In February of 2018, the poultry specialist employed by Kansas State University testified before the Senate Agriculture and Natural Resources Committee in support of Senate Bill 405 that would reduce the required separation distance between broiler chicken operations and habitable structures. This bill was ultimately passed and signed by the Governor of Kansas. State law now allows 1/3 million broiler chickens to be located as close as 1/4 mile or 1320 feet of a habitable structure and only 100 feet from a neighbor's property line. In addition up to 100,000 chickens can be located only 100 feet from a neighbor's property line without regard to the location of any habitable structures.

An important part of this testimony included the following statement, "Particulate matter has been monitored in university tests and has been shown to be virtually eliminated by 100' from the exhaust fans, and meets background levels by 500'," referring to Figure 2 in the Applied Poultry Research article that may be accessed via the following link:

https://academic.oup.com/japr/article-abstract/15/3/394/725104 (Click on PDF)

This study was conducted in 2005 and published in 2006. Another study of this type was conducted by most of the same authors in 2007 and published in 2013 with similar, though not identical results.

The purpose of this analysis is to identify the numerous flaws in the design and implementation of these studies.

Flawed Study Design

The most important and fundamental flaw in both studies is the assumption that the concentration of fine particles (PM2.5) in this case are representative of the potential health impacts to neighbors of broiler chicken operations. The design fails in 3 respects. First, the focus on fine particles reflects conventional air quality regulation in the United States, where risk of disease is related almost entirely to size of particle. Since the passage of the Clean Air Act, USEPA has regulated particulate mass emissions based on particle size (diameter in microns) first as total suspended particles (TSP), then inhalable PM10 and now as PM2.5. This is based primarily on studies of non-pathogenic particles produced from the combustion of fossil fuels by transportation vehicles and coal-fired power plants. Much evidence now shows that this regulatory scheme fails to account for particular risks from breathing diesel emissions, and from toxic components of emissions from other heavy industrial operations.

In the present case, emissions from broiler chicken houses, the risk of disease is also, and predominantly related to pathogens, endotoxins and allergens attached to manure, feather and litter particles. These are attached not only to the fine particles but also to
particles of any size. The study design fails to call for measurement of particulate matter greater than 2.5 microns. According to a draft 2012 USEPA report summarizing tests at two broiler sites, PM2.5 on average constituted only 4.3% of total suspended particles. Endotoxins are a component of the cell walls of certain bacteria that induces an inflammatory response in the lungs. While impacts of endotoxins and allergens would be related mostly to respirable particles, disease may also be transmitted by the pathogens on larger particles that enter the nose and mouth and that may attach to a person's clothes for later transmission to family members.

Secondly, the background, or control concentrations are inadequately characterized in these studies, even for PM2.5. The physical character of the fine particles upwind of the site, or when chickens are absent, is substantially different from those emerging from the barns. Upwind particles would be run-of-the-mill ambient non-pathogenic particles. The particles emerging from the barns would be potentially infectious, and mass-only measurement of the fine component will not properly assess their risk. Even if these downwind fine particles are greatly dispersed, a few are still capable of causing disease.

Third, in order to compare the results to the National Ambient Air Quality Standard (NAAQS) for PM2.5, which at the time of publication of the first study was 65 ug/M3 and at time the second study is the current 35 ug/M3, the authors collected average data over 24-48 hour periods in the first study and 22 hours in the second study during each monitoring event. Figure 4 from the link to the 2006 study cited above shows that separate, real-time PM2.5 measurements 500 feet downwind closely tracked the 6 to 8 hour spikes in the values measured inside the barns. These spikes also correspond roughly to diurnal changes in bird activity.

This important hourly effect was obscured when the results were averaged over 24 and 48 hours and compared to "controls." In contrast, disease transmission from pathogens can be nearly instantaneous, and effects of endotoxins and allergens can occur in shorter periods than 24 hours.

**Issues specific to the 2006 study**

1. *Inadequate characterization of background.* The authors established only one control monitor which was only about 100 feet upwind of the barns, and thus subject to compromise from opposing winds. In addition the data obtained with birds absent is irrelevant because only one 24 hour period was measured and on a different day than the other measurements.

2. *Atypical study setting.* Market weight of the birds was only 3.8 to 3.9 pounds. The most recent estimate of average market weights is 6.16 lb. Emissions increase with number and weight of birds. In addition the ratio of PM2.5 emissions to total suspended particles increases significantly with bird age. The aforementioned USEPA test summary showed final bird weight ranging from 5.81 to 6.12 pounds.
3. **Validity Questioned.** In their 2013 study the authors acknowledged some issues with the prior study as follows, referring to Visser et al. [ref. 2, here].

"**Limitations on the sensitivity of instruments at low levels, along with limitations on available weather data (wind speed or direction), limited the confidence in the results of that study.**"

4. The authors did not take measurements during chicken harvest that generates elevated emissions associated with the catching of chickens for loading onto trucks for transport to slaughter. One study found that bacteria, endotoxin and dust concentrations escalated to about three times normal during this activity while fans would be blowing this material into the external environment.\(^{12}\) It is well documented that even short term exposure to these materials could be harmful to human health.

**Issues specific to the 2013 study**

1. **Invalid plume analysis.** The downwind sampling stations were only 5 feet in height and located well below the elevation of the barn fans. So the authors conducted a visible smoke test which showed the plume tending to align along the field surface rather than remain at the height of the exhaust fans. See figures 1 and 2 from the 2013 *Applied Poultry Research* article at this link:

https://academic.oup.com/japr/article-abstract/22/2/351/710486  (Click on PDF)

This approach is highly misleading because PM 2.5 particles are generally not visible to the human eye in this setting and will remain aloft much longer than the larger smoke particles.\(^{13}\) A similar study by others measured PM 2.5 from monitors mounted on 34 foot tall towers and obtained values in line with dispersion modeling.\(^{14}\) Thus there is no evidence that the low-situated sampling stations accurately measured PM2.5. The data would be substantially biased to the low side. We also note that frequent winds from the southwest during the test program, acting on the PM2.5 plume aloft, would likely compromise the results of the "east control" or background monitor.

2. In this study the authors conducted both real-time and gravimetric (filter) monitoring. While the real-time measurements extended through the day of chicken harvest, no such monitors were inside the barn. Thus the external monitors would be subject to the improper placement discussed above. Gravimetric measurements were taken inside the barns but not on the day of chicken harvest. Thus elevated emissions that would have been likely on day of harvest were not properly captured. The authors also noted that the real-time monitoring instruments were less reliable, two of them having failed to generate enough data.

3. The authors say that the average values at 200, 300 and 500 feet downwind "quickly dispersed to near background levels," and they were not significantly different from one another. Statistical significance is a function of the amount of data and there was only
one monitor at 500 feet, and it collected only 12 data values, not enough to draw meaningful conclusions even for the small PM2.5 portion of suspended particulate. Indeed, the PM2.5 measured at the 500-foot monitor exceeded the 300 foot monitor a fourth of the time and the 200 foot monitor a third of the time. The 500-foot values also exceeded the PM2.5 NAAQS a third of the time.

Conclusion

The data & analysis suggesting there are no health risks associated with particulate emissions from industrial scale chicken barns presented in legislative testimony on SB 405 is invalid. Likewise a later study conducted by many of the same authors is seriously compromised by faulty study design. Thus we conclude that SB 405, authorizing as many as 1/3 million chickens within only 1/4 mile of neighboring homes and other community structures and only 100 feet from neighboring property lines, was passed by the Kansas Legislature without serious consideration of the health risks to the surrounding community.

References:
1. R. Scott Beyer, Assoc. Professor, State Extension Poultry Specialist, Kansas State University, written testimony before the Kansas Senate Agricultural and Natural Resources Committee, Feb 12, 2018.
9. Ibid.


13. L. S. Hadlocon, et al., "Modeling of particulate matter dispersion from a poultry facility using AERMOD", *Journal Air& Waste management Assn*, 65(2):217, 2015. The emission source in this case was an egg layer confinement; however the authors utilized tall towers to demonstrate that the measurements further downwind were almost entirely PM2.5 rather than larger particles in the initial plume.