INFORMATION BRIEF
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The Continuing Concern Over Phosphorus

Since the inception of the 1972 federal Clean Water Act, Minnesota has worked to improve its water quality, including trying to reduce the amount of phosphorus in our rivers and lakes. The 2003 Legislature enacted some laws addressing the phosphorus issue. This information brief describes the phosphorus problem, actions by the 2003 Legislature to address it, recent efforts to reduce the amount of phosphorus in the state, methods to reduce phosphorus, and what other states are doing. Appendices list tips and best management practices for reducing and preventing phosphorus in surface and wastewater.

Phosphorus Concerns

Phosphorus is the primary nutrient polluting Minnesota's surface waters. Too much phosphorus causes excessive growth of nuisance algae. When there are excessive amounts of algae in surface water and that algae dies, the decaying algae can use up all of the oxygen in the water and cause fish kills. Additionally, severe algae blooms may directly poison animals that ingest the algae or cause allergic reactions in people who swim in the polluted water.

Phosphorus in lakes and streams comes from both point and nonpoint sources. Point sources are typically industrial and publicly owned wastewater treatment facilities. Point sources usually have distinct pipe discharges to surface water and are regulated under state and federal water pollution permit programs. Nonpoint sources are typically associated with polluted runoff from urban areas and farmland. Nonpoint sources generally do not have distinct discharge points and are not normally regulated under state water pollution permit programs. The amount of phosphorus contributed to surface waters varies statewide from point and nonpoint sources, and the precise amounts from each source are not well known.

Legislation Enacted in 2003

A 2003 law requires the Pollution Control Agency (PCA) to study lowering phosphorus amounts in the wastewater stream, especially at public wastewater treatment plants (Laws 2003, ch. 128, art. 1, § 166). The study must establish a timeline for an overall goal for pollution abatement in state waters, as defined in Minnesota Statutes, section 115.42. The agency must also review the rules on nutrients in cleaning agents. A separate section of the law, section 122, creates a state goal of reducing phosphorus from noningested sources entering municipal wastewater treatment systems by at least 50 percent from the timetable established by the PCA study mandated in section 166.

The Legislative Commission on Minnesota Resources (LCMR) provided $244,000 from the environment and natural resources trust fund for the study, which was due to the legislature in January 2004. The LCMR provided an additional $296,000 in trust fund dollars for a two-year study to develop best management practices for phosphorus removal at wastewater treatment plants. The study will be under the auspices of the Minnesota Environmental Science and Economic Review Board and will involve wastewater treatment analysis at 17 city plants scattered across the state.

Recent Minnesota Reduction Efforts

Local Phosphorus Reduction

Lake Calhoun in Minneapolis reduced its level of phosphorus by 66 percent over the past six years. It was achieved through the Chain of Lakes Clean Water Partnership Program at a cost of $8 million. Keys to the program were widespread neighborhood education efforts on lawn care practices and nonpoint pollution reduction, lake shoreland stabilization, and wetland and pond creation for pollution filtering.

Phosphorus Reduction Study

In 1999, University of Minnesota Professor William Easter studied the costs associated with four different agricultural phosphorus reduction policies in the Minnesota River. The study found that a tax on phosphate fertilizers by far had the lowest transaction costs ($0.94 million), followed by educational programs on best management practices ($3.11 million), a requirement for conservation tillage on all cropped land ($7.85 million), and expansion of a permanent conservation reserve program ($9.37 million).

Water Quality Trading

The U.S. Environmental Protection Agency (EPA) endorsed a 2003 water quality trading policy to cut pollution discharges into the nation's waterways, which has some application in Minnesota.

Water quality trading uses economic incentives to improve water quality. It allows one source to meet its regulatory obligations by using pollutant reductions created by another source that has lower pollution control costs. The standards remain the same, but efficiency increases and costs decrease. Under the EPA policy, industrial and municipal facilities would first meet technology control requirements and then could use pollution reduction credits to make further progress towards water quality goals.

A Minnesota water pollution trading effort has been in place since 1999. It involves the Southern Minnesota Beet Sugar Cooperative plant in Renville. The plant wanted to increase its wastewater discharge to the Minnesota River in order to accommodate a planned 40 percent increase in production. An increased discharge normally would be prohibited because the river is severely impacted by excess phosphorus. However, the PCA issued the plant a permit allowing the increased discharge, but under the condition that the plant must obtain offsetting phosphorus reductions from nonpoint sources in the river basin.

The plant has been getting the reductions by following best management practices with area farmers. The PCA reports that these practices are achieving the phosphorus removal goals of the trading effort.

Methods of Phosphorus Reduction

There are a variety of ways phosphorus in lakes and rivers can be reduced, as listed below.

Cleanup

- **Aluminum Sulfate (Alum)** binds with phosphorus, causing it to settle out of water and stops phosphorus from being released from the sediments.
- **Biological Phosphorus Removal or BNR (Biological Nutrient Removal)** may involve a number of different methods that use biological materials (such as bacteria) to treat phosphorus levels in water.
- **Dredging** removes sediments, which may contain high levels of phosphorus.

Prevention

- **Shoreline Management** uses erosion prevention methods such as buffers, vegetation, and timber management.
- **Agricultural Management** includes a number of different practices such as changes in fertilizer use, soil management, cropping practices, tillage, and structures.
- **Criterion Limits** set maximum phosphorus content levels for both water bodies and pollution discharges from water treatment facilities and industries.
- **Water Quality Trading** allows various polluters to trade with each other for the “right to pollute.”
- **Product Regulations** ban products containing phosphorus or limit phosphorus content within products (dishwasher detergents, lawn fertilizers, etc.).
- **Education Programs** help communities understand sources of phosphorus such as lawn fertilizers and yard waste so they can help prevent it from getting into the water; other programs target farmers and contractors.
- **Cost Share Programs** help farmers and municipalities financially by supplementing purchases of new technologies or providing matching grants, tax incentives, or low-cost loans.

Selected State Legislation and Phosphorus Reduction Efforts

Several states have addressed reducing phosphorus in their surface and wastewaters, as described below.

State/Province	Reduction Actions
Florida	Will provide $600 million over the next 13 years in response to recent amendments to the Everglades Forever Act, including the requirement to reduce the numeric criterion of phosphorus levels in the Florida Everglades to 10 parts per billion (ppb). (Everglades Forever Act)
Georgia	Reduces industrial phosphorus by requiring those with permits to discharge more than 3 million gallons per day to meet a minimum standard of 0.30 milligrams of phosphorus per liter of wastewater. (Georgia Code 12-5-23.2)
Iowa	Recently passed a bill that bans building livestock operations in flood plains, imposes fees on producers to fund state environmental inspectors, and limits manure applications based on how much algae-feeding phosphorus the material contains. (SF2293) In addition, Iowa has a volunteer water-quality monitoring program with approximately 1,465 trained samplers checking 5,000 sites.
Kentucky	Established cost share program initially funded through an increase in pesticide product registration fees but has since gotten general fund appropriations. Approximately $2.65 million per year was available in 1998. Most of the funds are used to fund animal waste systems.
Maryland	All agricultural operations with annual incomes above $2,500 or that have more than eight animal units (one animal unit equals 1,000 pounds live weight) must implement nitrogen/phosphorus-based nutrient management plans. Reduces phosphorus in manure through feeding management. Transports manure from fields with excessive phosphorus to fields needing nutrients. Uses tax incentives: provides a tax credit up to 50 percent or $4,500 per year for the cost of nitrogen fertilizer for farmers who must reduce the use of manures to control phosphorus; provides a 100 percent state income tax deduction for costs involving more efficient spreader equipment that lowers the amount of manure dispersed.
New York	Made $15 million available for phosphorus reduction projects from wastewater treatment plants and agricultural nonpoint source control projects. (Clean Water/Clean Air Bond Act of 1996)
North Carolina	Farmers participate in a voluntary Agriculture Cost Share Program by submitting an application of their best management practices (BMP). If approved, participating farmers receive 75 percent of the average costs; the other 25 percent can be paid either directly or in-kind. The program also provides local districts with matching funds to hire personnel to plan and install the BMPs. In fiscal year 1996-1997, the program received approximately $15.9 million in state appropriations.

Pennsylvania	Uses a cost share program for farmers implementing nutrient management plans; $0.56 million was allocated in 1998 and another $2.17 million was allocated for low interest loans/grants.
Rhode Island	Prohibits the sale of cleaning products containing more than a certain percentage of phosphorus. (Phosphorus Reduction Act of 1995)
Virginia	Issues tax credit of 25 percent for the purchase of more efficient farm nutrient and pesticide application equipment that meets specifications. Recipients of the credit also must develop a nutrient management plan for their operations. (Virginia Code 58.1-337) Cost share program that began in 1987 gives 75 percent of the costs of BMPs to participating farmers. These farmers must have a nutrient management plan to participate. In FY 1999-2000, Virginia allocated $12 million to the program. (Virginia Code 58.1-339.3) Limits or bans phosphorus content in household and industrial cleaning products (with various exemptions). (Virginia Code 62.1-193.2) Voluntary nutrient management and training program. (Virginia Code 10.1-104.2)
Manitoba	Bans winter spreading of manure for large-scale producers. Enforces limits on the amount of manure that can be spread on land. Requires manure management plans for large-scale producers. Requires permits for all manure storage facilities prior to construction. (Livestock Manure & Mortalities Management Regulation)

Appendix A: Phosphorus Reduction Tips

These methods depict the best management practices for phosphorus reduction for business users, wastewater treatment plants, and drinking water treatment facilities, as established by the Minnesota Pollution Control Agency.

Excerpted from: "Phosphorus Management Plan Development Resources," March 2003, Minnesota Pollution Control Agency and the Minnesota Technical Assistance Program.

Phosphorus contributors	Tips to reduce phosphorus
All business users – commercial, industrial, and institutional Including agricultural co-ops, car/truck washing facilities, dairies, food processing plants, meat packing and locker plants, metal finishing facilities, municipal water treatment plants that add phosphorus to drinking water, nursing homes, restaurants, schools and other businesses or institutions with phosphorus sources	**Cleaning & sanitizing** • Establish purchasing criteria for cleaning products • Use low- or nonphosphorus cleaners and detergents • Use low proper concentrations of cleaners and detergents • Use cleaners and detergents as directed by manufacturer • Do not accept sample cleaners from vendors
Industrial/metal finisher	**Metal preparation, finishing, & painting** • Evaluate low- and nonphosphorus systems • Reuse water where it will enhance cleaning • Maintain proper levels of phosphate in the bath • Keep process solutions in their tanks by reducing carryover • Use deionized reverse osmosis water for process baths and rinses • Ensure all process controls are properly set, calibrated, and maintained • Keep spray nozzles cleaned and maintained
Industrial/food processor Including dairies, meat packing and locker plants	**Food processing** • Keep food by-products off the floor and out of drains • Use dry cleanup practices prior to wet cleaning • Reduce spills, leaks, and tank overflows • Use an automatic clean-in-place (CIP) system • Reuse food by-products for animal feed, composting, or landspreading
Wastewater Treatment Facility	• Improve phosphorus removal using biological or chemical treatment methods

Domestic	• Institute environmentally preferable purchasing in your household. Find sources for low- or nonphosphorus dishwashing liquids and soaps • Use laundry detergent purchased in Minnesota or other states in which only low- and nonphosphorus detergent is sold **Prevent phosphorus from entering storm sewers** • Wash the car on the lawn to prevent phosphorus-laden rinse water from running into stormwater sewers • Collect organic material (leaves, grass clippings, etc.) from street drains and gutters. Check fall leaf pick up dates to take advantage of composting services • Use phosphorus-free lawn fertilizer • Restore natural shoreland or streambank habitat to prevent phosphorus-laden runoff from entering surface water • Use lawn mowers that chop up grass clippings and leave them on the lawn. These mulching mowers reduce the need for fertilizers
Drinking water treatment plant	• Optimize the addition of phosphorus to the drinking water supply. This prevents pipe corrosion

Water conservation

Reducing effluent flows from businesses may reveal hidden phosphorus concentrations.

Businesses

- Monitor water use to establish a baseline
- Continue monitoring to raise employee awareness
- Implement a training program to show employees how to use water efficiently
- Use pressure gauges and control valves on any mist spray rinse
- Use adjustable/low pressure nozzles
- Use smaller size nozzles
- Angle and space nozzles to maximize the contact of the water's spray
- Use solenoid valves to stop the flow of water when production stops
- Implement programs to stop water flow during nonproduction times
- Repair leaks in hoses and nozzles
- Implement a preventing maintenance plan
- Use flow meters to identify causes of high water use
- Modify drain zones to return more solution to previous stages
- If your company has different operating divisions, consider charging water use back to each division, this can create financial responsibility and will maximize water use and efficiency.

Domestic

- Install low-flow showerheads and flush toilets
- Redirect groundwater sump pump discharge from laundry sinks to lawns or the storm sewer

Appendix B: Agricultural Best Management Practices

This section describes best management practices (BMP) in agriculture for preventing erosion, controlling runoff, and reducing and removing phosphorus. Excerpted from “Best Management Practices for Phosphorus,” Kansas State University Agricultural Experiment Station, MF-231, February 1998.

Ten Erosion and Runoff-Control Best Management Practices for Phosphorus		
Practice	**Description**	**Benefit**
1. Conservation tillage	Cropping system that maintains at least 30 percent of the soil surface covered with residues after planting	Helps reduce erosion. Most effective as a BMP when utilized along with phosphorus-placement methods such as deep banding, incorporation, or seed placement
2. Contour farming	Planting crops in rows that follow the contours of the land, perpendicular to the slope of the land	Crop furrows are positioned to block downhill water flow, reducing sheet and rill erosion
3. Gradient terraces	A terrace designed to divert runoff to a suitable outlet, such as a grass waterway	Reduces speed of runoff, and hence, the amount of soil that is eroded from the field during an intense storm
4. Level terraces	A terrace designed to store water until it can be passed through an underground outlet or seep into the soil	Breaks slopes into segments to stop water movement and allow eroding soil particles to settle out rather than leaving the field
5. Grass waterways	Sodded channel that provides an outlet for runoff	Serves as a controlled outlet for field runoff water and sediment movement, reducing the potential for gully erosion
6. Contour strip cropping	Alternating strips of close-growing, erosion-resistant crops, and erosion-susceptible row crops, planted on the contour	Eroding sediments from the row crop strips are trapped and deposited in the strips of solid-seeded, erosion-resistance crops
7. Vegetative filter strips	Strips of permanent vegetation on the downhill perimeter of erosive-crop fields of between the field and water bodies	Catches and filters sediments from surface runoff
8. Constructed wetland	Artificial wetland created downhill from crop fields	Sediments and runoff are collected, and soluble nutrients are assimilated by growing vegetation
9. Sediment-control basin	A short earth embankment constructed across the slope to form a sediment basin	Traps runoff water and allows sediments to settle out

10. Critical-area planting	Planting permanent vegetative cover on highly erodible lands that cannot be stabilized by ordinary conservation practices	Takes erodible land out of production, reducing or eliminating need for phosphorus application on the area

Eight Phosphorus Best Management Practices		
Practice	**Description**	**Benefit**
1. Soil testing and sound fertilizer recommendations	Sample the upper six inches of soil to analyze for available phosphorus. Fertilizes soils with medium or lower phosphorus soil-test values using environmentally and economically sound agronomic guidelines. Soils testing high should not receive phosphorus fertilizer unless as a low rate of banded starter	Helps determine accurate fertilizer recommendations and reduce potential for excessive phosphorus applications
2. Determine available phosphorus credits	Credit all available phosphorus from manure and other organic sources	Results in more accurate phosphorus recommendations
3. Site-specific management	Rather than applying a single phosphorus rate over the entire field, phosphorus-application rates are varied on-the-go with a variable-rate applicator	Helps ensure no area of a field receives less or more phosphorus than necessary
4. Phosphorous placement	Phosphorus fertilizer should be incorporated, deep banded, or banded near the seed at planting on soils with runoff potential	Reduces potential for runoff of soluble phosphorous
5. Manure collection, storage, and handling	Sample manure to determine its nutrient content, then calibrate the manure spreader and apply no more than needed to meet the phosphorus requirement of the crop. Incorporate after application. Do not apply manure to frozen soil	Helps avoid runoff problems and the application of excessive levels of nutrients
6. Irrigation management	Manage irrigation to prevent overapplication	Helps prevent phosphorus runoff and leaching
7. Setback zones	Do not apply phosphorus fertilizers or manure within 100 feet of surface waters or in areas subject to flooding	Helps prevent direct movement of applied phosphorus into surface waters

8. Erosion- and runoff-control measures	(See table above)	Phosphorous is often tightly attached to soil particles. Reducing soil erosion helps reduce phosphorus losses if phosphorous has been applied to the field surface

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