Introduction

This second annual report to the Governor, the Secretary of Administration and the Land and Water Conservation Board on the trading of water pollution credits describes the progress and status of water pollution trading activities in Wisconsin. Prepared in response to s. 283.84(5), Stats., this document contains updates on the three pilot projects which are underway to provide information to be used in coordinating state and local efforts to improve water quality through trading.

Definition

Watershed-based (pollutant) trading is allowing one entity to remove or prevent additional pollutant discharges while allowing another to discharge more than would otherwise be required. Under the control of an agreement between the two parties involved, the trade must, ideally, improve water quality and not result, at a minimum, in a lowering of water quality. From the economic side, watershed-based trading is a tool to be used in watershed management whereby all sources contribute to reducing pollution without any one entity bearing an excessive financial burden. This shift in responsibility may result in a more equitable, efficient, cost-effective means to address water quality problems in a watershed.

Goals

The primary focus of watershed based trading is to ensure that water quality goals are attained and maintained throughout a watershed by implementing the most cost-effective reductions in pollutants from various sources. The immediate goals for the Department of Natural Resources (Department) and the various participating organizations and entities are to:

- evaluate the potential for trading;
- develop and evaluate a framework for trading;
- allow trades to move forward if trading appears to be viable and willing partners exist;
- create, at the end of two years, a process for future trading.

The types of trades most likely to occur in the pilot projects are Point-to-Point (P-P) Trading and Point-to-Nonpoint (P-NP) Trading. A P-P Trade is where one point source, instead of reducing its own pollutant discharge, arranges for another point source to undertake a reduction in pollutant discharges greater than would otherwise be required. A P-NP Trade is where a point source arranges for a nonpoint source to undertake greater than required pollutant reductions as an alternative to the point source upgrading its own treatment.

General Activities

Primary efforts under this trading program are those associated with the pilot projects as described below. In addition, the Department is participating in the following activities to contribute to the development of a framework for pollutant trading in the state:

- Federal Policies and Guidance - The U.S. Environmental Protection Agency, Region 5 (EPA-5) has, in response to specific inquiries or actions of the states, provided additional guidance for the states to use in implementing watershed based trading programs. This additional guidance resulted in WDNR asking further questions as to the impact of such guidance on the progress of watershed based trading in Wisconsin. The questions and EPA-5 paraphrased responses were as follows:
  - Does EPA's trading policy of not allowing trading as a means to meeting technology-based limits for point sources apply to state-enacted technology limits? *EPA-5 response: "We would defer to WDNR as to whether the use of trading as a means of implementing these phosphorus limitations in NPDES permits is appropriate under state rule…"*
  - Does EPA's policy prohibit any trading in watersheds with 303(d) listed waters unless the trade is based on a TMDL load? *EPA-5 response: Federal regulation "…requires that permits for point source discharges apply effluent limitations to comply with water quality standards… In the case of impaired waters where there is no assimilative capacity, NPDES permits must apply limitations set equal to the State's water quality criteria. We recognize that this approach to setting limitations in impaired waterbodies is not well suited to situations where the pollutants responsible for an impairment do not have instream criteria which can be directly applied to an effluent… To the extent that your principal interest is the control of nutrients and oxygen depleting materials, there may be actions that could be taken to achieve the goals of trading in the absence of a TMDL…"*

  These responses were received positively by the Department because they revealed a willingness on the part of EPA-5 to be flexible in implementing their guidance and policy on watershed based trading. We, therefore, have been able to comfortably proceed forward with the plans for the pilot projects.

- Great Lakes Trading Network - WDNR continues to participate with other states, governmental units, and interested public and private parties within the Great Lakes Trading Network (GLTN) organization. This group advocates for the concept of watershed based trading and, primarily, shares experiences related to the implementation of trading. Regularly scheduled conference calls are the primary format for communication. The Network organized a meeting with the EPA Assistant Administrator for Water to discuss watershed based trading and provide examples of projects where trading was or is anticipated to be a cost-effective solution to water quality problems. EPA continues to express enthusiasm and support for the concept of watershed based trading and the GLTN will continue to work with EPA to demonstrate benefits of the program. Lastly, the GLTN is organizing a national conference for late spring 2000 to further share experiences and to facilitate the further development of a watershed based trading framework, which can be implemented within the state and federal clean water programs.

Progress and Status of Pilots

The Department of Natural Resources has selected the Red Cedar River, Fox-Wolf and Rock River Basins as the three pilot areas to explore the feasibility of watershed based trading among various sources of pollution. Phosphorus has been identified as the primary pollutant of concern

for all three pilots. The main objective of these pilots is to explore cost-effective and geographically targeted solutions for phosphorus reduction in the three basins. Each pilot is expected to help answer different questions related to the legal, economic and technical aspects of watershed based trading.

The Red Cedar River Basin

The Red Cedar Watershed is in west central Wisconsin and is part of the Lower Chippewa River Basin. The Red Cedar River basin drains approximately 1800 square miles and includes parts of Barron, Chippewa, Dunn, Polk, Rusk, Sawyer, St. Croix, and Washburn Counties. Northern parts of the basin are predominantly forested and agriculture is a dominant land use in the rest of the basin. The municipalities in the basin include Menomonie, Glenwood City, Downing, Boyceville, Wheeler, Colfax, Prairie Farm, Ridgeland, Dallas, Chetek, Turtle Lake, Almena, Barron, Cameron, Rice Lake, Cumberland, Haugen, and Birchwood.

A project was started here in 1994 under the oversight of the Red Cedar Steering Committee. This is a voluntary organization that has become the partnership team for the trading project. They have met at an approximate rate of once a month for the last several years to explore new ways of managing the water resource within the watershed. They have review and commented on the proposals for trading.

There has been, and continues to be, extensive monitoring within the Red Cedar Watershed to evaluate water quality, to identify the causative factors and to gather public perception on goals to be set. Information has been gathered to develop and calibrate the Simulator for Water Resources in Rural Basins (SWRRB) water quality model. This model was developed to evaluate pollutant loading for an impoundment in the lower part of the basin. The model provides approximate loading rates for total suspended solids and total phosphorus, and partitions them into different land uses. This information is useful to set water goals and source reduction rates for this impoundment. However, additional monitoring is needed to collect information on other impoundments and lakes upstream in the watershed. Without this information on how to improve water conditions throughout the watershed, partnership and source cooperation is unlikely. Monitoring/modeling projects are designed for Rice Lake, Lake Chetek and Red Cedar Lake.

To date, the City of Cumberland has made the most progress toward implementation of a trade to offset their phosphorus discharge. The City's WPDES permit contains a condition that requires Cumberland to submit a letter of intent to the Department regarding watershed based trading. The City submitted a report on June 4, 1999 to satisfy this requirement.

The Department and the City of Cumberland met in January of 1999 to discuss the detail needed for an acceptable trade. This resulted in the following:

- Cumberland will assure that twice the quantity of phosphorus is removed in trading than they would otherwise have to remove at the treatment plant. This will require that trading partners control an estimated 4,400 pounds per year be controlled.

- The treatment plant influent will be capped at 6,000 pounds per year and the effluent will not exceed 2,800 pounds per year. The City would be expected to employ phosphorus minimization actions to meet these requirements.
- The City can accomplish a phosphorus trade on any lands that drain to the Hay River above the Prairie Farm flowage.
- The City will provide a practice-by-practice calculation of the pounds of phosphorus removed.
- The City cannot obtain credit for any practice which implements any of the four animal waste prohibitions identified in s. 283.16(3)(a)1. through 4., Stats.
- Commitment for the trades will occur by October 1, 2000 and be implemented by October 1, 2001.
- The City must keep records of practices installed, maintenance provided and costs incurred.
- The agreement may be revised after the City's WPDES permit expires in December 2004.
- The City can discontinue the trading agreement anytime by notifying the Department in writing. The City would then be expected to construct facilities for phosphorus removal at the treatment plant during the following construction year and achieve the 1.0 mg/l phosphorus limit.

Cumberland, in conjunction with the Barron County Land Conservation Department (LCD), has submitted a report titled "City of Cumberland Point to Non-point Phosphorus Trading Project." This document was prepared by the Barron County Land Conservation Department for the point-to-nonpoint nutrient trading project proposed between the City of Cumberland and other sources in the Hay River Watershed. The minimum goal set by the DNR, as noted above, is to remove 4,400 pounds of phosphorus from the watershed annually. Because many of the crop fields are quite high in soil phosphorus levels, and because a considerable amount of animal waste is applied throughout the year, the Barron County LCD believes this amount of reduction can be readily attained through nonpoint source reductions, and may even be exceeded.

Other facilities are in the process of evaluating trading to meet phosphorus limits. The Dunn County Land Conservation Department has made contact with the Department on behalf of the City of Colfax to develop a proposal similar to the one for Cumberland. Colfax has been required to complete this evaluation before receiving approval for an alternative phosphorus limitation in their WPDES permit which now requires that they meet a 1.0 mg/l phosphorus limit, effective October 1, 2000. The City of Turtle Lake and the Turkey Store (for the wastewater treatment facility serving the Barron processing plant) are also considering similar alternative limit requests and may also be asked to evaluate trading possibilities.

The Department will continue to work with these facilities to develop the criteria under which trading will be acceptable. When trades are implemented, detailed records will be required to evaluate the cost and success of the trades.

The Rock River Basin

The Rock River Basin is located in south central Wisconsin. This 3,000 square mile basin is diamond shaped and covers an area roughly bound by the Horicon Marsh to the north, the City of Beloit to the south, the City of Madison to the west and the City of Oconomowoc to the east.

Nutrient trading has been actively discussed in this area since about 1996. The Department's Memorandum of Understanding (MOU) with the Rock River Watershed Partnership (RRWP) was signed in January 1997 and committed the Department to a minimum three year relationship with this group, centered around exploring alternative methods of removing phosphorus and improving water quality. There are approximately 60 signers of the MOU who are actively participating in the partnership.

The Department and RRWP undertook an aggressive work plan to develop and implement a least cost and maximum yield approach to watershed based trading/water quality management in the basin. Current efforts are centered on phosphorous management with an acknowledgment by all parties that a successful phosphorous trading scheme could be expanded to other nutrients. The owners/operators of several publicly-owned treatment works (POTWs) formed an intergovernmental cooperation group under s. 66.30, Stats., to administer funds necessary to conduct the five elements of the work plan. The intergovernmental group developed a budget of $340,000 to implement the work plan. Grants from EPA and WDNR helped fund other parts of the work plan. The balance of the budget is obtained through an assessment from each participating POTW and industry. The goal is to complete all tasks by the end of 1999. The information developed by elements of the work plan will provide the base of knowledge needed for POTWs and industries to make a decision to pursue or not pursue a trade in lieu of the phosphorus limitation requirements contained in NR 217, Wis. Adm. Code.

Specific elements of the work plan and accomplishments to date are as follows:

1. Modeling of Nutrient Loading in the Watershed. The objective of the modeling effort is to identify subwatersheds in the Rock River Basin which are contributing the greatest phosphorus pollutant loading and those which will be most likely to respond to applied best management practices. These watersheds will then be targeted for trading. Earth Tech (a consulting company located in Madison) was contracted to conduct the modeling study. The modeling effort, which was initiated in June 1998, is on schedule for completion by December 1999. The Soil and Water Assessment Tool (SWAT) watershed model was piloted in two watersheds to calibrate the model. The pilot produced a satisfactory degree of accuracy. Earth Tech is proceeding to complete modeling for the entire watershed. This element of the work plan is the largest single cost, but it is the centerpiece of the nutrient trading effort that will allow us to make intelligent least cost decisions in the trading environment.

2. Water Quality Monitoring. The water quality monitoring effort was initiated for a two fold purpose: 1) To provide data to calibrate the computer model; 2) To provide background data to evaluate changes in water quality that may occur as a result of management efforts. One year of monitoring has been completed as of August 1999. A second year of monitoring is planned. The monitoring project is a partnership effort with the U.S. Geological Survey (USGS), WDNR and the POTWs in the basin. WDNR obtained needed equipment and trained POTW staff on sampling protocol. USGS coordinates the timing of sample collections by POTW staff at the eight sampling stations. Analysis of samples is done in the lab of Madison Metropolitan Sewerage District.

3. Development of Watershed-Based Trading Structure and Framework. The objective of this element of the work plan is to develop a standardized framework under which trading can occur with a minimum of overhead costs. Three work groups comprised of WDNR, RRWP, University of Wisconsin Extension, Natural Resources Conservation Service, county LCD and industry staff are developing sample approaches/trading documents with a scheduled completion date of December 1999.

   The Administration of Pollutant Trading Work Group developed proposed concepts for efficiently facilitating trades under two different scenarios: 1) Trade initiator contracts directly with trade recipient with/without facilitation by a Land Conservation Department; 2) Trade initiator negotiates with a trade recipient through a facilitator/broker, most likely the Land Conservation Department. A comprehensive "Issue List" which documents key issues and concerns raised by RRWP participants and proposed policy for addressing these issues has been developed.

   The Trade Ratios Work Group is nearing completion on development of a phosphorous point-to-nonpoint trade ratio calculation formula to determine the amount of phosphorous that must be removed by a prospective trade. The formula will utilize standardized "scores" that can be assigned according to technological reliability of the nonpoint practice, spatial factors, temporal factors, chemical factors, proximity to specifically-identified impaired waters, targeting and collateral water quality improvement potential. The trade ratios work group is also developing a spreadsheet which will standardize values to be used for determining amount of phosphorous removed by nonpoint best management practices. This spreadsheet will also provide prospective traders with information on costs of best management practices.

   The Contract Language Work Group is developing a standardized format for trade contracts. The work group agreed that by April 30, 2000 prospective trade initiators must declare their intent to participate/not participate in a trade. Those deciding to initiate a trade must complete the trade (have nonpoint best management practices installed) by December 2001. Those deciding not to initiate a trade must complete an upgrade of their facility within the May 2001 to October 2002 period, depending upon the status of the facility in the upgrade process.

4. Literature Search on Best Management Practices Effectiveness and Cost. This element of the work plan has been completed. A report entitled "A Review of Agricultural and Urban Best Management Practices for the Reduction of Phosphorous Pollution" has been written and published by WDNRs Bureau of Integrated Sciences Services. (A synopsis of this review appears later in this report.) This document summarizes the information contained in the technical literature so it is readily available for use by those considering or implementing trades. This document is an important source of the information contained in the effectiveness/cost spreadsheets discussed above.

5. Biological Impact of Phosphorous in River Systems. The objective of this task is to determine what are the limiting factors for streams in the basin. This is a collaborative effort

by WDNR and the University of Wisconsin. Twenty-seven (27) sites in the basin are being assessed from a chemical, physical and biological perspective, including an assessment of habitat limitations. This project will help us understand why the Rock River aquatic resources are limited and what the response of the river will be to removal of certain forms of pollution. This effort will further help us target where nutrient trading efforts are best spent. Funding for the UW's involvement is through the RRWP. Completion of the field studies is scheduled by late fall 1999, with results of the final analysis available by early 2000.

Wastewater discharge permits for those entities participating in the RRWP have been or will be modified to place the requirements of NR217 on hold until the results of the above work efforts are available. We believe this effort should help the Department and the regulated community make intelligent choices about the application of the concept of watershed-based trading to reduce the cost of point source pollution control and to make overall gains in water quality in the basin. The successful collaborative partnership approach by those participating in the Rock River Basin Pilot has been a valuable learning experience that will result in future environmental gains whether or not watershed-based trading is proven to be an economically/environmentally viable concept.

Fox-Wolf Drainage Basin

Progress continues to be made in the Fox-Wolf Basin toward implementing watershed based trading. The watershed based trading team, headed by the Fox-Wolf 2000 organization, has completed a number of actions over the last year, implemented others and made plans for additional activities to be completed over the coming months.

To support the watershed based trading activities, Fox-Wolf 2000, has solicited grants from a number of sources to allow them to implement actions. Grants have been received from the Water Environment Research Foundation for $95,000, from the Joyce Foundation for $66,000, from the Green Bay Metropolitan Sewerage District for $52,000 and from the Department of Natural Resources for $14,000. These grants are addressing a number of areas that have been identified to be a necessary part of the watershed based trading process. These include research on the economic and legal basis for watershed based trading, communications and public information about trading, participation on advisory groups addressing trading, participation in the nonpoint source program redesign and conducting modeling for three sub-basins in the Fox-Wolf Basin. The economic analysis is investigating the relative costs of phosphorus removal at point sources versus nonpoint removal costs and which areas of the basin are likely to be the most cost effective areas to implement trading. The analysis has shown wide differences in the removal costs for phosphorus at the point sources now providing treatment, and suggests that the high cost systems are logical facilities to explore as potential point-to-point trading partners. This study has been completed and has been forwarded to a number of groups for their information.

The legal analysis is looking at some of the legal constraints and barriers to watershed based trading in the basin and what needs to be done to address these. This report is nearly finished and will soon be available to the Department and the others funding this work.

Fox-Wolf 2000 has hired a communications director to provide information to potential trading parties, organize educational forums, summarize the information that is important from these discussions and inform the general public about the benefits of trading. A forum was held in June 1999 with representatives from the Water Environment Research Foundation, local groups interested in trading and State regulatory agencies to discuss the feasibility of trades in this basin. This resulted in sharing of information from the local area with the WERF members who have knowledge of this activity at other pilot areas in the country and provided an opportunity for them to offer their suggestions and perspectives. A quarterly newsletter prepared by Fox-Wolf 2000 has devoted one entire issue to watershed based trading as another information and educational effort. There is also a web site (http://www.fwb2k.org/), as another tool to inform and educate on this topic.

Fox-Wolf 2000 is participating in the Great Lakes Trading Network, a group of organizations and states interested in watershed based trading. Monthly conference calls are held to update members of the status of trading in the states surrounding the Great Lakes and to share ideas and issues with this larger group. Fox-Wolf 2000 is also participating in the effort to redesign the nonpoint program in Wisconsin. This provides the opportunity to incorporate the concept of watershed based trading into this program.

Fox-Wolf 2000 staff has developed or is working on computer models for the Lower Fox River, Pigeon River and Big Green Lake sub-basins. These models will be used to assist planning for actions to address phosphorus problems in these basins. They have also proposed working with the Lower Fox Partners Team in the development of a Total Maximum Daily Load (TMDL) model for the Lower Fox River Basin. Development of a TMDL is a critical step in establishing the levels of phosphorus reduction necessary in a basin to achieve a desired water quality level.

Upcoming activities include plans to hold a series of meetings during the fall of 1999 in each of the three main sub-basins of the Fox-Wolf with dischargers, county Land Conservation Departments, Department of Natural Resources field staff, environmental organizations and other interested parties. These meetings would serve to inform and educate the participants about the concept of watershed based trading and determine if interest exists in this area. A few inquiries have already been made by facilities that have heard of the concept and have an initial interest. Efforts are underway by Department of Natural Resources staff to provide a list of facilities that may be potential trading partners.

A final report to the agencies that are providing grant funds is due in April 2000. By then the actions planned to date will be completed and a better idea will exist about the interest and possibility for watershed based trading in the Fox-Wolf Basin.

Beyond the Pilots

As part of the effort to evaluate watershed-based trading, the Department is counting on the pilots to provide the majority of the answers to questions regarding implementation of watershed based trading. However, there are other sources of information and other groups that can be utilized that may give a more statewide perspective or help identify generalizations that would be

appropriate to a framework. Two of these opportunities are: 1) the Watershed Advisory Committee, and the perspective they can lend, and 2) contracted research studies to provide the technical background. Both of these efforts will be important in the development of a statewide framework.

Watershed Advisory Committee

The Watershed Advisory Committee is a group of representatives from a broad array of interests associated with policies set by the WDNR, Bureau of Watershed Management. This committee meets periodically to discuss issues and to advise the Bureau on topics of importance for the Bureau's many programs. Watershed based trading is an issue this committee will have an opportunity to comment on during the development of a statewide trading policy. The committee has been briefed on the progress being made in the pilots and several questions at that briefing may ultimately have statewide significance. These five questions were presented and the committee discussed them, with the following feedback:

1. **Should trade ratios be universal or site specific?** *A simple trade ratio of 2:1 or 4:1 (nonpoint-to-point) could be selected for a given point source in a given watershed. This would be considered a universal trade ratio. Another option would be to consider a different trade ratio depending on how far upstream a nonpoint source was, what practice was selected to control the nonpoint source, etc. This would be considered a site-specific ratio.*

The committee clearly supported some form of a site-specific trade ratio. Perhaps a universal minimum and maximum could be established, but within that range there should be the opportunity to vary the ratio based on conditions at the site. Ideally, some sort of model or matrix could be set up to facilitate identification of the parameters to consider when setting the trade ratio.

2. **Should trades be restricted to a fairly small geographical area or can they be considered in a larger basin context?** *It is postulated that limiting the area for trading will result in a localized water quality improvement that is measurable. However, a broader view may be that any improvement within a larger basin would still result in an improvement at the farthest downstream water body and, therefore, such a trade should be allowed.*

The committee generally felt that if trades occur on a smaller scale, they would likely be more successful, viable and attractive. They will also be more visible to the public in terms of seeing how their money was spent. It would also allow trades to be focused in areas that have a localized problem or in "threatened" waters. However, the committee still felt that the option to expand the trades to a larger basin under certain situations would be appropriate and should not be ruled out. For example, if phosphorus loading to a lake with a large watershed is the concern, then, in order to reduce the loads to the lake, we should consider reducing the loads anywhere in the lake's basin.

3. **Should trade ratios be used to make some trades more economically attractive?** *If the intent is to target certain areas for trading in order to see a more localized impact, then the*

trade ratio for those areas should be lower than in an area that is farther away or not as directly related to the area of impact.

The committee felt that watershed based trading should be a tool to meet water quality standards and, if the trade ratio works toward this goal and is good for the environment, then making a trade ratio favorable in these situations is a good idea. The trade ratio must result in a water quality improvement.

4. **How can we encourage the nonpoint source community and environmental groups to be more involved in the process?** *While point sources are under a mandate to reduce phosphorus at their treatment plants, the nonpoint sources have no such mandate and have been reluctant to participate. Environmental groups have similarly not shown a strong interest in the issues related to watershed based trading.*

There are a number of reasons the committee cited for why these groups may not be involved. Certainly, economics will play a significant role. If there is no requirement placed on an agricultural facility to meet a certain limit or requirement, then the costs outweigh the perceived benefit. In many cases, the farmer is not aware of how controlling sediment may help his/her business. More effort needs to be made in the area of information and education on the benefits and the advantage of accepting funding from a point source to construct practices to control nonpoint sources.

5. **How will we define water quality improvements?** *The statute requires that watershed based trading result in an improvement in water quality. It does not define what "improvement" means.*

The committee discussed this topic for some time, but was unable to reach any sort of consensus. They made the distinction between actual measured values and the public's perception of the problem and what constitutes a solution. It doesn't make sense to ask the nonpoint sources to complete in-stream water quality tests to show improvement if point sources are not asked to do this. In the absence of a more science-based approach, a calculated load reduction may be the best way to identify an improvement.

Research

In the biennium, $100,000 of funding was available to assist the pilots in the development of a trading framework. One of the first work products identified by all three pilots was the need to know what the different best management practices for nonpoint source pollution cost and their efficiencies. This information is essential in establishing an appropriate trading ratio. A literature review and the development of useable tables for the pilots have been completed this year. Additionally, the effect of phosphorus on measurable water quality has also been an issue of concern, especially in the riverine portions of the basins. Summaries of the reports on these two topical areas are provided below:

"A Review of Agricultural and Urban Best Management Practices for the Reduction of Phosphorus Pollution" Prepared by Chad Cook for the Department's Bureau of Integrated Science Services, May 1999 (PUBL-SS-943-99)

Urban areas and agricultural activities are two major sources of nonpoint source pollution. Urban runoff contributes sediment, nutrients and pesticides from lawns, and heavy metals and organic contaminants from vehicles. Agricultural activities such as animal facilities, grazing, plowing, irrigation, fertilizing, planting, and harvesting are all activities that primarily contribute sediment and nutrient loading to the surface waters. Although nitrogen and phosphorus are both nutrients of concern for aquatic systems, phosphorus is predominantly responsible for the degradation of freshwater systems. This report identifies the best management practices (BMPs) for controlling phosphorus along with their costs and efficiencies.

Many practices exist to control phosphorus from nonpoint sources in an environmentally, economically and socially acceptable way. Agricultural BMPs are classified as cultural, structural, and management oriented. Table 1 (attached) summarizes many agricultural BMPs, their effectiveness in reducing sediment and phosphorus loading, their potential cost, and cost-share opportunities. Urban BMPs include prevention techniques, source control techniques, and regional techniques. A summary of urban BMPs is provided in the attached Table 2. The reduction estimates in Tables 1 and 2 are most likely to occur under optimum site conditions. Improper design, sizing, and construction can reduce the load reduction potential significantly. Based upon the literature review presented in this report, the following conclusions can be drawn:

- Effectiveness is largely dependent on site-specific characteristics.

- In general, the higher the initial phosphorus levels, the more cost-effective initial reductions will be.

- For agricultural systems with similar slopes and flow path characteristics, the more distant a pollution source is from a waterbody, the less impact it will have. However, in urban systems, it may not be the case, as the impervious surfaces may bring pollutants from greater distances.

- A multiple BMP system is generally more effective than a one or two BMP system..

- Nonstructural BMPs are typically more cost-effective, but in general achieve a lesser reduction compared to structural BMPs.

- Careful attention should be given to phosphorus concentration and loads after BMP implementation because pollutant reduction by BMPs may not decrease pollutant levels below environmentally healthy levels. Implementation should strive to reduce input levels to less than critical eutrophication levels.

Site evaluation is the most important step in designing BMPs and factors such as contributing area, soils, slope, and inputs are all critical in effective BMP selection processes. BMPs, with careful design and under the right conditions, can effectively reduce pollution loads to waterbodies.

Preliminary Report of Monitoring Activities during 1998, communication from Paul Garrison, Bureau of Integrated Science Services, DNR, August, 1999

Water quality samples were collected from the three pilot basins during the period May through November in 1998. Water chemistry samples were collected on a monthly basis only during low-flow conditions. Samples were collected for attached algae in August and macroinvertebrates in September and October. In all three basins, samples were collected to assess water quality in selected tributaries (wadeable streams) as well as the length of the main stem. The purpose of the sampling was to assess the water quality of a number of tributaries as well as the main stem of the rivers. Samples were collected from 24 tributary and 8 main stem sites in the Rock River Basin, 26 tributary and 6 main stem sites in the Fox/Wolf Basin, and 13 tributary and 7 main stem sites in the Red Cedar Basin. Only three sites in the Fox/Wolf Basin were in the Wolf River Basin.

In the tributaries, there appeared to be a weak relationship between phosphorus values and other measures of water quality. For example, in the South and West Branches of the Rock River, phosphorus levels exceeded 2400 $\mu g\ L^{-1}$, yet algal levels, as indicated by chlorophyll, were relatively low. This stretch of the river is relatively small and fast flowing with a number of riffles. Undoubtedly if flows were more stagnant, the river would possess noxious algal levels. Sediment seemed to be more of a water quality problem in the tributaries. From an aesthetic point of view, the streams that appeared the worse were those that had the highest suspended sediment.

In contrast, the water quality in the main stem of the Rock River (below Horicon Marsh) and the Fox River was much more responsive to phosphorus levels. In fact, there was a significant statistical relationship between phosphorus and chlorophyll in these systems. These systems seem to be analogous to large narrow lakes. In lakes, there is a very strong statistical relationship between phosphorus and chlorophyll.

In summary, the nutrient levels of the Rock River Basin, both in the tributaries and the main stem, were higher than the Fox River or Red Cedar River basins. The latter basin on average possessed the best water quality of the three pilot basins. Although dissolved oxygen was only measured during the day, low levels ($< 5\ mg\ L^{-1}$) were only found at two sites. Elevated nitrogen levels in the Rock and Fox River basins was largely a result of nitrate. While sediment and physical factors (e.g., current velocity) largely determine water quality in the tributaries, phosphorus clearly is the controlling factor in algal levels, and thus water quality, in the main stem of the Fox and Rock River basins. This is not as evident in the Red Cedar Basin since it possesses a more riffle environment. However, in the impoundments, large algal blooms occur as a result of elevated phosphorus levels.

Summary

As outlined in this report, the Department has continued to make progress in evaluating the potential for watershed-based trading. Over the last year, the three pilots have taken different approaches to determining the appropriateness of watershed-based trading in their area. The Department and the stakeholder groups (pilots) have identified and discussed a large number of issues. This year has seen the completion of additional monitoring and modeling work, the resolution of a number of administrative and institutional issues and potentially the first trade of pollutant credits with the City of Cumberland. The expectation for next year includes the completion of trades in the Red Cedar River Basin, finalizing a framework for trading in the Rock River Basin and the identification of the level of interest and the possibility for trading in the Fox-Wolf Basin.

Table 1. Agricultural BMP Summary

BMP	*Phosphorus Reduction*	*Sediment Reduction*	*Cost*	*Incentive Payment/Cost Share*	
				WDNR[1]	*EQIP*[9]
Conservation Tillage	15-85%	15-90%	$9-$26 per acre per year[2]	$18.50 per acre for up to 6 years or 50%	$10.00-$15.00 per acre per year for up to 3 years
Contour Farming	Similar to sediment reduction, less effective on soluble P than total P	30-50%	$4 per acre per year[2]	$9.00 per acre for up to 3 years or 50-70%[11]	$9.00 per acre
Contour Stripcropping		40-75%	$5-$6 per acre per year[2]	$13.50 per acre for up to 3 years or 50-70%[11]	$13.50 per acre
Barnyard Diversions	9%	Potentially high, depends on barnyard conditions	$373 per year[3] or $4 per linear ft.[4]	70%	75%
Roof Gutters	44%		$175 per year[3] or $9-$14 per linear ft.[4]	70%	75%
Filter Strips	62%	74%	$20-$25 per acre per year[3]	70% or about $125 per acre per year for 5 years[6]	75%
Created Wetlands	15-99%	65-97%	$467-$2,337 per acre per year[5]	70% for wetland restoration	75% for wetland restoration
Sediment Basins	More effective on total P than soluble P	97%	Generally low, unless designed for permanent water storage	70%	50% for barnyard basins 75% for nonbarnyard basins
Grassed Waterways	30%[12]	80%[12]	$447 per acre per year[7]	70%	75%
Stream Fencing	Medium to High	40%	$0.15 per linear foot per year[7]	50% or $0.18-$0.48 per linear foot	75% not to exceed $0.56 to $1.10 per linear foot
Animal Waste Storage Structures	90%	Low	$12-$117 per cow per year[8]	70% of first $20,000 and 50% of remainder, not exceeding $35,000	50% not to exceed $25,000 per structure
Nutrient Management Strategies	Potentially high, depending on management practices.		$4-$13 per acre per year	50% for up to 3 years	$3.00-$10.00 per acre for 3 years[10]

[1] Cost share or incentive rates for BMPs as per Chapter NR 120, Nonpoint Source Pollution Abatement Program. These are maximum rates.
[2] Producer costs, rounded to nearest dollar, as calculated in Natural Resources Conservation Service, 1995.
[3] This value is estimated using cost estimate from Baun (1997) and amortizing to an annual value. An 8% interest rate and the practice life expectancy were used. Life expectancies were according to NRCS guidelines.
[4] Linear foot estimate is from Dane County Land Conservation Department Rate Sheet.
[5] This value is estimated using cost estimates from Knight, 1993 and amortizing to an annual value. An 8% interest rate and the practice life expectancy were used. Life expectancies were according to NRCS guidelines.
[6] The $125 per year estimate is from *Per Acre Incentive Payments for Riparian Buffers*, by an unknown author.
[7] This is an amortized value from cost estimates from the Dane County Land Conservation Department Rate Sheet. Amortization used 8% interest and the practice life expectancy. Life expectancies were according to NRCS guidelines.
[8] This estimate is amortized from cost estimates from UWEX et al., 1998. Amortization used 8% interest and the practice life expectancy were used. Life expectancies were according to NRCS guidelines.
[9] Cost share or incentive rates for BMPs as per the Natural Resources Conservation Service EQIP. These are maximum rates.
[10] Manure incorporation and spreading schedules would be covered in a nutrient management plan for purposes of cost share eligibility.
[11] A 70% cost share is available through a Wisconsin wildlife habitat recreation program.
[12] Estimated from urban grassed waterway data.

Table 2. Urban BMP Summary

BMP	*Total Phosphorus Reduction*[1]	*Soluble Phosphorus Reduction*[1]	*Sediment Reduction*[1]	*Cost*[2]	*Incentive Payment/Cost Share*[3]
Dry Pond	10%	2%	7%	Generally low	70%
Dry Extended Detention Ponds	19%	-9%	61%	Generally low	70%
Wet Ponds	47%	51%	77%	Moderate to high	70%
Wet Extended Detention Ponds	58%	58%	60%	Moderate to high	70%
Shallow Marsh	38%	37%	84%	Moderate to high	70%
Extended Detention Wetland	24%	32%	63%	Moderate to high	70%
Pond/Wetland System	54%	39%	72%	Most expensive pond option	70%
Infiltration Trenches	Unknown. Very few studies have monitored this BMP.			Cost-effective on smaller sites. Rehab costs high	70%
Infiltration Basins	Unknown. Very few studies have monitored this BMP.			Moderate construction costs. Rehab costs high	70%
Porous Pavement	up to 60%[5]		up to 91%[5]	Cost-effective compared to conventional asphalt	70%
Sand Filters (surface)	60%	-37%	83%	High	70%
Grass Swales	29%	34%	81%	Low compared to curb and gutter	70%
Filter Strips	63%[6]	50%[6]	80%[6]	High compared to trenches and sand filters	70%
Street Sweeping	less than 15%[4]		less than 30%[4]	approx. $16 per curb mile[4]	

[1] These are median values of studies contained in the *National Urban BMP Database*. See Brown and Schueler (1997) for more information.
[2] Cost information is from *A Current Assessment of Urban Best Management Practices, Techniques for Reducing Non-Point Source Pollution in the Coastal Zone*, by Schueler et al. (1992).
[3] Cost share information is from NR 120, and is for land in the WDNR's Priority Watershed Program.
[4] This values are from studies conducted by Pitt (1979) and SEWRPC and WDNR (1983).
[5] These reduction estimates are from studies conducted by the Maryland Department of the Environment (1983), OWML (1986), and Kuo et al. (1988).
[6] These are median values from a compilation of data from filter strip studies contained in Appendix A.