COVER YOUR COSTS
SUSTAINABLE AGRICULTURE SOLUTIONS
FOR COST EFFECTIVE WATER TREATMENT
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EXECUTIVE SUMMARY

In the Upper Mississippi River Basin over 4,000 water bodies do not meet federal water quality standards, meaning costly facility upgrades for many communities in the region. Addressing local non-point source pollution, specifically agricultural runoff, can improve water quality at a significantly lower cost. Agriculture is the predominant land use in this region and accounts for about 70% of the nutrient loading into the Mississippi River and Gulf of Mexico. Cover crops are one of the most effective practices for reducing agricultural nutrient pollution. This report reviews the problem of nutrient pollution, the use of cover crops as a solution and three examples of water utilities that have used cover crops to solve or prevent water quality issues without breaking the bank.
INTRODUCTION

Water facility managers are used to treating for a variety of contaminants, yet for many managers in rural communities in the Upper Mississippi River Basin, nutrients from agriculture are a common problem. Poor soil management and over application of fertilizers and animal manures on private lands are the main causes of nutrient contamination, specifically contamination from phosphorus and nitrogen. Facility managers can significantly reduce the cost of water treatment by working with growers and producers to decrease nutrient loss from agricultural lands in the watershed. Cover crops in particular are a valuable agricultural practice that can significantly reduce nutrient pollution running off into nearby water bodies, saving source water and wastewater utilities on treatment costs.

Cover crops are unharvested, non-commodity crops grown before or after harvested crops, when the soil would otherwise be bare. Cover crops are planted to prevent wind and water erosion, reduce nutrient loss and improve soil health. Annual commodity crops, such as corn and soybeans, only substantially cover the soil about four months out of the year. Once harvested, these crops often do not have enough residue to protect the soil from eroding until the next growing season. Cover crops protect the soil from erosion in the same way as the commodity crop residue; by significantly covering the soil and providing an active growing plant to absorb and hold onto nutrients. Cover crops also supplement and secure the residues left by commodity crops. Crop residues contain nutrients that will go back into the soil to be used by next year’s crops. Residues also provide ground cover which reduces erosion. Cover crops hold onto nutrients until the next growing season so they can be used by the next crop instead of getting lost to surface or ground water.

Cover crop signs. Photo: Elizabeth Lillard.
NITROGEN

Nitrate is soluble and highly mobile in soils, which makes it easy for plant uptake but also prone to filtering down through soil or moving with water. The U.S. Geological Survey estimates that corn and soybean fields alone contribute a little over 50% of the total nitrogen load to the Mississippi River and the Gulf of Mexico. This is directly tied to fertilizer application and the extensive use of agricultural drainage in the Basin. A decrease in pasture and forage acres, which receive less fertilizer than cropped acres and grow plants for more months of the year, and increasing fertilizer usage over the last fifty years have led to the significant nitrogen loading.

Nitrate is soluble and highly mobile in soils, which makes it easy for plant uptake but also prone to filtering down through soil or moving with water. Agricultural tile drains increase this process by drawing water down more rapidly to prevent overly wet field conditions. (See Figure 2) Tile drainage systems contribute to surface water contamination by draining the nutrient-rich water directly into surface water bodies; not allowing it to filter out naturally.
The properties that make nitrate a common contaminant also make it difficult to treat at the utility level. Ion exchange and reverse osmosis provide the two main methods for treating nitrates in drinking water. Total nitrogen can also be treated using ion exchange. Other TN removal methods can include chlorination of ammonia and biological removal. These methods are time consuming, involve some careful calibration, and have some waste management requirements, making efforts to address nutrient losses at their sources all the more cost effective and valuable to water utilities.

Des Moines Water Works Lawsuit

Nitrate pollution is a serious concern in the City of Des Moines, Iowa. In 2015 alone, the city’s water utility, Des Moines Water Works (DMWW), spent $1.5 million removing nitrates. If nitrate levels continue to grow, DMWW will have to make significant and costly facility upgrades. In early 2016, DMWW approved a plan, with $70 million dedicated to nitrate-reduction capital improvements.

As a result, DMWW is pursuing legal action against three rural counties upstream from the facility. The lawsuit alleges the nitrates running off of farm fields are polluting the drinking water supply. DMWW seeks to make farms comply with federal clean water standards that apply to factories and commercial enterprises. The lawsuit is scheduled to be heard in court in June 2017.
Phosphorus behaves very differently than nitrate. Most forms of P are not very soluble in water and easily bind with particles of soil. Phosphorus in fertilizers comes in the form of phosphate, and is designed to be initially water soluble upon application. Once the fertilizer touches the soil, the phosphates begin to dissolve from soil moisture. Through a series of chemical reactions, the once easily solvent phosphate becomes insoluble and bound to soil particles. This phosphorus cannot be transported unless the soil itself is moved. Therefore during a soil erosion event, all the bound phosphorus will be conveyed to the nearest water body. Once the phosphorus reaches the water it becomes available for aquatic plants, and algae growth. Excessive levels of phosphorus lead to explosive algal bloom growth, and ultimately to toxin production.

There are a variety of harmful toxins that can be produced by HABs. In the Midwest, microsystin is the most commonly produced HAB toxin. The EPA Health Advisory for microsystin is 0.0016 mg/L. Since it is a health advisory it is not legally enforceable, but is considered a recommended standard. However it is currently the only published numerical federal limit. Drinking water treatment facilities have to treat for both the toxin and the actual algae. Utilities can use an array of options for treating microsystin including conventional coagulation, chlorination, ozonation, and powdered activated carbon, among others. Effectiveness of these treatments vary depending on toxin concentration, plant configuration and water chemistry.

Microsystin is not a primary concern for wastewater treatment facilities. They are more focused on treating for phosphorus. Phosphorus treatment options include filtration, chemical precipitation, and various biological processes. Regardless, treating for HABs and phosphorus increases costs quickly for both drinking water and wastewater utilities and their customers.
Toledo Water Crisis

The City of Toledo Ohio experienced one of the most well-publicized examples of HAB contamination. In August 2014, the city issued a “do not drink or boil” warning, resulting from high levels of microsystin. This advisory lasted for several days and affected almost 500,000 people. Toledo area hospitals saw a noticeable uptick in patient visits complaining of symptoms related to microsystin contamination. Residents had to resort to using bottled water, causing serious shortages in northeast Ohio and southeastern Michigan.18

Dead fish wash up on shore as a result of the 2014 HAB. Photo: Tom Archer, MI Sea Grant. Inset: NWF CEO Colin O’Mara discusses the water. Photo: Jordan Lubetkin, NWF.
Protecting local water quality by managing nutrients within a watershed is the most efficient and cost effective method of addressing nitrate and phosphorus pollution in drinking water and wastewater.

**According to the Iowa Nutrient Reduction Strategy (INRS), using cover crops is the single best practice for reducing both nitrate and phosphorus loss from agricultural fields.**

According to the Iowa Nutrient Reduction Strategy (INRS), using cover crops is the single best practice for reducing both nitrate and phosphorus loss from agricultural fields.¹⁹ The INRS is the result of two years of work by the Iowa Department of Agriculture, Department of Natural Resources and Iowa State University and includes an extensive scientific assessment and literature review. INRS data shows that using cover crops results in a 30% reduction of nitrogen runoff and a 50% reduction in phosphorus runoff.²⁰

Living plants take up both nitrate and water, therefore the majority of nitrate and water leaching occurs during the fallow season. Cover crops can significantly reduce both nitrate and water loss by extending the active uptake periods of the field. Nitrate loss reductions range from 6 to 94%, depending on plant species, amount of cover crop growth, amount of nitrate in the soil, and amount of water moving through the soil. A recent study in Illinois found on average, cover crops absorbed 53 pounds of nitrogen per acre, which is a 68% reduction in runoff for the tested fields.²¹ These are significant reductions that can dramatically improve water quality. Cover crops alter nitrogen (N) uptake patterns, reduce downward movement of nitrate, and pull nitrate from deep soil layers. Nitrate is soluble in water and can be lost from fields through the downward movement of water. This phenomenon is especially prevalent if the field is tile drained. Without tile drainage, the water permeates downward at a much slower rate, and will eventually reach groundwater or surface water through subsurface flows. However, even without tile drainage, nitrate will pollute nearby water bodies, and is a concern to local water utilities.

Cover crops are not just beneficial to water quality. A survey of over 2,000 farmers conducted in March 2016 by the Sustainable Agriculture research and Education (SARE) program and the Conservation
Technology Information Center (CTIC) found that corn yields improved an average of 3.4 bushels per acre after using cover crops. The data also showed that yields increased over 8 bushels per acre after using cover crops for four years or more.

This makes cover crops an ideal agricultural practice for farms located in source water areas. It offers critical protection for drinking water sources, reduces cost of waste water treatment, and provides benefits to farmers.

**Case Study: Oconomowoc, Wisconsin**

Cover crops and other practices are already being used to manage water quality and treatment costs. The City of Oconomowoc, Wisconsin launched the Oconomowoc Watershed Protection Program (OWPP) in 2015, to coordinate with local partners, private land owners and agricultural producers to improve the overall environmental health of the Oconomowoc River watershed. This program, led by the city utility, provides an alternative permit compliance option called Adaptive Management, which is offered by the Wisconsin Department of Natural Resources. New permit limits, set in 2014, require the city wastewater treatment facility to reduce effluent limits to 0.17mg/l for total phosphorus or approximately 4,500 pounds per year. Upgrading the wastewater treatment facility to comply with those reductions presented an estimated $5 million initial investment, along with an additional $10 million to upgrade the municipal storm water system, which is also affected by stricter permit limits. Annual operating costs for an upgraded facility would likely average around $1 million. OWPP is currently designed for 5 years with an estimated total cost of $3 million.

Adaptive Management does not change the required reduction of 4,500 pounds of total phosphorus per year; it changes the source of the reductions. Phosphorus reductions will instead come from a variety of different sources across the watershed including, upstream...
agricultural areas and urban storm water systems, in addition to reductions at the wastewater facility. OWPP is coordinating partnerships and building relationships across the watershed to ensure the city wastewater treatment facility is in compliance and the watershed is healthy. Partners include: municipal separate storm water sewer systems, industrial permit holders, land owners, lake management districts, land conservation organizations and county land management departments.

The Oconomowoc River watershed is almost 50% agriculture. Therefore cooperation and collaboration with local producers is critical to the success of the program. OWPP has projects underway with two farmers, both of which are planting cover crops. There are currently 19 farmer projects pending, all of which include the use of cover crops, among other conservation practices.

Tom Steinbach is the Oconomowoc’s Wastewater Utility Operations Manager and has been leading this effort on behalf of the city. He touts the watershed approach, saying “the OWFPP will ensure the city will realize cost savings for wastewater treatment and storm water management and at the same time ensure the health of the environment and water quality.” Moving forward, OWPP will continue to reach out to local producers by hosting farmer education programs during the non-harvest season as well as continuing to meet with stakeholders and partners. This approach will save taxpayers and rate payers millions of dollars and improve water quality and environmental health for the benefit of all residents.

Case Study: WAUPACA WISCONSIN

Not all successful programs are as large or complex as Oconomowoc’s. The city of Waupaca, Wisconsin has been working with local farmers since the 1990’s. Although the city could apply for the Adaptive Management permit compliance option, it has not been necessary. In the early 90’s the
Wisconsin Department of Natural Resources had to shut down one of the city’s wells due to high nitrate levels. City utility officials decided to take action by looking at farming activities in critical source water areas. After conversations about farm management and nutrient reduction practices, the city entered into contracts with several farmers whereby the city pays the farmers to reduce nitrate runoff. The city saw improvements relatively quickly, which banished doubts about effectiveness.

Now, more than 20 years later, the city is still engaging local farmers through agreements. Currently the city has agreements with two farmers that have land covering about 1000 acres in and near critical source water areas. These agreements cost the city roughly $10,000 annually and have been very successful. As a result the city has not had to do any treatment of nitrates in several years. This has save the utility upwards of $1 million.

These farm arrangements not just beneficial to the city. The farmer receives a free cropping consultation and a per acre payment, as well as the many benefits that good farm management and cover crops provide. The city hires a crop consultant to work with each farmer to develop nutrient management strategies, and a whole farm plan, using practices such as cover crops, reduced fertilizer application and conservation tillage. The consultant also measures and monitors the farms’ soil and runoff nitrate levels. All of this information is then shared with the city. The amount the city ultimately pays the farmer is based on the type of crop planted. The agreements do not allow the farmer to plant crops that have high nitrogen requirements such as corn or potatoes. If the farmer plants crops that have medium nitrogen requirements, the city pays $13 per acre per year. For crops that have low nitrogen requirements the payment increases to $23 per acre per year.

City staff typically only checks in with the farmers once a year to make sure everything is still going smoothly. Built on trust, these stable relationships have survived several periods of staff changes from the treatment facility to the public works department. The current Public Works Director Justin Berrens started about a year ago and was not working at the city when the program began. However he recognizes the economic and environmental value of the program and is dedicated to seeing it continue.

Case Study: GRISWOLD IOWA

Wisconsin is not the only state with examples of successful water utility – agriculture partnerships. Griswold, Iowa has been working with farmers for several years as part of Iowa Department of Natural Resources’ (IA DNR), Source Water Protection Program. Griswold’s nitrate levels are close to the EPA’s 10mg/L limit. According to estimates provided by IA DNR, a nitrate removal system would have cost Griswold around $1 million to install and roughly $60,000 a year to maintain.
First the team mapped out the area around the town and determine the source water area or capture zone. The team found agriculture to be the main source of pollution in the capture zone and invited area farmers to participate in the project and the SWP team. This allowed farmers to actively participate as key partners in forming and implementing a solution. The team identified planting cover crops in high priority capture zones as the solution, with a specific goal of increasing cover cropped acres in the capture zone by 25% each year. The SWP team measures and evaluates nitrates in the town’s wells to monitor progress. This fall will be the fourth year of planting cover crops, and the team hopes to see 450 acres planted. Although this was to be the last year of the program, the SWP team is making plans to continue for several more years. Griswold has seen a decline in nitrate levels, and staff anticipates larger decreases in the future after consecutive years of cover cropping.

Because the town does not have the resources to afford a facility upgrade, staff decided to look at source water protection as an alternative. Working with the Iowa DNR, Griswold developed a Source Water Protection (SWP) project and coordination team. The SWP team defined two goals for the project; prevention of contaminants and ensuring sustainable drinking water.
GETTING STARTED

To get started on developing a source water protection plan or an alternative nutrient management strategy, there are numerous resources available. To help you get started contact:

- Your state rural water association: The National Rural Water Association (NRWA) is a non-profit organization dedicated to providing training and technical assistance to small water and wastewater systems in the United States. NRWA has 49 affiliated State Rural Water Associations (SRWA). However the SRWA’s cover all 50 states, tribal systems, and U.S. territories. Rural Water can provide assistance with every aspect of utility operation, management and finance. [http://nrwa.org/](http://nrwa.org/)

- Your state’s department of natural resources, environmental quality or equivalent: Each state in the Upper Mississippi River Basin has a department dedicated to environmental health and natural resource management. Within each of these agencies, there is staff available to help source water protection efforts. This staff can provide support for developing source water protection plans and connect you with other resources.

- Your local county conservation office: County conservation offices and districts are local units of governments that are focused on preserving a county’s natural resources, promoting good farm techniques and preventing erosion. County conservation staff typically works closely with local farmers, providing technical support for conservation practices design and implementation. They can help get in touch with farmers who might be interested in working with a utility on source water protection.

- The National Wildlife Federation Agriculture staff: We work with conservation minded farmers all across the Upper Mississippi River Basin and have experience facilitating conversations with farmers. We can provide technical support regarding source water protection plan implementation. For more information reach out to Elizabeth Lillard (lililarde@nwf.org).
Here are some simple steps and strategies to consider when developing and implementing a cost-effective strategy to address nutrients at their source:

- **Funding transparency**: It is critical as you develop relationships with local farmers to be very clear about what kind of funding is available to them and what you hope to accomplish.

- **Set goals and do your research**: Before you begin conversations with farmers, know what you are hoping to achieve and what kind of action you are looking for. Do some research, perhaps by talking to county conservation staff, about what practices are most likely to be successful and help you realize your goals.

- **Understand your audience and their needs**: Work to hear farmers’ concerns and to identify solutions that work for both parties. As noted in this report, cover crops can often provide that workable solution.

- **From the first step, define the partnership/project in terms of mutual benefit and remind all partners of shared values. This will get all participants on the same page from the day one.**

- **Be willing to find the information and expertise needed to define solutions and implement them**.

- **Define success and how to measure it to ensure the project has an impact and partners can celebrate that success**.

- **Understand that the process will likely take more time than you predict. Be patient. The cost savings, environmental benefits, and community building are worth it**.
CONCLUSION

Nutrient pollution poses a costly problem for water treatment facilities in the Midwest. Cover crops offer a solution that protects water quality at a fraction of the cost, while providing benefits to farmers. Soil health benefits and yield increases typically take several years to manifest, which is a barrier to adoption for some farmers. However in the long term, this strategy offers a win-win solution for utilities and farmers.

Conventional farming systems often leave soil exposed for half of the year, allowing both soil and nutrients to erode and diminish. By blanketing the ground, cover crops protect the field and nearby waters. Cover crops significantly reduce both nitrogen and phosphorus pollution, making it an ideal management practice. Building relationships with farmers and the larger community is one of the best ways to get cover crops planted in critical source water areas. Cover crops are not widely used in the Upper Mississippi River Basin, partially due to time, money and labor constraints. However, given proper financial and technical assistance, willingness to implement new practices such as cover crops that benefit farmers and water quality.

Cost effective nutrient reductions make cover crops critical to successful source water protection efforts. Increased cover crop use is good for water quality, the land, farmers and the community.
CITATIONS

3 Iowa Department of Agriculture and Land Stewardship, Iowa Department of Natural Resources, and Iowa State University College of Agriculture and Life Sciences. “Iowa Nutrient Reduction Strategy: A Science and Technology-Based Framework to Assess and Reduce Nutrients to Iowa Waters and the Gulf of Mexico,” September 2014.
20 Ibid.