Michigan Does Not Need Another Public Health Crisis
Public Health Risks Associated With
Concentrated Animal Feeding Operations (CAFOs)

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INTRODUCTION

Michigan is facing a steep rise in concentrated animal feeding operations (CAFOs), aka "factory farms." There is a mounting body of incriminating scientific evidence that intensive livestock production threatens both public health as well as the environment even if the requisite waste disposal plans, known as Comprehensive Nutrient Management Plans (CNMPs), are adhered to. CNMPs are based on manure best management practices (BMPs), which were primarily designed to optimize crop growth and minimize nutrient losses. As a physician, I am not convinced that manure BMPs are adequately protective of human health.

I. KEY PUBLIC HEALTH POINTS

Livestock waste is a valuable source of plant nutrients but –

Too much of a good thing can be a bad thing – nutrients (nitrogen & phosphorus) lost to the environment become pollutants

- Contamination of private drinking water wells with nitrate (derived from nitrogen) that leaches into groundwater: "Blue baby syndrome," increased risk of cancer (particularly colorectal), pregnancy complications.
- Harmful algal blooms fed by runoff of nutrients: Toxin (microcystin) produced by cyanobacteria can sicken humans (and fatally poison dogs and other animals).

Too much of a bad thing can be a very bad thing

- **Untreated livestock waste contains human pathogens (germs or microbes capable of causing human disease):** Contamination of recreational surface waters (pathogens carried in runoff or delivered via drain tiles) and private drinking wells (pathogens leach into groundwater): Risk of infectious diseases (most commonly diarrheal illnesses).
- **CAFO air emissions exempt from regulation:** Proven harmful to health. Also, a significant (and unaccounted for) source of nitrogen pollution.

II. MAJOR PUBLIC HEALTH RISKS

A. INFECTIOUS DISEASES

Zoonoses: Infections transmitted from animals to humans

Livestock waste contains pathogens that can infect and cause disease in humans (zoogens):

- Salmonella, Campylobacter, E. coli O157:H7, Yersinia, Giardia, Cryptosporidium – clinically most important.
- Numbers and kinds in each batch of waste vary depending on source species and other factors.
- Most commonly cause diarrheal illnesses: Usually self-limited but can be severe or even fatal (particularly E. coli O157:H7 – bloody diarrhea, kidney failure, death). Giardia and Cryptosporidium can cause protracted disease.
- Children, the elderly, and people with weakened immune systems more vulnerable – higher risk of infection, severe disease, and death.

Antibiotic-resistant bacteria

- Antibiotic use in animal agriculture contributes to the emergence and spread of drug-resistant strains.
- ~70 percent of medically important antibiotics (total volume) sold in the U.S. used "on the farm."
- CAFO animals more susceptible to infections (stress and overcrowding)
- Injudicious antibiotic use selects for resistant strains. U.S. regulations effective 01/2017 a step in the right direction but not enough: 1) Usage of human medically important antibiotics as growth promoters banned and 2) Those administered in feed or water subject to the Veterinary Feed Directive drug process (veterinary approval required). However, agricultural antibiotic usage data is not transparent, including appropriateness of use – important in 1) Interpreting trends in antimicrobial resistance and formulating and implementing intervention strategies and 2) Discouraging inappropriate usage.

Disparity between the regulation of human waste and livestock waste

It is illegal to use untreated human waste (raw sewage) as fertilizer but not untreated CAFO waste.

- Agricultural application of human waste (biosolids) is strictly regulated under the Clean Water Act (40 CFR [Code of Federal Regulations] Part 503) and Michigan Law Part 24. Human waste must first be treated to destroy human pathogens.
- Although there are distinctions between the two types of waste, livestock waste can contain as many human pathogens as raw sewage but need not be treated – it is regulated differently by the United States Department of Agriculture (USDA) under National Resources Conservation Service (NRCS) Code 590.

While manure BMPs do reduce the numbers of viable pathogens that reach water resources (survival and ultimate destination a function of many factors – time, distance, competition with natural soil bacteria, filtration by soil and vegetation, temperature, and ultraviolet radiation to name some), in my opinion, a critical question remains unanswered: **Do measures designed**

primarily to optimize crop growth and prevent overfertilization sufficiently guard against the introduction of unsafe numbers of microbial pathogens into water resources? Human waste is also used as fertilizer but must first be treated to reduce pathogens, and thereby infectivity. Only then can it be applied as fertilizer – class B biosolids with restrictions (akin to manure BMPs) and class A biosolids (essentially pathogen-free) without restrictions. By law, the pathogen reduction step can be omitted with livestock waste. Some animal waste storage systems do reduce pathogen content (e.g. anaerobic lagoons) while others do not to any appreciable degree (e.g. deep cement pit structures).

Recreational water illnesses (RWI)

- Exposure to recreational waters contaminated by pathogens (from waste runoff) while swimming or engaging in other water sports/activities.
- Ingestion (accidental swallowing) or contact with nonintact skin (e.g. open wounds) or mucosal surfaces (e.g. lining of mouth and eyes).
- Recreational water quality criteria are designed to reduce the risk of RWI to an "acceptable" rate using fecal indicator bacteria (FIB) counts. Threshold concentrations of FIB (E. coli and Enterococci), below which it is considered "safe to swim," were derived from epidemiologic studies of beaches impacted by wastewater treatment plants discharging effluent from treated municipal sewage, considered point source pollution (emanates from a single defined source). Because FIB do not reliably predict the risk of RWI from recreational waters impacted by runoff from fields fertilized with agricultural animal waste (nonpoint source pollution), it is difficult to determine the degree of risk (and therefore make the argument that the risk of RWI is acceptable). Alternative methods to assess risk utilizing mathematical modeling (e.g. Quantitative Microbial Risk Assessment or QMRA) are under development but require further refinement and validation (QMRA often subject to large uncertainties).

Foodborne illnesses

- Consumption of contaminated animal products (e.g. meat, eggs)
- Consumption of contaminated food crops (from waste used as fertilizer or irrigation water contaminated with waste)

Direct contact with animals or their excreta (urine & feces) or secretions, tissues, and other bodily fluids: Predominantly an occupational health concern. However, workers can transmit infection to family and community members.

Influenza A and swine CAFOS

Pigs and people can share influenza A viruses and those viruses can genetically intermingle, generating new variant swine influenza A viruses – strains potentially capable of causing dangerous pandemics. There are several well-documented cases of transmission of variant influenza virus to humans traced to contact with pigs at county fairs. Swine CAFOs can also amplify influenza A strains circulating in a community, with pigs serving as reservoirs

(convincing evidence that this occurred in North Carolina, second to Iowa in swine CAFOs, during the deadly 2009-10 H1N1 influenza A pandemic).

B. CONTAMINATION OF DRINKING WATER SOURCES BY AGRICULTURAL ANIMAL WASTE

Municipal drinking water supplies (derived from surface waters or groundwater) are protected under the Safe Drinking Water Act – monitored for nitrate and pathogens and treated.

Private wells (fed by groundwater) a major source of drinking water for rural residents but owners must test their well water and protect themselves. Remediation of public water systems or private drinking wells contaminated with nitrate is difficult and expensive. Nitrate is not removed by conventional drinking water treatment processes. Options for private well owners – install a water treatment system, dig a new well, or drink bottled water. Pathogen contamination is somewhat more easily managed.

Nitrate toxicity

- Infants given water with toxic levels of nitrate (or formula and foods mixed with contaminated water) are at risk for "blue baby syndrome," a serious and potentially fatal oxygen starvation condition.
- Pregnancy complications: Miscarriages, low birth weight, premature birth, and birth defects.
- Increased risk of cancer (especially colorectal cancer) even at levels below the legal limit of 10 ppm for public water supplies.

Nitrogen-compounds in animal waste are converted by soil bacteria to nitrate, which is taken up by plants.

How do nitrate and pathogens get into groundwater?

- Leaching of waste applied to fields as fertilizer – subsurface injection (or soil incorporation by other means) reduces risk of runoff but increases risk of leaching. Because the amount of waste that can be applied to a field each crop-year is limited by the crop's nitrogen requirements, agronomic rate calculations assume that no nitrogen will be lost to the environment (i.e. nitrogen added = nitrogen taken up by crop). However, some nitrogen will "escape" – see CNMP deficiencies below.
- Leaching of runoff that reaches porous soils.
- Leaching of waste that leaks from breaches in storage structures.

Note: I have focused on nutrients and pathogens, but other CAFO waste constituents such as veterinary pharmaceuticals, toxic trace elements, and naturally excreted hormones are potential contaminants. Hormones (exogenously administered or natural) can interfere with the

reproductive habits of aquatic species ("endocrine disruption"). Chemicals in cleaning agents used to periodically clean and disinfect storage structures are also of concern.

C. HARMFUL AIR EMISSIONS

Gases

- Ammonia (& other nitrogen compounds) – significant source of nitrogen pollution not accounted for by CNMP.
- Hydrogen sulfide
- Volatile organic compounds
- Methane (greenhouse gas)

Particulate matter (PM)

- Complex mixture of microscopic solids and liquid droplets suspended in air.
- Bioaerosols, a subset of PM released in CAFO air emissions, contain a variety biologic material including endotoxin (a highly pro-inflammatory bacterial cell wall component). Endotoxin exposure implicated in asthma pathogenesis and exacerbation. PM can even contain viable human pathogens.
- EPA criteria pollutant – harmful to human health if protective thresholds (National Ambient Air Quality Standards or NAAQS) are exceeded. CAFOs emissions contain substantial PM.

Health risks:

- Significant increases in childhood asthma, adult asthma, airway obstruction, and irritant-linked eye and upper airway symptoms.
    - Risk proportional to intensity and duration of exposure – dependent on CAFO size and density and proximity to CAFO(s).
    - People with preexisting conditions such as asthma (especially in children), chronic obstructive lung disease or COPD (usually an adult disease), and allergies are more likely to be adversely affected by toxic CAFO air emissions.
- While exposure to dangerously high levels of certain CAFO gases (e.g. hydrogen sulfide & ammonia) is predominantly an occupational health concern, long-term exposure to continuous low-levels of emissions can negatively impact human health on a local scale. The effects of "mixed exposures" entailing complex interactions between the various constituents in CAFO air emissions on health are given scant to no attention.

CAFOs exempt from monitoring and reporting under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Emergency Planning and Community Right to Know Act (EPCRA).

- Thanks to Congress (FARM Act 03/2018) and EPA (final rule 06/2019).
- Justification – lack of emissions estimating methodologies (EEMs).

- Industry-funded NAEMs (National Air Emissions Monitoring Study) launched by EPA in 2006 – still no EEMs.
- Manual of best management practices to reduce CAFO/AFO air emissions published by USDA and EPA in 09/2017 – voluntary and unenforceable.

D. MENTAL HEALTH

Living near a CAFO: Studies document negative impacts on mood (increased anxiety and depression) and quality of life.

Contributing factors:

- Odor: Are current regulations fair to neighbors who were there first?
  - Odor footprint: Nonfarm residence must be located outside the 5% odor footprint generated by the MI OFFSET 2018 odor model. "Odor annoyance" deemed acceptable 5% of the time (~18 out of 365 days per year). MI OFFSET 2108 doesn't account for the additive impact of odor from multiple separate CAFO sites.
  - Setbacks (large CAFOs): 600 ft for a non-farm residence (odor management plans allow reduction to minimum of 250 ft) & 1500 ft for areas of high public use.
- Negative impact on physical health.
- Significant residential property devaluation – downwind within at least a 3-mile radius (and downstream).
- Stigma attached to living near a CAFO
- Community divisiveness

III. ADDITIONAL IMPORTANT INFORMATION

A. While Michigan's rich agricultural heritage is reason for pride, the agricultural industry's plan for our state is reason for concern. Why Michigan is facing a steep rise in CAFOs:

- Increased livestock demand
  - New pork processing plant in Coldwater operational since 09/2017. Pennsylvania-based Clemens Food Group recruited to expand to Michigan with taxpayer-funded incentives. Valley View Pork, based in Walkerville, produces 230,000 pigs annually (per website), some of which are raised to finish in CAFOs by contract growers. The owner served on the Michigan Commission on Agriculture and Rural Development (MDARD) 2012 -16.
  - Huge dairy processing and whey powder manufacturing plants under construction in St. Johns (investors include Glanbia and Proliant Dairy Ingredients, Irish and Iowa companies respectively, and U.S. dairy cooperatives).

    - Production goals (slaughtering 22,000 hogs and processing 8 million pounds of milk per day) will likely be met with more and larger swine and dairy CAFOs.
- Strong Right to Farm laws, CAFO-friendly regulatory climate, and abundant water resources.
- Iowa and other CAFO-saturated states pushing back (tainted water) – agricultural industry ("Big Ag") looking elsewhere.

Michigan could become the next Iowa: In 2001, there were 722 permitted large CAFOs in Iowa. Estimates put the total of medium and large CAFOs at over 10,000 in 2017. Currently, Michigan has about 300 permitted large CAFOs. Iowa's CAFO explosion could portend Michigan's future.

B. Michigan's Right to Farm Act (RTFA)

Local communities have no say when it comes to CAFOs thanks to a 1999 RTFA amendment enacted by Michigan's Legislature that preempts local zoning ordinances aimed at keeping them in check. And in 2019 MDARD decided that zoning ordinances enacted prior to 1999 would no longer be referenced, citing legislative intent.

Multiple CAFOs multiply the associated environmental and public health risks but there are currently no CAFO size or density restrictions, which has led to geographical clustering, usually in poorer rural areas in an example of what many consider economic and environmental injustice, and depending on the community, racial injustice. Many rural communities in Michigan (e.g. Lenawee County) are already home to numerous CAFOs.

C. Economics

CAFOs marketed as "independent family farms" but growers contract with "integrators" (large companies that supply the animals and help manage/control production). CAFOs generally are profitable for the owners, but corporate agribusinesses reap the lion's share of the profits. Touted economic boost to the local community on the whole is debatable. Some local farmers probably benefit (increased demand for feed crops, access to less expensive fertilizer – CAFO waste) but other individuals and businesses (e.g. tourism-related) suffer economic loss.

CAFO farmer owns the waste and debt – and so does society:

- Cost externalization: Agricultural corporations not accountable/liable for the waste/pollution – lower cost/higher corporate profit margins.
- Financing (USDA Farm Service Agency loans) backed by U.S. taxpayer dollars

D. Michigan CAFO process

Site suitability determination: CAFO protected under RTFA if MDARD determines that the siting request is in conformance with Generally Accepted Agricultural and Management Practices (GAAMPs) for Site Selection and Odor Control for New and Expanding Livestock Production Facilities: For CAFOs >750 animal units on category 1 sites (traditional farmland "normally acceptable for livestock facilities") – 5 or fewer non-farm residences within 1/2 mile of CAFO, odor management plan, minimum setbacks (e.g. property lines, wells), additional considerations (e.g. wetlands, floodplains).

Required:

- **National Pollutant Discharge Elimination System (NPDES) permit:** Arbitrarily, large* CAFOs only (e.g. ≥ 1000 beef cattle, ≥ 2500 swine weighing 55 or more pounds). Issued by the Michigan Department of Environment, Great Lakes and Energy (EGLE). Required time frame to render a decision – within 180 days of receipt of application. Allows little time for blindsided communities to organize a viable opposition (nearly impossible to shut down once CAFO constructed). Permits virtually never denied. *An Animal Feeding Operation (AFO) with 999 beef cattle or 2499 finished weight swine does not technically require a permit.
- **Comprehensive nutrient management plan (CNMP):** Waste disposal plan – CAFO NPDES permit cornerstone. Allegedly adequately protective of the environment and public health. Based on GAAMPs for Manure Management and Utilization (manure BMPs) – devised and revised by MDARD. Though scientifically based, primarily designed to optimize crop growth and secondarily prevent overfertilization/pollution. Pathogen content of waste not factored in at all. Many other deficiencies (see below).

Not required:

- Oversight by local public health departments or the Michigan Department of Health and Human Services.
- Rigorous environmental, health, or economic impact assessments. Note: If financing is obtained through USDA FSA, a Phase II Environmental Assessment (EA), a low-level review, is required for large CAFOs. In the case of Flower Creek Swine, the FSA loan officer was tasked with completing the EA. The FSA State Environmental Coordinator, ultimately responsible for ensuring compliance of the EA with the National Environmental Policy Act (NEPA), signed off on it and issued a "Findings of No Significant Impact" (FONSI).

Not considered:

- Baseline pollution and significant contribution of ongoing nonpoint source agricultural pollution – no additional CNMP requirements.
- Proximity to Great Lakes.
- Infrastructure concerns (e.g. excess wear and tear on roads from increased heavy truck traffic and cost to maintain and repair, availability of fire services)

- Community development goals (see Right to Farm Act).

E. Why CNMPs are problematic

1) Disparity between the regulation of human and livestock waste: Discussed in section II.

2) More waste applied to relatively less land

- Trend over the past 2-3 decades: Fewer but larger farms.
- Untreated liquid-laden livestock waste (mixtures of urine and manure) too heavy and costly to transport far (in contrast, volume of water in biosolids often reduced – more economical to store and transport and therefore deliver where and when needed).

3) Overreliance on the CNMP despite multiple deficiencies (list not comprehensive)

- Agronomic rates:
  - Pathogen levels not considered.
  - Agronomic rates assume that because a maximum of one crop-year's worth of nitrogen can be applied, it will all be taken up by the crop (and therefore none lost to the environment). The timing of application relative to crop growth cycle is important. If CAFO waste is applied when the crops don't need/won't use the nitrogen (too late in the growing season, after harvesting, or during the winter) the nitrate won't wait around until the beginning of the next crop-year. Nitrate is highly dissolvable and mobile in water and therefore, "goes with the flow" – the flow of water that is. Pathogens also travel in water. Pathogens and unused nitrate in water (including runoff that reaches sandier soils) leach downward through soil into groundwater, potentially contaminating private drinking wells.
  - CNMPs do not account for the substantial amount of nitrogen in CAFO air emissions. Volatilized ammonia (a nitrogen compound) and particulate matter containing nitrogen-compounds, emanating from storage structures, eventually deposit on soil and surface waters, paying setbacks no head, contributing to nitrogen pollution.
  - Allow up to 4 crop-years of phosphorus (and up to 4 times as many pathogens).
- CNMPs allow application of waste to frozen or snow-covered ground – high risk of runoff.
- Baseline pollution not considered: No additional CNMP requirements.
- Drain tiles serve as major conduit for pollutants to surface waters – not adequately addressed by the CNMP. Drain tiles are usually located below root zone (where waste is injected or incorporated) but pathogens and unused nitrate leach further downward.

4) Monitoring and enforcing compliance problematic

- EGLE District Offices: Limited resources (manpower and money).

- CAFO owner/operator: Charged with tracking the transfer and use of CAFO waste. Expected to report violations.
- Big loophole: CAFO waste transferred ("manifested") offsite to other farmers is not technically legally bound by the CNMP (EGLE may prohibit the future transfer of waste to violators – if violations discovered and reported). Adherence to manure GAAMPs/BMPs encouraged but are voluntary and therefore unenforceable.

Assumptions

- The CNMP will work as well in the real world as it does on paper.
- There will be no pollution (loss of nutrients into the environment and or unsafe numbers of human pathogens reaching water resources).
- Land base will be sufficient to assimilate the nutrient content of massive amounts of waste (at baseline and in the future).
- Mother Nature will always cooperate.
- Humans will never make mistakes (unintentionally or otherwise).
- The CNMP will be adequately protective of public health and the environment.

No defined plan for CAFO waste storage structures that "age out"

F. Illustrative example: Flower Creek Swine, LLC in Claybanks Township, Oceana County (a 4000-swine CAFO that became operational in 2019)

- The CAFO is projected to generate at least as much waste as the entire population of Oceana County, which will likely be applied to farmlands within a few miles of the storage structure. It will contain high numbers of pathogens that can cause severe human illness, even death. It would be illegal to dispose of massive amounts of raw sewage (untreated human waste) year after year, in the same relatively small geographical area. Unleashing all that untreated waste in the Flower Creek Watershed risks contamination of surface waters (Flower Creek and Lake Michigan) and groundwater (supplying private drinking water wells) with excess nutrients and harmful pathogens. Note that White River Watershed is also at risk for pollution given the proximity of some of its farmlands to the CAFO.
- Significant baseline pollution (in large part due to ongoing agricultural nonpoint source pollution) established by two citizen-initiated studies:
    - Hydrologic and geomorphic analysis of Flower Creek Watershed projects that watershed levels of nitrogen and phosphorus, already high, will increase substantially, making it one of the most nutrient-laden watersheds in the Great Lakes basin [1].
    - Flower Creek, which flows directly into Lake Michigan and drains the watershed where most if not all of the untreated waste will be applied, is already impaired (high E. coli levels) and other water quality parameters degraded [2]. Because the waste will be stored in a deep cement pit it will undergo negligible pathogen

reduction. Water quality designations: Meets water quality standards for designated uses → Degraded → Impaired. Impaired waters are candidates for inclusion in the state's 303(d) list (under the Clean Water Act), which is submitted to the Environmental Protection Agency biannually for a Total Maximum Daily Load (TMDL) determination. The TMDL development process is slow and recommendations voluntary and unenforceable.
    - Qualified subject matter experts predict that the CAFO will make things worse [1, 2, 3].
- Groundwater: Difficult to determine baseline ("pre-CAFO") status. Statewide Nitrate Map (EGLE website) reflects data from 1983-2003 water samples. There is reason to be concerned that groundwater resources in Flower Creek Watershed are already contaminated with nitrate and/or pathogens given that groundwater and surface waters are hydrologically connected. The Michigan Agricultural Environmental Assistance Program (MAEAP) teams up with Oceana and Muskegon County Conservation Districts to offer free nitrate/nitrite screening on an annual basis. Positive screens are verified. Nonfarm residents are referred to the local public health department for confirmatory testing (performed by a certified water testing laboratory) and any necessary remediation. Farm residences are handled differently. Positive screens are also confirmed but the results are strictly confidential and MAEAP handles remediation. I would argue that the public has a "right to know."
- CAFO located less than 2 miles from Lake Michigan.
- Grant Township (provider of fires services for Claybanks Township) issued public statement that they will not provide fire services citing potentially inaccessible roads.
- Majority of community members opposed to CAFO but couldn't stop it and are virtually powerless to prevent its future expansion or construction of new CAFOs (Right to Farm Act).
- EGLE's stance: "The CAFO won't make things worse." Their concession – a somewhat more restrictive individual (vs. general) NPDES permit.

Questions and comments (including opposing viewpoints) welcome. Please feel free to contact me at: myhealthandcafos@gmail.com (I will respond).

This document will be periodically updated and revised as further relevant information comes to light.

1. Hyndman, David, PhD & Anthony Kendall, PhD: Preliminary Analysis of Proposed CAFO in the Flower Creek Watershed, January 10.2018
2. Rediske, Richard D., PhD: Flower Creek Monitoring Project 2018, E. coli, Nutrient, and Bioassessment Surveys, February 2019
3. Affidavit of Mark R. Luttenton, PhD

Additional supportive references provided upon request.