

Final Report

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Cost Effective Pollution Prevention Strategies to
Reduce Phosphorus in the Minnesota and Lower
Mississippi River Basins

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External report for distribution: Company names are included in this document only when the companies have agreed to have their information shared by MnTAP. Any appendices with company names have been removed to abide by MnTAP's Confidentiality Statement.

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Cost Effective Pollution Prevention Strategies to Reduce Phosphorus in the Minnesota and Lower Mississippi River Basins

Executive Summary

The Minnesota Technical Assistance Program (MnTAP) at the University of Minnesota worked successfully in partnership with operators of wastewater treatment plants to provide pollution prevention outreach and implementation assistance to industrial users of municipal treatment systems in southern Minnesota. As a result of this outreach and assistance effort, both publicly owned treatment works (POTWs) and industries have a greater understanding of pollution prevention opportunities for their operations and the benefits that reducing phosphorus, biochemical oxygen demand (BOD), total suspended solids (TSS), and water use can have on the environment and on their bottom line. Many industries have implemented pollution prevention practices and technologies and are benefiting from reduced loading of phosphorus, BOD, and TSS to the treatment plant, reduced water use, reduced regulations and surcharges, and cost savings due to minimizing raw material loss.

During the course of this two-year project with McKnight Foundation support, MnTAP helped companies reduce 30,796 pounds phosphorus, 3,025,272 pounds of organic and solids loading, 66.5 million gallons water, and save \$2.8 million. This cost savings of \$2.8 million to companies represents a 37:1 benefit to cost ratio considering the cost of this project at \$75,000. Results from this project were achieved through a variety of on-site activities including site visits, student interns, and company teams.

There were two key elements of this project that made it successful. First, POTWs were effective partners when working with industrial wastewater dischargers in small communities. Second, pollution prevention strategies significantly reduced loading when applied to industrial wastewater streams. Over the two-year period, as industrial users made changes, POTWs could see the impact of those changes reflected in their monitoring data. Some municipalities avoided the need to add more treatment capacity, saving money for both the city and the industry. Other cost savings were apparent from reduced surcharges on industries and reduced chemical cost to cities.

Based on the results of this project, MnTAP plans to apply the critical elements of this model to other parts of Minnesota, particularly the Upper Mississippi River basin including POTW partnering and pollution prevention strategies. Working with POTWs has helped establish long-term relationships so that in the future POTWs will think of prevention first approaches to dealing with industrial discharges.

Introduction and Background

Historically, industrial pretreatment programs have focused on end-of-pipe solutions to control the discharge of wastewater pollutants. Wastewater treatment and pretreatment systems require both high capital and operating expenditures and do not eliminate or reduce wastes. Instead, treatment results in a transfer of waste from one medium to another -- in this case, from liquid wastewater to sludge for disposal.

Pollution prevention -- reducing or eliminating wastes or pollutants at the source -- is given highest priority in the environmental management hierarchy. In addition to achieving source reduction, pollution prevention incorporates practices that reduce the use of raw materials, water, and energy. Besides protecting the environment and conserving natural resources, there are many financial incentives for companies to implement pollution prevention programs, including cost savings related to raw materials, lost product, water, energy, and waste treatment and disposal. Implementing pollution prevention practices can also reduce a company's environmental liability and improve its public image.

Industry is not the only beneficiary of pollution prevention programs; publicly owned treatment works (POTWs) also benefit from:

- reduced influent loadings of phosphorus, biochemical oxygen demand (BOD), total suspended solids (TSS), fats/oils/greases (FOG), and heavy metals;
- reduced influent water (hydraulic) loading, avoiding the need to invest in additional sewer and treatment capacity;
- improved biosolids quality through reduced loading of heavy metals;
- reduced chemical, energy, and sludge management costs;
- reduced water demand, which increases the life of existing water supplies and avoids further investments in water supply and treatment infrastructure.

Specifically, this two-year McKnight Foundation-supported project focused on reducing phosphorus and other industrial pollutant wastewater discharges to the Minnesota and Lower Mississippi Rivers to minimize both local and downstream impacts. Phosphorus is a plant nutrient that stimulates excess algal growth in lakes and streams. When algae die, the decomposition process depletes available oxygen, threatening the survival of fish and other aquatic organisms.

The majority of phosphorus loading comes from nonpoint sources during high rainfall periods causing significant runoff from agricultural lands. During these high flow periods, the Minnesota Pollution Control Agency's (MPCA) monitoring data has documented that only 10% of total phosphorus comes from point sources. But during low flow or low rainfall conditions, point sources contribute as much as 64% of total phosphorus to the river basin. These point sources include wastewater treatment plants and industrial dischargers. Industrial sources of phosphorus include food processing, phosphatizing, and cleaning operations.

The benefits of pollution prevention to municipalities and industry are undeniable, which is why the Minnesota Technical Assistance Program (MnTAP) partnered with local POTWs to help companies implement pollution prevention practices.

Review of Project Objective

The Minnesota Technical Assistance Program worked successfully in partnership with operators of wastewater treatment plants to provide pollution prevention outreach and implementation assistance to industrial users of these municipal treatment systems in southern Minnesota. As a result of this outreach and assistance effort, both publicly owned treatment works and industries have a greater understanding of pollution prevention opportunities for their operations and the benefits that reducing phosphorus, BOD, TSS and water use can have on the environment and their bottom line. Many industries have implemented pollution prevention practices and technologies and are benefiting from reduced loading of phosphorus, BOD, and TSS to the treatment plant, reduced water use, reduced regulations and surcharges, and cost savings due to minimizing raw material loss.

Project Activities and Results

Results from this two-year project were achieved through a series of activities including outreach, technical assistance, documenting pollution prevention reductions and cost savings, and transfer of results. Table 1 summarizes project activities, goals set for each activity (according to the original proposal), and year one and year two project results.

As the data in Table 1 show, the focus for activities in the first year of the project was on developing relationships with municipalities, including outreach to municipalities, promoting the program, holding partner meetings with cities and industries, and beginning to make contact with industries. In contrast, second year activities were concentrated on working more closely with industries through one-on-one assistance to achieve pollution prevention. Each activity in the table is discussed in some detail below:

Outreach

As an outreach tool in year one, MnTAP created a wastewater four-page “mini-newsletter”. In the second year of the project, MnTAP continued to use the wastewater mini-newsletter as a means to promote the project and keep the project and its resources in front of POTW operators. Two mini-newsletters were distributed in 2001, in addition to the two distributed in 2000, for a total of four for the project. The mini-newsletter was an effective publication to promote site visits and interns for the project.

Additionally, MnTAP took advantage of numerous speaking and display opportunities as a way to promote the project. This allowed staff to update POTW operators on the latest successes, technologies, and resources, and to touch base with them on their specific industrial wastewater needs. Events during 2001 included:

- Region 5 Wastewater Meeting, Bloomington (12/8/00) (since interim report)
- Minnesota Waste Conference, Minneapolis (2/21-22/01)
- Meeting with City of Rochester wastewater permittees, Rochester (3/13/01)
- MPCA Wastewater Operators Meeting, Bloomington (3/21-22/01)
- Minnesota Wastewater Operator’s Association (MWOA) Central Section Meeting, Cold Spring (4/10/01)
- All Staff meeting for Metropolitan Council Environmental Services (MCES), St. Paul (6/6/01)
- Great Lakes Regional Pollution Prevention Roundtable, Madison, WI (7/13/01)
- Annual MWOA Meeting, St. Cloud (7/26/01)
- Air and Waste Management Association (AWMA)/Water Environment Association (WEA) Conference on the Environment, Bloomington (11/1/01)

New resources developed in 2001 included:

- Wastewater Reduction Options for Poultry Processing Plants (6/01)
- Newsletters: two four-page newsletters (February and October 2001)

Phone Contact

Over the two-year project, MnTAP staff responded to 144 calls from industry and POTWs, 80 in the first year and 64 in the second year. This exceeded the project goal of contacting 60 industrial facilities. Phone contact was used to discuss pollution prevention technologies and opportunities, line up site visits, and promote the intern and grant/loan programs.

Site Visits

Outreach efforts, partner meetings, and phone calls resulted in a total of 88 site visits over two years, with 26 in the first year and 62 in the second year. The project goal of conducting 60 site visits was exceeded. As mentioned previously, focus in the second year was on one-on-one site assistance. Relationships developed with POTWs and industry in the first year, paid off in a high number of site visits in the second year. Site visits were necessary when working with industries to achieve pollution prevention by providing company-specific pollution prevention information based on their identified needs and opportunities. In addition, resources such as interns or financial assistance were identified as a way to meet company needs.

The six partner meetings held in 2000 led to many site visits in 2001. Partner meetings were very effective at involving all affected parties, getting a baseline understanding of the local pollution issues, and collectively discussing pollution prevention solutions to the loading problem. In addition, some of the project's best-documented successes were from industries located in those cities where initial partner meetings were held. MnTAP's experience has shown that building relationships with all parties from the beginning results in the greatest pollution prevention outcomes.

Use of pollution prevention teams is another example of a successful site visit tool based on developing relationships and involving all parties. The difference is that these teams operate internal to the industrial facility to identify and implement pollution prevention practices. During the course of this project, MnTAP had eight teams operating in industrial facilities: AMPI (Dawson), AMPI (Glencoe), Plainview Milk Products and Lakeside Foods (Plainview), Bongards Creamery (Norwood), Chiquita (Owatonna), and Marigold Foods (Minneapolis and Rochester). All of these industrial facilities have shown some level of reduction and cost savings. Following 12 to 18 months of work with these teams, MnTAP was able to document reductions, then pull back and let the teams continue on their own.

Table 1. Summary of Project Activities, Goals and Results

Activity	Outreach	Phone Contacts	Site Visits	Partner Meetings	Student Interns	Documented Results
Project Goals	Contact all southern Minnesota POTWs; Contact 100 industrial facilities	Provide assistance to 60 industrial facilities		None	1 per year	Documented results from 30 facilities
Year 1 Results - 2000 (POTW-focused)	266 municipalities; 100 industries	80	26	6 Marshall Faribault Hutchinson Mankato Rochester St. Peter	1 intern Marigold Foods	Phosphorus reduced: 11,640 pounds BOD/TSS reduced: 572,600 pounds Water conserved: 12,500,000 gallons Cost savings: \$2,095,993
Year 2 Results - 2001 (Industry-focused)	Focus on 30 municipalities and 40 industries	64	62	0	3 interns Quest Intl. Pillsbury WisPak	Phosphorus reduced: 19,156 pounds BOD/TSS reduced: 2,453,272 pounds Water conserved: 54,000,000 gallons Cost savings: \$735,497
TOTAL		144	88	6	4	Phosphorus reduced: 30,796 pounds BOD/TSS reduced: 3,025,872 pounds Water conserved: 66,500,000 gallons Cost savings: \$2,831,490

Student Interns

The project goal was for MnTAP to support one student project each summer for a total of two as part of MnTAP's cost-share. MnTAP exceeded this goal by supporting four student projects during the course of the project:

- Marigold Foods, Minneapolis (2000): Evaluated and implemented ways to collect waste milk products for reuse
- Quest International, Rochester (2001): Water reuse and reduction, following food by-product removal
- WisPak, North Mankato (2001): Reuse water for noncontact cooling water
- Pillsbury Bakeries and Food Service, Chanhassen (2001): Implement water conservation measures, reduce service availability charge (SAC) through equipment modification and replacements, split streaming, and adjusting cycle timing.

MnTAP staff will conduct follow-up of student projects for two years beyond their endpoint to document additional reductions. Student projects are an excellent way to achieve pollution prevention because MnTAP provides a student to the company for three to four months during which time they are dedicated to a defined project. The student can measure before and after impacts at the company, help the company implement pollution prevention practices, in addition to gaining experience in an industrial setting.

Documented Results

Year two produced reduction numbers that exceeded year one probably due to the focus on industrial users, relationships developed, and additional time to implement.

Phosphorus reduced: 19,156 pounds
BOD/TSS reduced: 2,453,272 pounds
Water conserved: 54,000,000 gallons
Cost savings: \$735,497

Data for documentation of individual company reductions and cost savings comes from three sources including student intern project data, company data that is gathered and reported internally, and monitoring data that MnTAP gathers from the cities on phosphorus, and BOD/TSS before and after the project.

Technology/Information Transfer

Prior to beginning work on this project, MnTAP researched the work that other state and local programs had conducted related to partnering with wastewater treatment operators and implementing load reduction programs. This project had a greater emphasis on phosphorus reduction compared to efforts in other parts of the country, due to the MPCA policy of establishing phosphorus monitoring, management planning, and limits, and was therefore of great interest to POTWs in southern Minnesota where the policy was first implemented.

Success stories and fact sheets were developed to document results. MnTAP relied heavily on the four mini-newsletters to share resource information and results of the project as it was developed. Each of the newsletters covered different industrial sectors, sources, and pollution prevention opportunities to reduce phosphorus.

February 2000	Reducing Phosphorus from Metal Phosphatizing
August 2000	Reducing Waste from Dairy Operations
February 2001	Cutting Wastewater in the Poultry Plant
October 2001	Plant Maintenance and Institutional Cleaning Operations

In addition, presentations to MWOA and other local conferences and events have helped spread the word on how pollution prevention technologies and practices have helped municipalities reduce loading from their industrial users prior to putting in additional treatment capacity. Presentation of final results from this project will be made in April 2002 at the National Pollution Prevention Roundtable Spring Conference in Portland.

Deviation of Project Activities from Proposed Activities

Project activities over the past two years followed the original proposed scope of work very closely including:

- 1) Identification of critical communities and key industrial users in those communities.
- 2) Holding partner meetings between POTWs, industries, and MnTAP.
- 3) Utilizing POTW operators to reach industries with pollution prevention and MnTAP information and to set up site visits.
- 4) Providing one-on-one technical assistance through site visits, teams and interns.
- 5) Holding meetings with MCES and working on SAC.

The primary activity that was not followed was working with POTWs to conduct more general wastewater assessments for small to medium businesses to identify pollution prevention opportunities. This opportunity was brought up with POTW operators, and while there was interest, they wanted to focus initially on their largest industrial users that were creating the greatest loading problems for them. Focusing on the large users also provided POTWs with the phosphorus, BOD/TSS, and water reductions they needed to meet plant capacity and permit limits. Interest in doing wastewater assessments for smaller facilities may come at a later time, and MnTAP will continue to follow-up with POTWs on these opportunities.

Quantified Project Results and Discussion

The combination of technical assistance activities including site visits, team activities, and intern projects over two years has resulted in significant reductions and cost savings as shown in Tables 1 and 2. For the 88 industrial users we were able to work with on-site, reductions were documented from 22 of them for the following:

- Phosphorus: 30,796 pounds
- BOD/TSS: 3,025,872 pounds
- Water: 66,500,000 gallons
- Cost savings: \$2,831,490

These are significant results given the time frame of two years. The cost savings of \$2.8 million compared to the \$75,000 investment in this project gives a 37:1 benefit to cost ratio in terms of company savings.

MnTAP's goal was to reach an implementation rate of close to 50%, but the actual company implementation rate was 25%, about the same as MnTAP's past documented implementation rate of

25 to 30%. MnTAP will continue to follow up with these companies to provide further assistance and document results over the next one to two years which may increase the implementation rate.

While the primary objective of this project was to reduce phosphorus, pollution prevention measures implemented also have a huge impact on reducing BOD and TSS. In other words, whatever process changes are put in place to cut back on phosphorus will also result in BOD and TSS reductions. Once the pollutant loading is minimized, companies find they don't need as much water to wash everything down the drain, so water conservation measures can be put in place also.

The best example of this is often in the food processing industry where solids loading is significant. Once solids are removed or recovered from the wastewater stream the source of phosphorus is also removed. Not as much water is needed to wash food byproducts away, and therefore water conservation measures can be put in place.

Much of the success of this project is due to partnering with POTWs and holding partner meetings with the industry involved. This partnership met a number of needs:

- MnTAP used the POTW as a way to reach industrial users
- POTWs offered industrial users a nonregulatory resource to reduce loading to their plants
- There was a sense of working together to reach common goals between the city, the industry, and MnTAP with all parties committed to the project.
- MnTAP had access to monitoring data from both the city and industry, to measure before and after impacts.

This project affirmed that one-on-one site work is most effective when it comes to implementing pollution prevention projects. Working closely on well-defined projects with dedicated resources through site visits, interns, or teams over a one to two year period virtually assures pollution prevention implementation along with the ability to document before and after results.

In addition, MnTAP was able to make use of some built-in incentives including SAC reduction in the metro area and phosphorus reduction policy in southern Minnesota. These incentives gave impetus to the project and helped the parties remain committed because they knew if reductions didn't happen it would cost them in terms of time or fees.

Table 2: Quantified Project Results

		2000				2001					
Company	MnTAP Activity	Phosphorus (pounds)	BOD/TSS (pounds)	Water (gallons)	Savings (\$)	Phosphorus (pounds)	BOD/TSS (pounds)	Water (gallons)	Savings (\$)	Other (pounds)	Reduction Practice
Dawson Dairy	team			4,000,000	60,000		795,000		9,348		byproduct recovery; water conservation
Faribault Food processor	team					5,252	607,200		120,772		byproduct recovery; water conservation
Dairy	phone					2,704	165,600		32,937		byproduct recovery; water conservation
Glencoe AMPI	team	4,745	438,100		106,000		112,000		4,284		byproduct recovery
Hutchinson Manufacturer	phone					6,000				58,000	eliminate H ₃ PO ₄ from treatment
Manufacturer	site visit	1,950			643						changed to low/no phosphorus cleaners
Lake City Manufacturer	intern	3,068									changed to low/no phosphorus cleaners
LeSueur Dairy	intern			8,500,000	26,000						improved CIP system
Mankato Food processor	intern							7,600,000	40,000		water conservation
Manufacturer	site visit						120				BOD/TSS reduction
Marshall/Melrose Food processor	site visit; intern							30,500,000	91,838		water conservation

Table 2: Quantified Project Results, continued

		2000				2001					
Company	MnTAP Activity	Phosphorus (pounds)	BOD/TSS (pounds)	Water (gallons)	Savings (\$)	Phosphorus (pounds)	BOD/TSS (pounds)	Water (gallons)	Savings (\$)	Other (pounds)	Reduction Practice
Minneapolis Dairy	team/ intern		17,500		9,350				15,000		byproduct recovery; water conservation
Food processor	intern							1,900,000	35,000		water conservation
Norwood Dairy	team	1,877	117,000		2,000,000						byproduct recovery; water conservation
Owatonna Manufacturer	site visit								14,650	126,000	chrome reduction/ reuse
Food processor	team							10,000,000			water conservation
Plainview Food processor	team						21,516				byproduct recovery
Dairy	team						62,054				byproduct recovery
Rochester Food processor	intern					1,560	127,400		47,195		P, BOD/TSS reduction water conservation
Dairy	team					6,968	890,000		15,000		byproduct recovery; water conservation
St. Paul Manufacturer	site visit							4,000,000	\$66,000		water conservation
TOTAL		11,640	\$572,600	\$12,500,000	\$2,095,993	\$19,156	2,453,272	54,000,000	\$735,497	\$126,000	

2000 – 2001 Results

Phosphorus: 30,796 pounds

BOD/TSS: 3,025,872 pounds

Water: 66,500,000 gallons

Cost savings: \$2,831,490

What We Have Learned From This Project

The purpose of this project was two-fold. First, that POTWs make good partners when trying to work with industrial wastewater dischargers in small communities. Second, that pollution prevention strategies can significantly reduce loading when applied to industrial wastewater streams.

Working with POTWs as Partners

This project was largely successful because of the relationship built between POTW operators and MnTAP staff. POTWs were a critical link between MnTAP and the industry by holding meetings and setting up site visits. POTWs also came to understand and see the benefits that pollution prevention can have on how they work with industrial users in their communities. Over the two-year period, POTWs saw the impact of industrial changes reflected in their monitoring data in terms of reduced water flow and reduced loading of phosphorus and BOD/TSS. Some POTWs were able to use pollution prevention strategies as a tool in the compliance agreements with industry. Others avoided adding phosphorus treatment capacity because they were able to reduce industrial contributions of phosphorus to meet a specified limit. Pollution prevention also became a “friendly” way of working with industrial users, and a way of developing a better working relationship between POTWs and their users. In other words, POTWs could bring helpful, non-regulatory resources to their users in the form of grants and student help that could be used to solve problems.

Utilizing Pollution Prevention Strategies in Place of Treatment Options

Results from this project show that pollution prevention practices can have a significant reduction impact on industrial wastewater discharges, both in terms of water use and pollutant loading. By evaluating and implementing pollution prevention, the potential exists for industries to avoid adding pretreatment equipment and for wastewater treatment facilities to avoid having to add extra treatment capacity for either hydraulic or pollutant loading. Both the industry and city are operating more efficiently and able to keep costs down, or even cut costs. In addition, as a result of this project the benefit of using internal teams to implement and document pollution prevention practices was demonstrated. MnTAP knew that on-site work was very effective and had many years’ experience with site visits and interns. But internal company teams were just getting started at MnTAP and they became an excellent tool for working with industry.

Summary

Based on the results of this project MnTAP would like to put the critical parts of this model to work in other parts of the state: POTW partnering, pollution prevention strategies and internal company teams. On an as-needed basis, MnTAP will continue to address the needs of the Minnesota and Lower Mississippi River Basins, but would like to apply what has been learned in this project to cities and industries in the Upper Mississippi River Basin. Work with POTWs in these areas will help MnTAP establish long-term relationships with POTWs, so that in the future, POTWs will think of prevention-first approaches and MnTAP as a valuable source of assistance.