor for CO from U.S. EPA reference document AP-42, Fifth Edition, Compilation of Air Pollution Emission Factors, Section 13.5 Table 13.5-2 (02/18).

If required, the permittee shall demonstrate compliance with applicable emission limitations through emission testing performed in accordance with 40 CFR Part 60, Appendix A, Methods 1-4 and 40 CFR Part 60, Appendix A, Reference Method 10.

b. Emissions limitation:

Emissions of VOC shall not exceed 0.66 lb/mmBtu.

Applicable compliance method:

Compliance shall be demonstrated using the emissions factor for VOC from U.S. EPA reference document AP-42, Fifth Edition, Compilation of Air Pollution Emission Factors, Section 13.5 Table 13.5-2 (02/18).

If required, the permittee shall demonstrate compliance with applicable emission limitations through emission testing performed in accordance with 40 CFR Part 60, Appendix A, Methods 1-4 and 40 CFR Part 60, Appendix A Reference Method 25A.

c. Emissions limitation:

Emissions of NOx shall not exceed 0.068 lb/mmBtu.

Applicable compliance method:

Compliance shall be demonstrated using the emissions factor for NOx from U.S. EPA reference document AP-42, Fifth Edition, Compilation of Air Pollution Emission Factors, Section 13.5 Table 13.5-1 (02/18).

If required, the permittee shall demonstrate compliance with applicable emission limitations through emission testing performed in accordance with 40 CFR Part 60, Appendix A, Methods 1-4 and 40 CFR Part 60, Appendix A Reference Method 7E

d. Emissions Limitation:

Emissions of SO_2 shall not exceed 0.33 lb/mmBtu.

Applicable Compliance Method:

The permittee shall demonstrate compliance with the emissions limitation through the required monitoring and recordkeeping in d)(1) and using the following equation:

$E = (10^6 \text{ Btu} / 1 \text{ mmBtu}) * (1 / \text{digester gas heat content}) * (H_2S \text{ ppm}_v / 1{,}000{,}000) * 0.088 \text{ lb } H_2S/\text{ft}^3 \; H_2S * 1.88 \text{ lb } SO_2/\text{lb } H_2S = SO_2 \text{ lb/mmBtu}$

Where:

E = SO_2 emissions rate, lb/mmBtu

Digester gas heat content = average heat content of digester gas in Btu/scf from d)(2).

H_2S ppm_v = average concentration of H_2S in digester gas, from d)(1)

If required, sulfur dioxide emissions shall be determined according to test Methods 1 - 4, and 6 as set forth in 40 CFR, Part 60 Appendix A.

e. If required, the permittee shall confirm, through the applicable methods and procedures specified in 40 CFR Part 60.18, that the flare’s exit velocity and the net heating value of the digester gas conform to the maximum design values specified by the flare manufacturer.

g) Miscellaneous Requirements

(1) None.

Appendix D

Bell, M.W., *et al.* Paper

Ammonia emissions from an anaerobic digestion plant estimated using atmospheric measurements and dispersion modelling

Michaël Bell, Y. Sim Tang, Ulrike Dragosits, Christophe Flechard, Paul Ward, Christine F. Braban

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Ammonia emissions from an anaerobic digestion plant estimated using atmospheric measurements and dispersion modelling

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ABSTRACT

Anaerobic digestion (AD) is becoming increasingly implemented within organic waste treatment operations. The storage and processing of large volumes of organic wastes through AD has been identified as a significant source of ammonia (NH_3) emissions, however the totality of ammonia emissions from an AD plant have not been previously quantified. The emissions from an AD plant processing food waste were estimated through integrating ambient NH_3 concentration measurements, atmospheric dispersion modelling, and comparison with published emission factors (EFs). Two dispersion models (ADMS and a backwards Lagrangian stochastic (bLS) model) were applied to calculate emission estimates. The bLS model (WindTrax) was used to back-calculate a total (top-down) emission rate for the AD plant from a point of continuous NH_3 measurement downwind from the plant. The back-calculated emission rates were then input to the ADMS forward dispersion model to make predictions of air NH_3 concentrations around the site, and evaluated against weekly passive sampler NH_3 measurements.

As an alternative approach emission rates from individual sources within the plant were initially estimated by applying literature EFs to the available site parameters concerning the chemical composition of waste materials, room air concentrations, ventilation rates, etc. The individual emission rates were input to ADMS and later tuned by fitting the simulated ambient concentrations to the observed (passive sampler) concentration field, which gave an excellent match to measurements after an iterative process. The total emission from the AD plant thus estimated by a bottom-up approach was 16.8 ± 1.8 mg s^{-1}, which was significantly higher than the back-calculated top-down estimate (7.4 ± 0.78 mg s^{-1}). The bottom-up approach offered a more realistic treatment of the source distribution within the plant area, while the complexity of the site was not ideally suited to the bLS method, thus the bottom-up method is believed to give a better estimate of emissions. The storage of solid digestate and the aerobic treatment of liquid effluents at the site were the greatest sources of NH_3 emissions.

1. Introduction

Anaerobic Digestion (AD) is an organic waste treatment technology that is seen as a viable means to recover heat and electricity from organic waste streams such as animal slurry and food wastes (e.g. Wulf et al., 2006). During AD processing organic matter is microbially decomposed in the absence of oxygen to recover biogas and a nutrient-rich digestate which is often used as an organic fertiliser (Pain et al., 1990). The biogas (a mixture of approximately 2/3 methane and 1/3 carbon dioxide) produced can be sold as an energy fuel or combusted on-site to produce renewable heat and/or electricity.

AD has been developed to provide multiple environmental benefits in waste processing, including replacement of fossil fuels with biogas, diversion of waste from landfill, and the abatement of methane (CH_4) emissions from manure storage (Maranon et al., 2011). AD is becoming increasingly attractive for farmers and municipalities and is underpinned in national and international policy objectives (e.g. European Commission, 2009). Anaerobically digested manure is associated with a reduction in odours and pathogens (Chynoweth et al., 1999; Hansen et al., 2006), and also an increased fraction of plant-available ammonium and nitrate in the digestate itself (Möller and Stinner, 2009). Digestion typically causes an increase in pH, thus digester effluents can be ideally suited to fertilise acid soils (Kvasauskas and Baltrenas, 2009).

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However, as the fraction of ammoniacal nitrogen is greater within the effluent mixture, there is a higher potential for N losses through ammonia (NH_3) volatilisation. Further, the elevated pH of digestate produces favourable thermodynamic conditions for the conversion of ammonium (NH_4^+) to NH_3 within solution, which increases NH_3 emissions (Pain et al., 1990; Hansen et al., 2005). AD plants are generally centralised locations where organic wastes are delivered, stored and processed in high volume, concentrating distributed sources of NH_3 emissions. Reduced nitrogen (NH_x) has become one of the dominant atmospheric pollutants in Western Europe due to the significant decreases in sulphur emissions and significant decreases in nitrogen oxide emissions through the implementation of catalytic converters. Ammonia contributes to the acidification and eutrophication of ecosystems (e.g. Vestreng and Storen, 2000; Bobbink et al., 2010; Nihlgard, 1985; Draaijers et al., 1989) and formation of particulate matter (PM2.5), which is recognised to have an adverse effect on respiratory and cardiovascular health (Lillyman et al., 2009).

Emissions of NH_3 in the UK (and worldwide) are generally dominated by the contribution from the agricultural sector (e.g. Misselbrook et al., 2000) originating from livestock housings, slurry stores, field application of organic manure and mineral fertilisers and grazing (Hill et al., 2008). Relative to unprocessed livestock manure, increased volatilisation of NH_3 has been measured following the application of anaerobically digested manures to agricultural fields (Clemens et al., 2006; Pain et al., 1990). Studies concerning gaseous emissions from AD plants have so far mostly focussed on greenhouse gases (GHG), and in particular the abatement or release of methane (e.g. Møller et al., 2009; Flesch et al., 2011; Liebetrau et al., 2013). However NH_3 emissions were measured from an AD plant in a life cycle analysis study carried out by Cumby et al. (2005). Fugitive emissions from the waste reception area were directly measured, but emissions from the storage of digestate were not measured. Clemens et al. (2006) investigated the treatment of animal slurries and co-digestion of mixed substrates through AD, and found NH_3 emissions from digested slurry to be twice as high as untreated slurry during a 140 day summer storage experiment.

Cumby et al. (2005) identified the key areas of NH_3 emission from AD plants as: (a) the waste reception and pre-processing area, where the organic waste substrates are delivered and passed into the input stream, and (b) the digestate storage area, which holds the final product of the AD process (separated or unseparated) before further processing or use as biofertiliser. The scale of NH_3 volatilisation is determined by environmental and substrate parameters including temperature, pH, ventilation and ammoniacal N concentration (TAN) (e.g. Hansen et al., 2005). NH_3 emissions are also dependent on site management practices concerning the handling, storage and treatment of organic wastes. For example, Whelan and Villa (2010) demonstrated in laboratory chamber experiments that NH_3 emissions from food waste digestate could be limited by covering storage facilities and increasing the depth to surface ratio, (maintaining a high concentration of NH_3 above the surface) despite an inherent propensity for volatilisation due to an elevated pH and NH_3:NH_4^+ ratio.

In situ NH_3 emissions from the whole of the AD plant site have not been previously measured, therefore through integrated atmospheric measurement and dispersion modelling methods the objectives of this study were to quantify and characterise the individual and overall sources of NH_3 emissions at a food waste AD plant in central Scotland.

2. Materials and methods

2.1. Site description

The experiment took place from May-July 2014 at the Deerdykes AD plant, located near Cumbernauld (55°55′28N, 4°03′24W), south of the Westfield Industrial Estate and approximately 250 m North of Mollinsburn. Constructed in 2010, the plant processes about 30,000 t yr^{-1} of a mixture co-mingled green/catering wastes from municipal collections, biodegradable industrial sludges and Category 3 animal by-products (animal materials with low-risk of infectious diseases). The AD plant comprises an inner concrete courtyard with several tall tanks and buildings (up to 6 m in height), (Figs. 1 and 2). At

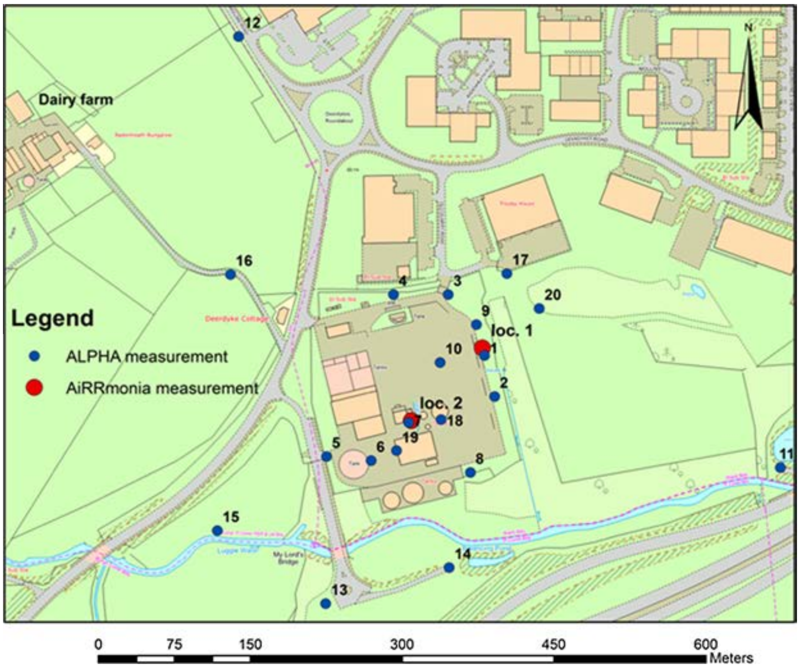

Fig. 1. Map of area surrounding the Deerdykes AD plant showing locations of passive ALPHA and continuous AiRRmonia NH_3 measurement sites. Samplers were predominantly aligned to the SW–NE axis of the site, in line with the prevailing wind direction.

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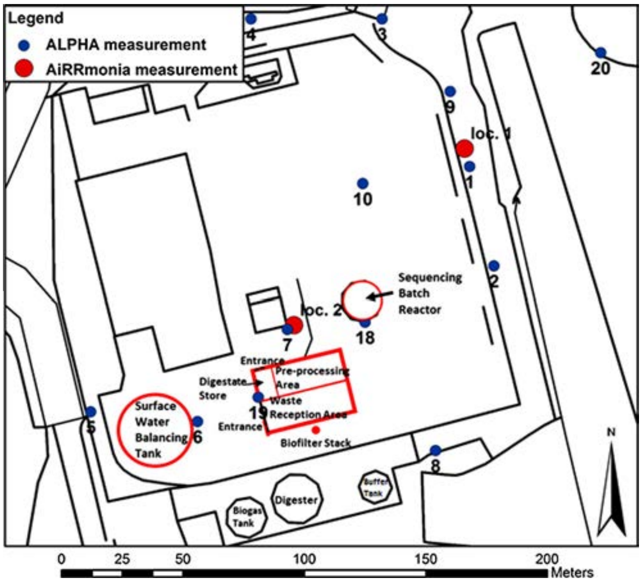

Fig. 2. Map of the central area at the Deerdykes AD showing location of passive (ALPHA) and continuous (AiRRmonia) measurements and the key sources of NH_3 (outlined in red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

the perimeter of the plant is a screening bund 2–3 m in height, partly surrounded by a tree belt and hedgerows with agricultural land, woodland and an industrial park beyond.

Wastes are delivered to the AD plant in both liquid and solid form, Fig. 3 summarises the processes and pathways for solid and liquid waste streams on the site. The solid wastes are delivered to the floor inside the waste reception area, and transferred to equipment that will shred and decontaminate the waste within an adjacent pre-processing area located within the same central waste reception building (WRB) (Fig. 3). Liquids and sludges are offloaded to a separate subterranean tank, before being pumped into the anaerobic digestion process via a buffer tank. Waste inputs are mixed with recycled, anaerobically treated and diluted process liquor to form a 15% dry matter slurry which is transferred into the AD unit operating within the mesophilic temperature range (37 °C) on a semi-continuous basis. The biogas released during AD (primarily methane and carbon dioxide) is withdrawn from the digester headspace and combusted on-site to recover electricity. The digested sludge (digestate) displaced from the bioreactor is dewatered and separated into liquid and solid fractions. Solids are stored within the digestate storage section of the WRB before agricultural use as biofertiliser. The liquor expressed from the sludge that isn't recycled to the AD unit is sent for treatment within a large sequencing batch reactor (SBR), before discharge to sewer. A multi-stage process creates the aerobic and anaerobic conditions needed to induce nitrification and denitrification, converting ammoniacal nitrogen to nitrite and nitrate and further reducing residual biological oxygen demand.

Solid digestate at Deerdykes is stored in shallow, wide heaps within the digestate storage area, with an average depth (z) of less than 1 m. The store is not ventilated, and the entrance is only opened up approximately two to three times per week to extract the digestate. A loader transfers the digestate into a container for haulage off site. Within the digestate storage area, the digestate pile typically covers the floor area, which is 60 m^2. However the surface of the digestate is not smooth; the surface area available for volatilisation was estimated to be increased by roughness by a factor of 5–10. The roughness factor(s) were applied to the source area to scale emissions accordingly in ADMS dispersion modelling.

Other components of the AD plant relevant to NH_3 emissions include the Surface Water Balancing Tank (SWBT) which captures surface water runoff and spillages to mitigate pollution. The waste reception area and pre-processing area are located within mechanically ventilated sections of the WRB, where extracted room air is discharged via a biofilter system designed to limit emissions of odorous compounds. The digestate storage area of the WRB is not connected to the biofilter system.

2.2. Ammonia measurements

Three NH_3 measurement techniques were applied: time-integrated sampling with passive diffusion ALPHA (Adapted Low-cost Passive High Adsorption) samplers (Tang et al., 2001), continuous on-line NH_3 analysis using a trace gas analyser (AiRRmonia, ECN, 2003, Mechatronics, NL) and instantaneous/snap measurements made with a portable NH_3 gas analyser (Micro 5, www.calgarysense.com).

2.2.1. Passive sampler measurements

ALPHA samplers have been extensively used (UK National Ammonia Monitoring Network, Vogt et al., 2013; Theobald et al., 2013; Riddick et al., 2014), and performed well in inter-comparison studies (Puchalski et al., 2011). Six ALPHA measurement periods in total were carried out at the site from 15/05/2014 to 10/07/2014. Sampler exposure durations ranged

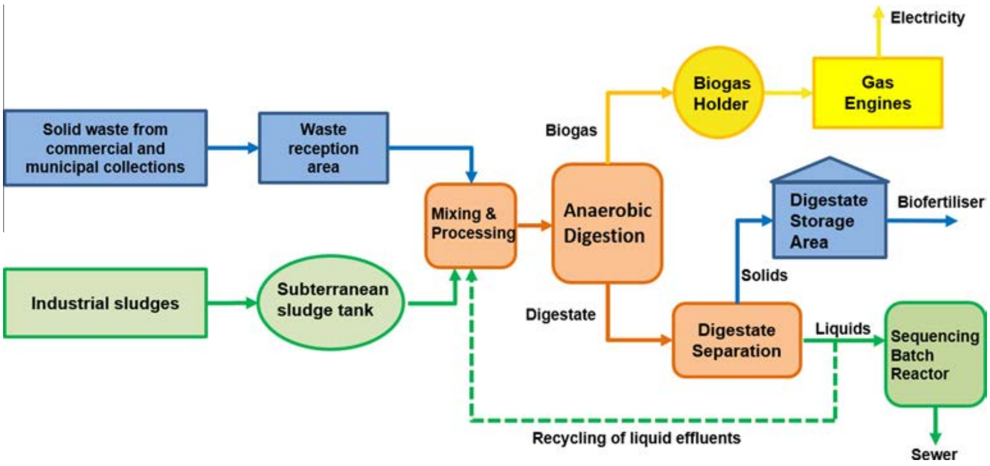

Fig. 3. Schematic diagram of pathways of solid and liquid wastes through AD plant.

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between 6 and 14 days. ALPHA samplers were deployed in triplicate at 20 locations across the site at a 1.5 m height (Fig. 1). Citric acid coated filter papers from the samplers were extracted in 3 ml deionised water, and analysed for NH_4^+ by the AMmonium Flow Injection Analysis system (AMFIA) (Wyers et al., 1993). Laboratory blanks were subtracted from samples and field blanks were used to check for contamination.

2.2.2. High temporal resolution continuous measurements

On-line continuous NH_3 concentration measurements were made with an AiRRmonia gas analyser. The continuous analyser was strategically deployed sequentially at two locations as shown in Fig. 2. The first measurement location, (28/05–26/06) was 100 m northwest of the AD plant along the axis of the prevailing wind direction (Loc. 1), while the second (27/06–16/07) was within the inner courtyard at the plant, 20 m from the entrance to the digestate store (Loc. 2). Air was sampled at a rate of 1 l min^{-1} and NH_3 diffused through a gas-permeable membrane into a stripping solution (converts NH_3 to NH_4^+ ions). Ammonium ions passed through into a detector block through an ion-selective membrane where the conductivity was measured. Liquid phase calibration of the conductivity cell was carried out in the field every 6 days with 0, 50 and 500 ppb NH_4^+ solutions and showed good stability over the periods of measurement. The AiRRmonia instrument was housed within a weather-proof container, where measurements were recorded every minute by the in-built datalogger, and later averaged at 10, 30 and 60 min periods for analysis.

2.2.3. Indoor NH_3 measurements

The gas alert Micro 5 portable multi-gas analyser was used to provide point measurements of room air concentrations inside the digestate store, preprocessing area and waste reception area at the site. By contrast to the ALPHA and AiRRmonia measurements in ambient outdoor air, the limit of detection for the Micro 5 device was much higher, of the order of 1 ppm (0.7 mg m^{-3}), as opposed to roughly 0.1 μg m^{-3} for ALPHA and AiRRmonia measurements. Yet the Micro 5 was suitable for the task due to high indoor concentrations. Measurements were weekly, characterising the observed NH_3 concentrations. It was not possible to install the Micro 5 due to lack of power outlets in the relevant buildings.

2.3. Meteorological and ancillary measurements

Standard meteorological measurements (wind speed, wind direction, temperature, relative humidity and rainfall) were provided by a citizen-operated local weather station in Cumbernauld (www.cumbernauld-weather.co.uk), located 1.6 km to the northeast of the site. These meteorological measurements were recorded by a Davis Vantage Pro2 system (www.davisnet.com). Cloud cover data, for use as a proxy atmospheric stability parameter with the ADMS meteorological pre-processor, was obtained from Glasgow Bishopton surface observation station which is 24 km from the site. The temperature was recorded inside the digestate store between 27/06/2014 and 06/07/2014 using a Tiny Tag data logger (www.geminidataloggers.com).

2.4. Atmospheric modelling

2.4.1. Lagrangian stochastic (bLS) dispersion model

The backward Langrangian stochastic (bLS) dispersion model “WindTrax”, described in detail in Flesch et al. (2004) and available at www.thunderbeachscientific.com was used to infer the total emission from the AD plant. The basic WindTrax equations are summarised below. The model in this work was configured to release 5×10^4 “fluid particles” backwards from a concentration receptor, the fraction of which intersect the source area derives a dispersion coefficient D. This dispersion coefficient gives the flux of NH_3 emitted from the source, (Q, μg m^{-2} s^{-1}) using the measured rise in concentration C above background C_b (in μg m^{-3}), by the relationship:

$$Q = (C - C_b) * D \tag{1}$$

where D is retrieved by the model as the number of source area interactions (N_{source}) and the thousands of trajectories (N) generated by the model from the receptor locations, along with the associated vertical velocity of each interaction (w_o) (see Eq. (2), and details in Flesch et al., 2004).

$$D = \frac{1}{N} \sum N_{source} \left| \frac{2}{w_o} \right| \tag{2}$$

Continuous NH_3 concentration data from the AiRRmonia measurements were averaged over 1 h periods. The AiRRmonia and meteorological data were filtered to measurements where the AD plant was directly upwind of the AiRRmonia gas analyser (wind direction 210–235°). This was sufficient so that at least 50% of the calculated plume trajectories covered the emission area. The input data was also filtered to remove calibration periods and known conditions where the inverse dispersion model is known to become inaccurate (Flesch et al., 2005). These conditions included low winds (where frictional velocity (μ^*) was less than 0.15 m s^{-1}) and strongly stable/unstable atmospheric stratification (L < 10 m).

Standard hourly meteorological measurements were input to WindTrax for the first measurement period (28/05–26/06). Including the following variables: NH_3 concentration at 2 m height (C μg/m^3), background concentration (C_b μg m^{-3}), wind speed (μ, m s^{-1}), wind direction (WD, °), and ADMS-calculated Monin-Obukhov length (L). To determine a background concentration (C_b) for the site, the AiRRmonia concentration measurements were filtered to strictly upwind (320–180°) periods. The model retrieved emission estimates from the AD plant for each 60 min timestep satisfying the measurement criteria, relying on the assumption that the downwind concentrations are directly proportional to the source emission rate. Thus for a perfect dispersion model under homogeneous conditions the real emission rate can be derived from the simulated concentration (C_{sim}) using the emission rate Q_{sim} (Eq. (3)).

$$Q = \frac{(C - C_b)}{(C/Q)_{sim}} \tag{3}$$

The Deerdykes AD facility presents complications for inverse dispersion calculations. Buildings and structures generate complex wind movements, and the relative intensity of all the emission sources is unknown. However studies using the inverse dispersion method have demonstrated insensitivity to these complications if measurements are taken far enough downwind (Flesch et al., 2005, 2011; McGinn et al., 2006). Two criteria are proposed by Flesch et al. (2005): (1) the downwind distance of the concentration sensor should be a minimum of ten times the height of the largest wind obstacle, and (2) roughly two times the maximum distance between potential sources. The Deerdykes facility meets the first criterion (waste reception building height is 6.4 m, distance to nearest source is 70 m) but not the second (distance between SWBT and SBR is 80 m). Therefore for intercomparison a second dispersion modelling method has been applied to estimate emissions.

2.4.2. ADMS dispersion modelling

Source strengths may be determined by assigning an arbitrary emission rate to a dispersion model and scaling the modelled concentrations to the measured values (above background) by

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Table 1
ADMS model inputs.

Variable	Units	Configuration/parameterisation	Value
Wind speed	m s^{-1}	Building configuration	–
Wind direction	°	Grid area (10 m spaced)	900 × 700 m
Rain	mm h^{-1}	Passive sampler locations	–
Temperature	°C	Surface roughness (z_0)[a]	0.2–1 m
Relative humidity	%	Dry deposition rate[b]	0.02 m s^{-1}
Cloud cover	Oktas (8ths)	Washout coefficient[c]	9×10^{-6} s^{-1}

[a] Gridded surface roughness file.
[b] Environment Agency (2010).
[c] CLAG (1994).

applying a correction factor (e.g. Hill et al., 2008; Faulkner et al., 2007; Theobald et al., 2013). A variant of this technique was applied with the Atmospheric Dispersion Modelling System (ADMS) (Carruthers et al., 1994). ADMS is an "advanced generation" Gaussian dispersion model, modified from the basic Gaussian equation to take into account vertical profiles of boundary layer parameters and continuous stability functions (Holmes and Morawska, 2006). These modifications lead to improved predictions of vertical and horizontal concentration distribution profiles under a range of stability conditions (Theobald et al., 2012). The ADMS-Urban version used also features a complex terrain module which can accommodate for a domain of variable roughness lengths (z_0), and include the dimensions of individual buildings to simulate concentrations where there are building effects. The ADMS model was configured with the input data listed in Table 1.

2.4.3. Modelling scenarios

The objective of the modelling scenarios was to test different source area treatments and modelling methods, and evaluate predictions against passive sampler measurements. Three scenarios were set up to investigate and evaluate different emissions estimates for the AD plant. A key objective was to find an emission estimate (model + emission inventory) that performs well in reproducing observed concentrations but also finds a balance with the conceptual model of emissions from the AD, arguments for which are developed from on-site investigations and published emission factors. All of the scenarios used the ADMS forward dispersion model to predict the long-term average concentrations across a 900 × 700 m model domain at a 10 × 10 m resolution. Each scenario used the meteorological data (inputs) and ALPHA NH_3 concentration measurements (verification data) corresponding to four sets of weekly ALPHA measurements (28/05–26/06).

Scenarios included:

(1) Top-down emission estimate of total emissions by bLS method, assuming homogeneous source area.
(2) Bottom-up estimates of individually defined sources, determined using theoretical methods and the available AD plant parameters. These include: published emission factors from the literature, room air concentration measurements (Micro 5), site parameters such as biofilter air flow rate and estimated scrubbing efficiency, chemical analysis of solid and liquid effluents obtained from the AD plant and assumptions regarding the ventilation rate of buildings.
(3) Optimised emission rates were derived following iteration of individual emission estimates (Scenario 2) to match simulated concentrations with ALPHA measurements, whilst taking into account site parameters.

2.4.4. Model performance evaluation

Evaluation of model performance requires a statistical comparison of concentration predictions (C_p) with observed values (C_o). To evaluate ADMS predictions against ALPHA measurements for each scenario, the five performance measures suggested by Chang and Hanna (2004) are used:

$$\text{Fractional bias}: \quad \text{FB} = \frac{2(\overline{C_o} - \overline{C_p})}{(\overline{C_o} + \overline{C_p})} \tag{4}$$

$$\text{Geometric mean bias}: \quad \text{MG} = \exp(\overline{\ln C_o} - \overline{\ln C_p}) \tag{5}$$

$$\text{Normalised mean square error}: \quad \text{NMSE} = \frac{\overline{(C_o - C_p)^2}}{\overline{C_o}\,\overline{C_p}} \tag{6}$$

$$\text{Geometric variance}: \quad \text{VG} = \exp\left[\overline{(\ln C_o - \ln C_p)^2}\right] \tag{7}$$

$$\text{FAC2} = \text{fraction of data that satisfy}: \quad 0.5 \leqslant \frac{C_p}{C_o} \leqslant 2 \tag{8}$$

Note overbars denote the mean of each dataset.

The NMSE, VG and FAC2 are composite measures that take into account the both bias and scatter in the predicted values relative to the observations, while the FB and MG are measures of model bias and describe the tendency of the model to over or under-predict observed concentrations. Chang and Hanna (2004) have suggested ranges for the five performance indices that indicate acceptable model performance. The ranges suggested are: $\text{FB} < 0.3$, $0.7 < \text{MG} < 1.3$, $\text{NMSE} < 1.5$, $\text{VG} < 4$ and $\text{FAC2} > 50\%$.

2.5. Theoretical estimation of emissions based on site parameters

Chemical analysis of digestion substrates and digestate is routinely carried out at various stages of the AD process by the plant operators. Some of these data (NH_4-N content, pH) were made available for the estimation of emissions, by applying to EFs within the literature along with other operational parameters such as ventilation rates, surface areas, and indoor room air concentration measurements made with the Micro 5.

Empirical relationships based upon the regression of NH_3 emissions against influencing parameters such as temperature, NH_4-N content, pH and air ventilation rates can give default predictions of NH_3 emission rates when limited parameters are available for calculation (e.g. Jarvis, 1993; Ross et al., 2002). The model of Borka et al. (2000) describes the emissions of NH_3 (E, mg m^{-2} h^{-1}) from manure in livestock buildings, and was developed from the regression of substrate temperature (TS, °C), air exchange rate (LD, m^3 h^{-1} m^{-2}), and NH_4-N content (TAN, g N kg^{-1}) (Eq. (9)), in controlled experiments within respiration chambers. This emission model has been applied to estimate emissions from the storage of solid fraction digestate at Deerdykes.

$$\text{E} = 17.254 * 1.060^{\text{TS}} * \text{LD}^{0.274} * \ \text{TAN} \tag{9}$$

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3. Results

A summary of the NH_3 measurements taken at the site is hereafter presented. The NH_3 measurements include firstly those taken with the AiRRmonia gas analyser, which initially was placed 100 m NE of the AD plant to operate nearly continuously from (28/05 to 26/06). The second period of continuous measurement placed the AiRRmonia analyser outside of the digestate storage area, which was expected to be the major source of NH_3 at the site. The following section summarises the NH_3 concentration distribution as measured by the weekly sampling network of ALPHA samplers placed at 20 locations around the site. Last of the measurements, the chemical properties of waste materials and estimates of emissions after applying literature EFs are given. The modelling results follow, including the evaluation of emission estimates (Scenario 1, 2 & 3) with ALPHA concentration measurements.

3.1. Continuous measurements

During the first continuous measurement period the AiRRmonia analyser was placed at Location 1, 100 m NE of the AD plant and inline with the prevailing SW wind direction (Fig. 5). Ammonia concentrations fluctuated with changes in wind direction, with the highest concentrations measured during SW wind directions when the AiRRmonia was downwind of the AD plant (Figs. 4 and 6). The mean measured air NH_3 concentration at this location from 28/05 to 26/06 was 4 $\mu g\ m^{-3}$. Filtering the AiRRmonia data measurements to periods where the AiRRmonia sensor was directly downwind of the central area of the AD plant (WD 210–235°, WS > 1 $m\ s^{-1}$) gave an average concentration C of 6.5 $\mu g\ m^{-3}$. The background concentration (C_b), approximated by filtering measurements to periods where the AiRRmonia sensor was upwind of the AD plant (310–180°), was 1.8 $\mu g\ m^{-3}$ (Table 2).

During the second period of AiRRmonia continuous air NH_3 concentration measurement, the instrument was placed to the north of the waste reception building at ALPHA site 7, 20 m from the entrance to the digestate store. The NH_3 concentration time series during this period (27/07–16/07) is characterised by a relatively low baseline (<10 $\mu g\ m^{-3}$) with high-concentration events occurring every 2–6 days, where air concentration would rise up to 300 $\mu g\ m^{-3}$ and return back to baseline level within a few hours (Fig. 7). Emissions from the digestate store are expected to be episodic as high concentrations accumulate inside and are released as the store is opened and the digestate is extracted. This occurred roughly three times per week (but exact days/times were not recorded by the plant operators), which is consistent with the number of emission events that occurred over the monitoring period. Therefore the digestate store door is a dominating source of emissions at this location which should be individually defined for dispersion modelling.

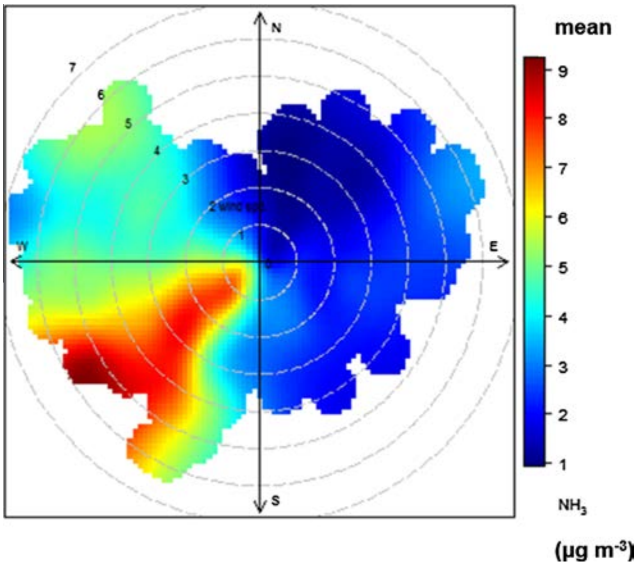

Fig. 4. Polarplot of AiRRmonia concentration measurements with wind speed and direction for AiRRmonia Period 1, (28th May–26th June). Averaging period is 10 min. Wind speed and direction data supplied by www.cumbernauld-weather.co.uk, plotted using the OpenAir package (Carslaw and Ropkins, 2012).

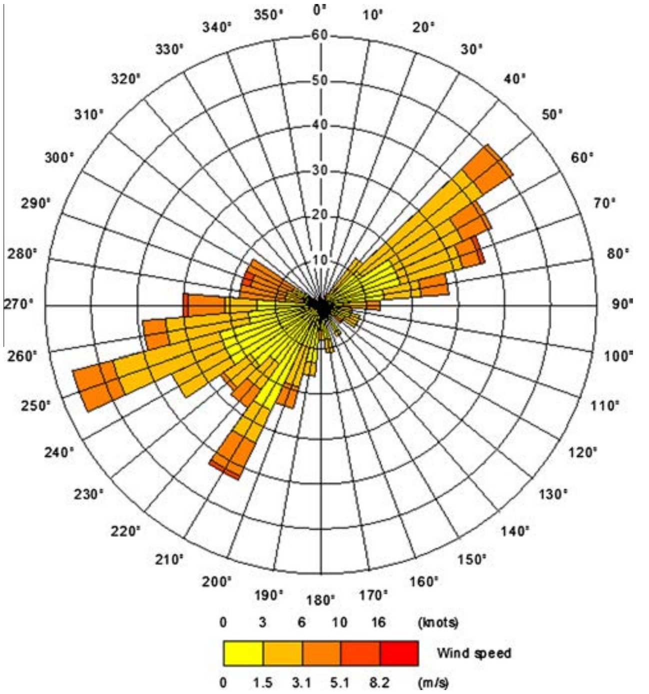

Fig. 5. Windrose of meteorological data from the 28th May to the 26th June. Averaging period is 1 h. Plotted using the ADMS met. data processor.

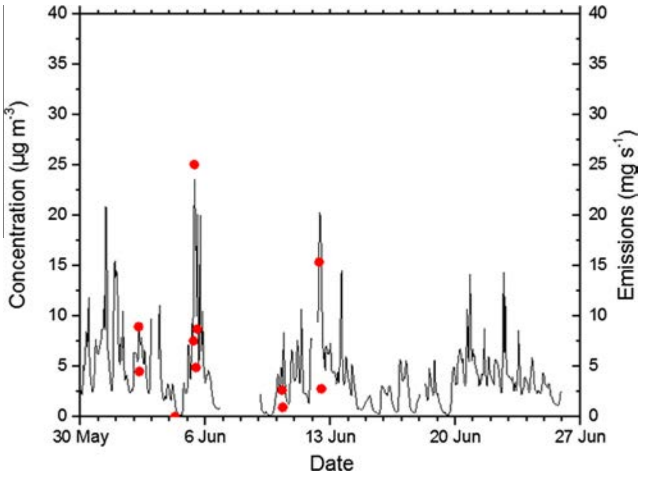

Fig. 6. Time series of AiRRmonia continuous air NH_3 measurements (black line) and bLS emissions estimates (red points), AiRRmonia Period 1, location 1 (28th May–26th June). Daily averaged wind direction arrows are annotated above (direction wind is coming from). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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Table 2
Average downwind and background NH_3 concentration measurements, AiRRmonia Period 1 (28th May–26th June), and average WindTrax emission rate calculations.

	AiRRmonia averaged concentration per wind sector ($\mu g\ NH_3\ m^{-3}$)			Average emission rate ($mg\ NH_3\ s^{-1}$)[a]		
	All wind sectors	210–235°	310–180°	Background concentration: $0.43\ \mu g\ m^{-3}$	Background concentration: $1.8\ \mu g\ m^{-3}$	Background concentration: $3.17\ \mu g\ m^{-3}$
Average	4	6.5	1.8	8.4	7.4	6.3
Standard deviation	3.1	4.9	1.4	7.2	7	7.2

[a] Averaged bLS estimate calculated from continuous AiRRmonia measurements, filtered to the downwind (210–235°) wind sector and meteorological criteria. Averaged emissions are calculated for the mean background concentration (310–180° wind sector) and to one standard deviation above and below the mean.

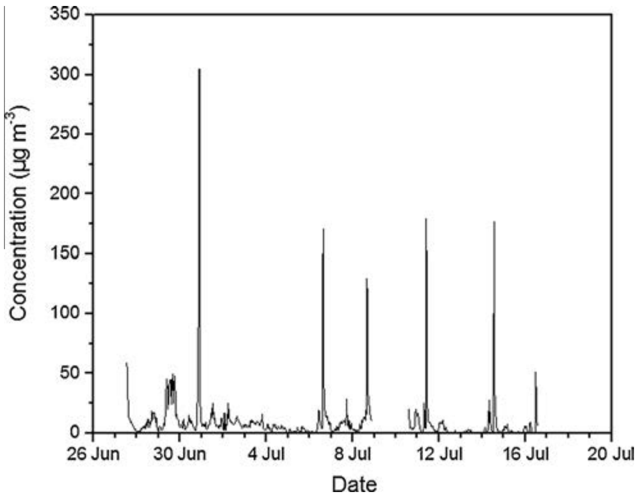

Fig. 7. Timeseries of AiRRmonia-measured NH_3 concentrations at Location 2, outside of digestate store.

3.2. Passive measurements

Of the 20 sampling locations across the site, the highest weekly mean concentrations ($6–20\ \mu g\ m^{-3}$) occurred near the central WRB at the AD plant, showing strong temporal variation between measurements (Supplementary material). The WRB is a compartmentalised space containing the digestate storage, waste reception and waste pre-processing areas. A strong decrease in concentration occurred with increasing distance from the plant, with background concentrations ($1.5\ \mu g\ m^{-3}$) found nearby (200 m), depending on the prevailing wind direction and the presence of hedge effects.

3.3. Theoretical emissions estimates

In reviewing the chemical analysis of the solid fraction digestate, there is a substantially higher Total Kjeldahl Nitrogen (TKN) and NH_4-N content than the literature values given, therefore more NH_3 should be available to volatilise thermodynamically (provided substrate pH is similar) (Table 3). Digestate store emission rates for air exchange rates of 0.5, 1 and $1.5\ m^3\ h^{-1}\ m^{-2}$ were calculated using Eq. (9), which compares well to the literature values given. The temperature within the digestate store displayed strong diurnal variations, with temperatures ranging from 10 to 25 °C night-day. The average air temperature (16.4 °C) was assumed to be equal to the average surface temperature of the digestate.

Emissions of NH_3 from the SBR, SWBT, the waste reception area, pre-processing area and biofilter stack are derived from emission measurements in the literature (Cumby et al., 2005; Borka et al., 2000; Willers et al., 1996; Leytem et al., 2010). These EFs are applied to the AD plant and presented in Table 4, using the available Deerdykes operational specifications, chemical measurements, and Gas-Micro-5 room air concentration measurements.

3.4. Inverse and forward dispersion modelling

3.4.1. bLS estimate of emissions

The WindTrax model treated the emissions from the AD plant as three homogeneous area sources that are marked by the boundaries of the WRB, SWBT & SBR (1000, 700 & $150\ m^2$ respectively, Fig. 2), which were identified as likely to be the main source areas. After filtering to the meteorological criteria set out in Section 2.4.1 only 11/690 hourly measurements are suitable for estimating emissions by the bLS method. From the remaining emission estimates, an important feature is the apparent temporal variation in strength of emissions, with a range of $0–25\ mg\ s^{-1}$ (Fig. 6).

Table 3
Intercomparison of the chemical composition and estimated emission rates of the Deerdykes digestate with different digestates reported in the literature. Deerdykes emission rates are calculated using the Borka et al. (2000) model.

Parameter	Deerdykes (food waste)			Cumby et al. (2005) (livestock slurry)	Clemens et al. (2006) (cattle slurry, summer experiment, 140 days)					Whelan and Villa, (2010) (food waste)		
	Digestate			Digestate	Cattle slurry		Digestate			Digestate		
TKN (mg/l)	62,600			6583	2170		2280			–		
NH_4-N (mg/l)	25,000			5040	1190		1510			5775		
pH	8.0			8.2	7.4		7.8			8.3		
DM (g/kg)	120			–	32.9		22.9			37.2		
J_{NH3} ($g\ NH_3\ m^{-2}\ d^{-1}$)	Borka et al. (2000) model[b]			–	Uncovered	Covered	Uncovered	Straw cover	Covered	$\alpha = 0.1$	$\alpha = 1$	$\alpha = 10$
	$\alpha = 0.5$[a]	$\alpha = 1.0$	$\alpha = 1.5$		0.7	0.4	1.6	0.9	0.6	2.1	14	38.9
	1.2	1.5	1.7									
EF_{NH3} (kg N as NH_3, % TKN/year)	–			21.8	–		–			–		

The Total Kjeldahl Nitrogen (TKN), NH_4 concentration (NH_4-N), pH and dry matter content (DM) are presented. NH_3 emission rates are given as the equivalent flux rate (J_{NH3}) and the yearly emission factor (EF_{NH3}).

[a] α is the ventilation rate (air changes per hour).

[b] Deerdykes equivalent fluxes calculated from the empirical model of Borka et al. (2000), Eq. (9). Where: TS = 16.4, LD = 0.5, 1.0, 1.5, TAN = 20.5.

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Table 4
Initial (literature EF-based) and optimised (fitted to ambient concentration measurements) NH_3 emission rates calculated for individual sources within AD plant.

Source name	Type	Emission factor	Intensity	Scenario 2: initial area-integrated emission rate ($mg\ s^{-1}$)	Scenario 3: optimised emission rate ($mg\ s^{-1}$)	Reference
Digestate store	Point	$17.4\ \mu g\ m^{-2}\ s^{-1}$	$60\ m^{b} \times 5$	5.2	7.3	Borka et al. (2000)[a]
Biofilter	Point	$465\ \mu g\ s^{-1}$	1	0.5	0.5	Cumby et al. (2005)[b]
Waste reception area door	Point	$1020\ \mu g\ s^{-1}$	1	1	0.1	Cumby et al. (2005)[c]
Pre-processing area	Line	$41.5\ \mu g\ m^{-1}\ s^{-1}$	31 m	1.3	0.6	Cumby et al. (2005)[d]
Sequencing batch reactor	Point	$61.1\ \mu g\ m^{-2}\ s^{-1}$	$200\ m^{b} \times (10/24)$	5.1	5.1	Willers et al. (1996)[e]
Surface Water Balancing Tank	Area	$23.4\ \mu g\ m^{-2}\ s^{-1}$	$616\ m^{b}$	14.4	3.2	Leytem et al. (2010)[f]
Total emissions				27.5	16.8	

[a] Eq. (9): assumed ventilation rate is 1.0 air changes per hour. Surface roughness factor is estimated to be 5.

[b] Calculated from the mean of the NH_3 concentration measurements within the waste reception area, mechanical ventilation rate is $9000\ m^3\ h^{-1}$. Estimated combined room air concentration is $1.43\ mg\ s^{-1}$. Biofilter NH_3 scrubbing efficiency is taken to be 87% as measured in the experiments of Cumby et al. (2005).

[c] Based on the assumption that 50% of air exchange occurs through direct discharge (Cumby et al., 2005), and that the large door to the waste reception area on the west side of the building is the only outlet. Measured room air concentration is $0.75\ mg\ m^{-3}$.

[d] Assumed 25% direct discharge from the pre-processing area which features two small personnel doors on the north side of the building. Emissions assumed to occur evenly across this surface. Measured room air concentration: $2.25\ mg\ m^{-3}$.

[e] The emission factor of $220\ mg^{-1}\ m^{-2}\ h^{-1}$ for SBR aerobic treatment of veal slurry (Willers et al., 1996), which was found to be suitable after comparing to chemical analysis of Deerdykes SBR liquid. The authors reported that this was the average emission over the course of a daily 22 h aeration cycle.

[f] Flesch et al. (2009) and Leytem et al. (2010) published emission rates from dairy farm wastewater lagoons in the U.S., the lower estimate of the two ($2.02\ g\ m^{-2}\ d^{-1}$, Leytem et al., 2010) was selected for the SWBT at Deerdykes.

Therefore there were periods where the analyser was directly downwind from the AD plant yet the measured concentration showed no rise above background, which suggests that emissions occur in events, such as delivery and removal of waste materials at the site, or aerobic denitrification cycles starting within the SBR for effluent treatment.

The average emission rate was $7.4\ mg\ s^{-1}$ or $3.9\ \mu g\ m^{-2}\ s^{-1}$ (total source area $1875\ m^2$), (Table 2). Despite the apparent variation in emissions at the site, it is necessary to set the plant emission rate as a single average value to evaluate the bLS emissions estimate against the long-term passive sampler observations. The small number of emission estimates has a high standard deviation of $6.98\ mg\ s^{-1}$. This averaged figure therefore may not be representative of the true averaged emission rate with such a small sample. Further consideration must also be given to the background concentration, its variability and the sensitivity of emission estimates to different selections. The average background concentration (C_b), after filtering measurements to the 320–180° wind direction, was $1.8\ \mu g\ m^{-2}\ s^{-1}$. Emissions from the plant were also estimated using background concentrations set to one standard deviation above and below the average C_b, which gave a range of averaged emission estimates of $6.4–8.4\ mg\ s^{-1}$ (Table 2).

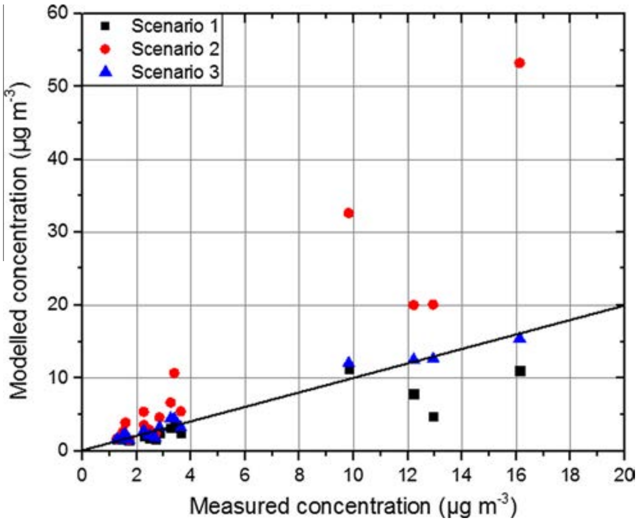

Fig. 8. Scatter plot of measured and ADMS-predicted NH_3 concentrations at ALPHA receptors, comparing model Scenarios 1, 2 & 3.

3.4.2. Evaluation of Scenario 1: bLS emissions estimates

The Scenario 1-simulated concentrations are generally lower than ALPHA measurements, with a regression of 0.68 (Fig. 8), indicating that this estimate is likely lower than the true averaged emission strength from the plant. There is a poorer fit near to the central area sources where concentrations are highest. WindTrax assumes that emissions are homogeneously distributed within the source area, which is not a realistic treatment and increases the degree of error in predicted concentrations around the central area. With increasing distance downwind, concentration predictions have a greater accuracy, in-line with a distance-related insensitivity to similar complications reported by Flesch et al. (2005, 2011).

3.4.3. ADMS modelling of NH_3 concentrations after differentiation of model into multiple sources: Scenario 2–3

Six discrete sources were input to the model to replace the homogenous area sources, with the aim to provide alternative estimates for total plant emissions, and to investigate emissions from individual sources and simulate NH_3 concentrations near the source area. Scenario 2 emission rates for each source were estimated by the theoretical methodology outlined in Section 2.4 (Table 4).

Overall, through optimisation the Scenario 3 total emissions from the plant were reduced to $16.8\ mg\ s^{-1}$, from the (theory-based) Scenario 2 estimate of $27.5\ mg\ s^{-1}$. Scenario 2-predicted concentrations at the passive receptors were higher by a factor of ~2.4 on average than the ammonia measured with ALPHA samplers (Fig. 8). In particular, the ADMS concentrations around the SWBT were much higher than the ALPHA measurements, with concentrations at site 5, 6 and 19 all exceeding measured concentrations by factors of ~3.2. The SWBT emission rate in the model leads to an overestimation of concentrations therefore the model was optimised using a factor to fit to observations. It was found that an optimisation factor of 0.22 best replicated the average concentration around the SWBT. Further optimisation factors were applied to the digestate store (1.4), the waste reception area door (0.06), and the pre-processing area line source (0.5) to fit the predicted concentrations against the ALPHA measurements.

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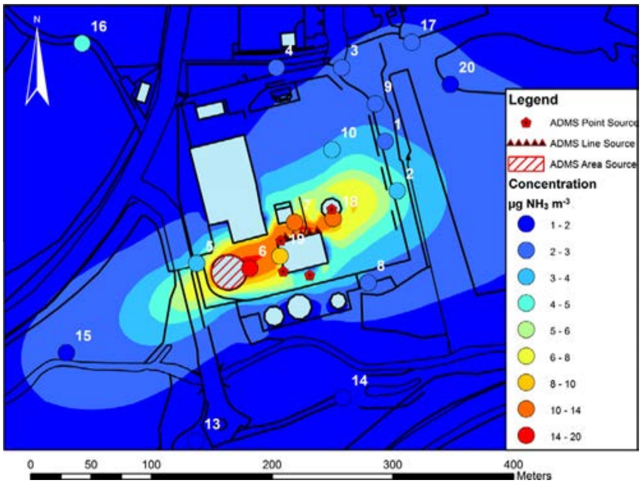

Fig. 9. Contour map of Scenario 3 predicted concentrations. This model shows an excellent fit to the ALPHA measurements and provides the best estimate of the magnitude and distribution of NH_3 emissions at Deerdykes. ALPHA measurements are set above the contour predictions, labelled by sample number on the same colourscale for evaluation. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Optimisation factors were derived after an empirical iterative-fit manner, yet there was consideration given to the conceptual model for NH_3 emissions from the site, and qualitative expectations of the degree of error associated with the initial emissions assessments. The optimised emission rates are given in Table 4. The predicted concentrations of the optimised model (Scenario 3) are shown in Figs. 8 and 9, where a near-perfect linear regression can be seen between measured and predicted concentrations.

4. Discussion

4.1. Assessment of modelling approach and comparison against measurements

The aim of this study was to estimate the NH_3 emissions from the Deerdykes AD plant. No direct measurements of emissions were made; rather the source strength was inferred through coupling of atmospheric measurements to forward and inverse dispersion modelling, and the estimation of emissions independently of atmospheric measurements through applying literature EFs and models to site parameters.

The Deerdykes AD plant was not ideally suited as a source area for the bLS technique due to the spatial complexity of various sources. The distance between potential sources was greater than the distance from the nearest source to the concentration receptor homogenous area source, which should not be the case to ensure accurate estimates with the bLS method (Flesch et al., 2005). Furthermore, the AiRRmonia concentration sensor was suitably downwind and under the right stability conditions during only 11/690 hourly measurement intervals. The predicted Scenario 1 emission estimate therefore may not be expected to be fully representative of the entire measurement period, and was less than half (7.4 mg s^{-1}) of the best-performing Scenario 3 estimate (16.1 mg s^{-1}). Some concentration predictions were inaccurate close to the source area, and all were generally lower than ALPHA measurements. The prediction of variable emissions between 0 and 25 mg s^{-1} may describe the periodical nature of emissions from the AD plant, a theory which is supported by large peaks in continuous AiRRmonia concentration measurements made outside of the digestate store (Fig. 7).

According to the Chang and Hanna (2004) evaluation criteria (Table 5), a perfect model would have MG, VG, R^2 and FAC2 = 1.0; and FB and NMSE = 0.0. Scenario 2 showed considerable bias to overestimate the observed concentrations and as a result the fractional bias (FB) and geometric mean bias (MG) criteria were failed (Table 5), mostly due to the SWBT emission factor being too high. Scenario 3 produced emissions estimates after an iterative-fit-optimisation to the observed concentration field which very closely reproduced the measured concentrations at the individual ALPHA receptors across the model domain. The initial condition of the iterative process was not arbitrary as estimates were produced after analysis of site parameters and reviewing information within the literature, whilst the optimisation process remained sympathetic to this understanding of emissions from the site and the uncertainties therein. The optimised emission factors tuned to the observed concentrations are far from being independent of measurements, therefore performance criteria approaching ideal values would have be to be expected. An independent evaluation was carried out by taking the Scenario 3 optimised emission rates and comparing the predicted and measured concentrations for an earlier (ALPHA Period 1, 15 May–27 May 2014) period with a very different prevailing wind direction. The Scenario 3 emissions estimates were therefore validated with strong performance in all evaluation criteria (Table 5). Scenario 3 also describes the spatial distribution and relative weight of individual sources developed by this methodology, giving a more detailed understanding of the nature of NH_3 emissions at the plant. The Scenario 1 bLS-calculated source strength is within the acceptability range for all of the performance measures; however Scenario 3 with six individual sources and a higher total estimate performs much better and is therefore expected to represent the true area-integrated emission rate for this period.

4.2. Key sources of emissions identified at the site

The largest source of NH_3 at the plant was found to be the digestate store (7.3 mg s^{-1}, 44% of total emissions). Continuous AiRRmonia measurements taken over a period of three weeks from 20 m outside of the digestate store revealed that concentrations were dominated by high-magnitude events during which the air concentration would rise up to 300 μg m^{-3} and return back to a low

Table 5
Model evaluation criteria intercomparing the performance of Scenario 1, 2 & 3. Values in bold indicate ‘acceptable’ model performance according to Chang and Hanna (2004).

Performance measure	Normalised mean square error (NMSE)	Geometric variance (VG)	Fractional bias (FB)	Geometric mean bias (MG)	FAC2 (%)
Chang and Hanna (2004) acceptability criteria	<1.5	<4	<0.3	0.7 < MG < 1.3	>50
Scenario 1	**0.02**	**1.3**	**0.25**	**1.29**	**95**
Scenario 2	**0.24**	**1.01**	−0.74	0.46	**80**
Scenario 3	**0.02**	**1.18**	**−0.06**	**0.95**	**100**
Scenario 3 independent Period 1	**0.03**	**1.01**	**−0.16**	**0.85**	**100**

FAC2: fraction of model predictions within a factor of two of observations.
ALPHA receptors 12 and 16 are excluded due to the influence of an adjacent dairy farm on measured concentrations.

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baseline (<10 μg m^{-3}) within a few hours (Fig. 7). This is consistent with the conceptual model of intense emission events occurring as the digestate store is opened, inducing ventilation and release of the NH_3 within the room air of the digestate store, measurements of which were as high as 60 ppm (42 mg m^{-3}). The Deerdykes digestate was found to be very rich in TKN and NH_4-N, with a high pH, contributing to high emissions estimated by the empirical model of Borka et al. (2000) (Eq. (9)). Estimated fugitive emissions from the waste reception and pre-processing area were low, comprising around 4% of emissions from the plant. Indoor measured concentrations from the waste reception area at the AD seemed to be around 26 times lower than similar measurements taken from an agricultural AD (Cumby et al., 2005), potentially highlighting differences in the degree of NH_3 volatilisation from solid food wastes compared to livestock manure digestion substrates. The SBR was the second greatest source of NH_3 at the plant (5.1 mg s^{-1}, 30% of total emissions), a source which required no correction to fit to observed NH_3 concentrations from the initial emission factor (220 mg m^{-2} h^{-1}) adopted from the findings of Willers et al. (1996).

If minimising NH_3 emissions from the plant were required, it would be an effective course of action for plant operators to concentrate on emissions from the digestate storage area. Very low emissions were occurring at the entrance to the waste reception area, this indoor space is maintained at a negative pressure and connected to the mechanical ventilation and biofilter system, the entrance is also opened and closed rapidly to minimise emissions during deliveries. Connecting the digestate storage compartment to the mechanical ventilation and biofilter system and would reduce the NH_3 concentration within the room air and emissions, assuming the 87% NH_3 scrubbing efficiency measured by Cumby et al. (2005). Taking steps to minimise the ventilation rate and exposure to the atmosphere would contribute to further reductions, such as covering the digestate, using the biofilter ventilation system to keep a negative pressure, or streamlining the extraction process to reduce the duration of the entrance being opened.

Applying the emission factor of Willers et al. (1996) to the Deerdykes SBR produced an emission rate that was the second highest on the site (30% of total emissions). However, the feasibility of minimising emissions from the SBR is likely to be much reduced relative to the digestate store, as emissions from the surface of the tank would need to be contained without interfering with the aerobic treatment process, and the 5 m tall SBR tank is a greater distance from the biofilter system. Emissions from the SWBT (19% of emissions) arise after spillages of organic waste materials delivered and processed at the site are channelled into the tank via a drainage network. Therefore an effective strategy to minimise emissions from this source would be to apply further measures to minimise the occurrences of spillages on site.

4.3. Uncertainty in emission estimates

The averaged coefficient of variation (CV) between ALPHA triplicates for measurement periods 2–5 ranged from 1.9 to 10.9%, with the average being 4.5% (Supplementary material). As the downwind air concentration of a pollutant can be assumed to be directly proportional to the source strength (building effects may be exempt from this), a maximum error of 10.9% may be applied to emission rates that have been deduced by fitting predicted concentrations to those observed at the ALPHA sites. This is quite small relative to the rule-of-thumb of 'plus or minus a factor of two' that has often been adopted to describe the quality of predictions from atmospheric dispersion models (Fox, 1984; Chang and Hanna, 2004). Taking Scenario 3 emission rates and the maximum error observed in the ALPHA measurements, an emission rate for all sources at Deerdykes AD plant = 16.8 ± 1.8 mg s^{-1}. The emission rates for the Scenario 1 (bLS) and Scenario 2 (initial) estimates were 7.4 ± 0.8 mg s^{-1} and 27.5 ± 3 mg s^{-1} respectively.

There is however, potential error associated with the ADMS model, which hence impacts upon the assumption that the downwind concentrations will be directly proportional to the source strength. For example, ADMS has been shown to underestimate predicted concentrations relative to measurements in certain case studies (Hanna et al., 2001; Baumann-Stanzer et al., 2008; Theobald et al., 2012). Therefore if ADMS is underestimating concentrations around the AD plant, a greater emission rate will be needed to fit predicted concentrations to the ALPHA measurements. Further, perhaps the defined dry deposition velocity is of 0.02 ms^{-1} is unsuitable, or simply the single universal deposition velocity is unsufficient for the complexity of the area, and a more advanced canopy resistance model with multiple cover types is required. It is possible to set up a model with inaccurate emission rates and yet still arrive at perfect concentration predictions if overcompensating parameters and variables are not correctly representative. An important parameter with a high uncertainty is L, which is not derived from site sonic anemometer measurements as would ideally be the case but has been output from the ADMS meteorological pre-processor using time of day/year, latitude and cloud cover as the proxy for surface heating.

With six discrete sources grouped in a small area, determining individual emission rates by optimising to fit measurements is challenging, as there may be multiple source strength configurations to arrive at the 'correct' predictions. However at Deerdykes buildings and structures add complexity which can isolate certain sources, and the ADMS complex terrain module has the capability to provide accurate predictions where there are building effects (Hill et al., 2001). Non-Gaussian simulated concentration profiles in the wake of the AD plant are visible in Fig. 9. Without direct emission measurements for verification, the applicability of emission factors reported in the literature (Table 4) and close fit between predicted and observed concentrations at passive sampler receptors suggest that emission estimates are robust, reducing the associated uncertainties in qualitative terms.

4.4. Suitability of emission factors for upscaling

The measurement period at Deerdykes was relatively short, representative of summer conditions. The volatilisation of NH_3 is exponentially related to temperature (Sommer et al., 1991), where emissions can be expected to be higher during summer than the rest of the year. Further measurements would be necessary to determine the seasonal variability in emissions.

The storage and treatment of solid and liquid effluents (digestate store and SBR) were identified as the greatest sources of NH_3 at the AD plant, contributing 74% of total emissions. The optimised emission factor of Scenario 3 (0.0018% Total FW input volatilised as NH_3) is likely to be representative of AD plants where the digestate is separated into liquid and solid effluents, the liquid effluents being aerobically treated on-site while solids are stored for a short period of time in a warehouse-type storage unit with no emission control. Ultimately the management of digestate is an economic choice that is up to the operator, ranging from treating as a waste product to marketing as a high-value horticultural soil fertiliser. The UK market for digestate is immature and distribution is largely driven by local circumstances, where spreading of unseparated digestate to agricultural land is the most common end-use (WRAP/EA, 2009). Therefore this emission factor is not likely to be representative of the majority of AD plants. However, the estimated emissions from substrate storage and processing at the plant may well be representative of other community ADs that process source-segregated municipal and industrial wastes. Future investigations into NH_3 emissions from AD plants may benefit from

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focusing on the storage of digestate, preferably taking measurements at sites with isolated digestate storage and treatment facilities. Isolated sources with low topographical complexity create favourable conditions to take advantage of the efficiencies of the bLS method, to give valuable emission estimates and contribute to a representative EF for this emerging source of NH_3 emissions.

5. Conclusion

This study has demonstrated an economical methodology for the estimation of NH_3 emissions from a complex source. Three different modelling scenarios and approaches are evaluated for quantifying ammonia emissions without direct flux measurements: (1) top-down bLS method, (2) literature EF-based estimates of individual sources, (3) tuning of individual emission rates to observations of the surrounding concentrations. In this case site complexity likely caused significant error in estimating NH_3 emissions from the AD plant by the bLS method. Despite the complications, bLS simulations and continuous ambient concentration measurements describe a large degree of temporal variation in emissions due to daily operations on site. In differentiating the source area into six individual sources, the observed concentration field was very accurately reproduced by the ADMS model after optimising the theoretical emission estimates in an iterative-fit process. The total emission from the AD plant thus estimated by a tuned bottom-up approach was 16.8 ± 1.8 mg s^{-1}, which was significantly higher than top-down bLS estimate (7.4 ± 0.8 mg s^{-1}). According to the tuned (Scenario 3) estimates the storage and treatment of solid and liquid fractions of the separated digestate comprised 74% of total emissions, while the emissions associated with substrates from the biofilter, waste reception area and pre-processing area contributed just 8%. The integrated approach involving the optimisation of emission factors and dispersion models to operation and measurement perspectives demonstrates a practical and useful approach to understanding emissions from facilities such as the AD plant, with potential application to other complex sources of gaseous emissions.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.wasman.2016.06.002.

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Appendix E

EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019

Category		Title
NFR	5.B.2	Biological treatment of waste – anaerobic digestion at biogas facilities
SNAP	091006	Biogas production
ISIC		
Version	Guidebook 2019	

Coordinator
Carlo Trozzi

Contributing authors (including to earlier versions of this chapter)
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Contents

1 Overview

This chapter covers the emissions from the biological treatment of waste by anaerobic digestion at biogas facilities. Feedstocks for anaerobic digestion can be any biodegradable organic material such as livestock manure and crops from agriculture, food waste from food processing industries, households and restaurants, and organic waste from municipalities. The 2014 nomenclature for reporting (NFR), used for the international reporting of emission inventory data, introduced the new source category '5.B.2 Biological treatment of waste — anaerobic digestion at biogas facilities'.

2 Description of sources

2.1 Process description

Anaerobic digestion is a natural process by which biomass is broken down by naturally occurring microorganisms in the absence of oxygen. These microorganisms digest the biomass and release a methane-rich gas (biogas) that, if collected in a biogas plant, can be used to generate renewable heat and power. The remaining material (digestate) is rich in nutrients, so it can be used as a fertiliser.

The digestion process depends on the biomass of microbes, the substrate composition, the temperature in the digester, the dry matter content of the feedstock, the residence time in the digester and the biogas technology. Depending on the digestion technique and in order to improve the digestion process, feedstock pre-treatment, heating of the digester and mixing of feedstock can be useful.

2.2 Techniques

Technologies developed to digest biomass fall into the following categories:

1. wet or low solid digestion: operated at a dry matter content of less than 10 % (but the feedstock can have much higher solid content, which would be diluted upon entry);
2. dry or high solid digestion: operated at between a 15 % and 35 % dry solid content;
3. two- or multi-stage digestion: the development of multi-stage processes aimed to improve different stages of the digestion process, thus providing flexibility and better process control for the different stages of the anaerobic biochemical reactions.

The general concept of a biogas facility comprises the following stages:

1. pre-storage of feedstock
2. anaerobic digestion in the digester
3. storage of the digestate.

In practice, not all feedstock is stored before anaerobic digestion, but may be fed directly into the digester. The digester can consist of more than one gas-tight vessel. The storage of the digestate can be in a gas-tight vessel, an open tank or another storage facility. The storage may be combined with, or preceded by, treatment of the digestate, e.g. the separation of the liquid and solid fractions before storage. The possible treatment of the liquid fraction in a wastewater treatment plant, the combustion of the solid fraction and the utilisation of digestate as organic fertiliser are beyond the scope of Chapter 5.B.2 (see section 2.3).

2.3 Emissions

The storage of feedstock and digestate in open tanks, as well as their mechanical treatment, may cause emissions of the nitrogen (N) gases ammonia (NH_3) and nitric oxide (NO), as well as N2O, CH4, odour and dust. Anaerobic digestion is carried out in gas-tight vessels, and fugitive air emissions are unlikely to occur except during transfer to and from the digester and storage of feedstocks and digestate. However, fugitive emissions of biogas are possible from emergency vent valves and from poorly sealed water traps.

The emissions generated by the combustion of the biogas are addressed separately in Chapter 1.A.1.

This chapter (Chapter 5.B.2) considers the potential for NH_3 emissions from the following sources of biogas facilities:

1. during storage of feedstock on the premises of the biogas facility ([1]);
2. during storage of the digestate.

Agricultural crops used for biogas production (energy crops) are commonly stored as silage. As the pH of silage is low for conservation purposes, NH_3 emissions resulting from the storage of energy crops before anaerobic digestion are negligible.

As the digester is completely enclosed, no NH_3 emissions should occur. In the operation of a biogas plant however, instances of excess pressure might occur. In these cases, pressure valves might release some biogas (approximately 1 % of gas produced). For greenhouse gas calculations, these losses are relevant, as about 60 % of the gas volume is methane. The concentration of NH_3 in biogas is far lower (0.1–1 %), depending on the substrates being fermented. For most digestion processes, the leakage losses will therefore be less than 0.05 % of the nitrogen (N) content of the resulting digestate. Therefore, this source is here considered negligible.

Emissions of NO, odour and dust from anaerobic digestion at biogas facilities are not considered because they are likely to be insignificant.

2.4 Controls

Information on ways to reduce NH_3 emissions during storage of livestock manures is provided in Chapter 3B (e.g. rigid covers can reduce NH_3 emissions from storage of livestock slurry by about 80 %). No data are available on controlling emissions of NH_3 from storage of food wastes, but these are likely to be very small. The process of anaerobic digestion leads to elevated pH values and total ammoniacal nitrogen (TAN) contents. Therefore, it is strongly recommended that digestate is held in a covered store. The same measures as for livestock manures can be applied for the reduction of NH_3 emissions.

Information on general abatement technologies for NH_3 emissions from storage processes is given in the United Nations Economic Commission for Europe (UNECE) Framework Advisory Code of Good Agricultural Practice for Reducing Ammonia Emissions

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([1]) NH_3 emissions from feedstock storage prior to the pre-storage on the premises of the biogas facility (e.g. the on-farm storage of livestock manures) are not considered in this chapter in order to avoid possible double counting. The on-farm storage of livestock manures is dealt with in Chapter 3.B.

(https://www.unece.org/fileadmin/DAM/env/documents/2014/AIR/WGSR/eb.air.wg.5.2001.7.e.pdf) and the draft *Guidance document on preventing and abating ammonia emissions from agricultural sources* https://www.unece.org/fileadmin/DAM/env/documents/2014/AIR/WGSR/eb.air.wg.5.2001.7.e.pdf). This guidance document also gives information on the emission reduction potential of a variety of abatement technologies in terms of a percentage of unabated storage. If the proportion of digestate stored with certain technologies is known, the emission factor (EF) for this proportion can be reduced by this value.

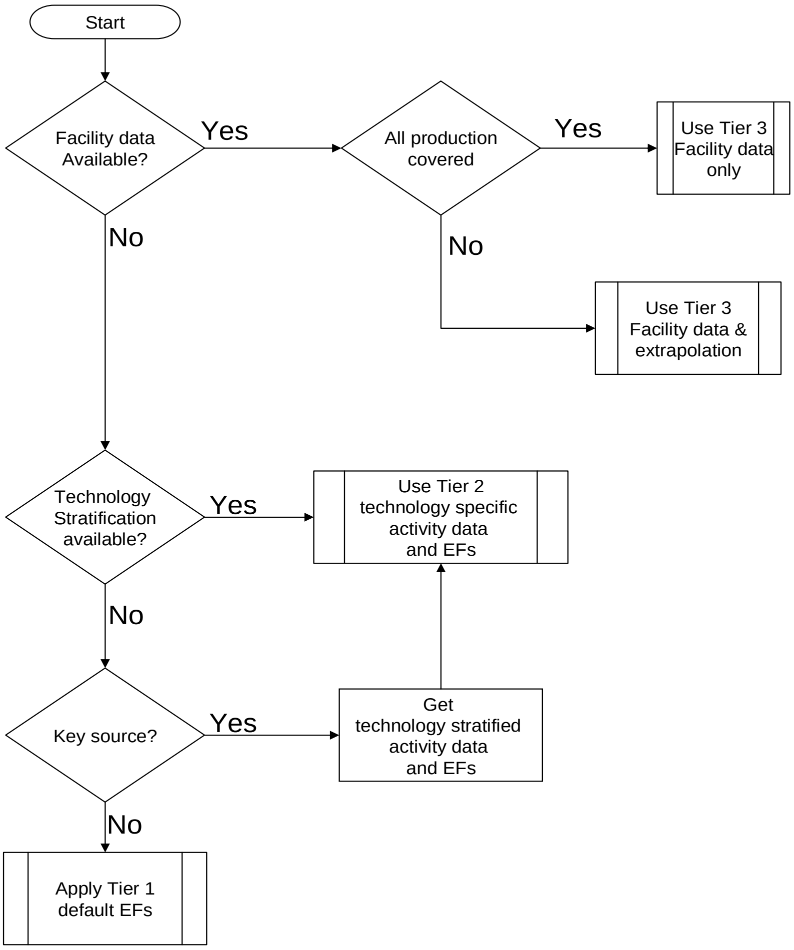
3 Methods

3.1 Choice of method

Figure 3.1 presents the procedure that should be used to select the methods for estimating emissions from this source category. The basic approach is outlined below.

- If detailed information is available, this should be used.
- If the source category is a key category, a Tier 2 or better method must be applied and detailed input data must be collected. The decision tree directs the user in such cases to the Tier 2 method, since it is expected that it will be easier to obtain the necessary input data for this approach than to collect the 'facility level' data needed for a Tier 3 estimate.
- The alternative to applying a Tier 3 method, that is, using a detailed process modelling at facility level, is included under 'facility data' in the decision tree.

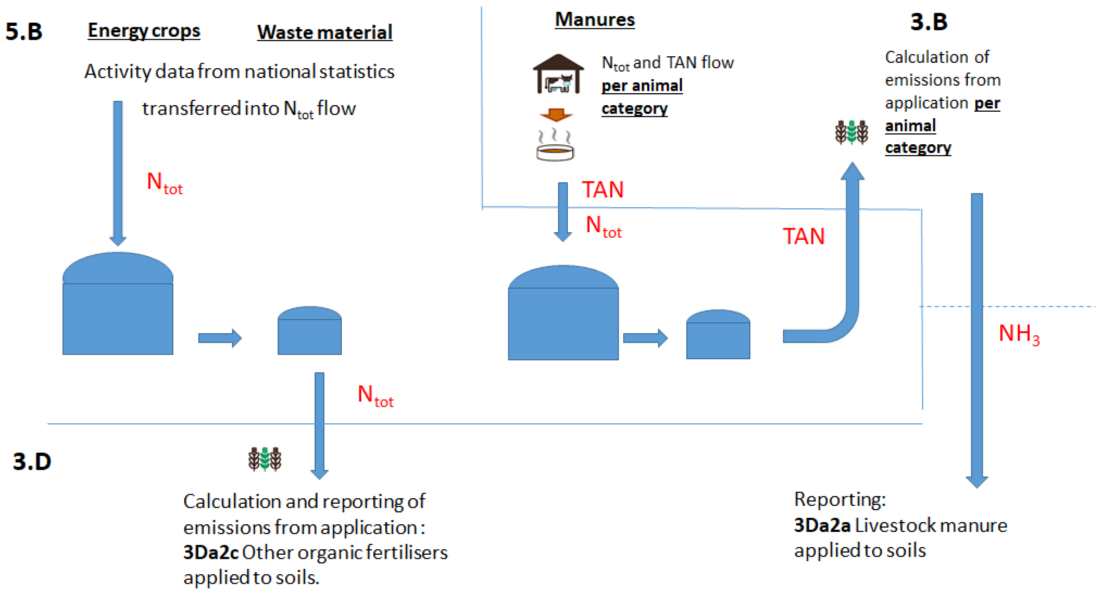
Figure 3.1 **Decision tree for source category 5.B.2 Biological treatment of waste — anaerobic digestion at biogas facilities**



3.2 Reporting emissions

As mentioned in chapter 3.B section 2.3, the Tier 2 method for calculating ammonia emissions from manure management follows a mass flow approach for total nitrogen (total-N) and total ammoniacal nitrogen (TAN). Therefore the emissions from application of digestates originating from livestock manure should be calculated in chapter 3.B, together with the emissions from application of untreated animal manures, and be reported under NFR code 3.D.a.2.a (Figure 3.2). Although being fully aware, that co-digestion of different feedstocks takes place, in 5.B.2, the digestion of manures should be calculated separately from the digestion of other organic wastes and of energy crops. The amount of total-N and TAN entering anaerobic digestion in manure must be consistent with formulae 22, 23, 28 and 29 in 3.B (chapter 3.4, Step 8). Emissions from spreading digestates resulting from digestion of manure are calculated in chapter 3B. Emissions from spreading digestates resulting from digestion of other organic wastes and energy crops are calculated in 3.D and reported under NFR code 3.D.a.2.c.

Figure 3.2 Reporting of emissions from anaerobic digestion at biogas facilities



If a Tier 1 approach is used, care should be taken not to double count emissions resulting from application of N excreted by livestock in 3.B According to Tier 1 in 3.B, emissions from manures are calculated based on animal places, including emissions from application. In this case, all N excreted by livestock is accounted for. Therefore no N from digested manures calculated in 5.B.2 should be considered for calculating emissions in 3.B if a Tier 1 approach is used in 3.B.

3.3 Tier 1 default approach

3.3.1 Algorithm

The Tier 1 approach estimates the total emission, E_{NH3} (in kg NH_3 per year), from:

$$E_{\mathrm{NH3}} = AR_{\mathrm{feedstock}} \times EF_{\mathrm{NH3\text{-}N,\,Tier\,1}} \times 17/14 \qquad (1)$$

where $AR_{feedstock}$ is the total annual amount of N in feedstock, in kg a^{-1}; and $EF_{NH3\text{-}N,\ Tier\ 1}$ is the Tier 1 NH_3-N EF related to N in feedstock, in kg NH_3-N per kg N. If no specific N amount is available from national data, $AR_{feedstock}$ is calculated by multiplying the total fresh weight of feedstock (tonnes a^{-1}) by the dry matter content of the feedstock (kg kg^{-1}) and the concentration of N in the feedstock dry matter (kg N per kg DM).

3.3.2 Default emission factor

The default EF (Table 3.1) is the total of the Tier 2 EFs provided in section 3.4.2. The range of uncertainty (95 % confidence interval) is estimated in accordance with section 3.4.2.

Table 3.1 Tier 1 EFs for source category 5.B.2 Biological treatment of waste — anaerobic digestion at biogas facilities

Tier 1 EFs					
	Code	Name			
NFR source category	5.B.2	Biological treatment of waste — anaerobic digestion at biogas facilities			
Fuel	NA				
SNAP (if applicable)	091006	Biogas production			
Technologies/practices					
Region or regional conditions	NA				
Abatement technologies	See section 2.4				
Not applicable	As, Cu, Ni, Se				
Not estimated	NO_x, CO, NMVOC, SO_2, TSP, PM_{10}, $PM_{2.5}$, BC, HCB, Pb, Cd, Hg, Cr, Zn, HCH, PCBs, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene				
Pollutant	**Value**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
NH_3-N	0.0275	kg NH_3-N per kg N in feedstock	0.0163	0.0501	See text

Total nitrogen in digestate after storage is calculated using equation (2)

$$N_{tot,dig} = N_{tot,sub} - (E_{NH3} \times 14/17) \quad (2)$$

With:

$N_{tot,dig}$: Total amount of N in digestate after storage in kg a^{-1}

$N_{tot,sub}$: Total amount of N in the feedstock entering 5.B.2 in kg a^{-1}

E_{NH3}: Ammonia emitted in kg a^{-1}, calculated in equation (1)

3.3.3 Activity data

The Tier 1 method requires the total annual amount of N in the feedstock entering the biogas plants to be known. In case if the data are not available they can be derived from the amount of fresh matter, based on data gathered by statistical surveys or derived from proxy data, e.g. livestock numbers and excretion rates, as well as information (e.g. expert judgement) on the percentage of manure being digested in biogas plants.

Table 3. provides default factors for the conversion of fresh matter units into N units.

3.4 Tier 2 technology-specific approach

3.4.1 Algorithm

The Tier 2 approach estimates the total emission, E_{NH3} (in kg NH_3 per year), from:

$$E_{\mathrm{NH3}} = AR_{\mathrm{feedstock}} \times \sum_{\mathrm{stages}} EF_{\mathrm{NH3\text{-}N,\,stage\ i}} \times 17/14 \qquad (3)$$

where $AR_{feedstock}$ is the total annual amount of N in feedstock, in kg a^{-1}; and $EF_{NH3\text{-}N,\ stage\ i}$ is the NH_3-N EF for stage i (i is the pre-storage, digester, and storage of digestate) related to the **total N in feedstock** (kg NH_3-N per kg total N). If no specific N amount is available from national data, $AR_{feedstock}$ is calculated by multiplying the total fresh weight of feedstock (tonnes a^{-1}) by the dry matter content of the feedstock (kg kg^{-1}) and the concentration of N in the feedstock dry matter (kg N kg^{-1}).

As pointed out in section 2.3, NH_3 emissions from the digester or the system of digesters can be assumed to be negligible.

As mentioned in section 3.2, emissions from the field application of digestates resulting from biogas production should be calculated in chapter 3.B for digested manures and in 3.D.a.2.c for digested energy crops and organic waste. Therefore in 5.B.2, the N-flow should be calculated separately for manures on one hand and energy crops and wastes on the other hand. As emission factors in 3.B are based on TAN the TAN flow needs to be considered for manures. The emission factor in 3.D.a.2.c is based on total N, therefore no TAN flow needs to be considered for energy crops and waste.

For digested manures, the TAN and total-N in manure (TAN_{sub} and N_{tot} respectively, kg a^{-1}) are:

$$TAN_{sub} = m_{biogas\_slurry\_TAN} + m_{biogas\_solid\_TAN} \qquad (4)$$

$$N_{sub} = m_{biogas\_slurry\_N} + m_{biogas\_solid\_N} \qquad (5)$$

where $m_{biogas\_slurry\_TAN}$, $m_{biogas\_solid\_TAN}$, $m_{biogas\_slurry\_N}$ and $m_{biogas\_solid\_N}$ are obtained from equations 22, 23, 28 and 29 in chapter 3B.

The TAN in digestate that is returned to chapter 3B (for use in equation 35; m_{dig_TAN}) is calculated using equation 6:

$$m_{dig\_TAN} = TAN_{sub} + f_{min} \times (N_{tot} - TAN_{sub}) - (E_{NH3} \times 14/17) \qquad (6)$$

where

m_{dig_TAN}: TAN in digestate after storage in kg a^{-1}

$f_{\ min}$: relative share of organic N entering the digester that is mineralized to TAN in the digester in kg kg^{-1}

E_{NH3}: NH3 emitted in kg a^{-1}, calculated from total N in equation (3)

The total-N in digestate that is returned to 3B (for use in equation 36; m_{dig_TAN}kg a^{-1}) is:

$$m_{dig\_N} = N_{tot\_dig} - (E_{NH3} \times 14/17) \qquad (7)$$

If no national data are available for f_{min}, a value of 0.32 for the N-mineralization of organic N in manures digested in biogas plants is recommended as used in the German emission inventory (Haenel et al 2018).

As calculations in 3.B are differentiated for different animal categories, TAN flow for digestion should also be calculated separately for the respective animal categories.

For digested energy crops and waste, $N_{tot,dig}$ in digestate after storage is calculated using equation (2) replacing E_{NH3} from equation (1) by E_{NH3} from equation (3)

3.4.2 Tier 2 emission factors

The European Union (EU) reference document on best available techniques (BREF document) for 'Waste treatment industries' (EC, 2006) gives typical emission ranges for most pollutants, but there is no information for NH_3 emissions. This section presents the Tier 2 NH_3 EFs for anaerobic digestion at biogas facilities adopted from Cuhls et al. (2010). These EFs were derived from trials with municipal organic waste and green waste (gardening waste). For all stages, they were calculated by relating the stage-specific NH_3 emissions (if enclosed, before air scrubbing) to the total amount of fresh matter of the feedstock entering the biogas plants. However, because of the degradation of organic matter during the process, which might vary between the different feedstocks, fresh matter is an inappropriate entity for relating NH_3 emissions to. Hence, the EFs derived by Cuhls et al. (2010) were converted into units of kg NH_3-N per kg N in the feedstock. The input material for the German plants covered by the study of Cuhls et al (2010) are municipal organic wastes and green wastes (gardening wastes). These two substrates are used in approximately equal proportions for biogas production in Germany. Therefore, the arithmetic mean of the N content in fresh matter of municipal organic waste and green waste was used for the conversion. The data are provided in Table 3.4.

NH_3 emissions from the digester can be considered negligible (see section 2.3), hence an EF of zero is suggested.

Cuhls et al. (2010) only provide emission factors for the storage of separated digestate (solid and liquid fractions). Therefore, this emission factor for storage was estimated by adding the emission factors for the storage of the two digestate fractions after separation. It applies to open storage only; if the digestate is stored in closed storage, the ammonia emission can be considered negligible. Countries are encouraged to use more specific national emission factors.

According to Heldstab et al. (2015), p. 284, the uncertainties (95 % confidence interval) of the EFs provided by Cuhls et al. (2010) are estimated to be a factor of 1.75.

Table 3.2 Tier 2 EFs for source category 5.B.2 Biological treatment of waste — anaerobic digestion at biogas facilities; pre-storage of feedstock

Tier 2 EFs		
	Code	Name
NFR source category	5.B.2	Biological treatment of waste — anaerobic digestion at biogas facilities
Fuel	NA	
SNAP (if applicable)	091006	Biogas production
Technologies/practices	Pre-storage	
Region or regional conditions	NA	
Abatement technologies	See section 2.4	
Not applicable	As, Cu, Ni, Se	

Not estimated	NO_x, CO, NMVOC, SO_2, TSP, PM_{10}, $PM_{2.5}$, BC, HCB, Pb, Cd, Hg, Cr, Zn, HCH, PCBs, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene				
Pollutant	**Value**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
NH_3	0.0009	kg NH_3-N per kg N in feedstock	0.0005	0.0015	See text

Table 3.3 Tier 2 EFs for source category 5.B.2 Biological treatment of waste — anaerobic digestion at biogas facilities; storage of digestate (open storage)

Tier 2 EFs					
	Code	Name			
NFR source category	5.B.2	Biological treatment of waste — anaerobic digestion at biogas facilities			
Fuel	NA				
SNAP (if applicable)	091006	Biogas production			
Technologies/Practices	Storage of non-separated digestate				
Region or regional conditions	NA				
Abatement technologies	See section 2.4				
Not applicable	As, Cu, Ni, Se				
Not estimated	NO_x, CO, NMVOC, SO_2, TSP, PM_{10}, $PM_{2.5}$, BC, HCB, Pb, Cd, Hg, Cr, Zn, HCH, PCBs, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene				
Pollutant	**Value**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
NH_3	0.0266	kg NH_3-N per kg N in feedstock	0.0152	0.0465	See text

3.4.3 Activity data

Surveys on the amounts of different types of feedstock are necessary to derive the necessary activity data on N entering anaerobic digestion. These cover all biodegradable organic materials including livestock manures, crops that are grown for energy production and other organic agricultural wastes, such as crop residues, that are used for anaerobic digestion at biogas facilities. According to the definition of the EFs (see section 3.4.2), the total N amounts of feedstock entering the biogas plants are required for calculating the emissions in the biogas process with the Tier 2 methodology.

The amounts of N and TAN in livestock manures to be digested should be derived from the corresponding N and TAN flows calculated in Chapter 3.B, section 3.4 (Step 8).

Table 3. gives the N contents of some possible feedstock types. These default values can be used to convert feedstock fresh matter into amounts of N. The figures in

Table 3. are based on German data, but are also in reasonable agreement with data from the United Kingdom (Webb, J., UK national atmospheric emission inventory team, personal communication, 2016). Countries are encouraged to use their own national data if available.

If dry matter contents differ substantially from those given in

Table 3., N contents can be corrected using the ratio of national to default dry matter contents. In particular, for municipal organic waste, green waste and food waste it is strongly recommended that national data are established, as N content can vary widely.

According to Heldstab et al. (2015), p. 284, the uncertainty of the activity data (95 % confidence interval) is estimated to range from –20 % to +20%.

Table 3.4 N content for various feedstock categories

Feedstock type	Dry matter content of fresh matter (kg kg^{-1})	N content of fresh matter (kg kg^{-1})
Municipal organic waste ([a])	0.40	0.0068
Green waste (grass, etc.) ([a])	Not available	0.0046
Food waste (food processing) [1)]	Not available	0.0051
Cattle slurry ([a])	0.10	0.0052
Pig slurry ([a])	0.06	0.0048
Cattle solid manure ([b])	0.25	0.0052
Pig solid manure ([b])	0.25	0.0060
Poultry manure ([b])	0.50	0.0175
Maize silage ([a])	0.35	0.0046
Grass silage ([a])	0.35	0.0094
Straw ([a])	0.86	0.0051

Sources: ([a])KTBL, (2013), ([b]) LfL (2013).

3.5 Tier 3 emission modelling and use of facility data

This guidebook does not provide a Tier 3 method because of the scarcity of sound methodologies with this approach. However, Wulf and Haenel (2014) proposed a method that could be considered by the countries to implement Tier 3 emission estimates for agricultural feedstock ([2]). A comprehensive description of this German methodology is given by Haenel et al. (2018).

4 Data quality

4.1 Completeness

A complete inventory for biogas facilities should estimate NH_3, NO, total suspended particles (TSP), particulate matter (PM) and non-methane volatile organic compounds (NMVOCs). However, at present, NO, TSP, PM and NMVOC emissions from biogas facilities cannot be reported, as no methods exist to calculate these emissions.

It is essential to include the complete range of feedstocks in the emission calculations and to ensure that emissions from the utilisation of digestate are reported properly (e.g. utilisation as fertiliser in section 3.D and incineration in Chapter 1.A).

4.2 Avoiding double counting with other sectors

Care should be taken not to double count emissions from biogas facilities. NH_3 emissions resulting from the storage of agricultural feedstocks not located on the premises of biogas facilities have to be considered in Chapter 3.B (Manure management).

In addition, emissions produced from the burning of the biogas produced in engines, boilers and/or turbines have to be reported in the relevant chapter (Chapter 1.A, Combustion). Emissions following the application to land of digestate derived from livestock manure are calculated in 3B and reported in 3Da2a.

([2])http://www.tfeip-secretariat.org/assets/Ag_Nature/2014/Biogasemission-inventoryTFEIP5.pptx

4.3 Verification

There are no direct methods to evaluate total inventory estimates of NH_3 emissions from the biological treatment of waste.

4.4 Developing a consistent time series and recalculation

There are no specific issues related to developing a consistent time series and recalculation.

4.5 Uncertainty assessment

General guidance on quantifying uncertainties in emission estimates is given in Part A, Chapter 5, 'Uncertainties', of the EMEP/EEA Guidebook (EMEP/EEA, 2016).

The uncertainties related to the EFs are addressed in section 3.4.2. It is good practice to consider that, from country to country, the composition of the treated waste may vary because of differences in waste definitions and fractionation. This could lead to country-specific EFs that are not comparable with those of other countries.

For more on the uncertainty of the activity data, see section 3.4.3.

4.6 Inventory quality assurance/quality control (QA/QC)

There are no specific issues related to inventory quality assurance/quality control (QA/QC).

4.7 Gridding

There are no specific issues related to gridding.

4.8 Reporting and documentation

Emissions calculated with Equations 1 or 2 are to be reported under NFR 5.B.2.

It should be noted that emissions from the application of digestate to land need to be reported under NFR 3.D.a.2.c.

Documentation, detailing when and where the biogas facility inventory was checked and by whom, is required.

5 References

Cuhls, C., Mähl B. and Clemens J., 2010, 'Emissionen aus Biogasanlagen und technische Maßnahmen zu ihrer Minderung', in: Thomé-Kozmiensky, K. J. and Beckmann, M (eds), *Erneuerbare Energien Band 4*, TK Verlag — Fachverlag für Kreislaufwirtschaft, Neuruppin, Germany, 147–160

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EMEP/EEA, 2016, 'General guidance - Uncertainties', in: *EMEP/EEA air pollutant emission inventory guidebook 2016 — Technical guidance to prepare national emission inventories*, EEA Technical Report

No 21/2016, European Environment Agency (http://www.eea.europa.eu/emep-eea-guidebook), accessed 30 September 2016.

Haenel, H.-D., Rösemann, C., Dämmgen, U., Döring, U., Wulf, S., Eurich-Menden, B., Freibauer, A., Döhler, H., Schreiner, C. and Osterburg B., 2018, *Calculations of gaseous and particulate emissions from German agriculture 1990–2016: Report on methods and data (RMD) Submission 2018*, Thünen Report 57, Thünen Institute, Braunschweig, Germany DOI:10.3220/REP1519913866000

Heldstab, J., Herren, M. and Walder, J., 2015, *Switzerland's Informative Inventory Report 2015 (IIR) — Submission of March 2015 to the United Nations ECE Secretariat*, Federal Office for the Environment (FOEN), Air Pollution Control and Chemicals Division, Bern, Switzerland.

KTBL, 2013, Internal substrate database. Association for technology and structures in agriculture (KTBL), Darmstadt, Germany. Database accessed 3 August 2016. Database is used for all KTBL publications.

LfL, 2013, Basic data for German agricultural consultancy. Bavarian State Research Center for Agriculture, Freising, Germany (http://www.lfl.bayern.de/mam/cms07/iab/dateien/basisdaten_2013_7.pdf) accessed 3 August 2016.

Wulf, S. and Haenel, H.-D., 2014, 'Implementation of biogas-production into the German agricultural emission inventory', the Task Force on Emission Inventories and Projections' Expert Panel on Agriculture and Nature, 13 May 2014, Ghent, Belgium.

6 Point of enquiry

Enquiries concerning this chapter should be directed to the relevant leader(s) of the Task Force on Emission Inventories and Projections' (TFEIP's) Expert Panel on combustion and industry. Please refer to the TFEIP website (www.tfeip-secretariat.org/) for the contact details of the current expert panel leaders.

Appendix F

Ohio EPA DAPC Air Toxics Policy

OPTION A

REVIEW OF NEW SOURCES OF AIR TOXIC EMISSIONS

Ohio Environmental Protection Agency
Division of Air Pollution Control
1800 WaterMark Drive
Columbus, Ohio 43215

REVIEW OF NEW SOURCES OF TOXIC EMISSIONS

Synopsis

The following is a summary of the Ohio Environmental Protection Agency (EPA) policy for the control of toxic air emissions.

1. Determine if a threshold limit value (TLV) exists for the specific compound which is emitted form the source.

2. Divide the TLV by ten to adjust the standard from the working population to the general public (TLV/10).

3. Adjust the standard to account for the duration of the exposure (operating hours of the source) of “X” hours per day and “Y” days per week from 8 hours per day and 5 days per week. This formula is used to obtain the Maximum Acceptable Ground-Level Concentration (MAGLC).

$$\frac{TLV}{10} \times \frac{8}{X} \times \frac{5}{Y} = 4\ \frac{TLV}{XY} = MAGLC$$

4. The Director may, on a case-by-case basis, accept an alternate analysis from a new source applicant.

Introduction

The basis for the air program's activities have been based upon the ambient air quality standards for "criteria pollutants." These standards, designed to protect health and welfare, have been established by U.S. EPA for the following six (6) pollutants:

1. Total suspended particulates,
2. Sulfur dioxide,
3. Carbon monoxide,
4. Nitrogen dioxide,
5. Ozone, and
6. Lead (Pb).

Emission limitations for new and existing sources have been established under the federal National Emission Standards for Hazardous Air Pollutants (NESHAPs) for the following pollutants:

1. Vinyl chloride,
2. Asbestos,
3. Beryllium,
4. Mercury,
5. Benzene, and
6. Arsenic (proposed).

The federal New Source Performance Standards (NSPS) also address several additional pollutants which are:

1. Fluorides,
2. Sulfuric acid mist,
3. Hydrogen sulfides, and
4. Reduced sulfur compounds.

For new sources, the Permit to Install rules require the application of Best Available Technology, and emissions of non-specified contaminants can be controlled through this mechanism. However, this level of review may not be adequate for toxic emissions. U.S. EPA has been slow to promulgate NESHAPs for additional pollutants. In order to assist in the review of new sources of toxic contaminants, the following policy has been developed by the Air Quality Modeling and Planning Section of the Division of Air Pollution Control.

Background and Rationale

The American Conference of Governmental Industrial Hygienists (ACGIH) has been involved with the safety aspects of work places where individuals may be exposed to varying levels of toxic substances. The ACGIH publishes and continuously updates a list of "Threshold Limit Values" (TLVs) for many substances. These TLVs represent maximum concentrations under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effects. Most of the TLVs refer to time-weighted average concentrations for a normal work day, with certain excursions within limits permissible during that time period, as long as the weighted average is not exceeded. However, for certain substances, there are levels that should not be exceeded at any time.

As outlined below, there are certain limitations and dangers in the literal application of TLVs for air pollution control purposes.

1. Threshold Limit Values are based on the information gathered in industrial/commercial settings, through experience from medical research and practice, from experimental human and animal studies, and also from a combination of these sources. Only in a few instances have the values been established firmly on a basis of examinations of human subjects correlated with extensive environmental observations.

2. The TLVs were determined for a population of workers who are essentially healthy and who fall within a "working age group" of about 17 to 65 years.

3. Synergistic effects of mixtures of substances are not considered in the development of TLVs, although the TLVs for mixtures can be calculated via the appropriate formula.

4. Individuals vary in sensitivity of susceptibility to toxic substances.

5. Often a single value is given for substances which occur in different forms and may have different toxicities.

6. For most contaminants, a worker during a normal work schedule (8 hours per day, 5 days a week) receives 40 hours of exposure per week daily and weekend periods in which the body may rid itself of the accumulated substances before toxic levels are reached. For a person living continuously in an environment containing such substances, however, these recovery periods do not exist. Exposure to TLV levels may, therefore, subject the person to an unacceptably high risk of injury.

In setting ambient goals for toxic substances, two time periods must be considered.

1. Duration of Exposure - This is the amount of time a person spends in contact with a toxic substance. (In this application, it is assumed that a person may continuously be exposed to the specific contaminants during the operating hours of a source.)

2. Averaging Time - This time period is used to measure compliance with the standard.

For example, the OSHA TLVs have a maximum allowable duration of exposure of 8 hours/day and 40 hours/week, but an averaging time of 8 hours for determining compliance with the rules. Similarly, the ambient lead standard has a continuous duration of exposure, but a quarterly averaging time for determining compliance. Also, the ACGIH publishes acceptable ceiling concentration values within an 8-hour workday, and acceptable peak concentrations for a short period of time, in addition to the time-weighed 8-hour weekday.

Determination of Maximum Acceptable Ground-Level Concentration (MAGLC)

Taking into account the duration of exposure and averaging time, the following stepwise procedure should be used to determine the allowable ambient air concentration for a toxic substance:

1. Determine if a TLV exists for the specific compound which is emitted from the source.

2. Divide the TLV by ten (10) to adjust the standard from the working population to the general public (TLV/10).

3. Adjust the standard to account for the duration of the exposure (operating hours of the source) of "X" hours per day and "Y" days per week from 8 hours per day and 5 days per week.

$$\frac{TLV}{10} \times \frac{8}{X} \times \frac{5}{Y} = 4\ \frac{TLV}{XY}$$

4. The TLVs are based on an averaging time of 8 hours per day. The standard method of determining the ambient air quality effect of the source is through dispersion modeling. The most readily adaptable averaging time for dispersion models is generally one hour. The approvability of a source will be based on the predicted one-hour averaging time (under worst-case meteorology) in comparison to the MAGLC obtained from Step 3. If the impact of the source is greater than the MAGLC, additional measures by the source will be necessary before the Permit to Install can be issued. Because no adjustment is made to the formula in Step 3, an additional safety factor of approximately 30% is produced (see Appendix A for the derivation of the 30% safety factor).

$$MAGLC = 4\ \frac{TLV}{XY}$$

By using a factor of 10 in Step 2 and by decreasing the averaging time in Step 3, the TLV has been adjusted for the greater susceptibility of the general population in comparison to healthy workers.

The 8/X and the 5/Y multipliers in Step 3 are used to relate the exposure to longer than 40-hour time periods and ascertain that the individual's total exposure will be no greater than that allowed by the TLV.

For less than 40 hours per week of plant operation, the MAGLC formula will yield a value greater than the TLV/10. Although excursions of up to three times the TLV can be calculated in some cases, it does not appear reasonable to permit this situation for the general population. A condition on the formula is, therefore, necessary to limit the allowable concentration to TLV/10 for operating times less than 40 hours per week.

Thus, from the above analysis, the derivation of the maximum acceptable ground-level concentration (maximum one hour average) beyond the plant boundary of a continuous emitting source would be:

$$MAGLC = \frac{TLV}{10} \times \frac{8\ hours}{24\ hours} \times \frac{5\ days}{7\ days} = \frac{TLV}{42}$$

An example of this procedure is contained in Appendix B.

The application of the policy is for use as a guideline in the review of new source applications. There may be cases where the TLV values are inappropriate for this type of application. The Director may consider, on a case-by-case basis, other data in the determination of a Maximum Acceptable Ground-Level Concentration from a new source.

Comparisons of MAGLC to National Ambient Air Quality Standards Values

In order to determine the relative stringency of this procedure, a comparison was made using this method with the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide and ozone, and with the NESHAP for beryllium:

A. Sulfur Dioxide

For a continuously emitting sulfur dioxide source, the acceptable one-hour ground-level concentration would be:

$$MAGLC = \frac{4\ TLV}{X\ Y} = \frac{(4)\ (5\ ppm)}{(24\ hr/day)(7\ days/week)} = 0.12\ ppm$$

Under the NAAQS, the three-hour standard is 0.5 ppm, not to be exceeded more than once per year.

B. Ozone

For an intermittent ozone source operating three hours per day, five days per week, the allowable impact would be:

$$MAGLC = \frac{TLV}{10} = \frac{0.1\ ppm}{10} = 0.01\ ppm$$

The NAAQS for ozone is 0.12 ppm one-hour average, not to be exceeded more than once per year over a three-year period.

APPENDIX A

The vertical (σ_z) and horizontal (σ_y) dispersion parameters utilized in most gaussian models were developed by Pasquill[1] and modified by Gifford[2]. Although the original experiments were based on a ten-minute sampling time, in practice, σ_y and σ_z values are considered to represent dispersion for a one-hour average. Due to wind direction fluctuations and variations in wind speed, it is necessary to adjust predictions which are greater than one-hour to account for these meteorological phenomena. To apply the predictions to longer than a one-hour period, the following equation is suggested by Turner[3]:

$$X_s = X_k \frac{(t_k)^p}{t_s}$$

Where

X_s is the concentration predicted over an averaging time t_s,

X_k is the concentration predicted over an averaging time t_k,and

p is a constant and should be between 0.17 and 0.2

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[1] F. Pasquill, “The estimation of the dispersion of windborne material,” Meteorological Magazine, Vol. 90, 1961, pp. 33-49.

[2] F.A. Gifford, “Use of routine meteological observations for estimation atmospheric diffusion,” Nuclear Safety, Vol. 2, 1961 p. 47.

[3] D.B. Turner, “Workbook of Atmospheric Dispersion Estimates,” Office of Air Programs Publication, No. AP-26, U.S. EPA, Research Triangle Park, North Carolina, 1970.

As shown below, applying this equation to the case of estimating an eight-hour average concentration, the one-hour predicted concentration should be reduced by 32%.

$$X_s = \frac{(t_k)^p}{t_s}$$

$$\frac{X_s}{X_k} = \frac{(1)}{(8)}0.185$$

$$\frac{X_s}{X_k} = 0.680$$

By not allowing for this adjustment when reducing the averaging time from eight-hour to one-hour in step 4, an additional safety factor of 32% is realized.

APPENDIX B

A new hazardous waste incinerator is proposing to burn sludge containing cadmium. The incinerator is equipped with a wet scrubber which is designed to remove 98% of the cadmium in the waste gas stream and will emit 4.6 pound per hour of cadmium. The incinerator will operate 24 hours per day, 7 days per week.

The TLV for cadmium is 0.1 mg/m^3, and from Step 4, the maximum allowable ground-level concentration would be:

$$MAGLC = \frac{4\ TLV}{X\ Y} = \frac{(4)\ (0.05\ mg/m^3)}{(24\ hr/day)(7\ days/week)} = 1.19 \times 10^{-3}\ mg/m^3$$

$$= 1.19 \text{ x } 10^{-6}\ g/m^3$$

From the PTMAX model, the maximum one-hour impact from the source is predicted to be 6.24x10^{-6} at 0.5 m/sec wind speed and F stability.

Since the predicted concentration is greater than the MAGLC of 1.19x10^{-6} g/m^3, the source will be required to develop a plan to reduce the ambient impact of the cadmium emissions.