UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

JUL - 2 2012

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Mr. Edward Hanlon
Designated Federal Officer
EPA Science Advisory Board Staff Office
Mail Code: 1400R
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460-4164

Dear Mr. Hanlon:

At the March 14-16, 2012, meeting of the Science Advisory Board (SAB) Animal Feeding Operations Emission Review Panel, panel members raised questions regarding the two documents the Office of Air and Radiation had submitted for SAB review. While my staff was able to respond to a number of the questions during the meeting, some of the questions required additional research. These questions were submitted by the Panel's Designated Federal Official and the attached files contain the EPA's responses.

If the SAB has any additional questions, please contact Ms. Robin Dunkins at (919) 541-5335.

Sincerely,

Stephen D. Page
Director
Office of Air Quality Planning
and Standards

Enclosures

EPA Responses to Additional Science Advisory Board Data Request (5/22/12)

On March 14-16, 2012, the EPA's Science Advisory Board (SAB) convened a panel to review the draft emissions-estimating methodologies (EEMs) developed by the EPA for broiler confinement operations and swine and dairy lagoons/basins. This document presents the EPA's responses to panel members' questions and requests for additional data. This document is organized to follow the numbered questions submitted by the SAB (see Index of SAB Questions).

Where applicable, page numbers corresponding to the full pdf file (i.e., the file containing the draft EEM document sections and appendices) and the individual document sections are provided for data and information cited in the question responses.

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3.1.4 More direct estimates of total solids and nutrient loading to lagoons/basins are needed for the lagoon study. Collectible cow units may be helpful. *37*

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1 Broiler Report

1.1 Paul Sampson:

1.1.1 Mean variance relationships are not in the document, nor is a comparison of diagnostic variance vs. means. Were other assessments conducted other than just normality?

Response: Mean-variance relationships are addressed for ammonia (NH_3) emissions in Section 7.4.4 of the broiler emission estimating methodology (EEM) development document. The EPA considered using a skew-right distribution for NH_3 emissions, which would account for a mean-variance relationship if one were needed, based on the examination of the histograms in Section 7.2 of the broiler EEM development document. The EPA also used the plots of NH_3 emissions vs. average bird mass in Figures 7-5 and 7-6 to determine that accounting for a mean-variance relationship for NH_3 emissions was not necessary (the vertical spread of emissions for any given value of average bird mass showed no consistent pattern). The EPA did not assess the need for a probability distribution other than the normal distribution for the other pollutants. The EPA did not conduct a comparison of diagnostic variance vs. means.

Response references:

- Draft Broiler EEM Document, Section 7.2 (p. 158 of full pdf file; p. 7-11 of Section 7)
- Draft Broiler EEM Document, Section 7.4.4 document (p. 183 of full pdf file; p. 7-36 of Section 7)
- Draft Broiler EEM Document, Figure 7-5 (p. 162 of full pdf file; p. 7-15 of Section 7)
- Draft Broiler EEM Document, Figure 7-6 (p. 163 of full pdf file; p. 7-16 of Section 7)

1.1.2 If Amy has saved results of her current fitted models, she should be able to generate some residual analyses without much effort. In the case of the Broiler report, in addition to normal quantile-quantile (QQ) plots and the overall plots of residual plots vs. fitted value, we strongly suggest that residuals (and/or validation prediction errors) be broken down and examined according to spatial and temporal design factors. For example, boxplots of residuals should be made by site, house, flock, and season. We also suggest time series plots of observed and fitted (or predictions in the case of cross-validation) emissions separately for each of the five houses at the 3 sites.

Response: The requested plots were not developed during the EPA's analysis of the data and are not available.

1.1.3 It would be helpful to see ACFs (auto-correlation functions) and/or PACFs (partial auto-correlation function) of model residuals, but this is a little more than just a plot of existing data. All of these might be just for NH3. My bullet points for the Lagoons report currently request similar things:

Suggestion: Boxplots of emissions by the many farm level categorical factors, perhaps separately for different seasons or levels of other factors.

Diagnostics: the usual residuals vs. fitted values, QQ-plots to assess distributional form, etc., but also, break down residuals by farm (hence by animal). However, also generate, separately for each farm, time series of measured and fitted or predicted emissions according to the model.

Response: Plots of the ACFs and PACFs of model residuals were not developed during the EPA's analysis of the data and are not available.

1.2 Rick Kohn: How much data was eliminated due to incompleteness?

Response: Table SAB-1 summarizes the number of broiler emissions observations lost for both the California and Kentucky sites due to incompleteness of the predictor variables

(i.e., inventory, average bird mass, temperature, relative humidity, pressure, confinement temperature, confinement relative humidity).

Response references:

Draft Broiler EEM Document, Section 7.2 (p. 158 of full pdf file; p. 7-11 of Section 7)

Table SAB-1. Broiler Emissions Data Excluded Due to Incompleteness

Pollutant	Total Emissions Observations (daily values)	Obs. w/Missing Predictor Variable(s)		Total Emissions Obs. for EEM Development
		Days	Percent of Total	
NH_3	1,279	68	5%	1,211
H_2S	1,463	68	5%	1,395
PM_{10}	1,219	45	4%	1,174
$PM_{2.5}$	593	14	2%	579
TSP	601	16	3%	585
VOC	360	5	1%	355

1.3 Deanne Meyer: Is there a summary table on detection limits for analytical methods?

Response: Detection limits of the various instruments are presented in the National Air Emissions Monitor Study (NAEMS) Quality Assurance Project Plan (QAPP) and the QAPP developed for the Kentucky sites, which are included in Appendix A of the draft broiler document.

Response references:

- Draft Broiler EEM Document, Appendix A, NAEMS Barn QAPP, Table 1.4.1 (pp. 330 – 331 of the full pdf file)
- Draft Broiler EEM Document, Appendix A, QAPP for the Kentucky Sites, Table 7.1 (p. 469 of the full pdf file)
- Draft Lagoon EEM Document, Appendix A, Open Source QAPP, Table 6.1 (pp. 170 – 172 of the full pdf file); Table 6.2 (p. 172 of the full pdf file)

1.4 Dave Allen: Measurements were made of cleaned-out litter; where was sample taken in this litter? If you are going to do a mass balance it would be good to know how long after the litter was removed from the house the sample was taken.

Response: The procedures for litter sample collection at site CA1B are outlined in the standard operating procedure (SOP) document M1 (manure sampling) located in Appendix C of the draft broiler document. As reflected in the final report for site CA1B, three types of manure samples were collected: surface litter, decaked litter and litter removed during full clean-out. Surface litter samples were collected over the grow-out period from 16 random locations per house, including 8 samples from the front of the house with relatively fresh litter, and 8 from the back of the house with the older litter. The samples were considered representative of the house litter. At each sampling location, all litter within a 0.6-m radius was brought to the center of the sampling location and mixed thoroughly. Composite samples from the mixtures were analyzed for pH, solids and NH_3. Samples of decaked litter and litter removed during full clean-out were collected from a blended litter pile before it was removed from the house. The decaked and full litter clean-out samples were taken from the house prior to clean-out activities. A total of 12 samples were collected for each litter decaking and clean-out event and analyzed for ash (for samples collected after December 2, 2008), nitrogen and solids content.

As described in the QAPP for the Kentucky sites, two types of litter samples were collected: total litter and decaked litter. For total litter sampling, the broiler house was divided into nonbrooding and brooding zones. Each zone was then subdivided into three sections: sidewall, waterer and feeder, and central. Twenty random samples were collected from each section and pooled together to form one composite sample per section (three composite samples per zone). For decaked litter, shovel samples were taken from each load of removed litter and combined to form two composite samples.

Response references:

- Draft Broiler EEM Document, Appendix C, SOP M1 (pp. 1271 - 1282 of full pdf file)

- Draft Broiler EEM Document, Section 3.3.1.7 (pp. 41 – 42 of full pdf file; pp. 3-16 and 3-17 of Section 3)
- Draft Broiler EEM Document, Appendix B, CA1B site monitoring plan (SMP) (p. 755 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for site CA1B (pp. 1760 -1761 of full pdf file)
- Draft Broiler EEM Document, Section 3.3.2.7 (pp. 52 - 53 of full pdf file; pp. 3-27 - 3-28 of Section 3)
- Draft Broiler EEM Document, Appendix A, QAPP for Kentucky sites, Section 12.9 (pp. 501 – 503 of full pdf file)

1.5 Peter Bloomfield: Table 7-13 on page 7-43: please clarify what is being shown, and what is shown in table and what should occur when eliminating a variable.

Response: Each column in Table 7-13 shows the fit statistics for each of the steps in the backward-elimination process that were completed to determine the final version of the IA EEM. The fit statistics listed in each column of the table were ultimately used to determine the version of the EEM, that best represented the data (i.e., accounted for the most variability in the data).

The backward-elimination process begins by building an EEM including all variables and their interaction terms. The EPA built this regression-based EEM using the Statistical Analysis System (SAS) software, which provides a test of the significance of each term in the EEM as standard SAS output. To declare statistical significance, the EPA looked for p-values with an order of magnitude of $\alpha = 0.001$. The EPA examined this SAS output and determined which variable was the least statistically significant (i.e., the largest p-value). The EPA documented which candidate predictor variable was eliminated; the EPA then eliminated that variable from the list in SAS and recalculated the EEM. This process continued until all variables remaining in the EEM had a p-value (not shown in Table 7-13) less than or equal to 0.001. Table 7-13 shows that the IA EEM was completed at step 10 after eliminating the 10 terms shown in the last row.

The fit statistics based on the base dataset included in Table 7-13 are the negative two residual/restricted log likelihood (-2RLL) and the Bayesian Information Criterion (BIC), which is based on the -2RLL. [*In the draft broiler EEM document, this variable was incorrectly labeled as "-2LL."*] Minimizing the -2RLL value is the mathematical equivalent of maximizing the probabilities that different sets of parameter values will reproduce emissions values present in the NAEMS dataset. When comparing the values of -2RLL for two different EEMs, the one with the lower -2RLL better fits the data. The BIC statistic is a function of -2RLL, with a penalty added for the number of parameters in the EEM for situations in which fewer parameters are desirable. Lower values of the BIC statistic are also better; however there are instances where eliminating a term increases the -2RLL while decreasing the BIC. If both the -2RLL and the BIC decrease with a backward-elimination step, there is strong evidence that the resulting EEM provides a better fit to the data. However, sometimes when the statistics disagree other fit statistics must be considered, or it may be the case that the difference between two EEMs has little practical significance.

The fit statistics based on the cross-validation dataset included the percentage in the prediction interval (% in PI), the interval width in kg (Width), the root mean square error in kg (RMSE), the R^2 value, the intercept in kg (γ_0), the slope (γ_1), and the variable eliminated. The "% in PI" value gives the percent of cross-validation emissions that fall inside the 95 percent prediction intervals of values estimated using the cross-validation data. Values close to 95 indicate that the quantification of uncertainty is on target. Values greater than 95 percent indicate "over fitting" of the EEM, which leads to larger interval widths. The width of each prediction interval quantifies the uncertainty of the point prediction. For a given confidence level, narrower intervals are desirable as they indicate better quantification of the mean trend. Narrower intervals result in a smaller range of predicted emissions, thereby providing a more informative estimate of the mean emissions. The RMSE value is a measure of the average distance between the point predictions and the actual emissions with smaller values indicating a better fit to the data. The term R^2 is interpreted as the proportion of variability in the measured cross-validation emissions

values that is explained by the predictions of cross-validation emissions values. Values of R^2 closer to one indicate a better fit of the EEM to the cross-validation data. Regarding the intercept (γ_0) and the slope (γ_1), if the EEM fit the cross-validation data perfectly, the intercept, γ_0, of the regression would equal zero and the slope, γ_1, would equal one. If the estimate of the intercept or slope, γ_0 or γ_1, is significantly different from 0 or 1, respectively, the EEM resulting from a given backward-elimination run contains systematic bias (i.e., the EEM has an inherent error in the emissions estimate that is not accounted for by the predictor variables).

<u>Response references</u>:

- Draft Broiler EEM Document, Section 7.5 (pp. 184 – 197 of full pdf file)

1.6 Eric Smith:

1.6.1 Table 7-8 on page 7-36. Please clarify - that the second entry (sigma squared h) is actually sigma squared, otherwise there is significant variance component due to house.

Response: The second entry was mistakenly identified as sigma squared h instead of sigma squared.

1.6.2 Check to see if the -2LL and BIC are based on Restricted Maximum Likelihood (REML) or Maximum Likelihood (ML) methods. If model building is of interest, it is better to report ML calculations.

Response: See response to Question 1.5. Table 7-13 of the draft broiler EEM document shows the -2LL and the BIC statistic. The -2LL presented in the table is based on the REML method (i.e., the value in the table is the residual/restricted log likelihood (-2RLL)). Similarly, the BIC presented in the table is based on the REML method.

<u>Response references</u>:

- Draft Broiler EEM Document, Section 7.5 (pp. 184 – 197 of full pdf file; pp. 7-37 and 7-50 of Section 7)

1.6.3 Is bird mass an estimated quantity, if so, how many birds were weighted to estimate the mass? Was the same approach used in both locations?

Response: For site CA1B, the average weight of the birds was measured at least weekly between days 1 and 47 during three consecutive cycles of birds. For each measurement period, 25 or 50 birds of each gender (50 or 100 total) were measured in each house and the average mass reported. The bird mass was then estimated based on a regression curve fit through the bird mass versus age data collected over three cycles of birds. For the Kentucky sites, an automatic bird weigh-scale system (Model RSC-2, Rotem, Petach Tikva, Israel) was placed in each house to continuously monitor bird body weight.

Response references:

- Draft Broiler EEM Document, Appendix A, NAEMS Barn QAPP, Section 2.1.6 (p. 356 of full pdf file)
- Draft Broiler EEM Document, Appendix C, SOP S2, Section 9.5 (p.1460 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for site CA1B (p. 1759 and 1773 of full pdf file)
- Draft Broiler EEM Document, Appendix A, QAPP for Kentucky sites (pp. 654-655 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for Kentucky sites (p. 2067 of full pdf file)

1.6.4 What version of SAS was used and which procedure?

Response: A combination of versions 9.2 and 9.3 were used. The EPA used Proc Mixed to develop the draft broiler EEMs and used both Proc Mixed and Proc Glimmix to develop the draft swine and dairy lagoon/basin EEM. Also, the EPA used Proc NLIN for broiler NH_3 emissions when the Gompertz growth curve was being considered as the functional

form through which average bird mass should enter the mean trend. The EPA also used Proc NLIN to explore different ways to scale average bird mass before exponentiating when exponential functions of average bird mass were considered for some of the pollutants.

The following procedures were used for exploratory data analysis:

- GPLOT
- UNIVARIATE
- FREQ
- CORR
- GSCATTER
- MEANS
- DATASETS

1.7 Dave Allen: Panel should consider providing advice on how EPA could use more data than was used in the report. Panel could suggest criteria for looking at additional data and how to use it. Any particular criteria to specify?

Response: As reflected in the Air Quality Agreement and in the draft documents submitted to the Science Advisory Board, the EPA is committed to using data gathered under the NAEMS and other relevant information to develop the EEMs. In addition to the NAEMS data, the EPA has engaged in the following activities to identify and obtain other relevant information. In September 2010, the EPA participated in the "Livestock and Poultry Air Emissions Standardization Workshop" hosted by USDA's Agricultural Air Quality Task Force. A diverse group of research, extension, industry, regulatory representatives and other interested persons participated in this workshop. Participants engaged in a lengthy discussion regarding the NAEMS and the EPA's commitment to obtain other relevant data. During this discussion, EPA representatives outlined the Agency's effort to identify and obtain other relevant information and stressed the need for receiving peer reviewed papers as well as the associated databases. On January 19, 2011, the EPA issued a Call for Information (CFI) in the *Federal Register* seeking peer-reviewed, quality-assured emissions and process data relevant to developing EEMs for animal feeding operations. In response to the CFI, the Agency received several peer-reviewed papers. Some of these papers were for broiler confinement houses and swine and dairy lagoons/basins. However, the databases used by the researchers to support their findings presented in these papers pertaining to broiler confinement houses and swine and dairy lagoons/basins were not submitted to the EPA. The EPA welcomes the panel's comments on additional data and how it can be used to develop the EEMs.

1.8 Brock Faulkner: It would be helpful to know why certain percentages of data were disqualified in the first place. With that information, could specify criteria.

Response: As reflected in the final site report for CA1B, the number of daily NH_3 emissions measurements was reduced by delays in receiving the INNOVA 1412 instrument at the beginning of the study, and by calibration and maintenance issues with

the INNOVA 1412 in the field. The quantity of PM emissions data was reduced by TEOM failures. The major data invalidations are further itemized in the final site report referenced below.

For the Kentucky sites, specific reasons for data invalidations were not provided to EPA. However, general reasons for data invalidation are provided and can be found in Appendix D of the draft broiler EEM document.

Response references:

- Draft Broiler EEM Document, Appendix D, Final report for site CA1B (pp. 1780, 1790 - 1792 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for the Kentucky sites (pp. 2083 of full pdf file)

1.9 Dave Allen: Let's further consider whether raw, unqualified data should also be presented on EPA website.

Response: For the purpose of this response the EPA has defined "raw data" as data that has not undergone quality assurance/quality control (QA/QC) procedures established by the California and Kentucky site researchers and approved by the EPA; whereas, "processed data" is data that has undergone an EPA approved QA/QC process. The EPA has not received the final raw data for either CA1B or the Kentucky sites. To date, the EPA has made the daily processed data that have been submitted for CA1B and the Kentucky sites available to the public at the following website - www.epa.gov/airquality/agmonitoring/.

1.10 Viney Aneja: Why did EPA check negative measurements? / April Leytem: Was any method applied to identify and eliminate outliers (both negative and positive)?
Response: For the California and Kentucky broiler sites, the researchers utilized extensive QA/QC procedures outlined in their respective QAPPs to ensure that invalid emissions and process data had been removed from the datasets prior to submitting the data to EPA. The QA/QC procedures included initial and periodic calibrations, bias and precision checks for monitoring instruments, comparisons of measurement values to preset ranges, and

graphical control charts of data values. The daily emissions and process values presented in the tables of the final reports and final data spreadsheets did not contain data that were flagged by the site researchers.

The EPA did not conduct statistical outlier tests on the data submitted by the California and Kentucky researchers. However, the EPA's review of the data identified negative emissions values in the daily dataset for site CA1B. Initially, the EPA questioned whether QA/QC procedures implemented by the NAEMS researchers had mislabeled these emissions as valid, when they should have been invalidated. Negative daily emissions from animal confinement houses seemed invalid because they suggest that the broiler houses were, on certain days, acting as sinks of emissions. Similarly, negative emissions for the half-hour periods utilized in open source EEM development would suggest that the lagoon or basin was acting as an emissions sink for that half-hour. Consequently, the EPA omitted the negative values from CA1B EEM development datasets until clarification could be obtained from the NAEMS researchers.

Attachment A to this document contains a more detailed discussion of negative emissions.

Response references:

- Draft Broiler EEM Document, Appendix A, NAEMS Barn QAPP (pp. 365 – 372, 407 – 408, and 416 – 425 of full pdf file)
- Draft Broiler EEM Document, Appendix A, QAPP for Kentucky sites (pp. 508 – 517, 534 – 535, 548 – 556 of full pdf file)
- Draft Lagoon EEM Document, Appendix A, Open Source QAPP (pp. 179 – 191, 246 – 254, and 289 – 311 of full pdf file)

1.11 Ronaldo Maghirang: For the broiler report, provide estimates of uncertainty for the emission rates. Include estimates of uncertainty for calculated emission rates from RPM and bLS methods.

Response: As described in the references cited below, the QAPPs and final summary reports developed for CA1B and the Kentucky sites discuss the uncertainty associated with each measurement technique used to collect the emissions and process data. Additionally, the draft broiler and lagoon EEMs developed by the EPA produce a point estimate of emissions and a 95-percent prediction interval that consists of a lower and upper bound on each side of the point estimate. Section 7.6 of the draft broiler document presents an example calculation of the point estimate and prediction interval boundaries.

Response references:

- Draft Broiler EEM Document, Appendix A, NAEMS QAPP (pp. 338 - 342 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final summary report for site CA1B (pp. 1769 – 1771 of full pdf file)
- Draft Broiler EEM Document, Appendix A, QAPP for Kentucky sites (pp. 466 – 468 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for Kentucky sites (p. 2083 of full pdf file)
- Draft Broiler EEM Document, Section 7 (pp. 148 - 201 of full pdf file)
- Draft Broiler EEM Document, Section 8 (pp. 202 - 284 of full pdf file)

2 Lagoon Report

2.1 Dave Allen: Were all negative values for Lagoon Report thrown out, or were they screened and selectively used? How did EPA handle negative values? For broilers say why; what drove negative values in this set of data? Drift?

Response: Sections 3, 4 and 5 of the draft lagoon EEM document and Sections 4, 5 and 7 of the draft broiler EEM document discuss the EPA's approach for handling negative emissions values. Attachment A to this document contains a detailed discussion of the negative emissions values.

As reflected in both the draft EEM documents and in Attachment A, the EPA did not include negative emissions values in the datasets used to develop the draft EEMs for broiler confinement operations and dairy and swine lagoons/basins. The EPA questioned the validity of the negative emissions values at the broiler and lagoon sites and chose to omit these values from the EEM development datasets.

Conversations with NAEMS researchers indicated that negative emissions values can occur as a result of several factors, including:

1. Precision check corrections of measurements (barns and open sources)
2. Concentration measurements near the method detection limit (barns and open sources)
3. Instance of high instability during the calculation interval (open sources only)
4. High variability in wind direction during the emissions calculation interval (open sources only)

Response references:

- Draft Lagoon EEM Document, Section 3.1,1 (p. 37 of full pdf file)
- Draft Lagoon EEM Document, Section 4.2.2 (pp. 65 - 66 of full pdf file)
- Draft Lagoon EEM Document, Section 5.1 (pp. 77 - 78 of full pdf file)
- Draft Broiler EEM Document, Section 4 (pp. 55, 62 of full pdf file)
- Draft Broiler EEM Document, Section 5 (p. 91 of full pdf file)
- Draft Broiler EEM Document, Section 7 (p. 153 of full pdf file)

2.2 Deanne Meyer: EPA should provide information on how outliers were handled, and provide a better description on what the negative value is. April Leytem: This is more important for the lagoon data.

Response: The data handling procedures followed by the EPA are specified in Section 3 (available data) and Section 4 (data preparation) of the draft swine and dairy lagoon/basin

EEM document. In addition, Attachment A of this document contains a detailed discussion of the procedures followed by the EPA in handling negative emissions values identified in the data submitted by the NAEMS researchers. For the lagoon/basin sites, the emissions and process data collected at the dairy and swine sites were subjected to extensive QA/QC procedures by the NAEMS researchers before the data were submitted to the EPA. The half-hour dataset submitted to the EPA included all calculated data values and any QA/QC flags assigned by the NAEMS researchers. Based on guidance provided by the NAEMS researchers, the EPA processed the dataset to exclude the flagged observations prior to using this dataset to develop the draft dairy and swine lagoon EEMs. The EPA did not subject this data to a statistical outlier test.

Response references:

- Draft Lagoon EEM Document, Section 3 (pp. 36 - 40 of full pdf file)
- Draft Lagoon EEM Document, Section 4 (pp. 55 - 67 of full pdf file)

2.3 Deanne Meyer: Since EPA assumed that lagoon volume capacity for static assumed same volume, EPA should describe lagoon shape (e.g., typical sides; straight vs. curved; sloping shape; range of design shapes, etc.).

Response: The data regarding lagoon configurations and dimensions are provided in the SMPs contained in Appendix B of the draft swine and dairy lagoon/basin EEM document. All design data specifications provided by the producer are contained in Table 2 of the SMPs. The SMPs do not indicate the assumptions that were used to determine the design surface area values. For convenience, Table SAB-2 presents the design data.

Response references:

- Draft Lagoon EEM Document, Appendix B, Lagoon SMPs (pp. 403 – 531 of full pdf file)

Table SAB-2. Lagoon/Basin Design Data from the SMPs

Parameter	IA3A	IN4A	NC3A	NC4A	OK3A	OK4A	IN5A	WA5A (unit2)	WI5A (Unit 1)	WI5A (Unit 2)
Animal type	Finisher	Sows, piglets	Finisher	Sows	Finisher	Sows	Dairy Cattle	Dairy cows	Dairy cows	Dairy cows
Avg. animal weight (lb)	150	475 (sows)	135	433 (sows)	170	230-750	1500	1400	1400	1400
Avg. piglet weight	NA	8 (piglets)	NA	NA	NA	(blank)	NA	NA	NA	NA
Total farm animal capacity (hd)	3,840	1,400 (sows)	8,000	2,000 (sows)	3,024	2784	2,600	4401 milking cows & 1200 dry cows	650	650
Year of facility construction	1998	1968-1992	1996	1994	1997	1994	2003	2002	1991	1991
Single stage	Y	Y	Y	Y	Y	Y	Y	N	N	N
Type of storage	Basin	Lagoon	Lagoon	Lagoon	Lagoon	Lagoon	Dirt lagoon	Drying ponds	Lagoon	Lagoon
Type of liner	Concrete	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Lagoon loading freq.	Every 10 wks	Every 2 wks	24 hr	Weekly	3 times per week	24 hr	2 hr	Continuous	Every hour	Every hour
Vol loading rate	(*blank*)	2.11 - 2.56 (lb VS/d-1,000 ft^3)	5.7 (lb/d-1,000 ft^3)	1.82 (lb VS/d-1,000 ft^3)	*(blank)*	0.0048 (lb VS/d-ft^3)	(*blank*)	*(blank)*	350,000 (lb VS/d-ft3)	350,000 (lb VS/d-ft3)
Surface loading rate	(*blank*)	1,001 – 1,073 (lb VS/d-ac)	2,006 (lb VS/d-ac)	692 (lb VS/d-ac)	*(blank)*	0.0597 (lb VS/d-ft^2)	(*blank*)	*(blank)*	None	None
Type of cover	Crust	None	None	None	None	None	None	*(blank)*	None	None
Solids separation	Y	N	N	N	N	N	Y	Y	Y	Y
Odor control	N	N	*(blank)*	N	Micro-Aid	N	None	None	None	None
Sludge removal cycle	N	Never	15 yr	15 yr	20 yr	20 yr	None	2 yr (alternating use 1 yr)	2/year	2/year
Last time sludge removed	N	Never	Never	Never	Never	Never	Never	2006 (E), 2005 (W)	2006	2006
Agitation prior to pump out	Y	N	N	N	N	N	Yes	(blank)	Yes	Minimum
Manure removal freq.	365	365	As weather permits	As weather permits	Every 6 months	180-365	Irrigation during growing Season	Varies	180 days	180 days
Volume (ft^3)	203,537	1,200,000	1,623,326	2,007,450	1,011,463	234,133	1,702,400	2,005,200	373,000	226,700
Surface area (ft^2)	25,442	121,000	204,386	249,672	120,600	242,056	280 x 380	141,000 (E) 163,200 (W)	45,900	31,200
Berm slope	Vertical	3:01	3:01	3:01	3.8:1	4:01	2.5 :1	3 :1 – 4 :1	2:1	2:1
Max side length (ft)	180 diam.	378	567.5	624	683	632	380	600 (E) ≈ 600 (W)	270	260
Min side length (ft)	*(blank)*	365	370	410	193	383	280	235 (E)	170	120

Table SAB-2. Lagoon/Basin Design Data from the SMPs

Parameter	IA3A	IN4A	NC3A	NC4A	OK3A	OK4A	IN5A	WA5A (unit2)	WI5A (Unit 1)	WI5A (Unit 2)
								271 (W)		
Actual freeboard (ft)	1	4	*(blank)*	*(blank)*	2	1.5	5	*(blank)*	1	1
Inner berm height (ft)	*(blank)*	4	*(blank)*	*(blank)*	4	10-Apr	10	Varies	12	12
Outer berm height (ft)	*(blank)*	12	*(blank)*	*(blank)*	5	0-2	5	12 (max)	12	13
Liquid depth	7 max	12	*(blank)*	10 total	20	18	16	16-18	11	11
Sludge depth (ft)	1	Unknown	1.9	2.33	2	Unknown	0	Varies	1	1
No. of inlets	2	1	1	*(blank)*	1	2	1	1	1	1
Shape	Round	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular and trapezoidal	Rectangular	Rectangular
Rotating or Continuous	Rotating	Continuous	Rotating	Rotating	Rotating	Rotating	Continuous	Rotating	Rotating	Rotating
Stage	NA	NA	NA	NA	NA	NA	NA	NA	1st	2nd
Number of units	1	1	1	1	1	1	1	2	1	1

2.4 Ronaldo Maghirang: Did parameter measurements have calculated uncertainty values (e.g., 10 %? 20 %?)

Response: The discussion of uncertainty/error in measurement methodologies is contained in Section 7 of the open source QAPP. Specific accuracy estimates for the various measurement methods are presented in Section 7.2 of the open source QAPP.

Response references:

- Draft Lagoon EEM Document, Appendix A, NAEMS Open Source QAPP, Section 7.2 (pp. 183 – 191 of full pdf file)

2.5 Robert Hagevoort: Lagoon Report, Section 3:

2.5.1 Table 3-1, page 3-3. What does 'not received' data mean. If data exists, should be reviewed. Clarify caption D regarding nitrogen. Conduct a nitrogen mass balance on this data.

Response: As indicated by footnote "a" in Table 3-1, "Data not received" is used in instances where the NAEMS QAPP indicated that the parameter would be measured, but that data have not been submitted to the EPA. Furthermore, the final reports submitted to the EPA do not indicate that the data were not collected. With regard to footnote "d" in Table 3-1, data for the various parameters that could be used in developing a nitrogen mass balance were only provided for five of the nine sites monitored (NC4A, OK4A, IA3A, NC3A and OK3A). However, this data did not always coincide with NAEMS monitoring periods. Most data collection occurred after NAEMS lagoon/basin monitoring had been completed. Table 4-2 of the draft lagoon EEM document provides the list of dates that the data are available for each site. Additionally, the final site reports submitted to the EPA only referred to the "nitrogen content" and did not specify the form of nitrogen reported (Total Kjeldahl Nitrogen was specified in the QAPP, but there is no confirmation in the final reports). The EPA has not conducted a nitrogen mass balance on the data at this time.

Response references:

- Draft Lagoon EEM Document, Table 3-1 (pp. 38 – 39 of full pdf file; pp. 3-3 – 3-4 of Section 3)
- Draft Lagoon EEM Document, Table 4-2 (pp. 61 – 62 of full pdf file; pp. 4-7 – 4-8 of Section 4)

2.5.2 Table 3.2: H_2S for IN5A data: clarify why average emissions are zero, and max daily as 42.9.

Response: The average daily H_2S emissions from the bLS model for IN5A should be 13.1 kg/d rather than zero.

2.5.3 Clarify how much manure is captured in lagoons. Did all manure end up in lagoons?

Response: The SMP for each swine and dairy site describes the lagoon/basin system used at that particular site and, for some sites; additional information was provided in the final report submitted to the EPA. Pertinent information regarding each site's lagoon/basis system has been extracted from the site's SMP and incorporated into this response.

For the swine sites, the SMPs suggest that all the manure was discharged to the lagoons. For the dairies, solids separation and other processes were used that limited the amount of waste reaching the monitored lagoons/basins. Exact amounts or percentage of removal at each stage were not provided. Because the waste treatment systems at the dairy sites consist of multiple stages, the descriptions below also note which stages were monitored under the NAEMS.

Dairy Sites

IN5A: Manure is vacuumed from the lactating cow barns and special needs barn every 12 hours, and placed in basins near the barns. Manure is flushed from the holding area and milking parlor every half hour. A small amount of waste is held in a slurry tank. The exact amount was not specified in SMP. Wastewater (flush) from the holding area and milking parlor goes to a rectangular settling basin south of the road, then into the waste lagoon south of the road. This waste lagoon was monitored under the NAEMS. The final site

report also indicates that manure from the barns was scraped into pits that are located at the end of each barn.

Response references:

- Draft Lagoon EEM Document, Appendix B, IN5A SMP (pp. 433 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final site report for IN5A (1453 of full pdf file)

WA5A: The farm has freestall style barns, with automated flushing four times daily. Manure is transferred to the upper lagoon/settling basins (these two upper lagoons/settling basins were monitored under the NAEMS) from a sand separation pit. Liquids are skim separated and returned as flush to the barns. Settled solids are removed yearly. Remaining solids are strained through Agpro screens and centrifugal/screw presses, and liquid transferred to large serpentine concrete basins for secondary settling. Solids are then dried for bedding. Removed water is stored in a large clarified water storage basin for dilution of barn flush water.

Response references:

- Draft Lagoon EEM Document, Appendix B, WA5A SMP (p. 500 of full pdf file)

WI5A: Manure from the freestall barns and the milking parlor complex is removed by flushing three times daily. The manure flushed from the parlor, holding pen, and freestall barns flows to a solids separator, from which the solids are removed and stacked on a pad until they are spread on fields. The liquid effluent from the solids separator is pumped back into vertical tanks for reuse to flush the barns. Once a week, enough water is removed from the third stage of the three-stage lagoon and added to the flush tanks to make up for water lost in the recycled flush system. The three-stage lagoon receives effluent from the barns and milking parlor. The lagoons are pumped out into trucks twice yearly. The first and second stages of the three-stage lagoon system were monitored during the NAEMS.

Response references:

- Draft Lagoon EEM Document, Appendix B, WI5A SMP (p. 518 of full pdf file)

Swine Breeding and Gestation Sites

IN4A: Liquid waste from the deep pits of the barns is transferred once every two weeks to the lagoon by a single inlet on the east side of the lagoon. A manure composting pile is typically present within 5 m (16 ft) of the base of the north berm of the lagoon (was moved for the study).

Response references:

- Draft Lagoon EEM Document, Appendix B, IN4A SMP (p. 419 of full pdf file)

NC4A: Manure from the barns is transferred once a week from the gestation, farrowing, and breeding barns to the lagoon by pull plug and lagoon water recharge. Wastewater from all three buildings combines into one inlet (southwest corner of the lagoon).

Response references:

- Draft Lagoon EEM Document, Appendix B, NC4A SMP (p. 460 of full pdf file)

OK4A: Manure from the barns is transferred weekly from the two gestation units and every 2.5 weeks from the farrowing unit to the lagoon by pull plug and lagoon water recharge. Waste water from the two gestation units combines into one inlet (the southerly inlet), while wastewater from the farrowing unit enters the lagoon from the northerly inlet.

Response references:

- Draft Lagoon EEM Document, Appendix B, OK4A SMP (p. 487 of full pdf file)

Swine Growing and Finishing Sites

IA3A: Manure from the 2-ft deep pits in each of the four barns is transferred approximately once every ten weeks to the basin, through two inlets.

Response references:

- Draft Lagoon EEM Document, Appendix B, IA3A SMP (p. 405 of full pdf file)

NC3A: Manure from the barns is transferred daily to the lagoon by pull plug and lagoon water recharge. Wastewater combines into one inlet.

Response references:

- Draft Lagoon EEM Document, Appendix B, NC3A SMP (p. 447 of full pdf file)

OK3A: Manure from the barns is transferred three times a week to the lagoon by a pull plug system with lagoon water recharge. Wastewater from all three units combines into one inlet.

Response references:

- Draft Lagoon EEM Document, Appendix B, OK3A SMP (p. 474 of full pdf file)

2.5.4 Clarify whether solids separation systems are in place. Settling ponds? Solids separation?

Response: The design specifications of the manure handling and treatment processes at each monitoring site are contained in Table 2 of each SMP (see Appendix B of the draft lagoon EEM document). Table SAB-3 summarizes the available information regarding solids separation.

Response references:

Draft Lagoon EEM Document, Appendix B, Lagoon SMPs (pp. 403 – 531 of full pdf file)

Table SAB-3. Design Data for Manure Handling and Treatment Processes from SMPs

Parameter	IN4A	NC4A	OK4A	IA3A	NC3A	OK3A	IN5A	WA5A (Unit 2)	WI5A (Unit 1)	WI5A (Unit 2)
Single stage?	Y	Y	Y	Y	Y	Y	Y	N	N	N
Solids separation	N	N	N	N	N	N	Y	Y	Y	Y
Type of Solid Separation	Not applicable						Separat or pit	Sand separation pit	Not specified	
Number of units monitored	1	1	1	1	1	1	1	2	1	1
PDF Page No.	p. 429	p. 470	p. 495	p. 414	p. 456	p. 482	p. 442	p. 511	p. 529	

2.6 Deanne Meyer: Lagoon Report, Section 3:

2.6.1 Discuss cow excretion data, what % of structures contribute to the volatile concentrations, and % of residence time manure is on hard surface.

Response: Based on information contained in the SMPs (Appendix B of the draft lagoon EEM document) all animal confinement barns and milking parlors at each site contribute to the wastewater entering the lagoon/basin system and thus the volatile concentrations. With respect to the residence time at dairies, Table 2 in the SMPs specifies the manure removal schedule for each site (i.e., lagoon loading interval). These values are provided in the table included in the response to Question 2.3.

Response references:

- Draft Lagoon EEM Document, Appendix B, Lagoon SMPs (pp. 403 – 531 of full pdf file)

2.6.2 Need table of when lagoon data was collected on each facility.

Response: The monitoring period dates are provided in the final site reports. Table SAB-4 summarizes the dates when data were collected at each open source site.

Response references:

- Draft Lagoon EEM Document, Appendix B, Lagoon SMPs (pp. 403 – 531 of full pdf file)

Table SAB-4. Lagoon Data Collection Schedule by Monitoring Period and Site

Site	Monitoring Period										PDF Page No.
	1	2	3	4	5	6	7	8	9	10	
IN5A						9/11/08 - 11/30/08	12/1/08 - 2/28/09	3/1/09 - 5/31/09	6/1/09 - 8/17/09		p. 1457
WA5A			2/25/08 - 3/12/08	3/12/08 - 3/26/08	8/8/08 - 9/3/08	9/3/08 - 9/26/08		5/18/09 - 6/4/09	6/4/09 - 6/20/09		p. 2339
WI5A	7/18/07 - 8/28/07	11/13/07 - 11/28/07	11/28/07 - 12/18/07	4/23/08 - 5/13/08	6/25/08 - 7/14/08	10/21/08 - 11/11/08	12/17/08 - 1/7/09	3/10/09 - 4/7/09			p. 2463
IN4A	7/1/07 - 8/31/07	9/1/07 - 11/30/07	12/1/07 - 2/28/08	3/1/08 - 5/31/08	6/1/08 - 7/14/08						p. 1258
NC4A		10/4/07 - 10/22/07	1/29/08 - 2/11/08	3/31/08 - 4/16/08	8/13/08 - 9/2/08	9/4/08 - 9/23/08	1/14/09 - 2/2/09	4/28/09 - 5/11/09	7/1/09 - 7/21/09		p. 1845
OK4A	6/27/07 - 8/29/07	11/7/07 - 11/27/07	11/28/07 - 12/18/07	4/23/08 - 5/6/08		10/1/08 - 10/15/08	1/8/09 - 1/27/09	4/1/09 - 4/21/09	6/25/09 - 7/14/09		p. 2169
IA3A		8/30/07 - 9/26/07	12/19/07 - 1/15/08	5/14/08 - 6/4/08	6/4/08 - 6/25/08	11/13/08 - 11/25/08	11/25/08 - 12/16/08	4/8/09 - 4/23/09	7/28/09 - 8/17/09		p. 1118
NC3A		10/24/07 - 11/7/07	2/13/08 - 3/5/08	3/6/08 - 3/26/08		9/25/08 - 10/14/08	2/4/09 - 2/23/09	5/12/09 - 6/2/09	6/2/09 - 6/22/09	9/24/09 - 12/1/09	p. 1656
OK3A		8/30/07 - 9/18/07	1/24/08 - 2/19/08	5/7/08 - 5/29/08	5/29/08 - 6/10/08	11/5/08 - 12/2/08	12/2/08 - 12/16/08	4/23/09 - 5/14/09	7/15/09 - 8/4/09		p. 2000

2.7 April Leytem:

2.7.1 Provide scientific basis for model selection (RPM vs. bLS). Both models may work equally well. If there is more data available using the bLS model discuss why you chose to not use that data. There was one validation study done (Ro et al., 2011) that compared the RPM and bLS model and found that the RPM over-estimated the emissions by 30% and the bLS model under-estimated by 2%.

Response: Section 6.2 of the open source QAPP (see Appendix A of the draft lagoon EEM document), notes that:

"Emissions of NH_3 will be determined from the difference in upwind and downwind concentration measurements from the TDLAS open path systems and a Gaussian plume fit approach (Radial Plume Mapping: RPM). Emissions of H_2S will be determined using UV-DOAS open-path systems or PF with synthetic open path sampling systems (if the UV-DOAS measurement H_2S is not validated) and a Lagrangian Stochastic approach." (p. 169 of full pdf file)

The section goes on to state that the bLS method for NH_3 was performed for an intercomparison of the methods with the goal of a method validation similar to EPA method 301, "*An intercomparison between the RPM and bLS methods, with the goal of validating the bLS method using methodologies similar to EPA Method 301, will be conducted at two farms, which will each have their emissions measured continuously for one entire year."* (p. 173 of full pdf file)

The results of the method comparison conducted by the NAEMS researchers are discussed in the final site reports (see Appendix D of the draft lagoon EEM document).

The QAPP states that the RPM method was the primary method for the calculation of NH_3 emissions values, and the bLS method was a secondary method that was undergoing field testing under the NAEMS.

Response references:

- Draft Lagoon EEM Document, Appendix D, Final report for site IA3A (p. 1136 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site IN4A (p. 1277 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site IN5A (pp. 1475-1476 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site NC3A (pp. 1675 – 1676 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site NC4A (pp. 1864-1865 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site OK3A (p. 2021 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site OK4A (p. 2189 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site WA5A (p. 2356 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site WI5A (p. 2482 of full pdf file)

2.7.2 Table 4-1. For WA5A and WI5A it says that there were no valid emissions days for NH_3 using the RPM model, but in the final project report submitted by Dr. Heber there were 12 valid days worth of data reported for WA5A and 22 days for WI5A, what happened to that data?

Response: There is a discrepancy in the WA5A final report submitted to the EPA. Table 4.4.1-2 of the WA5A final report (see Appendix D of the draft lagoon EEM document) notes there were 12 valid emissions days (number of days (d) with ≥36 valid 1/2 h periods) for the RPM method and 1 valid emissions day for the bLS method. However, Section 6.9 of the same final report indicates that there are no days that contain ≥ 36 half hours of NH_3 emissions data for the RPM method. With respect to WI5A, Table 4.4.1-2

of the final site report shows there were 0 valid RPM days and 22 valid bLS days. (see Appendix D of the draft lagoon EEM document)

The values presented in Table 4-1 of the draft lagoon EEM document are based on the data tables contained in the final site reports rather than the narrative sections of the reports. The EPA will coordinate with the NAEMS Science Advisor on this issue.

Response references:

- Draft Lagoon EEM Document, Appendix D, Final report for site WA5A, Table 4.4.1-2 (p. 1256 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site WA5A, Section 6.9 (p. 1334)
- Draft Lagoon EEM Document, Appendix D, Final report for site WA5A (p. 1256 of full pdf file)
- Draft Lagoon EEM Document, Appendix D, Final report for site WI5A (p. 1382 of full pdf file)
- Draft Lagoon EEM Document, Table 4-1 (pp. 59 - 60 of full pdf file)

3 Both Reports:

3.1 Deanne Meyer: Additional information needed on the reports we've reviewed in order to better understand what we've seen:

3.1.1 Description (preferably in table format) of which data identified in SOP were not received and why. Were these not collected, collected and not submitted; collected but not required therefore not submitted? [needed for both studies]

Response: Table 4-2 in the draft broiler document and table 3-1 in the draft swine and dairy lagoon/basin document summarizes the emissions and process data elements that were required to be monitored by either the NAEMS Monitoring Protocol, the QAPPs, the SMPs or the SOP documents submitted to the EPA. These tables also provide specific information regarding data availability that is based upon the EPA's review of the final reports and data spreadsheets.

Response references:

- Draft Broiler EEM Document, Table 4-2 (pp. 56 – 61 of full pdf file; pp. 4-3 – 4-8 of Section 4)
- Draft Swine and Dairy Lagoon/Basin EEM Document, Table 3-1 (pp. 38 – 39 of full pdf file; pp. 3-3 – 3-4 of Section 3)

3.1.2 The lagoon report assumes a constant surface area. This needs explanation or verification. Surface area can vary tremendously in structures with slope and considerable depth. If surface area is used to determine EEM then which surface area is used? Certainly, the structure is not full 365 days a year.

Response: The EPA acknowledges that the surface area of the lagoon varies depending on the liquid depth and the design lagoon side walls (i.e., straight versus sloping sides). However, the EPA does not have data to characterize the change in lagoon liquid depth over time. Therefore, EPA used the design surface area specified in the SMPs in the EEM development. The SMPs do not indicate the assumptions that were used to determine the design surface area values.

Response references:

- Draft Lagoon EEM Document, Appendix B, Lagoon SMPs (pp. 403 – 531 of full pdf file)

3.1.3 More direct estimates of manure and manure nutrient excretion and moisture content of litter are needed for the broiler study.

Response: The broiler manure composition data available for site CA1B are contained in the final site report (see Appendix D of the draft broiler EEM document). A summary of the manure composition data submitted for the Kentucky sites is presented in Table SAB-5 below. These data were provided to the EPA in a supplemental submittal and are not contained in the final report for the Kentucky sites.

Response references:

- Draft Broiler EEM Document, Appendix D, Final report for site CA1B (pp. 2054 – 2055 of full pdf file)
- Draft Broiler EEM Document, Appendix C, SOP M1 (pp. 820 – 832 of full pdf file)

Table SAB-5. Manure Composition Data for the Kentucky Sites

Lab ID	Samples Description	Total Solids (%)	Moisture (%)	pH	TKN (%)	NH_3-N (mg/kg)	TKN	NH_3-N (kg/Mg)
1	KY1B-1 H5 Jan 06 Crust	52.021	47.979	8.060	2.352	5600.113	23.520	5.600
2	KY1B-1 H5 Jan 06 Pre Crust:							
2A	KY1B-1 H5 Brood (Zone 1), Composite, 1/30/06	54.790	45.210	7.930	2.457	7757.983	24.570	7.758
2B	KY1B-1 H5 Non-Brood (Zone 1), Composite, 1/30/06	47.077	52.923	7.973	2.203	8427.710	22.027	8.428
2C	KY1B-1 H5 Non-Brood (Zone 1), Composite, 1/30/06	50.967	49.033	7.543	1.857	8569.402	18.573	8.569
3	KY1B-1 H5 6/12/06 Litter	60.717	39.283	7.543	3.049	9704.412	30.485	9.704
4	KY1B-2 H3 Jan 06 Pre Crust:							
4A	KY1B-2 H3 Section 1, Brood End, 2/2/06	68.147	31.853	8.213	2.837	6027.343	28.373	6.027
4B	KY1B-2 H3 Section 2, Brood End, 2/2/06	65.000	35.000	8.347	2.615	4525.363	26.145	4.525
4C	KY1B-2 H3 Section 3, Brood End, 2/2/06	58.921	41.079	8.253	2.487	5071.506	24.873	5.072
5	KY1B-2 H3 2/06 Pre Crust:							
5A	KY1B-2 H3 Section 1, Non-Brood, 2/2/06	66.069	33.931	7.950	2.529	5757.822	25.293	5.758
5B	KY1B-2 H3 Section 2, Non-Brood, 2/2/06	68.307	31.693	8.023	2.359	5941.733	23.590	5.942
5C	KY1B-2 H3 Section 3, Non-Brood, 2/2/06	72.151	27.849	7.490	2.718	7772.780	27.183	7.773
6	KY1B-2 H3 2/9/06 Cake	55.315	44.685	8.210	2.277	6510.521	22.773	6.511
7	KY1B-1 H5 8/06 Pre Crust:							
7A	KY1B-1 H5 8/14/06, Brood End (South) Section 1, 0 - 85	57.898	42.102	7.557	2.938	8404.273	29.377	8.404
7B	KY1B-1 H5 8/14/06, Brood End (South) Section 2, 85 -170	60.889	39.111	7.820	2.814	7215.391	28.140	7.215
7C	KY1B-1 H5 8/14/06, Brood End (Center) Section 3, 170 - 255	60.843	39.157	7.687	2.611	6937.027	26.110	6.937
8	KY1B-2 H3 July 06 Loads 7	66.737	33.263	8.417	2.779	5311.949	27.790	5.312

3.1.4 More direct estimates of total solids and nutrient loading to lagoons/basins are needed for the lagoon study. Collectible cow units may be helpful.

Response: The nutrient measurements information provided to EPA are available in Section 4 of the final site reports (Appendix D of draft lagoon EEM document). Table SAB-6 summarizes the information from the final reports. Additional information on the manure sampling techniques is provided in the NAEMS SOP M1.

When multiple samples of the lagoon/basin liquid/ manure were collected, samples were taken from random locations around the lagoon/basin edge to form a composite sample for analysis. No samples were collected during the winter when the lagoons/basins were frozen. No data were submitted for sites IN4A, IN5A, WA5A, or WI5A.

With regard to collectible cow units (i.e., cow equivalent of percent of manure collected and sent to treatment), based on the information contained in the final reports, SMPs, and QAPP, none of the NAEMS dairy monitoring sites have areas (e.g., corrals) where manure could be deposited but not collected. Consequently, the collectible cow unit for each site would be the farm inventory. However, under the NAEMS, actual daily farm inventory values were not reported. Therefore, the farm capacity values specified in the SMPs were assumed to represent the farm inventory. The farm capacities specified in the SMPs for each dairy monitoring site are: 2,600 cows at site IN5A; 4,400 milking cows and 1,200 dry cows at site WA5A; and 1,700 cows at site WI5A.

Response references:

- Draft Lagoon EEM Document, Appendix B, Lagoon SMPs (pp. 403 – 531 of full pdf file)
- Draft Lagoon EEM Document, Appendix C, SOP M1 (pp. 820 – 832 of full pdf file)

Table SAB-6. Characteristics of Liquid Manure Samples

Site (page reference)	Date	No. of Samples	pH (SU) (Mean ± standard deviation)	Percent (wet weight basis)			
				Nitrogen (Mean ± standard deviation)	Solids (Mean ± standard deviation)	Ammonia (Mean ± standard deviation)	Sulfur (Mean ± standard deviation)
IA3A (p. 1135)	6/4/2008	3	7.54 ± 0.02	N/A	1.33 ± 0.05	0.24 ± 0.01	N/A
	4/9/2009	3	7.62 ± 0.03	0.37 ± 0.02	1.81 ± 0.04	0.30 ± 0.01	N/A
	(est 4/15/2009)	3	7.44 ± 0.08	0.40 ± 0.02	1.82 ± 0.12	0.30 ± 0.03	N/A
	7/29/2009	3	6.91 ± 0.02	0.47 ± 0.02	4.20 ± 0.13	0.36 ± 0.02	0.03 ± 0.00
	8/18/2009	3	7.11 ± 0.10	0.48 ± 0.02	4.37 ± 0.07	0.33 ± 0.00	0.03 ± 0.00
NC3A (p. 1675)	9/1/2009	1	7.64	0.29	N/A	N/A	0.03
	7/13/2009	1	7.56	0.51	N/A	N/A	0.03
	5/21/2009	1	7.45	0.4	N/A	N/A	0.05
	3/31/2009	1	7.94	0.24	N/A	N/A	0.04
	2/18/2009	1	6.87	0.17	N/A	N/A	0.03
	12/16/2008	1	7.81	0.32	N/A	N/A	0.04
	10/15/2008	1	7.61	0.32	N/A	N/A	0.04
	8/26/2008	1	7.88	0.34	N/A	N/A	0.04
	7/10/2008	1	7.82	0.49	N/A	N/A	0.05
	5/16/2008	1	7.75	0.67	N/A	N/A	0.05
	3/25/2008	1	7.46	0.68	N/A	N/A	0.05
	1/23/2008	1	7.36	0.56	N/A	N/A	0.05
	11/20/2007	1	7.29	0.36	N/A	N/A	0.05
	9/27/2007	1	7.89	0.3	N/A	N/A	0.05
	8/6/2007	1	7.94	0.47	N/A	N/A	0.04
	6/15/2007	1	7.68	0.59	N/A	N/A	0.05
	4/19/2007	1	7.82	0.53	N/A	N/A	0.04
	3/22/2007	1	7.71	0.59	N/A	N/A	0.05
	1/24/2007	1	7.79	0.4	N/A	N/A	0.04
	12/1/2006	1	6.8	0.23	N/A	N/A	0.03
NC4A (p. 1864)	8/31/2009	1	7.4	0.2	N/A	N/A	0.08
	7/17/2009	1	7.66	0.3	N/A	N/A	0.08
	5/26/2009	1	7.46	0.36	N/A	N/A	0.01
	4/3/2009	1	7.3	0.3	N/A	N/A	0.07
	4/3/2009	1	7.3	0.3	N/A	N/A	0.07
	2/18/2009	1	7.31	0.32	N/A	N/A	0.07
	12/16/2009	1	7.63	0.24	N/A	N/A	0.07
	10/15/2008	1	7.56	0.24	N/A	N/A	0.07
	8/26/2008	1	7.68	0.26	N/A	N/A	0.08
	7/9/2008	1	7.42	0.3	N/A	N/A	0.09
	7/9/2008	1	7.42	0.3	N/A	N/A	0.09
	5/16/2008	1	7.79	0.33	N/A	N/A	0.07
	5/25/2009	1	7.49	0.38	N/A	N/A	0.08
	1/24/2008	1	7.51	0.29	N/A	N/A	0.08
	11/20/2007	1	7.41	0.29	N/A	N/A	0.08
	9/25/2007	1	7.68	0.26	N/A	N/A	0.08
	8/1/2007	1	7.68	0.27	N/A	N/A	0.07
	6/15/2007	1	7.22	0.28	N/A	N/A	0.07
	4/19/2007	1	7.5	0.39	N/A	N/A	0.07

Table SAB-6. Characteristics of Liquid Manure Samples

Site (page reference)	Date	No. of Samples	pH (SU) (Mean ± standard deviation)	Percent (wet weight basis)			
				Nitrogen (Mean ± standard deviation)	Solids (Mean ± standard deviation)	Ammonia (Mean ± standard deviation)	Sulfur (Mean ± standard deviation)
	3/22/2007	1	7.54	0.31	N/A	N/A	0.06
	1/24/2007	1	7.59	0.23	N/A	N/A	0.04
	12/1/2006	1	7.41	0.2	N/A	N/A	0.05
OK3A (p. 2021)	11/28/2007	1	8.36	0.68	0.55	0.55	0.03
	11/19/2008	1	8.26	0.46	0.43	0.45	0.03
	7/17/2009	1	7.9	0.57	0.4	0.49	0.02
OK4A (p. 2189)	11/1/2008	1	8.28	0.44	0.2	0.33	0.03

N/A = Not available.

3.2 Lingying Zhao:

3.2.1 We need data on nutrient contents of animal manure, feed, and animal products. A mass-balance analysis can be conducted using these data to verify if the modeling results are correct in bulk part.

Response: For the broiler sites, the final site reports (see Appendix D of the draft broiler EEM document) present the compositional analyses for manure. The response to Question 3.1.3 summarizes the manure composition data provided. Table SAB-7 below presents the feed composition data that have been submitted to the EPA for site CA1B. Feed ration schedules and feed consumption amounts for site CA1B were not provided. For the Kentucky sites, feed composition, ration schedules and feed consumption data were not provided to the EPA. The NAEMS monitoring plan did not include analyses to assess the nitrogen composition of birds sent to market or mortalities at any of the broiler farms.

Table SAB-7. Feed Composition Data for Site CA1B

Sample Location	No. of Samples	Sample Date	Percent (wet weight basis)			
			Total Nitrogen (%)	Total Nitrogen Std	Total Solids (%)	Total Solids Std
House 10	2	01/09/08	3.90	0.08	86.25	0.92
	2	08/10/08	2.52	0.04	88.65	0.21
	2	02/17/09	2.68	0.11	87.85	0.07
		Avg. =	3.03	0.08	87.58	0.40
House 12	2	01/09/08	4.01	0.01	89.80	0.42
	2	08/10/08	2.21	0.04	89.85	2.05
	2	02/17/09	3.08	0.03	87.65	0.07
		Avg. =	3.10	0.02	89.10	0.85

For the open sources, data sufficient to construct a mass balance across all the open sources were not submitted to EPA. The composition of lagoon liquid is presented in Section 4 of the NAEMS final site reports (see Appendix D of the draft lagoon EEM document) and the available information is summarized in Question 3.1.4.

Of the open source sites, the barns at sites NC4A, OK4A, WA5A and WI5A were monitored under the NAEMS. The compositional information submitted to the EPA is summarized in Table SAB-8. The NAEMS monitoring plan did not include analyses to assess the nitrogen composition of swine sent to market or mortalities at any of the swine farms. The NAEMS researchers did not submit any feed or water consumption data for the dairy or swine sites to the EPA. Also, the NAEMS researchers did not submit any milk production data for site WA5B.

Table SAB-8. Availability of Compositional Data for Dairy and Swine Sites

Site Pairs	Feed Composition Data?	Water Composition Data?	Milk Composition Data?
NC4A/NC4B	Yes (6 sample dates)	Yes (6 sample dates)	N/A
OK4A/OK4B	Yes (6 sample dates)	Yes (2 sample dates)	N/A
WA5A/WA5B	Yes (8 sample dates)	No	Yes (8 sample dates)
WI5A/WI5B	No	No	No

N/A= Not applicable.

Response references:

[*The EPA will post the supplemental data spreadsheets provided by the NAEMS researchers to the EPA website and inform the SAB's Designated Federal Officer (DFO) when the data are available.*]

3.2.2 In addition, as we suggested, hourly average data is useful for modeling, not daily average.

Response: The Consent Agreement specifies that the EPA must use the NAEMS data, and other relevant data, to develop EEMs that will provide daily and annual emissions estimates from an AFO. The EPA's initial plan was to develop the draft EEMs using daily data values, although the draft dairy and swine lagoon EEM were developed using half-hour data values due to the limited number of daily data values available. At this time, hourly data values have been submitted to the EPA only for site CA1B.

4 Additional Requests for Data:

4.1 Brock Faulkner: Table 4-1 shows MANY more "valid test days" for bLS modeling than it does for the RPM method, but a statement on p. 5-6 contradicts this. What is the data availability for bLS and RPM data?

Response: Table 4-1 of the draft lagoon EEM document presents the data availability for the daily RPM and bLS emissions values submitted by the NAEMS researchers in the final site reports. On page 5-6 of the draft lagoon EEM document, the size comparison between the RPM and bLS datasets refers to the half-hour values that were submitted in spreadsheet form to the EPA by the NAEMS researchers. The lagoon EEM document will be revised to clarify that the discussion regarding the dataset size refers to the half-hour data, rather than the daily data.

The half-hour data received by the EPA was in draft form and contained flagged records. The EPA removed the flagged records from the dataset based on discussions with the NAEMS researchers. However, the resulting half-hour dataset prepared by the EPA prepared by removing the flagged data does not provide the same number of daily emissions values as presented in the final reports. This discrepancy indicates inconsistencies in the manner in which the flagged data were handled between the draft half-hour dataset submitted to the EPA and the dataset the NAEMS researchers used to develop the daily values presented in the final site reports. Consequently, the EPA has requested the final half-hour dataset from the NAEMS researchers.

Response references:

- Draft Open Source EEM Document, Section 5.1 (p. 77 of full pdf file)

4.2 Milk production data availability

4.2.1 Wendy Powers-Shilling: Clarify if milk production data were collected. It was my understanding part way through the study that every day bulk tank milk (in lbs) and dairy milk cow numbers was collected and recorded at the dairy sites.

4.2.2 Brock Faulkner: Dr. Heber stated in 2010 that he had milk production data for the dairies that were studied, but this data is not included in the dataset. Was this data collected? Was this data submitted to EPA? If not, why? This is standard data collected by producers.

Response: According to the barn and open-source QAPPs developed for the NAEMS, milk production data were to be recorded only at the dairy confinement monitoring sites (milk production data were not recorded at the open-source sites). Consequently, milk production data for NAEMS open sources is potentially available only for the following site combinations where both houses and open sources were monitored at the same farm: WA5A/WA5B and WI5A/WI5B. Daily milk production values for site WI5B have been submitted to the EPA; however, composition data were not submitted to the EPA. For site WA5B, milk composition data has been submitted to the EPA but production data have not been provided.

Response references:

- Draft Broiler EEM Document, Appendix A, Barn QAPP (pp. 344, 356, and 431 of full pdf file)

4.3 Viney Aneja:

4.3.1 Was background data collected, and how was it utilized for the development of EEMs.

Response: Background (ambient) concentration measurements were taken at both the broiler house and lagoon monitoring sites. The background data were used to correct for house and lagoon emissions rates for contributions from the ambient air. For broiler houses, the background concentrations were subtracted from the house exhaust concentrations to obtain the concentrations of pollutant attributable to the source. For

open sources, emissions were calculated as the difference between downwind and background path-integrated concentrations.

Response references:

- Draft Broiler EEM Document, Appendix D, Final report for site CA1B (p. 1770 – 1773 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for Kentucky sites (pp. 2075 - 2076 of full pdf file)
- Draft Broiler EEM Document, Appendix C, SOP B4 (pp. 927 – 946 of full pdf file)
- Draft Broiler EEM Document, Appendix A, QAPP for Kentucky sites, Appendix J (pp. 616 – 620 of full pdf file)
- Draft Lagoon EEM Document, Appendix A, NAEMS Open Source QAPP (pp. 231 – 241 of full pdf file)
- Draft Lagoon EEM Document, Appendix C, SOP O1 (pp. 876 - 914 of full pdf file)

4.3.2 In the development of emissions for ammonia and hydrogen sulfide from water holding structures (i.e. lagoons and basins) for swine and dairy using the RPM model (Section 4.2) daily emissions were provided to US EPA by the NAEMS researchers. Continuous concentration measurements and meteorology dataset should be provided, and the emissions be computed on a smaller time resolution as opposed to daily emissions.

Response: For the lagoons/basins, the smallest time increment of the emissions values submitted to EPA by NAEMS researches were half-hour measurements. Although the RPM and bLS models can, in principle, be used to calculate emissions on a smaller time interval, data for a smaller time interval (e.g., 5 minutes) were not submitted to the EPA.

Response references:

- Draft Lagoon EEM Document, Appendix C, SOP C2 (pp. 557 – 582)
- Draft Lagoon EEM Document, Appendix C, SOP O2 (pp. 890 – 914)

4.3.3 The data for partially enclosed i.e. naturally ventilated housing for both swine and dairy was not discussed. This is an important data need as ~50% of all swine housing in NC is naturally ventilated.

Response: To date, the EPA has focused its analysis of the data collected for the swine and dairy industry on lagoons and basins. The EPA has not begun analyzing data submitted for swine and dairy confinement houses. With regard to measuring emissions from naturally ventilated confinement houses, the NAEMS did measure emissions from naturally ventilated dairy confinement houses but not from swine confinement houses. As outlined in the Consent Agreement, the type of facility to be monitored for each animal sector was determined by a panel of stakeholders that included industry experts; university, EPA and USDA scientists; state and local air quality agencies; and other interested stakeholders.

Response references:

- Draft Lagoon EEM Document, Appendix E, Consent Agreement (p. 2629)

4.3.4 The total nitrogen and sulfur content data of the lagoon and basin needs to be provided, and both of these should be used as static variables to determine ammonia and H_2S emissions.

Response: The lagoon compositional data, where available, are presented in each of the NAEMS final reports in Section 4. The compositional data are summarized in the response to Question 3.1.4. The EPA did not receive nitrogen or sulfur content information for one of the swine sites or for any of the dairy sites. Due to this lack of data coverage, the EPA has not incorporated these data into the draft lagoon EEM at this time.

Response references:

- Draft Lagoon EEM Document, Appendix D, Final site reports (pp. 1105 – 2613)

4.4 Al Rotz: There were a couple issues related to the VOC portion of the document that could be added to the additional data needs.

4.4.1 Better documentation of the measurement procedures used for monitoring VOC emissions. This should include the deviation from the initial procedures planned and why the procedures were modified. This could include a brief discussion on the difficulty of accurately measuring VOCs, strengths and weaknesses of the procedures used and justification for not using the data for developing EEMs.

Response: The EPA will clarify the summary of the VOC measurement procedures for the final broiler report. Although the NAEMS open source QAPP states that VOC emissions from open source were to be measured, VOC emissions data for open sources were not submitted to the EPA.

As specified in the Federal Register notice that announced the Consent Agreement (70 FR 4972), the NAEMS VOC sampling plan for broiler houses consisted of grab sampling to collect data for an initial VOC characterization study to identify the top VOC species (on a mass contribution basis), periodic grab sampling of the top VOC species, and continuous monitoring of total nonmethane hydrocarbons (NMHC). The final site reports provide site-specific descriptions of the grab and continuous sampling procedures and results.

Response references:

- Draft Broiler EEM Document, Appendix E, Consent Agreement (pp. 2159, 2161, and 2157 of full pdf file)
- Draft Broiler EEM Document, Appendix A, NAEMS Barn QAPP, Section 2.1.8.1 (p. 357 of full pdf file)
- Draft Broiler EEM Document, Appendix A, Section 2.3.1.4 of NAEMS Barn QAPP (pp. 361 - 362 of full pdf file)

- Draft Broiler EEM Document, Appendix B, CA1B SMP (pp. 754 – 755 of full pdf file)
- Draft Broiler EEM Document, Appendix C, SOP G6 (pp. 1149 -1163 of full pdf file);
- Draft Broiler EEM Document, Appendix C, SOPs V1 – V6 (pp. 1575-1701 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for site CA1B, Section 3.7 (pp. 1763 – 1764 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for site CA1B, Section 3.8.3.3 (p. 1766 of full pdf file)
- Draft Broiler EEM Document, Appendix D, QAPP for Kentucky sites, Section 12.1 (pp. 494 - 495 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for Kentucky sites (pp. 2080 - 2081 of full pdf file)

4.4.2 Documentation of the VOC species emitted from the facilities. This includes both the broiler houses and the manure storages. Even though the data are not sufficient for EEM development, the data are useful. Data on the compounds making up the total VOC measurement is useful for future work.

Response: Tables containing information on the top VOC species measured at the broiler sites are provided in the final site reports submitted to the EPA (referenced below) and the data are summarized below in Tables SAB-9 and SAB-10. The EPA did not receive any VOC emissions data for open sources.

Response references:

- Draft Broiler EEM Document, Appendix D, Final report for site CA1B (pp. 1777 – 1778 of full pdf file)
- Draft Broiler EEM Document, Appendix D, Final report for Kentucky sites (p. 2107 of full pdf file)

Table SAB-9. Average Concentration of 20 Most Prevalent VOCs at Site CA1B

Compound	Concentration, ng/m^3	% of Total	Cumulative %
2, 3-Butanedione	3.11E+05	34.33%	34.3
Dimethyl disulfide	9.43E+04	10.41%	44.7
Acetaldehyde	6.77E+04	7.47%	52.2
2-Butanone	6.32E+04	6.98%	59.2
iso-Propanol	4.11E+04	4.54%	63.7
Pentane	3.96E+04	4.37%	68.1
Dimethyl sulfide	3.03E+04	3.35%	71.4
Acetic acid	2.71E+04	2.99%	74.4
Hexanal	1.69E+04	1.86%	76.3
Ethyl acetate	1.65E+04	1.82%	78.1
Hexane	1.44E+04	1.59%	79.7
Propanoic acid	1.36E+04	1.51%	81.2
Pentanal	1.31E+04	1.45%	82.7
Phenol	1.22E+04	1.35%	84
1-Butanol	9.38E+03	1.04%	85
2-Pentanone	8.86E+03	0.98%	86
4-Methyl-phenol	8.61E+03	0.95%	87
Heptanal	8.50E+03	0.94%	87.9
Butanal	8.39E+03	0.93%	88.8
Octanal	8.20E+03	0.91%	89.7

Table SAB-10. Top-25 Speciated NMHC Concentration Levels and Mass Conversion Coefficients for Empty and Occupied Broiler House Samples for the Kentucky Sites

Compound	Empty House (KY1B-2)		Occupied House (KY1B-1)	
	Sample Concentration, ppb	Conversion Coefficient, lb/lb·C_3H_8	Sample Concentration, ppb	Conversion Coefficient, lb/lb·C_3H_8
2,3-Butanedione	4.6	0.01	260.7	0.48
2-Pentanone	5.7	0.015	6.5	0.015
2-Butanone	N/A	N/A	14.9	0.023
2-Methyl propanoic acid	N/A	N/A	7.7	0.014
2-Methyl-3Pentanone	N/A	N/A	12.4	0.04
3-Hydroxy-2Butanone	3.5	0.007	15.8	0.03
3-Methylindole	1.8	0.013	N/A	N/A
3-Methyl butanoic acid	N/A	N/A	9.4	0.026
4-Ethylphenol	1.8	0.011	N/A	N/A
4-Methylphenol	7.1	0.032	N/A	N/A
Acetamide	N/A	N/A	10.1	0.006
Acetic acid	67.6	0.049	344.1	0.221
Acetone	30.1	0.032	40.9	0.038
Acetonitrile	N/A	N/A	13.5	0.006
Benzalaldehyde	10.7	0.048	N/A	N/A
Benzoic acid	8.2	0.043	N/A	N/A
Butanoic acid	3.3	0.007	18.9	0.036
Butanol	301.2	0.542	39.3	0.062
Dimethyl disulfide	7.2	0.008	7.8	0.008
Dimethyl sulfone	6.9	0.008	4.6	0.005
Ethanol	28.6	0.016	120.1	0.059
Hexane	22.6	0.071	10.5	0.029
Indole	N/A	N/A	3.9	0.02
Isoprene	8.3	0.017	N/A	N/A
Methanol	63.8	0.012	160.4	0.028
Pentane	N/A	N/A	9	0.017
Phenol	18.3	0.063	N/A	N/A
Propanoic acid	5.5	0.007	14.4	0.017
Propanol	5.6	0.006	15.6	0.015
Propene	N/A	N/A	10.9	0.007
Sulfolane	1.7	0.005	N/A	N/A
Tetra methyl pyrazine	N/A	N/A	3.4	0.027
Toluene	50.2	0.197	N/A	N/A
Triethyl citrate	14	0.282	N/A	N/A
Trimethyl oxazalone	N/A	N/A	5.1	0.018
Unknown compound	10.5	0.122	N/A	N/A

Note: The final report does not define the term “N/A.”

Attachment A

Discussion of Negative Emissions Values for Broiler Confinement Houses and Swine and Dairy Lagoons/Basins

Strict QA/QC procedures were followed by the researchers throughout the data collection and preliminary data analyses for all broiler and lagoon/basin monitoring sites. The researchers developed Quality Assurance Project Plans (QAPPs), standard operating procedures (SOPs) for sampling systems and monitoring instruments, and site-specific monitoring plans (SMPs) and provided extensive training for on-site operators and producers. The draft EEM development documents for broilers and lagoons/basins provide the QAPPs, SOPs and SMPs developed by the researchers (see the response references at the end of this document).

Monitoring instruments underwent initial and periodic calibration, bias and precision checks and were corrected if they failed the QC checks. The frequency of each check/calibration event was dependent on the type of instrument and on the site investigator. For example, the NH_3 gas analyzer was checked with calibration gases weekly or semi-weekly for the Kentucky sites, while the calibration checks were conducted every two months at site CA1B. The investigators also implemented external system audits conducted by independent personnel and maintained supporting documentation (e.g., field logs, instrument calibration records).

All of the monitoring sites were equipped with data acquisition (DAQ) systems that allowed on-site operators, and other authorized personnel to view the measured data and parameter values daily through real-time computer displays via high-speed Internet connections. The DAQ systems also generated email notifications for project personnel when monitored parameter values were outside of preset ranges.

All of the monitoring sites administered under the National Air Emissions Monitoring Study (NAEMS) for AFOs (i.e., site CA1B and all of the dairy and swine lagoon/basin monitoring sites) also used control charts extensively in QA/QC procedures to assess data quality and measurement variability and to evaluate long-term trends in the instrument/equipment performance. The control charts provided a graphical means of determining whether the measured parameters were within acceptable upper and lower control limits. Data values outside the control limits triggered corrective actions by site operators to maintain data quality. The control charts were generated on site using Microsoft Excel® templates to provide a real-time assessment of the data quality.

Measurement data recorded at each site were uploaded to the respective researchers (Purdue University for site CA1B and Iowa State University for the Kentucky sites) each day for

review and evaluation. The researchers used custom-designed software to apply flags to measurement data that were considered to be invalid or outlier values, and to calculate emissions rates for the monitored sources.

In general, the researchers invalidated measurement data (e.g., pollutant concentration, ambient temperature) if the data values were:

- Unreasonably low or high when compared to normal ranges if there was supporting evidence that the data value was not correct (e.g., unresponsive relative humidity sensor inside a confinement house producing a reading of less than 10 percent).
- Obtained during system installation, testing or maintenance during which uncorrectable errors might be introduced.
- Obtained when a sensor or instrument was proven to be malfunctioning (e.g., unstable).
- Obtained during calibration or precision check of a sensor or instrument and before the sensor or instrument reached equilibrium after the check.
- Obtained when the data acquisition and control hardware and/or software were not functioning correctly.

Data that the researchers deemed invalid were retained in the preprocessed data sets. However, the flagged data were not used to calculate the daily pollutant emissions values submitted to the EPA.

To verify the data spreadsheets received for the broiler and lagoon/basin monitoring sites, the EPA performed QA checks to confirm that the data counts, completeness percentages, and average emissions contained in the spreadsheets matched the values presented in the final site reports submitted by the researchers. During this analysis, the EPA observed that the spreadsheets and the final reports submitted by the NAEMS researchers for site CA1B and the dairy and swine lagoon/basin sites contained negative emissions values. For the broilers and lagoon/basin data, negative emissions represented less than 2 percent of all the values in the respective databases. In developing the draft EEMs for broilers and dairy and swine lagoons/basins, the EPA did not use the negative emissions values. Tables A-1 and A-2 summarize the negative emissions values for barns and open sources, respectively.

The EPA questioned whether QA/QC procedures completed by the NAEMS researchers had mislabeled these emissions as valid, when they should have been invalidated. The EPA questioned the negative daily emissions from animal confinement houses and the open sources

(e.g., lagoons and basins) because the data suggests these emission sources were acting as sinks of emissions for that day. The implication that the emission sources were acting as sinks is counterintuitive, based on the EPA's understanding of AFO processes.

The NAEMS Science Advisor assured the EPA that all daily emissions values presented in the final report tables and final data spreadsheets were valid emission values that met all QA/QC requirements and that the submitted data did not include any outlier values.

EPA staff discussed possible causes of negative emissions with the NAEMS researchers to better understand the conditions responsible for the reported negative emission values. For site CA1B, one possible explanation is that the negative emissions values for the gaseous species were the result of instrumentation drift paired with the calibration technique. Precision checks were conducted periodically using zero gas and span gases (Z/S checks) and instrument responses were recorded to monitor changes in system performance over time. The average response of the instrument to the zero and span gas applications was assessed, and the results were combined based on changes to the instrument or GSS to create linear correction models for correcting instrument readout data. This data adjustment was responsible for creating some negative concentration values for H_2S at site CA1B, as seen in the Calibration Chart in Appendix C of the final site report. Furthermore, this adjustment would affect the ultimate emissions calculation and possibly result in negative emissions for the house. Section 3.8.3 and Appendix D of the final site report for CA1B note when calibrations of NH_3 and H_2S occurred and the equations used to adjust the concentrations. The NH_3 concentrations were adjusted using one of five equations developed after calibration checks. The H_2S concentrations were adjusted using one of three linear equations developed over after calibration checks.

For the open source data, EPA staff had several conversations with the NAEMS researchers to determine possible causes of negative emission values. The consensus was that negative emissions could occur because of several conditions, including:

1. Concentration measurements near the method detection limit (MDL) of the measurement technique.

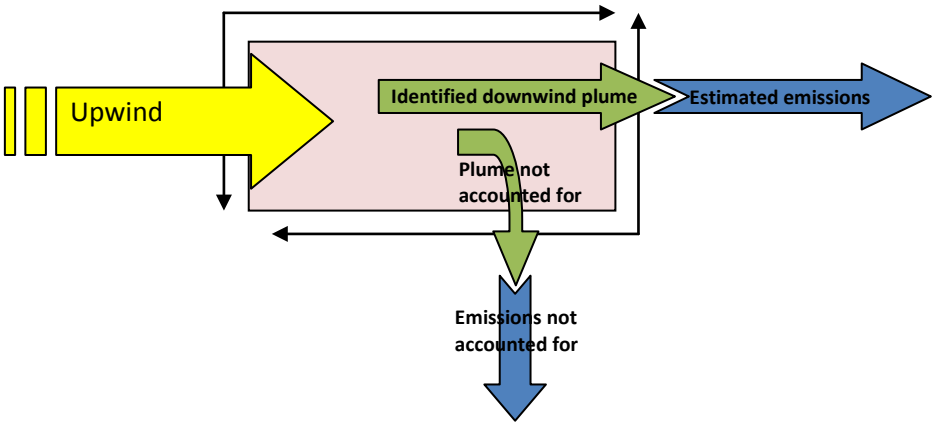
2. Instances of high atmospheric instability during the emissions calculation interval.

3. High variability in wind direction during the emissions calculation interval.

For concentrations measured near the MDL, the actual emissions may not be appropriately resolved with the method, resulting in negative values. In instances of high atmospheric instability, a portion of the emissions from the surface of the lagoon could travel

vertically in the atmosphere. This vertical plume would not be captured by the instrument monitoring paths which were oriented to capture emissions in vertical planes surrounding the lagoon perimeter.

Instances of variable wind direction could cause the monitoring systems at the open sources to under-estimate the emissions from the lagoon. The emissions rates for open sources were determined based on the difference between the upwind and downwind concentrations. Consequently, negative emissions rates could be calculated if the upwind concentrations were greater than the downwind concentrations. The designations as to the upwind and downwind sides of the lagoon were made based on the predominant wind direction for a given half-hour period. Variable wind directions during that half hour could cause emissions that leave the lagoon through measurement planes that were perpendicular to the downwind side to be excluded from the emissions calculation. For example, variable wind direction over the half-hour period could cause emissions from the lagoon to exit on both the south and east edges of the lagoon. If 70 percent of emissions from the lagoon cross through the measurement plane on the east side of the lagoon, and this side is identified as the downwind side, then the remaining 30 percent of emissions would not be included in the emissions calculation (i.e., the emission calculation would not include emissions leaving the lagoon on the south side). This scenario could result in negative concentration values (and subsequent emissions rate) if the upwind concentrations were greater than the under-measured downwind concentrations.



Response references:

- Draft Broiler EEM Document, Appendix A, NAEMS Barn QAPP (pp. 365 – 372, 407 – 408, and 416 – 425 of full pdf file)
- Draft Broiler EEM Document, Appendix A, QAPP for Kentucky sites (pp. 508 – 517, 534 – 535, and 548 – 556 of full pdf file)

- Draft Broiler EEM Document, Appendix D, CA1B Final site report (pp. 1764 – 1768 and 1790 -1792 of full pdf file)
- Draft Lagoon EEM Document, Appendix A, NAEMS open source QAPP (pp. 179 – 191, 246 – 254, and 289 – 311 of full pdf file)

Table A-1. Summary of Negative Emissions Values for the Broiler Sites

Site	Location	NH_3		H_2S		PM_{10}		$PM_{2.5}$		TSP		VOC	
		Total	Negative	Total	Negative	Total	Negative	Total	Negative	Total	Negative	Total	Negative
CA1B	House 10	467	0	592	**9**	352	**3**	53	0	37	0	0	0
CA1B	House 12	466	0	590	**10**	376	**1**	43	0	39	0	0	0
Tyson	Tyson 1-5	378	0	342	**1**	301	0	286	0	315	0	280	**1**
Tyson	Tyson 3-3	336	0	291	0	305	0	301	0	301	0	227	0

Table A-2. Summary of Negative Emissions Values for the Open Sources

Pollutant	Measurement Method	No. of Valid Emissions Values		No. of Negative Emissions Values		Percent Negative	
		Daily	30-min	Daily	30-min	Daily	30-min
NH_3	RPM	69	17,292	0	134	0%	1%
	bLS	285	6,416	18	1,108	6%	17%