



Drivers of Nutrient Load Reductions

Water Resources Center

UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

A survey conducted by the University of Minnesota
Water Resources Center for the Great Lakes
Regional Water Program



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

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September 19, 2012

This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture and the U.S. Environmental Protection Agency under NIFA award # 2010-48691-21684. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

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Acronyms

4Rs – A nutrient stewardship framework that promotes using the Right fertilizer source at the Right rate, at the Right time and in the Right place. (See <http://www.nutrientstewardship.com/about>)

CWP – Clean Water Partnership, a Minnesota program established in 1987 providing grants and loans to local governments to help control non-point sources of pollution.
(<http://www.pca.state.mn.us/aj0rb37>)

EQIP – Environmental Quality Improvement Program – A federal program that provides financial assistance for a wide range of rural conservation practices.

HUC – Hydrologic Unit Code. A unique identifier assigned to every watershed; more digits indicates a smaller watershed. E.g., if the identifier has 8 digits it is very roughly the size of a county. A watershed with a 12-digit HUC may be only 10 square miles. <http://water.usgs.gov/GIS/huc.html>

LUG, LGU – local units of government, local government units. Generally includes townships, cities, counties, watershed districts, and conservation districts.

LWCD – Land & Water Conservation Department. In Wisconsin, LWCDs are the county departments responsible for developing and encouraging adoption of local conservation programs. LWCDs replaced Conservation Districts in 1982. (From: <http://www.wlwca.org/whatiswlcwca.html> .)
Compare to other states' SWCDs, which are not county departments.

MRBI – Mississippi River Basin Healthy Watershed Initiative, a program of the USDA Natural Resources Conservation Service to focus financial and technical assistance on critical areas.
<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/initiatives>

PI – Phosphorus Index – a tool to help producers make decisions about how to reduce phosphorus losses from farmland.

PF – Pheasants Forever

SWCD – Soil and Water Conservation Districts. In Minnesota, Ohio, Indiana, and Illinois, SWCDs are responsible for developing and encouraging adoption of local conservation programs and coordinating assistance from a variety of sources. They are not part of county government, but may be county-based and partially funded by counties. <http://www.aiswcd.org/Guide/about.htm>

TU – Trout Unlimited

USGS – US Geologic Survey

Executive Summary

Twenty water planners from across five states were interviewed in 2012 to understand what drives successful nutrient reduction projects and what role Universities can play to support their work.

Key results:

- Nearly all respondents were quick to point out **the importance of individual leaders and interpersonal skills** for driving the successful projects.
- No one driver is more critical than others. This report describes the impacts of and relationships among the drivers.
- Respondents from the same state talked about a similar small set of nutrient reduction activities. For example, promoting cover crops was important in Ohio and Indiana, while nutrient management practices were important in Wisconsin. This focus on a small set of activities probably reflects a combination of state-level programs that emphasize particular practices and environmental conditions that make some practices particularly effective.
- **There are many ways to build success.** No consistent procedure or sequencing of drivers emerged among the successful projects. Project managers used the various drivers in different ways. For example, one group used a Mississippi River Basin Healthy Watershed Initiative (MRBI) proposal as a way to organize stakeholders and build partnerships; while other groups used MRBI for funding, but only after partnerships and project activities were already established.
- The amount of **monitoring and assessment is inadequate** for developing effective projects or for determining impacts. Only half of the projects had enough water quality monitoring to measure changes.
- **Data can motivate change**, but may be underutilized for this purpose. Some examples of the utility of data in reducing nutrient losses were: In one project, after years of water quality monitoring, the public now asks for the reports and keeps an eye on trends. Another respondent observed how readily farmers respond when they see the data, understand how they rank out compared to other farmers, and understand that not all fields need to be treated the same. In Wisconsin, the Manure Advisory System (<http://www.manureadvisorysystem.wi.gov>), provides clear data and guidance for manure application practices.
- **The TMDL process is not a primary driver.** When asked “What is the role of the TMDL process in nutrient reduction activities?” responses were generally unenthusiastic. Many people appreciated the value of TMDL reports in making funding available. Some respondents used TMDL reports as a source of background data or as an educational opportunity.

Implications for University work

- Even in projects that don’t have a training component, consider the impact of all projects on local staff development.
- It is valuable to involve local offices when designing research and outreach.
- Most drivers impact all projects so research and outreach related to any driver is useful.
- Drivers interact, so integration is essential. For example, research is more useful if it simultaneously addresses production and environmental goals. Training programs are more useful if they explain watershed planning in the context of the policy setting and civic engagement principles. Outreach programs are more effective if they engage both landowners and policy makers.
- More research is needed into agricultural systems. Many helpful practices have been identified – such as cover crops and perennials. But more research is needed to address the challenges that prevent landowners from incorporating these practices into their whole farm system.

Method

Background and goals

The Universities associated with the Great Lakes Regional Water Program (EPA Region 5) want to support reductions in nutrient delivery to the Gulf of Mexico. To identify our most effective roles, we first wanted to understand what drives implementation of land management practices that reduce nutrient delivery to surface water at the local and state scale. This information will help us understand the leverage points where we could make a difference.

We considered focusing on either nitrogen or phosphorus alone, since different and sometimes conflicting management practices are used to treat each. However, N and P are similar with regard to watershed planning. In both cases, a high level of landowner engagement and voluntary practices are needed. Water quality standards are hard to set because both are essential nutrients and pollutants, and normal levels vary across healthy, functional systems.

Participants

To understand drivers of nutrient reductions, we interviewed 20 watershed planners – people working primarily at the local level and who have years of experience with nutrient reduction efforts.

This project was limited to the five states of EPA Region 5 that drain to the Gulf of Mexico. We targeted watershed planners experienced with managing nutrient reduction efforts. Initial participants were identified by the EPA Region 5 water team leaders. At the end of interviews, people were asked for suggestions of further participants. Participation by state was:

Illinois	4
Indiana	5
Minnesota	4
Ohio	3
Wisconsin	4

Interview topics

Participants were first asked to identify a project that has been successful at reducing nutrient loads at the watershed scale and then to describe the project activities and how success was determined. Then the interviewer asked what was organizing or driving the project activity, and suggested four possible drivers:

- Watershed planning
- Incentive programs
- Economic forces
- Rules and regulations

Other topics discussed included the impact of TMDL activity, models and tools used to estimate impacts, and finally, how Universities could help support nutrient reduction efforts.

Summary of Responses

Types of projects

When participants were asked to describe a successful project, many could not identify a project that they could confidently say had led to nutrient load reductions. But all highlighted one or more projects they felt were promising. All but one of the projects were in predominantly agricultural settings.

Respondents worked at a variety of geographic scales. Projects included:

- 4 large river watersheds (e.g. 8-digit HUCs)
- 5 medium-sized river watersheds
- 2 small stream watersheds (e.g. 12-digit HUCs)
- 1 urban stream watershed
- 3 lake watersheds (2 very large, 1 very small)
- 2 respondents worked at the county scale
- 2 talked about broad programs or methods, rather than specific projects.

Many projects were not monitored to determine success

Of the 20 highlighted projects, ten had adequate water quality monitoring data to demonstrate nutrient and/or sediment loading improvements. Six did not have water monitoring data, but were able to document increased implementation of the desired practices. One used modeling to demonstrate improvements, and three had no evidence of improvements.

Water quality monitoring is necessary to track long-term results. Short- and medium-term results can be tracked by monitoring adoption of practices and changes in attitudes and knowledge.

Land management practices varied by state

Participants from each state emphasized different practices. This focus on a small set of activities probably reflects a combination of state-level programs that emphasize particular practices and environmental conditions that make some practices particularly effective. The most common practices were:

- Ohio: field practices, especially nutrient management, cover crops, and residue management.
- Indiana: predominantly field practices including cover crops, reduced tillage, nutrient and pest management, and stream buffers.
- Illinois: structures such as sediment basins, restored wetlands, erosion control structures, and dam removal.
- Wisconsin: field practices, especially nutrient management; and secondarily, barnyard practices and structural practices.
- Minnesota: hydrology and feedlot-related practices, such as water storage, ditch design and buffers, and feedlot inventories and management; plus field practices to reduce soil loss and increase perennials.

Drivers of Nutrient Reduction Successes

The TMDL process has some impact on nutrient reduction activities, but with few nutrient standards, other forces are more important. Four other possible drivers were suggested to interviewees and they were asked which was most important for their particular project:

- **Watershed planning,**
- **Incentive programs** (federal and state financial support such as EQIP, land set-aside programs, and the MRBI),
- **Economic forces** (such as commodity and land prices, and land tenure patterns), or
- **Rules and regulations.**

Their first response was almost always:

- **Specific individuals.**
That is, when asked what drove a project, respondents first thought about those key individuals who are skilled at working with people, understand the science, and keep their eye on the ball for the long haul.

Then we discussed what tools these skilled individuals used. In addition to the four drivers mentioned above, respondents added three more:

- **Focusing event** – An acute water quality concern or a highly publicized gathering can trigger widespread awareness and galvanize action.
- **Monitoring data** – An extensive set of monitoring data that tells a clear story can act like a focusing event and galvanize action.
- **Targeting** – A process of identifying and prioritizing opportunities can organize and motivate project activity.

The Role of Each Driver

Every project needs a **focal point around which to organize and motivate stakeholders, and build partnerships.** Any of the drivers listed above may serve as the organizing force. For example, the focal points described by respondents included a watershed planning process, writing a large grant proposal, a regulatory change or threat, concern about loss of a high-value recreation area, and a threat to urban drinking water source.

For any particular project, one of the drivers serves as the initial organizing point, while the remaining drivers determine the shape of the project or are tools to implement the project. That is, all drivers listed are influential, and none are consistently the key trigger.

The following is a summary of how respondents described the roles of the various drivers. Further detail about their comments is in Appendix A (page 12).

The following is a summary of comments made by respondents.

Watershed Planning

- Essential to keep project activities headed towards a clear goal.
- Watershed planning is useful for building partnerships, securing funding, prioritizing, providing project structure, and communicating to generate support.

Incentive programs

- Incentive programs are necessary; nothing happens without funding.

- The role in the process varies. Writing program grant proposals may be used early in the process to focus motivation and to build partnerships; or programs may be used late in the process after partnerships and goals are well-defined.

Economic Forces

- A huge driver; and yet, not the end-all determinant of behavior.
- Project managers need to understand and work with the financial and economic environment of landowners. This is the driver they have the least control over.

Rules and Regulations

- Regulations are a useful tool but must be used carefully.

Individual Leaders

- Many respondents identified specific individuals who set the ball rolling or whose interpersonal skills kept partnerships working. The projects and outcomes would not have happened without these individuals.
- Ideally, all the major partners will be represented by good leaders.
- Features of effective leaders include: great communication skills, technically competent, dynamic, and spends a lot of time with people.

Data

- If data is available and understandable, citizens and landowners will look for it and they will respond to it.

Focusing Event

- Potentially, a powerful tool, but not for the long-term.

TMDL Process

- Respondents used the TMDL process to
 - gain access to funding opportunities
 - help focus and plan implementation activities
 - use the report as a data information source and tool for communicating with the public.
- In many cases, local staff were not closely involved in the TMDL process.
- More detailed comments about the impact of the TMDL process are in Appendix B (page 18).

The Role of the University

Respondents identified four roles that the Land Grant Universities are or should be playing:

- Conduct research,
- Train local staff,
- Deliver education and outreach
- Implement watershed work

Detailed responses are in Appendix C (page 19).

Research

One respondent emphasized the importance of cooperating with local offices when conducting research; pay attention to what they are doing and use their help and insights.

Requested research topics fell into four categories.

- 1) Ag systems research
 - a) Generate creative ideas and develop practical, effective, profitable, region-specific solutions to the agronomic challenges of conservation **cropping systems**, especially with regard to:
 - alternative crops, especially perennials;
 - cover crops;
 - nutrient management;
 - night exercise areas.

These need to be long-term and consistent programs.

- b) **Define a best managed landscape.** I.e., how many acres need to be perennials and non-cropped land?
 - c) Further understand the **hydrology of pollution.** E.g.:
 - What's the contribution of large floods vs. base flow?
 - Sediment delivery processes from field to stream.
 - Why don't P levels decline when practices change? (lag time issues, thresholds, targeting, other sources?)
 - Understand the contribution of in-stream sediment sources and how to address.
 - d) Generate creative ideas and develop practical, effective, region-specific **solutions to the hydrologic challenges**, e.g.:
 - Bioreactors
 - 2-stage ditches,
 - Wet filter strips,
 - Water storage and retention.
- 2) Social science research
 - a) Study and measure sociological features of farmers that relate to land management choices. Use this information to design more effective programs and policies.
 - 3) Monitoring and assessment methods
 - a) Continue to develop methods for **targeting and focusing resources** – identify the right places, practices, sequencing to achieve results.
 - b) Develop **edge-of-field monitoring** methods. The methods should:
 - identify effective systems (rather than just individual practices).
 - Link to watershed models.
 - c) Continue to develop methods of measuring the **impacts of BMPs** and continue to quantify those impacts at various scales.
 - d) Stay in the forefront of **assessment science**, e.g.
 - continue to develop assessment methods based on biological science,
 - examine TMDL standards to assure they are meaningful and attainable,
 - work with agencies to develop assessment and targeting tools like the P Index.
 - 4) Other research topics
 - a) Compile data into **literature reviews** targeted to the needs of local agency staff.
 - b) Study the **economic value of non-cropland** and identify ways to increase that value. (e.g. game habitat.)
 - c) Programs and policies can have negative effects. Influence the Farm Bill and other policy by studying **policy/program impacts**.

Train local staff

Requested training topics:

- Train state and local staff in principles of behavior change and social change.
- Train local staff in effective watershed planning, project management, funding opportunities, community engagement, and implementation.

- Help citizen groups build capacity.

Deliver education and outreach

Outreach to agriculture

- Build strong partnerships with agencies and industry to increase the **consistency among messages**. Farmers need support from all these directions to get through the challenges of adopting new practices. Two examples of message inconsistency are:
 - nutrient management recommendations,
 - conflicts between pest management and conservation messages.
- Universities are in a unique position to communicate with a broad range of stakeholders. Use that strength.
- Build strong partnerships with organizations to reach broader audiences – e.g. agricultural groups that can influence their membership more effectively on some topics than direct Extension contact.
- Assess Extension messages and methods, assuring that water quality information is provided hand-in-hand with agronomic information.
- Re-assess the format and delivery of information to better suit the audience. Some Extension publications are not user-friendly.
- Demonstration sites are an important form of education.

Outreach to the community

- Design water quality education and outreach efforts to prepare a community for water quality projects. Help create a local attitude/capacity that gives local agencies and organizations a more receptive context to do their work. For example, create more understanding of the ecological importance of streams and the significance of local actions.

Help local offices with outreach

- Work with local offices on their education efforts so they don't have to start from scratch developing materials and programs.

Implement watershed work

The previous three University roles are to support local watershed work. The fourth role for Universities is to actually conduct the watershed planning, monitoring, and implementation. Specifically, respondents made the following suggestions:

- Provide the social science expertise for watershed projects.
- Consider how the design of University-led projects impacts the person-to-person contact that is essential to project success.
- Track application or sales of fertilizer to help with targeting.
- Do the modeling and monitoring for specific watershed projects. Many projects have inadequate monitoring to be able to assess results and adapt implementation.
- Develop tools such as the Manure Advisory System (<http://www.manureadvisorysystem.wi.gov>) that help citizens make management decisions.

Views of Local vs. State Water Leaders

For a separate project, we conducted an online survey of 29 state agency staff and University faculty about the TMDL and impaired waters process in their state. The purpose was to identify roles for universities in the TMDL process. Here is a comparison of the responses of that survey of state-level leaders and the current survey of local leaders.

- Both surveys reported the need for **research related to targeting** – better understanding pollutant dynamics, and developing methods for identifying key treatment sites and the most effective treatments.
- The **local managers put more emphasis on agronomic research** – developing cropping systems that are profitable and environmentally sound.
- Both the state and local specialists emphasized the value of Universities in facilitating **bridge-building** among diverse stakeholders, but their emphases were different. State specialists wanted better agency-University communication so University staff would better understand the Clean Water Act and related needs. Local specialists were interested in increasing the consistency of messages from various sources. Local specialists also wanted researchers to include them in their research and use the insights of local experience.
- Both surveys identified the need for **research related to monitoring, standards, and assessment**; but these topics were emphasized more by the state specialists.
- State specialists identified the need to evaluate and improve college curricula to better match the needs of water resource management.
- Local specialists especially appreciated practical decision-making tools (e.g., P Index, Manure Advisory System), more than the research models (e.g., SWAT)
- Participants in both surveys wanted more involvement from Universities in conducting the monitoring (both physical and social), TMDL development, and implementation components.
- Other roles mentioned in both:
 - Policy analysis
 - Training LGU staff in project management and watershed planning. The local staff were especially interested in more guidance in principles of behavior change, building community capacity, and other social science skills.
 - Education and outreach

Appendix A: Detailed Responses: Drivers of Nutrient Reductions

Watershed Planning is useful for:

Building partnerships

- There were two organizing forces behind the restoration activities: a DNR biologist who drove a monitoring effort, and **a sanitary district that wanted a lake management plan** – those two evolved separately and did not depend on each other, but came together to drive improvements. (WI)
- The IN Conservation Partnership is leading this effort. (IN)
- The biggest thing is getting organized and getting a water plan that landowners are behind. (MN)
- All of the drivers are important; takes a variety of tools. A plan is a good focusing tool to bring these together, and for **working with all the players**. (MN)
- We set up a funding plan that included dollars from ag retailers, so they are closely involved. (OH)

Securing funding

- A resource plan is necessary to get funding. (IL)
- [After the partnership was established] we did a TMDL and created a 501c3 to be **able to access grant dollars**.
- Later we developed a broader water plan. Then, we were in a position to take advantage of MRBI grant for implementation. At this point, the watershed is on "autopilot" -- people have expectations for what the watershed will do. (OH)
- Good modeling helps organizations get funding. (IL)
- We reference our plan to get funding. (MN)

Prioritizing

- Inventoried 80% of the watershed and identified the 20% worst fields. Targeting was important. (12% of land generated 50% of load.) Eight of the ten highest risk farmers cooperated. (WI)
- First implemented "soft practices"; they are cheaper, have more impact. Later, we provided cost-share on hard structures. [We had a long enough time frame to sequence the implementation this way.] (WI)
- The Buffer Initiative method: First identify Ws with enough of a problem to be worth fixing and enough of an opportunity to improve. I.e. identify impaired water and have an improvement plan. Then, inventory watershed using the PI and focus on the top P-yielding farms; monitor. (WI)
- "I'm more excited about these projects than I have ever been [referring to the methodologies used in Pleasant Valley and the Buffer Initiative]. We're finally getting the science right and together." (WI)
- The value of the plan was to provide a structure, set priorities, and to show performance. You have to be ready to tweak the plan when new/additional sources become apparent. (WI)
- In a couple watersheds, the watershed action plans help drive activities. (OH)

Giving the Project Structure

- All of the drivers are important; takes a variety of tools. **A plan is a good focusing tool** to bring these together, and for working with all the players. (MN)

- The biggest thing is getting organized and getting a water plan that landowners are behind. (MN)
- The value of the plan was to provide a structure, set priorities, and to show performance. You have to be ready to tweak the plan when new/additional sources become apparent. (WI)
- "I'm more excited about these projects than I have ever been [referring to the methodologies used in Pleasant Valley and the Buffer Initiative]. We're finally getting the science right and together." (WI)
- Need strong local leadership, need a good plan. One-on-one talking. Good plans have plenty of implementation detail. (IL)
- Later we developed a broader water plan. Then, we were in a position to take advantage of MRBI grant for implementation. At this point, the watershed is on "autopilot" -- people have expectations for what the watershed will do. (OH)
- It's expensive work. (MN)

Communicating to gain support

- When farmers see that not all fields need to be treated; and once farmers see the data and how they rank out, they are cooperative. (In contrast to making sweeping statements about what practice everyone needs to do.) (WI)
- The value of the plan was to provide a structure, set priorities, and to show performance. You have to be ready to tweak the plan when new/additional sources become apparent. (WI)

Incentive Programs can have positive and negative impacts

The impact of programs depends on how they are used.

- Incentives work, but right now they are not enough. (MN)
- Grant incentives in our project are based on performance -- farmers and the public receive this well. (OH)
- Farmers need cost-share at first to learn how to fit cover crops into operation. Once they figure it out, it pays for itself. (OH)
- **Success depends on targeting (but most ag programs do not do this).** A small proportion of farmers are responsible for a large portion of load. Need to combine targeting with locally determined solutions. (WI)
- **Targeted dollars are no benefit if there aren't the leaders.** You need a communications person who understands the science. (OH)

Programs can give projects structure.

- An important driver was WI's Priority Watershed Program, which **allowed us to focus an effective amount of time and dollars on a watershed.** The main funding mechanism now is the "targeted runoff management program" which is less effective because it is less focused. (WI)
- Programs (e.g. MRBI, 319) **focus funding** and support the building of partnerships around a project area. (IN)
- Project activities have been organized as a result of a CWP grant, and drainage benefits redetermination activities. (MN)

Programs can support building partnerships.

- A large, 5-county MRBI grant proposal was initiated by an SWCD and an NRCS employee. **Eventually 30 partners were brought in.** Took time to build wide enthusiasm.(IN)
- Programs (e.g. MRBI, 319) focus funding and support the building of partnerships around a project area. (IN)

Programs are not a driver, but the tools to implement a project. A single project will take advantage of multiple incentive programs as funding sources.

- **You can't do anything without the funding programs in place.** The seed money triggers local investment. Nobody has the money [to do water quality projects], so government programs are critical.
- Funding for a project came from multiple funding programs (several respondents)
- There are about 20 watershed projects around the state; they are more independent of one another and have more diverse funding sources than when the Priority Watershed Program was in place. (WI)
- Programs aren't a driver – they are just a tool. (MN)

Depending on their design, incentive programs can have negative impacts on the effectiveness of local project activity.

- An important driver was WI's Priority Watershed Program, which allowed us to focus an effective amount of time and dollars on a watershed. The main funding mechanism now is the "targeted runoff management program" which **is less effective because it is less focused.** (WI)
- Problem is you get 2 yrs of funding [from programs], but **it's for only one of several pieces needed** (e.g., monitoring, implementation, education). It would be good to have 5-yr or even some 10-yr grant commitments. (MN)

Economic Forces

Economics is a huge driver of nutrient-related practices.

- Economics is the big driver – international food and fuel markets. Farm bill is such a huge driver of practices. (MN)
- Economics is a huge driver; this is the most important thing to focus on to make nutrient management programs work. (OH)
- Economics [high land values] is driving non-participation. (MN)
- Crop risk insurance would be helpful. (WI)
- Transport of manure is now possible because there is a market for manure. Economic pressures have led to less tillage. **But economics is not completely influential in the long term.** (OH)

Need to understand and work with the financial demographics

- Today it is all about economics--more so than 20 years ago. Farmers are more business oriented? The advantage of this is that when they make a decision, they do it. (WI)
- Success requires young, financially stable farmers because they can make investments on a longer time frame. Projects are more successful where a high percentage of the land is owned rather than rented. (WI)
- Absentee landowners are an issue. (We are starting work with the IPM Institute in WI to work with and educate absentee landowners.). (OH)

Rules and Regulations

- Regulation isn't a driver – there is no regulation. (MN)

Regulations and fear of regulation can be a widespread driver

- Statewide Performance Standards drive activities now. Participants in the Farmland Preservation Program (half the farms in the state) are required to meet the standards. (WI)
- Farm bill is such a huge driver of practices. (MN)
- Regulation and specter of future regulation galvanized partners to action. (IL)

- Fear of regulations is a big driver -- landowners don't want to lose their flexibility. (OH)

Rules can create negative constraints on nutrient reduction activities

- The privacy provision [of federal programs] is a killer because we need the resource inventory data. The other killer is that Farm Bill dollars go to production instead of conservation. (WI)

Regulations are a tool to be used carefully

- Regulation was important, but we used it carefully and in a limited way -- only when the majority of farmers in the area agreed that it was appropriate. (WI)
- In urban areas: zoning or regulation is the most important mechanism. Important to force the implementation of retention practices before development. (IL)
- The Open Lot Agreement has been important. (MN)

Individual Leaders

Many respondents identified specific individuals who set the ball rolling or whose interpersonal skills kept partnerships working. The projects and outcomes would not have happened without these individuals.

- Activities were initiated by local interests in mid-1980's who approached the DNR. (WI)
- The County Conservationist is very aggressive in getting grants and pushing practices. The urban members of the LWCD committee are asking for an aggressive approach – giving the Conservationist the legitimacy to be aggressive. (WI)
- Partnership started in early 90's because of individuals. (IN)
- A large, 5-county MRBI grant proposal was initiated by an SWCD and an NRCS employee. Eventually 30 partners were brought in. Took time to build wide enthusiasm. (IN)
- An SWCD employee conceived and drove the effort for 4-5 years. He contacted the landowners and implemented CRP. It was successful because he could focus on a specific area. (MN)
- What works is where you have a community champion – SWCD, conservation groups, non-profit or other. Where there is leadership -- people who build rapport and trust -- things happen. Without that champion, they just sit around and twiddle their thumbs. (MN)
- In general, LWCD committees in rural areas are less aggressive than those in urban areas. (WI)

Leadership must represent the major partners.

- Success relies on having a strong leader from the ag retailers organization, fertilizer inst., and the NRCS. (IN)
- One-on-one [i.e. agency-to-farmer] is not so important here. **The biggest driver is word of mouth** about cover crops: land owners standing up to say what they are doing and how it works and how it makes money; the on-farm network concept; field days; farmers talking to farmers. (OH)

Some features of effective leaders: great communication skills, technically competent, dynamic, and spends a lot of time with people.

- Essential to have strong partnerships; strong vocal leaders. Essential to have boots on the ground who are both technically competent and can communicate with farmers. (IN)
- Successes relate to individual personalities – they need to be dynamic and a heck of a sales person. Hard to recognize these people on an interview panel. (WI)
- You need a durable, long term system where you can train new young people so they can be confident. Give them time to learn and then set them free. You need a person who delivers what they promise without too many hoops. (WI)

- Have to have the one-on-one contact with farmers. (WI)
- High participation was a result of spending a lot of time in the watershed; we met all the people; worked especially closely with a few folks in good standing in the community. (WI)
- Partnerships are critical (MN).

Focusing Event

Focusing events can be useful as a trigger or initial motivator and organizing focus, but they don't necessarily provide long-term motivation. In most cases described by respondents, the focus of the effort shifted over time.

- Action was driven by concern about preserving the economic value of a **high-value recreation** area. (WI)
- Before any water plan, there was concern especially about **drinking water quality**, and also about flooding and habitat quality. (IN)
- **Severe algae events** restricted recreational uses, especially in wealthy urban areas. (IN)
- There was **high N in the drinking water**; the **city wanted to build a reservoir** on a high quality fishing stream; local river organization complained to the EPA. (IL)
- Two **conferences** brought farmers and ag retailers into the discussion. Now major stakeholders are on the same page promoting the 4Rs. (OH)
- Regulation and **specter of future regulation** galvanized partners to action. (IL)
- **Landowner interests and environmental interests coincided**: Farmers wanted healthy livestock and organic certification, and TU and PF wanted to maintain health of cold water streams. (IN)
- Organized originally around atrazine and city **drinking water** concerns. **Later we developed a broader water plan**. Then, we were in a position to take advantage of MRBI grant for implementation. (OH)
- Ten years into the project, we realized **ditches** were a concern and started to address them. (IN)

Data

If data is available and understandable, citizens and landowners will look for it and will respond to it.

- Our big driver is the monitoring data that people keep an eye on and ask about. (OH)
- Citizen stream monitoring showed high turbidity, so we decided to focus on that. (MN)
- When farmers see that not all fields need to be treated; and once farmers see the data and how they rank out, they are cooperative. [In contrast to making broad statements about what practice everyone needs to do.] (WI)
- The Manure Advisory System (<http://www.manureadvisorysystem.wi.gov>) is important. Farmers need plans based on averages (e.g. using the PI) and they need guidance to deal with short term events. (WI)
- If you bring the information [data] forward it is hard for people to argue with you. (MN)

Data provides structure and standards for comparison. Monitoring programs can be a source of funding.

- Wisconsin now has P ambient standards for lakes, flowages, and streams. These can be used for estimating effluent limits. (WI)
- There were two organizing forces behind the restoration activities: a DNR biologist who drove a monitoring effort, and a sanitary district that wanted lake mgt plan – those two evolved separately and did not depend on each other, but came together to drive improvements. (WI)

Targeting

Reactions to “targeting” were mixed.

- Success depends on targeting (but most ag programs do not do this). A small proportion of farmers are responsible for a large portion of load. Need to combine targeting with locally determined solutions. (WI)
- We avoid targeting because it implies keeping services away from some people, but we can focus our efforts on certain areas. (IN)
- Having the tech capacity [to target] is a huge strength. (MN)
- Everyone needs to do something. We identify priorities, then pick off the highest potential sites, and then, of those, work with the people of high motivation – that’s plenty of work for us [even though we haven’t strictly targeted the highest potential sites]. (MN)

Other comments

- We’ve been focusing a lot on urban runoff [small rural towns] -- getting them familiar with urban runoff issues. They have been more willing than the ag people, so we have been focusing on them. (MN)
- The method of conservation delivery in MN needs to change – the method and what we are selling. (MN)
- Several respondents emphasized the importance of using all the drivers.

Appendix B: Detailed Responses: The TMDL Process as a Driver

TMDLs help with funding

- TMDL is completed but not yet approved. It has allowed for grant opportunities. (WI)
- Creating a TMDL was first task, so they could go after 319 and other funds. (IN)
- It is a way to focus and enhance funding, but local partners must be excited about it. (IN)
- CWA drives state activities by providing 319 \$. (OH)
- Enormous tool for securing funding. Have to utilize them correctly. (IL)

TMDLs help with information

- TMDLs are educational opportunities. (WI)
- I used it as background information/data. A lot of the info was too general to be helpful. (OH)
- used to educate people. (OH)

TMDL's help focus and plan

- Part of the push, but not the major push. Helps us focus on specific areas. They are listed in our water plan. (MN)
- The TMDL data and report helped us write Watershed Action Plan. Helped prioritize. (OH)
- The data helps us fine tune and focus programs. (MN)
- TMDL listings were used when NRCS chose where to target the MRBI. (IN)
- Provides watershed-scale thinking. (IN)

TMDLs aren't done or have little impact

- No TMDL was done. (WI)
- Have resulted in almost no reductions. (IL)
- TMDL was a driver for a few WSs, but mostly not. However some kind of plan is a driver, e.g. the adaptive management approach. (WI)
- None in the area. (IL)

TMDLs are poorly executed

- For decades DNR mgt didn't want to pursue TMDLs – until 8 years ago. And now some are too big. (WI)
- We haven't had great success with implementation--lack regulatory authority for non-point sources. (WI)
- TMDL has no impact. We write good TMDLs but no teeth in either the point or non-point implementation. We write E Coli TMDLs, but there are no funds for septic systems. (IN)
- A lot of the info was too general to be helpful. Tried to get a TMDL coordinator on our watershed team, but they wouldn't. (OH)
- Generally public health and other people thumb their noses at the TMDL as not useful nor used. State teams develop the TMDLs independent of local managers. (OH)
- I don't agree with standards based on beneficial use. (MN)

TMDLs have a negative impact

- The TMDL process is inflexible. Sometimes CWA pushes towards bad decisions because they focus on what they can regulate (NPDES) instead of lower cost options. (IL)
- The impact of TMDLs is confusion. It's a bad way to talk about wq – using an acronym that no one understands, especially producers. TMDLs drive what people are doing, but don't necessarily drive changes on the land. (MN)

Appendix C: Detailed Responses: The Role of the University

Conduct Research

Agricultural systems

- Need a consistent funding mechanism to do research on conservation cropping systems and find solutions to challenges in these systems. (IN)
- Need more research to figure out how to make cover crops work in corn/soy system. (MN)
- Need more people creating ideas for alternatives to corn/soybean, for landscape change. If we can get 10-20% of land into perennial crops that would make the difference. We need the university to continue to explore these options – make it profitable – even though there is a lot of pressure from commodity groups to focus on C/S. (MN)
- Need a definition of a best managed system; i.e., how many acres need to be set aside as non-cropped land. (WI)
- Understand the contribution of large floods vs. baseflow. (IL)
- Need more understanding of the contribution of in-stream sed sources and how to address. (WI).
- Maximize profit. (IL)
- Need to understand: P sources, explain why P levels aren't changing in response to practices, sed delivery rates/processes from field to stream. (WI)
- Losses from night exercise areas. (WI)
- Farmers need evidence: show it is really a problem, and show it really works. (This is a matter of improving research and outreach activities.) (WI)
- Nutrient management research. (IL, OH)
- Bioreactors, 2-stage ditch, wet filter strips (MN)

People skills

- Measuring the financial stability of farmers, their age or presence of a succession plan, and the percentage of owned vs. rented acres in a watershed could give some important information about why attempts at nutrient reduction are either more or less successful in a given watershed. I think those variables could also point us toward more effective policy solutions for nutrient management. (WI)

Monitoring and assessment

- Edge-of-field monitoring to identify sets of practices that work. (OH)
- Help bridge edge-of-field and watershed models. (WI)
- NRCS needs more monitoring and modeling to be able to quantify impacts. (IN)
- Regarding urban BMPs: we know the practices and we know what's in the stream; we don't know how to put them together – how to target back to the source. (IL)
- Make sure TMDLs are attainable. (MN)
- Assessment is moving towards biological diversity. (MN)
- Do the right thing in the right place. (MN)

Other

- Literature review of all the work done in complex, heavily studied systems (e.g. Western Lake Erie Basin). (OH)
- Increase the value of non-cropland by improving game habitat, etc. (IL)

- Change the farm bill (e.g. multiple farms need to be able to apply together for wetland projects.) (OH)
- Lobby congress. (IL)
- Pay attention to what local offices are doing and get their help and insight (i.e., don't do research without them). (IN)

Train Local Staff

All training suggestions related to social science skills.

- Provide support in sociological understanding of our target. People have to be motivated for anything to happen, and we don't understand how people work. We know attitudes drive changes, but we don't know how to monitor or influence attitudes; and is it our role to influence? We can do the monitoring and modeling, but we rely on the conservation offices to do the personal work. (WI)
- Figure out how to develop the wonder-individuals that can pull off the projects and talk to farmers. (WI)
- More guidance on what to do to increase adoption. (OH)
- Could use more training in project management and all the programs available. (OH)
- Support underfunded watershed groups to help them build skills, capacity. Guide them. Provide the leadership that volunteers can't do. Extension says they can do this, but they don't. (IL)

Deliver Education and Outreach

Agricultural topics

- University has advantage of different rapport than conservationists. Also, teach kids. (WI)
- University recs are behind all standards, but not all farmers and suppliers support those reqs. (WI)
- Deliver nutrient management info (IL).
- Tailor fact sheets [Extension bulletins] more to farmers. (OH)
- Get the information out. Need lots of demos so people have one near them -- bioreactors, 2-stage ditches, and wet filter strips. (MN)
- Need to talk about the wq issue and provide leadership saying that nutr reduction is important-- don't just talk about growing corn. (MN)
- Need everyone (Univ and agencies and ag industry) on the same page, giving consistent messages so farmers have the support they need to get through bumps in transitions to new systems. (E.g. pest management methods may conflict with conservation messages.) (IN)

Social science topics

- Create more targets of opportunity – i.e. receptive communities. (WI)
- Develop the local support needed for this work. As long as streams are viewed as conveyance instead of having ecological importance, wq work is extremely difficult. (IN)
- Build strong partnerships with local agencies. (WI)
- Partnerships are important because they distribute the University information. (MN)

Other

- Most important role for Universities is to help with education. Be willing to partner with us so we don't have to reinvent the wheel on education materials. (MN)
- There is only one University [Ext] staff in our county, so we don't use them much. (MN)

Implement Watershed Work

Social components

- Provide the social science expertise. (WI)
- Person-to-person contact makes things happen; partner in a way to make this happen. (MN)

Monitoring and assessment

- Track application or sales of fertilizer to help with targeting. (OH)
- University created the P Index and does SWAT modeling for us. (WI)
- DATCP funds UW to do PI and NMP software with annual grant, nutr mgt curriculum, and soil testing lab certification. (WI)
- Provide data. (MN)
- University has provided students to do monitoring. Need ongoing monitoring program (OH).

Other

- Extension does not generally participate in watershed work, except somewhat in the NW part of the state. (OH)

Appendix D: Efforts to Track Impacts of Nutrient Reduction Activities

Here are some existing efforts to collect and report data that could help link implementation activities to watershed- and basin-scale nutrient load reductions.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

<http://www.epa.gov/owow/keep/msbasin/>

The 2011 Operating Plan includes a generalized, state-by-state descriptions of efforts. Most states are still developing strategies.

The 2011 Annual Report summarizes activities (e.g. adoption of erosion control and nutrient management systems, adoption of state nutrient standards) and outcomes (e.g. N and P loading, extent of hypoxic zone). The report does not attempt to link activities and outcomes.

Conservation Effects Assessment Project (CEAP)

The project quantifies the reductions in nutrient loads attributable to all conservation practices implemented at any point in time for any reason or program.

“Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Upper Mississippi River Basin.”
June 2010 draft.

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/pub/?&cid=nrcs143_014161

EPA Tracking Tools

Water quality data

- **ADB** (Assessment Data Base) <http://www.epa.gov/waters/adb/index.htm>
- **STORET** (short for STOrage and RETrieval) <http://www.epa.gov/storet/dbtop.html>

Implementation tracking

- **GRTS** (Grant Reporting and Tracking System), for tracking 319 programs
<http://www.epa.gov/nps/Section319/grts.html>

TMDL development tracking

- **ATTAINS** (Assessment Total Maximum Daily Loads Tracking and Implementation System) database
 - a combination of NAD, ADB and NTTS (National TMDL Tracking System, <http://www.epa.gov/waters/tmdl>) used during TMDL development

Combined system

- **WATERS** (Watershed Assessment, Tracking & Environmental ResultS)
<http://www.epa.gov/waters/about/index.html>
 - WATERS links together the Water Quality Standards Data Base (WQSB, <http://www.epa.gov/wqsdatabase>), STORET, the National Assessment Data Base (NAD), NTTS, and GRTS

Total Maximum Daily Load (TMDL) Implementation Tracking Needs Assessment

“Total Maximum Daily Load (TMDL) Implementation Tracking Needs Assessment: Current Status and Future Needs for States in Regions 5, 6, and 10.” March 2008. Prepared for the Environmental Protection Agency Region 5, by The Cadmus Group, Inc.

http://www.epa.gov/region10/pdf/tmdl/tmdl_implementation_tracking_report.pdf

Appendix E: Tools for Estimating Watershed-Scale Impacts of Practices

<u>Outputs</u>	<u>Inputs</u>	<u>Scale</u>	<u>Further information</u>
ADAPT (Agricultural Drainage and Pesticide Transport Model)			
An integration of GLEAMS and DrainMod. The three studies cited demonstrate using ADAPT to predict watershed-scale nitrate loss and hydrograph impacts. Originally developed by Andy Ward at The Ohio State University; then used by David Mulla and associates at the University of Minnesota.			
Estimates movement of nitrate in drainage tiles.	Considers management and climate impacts	Primarily field scale, but has been used with some success at watershed level.	Gowda, P.H., A. D. Ward, D. A. White, D. B. Baker, and J. G. Lyon. 1999. Using field scale models to predict peak flows on agricultural watersheds. <i>Journal of the American Water Resources Association</i> . 35: 1223-1232. Sogbedji, J.M. and G.F. McIsaac. 2006. Evaluation of the ADAPT model for simulating nitrogen dynamics in a tile drained agricultural watershed in central Illinois. <i>Journal of Environmental Quality</i> . 35:1914-1923. Vinay Nangia, P. H. Gowda, D.J. Mulla.2010. Effects of changes in N-fertilizer management on water quality trends at the watershed scale. <i>Agricultural Water Management</i> , 97(11):1855-1860 (http://www.sciencedirect.com/science/article/pii/S0378377410002301)
AGNPS (Agricultural Non-Point Source Pollution Model)			
A system of several models intended to add a watershed component to conservation planning. Includes RUSLE, CCHE1D for stream networks, and CONCEPTS for stream corridors. Developed by USDA NRCS and ARS.			
Estimates sediment, N, P, organic C, pesticides	Considers agricultural landscapes	Watershed scale	http://go.usa.gov/KFO

BASINS (Better Assessment Science Integrating point & Non-point Sources)			Integrates several watershed models, including HSPF, SWAT, PLOAD, and AGWA. Uses open-source GIS software. Developed by USEPA.
Estimates water quality parameters	Considers a broad array of landscape conditions	Watershed scale	http://water.epa.gov/scitech/datait/models/basins/ Jack L . Kittle , Russell S . Kinerson , Paul B . Duda , and Anthony S . Donigian. 2005. In Watershed Models,edited by Donald K . Frevert and Vijay P . Singh. Chapter 11. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS). Pages 273–289. CRC Press. Russell S. Kinerson, John L. Kittle and Paul B. Duda. 2009. BASINS: Better Assessment Science Integrating Point and Nonpoint Sources. p. 1-24. In: Decision Support Systems for Risk-Based Management of Contaminated Sites, A. Marcomini et al. (eds). Springer Science.
BSTEM (Bank-Stability and Toe-Erosion Model)			Use where bank toe erosion threatens bank stability. Model can show the effects of riparian land use changes and erosion control measures to protect the bank. The same research group, also produced CONCEPTS (CONservational Channel Evolution and Pollutant Transport System), which is more complicated than BSTEM and predicts the response of flow and sediment transport to instream hydraulic structures. Key investigators include Andrew Simon and Eddy Langendoen.
Estimates sediment	Considers riparian land use	Bank site	http://www.ars.usda.gov/Research/docs.htm?docid=5044
DrainMod			Predicts the effects of drainage and associated water management practices on water table depths, the soil water regime and crop yields. Key investigator: Dr.Wayne Skaggs, Department of Biological & Agricultural Engineering, North Carolina State University.
Estimates water table, N, salinity	Considers ag drainage of poorly drained soil types. Also suitable for forested lands.	Field and watershed scale	http://www.bae.ncsu.edu/soil_water/drainmod/

HIT (High Impact Targeting System)			Web-accessible, GIS-based system for quickly identifying sites with high erosion potential. For targeting down to the field level. Combines soil loss volume estimate from Revised Universal Soil Loss Equation (RUSLE) with estimate of delivery to nearby streams from the Spatially-Explicit Delivery Model (SEDMOD). Developed by Michigan State University Institute of Water Research (IWR) and Michigan Department of Agriculture.
Estimates sheet erosion	Considers field erosion controls	Field to watershed scale	http://www.glc.org/tributary/documents/USGSARSwebinar/Oneil_HIT.pdf , http://www.iwr.msu.edu/research/research.html
HSPF (Hydrological Simulation Program - FORTRAN)			Simulates flow and water quality routing in watershed reaches. Not useful for channel processes. Requires extensive data inputs and highly trained environmental modelers.
Estimates runoff, sediment, and a variety of pollutants.	Considers agricultural landscapes	Watershed scale	http://www.epa.gov/ceampubl/swater/hspf/ , http://water.usgs.gov/software/HSPF/
L-THIA, with ArcView GIS (Long Term Hydrologic Impact Analysis)			An overview/screening model; identifies the need for more detailed modeling. Focuses on the average impact, rather than an extreme year or storm. A Curve Number based model. Does not require detailed data input.
Estimates loads of 14 nonpoint source pollutants, recharge, runoff	Considers rural and urban land uses. Does not consider land management practices	Watershed scale. Long-term average annual impacts.	https://engineering.purdue.edu/~lthia/

SPARROW
(SPAtially Referenced Regressions On Watershed attributes)

Relates in-stream water-quality measurements to spatially referenced characteristics of watersheds, including contaminant sources and factors influencing terrestrial and aquatic transport. A mass balance model. Doesn't model BMP impacts well. Developed by USGS.

Estimates annual stream loads of nutrients

Considers fertilizer and manure applications, atmospheric deposition, urban sources, land use, point sources

Watershed scale

<http://water.usgs.gov/nawqa/sparrow/>

STEPL
(Spreadsheet Tool for Estimating Pollutant Load)

BMP calculator estimates combined impacts of practices on a watershed. Based on Curve Number, USLE, sediment delivery ratio, and known BMP efficiencies. A relatively simple model and useful as an initial assessment tool. Developed by TetraTech for USEPA.

Estimates nutrients, annual sediment load from sheet and rill erosion

Considers an extensive list of agricultural & urban management practices, land use distribution, animal numbers and manure application, septic systems, irrigation

Subwatershed scale

Download the tool: <http://it.tetratech-ffx.com/stepl/>

A presentation (by Davenport?) describing STEPL:
http://www.glc.org/tributary/documents/SedReductionWebinar/TD_Sediment_Davenport.pdf

SWAT (Soil and Water Assessment Tool)

Developed over 30 years by the USDA Agricultural Research Service. Attempts to combine the impacts of multiple practices in the watershed. Ignores flow and routing through a watershed. Allows for simulation of a wide variety of land practices.

Estimates water, sediment, nutrient and pesticide yields

Considers climate, vegetation, runoff, percolation, pond storage, groundwater, contaminant loading, contaminant sources

Watershed scale, especially large basins

<http://swat.tamu.edu/>

P. W. Gassman, M. R. Reyes, C. H. Green, J. G. Arnold. The Soil and Water Assessment Tool: Historical Development, Applications, and Future Research Directions. 2007. Transactions of the ASABE, 50(4): 1211-1250.
http://www.card.iastate.edu/environment/items/asabe_swat.pdf

Review Articles

D. K. Borah, M. Bera. 2004. Watershed-scale hydrologic and nonpoint-source pollution models: review of applications. Transactions of the ASAE, Vol. 47(3):789-803. <https://wiki.umn.edu/pub/Wilson/TMDL-SpecialProblem/request.pdf>

Review of SWAT, HSPF, and DWSM.

Edsel B. Daniel, Janey V. Camp, Eugene J. LeBoeuf, Jessica R. Penrod, James P. Dobbins and Mark D. Abkowitz. 2011. Watershed Modeling and its Applications: A State-of-the-Art Review. The Open Hydrology Journal, 5:26-50. <http://www.benthamscience.com/open/tohydj/articles/V005/26TOHYDJ.pdf>

R. Jamieson, R. Gordon, D. Joy, H. Lee. 2004. Assessing microbial pollution of rural surface waters: A review of current watershed scale modeling approaches. Agricultural Water Management, 70(1):1. <http://www.sciencedirect.com/science/article/pii/S0378377404001477>

Nejadhashemi, A. P.; Woznicki, S. A. Douglas-Mankin, K. 2011. Comparison of four models (STEPL, PLOAD, L-THIA, and SWAT) in simulating sediment, nitrogen, and phosphorus loads and pollutant source areas. Transactions of the ASABE, Vol. 54(3):875-890.

Comparison of SWAT & HSPF Literatures (website). <http://swat.tamu.edu/publications/swat-hspf-literatures-comparison/>

Appendix F: Effectiveness of BMPs for Nutrient Reductions: A Sampling of Resources and Literature

<u>Title</u>	<u>Author</u>	<u>Year</u>	<u>Source, URL</u>	<u>Excerpt from Abstract</u>
Agricultural BMP Handbook for TMDLs in Minnesota	Tom Miller and Joel Peterson for the Minnesota Department of Agriculture	2012	http://www.mda.state.mn.us/protecting/cleanwaterfund/research/agbmphandbook.aspx	“The purpose of this project is to conduct a comprehensive inventory of agricultural Best Management Practices (ag-BMPs) that address water quality impairments in Minnesota. The goal is to create a single handbook that includes: A definition of ag-BMPs that affect water quality, An estimate of the effectiveness of each ag-BMP, An estimate for the cost of design, installation and maintenance, A list of the potential barrier to adoption, and A list of knowledge gaps. When complete, the ag-BMP handbook will provide watershed professionals (i.e. local soil and water conservation staff, project managers, engineers, consultants, etc) the information necessary to identify suitable ag-BMPs.”
Targeting land-use change for nitrate nitrogen load reductions in an agricultural watershed.	Jha, M., K.E. Schilling, P.W. Gassman, and C.W. Wolter.	2010	Journal of Soil and Water Conservation 65(6):342-352.	“The objective of the project was to evaluate the environmental effects of land-use changes, with a focus on understanding how the spatial distribution throughout a watershed influences their effectiveness. The Soil and Water Assessment Tool (SWAT) water quality model was applied.”
Effect of nitrogen best management practices on water quality at the watershed scale	D.J. Mulla	2008	In: Coastal Watershed Management, A. Fares and A. I. El-Kadi (eds.), WIT Press.	“This chapter summarizes the effectiveness of various agricultural Best Management Practices (BMPs) to reduce nitrate-N losses from tile drained areas of the Midwestern Corn Belt. These BMPs can be classified into three general categories: hydrologic modification, nutrient management and landscape diversification”
Riparian Buffer Width, Vegetative Cover, and Nitrogen Removal Effectiveness: A Review of Current Science and Regulations	Mayer, P. M., S. Reynolds, T. Canfield, and M. McCutchen.	2005	U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-05/118. http://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=140503	“We surveyed peer-reviewed scientific literature containing data on riparian buffers and nitrogen concentration in streams and ground water of riparian zones to identify causation and trends in the relationship between buffer width and nitrogen removal capacity. We also examined Federal and State regulations regarding riparian buffer widths to determine if such legislation reflects the current scientific understanding of buffer effectiveness”

Final report from the Gulf Hypoxia and Local Water Quality Concerns Workshop	Upper Mississippi River Sub-basin Hypoxia Nutrient Committee (UMRSHNC)	2005	http://water.epa.gov/type/watersheds/named/msbasin/upload/2005_9_23_msbasin_symposia_ia_presentations.pdf	A series of papers summarizing practices that impact nutrient loading and the challenges to document impacts.
Modeling Sediment and Phosphorus Losses in an Agricultural Watershed to Meet TMDLs	B. Dalzell, Prasanna H. Gowda, David J. Mulla	2004	Journal of the American Water Resources Association 40(2):533-543. 10.1111/j.1752-1688.2004.tb01048.x	
Estimating Runoff Phosphorus Losses from Calcareous Soils in the Minnesota River Basin	Fang, F., Brezonik, P. L., Mulla, D. J., Hatch, L. K.	2002	Journal of Environmental Quality. 31: 1918–1929. 10.2134/jeq2002.1918	
Lake Erie Agricultural Systems for Environmental Quality Project: An introduction	Richards RP, Calhoun FG, Matisoff G.	2002	Journal of Environmental Quality 31: 6-16. http://www.ncbi.nlm.nih.gov/pubmed/11837445	From abstract: “The Lake Erie Agricultural Systems for Environmental Quality (LEASEQ) project examined governmental programs, changes in agriculture, and changes in water and soil quality during the period 1975-1995, and sought to evaluate the linkages among these factors.”
Flux and Sources of Nutrients in the Mississippi–Atchafalaya River Basin: Topic 3 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico	Goolsby, Donald A., William A. Battaglin, Gregory B. Lawrence, Richard S. Artz, Brent T. Aulenbach, Richard P. Hooper, Dennis R. Keeney, and Gary J. Stensland	1999	NOAA Coastal Ocean Program Decision Analysis Series No. 17. NOAA Coastal Ocean Program, Silver Spring, MD. 130 pp. http://oceanservice.noaa.gov/products/hypox_t3final.pdf	“This report addresses the following two questions: What are the loads (flux) of nutrients transported from the Mississippi–Atchafalaya River Basin to the Gulf of Mexico, and where do they come from within the basin? and What is the relative importance of specific human activities, such as agriculture, point-source discharges, and atmospheric deposition in contributing to these loads?”

Effects of Reducing Nutrient Loads to Surface Waters within the Mississippi River Basin and the Gulf of Mexico: Topic 4 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico	Brezonik, Patrick L., Victor J. Bierman, Jr., Richard Alexander, James Anderson, John Barko, Mark Dortch, Lorin Hatch, Gary L. Hitchcock, Dennis Keeney, David Mulla, Val Smith, Clive Walker, Terry Whitledge, and William J. Wiseman, Jr.	1999	NOAA Coastal Ocean Program Decision Analysis Series No. 18. NOAA Coastal Ocean Program, Silver Spring, MD. 130 pp. http://oceanservice.noaa.gov/products/hypox_t4final.pdf	“The overall goal of this assessment was to evaluate the effects of nutrient-source reductions that may be implemented in the Mississippi River Basin (MRB) to reduce the problem of low oxygen conditions (hypoxia) in the nearshore Gulf of Mexico.”
Reducing Nutrient Loads, Especially Nitrate–Nitrogen, to Surface Water, Ground Water, and the Gulf of Mexico: Topic 5 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico	William J. Mitsch, Mitsch, William J., John W. Day, Jr., J. Wendell Gilliam, Peter M. Groffman, Donald L. Hey, Gyles W. Randall, and Naiming Wang	1999	NOAA Coastal Ocean Program Decision Analysis Series No. 19. NOAA Coastal Ocean Program, Silver Spring, MD. 111 pp. http://oceanservice.noaa.gov/products/hypox_t5final.pdf	“The goal of this report to identify and evaluate approaches for solving the problem of the hypoxia in the Gulf of Mexico. . . . Techniques reviewed included on-farm practices, created and restored wetlands and riparian zones, controlled drainage systems, stormwater runoff control, atmospheric controls on mobile and stationary sources, point-source control on wastewater treatment plants, Mississippi River diversion, and flood control in the Upper Mississippi River Basin.”