Public Comment on NC DEQ Industrial Hog Operation Air Quality Monitoring Study: Scientific Review

Co-signed by 12 scientists in fields relating to
air quality, public health, and environmental sciences

Hog waste being sprayed into the air in North Carolina. Photo: Donn Young

Major Points:

1. There are **numerous limitations** with the study design that must be considered when drawing conclusions or generalizing results.
2. We **disagree with the report's summary findings:** that air quality monitoring of IHOs in North Carolina should cease.
3. Instead, we believe that evidence, including this report, suggests that **monitoring the air quality impacts of IHOs <u>should both continue and increase</u>** in North Carolina.

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Executive Summary

N.C. Department of Environmental Quality
Attn: Jim Bowyer
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daq.publiccomments@ncdenr.gov

January 30, 2020

Dear Jim Bowyer,

We are 12 undersigned scientists in fields such as air quality monitoring, public health, and environmental sciences. We have each read the NC Department of Environmental Quality (NC DEQ) draft report on study of the air quality impacts of industrial hog operations (IHO) in Duplin County, North Carolina.

In this public comment, we outline **nine issues that limit the findings and quality of this air monitoring study.** These are grouped in three areas: the siting of monitoring locations; concentrations and thresholds; and completeness, quality, and attribution issues.

Given these limitations, **we disagree with the report's conclusion,** that the NC Department of Environmental Quality should cease monitoring the overall and specific impacts to air quality of IHOs, both in these counties and in North Carolina more generally.

Instead, in the light of the limitations, we interpret these initial study results as evidence that **air quality monitoring of the range of impacts of IHOs should both continue and increase in North Carolina.**

We consider the protection of the environmental quality of North Carolina for both its current and future residents an essential activity. This includes measuring and monitoring the impact of IHOs on air quality at ambient levels focused on NAAQS compliance in areas of moderate density, as was done in this report. However, we believe it also includes **measuring, monitoring, and action** to minimize the negative **acute, proximate, and highest-level exposures** that people experience, **acknowledging sub-compliance level impacts to quality of life and public health.** We ask that you continue and expand this study to represent and defend the environments and health of people whose experiences this study cannot represent.

Sincerely,

Sarav Arunachalam, PhD, MS
Calvin Cupini
Radhika Dhingra, PhD, MSPH, MS
Lawrence Engel, PhD, MS
Mike Dolan Fliss, PhD, MPS, MSW
Chris Heaney, PhD, MS
Brian Magi, PhD
Sarah Rhodes, PhD
Ana Maria Rule, PhD MHS
Sacoby Wilson, PhD, MS
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William Vizuete, PhD, MS

Signatories / Co-Authors

1. **Sarav Arunachalam**, PhD, MS. sarav@email.unc.edu. Deputy Director & Research Professor with UNC Institute for the Environment, Acting Director, Center for Environmental Modeling for Policy Development, Adjunct Professor, Environmental Sciences and Engineering, UNC Gillings School of Global Public Health. Dr. Arunachalam has over 25 years of experience studying air quality at local to regional scales, with a focus on developing and applying multi-scale chemistry – transport models to study nonattainment issues and developing methods for source attribution. He previously studied O3 formation in North Carolina and identified emissions controls from coal-fired power plants, that was in part, the basis of the 2002 NC Clean Smokestacks Act. Recently, Dr. Arunachalam has led the development of a series of web-based reduced-form screening tools to study near-source air pollution from traffic-related and other emissions sources for community applications focused on developing mitigation options. Dr. Arunachalam is on the Scientific Advisory Board of the Clean Air Carolina's Citizen Science program, the ICAO Committee on Aviation Environmental Protection's Impacts and Sciences Group, and Chair of the American Meteorological Society's Committee on Meteorological Aspects of Air Pollution. https://ie.unc.edu/people/arunachalam/

2. **Calvin A. Cupini**, Program Manager of Citizen Science and AirKeepers for Clean Air Carolina. Calvin works on localized pollution impacts in environmental justice areas, manages and implements the state-wide AirKeeper network of engaged citizens and low cost sensors, and advises staff in matters of public science and environmental economics. Calvin lead the community collaboration and deployment for the development of the Collocation Guide and Macro Analysis Tool for EPA's Air Sensor Toolbox for Citizen Scientists. He is a technical advisor to Earthwatch, SciStarter, The Pollution Detectives and the Science Museum of Virginia. Calvin is also a session chair for the Air Sensors International Conference.

3. **Radhika Dhingra**, PhD, MSPH, MS.rdhingra@unc.edu. Assistant Professor, Environmental Sciences and Engineering, UNC Gillings Global School of Public Health. Radhika has a doctorate in environmental epidemiology and a masters in environmental engineering. As an environmental epidemiologist she has 8 years of experience in environmental health research that includes the study of community-wide contamination from industrial sources, air pollution and vector-borne disease. Website: https://sph.unc.edu/adv_profile/radhika-dhingra-PhD/

4. **Lawrence Engel,** PhD, MS. larry.engel@unc.edu. Associate Professor, Epidemiology, UNC Gillings Global School of Public Health. Dr. Engel has over 20 years of experience in environmental and occupational health research. His current research in North Carolina focuses on the transport of environmental contaminants from point sources to nearby communities and the health impacts of these contaminants in these communities. Website: https://sph.unc.edu/adv_profile/lawrence-s-engel-phd/.

5. **Mike Dolan Fliss**, PhD, MPS, MSW. Mike.Dolan.Fliss@unc.edu. Research Scientist with NC Injury Prevention Research Center; epidemiologist & public health data scientist with NC Division of Public Health, Injury & Violence Prevention Branch. Mike has a PhD in Epidemiology, a Masters in Public Health Informatics, and a Masters in Social Work. He has been a research volunteer with the NC Environmental Justice Network focusing on CAFOs and other human experiences of pollution in North Carolina since 2015. Mike's previous studies have included supporting the Title VI complaint analysis and documenting the widespread and cumulative exposure to CAFOs in NC. Mike is one of the primary authors of this public comment. Website: http://epimike.web.unc.edu/

6. **Chris Heaney**, PhD MS. cheaney1@jhu.edu. Associate Professor, Department of Environmental Health and Engineering, Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health. Chris's research interests include environmental epidemiology, occupational and environmental health, infectious diseases, water and health, global climate change, and community-based participatory website. Recent related projects include the health impacts of industrial poultry integration and exposure to airborne swine-specific fecal pollution. Website: https://www.jhsph.edu/faculty/directory/profile/2595/christopher-d-heaney

7. **Brian Magi**, PhD. brian.magi@uncc.edu. Associate Professor, UNC Charlotte, Department of Geography and Earth Sciences. Brian has a PhD in Atmospheric Sciences. He is a member of the Mecklenburg County Air Quality Commission, and on the Board of Directors of Clean Air Carolina, and the Scientific Advisory Board of Clean Air Carolina's Citizen Science program. His expertise is related to aerosol/particle physics and chemistry, and he has been studying low-cost air monitoring as a tool for learning about local scale variability in ambient PM2.5. He also teaches courses in Atmospheric Chemistry and Global Environmental Change at UNC Charlotte. Brian is one of the primary authors of this public comment. His research group webpage is http://brianmagi.uncc.edu/

8. Sarah Rhodes, PhD. smrhodes@live.unc.edu. Research Affiliate in the Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill. For the past six years, Dr. Rhodes has been conducting research in partnership with the Rural Empowerment Association for Community Help and Johns Hopkins University to examine the role of swine CAFOs in the evolution and spread of antibiotic-resistant bacteria among hogs, swine CAFO workers, community residents, and the environment (e.g. air, water, surfaces) in North Carolina. Dr. Rhodes is currently working as a consultant in environmental/occupational epidemiology in Toronto, Ontario.

9. **Ana Maria Rule**, PhD MHS. arule1@jhu.edu. Assistant Professor, Department of Environmental Health and Engineering, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins Education and Research Center for Occupational Safety and Health. Dr. Rule's background is in aerosol research and exposure assessment. Her previous projects include collaboration with FDA researchers in Wisconsin optimizing air sampling techniques to evaluate potential exposures from manure irrigation systems; she has led an effort to investigate emissions from food animal transport vehicles, and is helping characterize bacterial aerosols and antibiotic resistance related to hog and dairy operations.She is currently director of the Environmental Exposure Assessment Lab, where she develops and applies methods for the assessment of airborne exposures to adult and pediatric populations, which include biological aerosols. Website: https://www.jhsph.edu/faculty/directory/profile/1984/ana-mar-a-rule

10. Sacoby Wilson, PhD, MS. swilson2@umd.edu. Associate Professor with the Maryland Institute for Applied Environmental Health and Department of Epidemiology and Biostatistics, School of Public Health, University of Maryland-College Park. Dr. Wilson has over 15 years of experience as an environmental health scientist in the areas of exposure science, environmental justice, environmental health disparities, community-engaged research including crowd science and community-based participatory research (CBPR), air pollution studies, built environment, industrial animal production, climate change, and community resiliency. He works primarily in partnership with community-based organizations to study and address environmental justice and health issues and translate research to action. Dr. Wilson is Director of the Community Engagement, Environmental Justice and Health (CEEJH) Initiative. CEEJH is focused on providing technical assistance to communities fighting against environmental injustice and environmental health disparities in the DMV region and across the nation.

He is a member of the USEPA's National Environmental Justice Advisory Council (NEJAC), on the board of the Citizen Science Association, a past Chair of the APHA Environment Section, past board member of Community-Campus Partnerships for Health, and a former Chair of the Alpha Goes Green Initiative, Alpha Phi Alpha Fraternity, Inc. He is also a senior fellow in the Environmental Leadership Program. Dr. Wilson, a two-time EPA STAR fellow, EPA MAI fellow, Udall Scholar, NASA Space Scholar, and Thurgood Marshall Scholar. Website: www.ceejhlab.org.

11. **Courtney Woods**, PhD. cgwoods@email.unc.edu. Assistant Professor, Department of Environmental Sciences and Engineering. Dr. Courtney Woods has over 10 years of experience in toxicology research and community-based participatory research in partnership with rural communities and environmental justice organizations across the southeastern US. Website: https://sph.unc.edu/adv_profile/courtney-g-woods/

12. **William Vizuete**, PhD, MS. vizuete@unc.edu. Associate Professor, Environmental Sciences and Engineering, UNC Gillings Global School of Public Health. In his research Dr. Vizuete seeks novel environmental engineering solutions to solve public health problems associated with air quality. Website: http://vizuete.web.unc.edu.

Concerns about DEQ CAFO Air Monitoring Report

Siting of monitoring locations

Selection of monitoring sites for compliance with regulatory standards may not capture public health exposure and may exclude maximum/peak exposure. How representative of community exposure are these sites?

1. Monitor strategy based on ambient compliance, not public health impact

   The siting strategy DEQ implemented is in line with compliance with National Ambient Air Quality Standards (NAAQS), which is geared towards county/regional air quality assessment. In contrast, the complaints due to odors associated with hog-farm operation are a specific emission source of pollution, and **the experiences of a community or even a household are as important to consider as county/regional air quality**.

   The quality of life and public health impacts of sub-compliance exposures may be as significant to these specific communities and households as meeting regional NAAQS thresholds. **Sub-compliance experiences (and unmonitored, higher intensity experiences) still represent a lowered environmental quality for residents that may continue to prompt complaints.** Additionally, measuring air quality experiences in rural areas may require unique monitoring coverage plans when compared to more dense city environments.

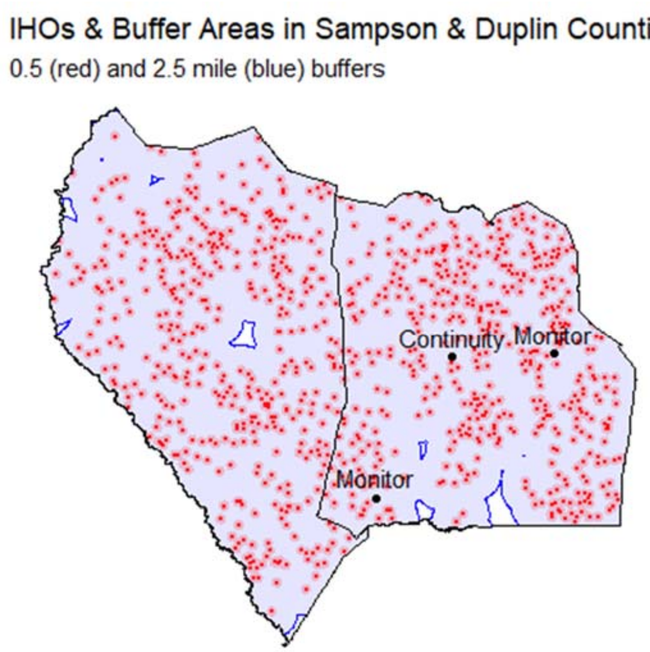
   As presented, the DCAMS Report **does not help understand community or household exposure**, so we would suggest that the DCAMS Report conclusion (that there is no significant air quality issue) is flawed because the analysis and study design themselves were aimed at understanding county/regional air quality assessment. This design strategy is different than one aimed at understanding quality of life and public health impacts. **Studies that combine air quality measurement with the people's lived experiences can help bridge this gap** - residents can (and have) identified that intense odorant chemicals and acute spikes in already high ambient exposures negatively impact activities of daily living, including being awoken from sleep at night by smells. This DCAMS report does not include experiences of individuals, households, or specific communities associated with this air monitoring data, so it is difficult to interpret the lived experience parallels of this data.

2. Study exclusions leave out tens of thousands with most proximate exposure

By following the EPA monitoring placement guidelines for ambient PM2.5, the study excluded the possibility of placement of monitoring locations within 0.5 miles of industrial hog operations (IHOs). However, given the extremely high density of IHOs in Sampson and in Duplin counties specifically (99% of each county is within 2.5 miles of an IHO), this **0.5 mile exclusion excludes over 30% (by area) of these counties (see below).**

These are not unpopulated areas; **nearly 100,000 people in NC (most of them in these two counties) live within 0.5 miles of an IHO.** By excluding these areas from study, the air quality experiences of these people are not represented by DCAMS Report conclusions. These areas, most proximate to IHOs, may also include some of the most intense air quality impacts, as they may be much closer to lagoons and spray fields in ways the monitors were not. Moreover, given that around one million North Carolina residents live within 3 miles of an IHO (from Title VI Complaint), ending this IHO-focused air quality monitoring program leaves the experiences of many North Carolinians largely unmonitored. **Given how many people are exposed to IHOs, and how many people are left out of this study, we recommend more monitoring to better understand how and when complaints arise. Less or no monitoring would undermine the lived experience of NC citizens in Duplin County**

Monitor locations, industrial hog operations (IHOs), & 0.5, 2.5 mile buffer areas



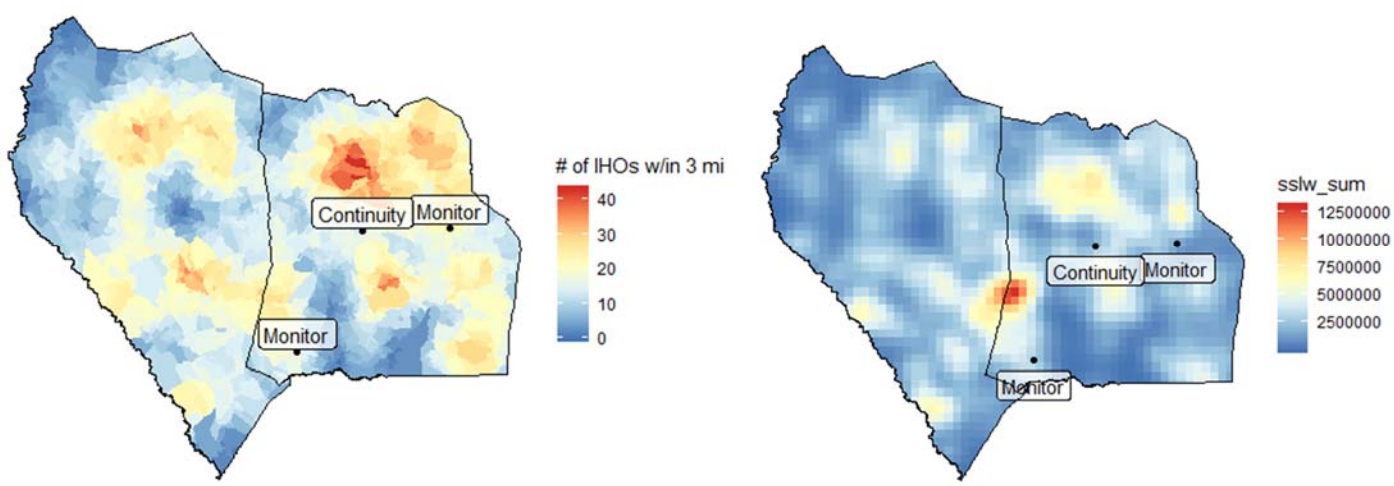
Includes 2,029 Industrial Hog Operations (IHOs) from 205 data of permitted CAFO locations as cleaned for the Title VI analysis. 0.5 mile buffers exclude 20 and 35% of Sampson and Duplin from the study respectively. 99% of each county area is within 2.5 miles of an IHO. Analysis and map by Mike Dolan Fliss, PhD, UNC Chapel Hill.

3. Monitor locations are placed in relatively low-density locations

The DEQ placement strategy, based on ambient PM2.5 measurement, precluded the study from measuring the closest, most proximate exposures to CAFOs. In addition, the monitor locations seem to suggest the **study is measuring the lower end of density of IHOs, whether by number of IHOs or proxy measures for manure density**, like steady state live weight (SSLW). This suggests the study is limited to measurement of less-proximate IHO impacts to ambient air quality in (relatively) lower IHO density areas in Sampson and Duplin Counties.

It is important to remember that the relative lower-density areas in these two counties are still some of the highest density IHO exposures in both the US and the world. Still, this study may not represent the upper range of ambient exposures given the additive impact of multiple IHO exposures in other places of the county. This is different than the highest proximate exposures (excluded from analysis) and acute exposures (likely sprayfield mechanisms) that may also be left out of the study entirely.

Monitor location vs. IHO density by count of IHOs and steady state live weight (SSLW)



Monitor locations are not placed in the highest density areas, whether by number of IHOs (top: sum of IHOs within 3 miles of a block centroid) or modeled steady state live weight (bottom: additive raster - +100% of SSLW at 0 miles, +0% at 4 miles or farther, bisquare in between). Analysis and map by Mike Dolan Fliss, PhD, UNC Chapel Hill.

4. Limited study does not represent range of people's lived experience

This study, including limiting monitoring in one county, is not representative of the range impacts Industrial Hog Operations (IHOs) have on air quality and people's lives in North Carolina. Residents experience the air quality impacts of IHO pollution in different ways.

To break down this range of people's lived experiences, we might consider a simplified table of exposures. (1) **IHO density** (by headcount, steady state live weight, estimated manure load, etc.) may be higher or lower. (2) Relevant **concurrent exposures** with negative impacts to PM2.5 and odorant chemical by co-located facilities (e.g. poultry feed operations locations, landfills) may likewise be high or low, partly determined by the high or low density of those co-located facilities. (3) The **exposure type**, related to the **mechanism**, includes at least (a) ambient lagoons as their source and (b) higher intensity proximate lagoon or (c) acute spray exposures.

Given limited monitoring locations, the comparison of monitor locations and high density CAFO exposures (above), the study design exclusions (0.5 miles), and the lack of sprayfield data or spikes in the monitors, we estimate the DEQ study includes an attempt to model ambient lagoon air quality impacts with lower IHO density and (assumed, little evidence in report) lower concurrent exposures. **Therefore, it is our estimation that this DEQ study could not capture the range of these air quality impacts or quantify the experiences of people in these diversity of settings**. However, it is our understanding that this diversity of human experiences (at least!) matters for communities living proximate to IHOs. Should DEQ continue its monitoring program, it should aim to provide both evidence for and ongoing surveillance of changes to at least these air quality impact combinations.

DEQ study: coverage of IHO-related air quality impact experiences

<table>
<tr><td colspan="3" rowspan="4"></td><td colspan="4">IHO Density (Head, SSLW)</td></tr>
<tr><td colspan="2">Lower</td><td colspan="2">Higher</td></tr>
<tr><td colspan="4">Concurrent Exposures</td></tr>
<tr><td>Low</td><td>High</td><td>Low</td><td>High</td></tr>
<tr><td rowspan="3">Exposure Type & Mechanism</td><td>Ambient</td><td>Lagoon</td><td>DEQ Study</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td rowspan="2">Acute / Proximate</td><td>Lagoon</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Spray</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
</table>

Table by Mike Dolan Fliss, PhD, UNC Chapel Hill.

Concentrations and thresholds

5. Time-series graphs need improvement to accurately communicate results

We suggest that the statistical summary of the valid data points be presented more clearly and completely to better convey the full scope of the data collected for PM2.5. Figure 5 and Figure 6 in the DEQ DCAMS Report summarize the hourly and daily PM2.5 at the various sites with all data points from all sites overlaid as a series of individual hourly and daily average PM2.5 for the full time span of the longest sampling (June 2018 to October 2019). Certainly the graphs contain all the information, but the presentation of the data could be much clearer. We suggest the following:

I. Separately plot the time series of data from each site using mathematical smoothing to generally guide the eye.
II. On the graph, include the average PM2.5 concentration from each site, the fraction of hours or days when PM2.5 > 12 ug/m3 (Annual NAAQS) and the fraction of hours or days when PM2.5 > 35 ug/m3 (24 hour NAAQS). **This additional information would better quantify instances when PM2.5 concentrations were high** (relative to 24 hour NAAQS) and quantify how high the general PM2.5 concentrations were (relative to the annual NAAQS).
III. Figure 5 and 6 should both denote the annual PM2.5 NAAQS and 24 hour NAAQS thresholds. Both are relevant in the conversation of acute exposure (something more along the lines of the 24 hour NAAQS) and prolonged exposure (annual NAAQS). We also would think both are relevant in and amongst CAFOs in Duplin county that operate with spraying schedules (leading to acute exposure) and operate all year round to generate prolonged exposure.

To prompt this discussion, we plotted the PM2.5 data from Sarecta and Williamsdale available at the DEQ Special Studies website (https://deq.nc.gov/about/divisions/air-quality/air-quality-data/special-studies/duplin-county) that was marked with the QA flag of “Ok” and that was greater than 0 ug/m3 since negative mass concentration is physically meaningless. We further partitioned the filtered PM2.5 data into day (05:00-20:00) and nighttime (21:00-04:00) values and calculated various bulk statistics for Sarecta and Williamsdale.

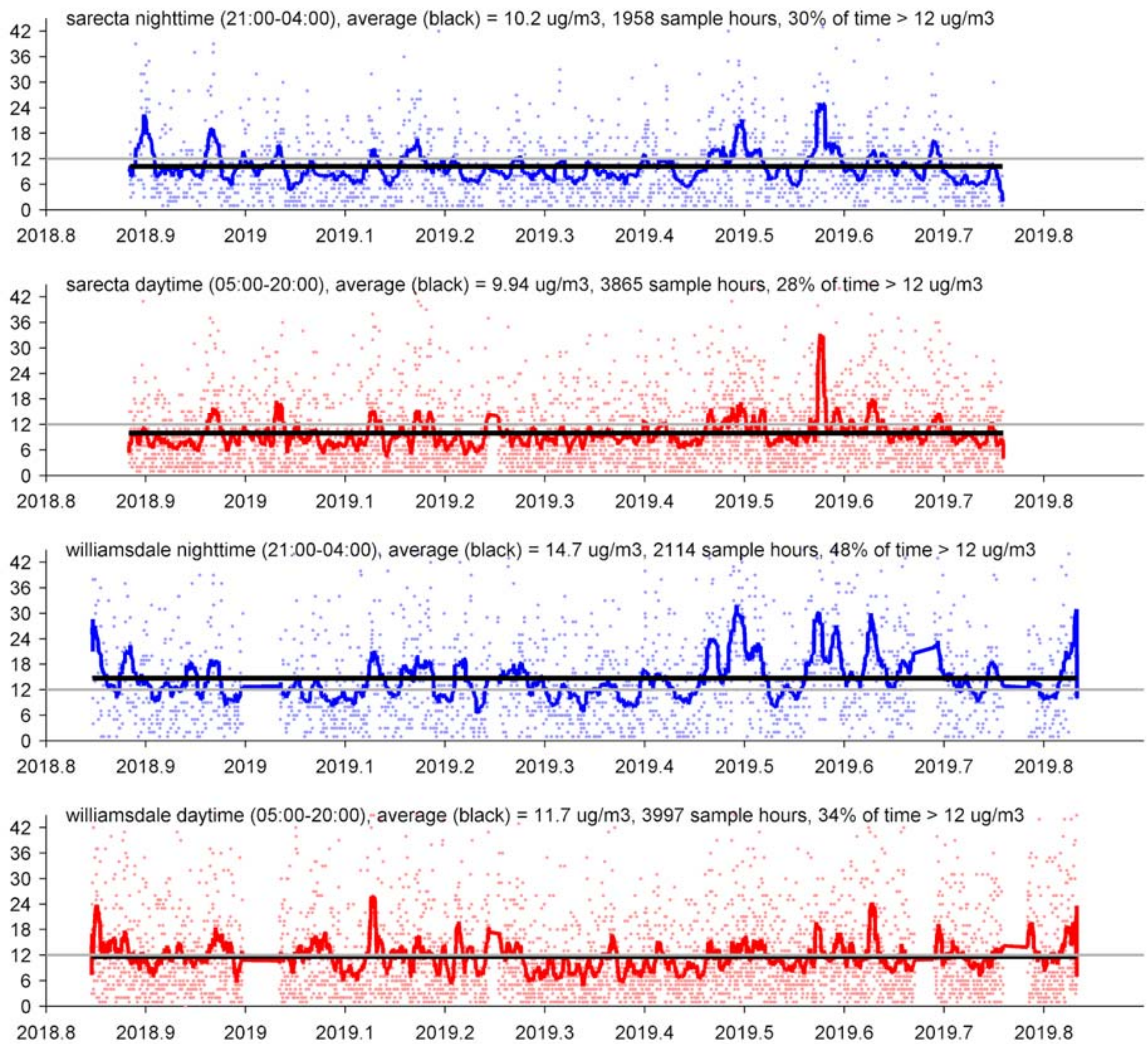
Sarecta day and night time averages were similar at 9.9 and 10.2 ug/m3, with 3865 and 1958 sample hours, respectively. Both day and night had values of PM2.5 > 12 ug/m3 about 30% of the time. Sarecta had 55 hours of PM2.5 > 35 ug/m3, or about 1% of the 5823 sample hours.

Williamsdale day and night time averages were noticeably different at 11.7 and 14.7 ug/m3, with 3997 and 2114 sample hours, respectively. Day and night had values of PM2.5 > 12 ug/m3 about 34% and 48% of the time, also consistent with the differences in the average values. Finally, Williamsdale had 226 hours of PM2.5 > 35 ug/m3, or about 4% of the 6111 sample hours.

If extrapolated over multiple years, **Williamsdale site data leans towards a violation of annual PM2.5 NAAQS, and also has about 4x more hours than Sarecta with PM2.5 > 35 ug/m3**. This, we suggest, should warrant further study using the E-BAMS deployed for additional years. If the findings continue to show that PM2.5 annual NAAQS is violated, then a downstream result could be an additional regulatory monitoring site for PM2.5 being located in Duplin County.

The caveat is that we have not necessarily explored all the dimensions of the data, and our results may change with different QA filtering or by considering the influence of wind speed and direction. However, even with that caveat, **the conclusion that there is no air quality problem (for PM2.5) seems to be the result of an analysis that ignores or minimizes the acute exposures that communities experience** – the lived experience of feeling the effect of the high PM2.5 for 4% of the time. For scale, if the Williamsdale and Sarecta analysis we provide holds up, 4% of a given year is about 15 days in any given year with high (>35 ug/m3) PM2.5 in Williamsdale area, and about 4 days in any given year for Sarecta area.

PM2.5 monitoring results in Sarecta and Williamsdale (daytime and nighttime)



Re-analysis & graph by Brian Magi, Associate Professor of Atmospheric Sciences, UNC Charlotte, Department of Geography and Earth Sciences. The y-axis is PM2.5 in units of ug/m3, the individual dots are the hourly PM2.5, and the thick red and blue lines represent a multi-hour mathematically smoothed average to guide the eye. Data greater than about 42 ug/m3 are not shown on the graphs, but represent a relatively tiny fraction of total sample hours.Specific data being plotted is available from DEQ DCAMS website with our filtering choices described in our text above (QA flag = Ok, and hourly PM2.5 > 0 ug/m3).

6. Annual PM2.5 average exceeds NAAQS

In DCAMS, assessment of PM2.5 was strictly limited to the 24 hour NAAQS value of 35 ug/m3. We would suggest that persistent emissions from year-round CAFO emissions make the DCAMS study area one where the annual PM2.5 NAAQS is also quite relevant. See the description of Point 5, but we argue that it is reasonable to surmise that **the annual PM2.5 NAAQS is in danger of violation near Williamsdale** (if we extrapolate out to three years assuming that the single sample year is "representative").

The US EPA acknowledges these annual PM2.5 measures, quantifying potential chronic exposures, have both a primary standard to protect sensitive populations and a secondary standard to protect the general public. If the current monitoring results (implying already high annual PM2.5 at monitoring locations) underestimates the annual ambient exposures of some groups in the highest density or most proximate areas, **there may be tens of thousands in these counties experiencing PM2.5 concentrations that exceeds the annual NAAQS health-based standard for PM2.5.** This is not grounds for ending monitoring, but the opposite: monitoring should be increasing, particularly to determine **whether some populations not well-captured by the DCAMS study are breathing air with PM2.5 concentration that exceeds annual NAAQS PM2.5 standard**. Those studies should also examine whether with most proximate exposures are receiving acute spray field exposure greater than the 24 hour levels, as well as non-violation-level impacts to quality of life impacts and non-criteria air pollutants not included on this list.

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 $\mu g/m3$ (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 $\mu g/m^3$	annual mean, averaged over 3 years
		secondary	1 year	15.0 $\mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Table taken from US EPA website. See https://www.epa.gov/criteria-air-pollutants/naaqs-table for footnotes.

Completeness, Quality, and Attribution Issues

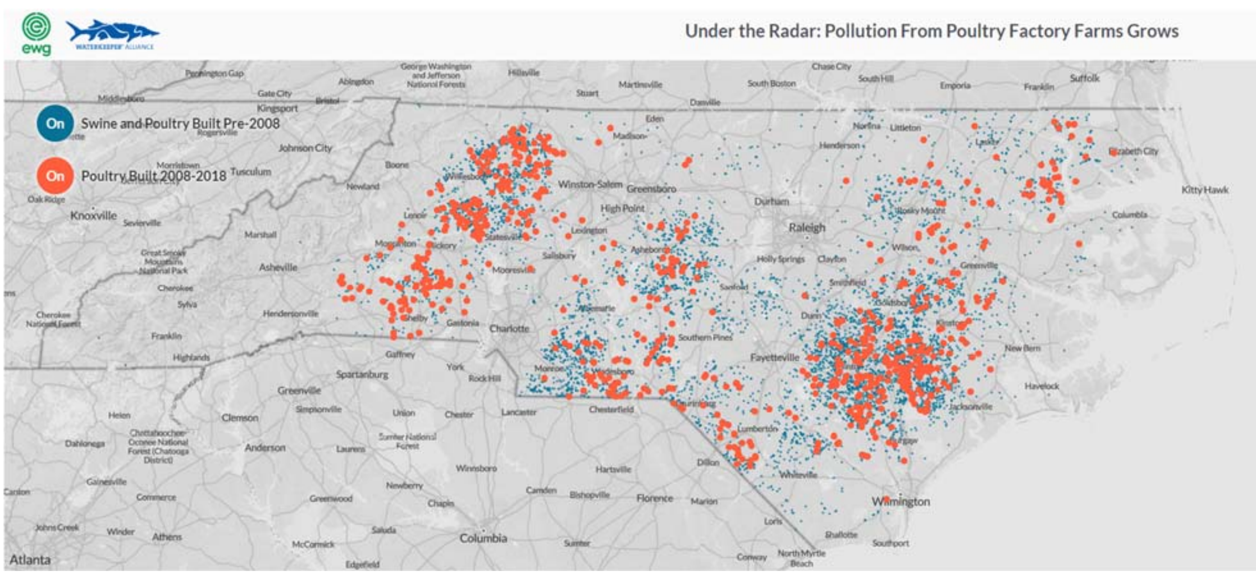
7. Study does not include cumulative impact, e.g. unpermitted poultry CAFOs

   The ambient air quality of North Carolina is impacted by more than industrial hog operations (IHOs). If the monitoring locations were not located to represent the cumulative impact of both IHOs and permitted and non-permitted releases, then the monitoring plan may not represent the ambient levels experienced elsewhere.

   Poultry concentrated animal feed operations (CAFOs) are of particular concern, since (1) they are currently unpermitted in North Carolina, yet (2) have documented air quality impacts that would be expected to add to the air quality impact of IHOs and (3) according to community data, are often co-located with IHOs, especially in the county under study.

   These estimated **nearly 5,000 unpermitted poultry operations in 2019, up from an estimated 4,000 operations ten years ago, add to the air quality impacts of permitted IHOs**. Future air quality monitoring studies should incorporate the expected impact of nearby poultry operations and other sources of air quality pollution. Without this, it's difficult to attribute what impacts air quality their study, designed for IHOs, is actually capturing and how representative the monitoring locations are.

Growth of poultry operations from pre 2008 to 2018



Data collected by the Environmental Working Group. Presented on web page of Waterkeeper Alliance.
https://www.ewg.org/research/under-radar

8. *No sprayfield activity data*

Spray fields are fundamental to understanding acute exposure to reduced air quality due to industrial animal hog operations, but, given the ambient focus, are **not included in the study analysis plan or documented to have been monitored**. Given the exclusion area of 0.5 miles within IHOs, it's possible the monitoring plan may have captured few or no proximate spray events. Without documenting actual spray activity near the monitors, farms may be able to to shield the monitors from high acute peak readings.

DEQ likely knows this analysis challenge exists (since it was notified of the practice of selective spray field applications to reduce monitoring in Title VI documentation); without accommodating for this lack of data by collecting other data on documented and actual spray field practices, it is possible this monitoring effort captured no spray field activity. **The report does not mention spray fields**, offering the only direct attribution of a peak to a transient smoke plume. If no measured contaminant peaks were due to hog waste, then monitoring sites may be mis-located to capture nearby spray events and under-measuring the impact on the air quality.

Hog waste being sprayed into the air. Photo: Donn Young

9. Numerous small questions remain about missingness and attribution

We have outstanding questions that we consider more minor, but worth mentioning.

The report lists that the **monitor in Candor** didn't pass expected **data completeness** checks. Why? Could this have been anticipated and fixed in future studies?

Many 24-hour average periods are excluded due to **missing data**. In some cases during (H2S peaks) there seemed to be a significant amount of missingness. Why is this, and how can it be fixed in future studies?

Though these issues are not as substantial as the previous 8 listed, we suggest the final report add more to contextualize these questions and how to avoid these issues in the future.

A. Appendix: Useful References & Links

DEQ Release on the open comment period
https://deq.nc.gov/news/press-releases/2019/12/16/release-comment-period-open-draft-air-monitoring-study-report

Title VI Complaint
https://earthjustice.org/sites/default/files/files/North-Carolina-EJ-Network-et-al-Complaint-under-Title-VI.pdf

Title VI Analysis & Findings
https://www.ncpolicywatch.com/wp-content/uploads/2014/09/UNC-Report.pdf

EPA Letter of Concern
https://www.epa.gov/sites/production/files/2018-05/documents/letter_of_concern_to_william_g_ross_nc_deq_re_admin_complaint_11r-14-r4_.pdf