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Disclaimer: The opinions expressed herein are those of the authors and do not necessarily reflect the views of The Johns Hopkins University.

Re: Hickman's Family Farms, Inc. / Saddle Mountain RV Park

We are writing to present our concerns regarding the construction of a layer facility in Tonopah, Az., owned and operated by Hickman's Family Farms, Inc. We are researchers at the department of Environmental Health Sciences at the Johns Hopkins Bloomberg School of Public Health. Our collective expertise is in air quality, animal agriculture, environmental health sciences and public health.

To characterize the potential effects of the Tonopah facility on the surrounding community, we investigated two similar layer facilities located in Arlington, Az. and Maricopa, Az. We collected data on particulate matter, ammonia, odors, and fly populations from six sample sites at and around the Arlington facility, and four sample sites at and around the Maricopa facility.

Key findings from our investigation include:

Particulate Matter (PM): At both facilities, peak airborne PM concentrations were highest at the facility fence lines and declined with increasing downwind distance, and were lowest at sites that were outside the wind's trajectory through the facilities. At Maricopa, median PM concentrations were highest at the facility fence line. At Arlington, median PM concentrations were highest at the two downwind sample sites closest to the facility. At both facilities, median PM concentrations were lowest at sites that were outside the wind's trajectory through the facilities.

Ammonia: At both facilities, ammonia concentrations were highest at the facility fence lines, declined with increasing downwind distance, and were lowest at sites that were outside the wind's trajectory through the facilities. For seven of the ten sample sites, levels were below the method's limit of detection. At Arlington, ammonia concentrations at the facility fence line exceeded the EPA chronic reference concentration (RfC) for adverse respiratory health effects associated with chronic inhalation (1).

Odors: At both facilities, odor levels were highest at the facility fence lines, declined with increasing downwind distance, and were lowest at sites that were outside the wind's trajectory through the facilities.

Flies: At both facilities, fly collection rates were highest at the facility fence lines. At Arlington, with the exception of one sample site (the exception may have been the result of interference from a nearby waste disposal site), fly collection rates declined with increasing distance from the facility. Prior research suggests large layer operations may significantly increase house fly (*Musca domestica*) populations up to four miles from facilities and may result in a "severe nuisance" up to two miles away (2).

Taken together, these findings strongly suggest the Arlington and Maricopa facilities contribute to elevated PM and ammonia concentrations, odors, and fly populations in nearby communities. Furthermore, based on these findings, we believe it is highly likely that the proposed Tonopah facility will similarly constitute a public nuisance and a potential health threat to members of the surrounding community.

Further details about our investigation are presented below. We also have concerns about the contribution of the facility to freshwater depletion; these are discussed in the Appendix.

Background

We understand that the first phase of the layer facility at Tonopah, Az. will accommodate 2.2 million layer hens (hereafter referred to as "layers"), with two open-lined pits for storing wastewater, including fluids used to clean and disinfect surfaces of eggs ("egg wash water") and effluent from washing housing interiors. From the materials that were accessible to us, the plan to handle manure is unclear, but we understand that fresh manure will drop onto a manure belt below enriched colony cages, to be conveyed at regular intervals to an area where it will be dried and trucked off site. We further understand that, at full capacity, Hickman's Family Farms, Inc. intends to have an inventory of up to 12 million chickens at the proposed facility. At the time of this writing, construction of the facility is underway.

The Tonopah facility is sited close to residences, natural attractions, and businesses. From the facility fence line, a recreation hot springs is located at 0.29 miles east, a restaurant is located 0.45 miles east, and an RV park is located 0.51 miles east. According to local business owners in

Tonopah, over 200 families reside at the RV park, and an estimated four to eight thousand individuals visit the hot springs annually.

The purpose of our investigation was to characterize the potential conditions near to and downwind from the Tonopah facility once in operation. To this end, we collected data on airborne particulate matter (PM), ammonia, odors, and fly populations from two similar facilities located at Arlington, Az. and Maricopa Az., both owned and operated by Hickman's Family Farms, Inc.

It is our understanding that the Arlington facility currently operates with an inventory of approximately 6 million layers, with an open-lined pit for storing wastewater (egg wash water and effluent from washing housing interiors). Manure from the facility is dried and composted on site. It is also our understanding that the Maricopa facility operates with an inventory of approximately 2.2 million layers, with an open-lined pit for storing wastewater. Manure from the facility is dried and trucked off site.

Study methods

On May 14 and 15, 2014, we collected air quality and other health-relevant (particulate matter, ammonia, odors and fly populations), and pertinent weather conditions (wind direction and speed) at selected sites near the Arlington and Maricopa facilities. The locations of sampling sites, relative to the property lines around each facility, are shown in Figures 1 and 2. All sampling occurred on public property, with the exception of one site NE of the Arlington facility, where we collected samples after securing permission from the property owner.

Wind conditions

Wind speed and wind direction data, prior to and during sampling periods, were collected from local weather sampling stations (3).

Particulate matter (PM)

PM was measured using light-scattering nephelometric monitors (pDR-1000, Thermo Scientific), with optimal response to particles in a size distribution between 0.1 and 10 micrometers in diameter. All monitors were zeroed before use in the field following manufacturer's instructions. At each sample site, two monitors were positioned approximately five feet above the ground and set to record PM concentrations every 30 seconds for a period of 29 to 107 minutes. At all monitoring locations, we recorded when vehicles passed by the monitors and removed the associated data from the final results in order to better isolate the effects of the layer facilities on air quality.

Ammonia (NH_3)

Ammonia was measured using 0.1 - 10 ppm-hrs Gastec Detector Tubes. At each sample site, two tubes were activated for a period ranging from approximately 45 minutes to 14 hours, and periodically observed for changes in concentration levels. Final readings were converted from part per million-hours (ppm-hours) to ppm (one part ammonia in one million parts of air) based on how long they were sampling in the field.

Odors

Odors at each site were independently assessed and recorded by each member of our research team, using a subjective scale ranging from 0 (no detectable odor) to 10 (very strong odor). In order to mitigate the effects of odor desensitization, odor measurements were first recorded at farthest sites outside the wind's trajectory through each facility, followed by the sites furthest downwind, and finally at sites closest to the facilities.

Flies

Fly populations were estimated using Rescue brand re-usable baited jug traps. At each sample site, a jug trap was filled with a bait mixture and left for a period ranging from approximately 1.5 to 15.5 hours. Jug traps were positioned downwind from other air sampling equipment in the unlikely event that the bait mixture might interfere with readings. At the end of each sampling period, captured flies were removed from the trap and counted. Insects that did not clearly exhibit distinguishing features of *Musca domestica* (e.g., red compound eyes, single pair of wings, gray thorax with longitudinal stripes, short antennae, etc.), *Sarcophagidae* (flesh fly), or *Calliphoridae* (carrion fly) were excluded from final counts. Because these flies are largely diurnal and inactive at night, final fly counts were expressed as collected flies per daylight hour.

Figure 1. Sample sites around the Arlington facility.

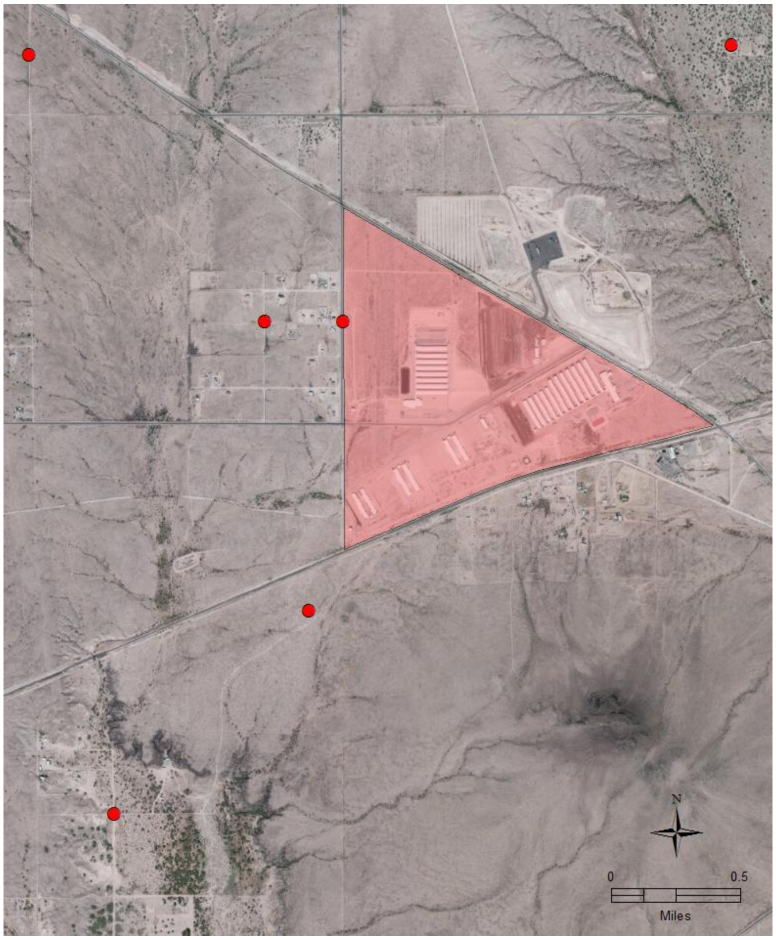


Figure 2. Sample sites around the Maricopa facility.

Results

Wind conditions

Wind conditions on both sampling days were highly variable, both in terms of speed and direction.

At Arlington, wind speeds during the sampling period on May 14th, 2014 were between 0 and 14 mph, with gusts up to 18 mph. Winds one hour prior to and during the sampling period were predominantly from the SE, at times varying between ESE and SSE. Average wind speeds for the month of May (and Anecdotal reports from local residents) suggest our investigation of the Arlington facility took place during a period of uncharacteristically high wind speeds (3).

At Maricopa, wind speeds during the sampling period on May 15th, 2014 were between 0 and 7 mph. Winds over the 14 hours prior to sampling were predominantly from the NE, and varied between SE, E, NNE, and WNW during the sampling period (3).

Particulate matter (PM)

At Maricopa, median PM concentrations were highest at the facility fence line (22 $\mu g/m^3$), and roughly twice as high as concentrations recorded farther downwind and outside the wind's trajectory through the facility (9-13 $\mu g/m^3$). At Arlington, median PM concentrations within 0.31 miles downwind of the facility (21-32 $\mu g/m^3$) were 130 to 300 percent higher than sites farther downwind and not downwind (8-9 $\mu g/m^3$). At both facilities, median PM concentrations were lowest at sites that were outside the wind's trajectory through the facilities.

At both facilities, peak PM concentrations were highest at the facility fence lines, declined with increasing downwind distance, and were lowest at sites that were outside the wind's trajectory through the facilities. The highest peak concentration at Arlington (432 $\mu g/m^3$) was over ten times higher than the peak concentration recorded 1.35 miles downwind (38 $\mu g/m^3$).

Median and maximum PM concentrations associated with the Arlington and Maricopa facilities are shown in Table 1. Median PM concentrations and associated interquartile ranges for each site are shown in Figures 3 and 4. PM values logged by each instrument were within ±10% agreement.

Ammonia (NH_3)

At both facilities, ammonia concentrations (Table 1) were highest at the facility fence lines, declined with increasing downwind distance, and were lowest at sites that were outside the wind's trajectory through the facilities. For seven of the ten sample sites, levels were below the limit of detection (LOD) for the method used.

Odors

At both facilities, odor levels (Table 1) were highest at the facility fence lines, declined with increasing downwind distance, and were lowest at sites that were outside the wind's trajectory through the facilities.

Table 1: Air quality and odors associated with Arlington and Maricopa facilities.

Facility	Site[a]	PM (μg/m^3)			NH_3 (ppm)	Odor
		Median[b]	IQR[b,c]	Max[b]		
Arlington	Fence line	21	14	432	0.55	8.50
	0.31 mi W (downwind)	32	24	108	0.12	5.00
	1.35 mi NW (downwind)	9	5	38	<LOD[d]	0.67
	0.28 mi SW*	8	3	11	<LOD	1.33
	1.35 mi SW*	8	3	25	<LOD	0.00
	1.30 mi NE*	9	6	36	<LOD	1.33
Maricopa	Fence line	22	75	239	0.10	8.83
	0.14 mi S (downwind)	12	9	135	<LOD	6.25[e]
	0.43 mi SE*	13	4	62	<LOD	2.83
	0.37 mi W*	9	5	91	<LOD	0.00

*Site outside the wind's trajectory through the facilities.

[a]Relative to property lines.

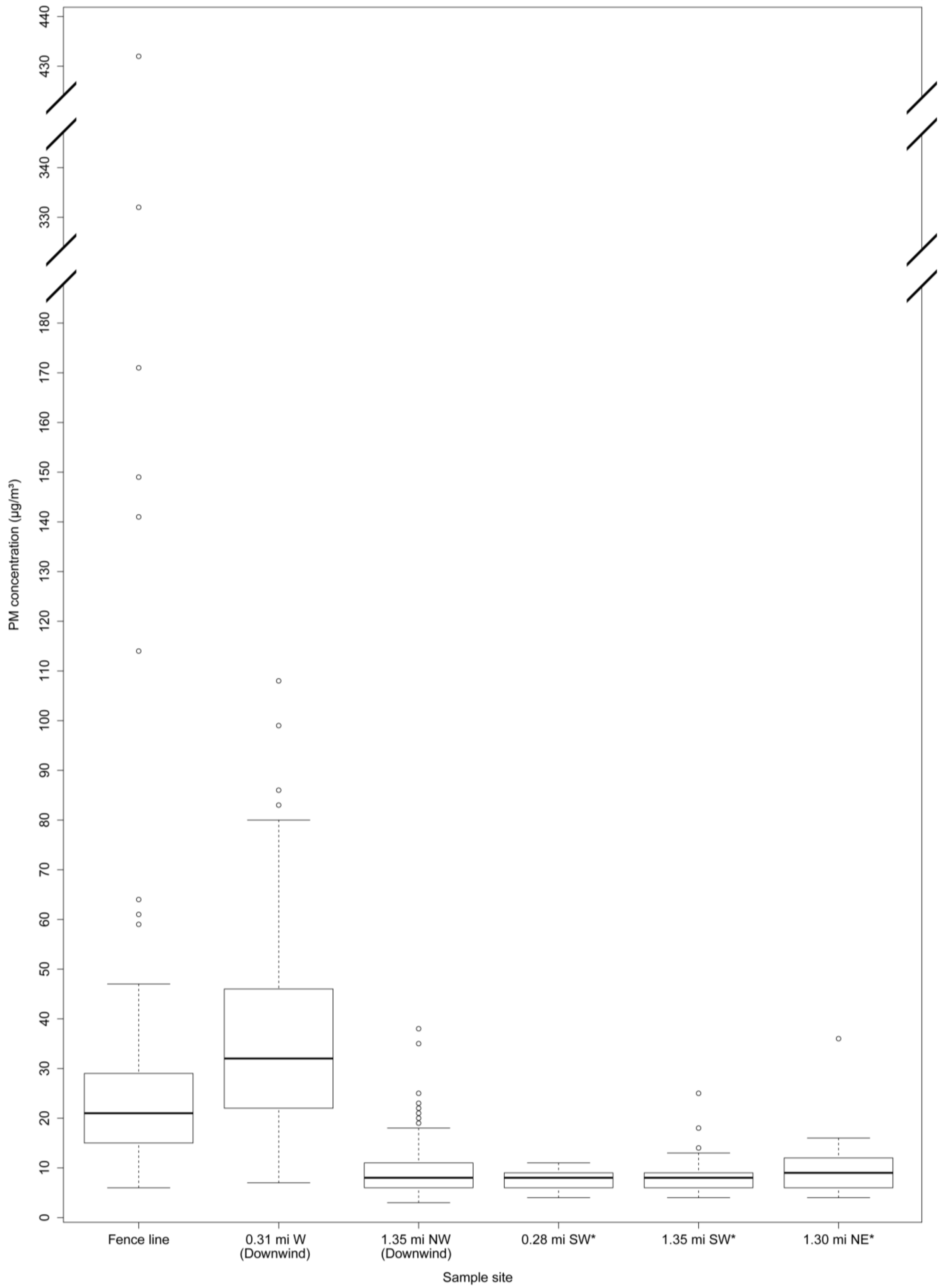
[b]Based on pooled readings from both monitors.

[c]Interquartile range.

[d]Below the limit of detection for the sampling method.

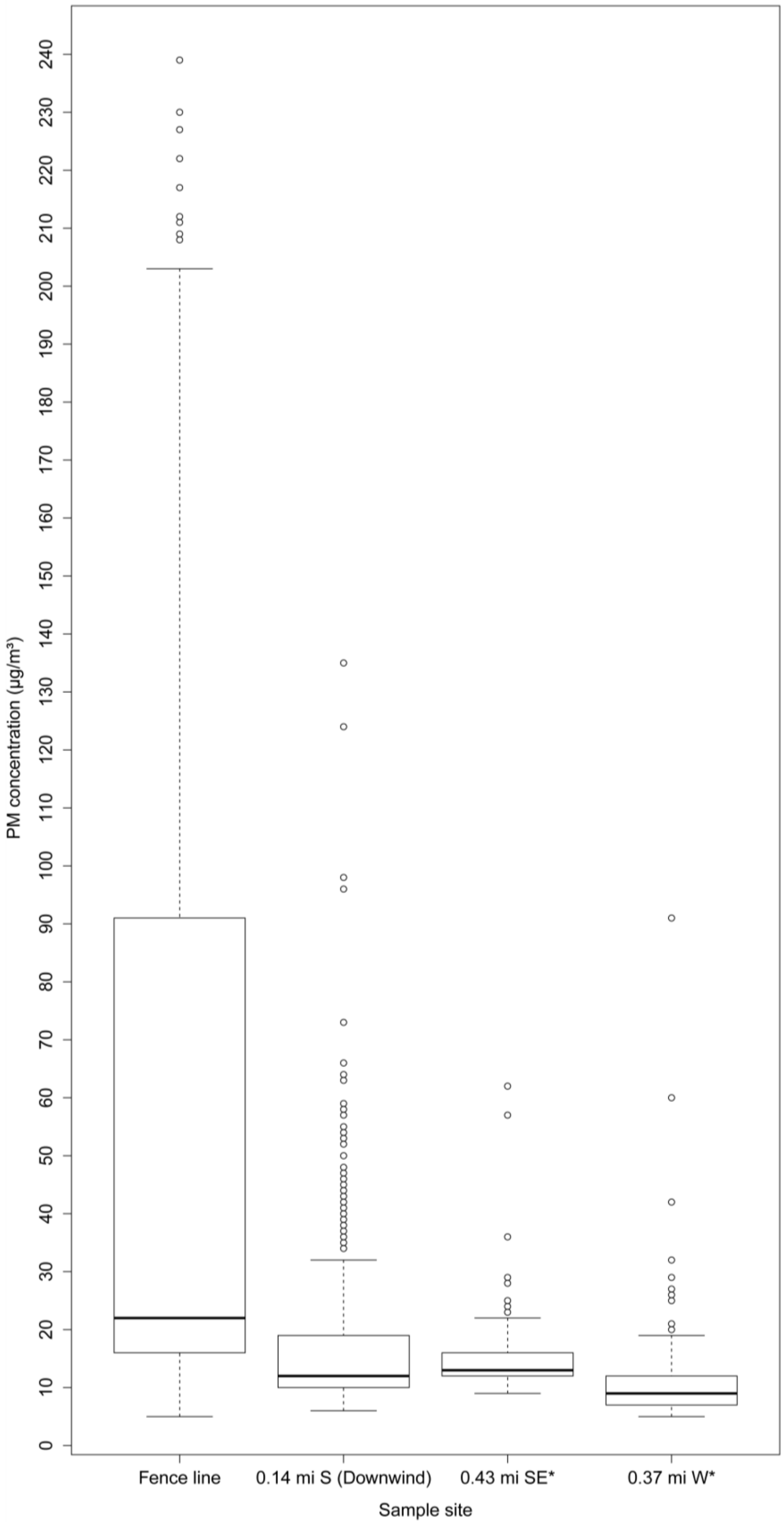
[e]One researcher was not present this site, thus this is the average of two data points instead of three.

Figure 3: Median PM concentrations and interquartile ranges at Arlington sample sites.



*Site outside the wind's trajectory through the facilities.

Figure 4: Median PM concentrations and interquartile ranges at Maricopa sample sites.



*Site outside the wind's trajectory through the facilities.

Flies

At both facilities, fly collection rates (Table 2) were highest at the facility fence lines. At Arlington, with the exception of one sample site (NE of the facility), fly collection rates declined with increasing distance from the facility, irrespective of wind direction. A photo of a jug trap following the collection period is shown in Figure 5.

Figure 5: Fly trap after collection period.

Table 2: Flies collected, per daylight hour, near the Arlington and Maricopa facilities.

Facility	Distance from property line	Flies per daylight hour
Arlington	0.00 mi (W)	1.95
	0.28 mi (SW)	1.08
	0.31 mi (W)	1.04
	1.30 mi (NE)	1.45
	1.35 mi (SW)	0.67
	1.35 mi (NW)	0.43
Maricopa	0.00 mi (S)	0.30
	0.14 mi (S)	0.00
	0.37 mi (W)	0.00
	0.43 mi (SE)	0.00

Discussion

The degree to which levels of airborne pollutants increase with greater downwind proximity to a layer facility is highly suggestive of that facility's contributions to downwind pollutants. If a facility is a source of airborne pollutants, for example, we would expect recorded concentrations of those pollutants to be highest at the facility fence line. Furthermore, if a facility attracts and/or serves as a breeding ground for flies, we would expect higher fly populations with increasing proximity to the facility, irrespective of wind direction. With a small number of exceptions, data collected as part of this investigation are consistent with these patterns, strongly suggesting that the Arlington and Maricopa facilities are contributors to elevated PM and ammonia concentrations, odors, and fly populations.

The instruments used in this investigation to measure particulate matter have an optimal response to particles between 0.1 and 10 micrometers in diameter. Assuming roughly half of the PM detected is PM 2.5 (a conservative estimate), median concentrations recorded 0.31 miles downwind of the Arlington facility (16 $\mu g/m^3$) exceeded U.S. Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) of 12 $\mu g/m^3$ (4).

Ammonia concentrations recorded at the Arlington facility fence line (0.55 ppm) exceeded the EPA's reference concentration (RfC) for adverse health effects associated with chronic inhalation (0.144 ppm) (1). The RfC can be interpreted as an airborne concentration of a contaminant below which adverse effects are unlikely to occur for persons chronically exposed. Above the RfC, adverse effects may occur. Ammonia concentrations recorded within 0.31 miles downwind of the Arlington facility and at the Maricopa facility fence line were 14 and 27 percent higher than the RfC, respectively.

Evidence from prior studies is consistent with our finding that the Maricopa and Arlington facilities are likely contributors to elevated fly populations. A four-year study published in 2005, for example, found strong associations between proximity to a Ohio layer facility (with an inventory of >2 million hens) and higher fly collection rates. Two years into the study period, a second layer facility was constructed. After the second facility was operational, fly collection rates increased significantly. The study authors concluded that large layer operations may significantly increase house fly populations up to four miles from the facilities and may result in a "severe nuisance" up to two miles away (2). Prior studies have also shown that flies from nearby animal confinement operations may be involved in the transmission of pathogens, including antibiotic resistant strains, to nearby communities (5,6). Persons near the Tonopah facility, such as those residing at the RV park, may be at a heightened risk of exposure to vector-borne pathogens if, for example, they come into contact with surfaces that have been contaminated by flies.

Limitations

The results of this investigation may have been influenced by highly variable wind conditions, both in terms of speed and direction. Intermittent gusts of wind, for example, may partly explain the number of outliers in PM data for some sample sites. Results may also have been affected by interference from other potential sources of pollutants and/or flies. A waste disposal site, for example, was located NE of the Arlington facility, which may partly explain elevated odor levels and fly collection rates recorded NE of the facility.

The duration of the data collection period was very brief (two days). Because most dosimeter tubes were left operational for less than an hour due to time restrictions, reported ammonia concentrations—which were below the limit of detection for seven of ten sample sites—may under-represent actual concentrations. Similarly, fly jug traps were in operation for brief periods, particularly at Maricopa where traps were in operation for 1.5 to 3.5 hours, which may partly explain low collection rates.

Conclusion

Taken together, these findings strongly suggest the Arlington and Maricopa facilities contribute to elevated PM and ammonia concentrations, odors, and fly populations in nearby communities. Furthermore, based on these findings, we believe it is highly likely that the proposed Tonopah facility will similarly pose a potential health threat and constitute a "public nuisance" to nearby/downwind communities, as defined by Arizona Revised Statues § 36-601, which provide the following criteria: "[a]ny condition or place in populous areas that constitutes a breeding place for flies, rodents, mosquitoes and other insects that are capable of carrying and transmitting disease-causing organisms . . ." Furthermore, A.R.S. § 13-2917(A)(1) states that it is a "public nuisance" to be "injurious to health. . . offensive to the senses or an obstruction to the free use of property that interferes with the comfortable enjoyment of life or property by an entire community or neighborhood or by a considerable number of persons."

Sincerely,

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Appendix

In addition to the aforementioned concerns, the Tonopah facility poses a substantial water usage burden in area of water scarcity. The Tonopah facility is sited in the Phoenix Active Management Area (AMA) region, directly adjacent to the Harquahala Basin—an irrigation non-expansion area—and is located in the Tonopah Desert where there is an ongoing groundwater recharge project critical for water quality and water security in the region. The Tonopah site is approximately 10 miles from the Tonopah Desert Recharge Project (TDRP) which is regulated by the Arizona Department of Water and drainage patterns from the Tonopah area trend to the TDRP basin. In this area with water scarcity issues the AMA has two categories of wells: exempt wells, which pump less than or equal to 35 gallons per minute; and non-exempt wells, which pump greater than 35 gallons per minute. Based on the sources and calculations given in Table 3, the Tonopah facility, once in operation, would require the total use of an estimated 222 gallons per minute (for an inventory of 2 million layers) to 1,333 gallons per minute (for an inventory of 12 million layers) for drinking and egg wash water. These estimates do not account for water use associated with irrigating feed crops. Water withdrawals of this extent may affect yields in surrounding wells and limit water availability to other businesses and residences that rely on well water for drinking.

Table 3. Estimates of Water Usage for Layer Operations

# of layers	Egg wash water gallons/day[a]	Drinking water gallons/day[b]	Total water gallons/day
2,000,000	23,100	320,000	343,100
4,000,000	46,200	640,000	686,200
6,000,000	69,300	960,000	1,029,300
12,000,000	138,600	1,920,000	2,058,600

a. 0.0132 gallons/water/bird/day. Shappell NW. Egg Wash Wastewater: Estrogenic Risk or Environmental Asset? Integr Environ Assess Manag. 2013; 9(3):517-23.

b. 0.16 gallons/water/bird/day. Cooperative Research Farms. The Care and Feeding of a Successful Layer Operation. 2009. Available from: www.cccfeeds.com/assets/files/Resources/Poultry/Layer_Low_Res_%20RGB_Sept_2009.pdf

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