Reducing Farm Phosphorus Runoff to the Yahara Lakes

By James Matson and Ed Odgers[1]

Phosphorus (P) is an essential plant nutrient, critical to agricultural production. Farmers apply P fertilizer and manure to ensure ample crop yields. But this "good" crop nutrient is also a "bad" water pollutant. High P levels trigger the smelly and potentially toxic algae blooms that often foul the Yahara Lakes – the crown jewels of Dane County. Farm runoff, especially from the Lake Mendota watershed, is the biggest source of P loading to the Yahara chain (nonfarm sources also contribute). Some of this P loading is a legacy from past decades. But that should not distract us from improving P management *today*, because today's practices will determine tomorrow's P legacy.

Farm P runoff is a serious statewide problem. To date, despite significant efforts and some successes, we have made little *overall* headway in reducing it. In some important ways, we are going backward:

- Mean Wisconsin soil P concentrations have *risen by nearly 40%* since the 1970's, as a result of P applications that exceed crop uptake. More P is thus poised to pollute our lakes and streams during soil erosion and runoff events.
- Wisconsin's soil erosion rate has *increased by 25%* since 1992, reversing an earlier trend.
- We are putting *more land into row crops* that are susceptible to soil erosion, and reducing protective crop rotations and perennial vegetative cover.
- We are *applying more P fertilizer* – all of which is imported from outside the state. P fertilizer applications increased by 50% from 2009 to 2014, reversing an earlier trend.
- We are *applying more manure to less land.* Next to imported P fertilizer, manure provides most of the P applied to Wisconsin cropland. Dairy consolidation is creating much bigger manure concentrations in some places. Farmland loss is reducing disposal options.
- *Heavier storms are increasing P runoff*. Experts warn that erosion rates may *double* by 2050, without stronger preventive action.
- State funding for farm conservation practices has *declined steadily* in recent decades.

All of these statewide trends apply, to a greater or lesser degree, in the Yahara watershed. Many result from large forces over which we have little local control. In light of these trends, what can we do to protect our lakes and maintain the goodwill that agriculture has traditionally enjoyed? In brief, we can:

- Ensure that every farm has a *nutrient management (NM) plan* to:
  - Prevent excessive P fertilizer and manure applications.
  - Keep soil P *on the land* and *out of the water*.
  - Avoid high-risk manure applications.
  - Help keep livestock numbers in line with manure management and land carrying capacity.
- Avoid wasteful development of farmland, which aggravates conservation challenges.
- Make it *more profitable* to do the right thing, and *less profitable* to do the wrong thing.
- Monitor farm conservation performance, while protecting farm confidentiality.
- Set clear performance goals, but leave management decisions in the hands of farmers. Every farm is different, so there is no "one size fits all" solution.
- Provide help, but expect accountability.
- Find the will and resources, both public and private, to get the job done.

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P Imports

The Mendota watershed is the largest source of farm P loading to the Yahara lakes – partly because its P load "cascades" into lower lakes. Many people are surprised to learn that we actually *import* large amounts of P to the Mendota watershed. P arrives mainly in the form of P fertilizer (mined in Florida or Africa) and P-rich livestock feed (imported by large dairy farms). A UW study estimated P imports at roughly 1,000 tons *per year*, as of 2007.[2] We may be importing even more P today.[3]

We also *export* P from the watershed, in the form of food and agricultural products. But, on balance, we *import* more P than we export. The UW study conservatively estimated our import surplus at roughly 300 tons *per year* as of 2007, and it may be higher today.

When P imports exceed P exports, our soil P "reservoir" grows and more P is poised to enter Lake Mendota during soil erosion and runoff events. Unfortunately, even if we *eliminate* our P import surplus, it may take years or decades to draw down excessive soil P levels. So we must also use *conservation practices* to keep P-rich soil *on the land* and *out of the water*. Conservation practices will be critically important, even if we succeed in reducing soil P levels.

P Management

To reduce P imports and soil P levels, we must avoid unnecessary P applications to cropland. That is a complex challenge. Farmers want to provide enough P to ensure ample crop yields, and different crops have different P needs (corn and alfalfa are big users).[4] Soil P levels can vary from place to place – they can be high in some places, relative to crop needs, and low in others. Soil P levels can also vary over the course of a crop rotation, depending on the timing of P applications and crop uptake. The challenge is to get the right amount of P in the right places, at the right times, without applying "too much" P anywhere. That requires periodic soil testing and a good *farm nutrient management plan* (NM plan).

A good NM plan (see state standards below) also uses conservation practices to keep soil and applied nutrients *on the land* and *out of the water*. Conservation practices may include things like crop rotations, conservation tillage, cover crops, manure injection, grass waterways, buffer strips and conservation set-asides that reduce soil erosion and runoff. Manure storage facilities can also help, by allowing farmers to postpone manure applications until conditions are favorable. Farmers can choose conservation practices that are appropriate for their operations. Conservation practices cost money, of course; and that cost is added to the farmer's basic cost of conducting soil tests and developing a NM plan. *Appendix 1* lists practices that are potentially eligible for state-funded cost-share grants.

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[2] Kara, et al., "Assessing a decade of phosphorus management in the Lake Mendota, Wisconsin watershed and scenarios for enhanced phosphorus management," *Aquatic Sciences* (2012). The study conservatively estimated a "most likely" annual P import amount of 854,000 kg, which is roughly 1,000 tons.

[3] P *fertilizer* imports to the Mendota watershed have probably increased since 2007 (reflecting a statewide trend). Livestock operators may be adding fewer P supplements to feed, but the volume of feed imports has probably increased due to rapid dairy growth in the watershed.

[4] Corn production illustrates the complexity of P flows. Corn requires a lot of P, and many farmers *add* P to ensure abundant corn yields. On the other hand, corn *removes* a lot of P from the soil as it grows; so it can help to "mine down" excessive soil P levels. Corn production, if not combined with effective conservation practices, can leave bare soil exposed to erosion for much of the year – *increasing* soil P runoff to surface water. Harvested corn may be *exported* from the watershed (taking P with it), or it may *stay* in the watershed as livestock feed (*reducing* the need for P-rich feed imports). Corn that *stays* as livestock feed is eventually returned to the soil as manure (which *increases* soil P levels but *reduces* the need for P fertilizer imports).

In-field conservation practices are generally more effective than narrow edge-of-field buffer strips. Broad riparian buffers and conservation set-asides can be very effective, but they can also be costly (farmers think about acreage lost to cropping, as well as out-of-pocket installation expenses). Large capital improvements, such as manure storage facilities and engineered landscape modifications, can also be effective but costly.

By minimizing soil erosion and runoff, good conservation practices can reduce the impact of high soil P levels – at least up to a point. Some practices tend to be more cost-effective than others, but there is no "one size fits all" prescription. Different farms can meet conservation targets in different ways.

Managing Manure

Last year, Wisconsin produced a record 30 billion pounds of milk – over 25% more than we did just 10 years ago. More milk means more cheese,[5] but it also means more manure. Today's cows produce over 2 pounds of manure (not counting flush water and other diluting materials) for every pound of milk.

Wisconsin now produces over 65 billion pounds of dairy manure each year. That alone might not be a problem. But milk and manure production is increasingly concentrated in large livestock facilities that must import P-rich feed from distant sources. Dairy growth is also concentrated in certain geographic areas, such as the Mendota watershed. In many places, bigger local accumulations of P-rich manure are creating costly new waste disposal challenges.

Next to imported P fertilizer, dairy manure is the biggest source of P applications to Wisconsin cropland. Manure is a good natural fertilizer that "recycles" P from livestock feed (both locally grown and imported). By returning P to the soil, manure can reduce the need for imported P fertilizer. Indeed, it makes environmental sense to substitute local manure for imported fertilizer, where possible. But manure has some important disadvantages:

- Its supply is driven by dairy and livestock production – *not* crop nutrient needs. That can lead to an "oversupply" in some locations.
- It is produced continuously but applied seasonally. It is hard to apply manure to growing crops, and risky to apply it to frozen ground. The pressure to apply manure during narrow seasonal windows, when weather conditions are uncertain, can lead to manure hauling "bottlenecks" and high-risk manure applications. To avoid high-risk applications, some operators may need more manure storage, hauling and application capacity; but that can be costly.
- It is heavy, because of its high water content, and that makes it expensive to haul. Hauling costs increase rapidly with hauling distance. That can create serious manure distribution problems.
- It is cumbersome to apply, compared to concentrated P fertilizer.
- It contains nutrients in fixed proportions that may not match crop nutrient needs. For example, it may be hard to apply the "right" amount of nitrogen without applying "too much" P, or *vice versa*. By contrast, P fertilizer can be precisely formulated to match crop nutrient needs.
- It can pose direct runoff risks when surface-applied, especially on frozen ground or before major snowmelt or rain events.
- It can pose pathogen and odor nuisance risks, especially in some areas.

[5] 90% of Wisconsin's milk production goes for cheese, and 90% of that cheese is consumed *outside the state*. The Wisconsin cheese industry needs an ample supply of milk to grow and compete in national and international markets. But recently, a "glut" of milk has depressed the prices that Wisconsin cheese manufacturers pay to dairy farmers.

In 1970, the average Wisconsin dairy farm had fewer than 30 cows. The cows fed on pasture and feed crops grown on the same farm, and returned manure to the farm soil. So P and other nutrients were continuously "recycled" in a locally sustainable way. Today's dairy farms are much larger and more geographically concentrated, and require far more imported feed. The average Wisconsin dairy farm now has over 125 cows, and the average Dane County dairy farm has over 173 cows. The state's largest dairy farm (not located in Dane County) has 8,000 to 10,000 cows. Just 3% of Wisconsin dairy farms (those with over 700 cows) now produce roughly 40% of Wisconsin's milk and dairy manure.

Larger dairy farms have flourished because they enjoy powerful economies of scale. Most milk production costs tend to fall per unit of output, as production levels rise; but *manure disposal costs* can be an important exception. Because manure disposal costs may *increase* per unit of output, as production levels rise, they can eventually limit herd growth. Responsible herd expansions may require large investments in manure storage and handling, manure hauling, and land acquisition for manure spreading. If some livestock operators try to expand *without* making adequate investments in manure management and "spreadable" land, our lakes will pay the price.

A 1,000 cow dairy farm produces as much P-equivalent fecal waste as the City of Sun Prairie (population 33,000), and typically requires at least 2,000 acres of cropland for safe manure disposal (circumstances vary). A 1,000-cow dairy farm must also haul about 12 million gallons of manure a year, at a cost of hundreds of thousands of dollars. Manure must be hauled over longer distances as herd size and manure volume grow, and as "spreadable" cropland gets harder to find. Manure hauling costs increase rapidly with hauling distance, so there can be a strong financial incentive to apply "too much" manure near livestock facilities.

Manure typically needs to be stored pending application. A 1,000-cow dairy farm typically needs at least 10 million gallons of storage capacity. But storage facilities are expensive (an "average-sized" storage facility may cost $350,000 or more). Land for manure spreading is also expensive (especially in Dane County, where farmland prices are high). Without adequate planning and investment, herd expansions can easily outrun manure storage and land carrying capacity. Operators may end up spreading too much manure on too little land, or in vulnerable places. They may also be forced to spread manure when runoff risks are high (such as in winter, or before major rain events). Inadequate planning and investment can also lead to manure spills and storage overflows.

Direct runoff of surface-applied manure is a major source of P loading to Lake Mendota. Farmers can minimize runoff by avoiding manure applications during high-risk periods (such as in winter, or before major rain events),[6] and by injecting manure below the soil surface. But these precautions may require added investments in manure storage, transportation and field application equipment. Regardless of application timing or methods, *excessive* manure applications will drive up soil P levels and thus increase P runoff risks.

Responsible manure management, like responsible crop management, begins with a good *NM plan* (see standards below). NM plans allow operators to assess, among other things, the amount of manure storage and "spreadable" land they need to manage their manure responsibly. NM plans also match manure applications to field characteristics and crop nutrient requirements, so as to avoid excessive or inappropriate applications. In short, NM plans are an essential tool for keeping livestock populations in line with land carrying capacity, and for minimizing P runoff risks.

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[6] A State of Wisconsin website gives farmers "real time" forecasts of runoff risks in their areas. See Runoff Risk Advisory Forecast: www.manureadvisorysystem.wi.gov/app/runoffrisk.

Nutrient Management Standards

It would be hard to manage a complex modern business without an accounting system. It is equally hard to manage P and other nutrients on a complex modern farm – be it a crop or livestock operation – without a NM plan. A NM plan provides a basic accounting and management system for "good" farm nutrients such as P, which can easily become "bad" water pollutants.

The NM planning process uses well-tested principles and practices to quantify and manage P runoff risks (actual runoff may be affected, in individual cases, by unusual weather events and other external factors). NM plans are indispensible tools for tracking soil P levels, reducing unnecessary P applications, keeping livestock populations in line with land carrying capacity, managing manure responsibly, minimizing soil erosion and P runoff, and achieving our water quality goals.

The State of Wisconsin has adopted NM standards for all Wisconsin farms. These are mandatory standards, not just guidelines. But compliance obligations may be contingent on cost-sharing. Under the current standards, every farm must have a NM plan that meets all of the following requirements:

- It must be prepared or approved by a qualified NM planner (a farmer may qualify, with some basic training).
- It must be based on soil tests analyzed by a certified soil-testing laboratory.
- It must consider cropping plans, crop nutrient needs, and existing soil nutrient concentrations.
- It must cover the entire crop rotation, and must be reviewed and updated annually.
- It must count nutrient contributions from *all sources*, including soil P as well as fertilizer, manure and bio-solid applications.[7]
- It must use a *P-Index* to quantify and manage P runoff risks on every field. The lower the *P-Index* value, the lower the likely amount of P runoff. The maximum legal *P-Index* value is 6 lbs./acre/year; but, with proper nutrient management practices, most farms can achieve much lower *P-Index* values.

  Note: *The "P-Index" weighs a variety of P runoff risk factors, including soil P levels, P input levels, field susceptibility to erosion, conservation practices, seasonal manure application risks, and prevailing weather patterns. Farmers can reduce P-Index values by managing crop rotations and P applications, implementing soil erosion and runoff control practices, and avoiding winter manure applications. Free software (SnapPlus) makes it relatively easy for farmers and NM planners to calculate P-Index values, and to assess the potential impact of alternative conservation practices.*

- It must avoid P and other nutrient applications that exceed rates recommended by the University of Wisconsin.

  Note: *UW recommendations are agronomic recommendations, not water quality recommendations. However, compliance with UW recommendations can help to prevent clearly excessive nutrient applications.*

- It must avoid manure and nutrient application practices that violate federal guidelines (USDA-NRCS 590). Wisconsin NM standards incorporate these federal guidelines by reference, as mandatory standards.

[7] "Bio-solids" are treated municipal sewage products. Bio-solids provide a relatively small amount of P to Wisconsin farmland, compared to imported P fertilizer and manure. But they can be an important source of P in some areas.

Nutrient Management Compliance

State NM standards provide a sound framework for managing farm nutrients, including P. The *P-Index*, in particular, provides a simple and well-accepted measure of likely P runoff. Farmers can use the NM planning process to reduce *P-Index* levels in a variety of different ways, with or without state-funded cost-share grants.[8] By implementing NM plans across the watershed, and working to reduce *P-Index* values in a systematic way, we can make real progress toward our water quality goals.

Unfortunately, there are serious NM implementation gaps at this time. As of 2017, only 32% of Wisconsin farms (37% of Dane County farms) reported having NM plans that met state standards. Some observers suggest that actual (unreported) compliance levels are significantly higher, but we don't really know. We also lack information about soil P levels and *P-Index* levels on individual farms, and about the degree to which existing NM plans are being faithfully implemented. Many farmers are reluctant to share NM information, which they view as proprietary.

Compliance with basic NM standards is a crucial first step. But to achieve state water quality (TMDL) goals, we will need to go further. All across the watershed, it will be necessary to achieve voluntary *P-Index* reductions that are *not* mandated by law.[10] Farmers may be willing to pursue voluntary reductions, but they will need financial help and technical assistance.

Traditional cost-share grants have thus far failed to achieve and maintain an adequate level of NM compliance statewide, partly because of inadequate state funding (see *Appendix 2*). One-time cost-share grants also do little to ensure *continued* compliance, or to promote voluntary *P-Index* reductions that go beyond what is legally mandated. While there is much that the state could do to streamline and enhance current NM incentives, it might also be possible to enhance current incentives at the county and local level. The *Yahara WINS* partnership offers a promising new source of funding for this purpose.

Nutrient Management by Livestock Operators

Nutrient management is especially critical for large livestock operations. Under current state law, the following livestock operations must meet basic state NM standards *regardless* of cost-sharing:

- Concentrated animal feeding operations (CAFOs) that have 1,000 or more "animal units" (about 700 dairy cows). These operations must obtain a pollution control permit from DNR.
- New or expanding livestock operations that are covered by a *livestock facility siting ordinance* (county or local).

A county or local government may adopt a *livestock facility siting ordinance* for operations that will have 500 or more "animal units" (about 350 dairy cows).[11] Pre-existing facilities are grandfathered, unless their number of "animal units" increases by more than 20%. To obtain a siting permit, an applicant must submit specific documentation to show that the proposed facility will meet uniform state livestock siting standards – *including* basic NM standards.

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[8] For a list of conservation practices that may qualify for cost-share grants, see *Appendix 1.*

[10] The maximum legal *P-Index* value for a farm field is 6 lbs./acre/year. Although some fields in the Yahara watershed may exceed this level, evidence suggests that the "average" *P-Index* level in the Yahara watershed may be more like 3 lbs./acre/year. That compares to a rough estimate of 2 lbs./acre/year statewide. In order to make real progress toward our water quality goals, we must reduce the "average" *P-Index* level in the watershed. More widespread implementation of NM plans, and better access to farm *P-Index* data across the watershed, would give us a better picture of our true status and progress.

[11] In a local jurisdiction that has a *livestock facility siting ordinance*, a new or expanding CAFO (over 1,000 "animal units") must obtain a DNR water quality permit *and* a local siting permit.

Permit applicants must show that they have enough land and manure storage capacity to implement their NM plans. The county or local government may monitor compliance, and may suspend a permit for noncompliance (no state action is required). A county or local government may adopt permit standards that are stronger than state standards, if the stronger local standards are needed to address well-documented local health or safety needs. Some 26 counties have adopted siting ordinances to date, but Dane County has not done so.

Manure Treatment as a Nutrient Management Tool

"Manure treatment" is often touted as a solution to our P management challenge. While manure treatment may have significant value as part of a broader NM strategy, it is not a "magic bullet." We must also be clear about what we mean by "manure treatment." The term may encompass many different systems, each having its own distinct purpose. Some treatment systems may facilitate P management, while others may not. Benefits may vary between farms, and by type of treatment.

Land spreading is an effective natural form of manure "treatment," if manure is not over-applied. But today's large livestock operations are generating much larger local pools of P-rich manure, which have the potential to overwhelm local land carrying capacity. Some people believe, or at least hope, that manure treatment technology will offer new management options.

Manure digesters are a widely publicized form of manure treatment. Many people have the idea that manure digesters extract P from manure, or somehow make manure "disappear;" but they do neither. *Manure digesters simply extract energy from manure, in the form of methane biogas.* The digestion process can serve as a pre-treatment to improve the efficiency of *other* treatments, and it can also help to reduce pathogen and odor risks. But it does *not* remove P or other nutrients, *nor* does it appreciably reduce manure volume or water content.

Other treatment systems can be used, alone or in combination with a manure digester, to extract P, separate bio-solids and water, purify extracted water, and produce potentially useful by-products such as fertilizer material and animal bedding.[12] Some of these treatments may facilitate P management, and allow livestock herd expansions that might otherwise be problematic. But each added treatment brings added cost and complexity. Ongoing research may reduce some treatment costs, and improve the convenience and reliability of treatment systems. But the jury is still out, and there is ample reason for caution. We should not assume that manure treatment will provide an easy or affordable "technical fix" to our manure management challenge.

Current law does not require livestock operators to treat manure; so operators are free to treat or not, based on their own business and operational needs. Large livestock operations have the most to gain from manure treatment; but treatment poses daunting fiscal and operational challenges, even for the largest operators. At today's market prices, by-product sales do not pay for the cost of treatment; and there are few market outlets for "extracted" P (competing P fertilizer products are cheaper and more convenient at this time). Most livestock operators can find cheaper ways to meet minimum state NM standards, without resorting to manure treatment. In short, there is no significant private market for manure treatment systems at this time.

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[12] For one overview of manure treatment options, see the commercial website at http://www.newtrient.com/Catalog/Dairy-Manure-101. See also Ma et al., "Review of emerging nutrient recovery technologies for farm-based anaerobic digesters and other renewable energy systems." *Report to the Innovation Center for US Dairy* (2013). A chart on page 30 summarizes cost and performance assessments.

Dane County has tried to facilitate manure treatment, by subsidizing the construction of 2 "community" manure digesters that serve a handful of farms.[13] One digester has additional systems to extract P and purified water, but the other does not. Both facilities serve farms that are located close to the facilities (to minimize manure hauling costs, which are a key barrier to participation). Operational funding for both facilities depends on state and federal "renewable energy" mandates (which require energy companies to obtain some of their energy from "renewable" sources at subsidized prices). The future of these energy production subsidies is uncertain; and, in any case, the subsidies do *not* include any supplementary financial incentives for P extraction.

Additional public subsidies could expand the scope of manure treatment in the Mendota watershed. But public subsidies could also send the wrong "price signals" – encouraging herd expansions that produce even more manure. Efforts to extract and export P will have little net benefit, if P exports are offset by rising P imports and livestock herd growth. Because manure treatment subsidies tend to benefit some livestock operators more than others, they can also raise competitive fairness issues. These concerns could be addressed by charging "user fees" to livestock operators, to defray treatment costs, but it is unclear how many operators would participate (and at what price).

Things could change over time. Demand for manure treatment services could grow, if the disposal of untreated manure becomes more difficult. Further research and development could reduce some treatment costs. Cheaper "low tech" treatments, such as manure composting, could work for some operators. The market for manure treatment by-products could also improve, if there is an increase in the cost of competing products (such as natural gas and imported P fertilizer). But there are also many downside risks, including the reduction or termination of current subsidies for biogas production. At this point, the potential for expanded manure treatment remains uncertain at best.

How Can We Do Better?

There is no "magic bullet" solution to our farm P runoff problem. Progress will require a sustained, multi-pronged effort on many farms over many years. Here are some ways to move forward, despite current headwinds:

- Increase public understanding and support. Be clear and realistic about where things stand, and where we need to go. Offer hope, but don't underestimate the challenge or the cost.
- Set clear expectations. We should *expect* and *work together to achieve* compliance with current state NM standards, as an indispensible foundation for P management on individual farms and across the watershed.
- Focus on careful management to reduce P imports, soil P levels, soil erosion, and P runoff risks. A narrow focus on P extraction and export will fail, if P exports are offset by larger livestock populations, increased P *imports*, and increased soil erosion and manure runoff.
- Reward effective P management. Provide stronger incentives for farmers to achieve and maintain compliance with state NM standards, and to achieve voluntary *P-Index* reductions that go *beyond* state standards. Offer financial incentives, public recognition and peer support.
- Support surveys and other information gathering to determine NM compliance levels, soil P levels, and *P-Index* levels on individual farms and across the watershed. Provide adequate county authority to acquire the needed information. Report aggregate findings and trends, but guaranty the confidentiality of individual farm data.
- Expand NM outreach and training, and provide training incentives for farmers.

[13] The 2 facilities serve about 2% of Dane County dairy farms, and handle roughly 10% of Dane County's dairy manure. On average, the farms served by the 2 facilities are 5 times larger than the average-sized Dane County dairy farm (sizes vary).

- Work toward systematic reduction of *P-Index* levels on individual farms, and across the watershed. Consider the amount by which *P-Index* levels must be reduced in order to achieve our water quality goals. Be patient but persistent. Improvement will take time.
- Mobilize additional resources, at the state and local level, to reward NM compliance and *P-Index* reductions on farms. Consider private "supply chain" incentives, as well as public support.
- Support county efforts to identify and address key priorities. Coordinate with Yahara WINS and other farm and community initiatives. Facilitate cooperation by being clear and transparent.
- Fund adequate county staff to administer NM programs, including information, outreach, training, surveys, compliance screening, technical assistance, compliance incentives, compliance certification and (when necessary as a last resort) enforcement.
- Work with stakeholders to reduce non-monetary barriers to effective NM compliance (lack of information; unnecessary complexity and paperwork; confidentiality concerns; and coordination among key players including landowners, renters, crop consultants, manure haulers and farm input suppliers).
- Work to ensure a high level of professionalism among NM service providers (crop consultants, manure haulers, and farm input suppliers).
- Work to reduce winter manure applications, and ensure that they meet rigorous standards. Provide information, cost-share funding and technical assistance, as appropriate. Require applicants for winter manure spreading permits to have *complete NM plans*, as well as winter spreading plans. Strengthen current winter application standards, as appropriate, and increase compliance monitoring.
- Consider manure treatment as a P management tool, but proceed with caution. Before offering public subsidies for manure treatment, consider cost-effectiveness, competitive fairness, practical feasibility, operational financing, long-term financial projections, and the extent to which livestock operators have "skin in the game." Consider whether public subsidies may encourage herd expansions that will produce even more manure (requiring more treatment).
- Adopt a county *livestock facility siting ordinance*, as authorized by state law, to ensure that new or expanded operations with 500 or more "animal units" (about 350 dairy cows) meet applicable NM requirements (no cost-sharing is required). 26 counties have already adopted such ordinances. State farm groups support the current livestock facility siting law, as do the WI Counties Assn. and the WI Towns Assn.
- Incorporate state NM standards, by reference, in chapter 14 of the Dane County ordinances. That would not change current state NM standards or cost-share requirements, but it would emphasize community expectations and help to focus NM efforts.
- Authorize citations under chapter 2 of the Dane County ordinances to enforce compliance with state NM standards, subject to current cost-sharing requirements. A civil citation process (similar to a "traffic ticket") could provide a fair and efficient way to address significant NM compliance problems, as it does under other county programs. Use citations as a last resort, when voluntary compliance efforts have failed. Require high-level approval (to ensure judicious use), and guaranty a right to hearing on contested citations.
- Consider reasonable "water quality" fees on fertilizer sales and large-scale manure production, to help "internalize" environmental costs and pay for NM incentives.
- Consider recommendations contained in *Food, Land and Water: Moving Forward* – a recent report published by the Wisconsin Land and Water Conservation Association (WI Land+Water). The recommendations were developed by statewide stakeholder workgroups, including leading farm, agribusiness, government, environmental, academic and community representatives.

Note: *WI Land+Water is a statewide organization that represents County Land Conservation Committees (elected officials) and Conservation Departments (professional county staff). See FLW report at: Wisconsinlandwater.org/programs/food, land and water project.*

Appendix 1

Conservation Practices and Cost-Share Rates

The State of Wisconsin provides some funding for county cost-share grants to farmers. Counties may use state funding to make cost-share grants for the following practices, at the following rates:

- Nutrient management plan: $7 per acre per year ($28 per acre for a typical 4-year cost-share contract).
- Annual conservation practices:
  - Contour farming, $9 per acre per year.
  - Cover crop, $25 per acre per year.
  - Stripcropping, $13.50 per acre per year.
  - Field stripcropping, $7.50 per acre per year.
  - High residue management systems, no−till systems, ridge till systems, and mulch till systems, $18.50 per acre per year.
  - Conservation plantings in riparian buffers, $100 per acre per year.
  - Pesticide management, $7.00 per acre per year.
- Long-term conservation practices (typically at 70% of actual, out-of-pocket cost):
  - Manure storage systems.
  - Manure storage system closure.
  - Barnyard runoff control systems.
  - Access road.
  - Trails and walkways.
  - Critical area stabilization.
  - Water diversions.
  - Feed storage runoff control systems.
  - Field windbreaks.
  - Filter strips.
  - Grade stabilization structures.
  - Livestock fencing.
  - Livestock watering facilities.
  - Milking center waste control systems.
  - Prescribed grazing.
  - Relocating or abandoning animal feeding operations.
  - Riparian buffers (may include some cost-share for lost cropping use).
  - Roofs.
  - Roof runoff systems.
  - Sediment basins.
  - Sinkhole treatment.
  - Streambank or shoreline protection.
  - Stream crossing.
  - Subsurface drains.
  - Terrace systems.
  - Underground outlets.
  - Waste transfer systems.
  - Wastewater treatment strips.
  - Water and sediment control basins.
  - Waterway systems.
  - Well decommissioning.
  - Wetland development or restoration.

Cost-shared practices must be installed per state standards, according to a cost-share contract between the county and the landowner. Once a farmer achieves compliance with state conservation standards, the farmer is obligated to maintain compliance regardless of cost-sharing (but in reality, many practices are discontinued after cost-share contracts are completed – often when farm ownership or operations change).

Appendix 2

Current State NM Incentives

Cost-Share Grants

Wisconsin's current NM standards are mandatory standards, not just guidelines. But compliance obligations are contingent cost-sharing (some important exceptions apply). Counties are responsible for administering NM standards and awarding cost-share grants. But state cost-share funding is limited, and the traditional cost-share process can be cumbersome for counties and farmers alike.

State funding for NM cost-share grants is extremely limited, relative to compliance needs. For 2017, the state provided only $1.7 million (statewide) to cost-share NM plans and related annual conservation practices like no-till and cover crops (an average of just $24,000 per county). Dane County, one of the leading agricultural counties in the state, received only $45,000 for these purposes.

A farmer may not avoid NM compliance obligations by refusing a legally adequate cost-share offer. But counties rely heavily on voluntary participation by farmers, and seldom take formal action to enforce NM standards. If farmers are unwilling to participate, budgeted cost-share dollars may go unspent. That weakens the case for increased state cost-share funding.

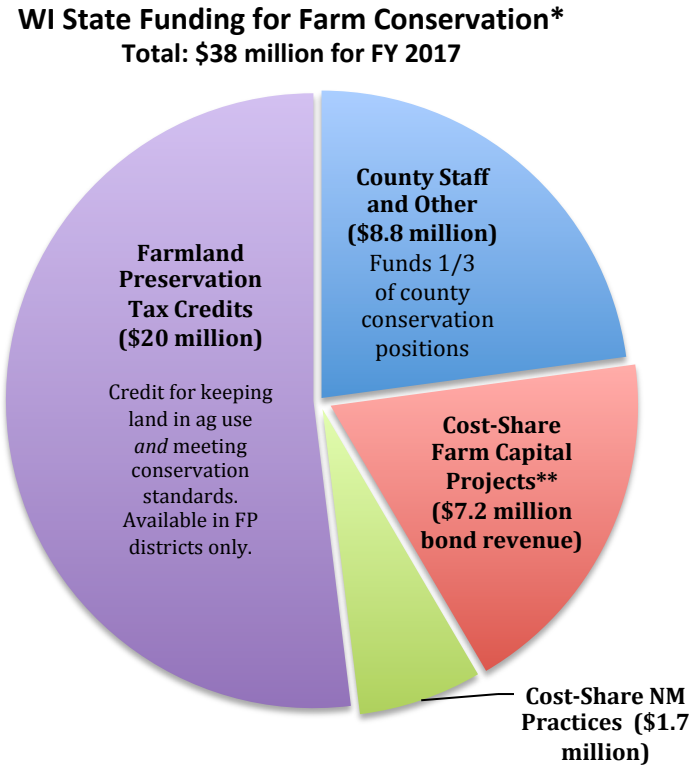
Under a typical NM cost-share contract, a county pays a farmer $7 per acre per year, for 4 years, to implement a NM plan over a 4-year crop rotation. NM plans are themselves relatively inexpensive, and can actually save farmers money by reducing unproductive P applications. But to achieve further *P-Index* reductions, farmers may need to implement additional conservation practices, at additional cost. Particularly in the case of livestock operators, this may entail additional expenses for manure storage and other capital improvements. In 2017, the state provided an average of only $100,000 per county to cost-share capital improvements of this sort (far less than the cost of a *single manure storage facility*).

Counties offer cost-share contracts on a one-time basis. Once the contract ends, the farmer is required to maintain compliance without further cost-sharing. But in reality, farmers often abandon cost-shared practices after cost-share contracts end (often when there is a change in farm ownership or operations).

Farmland Preservation Tax Credits

The Wisconsin Farmland Preservation (FP) program provides a different kind of NM compliance incentive to eligible landowners. The FP program offers *annual income tax credits* ($7-10 per acre) to eligible landowners who keep their land in agricultural use and comply with NM standards. Annual tax credits are easier to administer than cost-share grant contracts, and they provide more incentive for *continued* NM compliance (which counties periodically certify). If a landowner fails to comply, the county may terminate the landowner's tax credit eligibility.

FP tax credits are available in FP zoning districts covering about 1/3 of the state's farmland – but *not* in other areas. FP tax credits play an important role in the Mendota watershed, where a significant amount of land is covered by FP zoning. But rapid urban development could undermine that zoning. Even in FP zoning districts, some eligible landowners fail to claim the FP credit (some may believe that it does not adequately compensate them for the added cost of NM compliance).



- Funding notes:
  - Overall state conservation funding has declined steadily in recent decades.
  - These 2017 state totals do not include federal, county or local funding.
  - Federal funding varies, but typically exceeds state funding.
  - County and local funding also varies.
  - Combined funding, from all sources, falls far short of what will be needed to achieve state water quality (TMDL) goals.
  - See *Wisconsinlandwater.org/programs/food, land and water project* (Final Project Report, Chapter A – Surface Water Quality).

** Farm capital projects include things like manure storage facilities and riparian conservation easements that are funded by state borrowing (bond revenues).