Analysis of Poultry Operators in Maryland

A Proposal to Expand Maryland's Manure Transport Program

A chicken CAFO in Berlin, Maryland, near the Pocomoke River flooded after four inches of rainfall within 24 hours during the summer of 2018.
Photo credit: Assateague Coastal Trust/Tim Preziosi

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ACKNOWLEDGEMENTS

We would like to make a special thanks to our Environmental Law Professor, Sonya Ziaja, who allowed us to explore our passion for environmental justice and help us apply the information we learned in the classroom towards this policy brief. We would also like to make a special thanks to Molly Brown and Evan Isaacson of the Chesapeake Legal Alliance for their invaluable time, expertise, and guidance in understanding the environmental impacts affecting the Chesapeake Bay and the Eastern Shore of Maryland. Our team would not have accomplished and understood the importance of this topic and help view our newly acquired knowledge through real-life examples, and solutions, towards making the Chesapeake Bay a better place.

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Abstract

Modern-day poultry farm operations can be traced back to Perdue Farm's founder, Arthur Perdue, inventing the mass, industrialized approach in the Chesapeake Bay during the 1920s, with the majority of operations starting (and remaining present) in Maryland's Eastern Shore.[1] Over time, proper management, continued streamlining of operations, and other factors that helped control disease and maintain efficiency also gave rise to conditions that allowed poultry farms to become the behemoths that they are today. These modern poultry farm operations have placed the Eastern Shore as one of the leading centers of poultry production, with 2020 seeing 287,300,000 chickens being produced in Maryland.[2]

However, one of the larger issues persistent in the poultry industry today is the amount of poultry manure that is produced and the human health and environmental implications of poultry manure. This paper will focus on the complex challenge of agricultural nutrient pollution on Maryland's Eastern Shore, with a focus on presenting innovative policy solutions to mitigate the human health and environmental impact as a result of poultry operations.

Introduction

The Chesapeake Bay is one of the largest and most productive estuaries in the world. Characterized by its unique geography, the Chesapeake Bay is a rich, biodiverse habitat with significant economic value. The estuary's watershed region spans across six states (Maryland,

[1] Tom Pelton, Mariah Lamm, Abel Russ, Poultry Industry Pollution in the Chesapeake Region: Ammonia Air Emissions and Nitrogen Load Higher than EPA Estimates, ENVTL. INTEGRITY PROJECT (Apr. 22, 2020), https://environmentalintegrity.org/wp-content/uploads/2020/04/Chesapeake-Poultry-Report-.pdf.

[2] U.S. Dep't of Agric., 2020 State Agricultural Review, Maryland, MARYLAND STATISTICS, NOV. 2019, https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=MARYLAND.

Virginia, Delaware, West Virginia, Pennsylvania, and New York) in a highly developed region with many urban hotspots. Nutrient pollution, specifically from nitrogen and phosphorus, poses a unique challenge for the Chesapeake Bay. Agricultural practices, particularly poultry farming, have grown across the watershed region and contribute massive amounts of nutrient pollution to the ecosystem. Nutrient pollution threatens the Chesapeake Bay's biodiversity and productivity through the process of eutrophication.[3] As a result, human industrial practices from across this region threaten the biodiversity and stability of the Chesapeake Bay's ecosystems.

The Chesapeake Bay is the largest estuary in the United States and third largest in the world, with over 11,684 miles of shoreline along its coasts and tributaries.[4] Spanning across six states, the estuary receives water from a region of over 64,000 square miles.[5] Containing over 18 trillion gallons of water, the Chesapeake Bay maintains a vast salinity gradient, ranging from the salt water of the Atlantic Ocean at its mouth to the freshwater of its major tributaries, including the Susquehanna, Potomac, and James Rivers.[6] The expansive footprint of tributary rivers and streams of the Chesapeake Bay are the highest land-to-water ratio of any watershed in the world.[7]

The Chesapeake Bay flourishes as one of the world's most ecologically diverse and economically valuable bodies of water. This unique estuary is home to around 3,600 species of plants and animals, ranging from waterfowl to anadromous finfish and aquatic vegetation.[8] Such biodiversity provides the economic productivity of the Chesapeake Bay - over 500 million pounds

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[3] Chesapeake Bay Program, *Nutrients*, LEARN THE ISSUES , https://www.chesapeakebay.net/issues/nutrients (last visited Oct. 20, 2021).

[4] Chesapeake Bay Program, *Facts & Figures*, DISCOVER THE CHESAPEAKE, https://www.chesapeakebay.net/discover/facts (last visited Oct. 20, 2021).

[5] *Id*.
[6] *Id*.
[7] *Id*.
[8] *Id*.

of seafood are produced each year by the Chesapeake Bay.[9] Harvests of oysters, blue crabs, rockfish, and other aquatic species of the bay provide over $2 billion in sales and over 41,000 jobs per year between Maryland and Virginia alone.[10] Altogether, the economic value of the Chesapeake Bay (including fisheries, tourism, and property values) is estimated to be over $1.1 trillion.[11] The Chesapeake Bay's economic value and the livelihood of its millions of residents depend on the stability and conservation of its unique and vast ecosystem.

However, the Chesapeake Bay faces a multitude of environmental challenges. Runoff pollution throughout the expansive six-state watershed leads to excess nutrients entering the Chesapeake, causing algal blooms and dead zones, a process commonly known as eutrophication.[12] Nutrient pollution threatens the Chesapeake Bay's biodiversity and productivity. The issue of nutrient pollution is exacerbated by the loss of natural buffers like coastal forests and wetlands.[13] Nitrogen and phosphorus pollution persist as a major challenge to the Chesapeake Bay and is in large part a result of the region's large-scale poultry farming and concentrated animal feeding operations ("CAFOs").[14]

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[9] *Id*.
[10] Alicia Pimental, *Ask a Scientist: How big of an industry is the Chesapeake Bay?*, CHESAPEAKE BAY PROGRAM (June 9, 2011), https://www.chesapeakebay.net/news/blog/ask_a_scientist_how_big_of_an_industry_is_the_chesapeake_bay.
[11] Alicia Pimental, *Ask a Scientist: How big of an industry is the Chesapeake Bay?*, *CHESAPEAKE BAY PROGRAM* (June 9, 2011), https://www.chesapeakebay.net/news/blog/ask_a_scientist_how_big_of_an_industry_is_the_chesapeake_bay.
[12] *Stormwater Runoff*, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/stormwater_runoff (last visited Oct. 20, 2021).
[13] *Forest Buffers*, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/forest_buffers (last visited Oct. 20, 2021).
[14] *Agriculture*, CHESAPEAKE BAY FOUNDATION, https://www.cbf.org/issues/agriculture/ (last visited Oct. 20, 2021).

The Eastern Shore of Maryland is rich with agriculture and farming, with many of Maryland's CAFOs found on the lower Eastern Shore of Maryland in Wicomico and Worcester Counties.[15] Their presence in their counties has dramatically increased from seven in 2009 to 526 in 2020.[16] The Eastern Shore houses approximately 44 million chickens which is "roughly 241 times greater than the number of people in the region." [17]

In the United States there are approximately 450,000 AFOs, many of which concentrated on the Eastern Shore of Maryland.[18] In most AFO facilities, the animals live in close quarters and eat in their living facility rather than feeding in pasture.[19] AFOs may contain beef, dairy, swine, or poultry facilities. Poultry AFOs are both the leading source of agricultural production in Maryland and of pollution into the Chesapeake Bay.[20] Unfortunately, the problem of pollution in the Chesapeake Bay is only getting worse, as the AFO industry has grown significantly in recent years. Regulations, in the form of a General Discharge Permit, endeavor to limit and reduce pollution from these facilities.[21]

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15 Elizabeth Shwe, Report: Eastern Shore Has Unhealthy Levels of Nitrate in Drinking Water Due to CAFOs, Energy and Environment (Oct. 21, 2020), https://www.marylandmatters.org/2020/10/21/report-eastern-shore-has-unhealthy-levels-of-nitrate-in-drinking-water-due-to-cafos/.

16 *Id.*

17 Katlyn Schmitt & Darya Minovi, *Maryland Court Orders State to Limit Ammonia Pollution From Industrial Poultry Operations*, CPRBLOG (Mar. 22, 2021), http://progressivereform.org/cpr-blog/tags/CAFO/.

18 Manure & Waste Management, NRCS, https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/mnm/.

19 *Id.*

20 *Poultry Pollution*, SIERRA CLUB, https://www.sierraclub.org/maryland/poultry-pollution (last visited Oct. 20, 2021).

21 *Id.*

Effects of Nitrogen and Phosphorus from Agricultural Production

Decades of excessive nutrient pollution from agricultural production have degraded the Chesapeake Bay and threatened its overall vitality as an economic and ecological resource. Nutrient pollution in the Chesapeake Bay has been well-documented, and though some progress has been made, not nearly enough has been done. The Chesapeake Bay has been listed as "impaired" since 2000 due to pollution discharge.[22] Under the authority of the Clean Water Act, a Total Maximum Daily Load ("TMDL") was established for the Chesapeake Bay in 2010.

Nitrogen compound discharges have shown to be the most problematic.[23] Nitrogen creates Harmful Algal Blooms ("HABs"). These blooms may last for months at a time, significantly depleting oxygen supply in the water. Blooms can pose human health risks via the harvest and consumption of shellfish contaminated with algal or waterborne toxins due to eutrophication.[24]

Nitrogen primarily exists in marine and freshwater aquatic systems in four stable forms of inorganic nitrogen: ammonium (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-), and gaseous nitrogen (N_2). The first three forms are highly soluble, while the fourth form is considered generally inert. The largest pool of fixed nitrogen in estuarine, coastal, and marine surface waters is typically dissolved organic nitrogen ("DON"). The pool of DON compounds is composed of an array of reactive and

[22] Mueller, A. Jon, *The Chesapeake Bay TMDL*, CHESAPEAKE BAY FOUNDATION (Dec. 6, 2013), https://www.ncsl.org/documents/standcomm/scnri/mueller_cbf.pdf.
[23] Water Environment Federation. Nutrient Removal. 328. Bricker, S., B. Longstaf, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. No. 34. 2011.

[24] Bricker, S. et al., *Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change*. NOAA Coastal Ocean Program Decision Analysis Series No. 26. National Centers for Coastal Ocean Science, (2007).

labile compounds. These compounds include urea, dissolved amino acids, both free and combined, nucleic acids, amino sugars, aromatic compounds, and humic substances.[25]

Nitrogen and phosphorus loads into the Chesapeake Bay come from many sources, including sewage treatment plants, industrial facilities, agricultural production, commercial production, and the atmosphere. According to the Chesapeake Bay Program, nitrogen and phosphorus loads by sectors for 2019 were as follows:

Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST) Phase 6 Model

By Source Sector	**Nitrogen million lbs./yr. 2019**	**Sector %**	**Phosphorus million lbs./yr. 2019**	**Sector %**
Agriculture	118.96	45%	4.139	27%
Developed	39.68	15%	2.629	17%
Wastewater	35.37	13%	2.774	18%
Septic	7.89	3%		0%
Natural	45.90	17%	5.750	38%
Atmospheric Deposition to Watershed (to be reduced under Clean Air Act)	1.03	0%		0%
Atmospheric Deposition to Tidal Water	16.49	6%		0%
Total Basin-wide	**265.32**	**100%**	**15.293**	**100%**

- Discharge loads by sector for 2019, the most recent data

According to the data above, agriculture operations account for 45% of the nitrogen and 27% of the phosphorus load into the Chesapeake Bay. Nutrients into the Chesapeake Bay watershed vary by pathway but are primarily derived from stormwater runoff through agriculture

[25] Bronk, D., Dynamics of DON. In Biogeochemistry of Marine Dissolved Organic Matter; Hansell, D., Carlson, C. A., Eds.; Academic Press: New York. (2002)

lands and CAFO facilities. In addition to the nutrient loads, runoff contributes other detrimental pollutants, including pathogens, antibiotics, and endocrine disruptors.[26]

Excess loading of nitrogen and phosphorus compounds has profoundly adverse effects on the environment. The natural concentration of these nutrients in the waterbody limits the growth of phytoplankton. The concentration of Chlorophyll-a is generally used as a measure of the algal phytoplankton in the waterbody, and high concentrations lead to low dissolved oxygen levels.[27] Generally, although both nutrients are significant toward algal growth, nitrogen is the limiting nutrient (i.e. the limiting nutrient is the nutrient that exists in the lowest concentration relative to what organisms need) for coastal and marine water systems such as the Chesapeake Bay.[23]

Algae may use a variety of nitrogen and phosphorus compounds available in nature to support its growth. Typically, dissolved nitrogen is taken up by cells, reduced intracellularly to ammonium, and then assimilated into amino acids. The cellular immersion of nitrogen stimulates algal growth and exacerbates the photosynthetic consumption of oxygen in the waterbody, which creates eutrophic conditions..[28]

Eutrophication results in the creation of dense algal blooms containing noxious, foul-smelling phytoplankton. These algal blooms reduce water clarity and are detrimental to water

[26] Dwight D. Bowman, Manure Pathogens: Manure Management, Regulations, and Water Quality Protection, Water Environmental Foundation (2009).
[27] Green, Bently C. (1992) Thesis: Photosynthesis and Respirations Effects on the Tennessee-Tombigbee Waterway, Mississippi State University.
[28] Howarth, R. W.; Sharpley, A.; Walker, D. (2002) Sources of Nutrient Pollution to Coastal Waters in the United States, Implications for Achieving Coastal Water Quality Goals. Estuaries, 25, 656–676.

quality[29] Algal blooms limit light penetration, reduce growth and cause plants to die off.[30] Furthermore, algal blooms' high rates of photosynthesis deplete dissolved inorganic carbon and raise water pH to extreme levels when sunlight stimulates photosynthetic activity. When these dense algal blooms eventually die, microbial decomposition severely depletes dissolved oxygen, creating hypoxic or anoxic dead zones lacking sufficient oxygen to support most organisms.[31]

This oxygen depletion from algae creates a resultant "dead zone," often with dissolved oxygen concentrations of less than 0.5 mg/L, in which plant and aquatic life cannot sustain. Dead zones affect more than 245,000 square kilometers in over 400 near-shore systems.[32] Dead zones have unfortunately become particularly common in marine coastal environments surrounding large, nutrient-rich rivers. (e.g., Mississippi River and the Gulf of Mexico; Susquehanna River and the Chesapeake Bay).

Nitrogen loads have been decreasing over time due in large part to the efforts of voluntary and regulatory organizations. For example, 2019 loadings were 25% less than 1985 levels, showing a decrease from 331 to 248 million pounds per year. However, this is still short of the overall 2025 nitrogen level goals of a 40% reduction from the 1985 level of less than 200 million pounds per year.[33] Additional efforts, both regulatory and voluntary, are needed to ensure that the

[29] Chislock, M. F., Doster, E., Zitomer, R. A. & Wilson, A. E. (2013) Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems. Nature Education Knowledge 4(4):10
[30] Lehtiniemi, M. et al. Turbidity Decreases Anti-Predator Behaviour In Pike Larvae, Esox Lucius. Environmental Biology of Fishes 73, 1-8 (2005).
[31] M. F. Chislock, E. Doster, R. A. Zitomer & A. E. Wilson, *Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems*, Nature Education (2013).
[32] R.J. Diaz & R. Rosenberg, *Spreading Dead Zones and Consequences for Marine Ecosystems*, Science 321, 926-929 (2008).
[33] *Id.*

Chesapeake Bay can recover from prior pollution loads and sustain its viability as a cultural, economic, and environmental resource.

A primary source of nutrient pollution impacting the Chesapeake Bay that has much room for refinement and improvement is from Animal Feeding Operations ("AFOs") through both voluntary as well as regulatory incentivized pathways. AFOs contain animals for agricultural purposes.[34] AFO is used to describe a lot or facility (other than an aquatic animal production facility) where: 1) animals (other than aquatic animals) have been, are, or will be stabled or confined and fed or maintained for a total of 45 calendar days or more in any 12-month period, and 2) crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

Effects of CAFOs on the Environment

CAFOs exude various pollutants to the surrounding environment. Nitrogen and phosphorus enter into waterways through the discharge of wastewater. Environmentally detrimental pollutants are discharged not only through chicken litter manure applications, but also through the CAFO facility itself. Poultry houses produce gaseous Ammonia from poultry manure, which are spread out of poultry houses by industrial fans. This causes the ammonia to settle on nearby land and waterways.

[34] *Animal Feeding Operations*, EPA, https://www.epa.gov/npdes/animal-feeding-operations-afos (last visited Oct. 20, 2021).

Poultry Litter Manure

Manure contains large amounts of nitrogen and phosphorus, making it a valuable resource when properly utilized. The concentration of nitrogen and phosphorus makes manure an essential component for various plant and livestock operations. Manure's various uses include fertilizer and soil enrichment, biomass conversion, and energy production.

When used as fertilizer, manure is applied in a semi-solid or liquid form. When applied to land, manure provides nutrients that improve the soil's organic matter and tilth. Additionally, manure increases the amount of organic matter in the soil, which improves soil structure and soil's ability to retain water. By increasing the amount of organic matter in the soil, the soil's carbon sequestration is also increased. Carbon sequestration helps prevent carbon from entering the atmosphere and becoming carbon dioxide.

Biomass conversion is also an important benefit of applying manure to land. Biomass conversion is the process of growing organisms on manure or manure nutrients and then harvesting them to use as a component of animal feed, fertilizer, and soil amendments.[35] By using biomass conversion, the plant nutrients in the manure become more prevalent and enriched as a fertilizer. Livestock manure may also be used to produce fuel for heating, transportation, and energy generation.[36] The most common energy sources produced are biogas, bio-oil, and syngas.[37] The USDA has stated that manure used for energy production retains its nutrients, allowing it to be used for fertilizer later.[38]

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[35] *Animal Feeding Operations - Uses of Manure*, EPA, https://www.epa.gov/npdes/animal-feeding-operations-uses-manure (last visited Oct. 17, 2021).
[36] *Id.*
[37] *Id*.
[38] *Id*.

Maryland regulates the discharge of CAFOs manure through the state's Nonpoint Source Management Program. The Nonpoint Source Management Program uses a collaborative approach, pairing state and federal agencies with local governments to address pollution at a local level. Maryland integrates its agricultural programs through local Soil Conservation Districts ("SCDs").[39] Through SCDs, Maryland helps local farmers develop and implement best management practices ("BMPs"). To encourage local agricultural operations to reduce their waste, all SCD offices offer financial assistance and technical personnel.

Pollutants resulting from poultry CAFOs

While manure from CAFOs contains many beneficial properties, CAFOs also create various harmful pollutants, including nitrogen and phosphorus, of which nitrogen is considered the most harmful to the environment. There are two primary forms of nitrogen in manure, inorganic (Ammonium) nitrogen and organic nitrogen.[40] Through microbes and chemical reactions, Ammonium is converted to Ammonia. Organic and inorganic nitrogen is land-applied to agriculture fields by spreading manure on fields so that it can be incorporated into the soil for later use by crops or grasses. Nitrogen not properly incorporated into the soil is susceptible to washout during rain events, causing pollution to surrounding areas and waterways through runoff.[41]

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[39] Maryland Department of the Environment, *Maryland's 2015-2019 Nonpoint Source Management Plan* 1, 4–9, (2016), https://mde.maryland.gov/programs/water/319NonPointSource/Documents/NPS_Management_Plan/Maryland_2015-2019_NPS_Mgmt_Plan_2016_update.pdf.

[40] Quirine M. Ketterings, Greg Albrecht, Karl Cyzmmek, Shawn Bossard, *Nitrogen Credits from Manure*, Cornell University Cooperative Extension, 1 (2005), http://cceonondaga.org/resources/nitrogen-credits-from-manure.

[41] *Id*.

Poultry CAFOs accumulate Ammonium through storage and use of chicken litter on fields.[42] When layered on the ground, ammonium is rapidly converted to ammonia as nitrogen loss occurs.[43] Nitrogen loss occurs when manure is spread on soils allowing ammonia to be produced with subsequent volatilization into the air as gaseous ammonia.[44] In CAFO facilities, manure produces large concentrations of gaseous ammonia.[45] The ammonia is spread to surrounding areas through industrial fans inside the CAFO facility.[46] The air emissions combine with the ammonia that rises from the ground and settles on the surrounding environment.[47] On Maryland's Eastern Shore, ammonia from CAFOs settles on farmlands and in the Chesapeake Bay. The spread of ammonia is dangerous because ammonia breaks down into nitrogen in the environment. However, ammonia is also carried downwind, triggering coughing, asthma attacks, and the irritation and inflammation of throats and nasal passages for those who ingest the pollutant.[48]

A 2018 study by Johns Hopkins researchers found that ammonia emissions from poultry operations on the Eastern Shore contribute about 12 million pounds of nitrogen pollution into the Chesapeake Bay every year.[49] As such, recent studies have predicted that the total nitrogen pollution may be more than double the estimated 12 million pounds due to broiler barns (CAFOs focused on breeding chickens for slaughter) which breed increasingly larger chickens.[50]

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[42] Quirine M. Ketterings, Greg Albrecht, Karl Cyzmmek, Shawn Bossard, *Nitrogen Credits from Manure*, Cornell University Cooperative Extension, 1 (2005), http://cceonondaga.org/resources/nitrogen-credits-from-manure.
[43] *Id*.
[44] *Id*.
[45] Environmental Integrity Project, *Ammonia Air Emissions and Nitrogen Load Higher than EPA Estimates* 2 (2020).
[46] *Id*.
[47] *Id*. at 1.
[48] *Id*.
[49] *Id*.
[50] *Id*. at 4.

Federal Statutory Framework

In 1972, Congress enacted the Clean Water Act ("CWA") with the objective to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[51] Under the CWA, it is unlawful to discharge any pollutant from a point source into navigable waters without a permit. The National Pollutant Discharge Elimination System ("NPDES") is the EPA permit program which controls discharges. Id. A discharge is "any addition of any pollutant to navigable waters from any point source."[52] A point source is a "discrete conveyance such as pipes or man-made ditches."[53] A CAFO where "pollutants are or may be discharged" is governed by the CWA.[54]

The history of AFO and CAFO regulation and the resulting pollutants that could affect water sources was first brought to light under the EPA's Clean Water Act (CWA) of 1972.[55] The Clean Water Act has historically undergone many adaptations and amendments as more research was made available. At first, the CWA was primarily concerned with surface water protection, but by 2003, there were revisions made to broaden regulations and permits.[56] Under the CWA, the National Pollutant Discharge Elimination System (NPDES) program now requires permits for all CAFOs and more stringent regulations regardless of the means by which waste disposal was handled.[57] Under these NPDES permits, CAFOs were required to implement a Nutrient

[51] 33 U.S.C. § 1251(a) (2019).
[52] 33 U.S.C. § 1362(14).
[53] *EPA Guidance*, Summary of the Clean Water Act. https://www.epa.gov/laws-regulations/summary-clean-water-act (last visited Oct. 20, 2021).
[54] 33 U.S.C. § 1362(14).
[55] John Sweeten, *CAFO Fact Sheet Series*, https://extension.usu.edu/agwastemanagement/ou-files/pdfs/CAFO_Fact_Sheet.pdf (Last visited Oct. 20, 2021).
[56] Carrie Hribar, *Understanding Concentrated environmental health Animal Feeding Operations and Their Impact on Communities,* https://www.cdc.gov/nceh/ehs/docs/understanding_cafos_nalboh.pdf (last visited Oct. 20, 2021).
[57] *Id*. at 13.

Management Plan ("NMP") and maintain nutrient levels from the waste it produced.[58] These Regulations to measure and monitor waste produced from CAFOs have increased as the CAFOs have increased in Maryland. In the trend toward larger and more industrialized farms, water contamination and pollution are an increasing issue. With population growth and increasing means of mass producing agricultural needs in Maryland, this also means the byproducts of these chemicals are increasing in our waterways. Contamination in water sources including in drinking water is an increasing result from these pollutants.

Every CAFO is required to apply for an NPDES permit whether or not they discharge to surface waters.[59] Furthermore, each CAFO is required to "develop and implement a site-specific NMP. *Id*. The NMP establishes Best Management Practices, which are designed to "ensure adequate storage of manure and wastewater, proper management of mortalities and chemicals, and appropriate site-specific protocols for land application." *Id*.

Under the authority of the Clean Water Act, a Total Maximum Daily Load (TMDL) was established for the Chesapeake Bay in 2010.[60] The TMDL represents a detailed nitrogen and phosphorus budget for the watershed and includes mandatory quantitative load reductions from specific sources.[61] In essence, this becomes the regulatory and statutory pathway for establishing environmental reduction goals and standards.

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[58] *Id*. at 1.
[59] *Assateague Coastkeeper v. Maryland Dept. of Env't*, 200 Md. App. 665 at 672 (2011) (citing *Nat'l Pork Producers Council v. EPA,* 635 F.3d 738, 744 (5th Cir. 2011)).
[60] *Chesapeake Bay TMDL Fact Sheet,* EPA, https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-fact-sheet#:~:text=On%20December%2029%2C%202010%2C%20the,64%2C000%2Dsquare%2Dmile%20watershed (last visited Oct. 20, 2021).
[61] *Maryland's Phase III Watershed Implementation Plan to Restore Chesapeake Bay by 2025*, (Apr. 11, 2019), https://mde.maryland.gov/programs/Water/TMDL/TMDLImplementation/Documents/Phase%20III%20WIP%20Report/Draft%20Phase%20III%20WIP%20Document/Full%20Report_Phase%2

MAFOs and CAFOs require slightly different permitting plans. Both MAFOs and CAFOs are required to develop a Nutrient Management Plan (NMP), although CAFOs must develop a Comprehensive Nutrient Management Plan ("CNMP"), whereas a MAFO may either develop a CNMP, or a NMP and a Conservation Plan.[62] Nutrient Management Plans are defined as a plan prepared to manage the amount, placement, timing, and application of animal manure, fertilizer, biosolids, or other plant nutrients in order to minimize nutrient loss or runoff and to maintain the productivity of soil when growing agricultural products.[63] A CNMP includes an NMP portion and a conservation plan portion, along with an implementation schedule.[64] An NMP must be written by a nutrient management planner certified by the MDE and meet all requirements of COMAR 15.20.07 and 15.20.08.[65] The Conservation Plan shall include an analysis of resource concerns and any recommendations to resolve the concern for each field to which manure, litter, or process wastewater is anticipated to be applied for the life of the current permit.[66]

Agricultural stormwater runoff is excluded as a discharge requiring a federal NPDES permit.[67] The CWA regulates discharges to surface water only; it does not regulate discharges to ground water because groundwater does not qualify as "waters of the United States."[68]

However, agricultural runoff is excluded as a discharge that requires an NPDES permit, because the CWA does not regulate discharge to groundwater. *Assateague Coastkeeper at 671*

0III%20WIP-Draft_Maryland_4.11.2019.pdf (last visited Oct. 20, 2021). The TMDL represents a detailed nitrogen and phosphorus budget for the watershed and includes mandatory quantitative load reductions from specific sources.

62 Md. Dept. of the Envi., NPDES Permit NO. MDG01.*IV.A.1.* (2020).

63 *Id*.

64 *Id*. at II.E.

65 *Id*. at II.U.

66 *Id*. at III.B.5.

67 *See* 33 U.S.C. § 1362(14).

68 *Id.* at 671–72.

(citing Rice v. Harken Exploration Co., 250 F.3d 264, 269 (5th Cir. 2001).[69] Maryland has established a classification of AFOs known as Maryland Agricultural Feeding Operations ("MAFOs") to include in regulation those AFOs that should be CAFOs by size but do not discharge to surface water.[70]

Maryland Statutory Framework

Maryland provides for classifying "[A]n AFO that qualifies as a CAFO under federal regulations but does not discharge or propose to discharge to surface water is classified as a Maryland Animal Feeding Operation ("MAFO")." COMAR 26.08.03.09B(1)(d). MAFOs are not required to obtain a NPDES permit because MAFOs, categorically, do not discharge to surface water. The State discharge permit required for MAFOs addresses discharge affecting groundwater, and it does not permit discharge to surface water. *Id*. 26.08.03.09C(5)(c)-(6). *Assateague Coastkeeper v. Maryland Dep't of Env't*, 200 Md. App. 665, 679, 28 A.3d 178, 186–87 (2011).

A General Discharge Permit is required of a CAFO when its discharge contacts surface water. Every CAFO in Maryland shall have a discharge permit issued by the Department under both State and federal permitting authority. Medium and large AFOs are required to get a permit if they discharge or propose to discharge pollutants. Pollutants include manure, poultry litter, or processed wastewater to surface waters of the State, and application sites include: man-made ditch, flushing system, or other similar man-made device, and surface waters of the State which originate outside of and pass over, across, or through the facility, or otherwise come into direct contact with

[69] *Assateague Coastkeeper* at 671 *(citing Rice v. Harken Exploration Co.,* 250 F.3d 264, 269 (5th Cir. 2001

[70] *Animal Feeding Operations*. Environmental Protection Agency. https://www.epa.gov/npdes/animal-feeding-operations-afos (Last visited Oct. 20, 2021).

the animals confined in the operation. The table below outlines the size parameters for small, medium, and large AFOs for chicken production.

Animal Type	Circumstances under which Animal Feeding Operations Require Permit Coverage		
	CAFO or MAFO Registration Required	**CAFO/MAFO Registration Required under Certain Circumstances**	**Registration Needed Only if Designated**
	Large	**Medium**	**Small**
Chickens with liquid manure handling	30,000 or more animals	9,000—29,999 animals	less than 9,000 animals
Laying hens with dry manure handling	82,000 or more animals	25,000—81,999 animals	less than 25,000 animals
Chickens (other than laying hens) with dry manure handling	125,000 or more animals or greater than or equal to total house size of 100,000 ft^2	37,500—124,999 animals and less than total house size of 100,000 ft^2	less than 37,500 animals

Source: *GP, Part I.A.9*. Edited to only include chicken information.

To be considered a CAFO, an agricultural unit must first meet the classifications of an AFO categorized by type of animal, number of animals, and the way waste is discharged into the nearest water supply.[71] The USDA has categorized these terms so that a medium-sized CAFO with chickens with liquid manure handling for example must have between 9,000-29,999 animals and if the chickens are laying hens with dry manure handling, between 25,000-81,999 animals.[72] Regardless of the size of these AFOs, if they release waste that contaminates any waterway; it falls

[71] *Id.*
[72] Md. Dept. of the Envi., NPDES Permit NO. MDG01. *I.A.9*. (2020).

under the definition of CAFO.[73] For example, any size AFO that discharges manure or wastewater into a natural or man-made ditch, stream or other waterway is defined as a CAFO.[74] The discharge of these pollutants from the runoff into water sources is not regulated by the NPDES program.[75]

PROPOSED IMPROVEMENTS TO REGULATIONS AND PROJECTS

Stockpiling and Storage of Chicken Litter

Stockpiling and storing chicken litter reduces premature application of the litter on fields and reduces the overall impact on water quality compared to not piling. The regulatory limits on allowable days for chicken litter to sit stored and stockpiled in an open field are arbitrary and should be reconsidered. Both CAFOs and MAFOs may stockpile dry poultry manure in the field where the manure will be applied under an NMP.[76] CAFOs, on one hand, can store dry manure in the field, without separating the manure from groundwater and stormwater through use of a plastic liner and a cover, for no more than 14 days.[77] MAFOs, on the other hand, can store dry manure in the field for up to 30 days.[78] Although EPA regulations do not specify a time period for outdoor stockpiling of dry poultry manure, there is documentation suggesting an appropriate storage period of 14 days.[79] Additional documentation that could provide factual basis and risk level associated with alternative storage periods for chicken litter stockpiles was requested from the EPA by MDE

[73] *Id.*
[74] *Id.*
[75] U.S. Envtl. Protection Agency, *Animal Feeding Operations (AFOs)*, NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) (last visited Oct. 20, 2021), https://www.epa.gov/npdes/animal-feeding-operations-afos.
[76] Md. Dept. of the Envi., NPDES Permit NO. MDG01. IV.B.6.b.i-ii. (2020).
[77] *Id*.
[78] *Id*. at IV.B.6.b.i-ii.
[79] *Assateague Coastkeeper v. Maryland Dep't of Env't,* 200 Md. App. 665, 681(2011).

but were not provided, suggesting that the maximum-allowed daylength for chicken litter stockpiles were reached through an eyeball evaluation of appropriateness.[80] For example, there was no documented difference between the "15th day of storage, versus 10 days or 30 days."[81]

Furthermore, scientific experts at the Chesapeake Research Consortium gave the following recommendation:

> "The available data suggests that while any stockpiled litter presents a potential for nutrient loss to the environment, the majority of this risk occurs within the first days of litter pile construction. In other words, there is little difference (in terms of nutrient losses to the surrounding soil) between litter stockpiled for 14 days and litter stockpiled for 190 days. Still, the impact is greater than zero, and minimizing the need for such stockpiles will reduce even these minimal loads. [. . .] Temporary stockpiling of poultry litter should be encouraged when other immediate-use options (e.g., field applications meeting seasonal planting schedules, or regional hydrological cycles, or alternative off-site uses) are not available, regardless of the length of time required, up to a maximum of 190 days based on documented research trials of 190 days in length."[82]

Therefore, the 14- and 30-day maximum limitations for MAFOs and CAFOs, respectively, to stockpile chicken litter is arbitrary and without sufficient justification.

The maximum chicken litter stockpiling length should increase. There is no significant difference in water quality impacts resulting from litter storage between 14 days and 90 days (and even up to 190 days, according to the Science Panel).[83] If the regulations sought a reduction of water quality impact from MAFOs or CAFOs through stockpiled chicken litter, the regulations would kick in sooner than 14 or 30 days, respectively. Because the major discharge of nutrients occurs in the first few days of stockpiling, the 14-day mark is arbitrary. Such an arbitrary, short length allowance ultimately negates the benefit of stockpiling, which is the reduction of premature discharge, by pressuring operators to prematurely discharge. A greater length allowance for litter

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[80] *Id.*
[81] *Id*.
[82] Id. at 696–97, 197.
[83] *Assateague Coastkeeper v. Maryland Dep't of Env't*, 200 Md. App. 665, 695, 28 A.3d 178, 196 (2011).

to sit stockpiled or stored would provide operators more time to reasonably use or dispose of the litter.

Increasing Setback Limitations for CAFOs and MAFOs

Increasing setback requirements pertaining to poultry CAFOs and MAFOs would result in reduced discharge to surface and groundwaters and more content neighbors. "Setbacks" are defined as areas where no animal waste is applied between the fertilized field and either surface waters of the State or adjacent property.[84] Current permit setback requirements instruct farmers to maintain at least 100 feet from property lines and surface waters, streams, and drinking water wells; an approved alternative may be substituted for the 100-foot setback (with consent from the adjacent property owner for property line alternative).[85] However, a 100-foot distance requirement from any surface waters or neighboring property to a litter-fertilized field will provide minimal separation from any irritating or potentially hazardous odor or contaminant.

Though the setback-required distance between adjacent properties, State waters, and litter-fertilized fields already seems small, certain poultry MAFOs have their own alternative, reduced setback requirements. For property with a slope of 2% or less, a MAFO could satisfy the land application setback and buffer requirements of this permit by maintaining: 1) A vegetated filter strip at least ten feet wide along field ditches and in the final 35 feet of the field ditches adjoining the receiving waters or the operation boundary, whichever occurs first; and 2) A 35-foot vegetated filter strip or a 50-foot setback from all other surface waters of the State.

The Poultry Pasture should be regulated

The Poultry Pasture should be included within the Production Area. The Poultry Pasture escapes CWA's regulatory authority because it is not included in the Production Area. "Production

[84] Md. Dept. of the Envi., NPDES Permit NO. MDG01. *II.DD.*. (2020).
[85] *Id*. at IV.B.8.

Area" is defined as the "part of an AFO that includes, but is not limited to, the animal confinement area, the manure storage area, the raw materials storage area, the waste containment areas, any egg washing or egg processing operation, and any area used in the storage, handling, treatment, or disposal of mortalities."[86] "Poultry Pasture" refers to an area of an organic poultry CAFO or MAFO where chickens are allowed open-air access to areas outside a poultry house.[87] Poultry Pastures allow for raising poultry on pasture in addition to indoor confinement.[88] Notably, the Poultry Pasture is not considered part of the production area if the pasture area sustains vegetation during the normal vegetative growing season.[89]

Public Comment Period for AFO General Discharge Permit Applications

Prior to MDE's approval of the Required Plan(s), each submitted NOI and Required Plan will be available for public comment consistent with applicable public participation requirements in COMAR 26.08.04.09N(3), including public access to all submitted Plans and the opportunity to comment on all Plans and NOIs.[90] For CAFOs, the public may request a public hearing.[91] CAFOs will not be issued permit coverage prior to completion of the public participation process.[92] Both MAFOs and CAFOs are subject to the public comment period.

Pollution Trading

MDE should incorporate a means of trading pollution credits between regulated AFOs that surpass the effluent discharge standards and those that fall below the mark. Currently, the General Discharge Permit does not have a mechanism to include pollution trading.

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[86] *Id*. at II.BB.
[87] *Id*. at II.ZZ.
[88] *Id.*
[89] *Id*. at II.BB.
[90] *Id*. at III.C.3.
[91] *Id.*
[92] *Id.*

Manure Transport

Under the General Discharge Permit, AFOs are required to disclose any land application of manure, litter, or process wastewater on site in the Annual Implementation Reports ("AIR"), and provide information on the destination of any manure exported off site.[93] Exported manure must be accompanied by an analysis of that manure, and Maryland's NMP and the General Discharge Permit require that all manure be land applied in accordance with the NMP.

Maryland's Manure Transport Program

Maryland's Manure Transport Program ("MTP") serves to facilitate the transport of manure from manure's farm of origin to farms requiring manure. The MTP compensates toward the cost of transporting manure to farms in need or to alternative use facilities.[94] Established under the Maryland Water Quality Improvement Act ("WQIA") of 1998, the project facilitates the transport of poultry and livestock manure from farms in all areas of Maryland that are subject to phosphorus over-enrichment.[95]

History

In 1996-97, fish with unusual bloody lesions were appearing in the Pocomoke River, located on Maryland's lower Eastern Shore.[96] The Departments of Natural Resources, Environment, Agriculture, and Health and Mental Hygiene jointly investigated the situation and it's potential causes. Samples taken from the fish kills occurring in the summer of 1997 indicated

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[93] *Id*. at V.B.1.d.

[94] Manure Transport Program, MD. Dep't Of AGRIC., https://mda.maryland.gov/resource_conservation/pages/manure_management.aspx (last visited Oct. 20, 2021).

[95] Md. Code Ann., Agric. § 8-704.2 (West through 2021 Regular Session of the General Assembly); Agriculture Article, §8-704.2, Annotated Code of Maryland, https://mda.maryland.gov/resource_conservation/counties/Manure%20Transport%20Regs%20COMAR%2015.20.05_effective%20Nov2020.pdf.

[96] *Pfiesteria Fact Sheet*, Md. Dep't of the Environment, https://mde.state.md.us/programs/ResearchCenter/FactSheets/Documents/www.mde.state.md.us/assets/document/factsheets/pfiesteria.pdf (last visited Oct. 20, 2021).

the presence of pfiesteria piscicida - a potentially toxic estuarine microorganism.[97] Due to the potential human health impacts, a portion of the Pocomoke River, King's Creek, and the Chicamacomico River were closed.[98]

Their initial research found a strong correlation between algal blooms and high levels of nutrient runoff that resulted in the fish kills.[99] More specifically, a key finding by the Citizens' Pfiesteria Action Commission, chaired by Maryland's then-Governor Harry Hughes, found that dissolved phosphorus in runoff can be high, even without erosion, on soils with excessive phosphorus levels.[100] Leaders across the local, regional, state, and national level called for a stronger push to address nutrient pollution caused by poultry and hog farms along the Eastern Shore. As a result, in 1998, the Maryland General Assembly passed the Water Quality Improvement Act ("WQIA"), which has been described as one of the most comprehensive pieces of farm nutrient control legislation in the country.[101] Among an array of measures, nutrient management goals, programs, and budget initiatives, the WQIA also required all agricultural operations with annual incomes greater than $2,500, or more than eight animal units (one animal unit equals 1,000 pounds live weight), must have and implement a nitrogen- and phosphorus-based Nutrient Management Plan by a prescribed date.[102] Persons using sludge or animal manure must implement nitrogen-based plans by the same dates as those using commercial fertilizers.

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[97] *Id*.
[98] *Id*.
[99] Janet Pelly, *Toxic Pfiesteria outbreak triggers federal–state research plan,* Envi. Sci. Technol. Jun. 8, 2021, at 531

[100] *Animal Agriculture*, A Citizen's Guide to the Water Quality Improvement Act of 1998 https://extension.umd.edu/sites/default/files/2021-05/WaterQualityImpAct1998.pdf (last visited Oct. 20, 2021).
[101] *Id*.
[102] *Id*.

The Manure Transport Program, which was initially established as a pilot poultry litter transport program, began as a joint project between the State of Maryland and poultry processors. This cost-sharing program provided poultry processors up to $20 per ton (now at $28 per ton) to offset the cost of transportation and handling of poultry litter from farms with excess, making poultry litter more available for poultry farms throughout Maryland.[103] The initial goal of the pilot program specifically aimed to remove 20% of poultry litter produced by the four Lower Eastern Shore counties: Dorchester, Somerset, Wicomico, and Worcester.[104]

Scope and Functions of the Manure Transport Program

The manure transport program aims to facilitate transport of chicken litter from overproducers to land capable of holding additional phosphorus. The cost-sharing would also be available for transport to sites for other alternative uses, such as composting. The manure transport program was also expanded by the Maryland Department of Agriculture to link farmers with excess poultry manure with nearby farmers who can use litter as a nutrient source.[105]

Alternative uses of manure are defined as using poultry manure or other animal manure in environmentally acceptable ways as determined by the Maryland Department of Agriculture, other than through direct land application in an unprocessed form.[106] Cost-sharing is established as a grant from the Department for the purpose of handling and transporting manure from a farm in any area of the State that the Department determines is subject to phosphorus over enrichment, with the operations and individuals who are eligible for the manure transport program being entities who land-apply manure and receive it from eligible sending operations, has fields

[103] Thomas W. Simpson, ***Animal Agriculture, A Citizen's Guide to the Water Quality Improvement Act of 1998***, https://extension.umd.edu/sites/default/files/2021-05/WaterQualityImpAct1998.pdf (last visited Oct. 20, 2021).
[104] *Id*.
[105] *Id*.
[106] MD. CODE REGS. 15.20.05.02 (2021).

containing soils that are not phosphorus over enriched, and has a certified nutrient management plan for the operation that allows manure to be applied as a source of primary nutrients to these fields.[107]

Requirements for the manure transport is available to farmers or manure brokers who, through applying for grants to move poultry manure using either a standard application or the Maryland Department of Agriculture's Haul Now, Apply Later FastTrack option, are able to then receive the following:[108]

- Farmers or manure brokers receive up to $28 per ton to transport poultry litter
- The sending farm must be located in Maryland and raise broiler chickens for a participating Delmarva poultry companies
- Poultry litter must be transported further than seven (7) miles from the sending farm
- Transported poultry litter must be land-applied as a nutrient source for an agricultural crop, or be sent to an approved alternative use facility, and
- Either the farmer or the manure broker may apply for cost-share reimbursement to transport a load of poultry litter

Compliance with other health and environmental safety requirements for the transportation of manure and chicken litter is incorporated into the Manure Transport Program. These biosecurity requirements mandate the transporter of manure to comply with the Department's biosecurity and animal health requirements. These requirements include: the transport vehicle shall contain the livestock or poultry manure within the cargo area or tank without any loss of material during transport on a public road or railway; and all equipment used to handle or transport manure shall

[107] *Id*.
[108] *Conservation Grants*, MANURE TRANSPORT PROGRAM, https://mda.maryland.gov/resource_conservation/pages/manure_management.aspx (last visited Oct. 20, 2021).

be cleansed, washed, and disinfected before operating this equipment on or near another poultry or livestock operation.[109] In addition to these requirements, all poultry litter transports: must be covered while moved on a public road, highway, or railway; must cover a truck-mounted or a tractor-drawn spreader during the movement of the equipment from one farm to another, unless the farms are contiguous; and may not contain dead birds that are not completely composted.[110]

Each delivery site is required to have an off-loading site that is safe and does not pose any undue environmental risk to water quality.[111] Recipients of the poultry litter must: apply upon receipt if receiving liquid manure; apply within seven (7) days if receiving stackable, dried chicken litter; store or stockpile in a manner that protects it from rainfall, runoff and leaching.[112]

CONCLUSION

Although great strides in addressing nutrient pollution in the Chesapeake Bay have been made since the introduction of the Water Quality Improvement Act of 1998, the further regulation and permitting process for poultry farm operations, and the permitting process pertaining to CAFO and MAFO operations, there is still opportunities for further development and understanding. This cause for concern is further increased with the increasing impacts of climate change on the Chesapeake Bay.

Opportunities in the Manure Transport Program

With the exception of the amount of pounds of manure that have been transported from poultry farm operations since it's introduction, Maryland's Manure Transport Program ("MTP")

[109] *MD. CODE REGS. 15.20.05.04 (2021)*
[110] *Id.*
[111] *Id.*
[112] *Id.*

has had limited increase in funding since it's implementation in 1998. Current funding stream is at approximately $1 million dollars, reimbursing farmers $28 per ton of manure being transported from their poultry farm operations. This amount equates to about half of the costs poultry farm operators spend in transportation of their excess manure to an alternative site, and addresses approximately 20% of poultry manure produced. Any significant increase in funding can further increase the costs reimbursed to operators for their manure transport, incentivizing operators to "buy-in" to the MTP and increase the percentage of the poultry manure that is transported under the program. Current reimbursement plans are significantly higher for livestock manure transport compared to poultry manure transport, which cover approximately 80-85% of their transport costs.

Opportunities in the Poultry CAFOs and MAFOs Permitting Process

The permit process pertaining to poultry CAFOs and MAFOs have also presented areas of opportunity. Setback requirements outlined in the permit process that pertain to poultry CAFOs and MAFOs can also further reduce the amount of discharge that reaches surface and groundwaters. Because current permit setback requirements under the permit process instruct farmers to maintain a 100-foot distance from any surface water or neighboring property, which provides minimal separation from any irritating or potentially hazardous containment. Further research and exploration as to whether an increase in distance in the setback requirements are warranted to understand any significant impact that can result from this increase in distance. The poultry pasture, which escapes the CWA's regulatory authority given that it is not in the production area, could also serve as an opportunity to further explore what impact it may have on

addressing potential runoff sites compared to any benefits operators may gain from having this area exempted from regulation. Further exploration on the impacts of daylengths of stacking, which is currently based on very limited information, could help provide an understanding of the impact that periods of stacking storage may have.

Other Mitigating Measures

Another area that can be further explored but was not addressed in this brief is understanding the impact of cover crops near CAFOs and MAFOs, especially in critical areas where there is vast phosphorus and nitrogen build-up. One proposal can include a low-tech, high impact pilot program of tree planting near poultry operations to measure any impacts that such tree planting or other cover crops may have on reducing potential runoff or other environmental impacts resulting from nutrient build-up.

A low-level yet high impact would also be an education campaign to get an understanding as to what poultry farm operators currently understand and/or are aware of the resources and programs available to them to offset excess manure produced. Whether this is done through an education campaign, resource and website development, surveys, or other ways to get a sense of what poultry operators may or may not know, this can yield the current impact of the programs in place and what areas of opportunity are available for the agencies involved to further disseminate these resources.

The certification shall state:

We hereby certify that the brief for University of Baltimore is the product of the undersigned. We further certify that the undersigned have read the Competition Rules and that this brief complies with these Rules.

Date October 20, 2021

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Table of Authorities

Cases

Statutes

Other Authorities

ENVTL. INTEGRITY PROJECT (Apr. 22, 2020), https://environmentalintegrity.org/wp-content/uploads/2020/04/Chesapeake-Poultry-Report-.pdf.

2. U.S. Dep't of Agric., 2020 State Agricultural Review, Maryland, MARYLAND STATISTICS, NOV. 2019, https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=MARYLAND.
3. Chesapeake Bay Program, Nutrients, LEARN THE ISSUES , https://www.chesapeakebay.net/issues/nutrients (last visited Oct. 20, 2021).
4. Chesapeake Bay Program, Facts & Figures, DISCOVER THE CHESAPEAKE, https://www.chesapeakebay.net/discover/facts (last visited Oct. 20, 2021).
5. Alicia Pimental, Ask a Scientist: How big of an industry is the Chesapeake Bay?, CHESAPEAKE BAY PROGRAM (June 9, 2011), https://www.chesapeakebay.net/news/blog/ask_a_scientist_how_big_of_an_industry_is_the_chesapeake_bay.
6. Stormwater Runoff, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/stormwater_runoff (last visited Oct. 20, 2021).
7. Forest Buffers, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/forest_buffers (last visited Oct. 20, 2021).
8. Agriculture, CHESAPEAKE BAY FOUNDATION, https://www.cbf.org/issues/agriculture/ (last visited Oct. 20, 2021).
9. Elizabeth Shwe, Report: Eastern Shore Has Unhealthy Levels of Nitrate in Drinking Water Due to CAFOs, Energy and Environment (Oct. 21, 2020),
10. https://www.marylandmatters.org/2020/10/21/report-eastern-shore-has-unhealthy-levels-of-nitrate-in-drinking-water-due-to-cafos/.

11. Katlyn Schmitt & Darya Minovi, Maryland Court Orders State to Limit Ammonia Pollution From Industrial Poultry Operations, CPRBLOG (Mar. 22, 2021), http://progressivereform.org/cpr-blog/tags/CAFO/.

12. Manure & Waste Management, NRCS, https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/mnm/.

13. Poultry Pollution, SIERRA CLUB, https://www.sierraclub.org/maryland/poultry-pollution (last visited Oct. 20, 2021).

14. A. Jon Mueller, The Chesapeake Bay TMDL, CHESAPEAKE BAY FOUNDATION (Dec. 6, 2013), https://www.ncsl.org/documents/standcomm/scnri/mueller_cbf.pdf.

15. Water Environment Federation. Nutrient Removal. 328. Bricker, S., B. Longstaf, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. No. 34. 2011.

16. S. Bricker, et al., Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change. NOAA Coastal Ocean Program Decision Analysis Series No. 26. National Centers for Coastal Ocean Science, (2007).

17. Bronk, D., Dynamics of DON. In Biogeochemistry of Marine Dissolved Organic Matter; Hansell, D., Carlson, C. A., Eds.; Academic Press: New York. (2002)

18. Dwight D. Bowman, Manure Pathogens: Manure Management, Regulations, and Water Quality Protection, Water Environmental Foundation (2009).

19. Green, Bently C. (1992) Thesis: Photosynthesis and Respirations Effects on the Tennessee-Tombigbee Waterway, Mississippi State University.

20. Howarth, R. W.; Sharpley, A.; Walker, D. (2002) Sources of Nutrient Pollution to Coastal Waters in the United States, Implications for Achieving Coastal Water Quality Goals. Estuaries, 25, 656–676.

21. Chislock, M. F., Doster, E., Zitomer, R. A. & Wilson, A. E. (2013) Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems. Nature Education Knowledge 4(4):10
22. Lehtiniemi, M. et al. Turbidity Decreases Anti-Predator Behaviour In Pike Larvae, Esox Lucius. Environmental Biology of Fishes 73, 1-8 (2005).
23. R.J. Diaz & R. Rosenberg, Spreading Dead Zones and Consequences for Marine Ecosystems, Science 321, 926-929 (2008).
24. Animal Feeding Operations, EPA, https://www.epa.gov/npdes/animal-feeding-operations-afos (last visited Oct. 20, 2021).
25. Animal Feeding Operations - Uses of Manure, EPA, https://www.epa.gov/npdes/animal-feeding-operations-uses-manure (last visited Oct. 17, 2021).
26. Quirine M. Ketterings, Greg Albrecht, Karl Cyzmmek, Shawn Bossard, Nitrogen Credits from Manure, Cornell University Cooperative Extension, 1 (2005), http://cceonondaga.org/resources/nitrogen-credits-from-manure.
27. Carrie Hribar, Understanding Concentrated environmental health Animal Feeding Operations and Their Impact on Communities, https://www.cdc.gov/nceh/ehs/docs/understanding_cafos_nalboh.pdf (last visited Oct. 20, 2021).
28. Chesapeake Bay TMDL Fact Sheet, EPA, https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-fact-sheet#:~:text=On%20December%2029%2C%202010%2C%20the,64%2C000%2Dsquare%2Dmile%20watershed (last visited Oct. 20, 2021).

29. Maryland's Phase III Watershed Implementation Plan to Restore Chesapeake Bay by 2025, (Apr. 11, 2019),
30. https://mde.maryland.gov/programs/Water/TMDL/TMDLImplementation/Documents/Phase%20III%20WIP%20Report/Draft%20Phase%20III%20WIP%20Document/Full%20Report_Phase%20III%20WIP-Draft_Maryland_4.11.2019.pdf (last visited Oct. 20, 2021).
31. Animal Feeding Operations, Environmental Protection Agency. https://www.epa.gov/npdes/animal-feeding-operations-afos (last visited Oct. 20, 2021).
32. U.S. Envtl. Protection Agency, Animal Feeding Operations (AFOs), NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) (last visited Oct. 20, 2021), https://www.epa.gov/npdes/animal-feeding-operations-afos
33. Manure Transport Program, MD. Dep't Of AGRIC., https://mda.maryland.gov/resource_conservation/pages/manure_management.aspx (last visited Oct. 20, 2021).
34. Pfiesteria Fact Sheet, Md. Dep't of the Environment, https://mde.state.md.us/programs/ResearchCenter/FactSheets/Documents/www.mde.state.md.us/assets/document/factsheets/pfiesteria.pdf (last visited Oct. 20, 2021).
35. Janet Pelly, Toxic Pfiesteria outbreak triggers federal–state research plan, Envi. Sci. Technol. Jun. 8, 2021, at 531
36. Animal Agriculture, A Citizen's Guide to the Water Quality Improvement Act of 1998 https://extension.umd.edu/sites/default/files/2021-05/WaterQualityImpAct1998.pdf (last visited Oct. 20, 2021).

37. Thomas W. Simpson, Animal Agriculture, A Citizen's Guide to the Water Quality Improvement Act of 1998, https://extension.umd.edu/sites/default/files/2021-05/WaterQualityImpAct1998.pdf (last visited Oct. 20, 2021).
38. Conservation Grants, MANURE TRANSPORT PROGRAM, https://mda.maryland.gov/resource_conservation/pages/manure_management.aspx (last visited Oct. 20, 2021).