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State Legal Approaches to Reducing Water Quality Impacts from the Use of Agricultural Nutrients on Farmland

Peggy Kirk Hall and Ellen Essman

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An Agricultural Law Research Publication

State Legal Approaches to Reducing Water Quality Impacts from the Use of Agricultural Nutrients on Farmland

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About this report

This report is the result of a multi-year examination of state laws and regulations aimed at addressing the impact of agricultural nutrients on water quality in the United States. With funding from the **National Agricultural Library** at the United States Department of Agriculture, the **National Agricultural Law Center** partnered with the Agricultural & Resource Law Program in the College of Food, Agricultural & Environmental Sciences at **The Ohio State University** to conduct the research that is the basis of this report.

Ellen Essman, Sr. Research Associate in Agricultural & Resource Law at Ohio State, led the research for the project with the assistance of **Evin Bachelor**, Law Fellow in Agricultural & Resource Law at Ohio State. **Micah Brown,** Research Assistant with the National Agricultural Law Center, compiled the individual state charts that accompany this report. **Peggy Kirk Hall**, Associate Professor in Agricultural & Resource Law at Ohio State and **Ellen Essman** authored the report.

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Agricultural nutrients and water quality

Nutrients play a critical role in agricultural crop production in the United States. Historical data points toward a positive correlation between rising crop yields in the past 40 years and an increased use of fertilizers such as nitrogen and phosphorous and also suggests that 40 to 60% of crop yields in temperate climates like the U.S. are attributable to fertilizer inputs.[1] Despite their benefits, however, nutrients have detrimentally impacted water quality. The U.S. Environmental Protection Agency (U.S. EPA) estimates that nutrient pollution due to nitrogen and phosphorous from a multitude of sources has caused poor water quality in over 100,000 miles of rivers and streams and 2.5 million acres of water bodies in the U.S.[2] Excessive nitrogen and phosphorous in water can lead to eutrophication and the growth of harmful algal blooms that can contaminate surface and drinking water supplies and potentially harm both animal and human health.[3]

Attention to nutrient pollution in the U.S. has intensified in the last decade, as has the recognition that nutrients used in agricultural production are part of the problem. In a 2009 report to the U.S. EPA, a multi-state nutrient pollution task group identified "livestock agricultural practices" and "row crop agricultural operations" as two of the five primary sources of nitrogen and phosphorous pollution.[4] Two years later, the U.S. EPA issued a call to action to the states and recommended a state framework for addressing nitrogen and phosphorus pollution. The framework specifically targeted nitrogen and phosphorous from "agricultural areas" with recommendations to:

"partner with federal and state agricultural partners, non-government organizations, the private sector, landowners and other partners to develop watershed-scale plans that target the most effective practices where they are needed most, look for opportunities to include innovative approaches, such as targeted stewardship incentives, certainty agreements, and [nitrogen and phosphorous] markets, to accelerate adoption of agricultural conservation practices... [and] incorporate lessons learned from other successful agricultural initiatives in other parts of the country."[5]

The U.S. EPA reiterated its nutrient challenge in a 2016 memorandum to state environmental commissioners and water directors which declared that, among other sources, "agriculture is an important contributor to nutrient pollution in many watersheds..."[6]

Agriculture's contribution to nutrient pollution has not escaped the attention of the states. A 2012 survey by the Association of Clean Water Administrators found that 37 states were targeting primary pollution sources for nutrient pollution reduction efforts and that farmland (84%) was not far behind wastewater treatment plants (89%) and stormwater (86%) as the top targets, while confined animal feeding operations were of somewhat less concern (62%).[7] This focus by the states on farmland in addition to animal feeding operations is important. The federal Clean Water Act [8] grants the U.S. EPA legal authority to regulate point source discharges that may contribute to nutrient pollution, such as animal feeding operations. But the states maintain primary legal authority over nonpoint sources of nutrients, such as farmland and runoff from farmland.

The movement of agricultural nutrients from farmland to water sources, waterways and water bodies has been at the heart of prominent lawsuits against agricultural operations in recent years. In *Community Association for Restoration of the Environment, Inc. v. Cow Palace LLC*, plaintiffs effectively argued that a dairy's over-application of manure to agricultural fields, along with its improper management and storage of manure, presented an imminent and substantial endangerment to water and to people who could be consuming the water.[9]

Minnesota Department of Agriculture

The Des Moines Water Works public water utility gained widespread attention when it claimed that nutrients applied on farmland in several counties in Iowa were contaminating the utility's water sources.[10]

Additionally, a number of Petitions for Emergency Action filed under the federal Safe Drinking Water Act [11] rendered U.S. EPA investigations of several farms. The petitions successfully alleged that nitrates and bacteria from the farms' agricultural nutrients posed substantial threats to drinking water for which state and local officials had not taken adequate action to protect the public. [12] A claim of inadequate state attention to water quality impacts from agricultural nutrients was also behind the passage of the Lake Erie Bill of Rights in Toledo, Ohio on February 26, 2019. Proponents of the measure contended that the State of Ohio was not taking sufficient action to protect Lake Erie from "industrial farming practices" that are "encouraged and prioritized above the health and rights of the people and environment."[13]

Minnesota Department of Agriculture

State responses to water quality challenges

How are states responding to the water quality challenges posed by agricultural nutrients? Our project attempts to answer this question. We conducted a 50 state survey of laws, regulations and programs that affect agricultural nutrients at the ground level—on the farm. Our study sought to identify approaches state governments are taking that relate to minimizing water impacts from the application of nutrients on agricultural lands, including both commercial fertilizers and animal manure. This report presents our key findings and highlights examples of different state laws, regulations and programs.

Mandatory and voluntary approaches quickly emerged as two primary themes around which we organize this report.

Throughout our examination of state laws, we also aimed to determine whether there are commonalities in the approaches taken by the states. Mandatory and voluntary strategies quickly emerged as the two primary themes. We define **mandatory** approaches as those that require specific actions or inactions by persons who use nutrients on agricultural lands, while **voluntary** approaches allow a user of agricultural nutrients to decide whether to engage in programs and practices that relate to water quality, with or without incentives for doing so. Within each of the mandatory and voluntary categories, we further group the laws, regulations and programs according to similarities we recognized. The following sections present these two primary categories and the sub-categories within each.

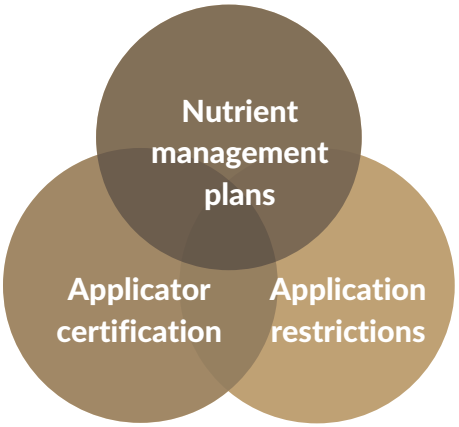
Mandatory approaches

Mandatory strategies are those that require or prohibit specific actions by those who use agricultural nutrients. As we identified such strategies, we recognized common themes in the types of approaches mandated by states. This led to our classification of mandatory approaches into three categories that are based on the nature of the particular activity the law or regulation affects: nutrient management planning, certification of nutrient applicators, and nutrient application restrictions.

The **"nutrient management plans"** category encompasses laws and regulations that mandate the development of written plans that manage the amount, source, placement and timing of plant nutrients and soil amendments. **"Application restrictions"** comprise the second category, which includes laws and regulations that place limitations on the physical application of agricultural nutrients to land. Our third category of **"applicator certification"** contains laws and regulations that establish minimum knowledge standards for the individuals who apply agricultural nutrients to land.

The categories are not separate from one another but can be interconnected as the figure below shows.

Figure 1. Types of mandatory approaches



We compiled the mandatory laws and regulations for each state into the "State Compilation on Mandatory Legal Approaches to Agricultural Nutrient Management" on the National Agricultural Law Center website. Figure 2 below presents a chart indicating the mandatory approaches for each state. In the sections that follow, we highlight examples of state laws, regulations and programs from our compilation for each category of mandatory approaches.

See our State Compilation of "Mandatory Legal Approaches to Agricultural Nutrient Management" on the National Agricultural Law Center website at https://nationalaglawcenter.org/state-compilations/.

Figure 2. State Mandatory Approaches at a Glance

State	NMPs	Applicator Certification	Application Restrictions
Alabama	X	X	x
Alaska	X		
Arizona	X		X
Arkansas	X	X	X
California	X		
Colorado	X		X
Connecticut	X		X
Delaware	X	X	X
Florida	X		X
Georgia	X	X	X
Hawaii	X		
Idaho	X		
Illinois	X	X	X
Indiana	X	X	X
Iowa	X	X	X
Kansas	X	X	X
Kentucky	X		
Louisiana	X		
Maine	X		X
Maryland	X	X	X
Massachusetts	X	X	X
Michigan	X		X
Minnesota	X	X	X
Mississippi	X		
Missouri	X		X
Montana	X		X
Nebraska	X	X	X
Nevada			
New Hampshire			
New Jersey	X		
New Mexico	X		X
New York	X		
North Carolina	X	X	X
North Dakota	X		X
Ohio	X	X	X
Oklahoma	X	X	X
Oregon	X		X
Pennsylvania	X		X
Rhode Island	X		
South Carolina	X	X	X
South Dakota	X		X
Tennessee	X		X
Texas	X		
Utah	X		
Vermont	X	X	X
Virginia	X		
Washington	X		
West Virginia	X		
Wisconsin	X		X
Wyoming	X		

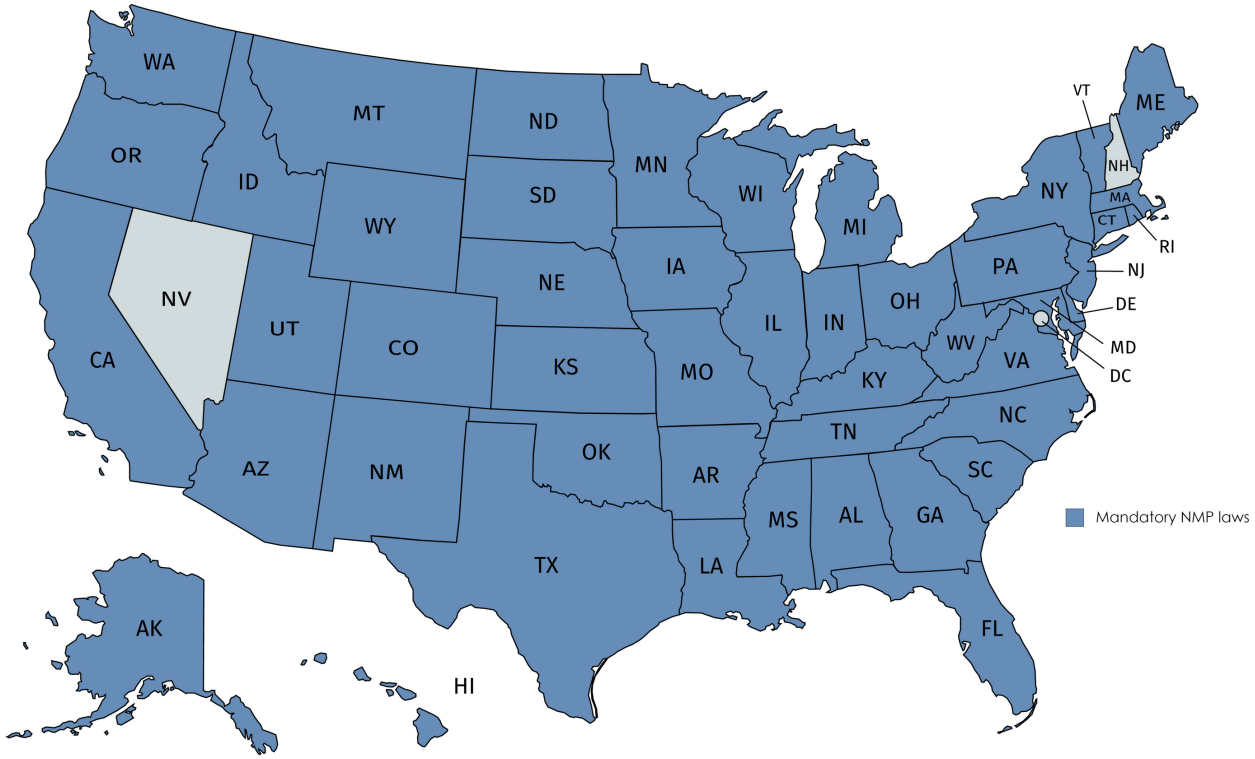
1. Nutrient management plans

Nutrient management planning centers around the development of a written nutrient management plan (NMP) that manages the amount, source, timing and placement of plant nutrients and soil amendments.[14] Traditionally focused on optimizing economic returns from nutrients, NMPs have become a common tool for also addressing the negative impact of nutrients on the environment.[15]

A NMP typically includes an inventory of nutrient sources, soil test analyses, determinations of crop nutrient needs, procedures for when and how to apply nutrients, best management practices for minimizing nutrient loss from the field, and manure spreading rates and plans for excess manure.[16]

We found that nutrient management planning is the most common approach mandated by states for addressing water quality impacts from agricultural nutrients. The map in Figure 3 below illustrates that all but two states require agricultural operators to engage in nutrient management planning in certain situations.

Figure 3. States with Mandatory NMP Requirements



Many of the nutrient management planning laws and regulations are due to permitting requirements for animal feeding operations, but we found additional state laws that require planning in other situations. We also learned that a number of states have enacted laws that set standards or certification for those who prepare or approve nutrient management plans (NMPs). We discuss each of these nutrient management planning subcategories below.

1.1 NMPs related to animal feeding operations

The Clean Water Act's National Pollutant Discharge Elimination System (NPDES) drives most of the state laws that require NMPs for the land application of manure from animal feeding operations (AFO) and confined animal feeding operations (CAFO).[17] Every state except New Hampshire, Massachusetts, and New Mexico is authorized by the U.S. EPA to administer at least part of the NPDES program and has enacted state laws and regulations for doing so.[18] AFOs and CAFOs that are subject to NPDES permitting requirements must develop a NMP as part of the permit process.[19] Despite their derivation from the Clean Water Act, we have included the state laws that address NMPs for NPDES permits in our State Compilation on "Mandatory Legal Approaches to Agricultural Nutrient Management" on the National Agricultural Law Center website, but we do not analyze the laws in this report.

Perhaps of greater interest, however, are the states that have established permitting programs and NMP laws and regulations that are independent of NPDES permitting programs. Virginia is one such state.

The **Virginia Pollution Abatement (VPA) Permit Program** [20] administered by the Department of Environmental Quality (DEQ) regulates the potential or actual discharge of animal and other wastes to surface waters, and applies to animal operations that fall beneath the state's NPDES permit thresholds. AFOs required to apply for a VPA permit must implement an approved NMP.

The NMP for a VPA permit has to include a site map indicating the location of the fields where waste generated by the facility will be applied by the operator, a site evaluation and assessment of soil types and potential productivities, nutrient management sampling including soil and waste monitoring, land area requirements for the operator's poultry waste management activities, calculation of waste application rates, and waste application schedules. A NMP must specify application rates for nutrients, as well as the timing of land application of waste. Reporting requirements and annual inspections by the DEQ determine whether the NMP has been properly implemented.

Virginia Pollution Abatement Permit Program

The treatment of sewage sludge, storage and land application of biosolids, industrial wastes (sludge and wastewater), municipal wastewater, and animal wastes (manure/litter from livestock and poultry) are regulated activities in the Commonwealth of Virginia. A Virginia Pollution Abatement (VPA) permit may be issued by DEQ whenever an owner handles waste and wastewater in a manner that does not involve discharging to a sewage treatment work, or to state waters pursuant to a valid Virginia Pollutant Discharge Elimination System (VPDES) permit. In general, land application of biosolids, industrial sludge or spray irrigation of industrial and municipal wastewater is covered by a VPA individual permit.

https://www.deq.virginia.gov/Programs/Water/LandApplicationBeneficialReuse.aspx

A few states require NMPs for operations that are not AFOs, but are either tangentially or directly related to AFOs. In **Iowa**, for instance, "animal truck wash facilities" that have effluent structures must have NMPs.[21] An animal truck wash facility is defined as an operation engaged in washing single-unit trucks, truck-tractors, semitrailers, or trailers used to transport animals. NMPs for animal truck wash facilities must include provisions for land applying the "effluent" created by the facility, which includes determining amount of effluent to be produced, nutrient concentrations of effluent, phosphorus index for each application field, land area required for the effluent, and application methods.

South Carolina, on the other hand, requires NMPs from a party directly related to AFOs—manure brokers. One stated purpose of the manure broker operations permitting regulations is to protect the environment and the health and welfare of citizens from pollutants generated by the processing, treatment and land application of dry animal manure and other animal byproducts.[22] The regulations define a manure broker as a person who accepts or purchases dry animal manure from an AFO and transfers this product to a third party for land application.

A manure broker may apply the manure themselves or transfer the manure to a third party for land application but in either case, the manure broker and third party must obtain a permit and abide by the same land application requirements as the owner of a confined animal facility.

A component of the manure broker permit process is to prepare a plan that addresses animal manure handling and application information, including a general crop management plan with the optimum time of year of the application of animal manure and other animal by-products and how it relates to crop type, soil information, crop planting, harvesting schedule for manure land application areas and a soil monitoring plan. A broker must maintain animal manure records, including manure sampling results, for a period of four years.

1.2 NMPs for other agricultural practices

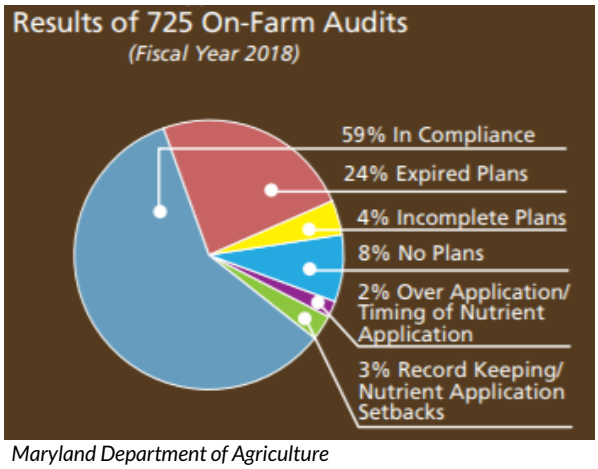
A handful of states require nutrient management plans for non-AFO agriculture. These state programs focus on the land application of any type of agricultural nutrient, not just animal manure nutrients. Maryland and Delaware are examples of states in which NMPs are part of a comprehensive nutrient management program.

Maryland's Agricultural Nutrient Management Program [23] aims to protect water quality in the Chesapeake Bay and its tributaries by ensuring that all farmers and urban land managers apply fertilizers, animal manure and other nutrient sources in an effective and environmentally sound manner. The law requires all agricultural operations that exceed a gross yearly income of at least $2,500 or 8,000 pounds of live animal weight to have a NMP by a certified preparer that includes all agricultural practices that relate to nutrient use including tillage, cropping, pasturage or production of any agricultural product; identification, management, and disposition of all primary nutrients produced on or imported to the operation; and recommendations for the management of fertilizer inputs and other nutrient sources.

Operators must update plans every three years, except that operators using only commercial fertilizers with no significant changes to the operation may use a NMP for more than three years if the operator complies with soil testing requirements and maintains a phosphorus fertility index value of 100 or less. The law also calls for operators to submit their NMPs to the agency and to file an annual report that summarizes the acreage managed under the NMP and certifies that the operator will follow the NMP in the upcoming year. Those who fail to comply with the law are subject to administrative penalties, not to exceed $100 for each violation or $2,000 per year per NMP. According to the Maryland Department of Agriculture, 96% of the state's 5,340 regulated farms submitted an NMP annual implementation report for fiscal year 2018.

Maryland's Department of Agriculture conducts on-farm audits to verify that farmers are following their plans. Figure 4 presents the results of audits conducted in 2018, in which the agency determined that 59% of the operations were in compliance while 5% had issues such as timing, over application, setback or record keeping.

Figure 4. Maryland NMP Audit Results



Maryland Department of Agriculture

Delaware's Nutrient Management Program [24] requires a NMP not just for all AFOs of more than eight animal units but also for any person who owns or leases more than 10 acres upon which nutrients are applied, which can also encompass nutrient applications to turf grass. Similar to Maryland's program, Delaware operators must file their NMPs and annual reports of NMP implementation with the state. Non-compliance with the program can result in civil penalties of not more than $1,000 per violation. Agency staff regularly conducts audits of facilities that must operate with a NMP.

Delaware Code
Title 3, Chapter 22 § 2247

All nutrient management plans shall include, but not be limited to:
(1) Field maps showing reference points (such as buildings, stream, irrigation equipment, etc.), number of acres and soil types;
(2) Soil and organic waste analyses;
(3) Current and planned crop rotations;
(4) Expected yields based on best 4 out of 7 year data or, in the absence thereof, soil productivity charts; and
(5) Recommended rates, timing and methods of nutrient applications.
(b) Nutrient management plans shall specify the level of nutrient applications that are needed to attain expected crop yields as defined in paragraph (a)(4) of this section. Applications of phosphorus to high phosphorous soils cannot exceed a 3-year crop removal rate. Nitrogen applications cannot exceed the expected yield, as defined in paragraph (a)(4) of this section of the specific crop.

1.3 NMPs for targeted areas

Another approach states have utilized is to mandate NMPs only in targeted areas of the state. Table 1 presents the targeted area approaches in four states that take this approach. For example, **Ohio's Watershed in Distress Rule** [25] allows the Department of Agriculture to designate an area as a watershed in distress using seven criteria that help determine if aquatic life is impaired by nutrients or sediment from agricultural land uses and a threat to public health, drinking water supplies, recreation, or public safety and welfare exist. Inside the boundaries of a watershed in distress, persons who produce, apply, or receive in excess of 350 tons and/or 100,000 gallons of manure yearly must develop and operate in conformance with a NMP, which should also incorporate the watershed in distress land application restrictions for saturated and frozen soils.

North Carolina has developed nutrient strategies for specific waters in the state that result in the classification of Nutrient Sensitive Waters and Special Watersheds. [26] The goal for designated areas like the Jordan watershed, Tar Pamlico Basin and Neuse River Basin is to equitably regulate nutrient pollution sources through local advisory and oversight committees. Agricultural nutrients applied for commercial crop production or from certain sizes of livestock operations must either be applied by someone who has

Table 1. Examples of State NMP Requirements for Targeted Areas

Ohio Watershed in distress	Areas determined by rule to have aquatic life impaired by nutrients or sediment from agricultural land uses and a threat to public health, drinking water supplies, recreation, or public safety and welfare threatened by nutrients.
North Carolina Nutrient sensitive waters and special watershed	Areas determined by rule to need additional nutrient reduction strategies due to excessive growth of microscopic or macroscopic vegetation or nutrient loading.
Arkansas Nutrient surplus area	Areas designated by the legislature as having such high nutrient concentrations that continued unrestricted applications could negatively impact soil fertility and waters of the state.
Connecticut Aquifer protection area	Area consisting of well fields, areas of contribution and recharge areas surrounding public drinking water supplies, as identified on maps approved by Commissioner of Energy and Environmental Protection.

completed nutrient management training or pursuant to a NMP. The NMP is one of several tools for meeting nutrient reduction targets within an area.

Arkansas targets "nutrient surplus areas,"[27] which are areas determined by the General Assembly to have soil concentrations of nutrients that are so high that continued application of nutrients to the soil could negatively impact the waters within the state. Nutrient applications within a nutrient surplus area are to be applied only with a NMP approved by the Arkansas Natural Resources Commission or under time, place, and manner restrictions determined necessary by the Commission to protect the soil fertility, crop vitality, and waters in the state. The legislature to date has declared eight watersheds as nutrient surplus areas for phosphorus and nitrogen, based upon current and projected levels of nutrients in the soil; current or potential impacts of surplus nutrients; animal litter, commercial fertilizer, compost and other sources of nutrients applied in the area; current or projected nutrient needs necessary to maintain soil fertility and cropping patterns; soil type, geology, hydrology and other physical characteristics of the area; and types and uses of water bodies in the area.

Connecticut's Aquifer Area Protection Program[28] aims to protect major public water supply wells from contamination. Aquifer protection areas are proposed by municipalities and approved by the Department of Energy and Environmental Protection. The department can require operations in an aquifer protection area that are engaged in agriculture and have gross sales of at least $2,500 to have a "farm resources management plan," which exempts the operation from permitting and other regulations for the area. Connecticut laws and regulations do not clarify the term "farm resources management plan."

1.4 Development of NMPs

There is disparity among the states over the issue of whether a person who prepares, reviews or approves a NMP must be certified by demonstrating a minimum level of nutrient management knowledge. A few states expressly require certification for those who create or approve NMPs for particular situations, especially in regards to animal feeding operation NMPs. One example is **Pennsylvania's Nutrient Management Specialist Certification Program**,[29] which requires operations that must have NMPs to use certified specialists to prepare the plan. Certification categories include an individual specialist, who may only develop NMPs for their own farm, a commercial specialist, who is able to develop NMPs for someone else's farm, or a public specialist, a public employee who can either be certified to review and approve NMPs or to create NMPs for others, or both. Competency requirements vary according to the type of specialist, but generally require precertification completion of training courses on nutrient management, best management practices, and NMP writing. Candidates for NMP certification must also pass a written examination approved by the Department of Agriculture that includes knowledge assessment on nutrient application and management, crop production, soil and manure testing and interpretation, using best management practices, soil science and fertility, fertilizer materials, environmental and economic impacts of nutrient management, and relevant laws and regulations. Specialists must apply for recertification every three years, which requires demonstration of attendance at approved training sessions.

Other states that require certification for those who prepare or approve NMPs have educational and competency standards that are similar to the Pennsylvania approach. We list different state certification programs in Table 2 below.

Table 2. State Certification Programs for NMP Development

Arkansas	Certified Nutrient Planner (only for Nutrient Surplus Areas or if NMP paid with federal or state funds)	Ark. Code. Ann. § 15-20-1004
Delaware	Nutrient Management Certification	Del. Code Ann. Title 3 § 2241
Idaho	Certified Nutrient Management Planner	Idaho Admin. Code r. 2.04.30.150
Maine	Certified Nutrient Management Planning Specialist	Maine Rev. Stat. Title 7 § 4204; Maine Code R. 565 § 7
Maryland	Certified Nutrient Management Consultant	Maryland Code Agric.§ 8-802
Pennsylvania	Nutrient Management Specialist	3 Pa. Code § 508
Vermont	Nutrient Management Technical Service Provider (beginning 7/1/2019)	6 Vermont Stat. Ann. § 4989
Wisconsin	Nutrient Management Planner	Wisc. Stat. ATCP 50.48

2. Application restrictions

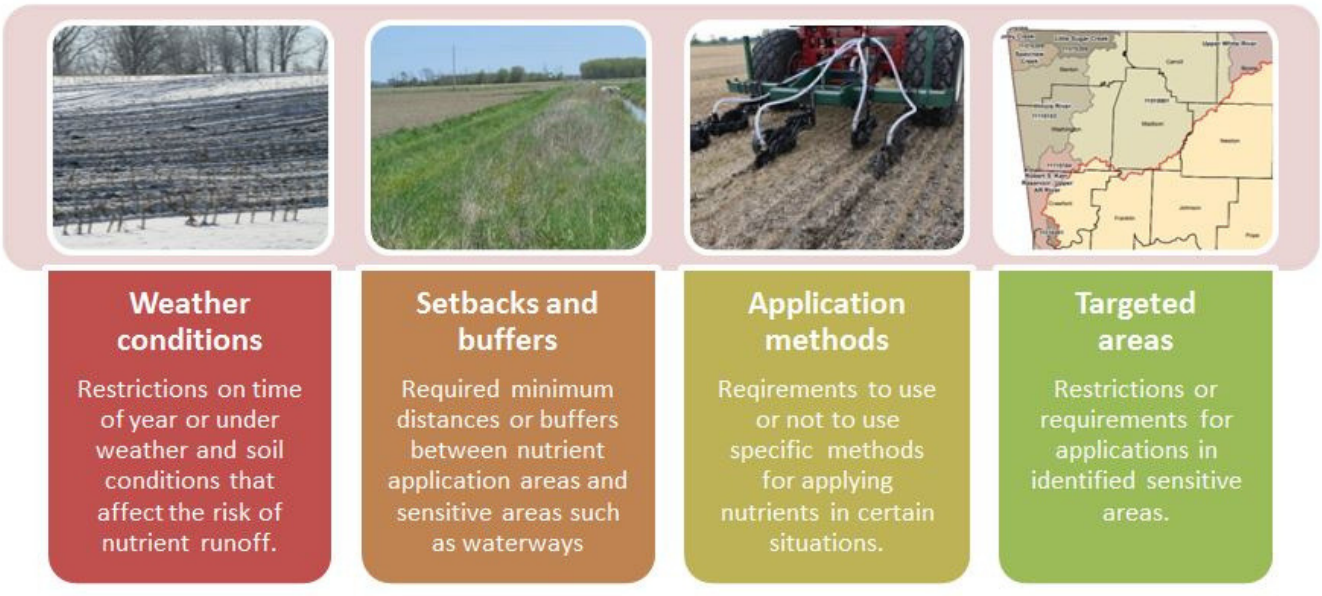
Many laws and regulations across the states restrict when, where and how an operator may apply agricultural nutrients to land surfaces. State laws that regulate animal feeding operations contain such restrictions, but we identified other application restrictions beyond state animal feeding operation programs. We found four different ways that states are mandating application restrictions, as illustrated in Figure 5 below.

The first approach is to restrict applications during certain **weather conditions**, as indicated by the time of year, when soils are frozen or saturated, or when there is an expectation of rain or flooding. As an example, Indiana law prohibits the application of unmanipulated organic fertilizer on frozen or snow covered ground if it is 200 feet or closer to surface water or in a floodway.[30]

A second method is to require **setbacks or buffers** between an application area and a waterway, water body or other sensitive areas. Minnesota's buffer law requires agricultural landowners of property next to public waters or drainage systems within mapped protection areas to install and maintain continuous buffers of perennial vegetation between their land and the water or to use approved alternate practices that yield comparable water quality benefits.[31]

States also mandate or prohibit specific **application methods** in particular situations. Pennsylvania does not allow anyone to mechanically land apply manure from CAFOs within 100 feet of surface water[32] and Indiana waives its restriction on applying unmanipulated organic fertilizer to frozen and snow-covered ground, for example, if the fertilizer is injected or incorporated within the same day.[33]

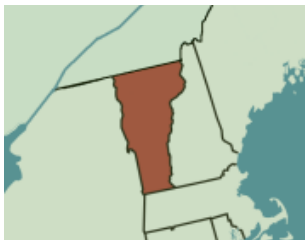
Figure 5. Types of State Nutrient Application Restrictions



A fourth approach is to develop application restrictions for **targeted areas**, typically in areas where soils or waters have higher nutrient levels or within a geographic region. An example is **Ohio's Watersheds in Distress Rule** that applies to areas that are designated as impaired either from nutrients or from sediments from agricultural sources. The rule prohibits the land application of manure between December 15 and March 1 without prior agency approval, on frozen ground or ground covered in more than one inch of snow at other times of the year unless injecting the manure or incorporating it within 24 hours of application or if the local weather forecast contains a more than 50 per cent chance of more than one-half inch of precipitation within 24 hours of applying the manure. [34]

These four types of application restrictions are not exclusive, as most states have instituted a combination of different approaches within the state. In the section that follows, we summarize application restrictions for the five states of Vermont, Iowa, Florida, Texas and Oregon. These states illustrate the diversity of application restriction approaches in place within a state and across different regions of the country.

Vermont

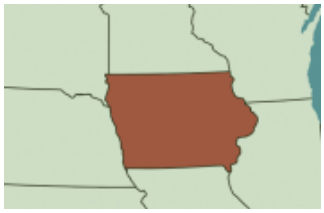


Vermont's Required Agricultural Practices (RAP)[35] apply to farmers who have an annual gross income of $2,000 or more from agricultural products; raise crops or a certain number of adult livestock (depends on the species) on four contiguous acres or more or where practices are determined to cause adverse water quality impacts; have filed 1040(F) income tax statement in one of the past two years; or have a business or farm management plan approved by the Secretary of Agriculture on how they will abide by RAPs.

RAP prohibits land application of manure or other agricultural wastes:

- Between December 15 and April 1, which can extend to December 1 and April 30 if conditions would create significant runoff potential.
- Between October 16 and April 14 for cropland subject to frequent flooding from adjacent waters. At other times, waste must be injected or incorporated within 48 hours.
- At any time of year on flooded land or when field conditions are conducive to flooding, on lands that are saturated, frozen, or snow covered, or on land that has exposed bedrock.
- Where average field slope exceeds 10%, no applications unless there is a 100 foot permanently vegetated buffer zone adjacent to down slope surface water.
- By mechanical means within 100 feet of private or 200 feet of public water supply.

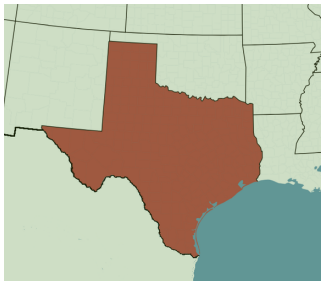
RAP also requires farmers to maintain 10 to 25 feet of perennial vegetative buffer between croplands and adjacent surface waters and ditches and prohibits tillage and the mechanical application of manure or other agricultural wastes within the buffer zone.



Iowa

Iowa law restricts the application of manure in several situations:

- Liquid manure from a storage structure at a concentrated feeding operation may not be applied on snow covered ground from December 21 to April 4, or on frozen ground from February 1 to April 1, unless there is a manure retention emergency due to unforeseen circumstances such as a natural disaster, unusual weather conditions, or an equipment or structural failure. [36]
- No manure applications by spray irrigation within an agricultural drainage well area.[37]
- No manure applications within 200 feet of a sinkhole, cistern, abandoned well, unplugged agricultural drainage well, drainage well surface inlet, drinking water well, designated wetland, or water source.
- No manure applications within 800 feet of designated "high-quality" water resources unless injected or incorporated on the same day or unless a permanent vegetated 50 foot buffer surrounds the designated area.[38]
- No land application of effluent from animal truck washes on frozen or snow covered ground, if temperatures are 32 degrees or below, if the soil cannot accept the application without the possibility of runoff or at a rate higher than one inch per hour.[39]



Texas

Texas law states that its CAFOs must base nutrient application on crop requirements and soil analyses and AFOs must apply manure, sludge, and wastewater uniformly to suitable land at appropriate times and agronomic rates according to crop needs. [40] Other application restrictions state that CAFOs and AFOs must:

- Not apply nutrients when the ground is frozen or saturated or during rainfall events.
- Place buffers and wellhead protective measures between land application areas and water supply wells used exclusively for agricultural irrigation.
- Have a 100 foot buffer between application areas and sinkholes or water, with exceptions for alternative conservation practices or field specific conditions that would yield similar nutrient reductions or if applying wastewater through low pressure, low profile center pivot irrigation systems in areas where the annual rainfall average is below 25 inches.
- Manage irrigation to minimize ponding or puddling of wastewater and prevent discharges to waters of the state.

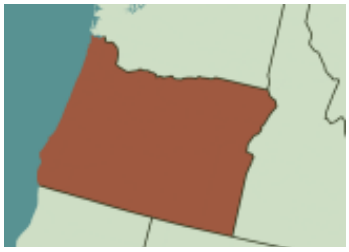
Florida

Florida focuses its application restrictions on targeted areas in the state. In the Northern Everglades, manure at agricultural operations must be applied uniformly at a phosphorous-based rate. In addition, the following restrictions apply to agricultural operations:

- Manure may not be applied when the soil is saturated or inundated with water; within 30 feet of any wetland, lake, stream, or estuary; or within 100 feet of an existing drinking water well.
- Agricultural operations that apply more than one ton of manure per acre per year may not apply the manure within 50 feet of any wetland, lake, stream, or estuary. [41]

In the Lake Okeechobee Drainage Basin, the following restrictions apply for dairy farms that produce milk from cows, goats, sheep, water buffalo, or other hooved mammals.

- Nutrients can be applied only if they do not surpass the annual nutrient requirements of the grasses and crops in the area.
- Waste cannot be land applied when the water table is less than 18 inches below the normal ground surface.
- Farms established after June 3, 1987 must have setback distances and buffers from certain water areas and a 200 foot buffer from drinking water supply wells. [42]



Oregon

Oregon's Agricultural Water Quality Program [43] establishes broad water quality protection standards for the state, but refines the standards into specific rules for 38 different geographic water quality management areas. Within each area, landowners and operators have flexibility to voluntarily adopt practices that will accomplish the mandates and enforcement occurs only if reasonable attempts at voluntary solutions have failed. Landowners and operators must find ways to comply with the following two nutrient application requirements:

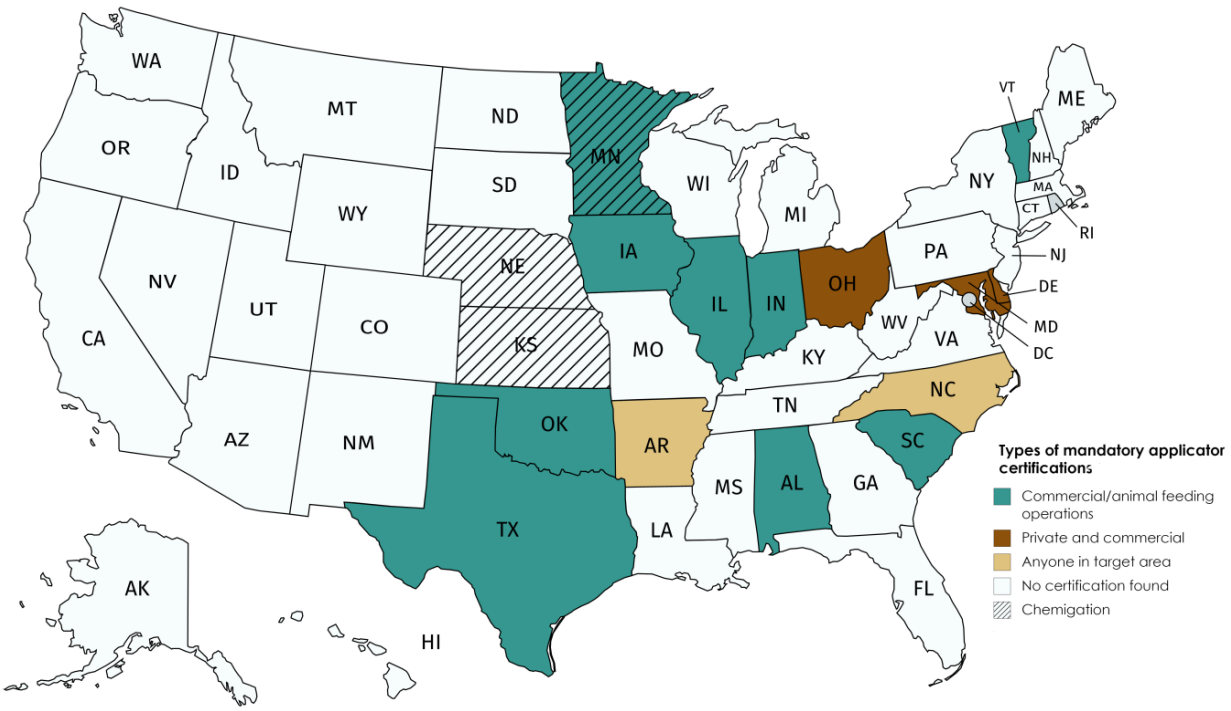
- All manure, sludge and commercial fertilizer applications must be done at time and in a manner that does not pollute waters of the state.[44]
- All landowners or operators must allow vegetation to be established along perennial and intermittent streams to protect water quality by filtering out pollutants from surface runoff, among other purposes, and no agricultural activities that would impair the function or condition of the vegetation are permitted.[45]

3. Applicator Certification

Education and training can enhance a farm operator's ability and willingness to change their management practices.[46] We identified a number of states that pursue educational strategies by establishing requirements and a certification process for those who make surface applications of agricultural nutrients. The map in Figure 6 below indicates that applicator certification laws and regulations exist in 18 states and are most prevalent in the eastern half of the United States.

Among those states, there is a range of different types of certifications for different types of applicators. Certification may extend only to commercial applicators who apply nutrients for hire, to private applicators who apply nutrients to their own land, or to both commercial and private applicators. Many of the states require owners or operators of animal feeding operations to be certified to handle and manage applications of manure. A handful of states in the Midwest have certification regulations for operators of chemigation equipment used to apply nutrients through irrigation systems. We highlight several of these certification approaches for the different categories below.

Figure 6. Mandatory Applicator Certification Laws



3.1 Commercial and animal feeding operation applicators

Indiana's Agricultural Fertilizer Certification Program [47] is an example of a common approach to commercial applicator certification. The program requires commercial applicators to pass an exam that encompasses fertilizer application planning, storage, equipment, transportation, techniques and environmental concerns. Certification is valid for four years but is renewed if an applicator participates in three hours of state-approved education on topics such as fertilizer material storage, chemistry, equipment calibration, use, transportation, or application development and implementation, spill response procedures, public and customer safety or concerns, applicator safety, environmental safety, environmental issues, employee training, and associated state and federal laws or regulations affecting fertilizer materials. Certified applicators may directly supervise employees in using fertilizers, but must ensure that the employees have participated in state-approved training. Indiana also includes any person applying manure from a confined feeding operation in excess of 10 cubic yards or 4,000 gallons per year to be certified as a private fertilizer applicator.

Some states also require those applying nutrients from AFOs to become certified to do so, whether for hire or as the private operator of the AFO. **Oklahoma** uses a similar approach for animal feeding operation certification, and varies certification requirements according to the type of livestock species. As an example, any person who land applies over 10 tons of poultry waste for a poultry feeding operation per year must be certified, whether the person applies the waste commercially or as the operator of the facility. Certification requires nine hours of education in the first year and an additional two hours of continuing education every year, up to 19 total hours. Once the 19-hour threshold is met, applicators must attend two hours of continuing education every three years.

Oklahoma's educational topics include waste handling systems; environmental processes for protecting water quality; nutrient management, including sampling procedures, application rate determination, equipment calibration, and record keeping systems; and laws and rules. Oklahoma has additional certification requirements for swine facilities, and also requires operators to provide nutrient management training to employees.

3.2 Private applicators

Although it is more common to require commercial or animal feeding operation applicators of nutrients to be certified, three states also require certification for private individuals applying nutrients to their own fields.

Delaware's State Nutrient Program [48] began certification for "private nutrient handlers" in 2004, which requires certification for persons who apply nutrients to ten or more acres of land that they own, lease, or control. Certification involves initial completion of at least nine credits of educational course work and six credits of continuing education every three years. Private nutrient handlers must record and keep the dates, locations, quantities, acreage, and methods of applications they make, along with copies of their nutrient management plans. The state also has a "commercial nutrient handler" certification process for those who apply nutrients for hire and a "nutrient generator" certification for those who operate facilities that produce organic or inorganic nutrients.

Maryland's Agricultural Nutrient Training Program [49] similarly requires a person who applies nutrients on more than ten acres of land to obtain an applicator voucher by passing an examination that covers regulations, nutrient management principles, basic soil science and soil fertility recommendations and maintaining two hours of continuing education every three years unless the person is a certified farm operator that has met requirements for preparing nutrient management plans. Commercial operators, however, must obtain certification as a nutrient management consultant, which requires meeting college education and nutrient management planning experience standards, passing an examination, and completing continuing education courses. The Department of Agriculture may suspend or refuse certification to violators.

Ohio became the third state to mandate private applicator certification in 2014 with its **Agricultural Fertilizer Applicator Certification**.[50] The law affects individuals who apply or supervise the application of fertilizers on more than 50 acres of land used for commercial agricultural purposes. Certification requires completing a three hour training program or passing a test, both of which address understanding the proper time, place, amount, application, storage and handling of fertilizers. Certified operators must maintain fertilizer records and be recertified every three years, which involves retaking the examination or attending an approved one hour continuing education class.

3.3 Applicators in target areas

We identified two states that require certification for any application of nutrients within targeted geographic areas. The "nutrient surplus area" approach employed by **Arkansas** for nutrient management planning (see section 1.3 above) also necessitates certification for anyone who applies nutrients within a designated nutrient

surplus area, while applicator certification in other areas of the state is voluntary.[51] The state offers both Certified Private Applicator and Commercial Applicator categories, both of which require passing an examination and renewing the certification after five years.

North Carolina's Water Supply Watershed Protection Program can result in the designation of "nutrient sensitive waters" (NSW) that are subject to excessive growth of vegetation that impairs the use of the water.[52] Regulations for a particular NSW can require applicator certification, as was the case for the Neuse River Basin management strategy. Applicators who apply fertilizer to at least 50 acres of cropland areas within the Neuse River Basin must complete training in nutrient management or operate with an approved nutrient management plan.[53]

3.4 Chemigation applicators

The **Kansas Chemigation Safety Law** [54] regulates the application of fertilizers, pesticides and effluents that are blended with fresh water through an irrigation system. To become a certified Chemigation Equipment Operator and be able to obtain a Chemigation User's Permit, a person must pass an examination that covers the proper use of anti-pollution devices, how to prepare chemicals, calibrating injection equipment, supervision of equipment, handling of water containing chemicals, remedial procedures if chemicals enter the water supply, label information, and state and federal regulations. The certificate is valid for five years. Renewal requires passing the examination again and providing copies of all chemigation records for the previous year.

Minnesota Department of Agriculture

Voluntary approaches

Encouraging voluntary behaviors through incentives is not new to agricultural conservation efforts. We found that states use a broad array of voluntary approaches that allow individuals to choose whether or how to follow a course of conduct that could reduce nutrient impacts on water quality. These types of approaches across the states are so numerous that we could not collect them into a 50-state compilation, as we did with mandatory approaches. We have, however, reviewed a sufficient number of tools and programs to recognize four common strategies states employ to engage voluntary participation in nutrient pollution reduction practices, illustrated in Figure 7.

Figure 7. Types of voluntary approaches to nutrient pollution reduction practices

Technical assistance, economic incentives, legal protections and research and education provide the overarching categories that describe the approaches. In the sections that follow, we present examples from across the country of voluntary programs in each of these categories.

1. Technical assistance

Technical assistance programs help producers use or adopt practices that can reduce nutrient impacts on water. Such programs ensure that farm operators have access to technical expertise and new tools and technologies. While technical consultation is a common feature of many state and federal government agencies, particularly in regards to conservation practices, we identified a few state approaches that relate directly to the agricultural nutrient issue and highlight these below.

1.1 Technical expertise

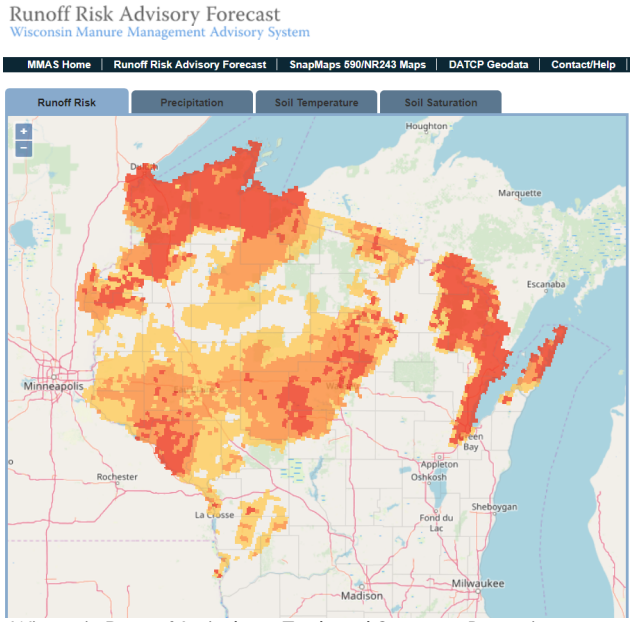
Given the prevalence of nutrient management planning laws described earlier, a very common approach states take is to provide technical experts or funding to assist operators in the development of NMPs. For example, Pennsylvania recently committed one million dollars to its Agricultural Plan Reimbursement Program,[55] which provides funding to farmers in the

Chesapeake Bay Watershed to obtain NMPs from private consultants. Farmers receive reimbursement for the cost of hiring a technical expert to develop plans for manure management, nutrient management, or erosion and sediment control, up to a maximum of $6,000 per farm. Pennsylvania's Act 38 [56] requires certain concentrated animal operations to operate under an approved NMP.

Vermont's Technical Assistance Program and Farmstead Best Management Practices Program [57] offer similar ways to ensure that farmers have access to technical expertise. The programs provide water quality compliance assistance, state permitting assistance, and engineering services for the design of best management practices. Vermont's Agency of Agriculture, Food and Markets administers the programs to help farmers abate non-point source agricultural discharges and maintain regulatory compliance.

1.2 Informational tools

Tools to assist with nutrient management planning and nutrient applications are also widely available across the states. Many of these tools are developed by universities or the USDA Natural Resource Conservation Service, but we did find examples of tools housed or developed by state agencies. Most common is the nutrient application forecasting tool. For example, the National Weather Service has partnered with the states of Wisconsin, Minnesota, Ohio and Michigan through the Great Lakes



Wisconsin Dept. of Agriculture, Trade and Consumer Protection

Restoration Initiative to form a regional runoff risk decision tools network. NWS helps each state develop a tool that utilizes site specific weather data and state specific rules and guidelines to forecast the best time to apply nutrients.

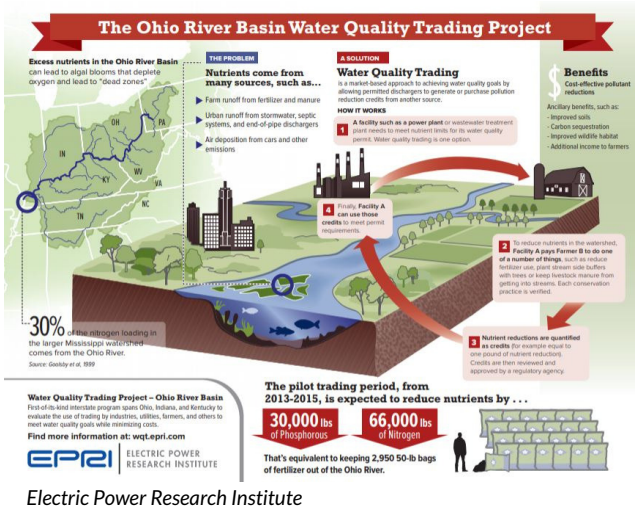
Generally, the tool gathers precipitation, temperature and snow melt data to estimate the amount of water in an area then combines water data with soil data to determine a whether nutrients would soak into the ground or flow over the surface. Based on this data, the tool advises whether runoff risk is not expected, low, moderate, or severe. **Wisconsin's Runoff Risk Advisory Forecast, Minnesota's Runoff Risk Advisor Forecast, Ohio's Applicator Forecast, and Michigan's EnviroImpact** [58] are now freely available online. We found similar forecasting tools in other regions of the country, including Washington, Oregon, Missouri, Pennsylvania, New York, and Virginia.[59]

2. Economic incentives

Like technical assistance, economic incentives aim to motivate the adoption of new practices through financial rewards such as cost share payments, tax benefits and reimbursements. A few of these approaches that we highlight below are water quality trading programs, tax credits and cost share programs.

2.1 Water quality trading programs

We discovered several programs that engage farmers in water quality trading, a tool that appears to be gaining traction for agricultural nutrient reduction purposes in recent years. The largest water quality trading program is **Ohio River Basin Water Quality Trading Project** [60] which involves Indiana, Kentucky and Ohio working in partnership with the Electric Power Research Institute. The program, established in 2012 and recently extended through 2020, allows farmers and industrial facilities to trade pollution credits to reduce fertilizer run-off and nutrient discharges. Farmers can receive cost share funds to implement best management practices such as nutrient management and cover crops. The practices must reduce the farm's loading of nitrogen or phosphorous below current conditions. Once practices and reductions are verified, the state issues a credit that the farmer can sell.



Electric Power Research Institute

Another example is **Maryland's Water Quality Trading Program** [61] in the Chesapeake Bay Watershed, which creates a public market for nitrogen, phosphorus and sediment reductions to help meet the State's nutrient reduction goals. The Maryland Department of the Environment and Department of Agriculture collaborate on the voluntary program. To participate, agricultural operations must meet baseline requirements for nutrient reduction in their region and can then generate credits from practices such as cover crops, reduced fertilizer application, manure export, riparian buffers, and crop conversions. Point sources and other interested buyers may purchase the credits through a nutrient trading market.

North Carolina's Nutrient Offsets and Trading [62] allows developers, wastewater treatment facilities, and others to meet a portion of their nutrient reduction requirements by purchasing nutrient offset credits. According to the state, the predominant nutrient reduction practice used by those seeking to generate nutrient reduction credits for sale is the restoration and enhancement of riparian forested buffers on agricultural lands.[63]

2.2 Tax credits

Virginia offers several tax credits that encourage nutrient reduction practices by farmers. The **Virginia Precision Agricultural Equipment Tax Credit**[64] provides a tax credit for purchases of farm nutrient and pesticide application equipment that can result in more precise nutrient applications, including pesticide and fertilizer sprayers, pneumatic fertilizer applicators, monitors, regulators and booms for sprayers and fertilizer applicators, manure applicators, tramline adapters, and planter banding attachments. The purchased equipment must meet state specifications and the farmer must have a nutrient management plan for the operation. Qualified purchases earn a 25 percent tax credit of up to $3,750. **Virginia's Agricultural Best Management Practices (BMP) Tax Credit** gives agricultural producers a 25 percent income tax credit on the first $70,000 expended on the voluntary installation of BMPs, not to exceed $17,500. The BMPs must be approved and inspected by the local soil and water conservation district.

In **Wisconsin**, eligible landowners may claim a tax credit on their income tax return in exchange for keeping the land in agricultural use and complying with the state's soil and water conservation standards, also known as agricultural performance standards. The **Farmland Preservation Tax Credit**[65] can range from $5 to $10 per acre, depending upon whether the land is located in a designated "agricultural enterprise area," an area zoned for farmland preservation, or the landowner has entered into a farmland preservation agreement. The county land conservation department verifies that the farm meets agricultural performance standards, which includes nutrient management planning and practices that control agricultural sources of nonpoint pollution.[66]

2.3 Cost share programs

An abundance of cost share programs aimed at reducing agricultural nutrient impacts exist across the country. The state of **Ohio** recently announced a $20 million package of three nutrient management programs for farms in the Western Lake Erie Basin.[67] The **Voluntary Nutrient Management Plan Development Program** will provide yet to be determined financial incentives for farmers to develop NMPs. The **Ohio Working Lands Program** includes a buffer program that will encourage producers to establish year-round vegetative cover on eligible cropland, including establishing hay and

forage that can be harvested. Farmers can receive an annual payment of $120 per acre for maintaining a 50 to 300 foot vegetative buffer for five years. The **Working Lands Program** also includes a small grains program that aims to expand the available time period for manure applications. Farmers will receive a $75 per acre payment for establishing and harvesting wheat, barley, oat, cereal rye, spelt or triticale, making manure applications, and establish a post-harvest cover crop. **Ohio's Cost Share and Equipment Buy Down Program** is still under development, but will provide funds for technological improvements to agricultural land, equipment and structures that reduce nutrient loss. Potential approved practices include nutrient injection equipment, manure management storage, and drainage water management.

Kansas also offers a number of programs that provide financial assistance to landowners, funded through the Kansas Water Plan Fund.[68] The state's **Water Resources Cost-Share Program, Non-Point Source Pollution Control Program, Riparian** and **Wetland Protection Program and Kansas Water Quality Buffer Initiative Program** are administered locally through county conservation district offices.[69] Land-owners apply for payments to install best management practices such as buffer strips, filter strips, field borders, pasture and hay land planting and livestock waste

Kansas Department of Agriculture

facilities and receive technical assistance for the planning and design of projects. Funds are also available for soil testing, and the state this year will provide additional funding for BMPs in high priority watersheds as part of the **Watershed Restoration and Protections Strategy**.[70]

We identified a few states that provide financial assistance to landowners to transport manure outside of nutrient heavy areas. For example, **Delaware's Nutrient Management Relocation Program**[71] assists with the cost of transporting manure from areas of excess to areas in need of nutrients. Applicants receive a reimbursement of no more than $20 per ton after submitting information about the manure, its destination and transportation. Similarly, Virginia offers a **Poultry Litter Transport Incentive Program** [72] to facilitate the efficient use of poultry litter from the state's highest poultry production counties to poultry litter markets outside the Chesapeake Bay watershed. Receiving fields must have soil and phosphorous tests and certified NMPs. The program pays $15 per ton of approved litter transport.

3. Legal protections

Legal protections give agricultural operators immunity from legal actions or changes in legal requirements for agricultural nutrient use. The **Minnesota Agricultural Water Quality Certification Program**[73] rewards farmers with certification and regulatory certainty for a period of ten years if they implement and maintain approved farm management practices. Certified producers are deemed to be in compliance with any new water quality rules or laws that arise during the period of certification. Certified farmers also receive priority for technical and financial assistance to implement practices that promote water quality.

Likewise, **Maryland's Agricultural Certainty Program**[74] gives farmers a ten year exemption from new environmental laws and regulations in return for installing best management practices that can help meet local or Chesapeake Bay Total Daily Maximum Load goals ahead of schedule. A certified verifier inspects farm operations who apply to the program every three years to determine compliance with local, state and federal environmental requirements. The farmer agrees to operate and maintain water quality practices at the current conditions. If so, the operation is excused for ten years from meeting new regulatory restrictions or performance standards that address nitrogen, phosphorus or sediment runoff.[75]

Minnesota Pollution Control Agency

4. Research and education

Research and education are traditional strategies for resolving critical issues such as those posed by agricultural nutrients. Such approaches endeavor to increase our understanding of the problem and expand the knowledge base of those who use and work with nutrients. The extent of research and education activities related to agricultural nutrients and water quality across the country is vast, indicating a strong effort by the states to rely on this traditional approach to problem solving. We highlight two states below that have developed coordinated strategies for research and education .

Minnesota voters approved an amend-ment to the state constitution in 2008 that authorized a sales and use tax increase that now funds the state's **Clean Water Fund**. [76] The Minnesota Department of Agri-culture received $16.66 million in 2018-2019 for the fund, to be used to protect, enhance and restore Minnesota's lakes, rivers, streams and groundwater. The fund supports a number of education and research and programs that address agricultural nutrients, including the Agricultural Water Quality Certification educational program mentioned in the previous section, above.

Minnesota's Nutrient Management Initiative, also supported by the Clean Water Fund, pays farmers and crop consultants to work together to conduct on-farm field trials comparing current nutrient management practices with alternative practices such as changes in nitrogen rate, nitrogen application timing, use of a nitrogen stabilizer product, new equip-ment, or use of a different nitrogen source. Farmers can use their farm specific trials as well along trials in the same region to aide with nutrient management decisions. Advanced nitrogen rate trials help guide nitrogen rate recommendations and are used for the state's nitrogen rate calculator. The program also summarizes statewide results of all field trials for outreach purposes.

The **Clean Water Research Program,** another Clean Water Fund project, provides research funding to research entities, organizations and individuals. The goals of the program are to identify processes that affect water quality, evaluate the effectiveness of agricultural BMPs, and develop technologies to target BMPs to critical areas of the landscape. The stated priorities of the program's current request for proposals have a strong focus on nutrient management: agricultural BMPs for groundwater protection, protocols for evaluating groundwater quality impacts of precision agriculture, economics of cover crops, and innovative nutrient management strategies. To date, the program has funded 39 research projects.

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Fertilizer Research and Education Program

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https://www.cdfa.ca.gov/is/ffldrs/frep/index.html

California's Fertilizer Research and Education Program (FREP) has invested more than $17 million on over 220 research and education projects since 1990 to promote the efficient and environmentally friendly use of fertilizers through the funding of fertilizer research and education.[77] The California Department of Food and Agriculture administers the program, which serves a broad array of interests that includes growers, agricultural supply and service professionals, extension personnel, consultants, and public agencies. FREP maintains a grant program that is funded by a mill assessment of not more than $0.001 per dollar on sales of fertilizer materials paid by fertilizer licensees who sell or distribute packaged or bulk fertilizing materials to unlicensed purchasers in California. Recent funded research projects include "Adapting CropManage Irrigation and Nitrogen Management Decision Support Tool for Central Valley Crops," "Agricultural Baseline Monitoring and BMP Implementation: Steps Toward Meeting TMDL Compliance Deadlines Within the Newport Bay/San Diego Creek Watershed," and "Agriculture and Fertilizer Education for Grades K-12."

The program maintains a strong connection between research and education. Since 2007, FREP has collaborated with the Western Plant Health Association (WPHA) to host a conference that encompasses technical research along with discussions on practical applications that address statewide and regional nutrient management issues. FREP's collaboration with the University of California provides training for Certified Crop Advisors and NMP training for growers. According to the agency, "FREP researchers make concerted efforts toward the extension of their research, in usable forms, into the hands of agriculturalists. Certified crop advisors and soil extension specialists provide a great chance for the successful implementation of FREP research - their encouragement of the application of the best practices, in combination with grower trust, is the key to completing the path toward agricultural nutrient efficiency."

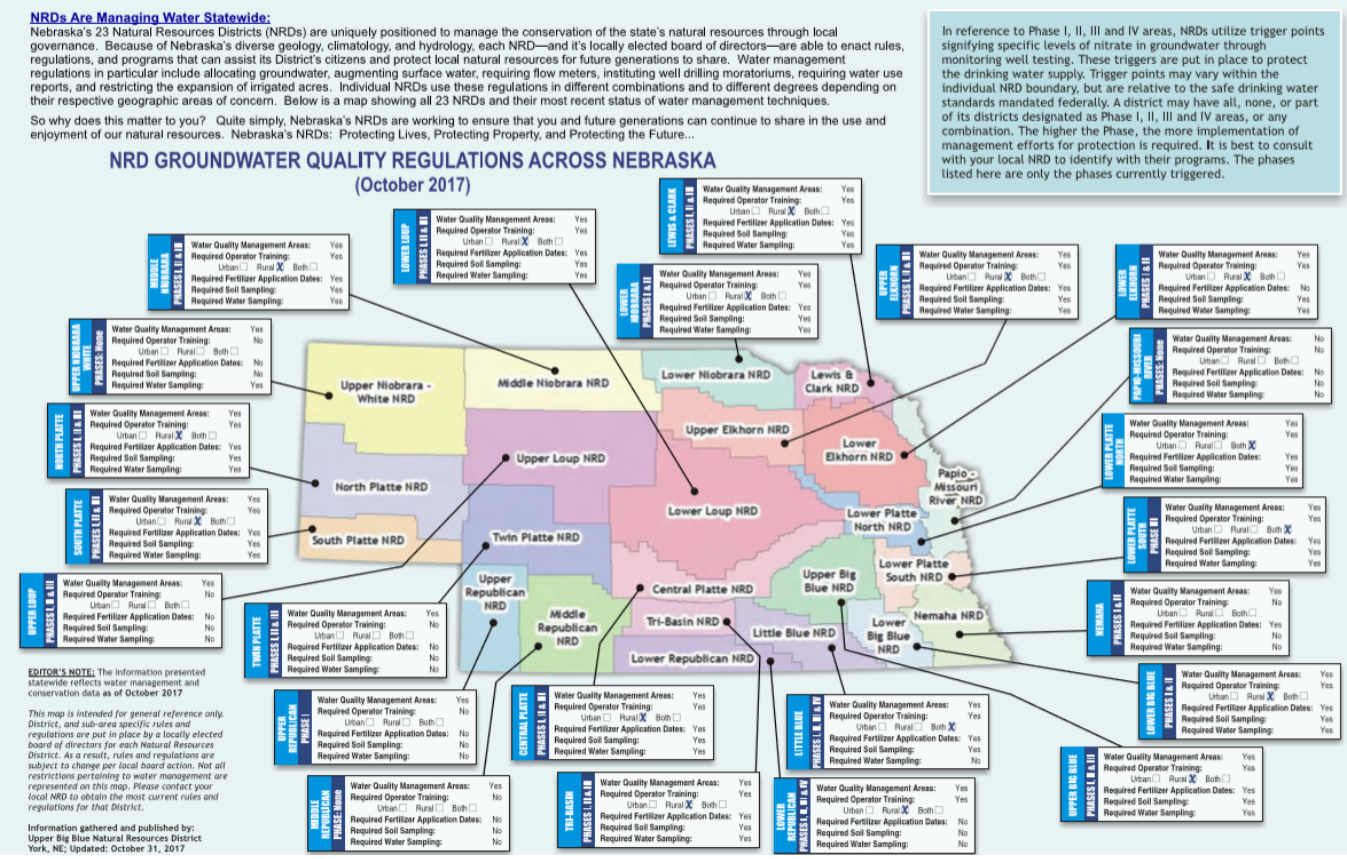
The role of local governance

University of Nebraska

The approaches we describe in this report focus on strategies administered at the state level of government, but local governments and agencies also play a key role. A number of states have responded to agricultural nutrient issues by utilizing or creating a governance framework that delegates implementation of nutrient reduction goals to local governments. These approaches rely on the ability of local governments, agencies and advisory boards to consider geographic, physical and other factors in determining a course of action for an identified area. The course of action may include mandatory actions, strategies and incentives for voluntary actions by farm operators in the area, or both mandatory and voluntary policies.

For example, **Nebraska** relies on its **Natural Resource Districts** (NRDs)[78] to implement rules and regulations to protect water quality under the state's **Ground Water Management and Protection Act** [79] and other environmental laws. The state's 23 regional NRDs are based on river basin boundaries and governed by elected boards of directors. State law charges the NRDs with responsibilities for natural resources within their boundaries such as pollution control and the management of groundwater and surface water, but each district sets its own priorities and develops its own programs to address local needs, which may include mandatory measures. In regards to water quality, the Ground Water Management and Protection Act gives Nebraska's Department of Environmental Quality the authority to determine if an area should be designated for the protection of groundwater quality, but the department works with the NRD in a designated area to develop a groundwater quality management plan and rules to implement the plan. Figure 8 below illustrates the diversity of water quality regulations in place across the state, which may include rural or urban operator training, fertilizer application date restrictions, soil sampling, and water testing.

Figure 8. Water Quality Regulations in Nebraska Natural Resources Districts



Nebraska Association of Resources Districts

Likewise, **California's State Water Resources Control Board** [80] sets statewide water quality policy and coordinates the Regional Water Quality Control Boards. The nine Regional Water Quality Control Boards are organized by water basins and charged with regulating surface and ground waters in the region as well as establishing nonpoint and point source discharges that are not regulated by the federal Clean Water Act.

Oregon's Agricultural Water Quality Program [81] requires the Oregon Department of Agriculture to prevent and control water pollution from agricultural activities. To do so, the agency partnered with local advisory committees to develop Water Quality Management Area Plans for the state's 38 agricultural water quality management areas. Generally, farm operators must prevent soil, fertilizers, livestock manure, and pesticides from entering waterways, but each area has its own set of requirements that are tailored to the management area. The agency and the local advisory committee reviews and updates the Area Plan every two years.

What do we know about what works?

Perhaps the most critical question we can raise about state responses to agricultural nutrient impacts on water quality is this: which approaches work? While there is not a simple answer to this question, efforts are in place to determine whether nutrient reductions result from conservation practices. For example, the USDA's Conservation Effects Assessment Project National Assessment for Cropland has conducted numerous studies that identify nitrogen and phosphorous reductions in areas where farmers have engaged in conservation practices.[82] Figure 9 summarizes results of several studies.

These and other modeling and assessment studies do indicate that conservation practices can reduce nitrogen and phosphorous in waterways.

There is an obvious challenge, however, to correlating nutrient pollution reductions with specific state laws, regulations and policies. Which legal approaches lead to nutrient reductions, and which are more successful at improving water quality than others? Are improvements higher where mandates are in place, or do voluntary practices yield similar results as mandatory requirements? Our report cannot answer these questions. But our hope is that compiling and organizing states' legal solutions to nutrient issues can form a foundation for future analysis of improvements to water quality resulting from specific approaches taken in specific areas.[83]

Figure 9. Nutrient Reductions from Conservation Effects Assessment Project Studies

Study	Reductions relative to if no conservation practices were in place
USDA/NRCS (2017). *Conservation Practice Adoption on Cultivated Cropland Acres: Effects on Instream Nutrient and Sediment Dynamics and Delivery in Western Lake Erie Basin, 2003-06 and 2012*	• N losses from cultivated croplands: 22% (2003-06); 26% (2012) • N load delivery to Lake Erie: 16% (2003-06); 17% (2012) • N deposition in ditches, channels, streams, and rivers in basin: 26% (2003-06); 37% (2012) • P losses from cultivated crop lands: 53% (2003-06); 61% (2012) • P load delivery to Lake Erie: 39% (2003-06); 41% (2012) • P deposition in ditches, channels, streams, and rivers in basin: 60% (2003-06); 72% (2012)
USDA/NRCS (2015). *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Texas Gulf Basin*	• N lost to surface runoff: 45% • N loss in subsurface flows: 29% • P total loss from fields: 33% • N loads delivered to rivers and streams in basin: 41% • P loads delivered to rivers and streams in basin: 55% • N instream loads delivered to Gulf of Mexico: 10% • P instream loads delivered to Gulf of Mexico: 6%
USDA/NRCS (2013). *Impacts of Conservation Adoption on Cultivated Acres of Cropland in the Chesapeake Bay Region, 2003-06 to 2011*	• N loss with surface runoff: 38% • N loss in subsurface flows by leaching: 12% • N total load delivered from edge-of-field to rivers and streams: 44% • N total load delivered to Bay: 17% • P total loss from fields: 44% • P total load delivered from edge-of-field to rivers and streams: 75% • P total load delivered to Bay: 75%

Insights and conclusions

An initial insight we quickly observed in our research is that there is notably more legal activity in agricultural nutrient management in particular geographic regions of the country. Three factors may have an impact on the advanced levels of state activity we observed in certain areas: higher annual rainfall, intensive agricultural production, and proximity to water resources that have experienced nutrient pollution issues, such as the Great Lakes, Mississippi River Basin and Chesapeake Bay. These water resource regions see the highest use of mandatory approaches to addressing water quality impacts from agricultural nutrients.

Our research also shows that states are relying heavily on nutrient management planning as a mechanism for addressing nutrient issues. The emphasis on NMPs extends to both mandatory and voluntary approaches and also encompasses certification of those who prepare NMPs. The reliance on NMPs raises a few concerns. Nutrient management planning requires extensive technical resources and assistance. Estimates of the cost of developing a farm NMP range from $2,400 to $12,100, dependent upon the size and complexity of the operation.[84] These costs may hinder the success of NMP approaches if public resources for assisting with NMP development are limited or operators are unwilling or unable to fund NMPs. Additionally, recent litigation against a dairy operation in the case of Community Association for Restoration of the Environment, Inc. v. Cow Palace LLC led a federal court judge to closely examine the dairy's NMP. The court concluded that the dairy's applications of manure were "untethered" from the NMP and that the NMP failed to account for residual nutrients in the soil, both of which resulted in water quality impacts from over application of nutrients. The court's close analysis of the NMP and the dairy's actions suggest that NMPs must be carefully drafted and implemented to accomplish the purpose of preventing agricultural nutrient runoff and ensuing liability for such runoff.

We were overwhelmed by the extent of mandatory and voluntary approaches taking place across the country that focus on conservation practices and application restrictions. Similar to NMPs, encouraging voluntary conservation practices can require significant financial resources. Without economic or other incentives, mandatory approaches such as Minnesota's buffer law face opposition from landowners concerned with high costs and the loss of property rights.[85]

External partnerships that can provide funding for NMPs and conservation practices may be critical to the success of such approaches.

Given the challenges that face nutrient reduction approaches, there is a high need for data that can verify the success of different policies, practices and programs. Only a few approaches include provisions and funding for monitoring and assessing impact, however. Conversely, monitoring and assessment appear to occur independently of specific state programs. Funding for monitoring and analysis should be integrated into approaches that center on practices that aim to reduce nutrient impacts.

As a whole, the landscape of state approaches across the country appears quite active yet outwardly disjointed. State nutrient reduction laws and regulations can be piece meal, existing in many different areas of a state's statutory code.

The implementation or oversight responsibilities for the laws may exist in several governmental agencies of the state. Some of the approaches are singular and without a foundational statewide strategy, perhaps taking a reactionary rather than preventive approach. Programs that utilize a governance structure that involves local advisory boards and local governments may ensure that broad, piecemeal approaches are comprehensively implemented at the local level.

Despite the concerns we raise, our research indicates that there is significant agricultural nutrient activity across the United States. Many states have enacted mandatory laws and regulations and developed voluntary programs to address agricultural nutrient impacts on water quality. States are heeding the call that the U.S. EPA made over a decade ago and are attempting to address the challenges of agricultural nutrient impacts on water quality.

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Credits for Visuals

We used **MapChart.net** to create all maps for this report, with the exception of the map in Figure 5 on page 12, which is from the Arkansas Natural Resources Commission.

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